Section 4: Emergency Systems

Section 5: Emergency Procedures

Section 6: Communications

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Machinery Symbols and Colour Scheme

Stop Valve	Storm Valve With Handwheel	Flexible Hose	Observation Glass	Overboard Discharge
Screw-Down Non-Return Valve	Flow Control Valve	Expansion Bend Pipe	Water Separator	Spool Piece
Angle Stop Valve	P1 P2 Pressure Reducing Valve	Hopper Without Cover	Air Trap / Deaerating Valve	Discharge/Drain
Angle Screw-Down Non-Return Valve	Solenoid Valve	Orifice	Gear or Screw Type Pump	N.O or N.C Normally Open or Normally Closed
Lift Check Non-Return Valve	Air Control Valve	Blind (Blank) Flange	Centrifugal Pump	Tank Penetration
Swing Check Non-Return Valve	Temperature Control Valve (With Handwheel)	Spectacle Flange (○ Open, ● Shut)	Mono Screw Pump	Air Horn
Gate Valve	3-Way Temperature Control Valve (With Handwheel)	Sounding Head with Filling Cap	Eductor (Ejector)	Dresser Type Expansion Joint
Butterfly Valve	Wax Expansion Temperature Control Valve	Sounding Head with Self-Closing Cap and Sampling Cock (Self-Closing)	Hand Pump	Not Connected Crossing Pipe
Ball Valve	3-Way Wax Expansion Temperature Control Valve	Suction Bellmouth	Liquid Level Gauge	Connected Crossing Pipe
2-Way Cock	Water Transducer	Vent Pipe	Cylinder Piston Actuator	T Pipe
3-Way Cock (L-Type)	Butterfly Valve With Air Actuator	Vent Pipe with Flame Screen	Hose Valve	Filter Regulating Valve With Strainer
3-Way Cock (T-Type)	Suction Non-Return Valve	Simplex Strainer	Flow Meter	Non-Return Ball Valve
Safety / Relief Valve	Float Valve	Duplex Strainer	Reciprocating Type Pump	Hydraulic Operated Valve (Open/Shut)
Angle Safety / Relief Valve	Deck Stand (Manual)	Mud Box	Manometer	Motorised Valve
Regulating Valve	Spark Arrester	Rose Box	Filter	Vacuum Breaker
Self-Closing Valve	Valve Locked Closed	Y-Type Strainer	H B Fire Hose Box	Tee Safety / Relief Valve
Quick-Closing Valve (Pneumatic Operated)	Valve Locked Open	Steam Trap Without Strainer	F B Foam Box	Viscosity Controller
Quick-Closing Valve (Wire Operated)	Bellows Type Expansion Joint	Steam Trap With Strainer	Accumulator	

- Domestic Fresh Water
- HT Cooling Water
- LT Cooling Water
- Sea Water
- Hydraulic Oil / Lubricating Oil
- Steam
- Condensate / Feed Water
- Fire/Wash Deck Water / CO_2
- Fuel Oil
- Marine Diesel Oil
- Compressed Air
- Bilge / Drain
- Electrical Signal
- Instrumentation
- Inert Gas

Electrical and Instrumentation Symbols

Trip	Automatic Trip
I	Interlock
XX	Locally Mounted Instrument (2 letters)
XXX	Locally Mounted Instrument (3 letters)
XXX / XXXX	Remotely Mounted Instrument
XXX / XXXX HH	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

CP	Compound Gauge
DPI	Differential Pressure Indicator
DPS	Differential Pressure Switch
DPT	Differential Pressure Transmitter
FD	Flow Detector
FS	Flow Switch
FT	Flow Transmitter
IL	Indication Lamps
LAH	Level Alarm High
LAL	Level Alarm Low
LI	Level Indicator
LIC	Level Indicating Controller
LS	Level Switch
LT	Level Transmitter
PAH	Pressure Alarm High
PAL	Pressure Alarm Low
PI	Pressure Indicator
PIC	Pressure Indicating Controller
PIAH	Pressure Indicator Alarm High
PIAL	Pressure Indicator Alarm Low
PIAHL	Pressure Indicator Alarm High Low
PS	Pressure Switch
PT	Pressure Transmitter
SAH	Salinity Alarm High
TAH	Temperature Alarm High
TAL	Temperature Alarm Low
TI	Temperature Indicator
TIC	Temperature Indicating Controller
TIAH	Temperature Indicator Alarm High
TIAL	Temperature Indicator Alarm Low
TIAHL	Temperature Indicator Alarm High Low
TS	Temperature Switch
TT	Temperature Transmitter
VAH	Viscosity Alarm High
VAL	Viscosity Alarm Low
VCA	Vacuum Alarm
VCI	Vacuum Indicator
VCT	Vacuum Transmitter
VI	Viscosity Indicator
VT	Viscosity Transmitter
XS	Auxiliary Unspecified Switch
ZI	Position Indicator
ZS	Limit Switch

PRINCIPAL MACHINERY PARTICULARS

Ref. No.	Item Name	Qty.	Manufacturer	Model	Type	Capacity / Power	Working Pressure (MPa)	Volt	Amp	kW	rpm	Start Method	Remote Control	Em'cy Stop and Pref. Trip
1	Main engine	1	DMD - MAN B&W	5S50MC (Mark-VI)	Two-stroke, slow speed, crosshead	7,150kW					127			
2	Main engine turbocharger	1	MAN B&W	TCA55 - 20028										
3	Main engine auxiliary blower	2	Dalian Jinchuan Kongtiao Fengi Co. Ltd..	JC53B-50		$2.79m^3$/second		440		35	3,550			
4	Steering gear	1	Kawasaki-Wuhan	FE21-064-T050	Two ram, four cylinders, Rapson-slide	628kNm	23.5							
5	Steering gear hydraulic pump	2	Kawasaki-Wuhan	LV-060-410R10	Axial piston, variable displacement pump	62.3 litre/minute		440		8.5				
6	Steering gear servo pump	2	Kawasaki-Wuhan	TOP-203Haf	Trochoid pump			440		0.4				
7	Rudder greasing pump	2	Delimon	FZ - A	Plunger pump		18	440						
8	Bow thrust	1	Brunvoll AS	FU - 63 - LTA - 1750	Hydraulic	760kW		2337 litre/minute 224MPa			378			
9	Stern tube bearing	1	Railko Ltd.	WA80H/S										
10	Forward stern tube seal	1	Kobelco Eagle Marine Engineering Ltd	AX - 560 - 3A	Compact air seal									
11	Aft stern tube seal	1	Kobelco Eagle Marine Engineering Ltd	AX - 560 - 3A	Compact air seal									
12	Stern tube LO circulating pump	2	Allweiler	SPF10 R56 G8.3-W20	Screw - 3 rotor	$2.0m^3/h$	0.26	440		0.6	3,290			
13	Stern tube LO pump	1	Allweiler	SPF10 R38 G8.3	Screw - 3 rotor	$0.5m^3/h$	0.3	440		0.6	3,360			
14	Diesel generator No.1	1	Zjmd - MAN B&W	5L23/30H	Medium speed, four-stroke	690kW					720			
15	Alternator	1	Hyundai	HFJ6-508	Self-excited, brushless	812kVA		440	1,040	650kw				
16	Diesel generator No.2 & No.3	2	Zlmd - MAN B&W	6L23/30H	Medium speed, four-stroke	825kW					720			
17	Alternator	2	Hyundai	HFZ6-508	Self-excited, brushless	957kVA		440	1,250	780kW				
18	Emergency generator	1	Nordhavn Sisu Diesel	634 DSBG	High speed, four-stroke	140kW					1,800			
19	Emergency alternator	1	Newage International Stamford	UCM274F	Self-excited, brushless	156kVA		440						
20	Auxiliary boiler	1	Aalborg Industries A/S	AQ - 18	Oil-fired vertical water tube boiler	18,000kg/h	0.7							
21	Sootblower	4	Aalborg Industries A/S		Compressed air	$14.8Nm^2/min$								
22	Composite boiler	1	Aalborg Industries A/S	AQ - 10/16	Combined oil-fired vertical water tube and exhaust gas smoke tube	3,000kg/h-oil 1,000kg/h-exh	0.7							
23	Sootblower	1	Aalborg Industries A/S	G-9B	Compressed air	$56Nm^3/min$								
24	Starting air compressor	3	Hatlapa-Sperre Industri A/S,	HV2 - 200	Reciprocating, water-cooled	$136m^3/h$	3.0	440		25	885			
25	Emergency air compressor	1	Hatlapa-Sperre Industri A/S,	H12 - 77	Reciprocating, air-cooled	$20m^3/h$	3.0	440		4.8	1,180			
26	Control air compressor	1	Tamrotor Marine Compressors	TMC 6/8 EANA	Screw, air-cooled	$20m^3/h/51m^3/h$	0.7	440		9.6	3,430			
27	Working air compressor	1	Tamrotor Marine Compressors	TMC 20/8 SANA	Screw, air-cooled	$71m^3/h/223m^3/h$	0.7	440		9.6	3,720			
28	Main air receiver	2	Jiujiang Marine Machinery	B7.0 - 3.0		$7.0m^3$	3.0							
29	Auxiliary air receiver	1	Jiujiang Marine Machinery	A.25 - 3.0		$0.25m^3$	3.0							
30	Control air receiver	1	Jiujiang Marine Machinery	A.25 - 0.7		$0.25m^3$	0.7							
31	Working air receiver	1	Jiujiang Marine Machinery	A.25 - 0.7		$0.25m^3$	0.7							

Ref No.	Item Name	Qty.	Manufacturer	Model	Type	Capacity / Power	Working Pressure (MPa)	Volt	Amp	kW	rpm	Start Method	Remote Control	Em’cy Stop and Pref. Trip
32	Control air dryer	1	Hankison-USN	HPRP-50	Refrigerant	60m^3/h	0.70							
33	Working (deck) air dryer	1	Hankison-USN	HHL-165	Desiccant	276m^3/h	0.70							
34	Main cooling SW pump	3	Shinko Industries Ltd	SVS-200-M	Centrifugal	270m^3/h	0.25	440		30	1,800			
35	Inert gas generator SW pump	1	Shinko Industries Ltd	SVS-200-M	Centrifugal	218m^3/h	0.40	440		45	1,800			
36	Deck seal SW pump	2	Shinko Industries Ltd	HJ-40-2M	Centrifugal	3m^3/h	0.35	440		1.5	3,600			
37	Bilge, ballast, fire and GS pump	2	Shinko Industries Ltd	RVP-300-MS	Centrifugal	220/280m^3/h	1.0/0.45	440		110	1,800			
38	Emergency fire pump	1	Shinko Industries Ltd	RVP-130-MS	Centrifugal	72m^3/h	0.90	440		40	1,800			
39	Fresh water generator	1	Alfa Laval A/S	DPU-36-C100	Low pressure	24m^3/36m^3/24h								
40	FWG ejector pump	1	Alfa Laval A/S	CNL-80-80/200	Centrifugal	86m^3/h	0.42	440	33.5	21.4	3,515	DOL		
41	FWG distillate pump	1	Alfa Laval A/S	PVVF-2040.2X-012	Centrifugal	2m^3/h	0.16	440	1.6	0.75	3,360	DOL		
42	Fresh water steriliser	1	Jowa AB	AG-s	Silver	0~6m^3/h								
43	Fresh water rehard filter	1	Jowa AB	F-150	Dolomite	2.5m^3/h								
44	High temp FW cooling pump		Shinko Industries Ltd	SVS-100-M	Centrifugal	66m^3/h	0.30	440		11	1,800			
45	Low temp FW cooling pump		Shinko Industries Ltd	SVS-200-M	Centrifugal	220m^3/h	0.35	440		37	1,800			
46	Inert gas generator FW cooling pump	1	Shinko Industries Ltd	HJ-40-2M	Centrifugal	6m^3/h	0.25	440		1.5	3,600			
47	Central FW cooler	2	Alfa Laval A/S	M15-BFM8	Plate	220m^3/h				3,250				
48	Jacket water preheater	1	Nantong CSEMC Ltd	JRG-7.5-00GC	Shell and tube	66m^3/h	0.7			1,212				
49	Auxiliary boiler feed pump	2	Grundfoss	CR32-5-2	Vertical, multi-stage, centrifugal	m^3/h	1.6	440		15	3,500			
50	Composite boiler feed pump	2	Grundfoss	CR5-13	Vertical, multi-stage, centrifugal	m^3/h	2.5	440		5	3,500			
51	Fuel oil supply unit	1	Aura Marine Asia Ltd	AMB-M-07-SS	Feeder booster unit									
52	Fuel oil supply pump	2	Aura Marine Asia Ltd	ACE-032L3/NTBP	Screw - 3 rotor	4.06m^3/h	0.5	440		2.5	3,500			
53	Fuel oil booster pump	2	Aura Marine Asia Ltd	ACE-032N3/NTBP	Screw - 3 rotor	5.34m^3/h	1.0	440		2.5	3,500			
54	Diesel oil supply pump		Aura Marine Asia Ltd	ACE-025N3/NVBP	Screw - 3 rotor	2.25m^3/h	0.6	440		1.3	3,500			
55	Viscosity control unit		VAF Instruments BV											
56	Auxiliary boiler FO supply pump	2	Aalborg Industries A/S	SPZ-20-R46-G8.3	Screw - 3 rotor	2.8m^3/h	2.5	440	6.3	3.6	3,400	DOL		
57	Auxiliary boiler ignition pump	1	Aalborg Industries A/S	RSA	Gear	0.06m^3/h		440	0.6	0.22	3,300	DOL		
58	Composite boiler FO supply pump	2	Aalborg Industries A/S	ZASV-850-G8.3	Screw - 3 rotor	m^3/h		440	1.33	0.77	3,300	DOL		
59	Composite boiler ignition pump	1	Aalborg Industries A/S	RSA	Gear	0.06m^3/h		440	0.6	0.23	3,300	DOL		
60	Composite boiler waste oil grinding pump	1	Aalborg Industries A/S	MILL PU-5	Centrifugal	25.9m^3/h	0.04	440	8.0	4.4	3,480			
61	Composite boiler waste oil pump	1	Aalborg Industries A/S	ANBP	Eccentric screw	m^3/h		440						
62	Auxiliary boiler FO heater	1	Aalborg Industries A/S	Vesta MX15-T32	Shell and tube	1.66m^3/h	1.9							
63	Composite boiler FO heater	1	Aalborg Industries A/S	Vesta MX10-T16	Shell and tube	0.35m^3/h	1.6							
64	Auxiliary boiler supply fan	1												

Ref No.	Item Name	Qty.	Manufacturer	Model	Type	Capacity / Power	Working Pressure (MPa)	Volt	Amp	kW	rpm	Start Method	Remote Control	Em'cy Stop and Pref. Trip
65	Composite boiler supply fan													
66	Main engine FO flow meter	2	VAF Instruments BV	B5025		9.6m³/h								
67	Generator engine FO flow meter	2	VAF Instruments BV	B5025		9.6m³/h								
68	HFO transfer pump	1	Allweiler AG	SNF940 ER42 E8.9 W1	Screw - 3 rotor	56m³/h	0.4	440		20.3	1,750			
69	MDO transfer pump	1	Allweiler AG	SNF940 ER42 E8.9 W1	Screw - 3 rotor	56m³/h	0.4	440		20.3	1,750			
70	HFO separator	2	GEA Westfalia GmbH	Osd 18-0136-067/15	Centrifugal	1.9m³/h		440						
71	HFO/MDO separator	1	GEA Westfalia GmbH	Osd 18-0136-067/15	Centrifugal	1.9m³/h		440						
72	FO separator supply pump	3	GEA Westfalia GmbH	R 35/25	Gear	2.3m³/h	0.2	440						
73	FO separator heater	3	GEA Westfalia GmbH	VW 3.0-15	Shell and tube	2m³/h								
74	Main engine LO pump	2	Shinko Industries Ltd	SAE-150-2	Centrifugal	160m³/h	0.45	440		45	1,800			
75	Main engine LO cooler	1	Alfa Laval A/S	M20-MFM	Plate	160m³/h				500				
76	Main engine LO auto backflush filter	1	Alfa Laval A/S	X280D-30/4-A08	Moatti automatic filter	187m³/h								
77	Main engine LO bypass filter	1	Alfa Laval A/S	L280-261-A05	Moatti manual filter	187m³/h								
78	Main engine camshaft LO pump	2	Allweiler AG	SPF40 R46 U8.3-W20	Screw - 3 rotor	6.0m³/h	0.4	440		1.7	3,445			
79	Main engine camshaft LO cooler	1	Alfa Laval A/S		Plate	5.2m³/h				6.4				
80	Main engine camshaft LO auto backflush filter	1	Alfa Laval A/S	T150D-12/6-A05	Protector automatic filter	9.5m³/h								
81	Main engine camshaft LO CJC fine filter	1	C.C.Jensen A/S	HDU 27/-	Off-line fine filter	0.3m³/h								
82	Main engine turbocharger LO pump	2	Allweiler AG	SPF40 R46 U8.3-20	Screw - 3 rotor	6m³/h	0.4	440		1.7	3,445			
83	Main engine turbocharger LO cooler	1	Alfa Laval A/S		Plate	m³/h				80				
84	Main engine turbocharger LO CJC fine filter	1	C.C.Jensen A/S	HDU 27/27MZ	Off-line fine filter	m³/h								
85	Cylinder oil transfer pump	1	Allweiler AG	SPF10 R38 G8.3-W20	Screw - 3 rotor	1m³/h	0.3	440		0.6	3,360			
86	LO transfer pump	1	Allweiler AG	SPF40 R46 U8.3-W20	Screw - 3 rotor	6m³/h	0.3	440		1.5	3,445			
87	Main engine LO separator	2	GEA Westfalia GmbH	Osd 6-91-067/5	Centrifugal	1.35m³/h		440						
88	Generator engine LO separator	1	GEA Westfalia GmbH	Osd 6-91-067/3	Centrifugal	0.55m³/h		440						
89	Main engine LO separator supply pump	2	GEA Westfalia GmbH	R 25/16	Gear	1.45m³/h	0.2	440						
90	Generator engine LO separator supply pump	1	GEA Westfalia GmbH	R 25/6.3		0.57m³/h	0.2	440						
91	Main engine LO separator heater	2	GEA Westfalia GmbH		Shell and Tube									
92	Generator engine LO separator heater	1	GEA Westfalia GmbH	B 10/20	Shell and Tube									

Ref No.	Item Name	Qty.	Manufacturer	Model	Type	Capacity / Power	Working Pressure (MPa)	Volt	Amp	kW	rpm	Start Method	Remote Control	Em'cy Stop and Pref. Trip
93	Bilge oil/water separator	1	B+V Industrietechnik GmbH	TMPB-5 - 2-stage	Turbulo compact separator	5m^3/h	0.15	440						
94	Oil/water separator pump	1	B+V Industrietechnik GmbH	BV 5A	Eccentric helical rotor	5m^3/h	0.23	440	3.5	1.75	1,692			
95	Oil/water separator discharge filters	2	C.C.Jensen A/S											
96	Engine room bilge pump	1				5m^3/h	0.3	440						
97	Sludge pump	1	Allweiler AG	AGM 95/1 GLRD	Geared lobe rotor	0.75m^3/h	0.1	440		2.0	1.750			
98	Main engine air cooler condensate drain pump	1	Shinko Industries Ltd	HJ-40-2M	Centrifugal	3m^3/h	0.25	440		1.5	3,600			
99	Main engine air cooler chemical cleaning pump	1	Shinko Industries Ltd	VJ-40-2M	Centrifugal	1m^3/h	0.3	440		2.2	3,600			
100	Galley air conditioning fresh water cooling booster pump	1	Shinko Industries Ltd	HJ-40-2M	Centrifugal	5.5m^3/h	0.25	440		1.5	3,600			
101	Domestic fresh water pump	2	Shinko Industries Ltd	HJ-40-2M	Centrifugal	6m^3/h	0.45	440		3.7	3,600			
102	Hot water circulating pump	1	Shinko Industries Ltd	HJ-40-2M		2m^3/h	0.20	440		1.5	3,600			
103	Fresh water hydrophore tank	1	Shanghai Marine Diesel	C-1.0-00		1m^3	0.5							
104	Fresh water calorifier	1	Shanghai Marine Diesel	C-0.5-00C		0.5m^3	0.5	440			30			
105	Sewage treatment unit	1	Jowa AB	BIO STP 3	Biological	2.45m^3/day		440		4.1				
106	Sewage treatment macerator pump	1	Zenit	GRS 100/2 G40 HT	High head impeller and grinder	14.4m^3/h	0.2	440	2.05	1.28	2,900	DOL		
107	Sewage treatment aeration compressor	2	Becker	DT 4.25/K	Rotary vane, dry running, air-cooled	30m^3/h	0.1	440		1.3	1,700	DOL		
108	Sewage treatment discharge pump	2	Herborber Pumpen Technik	Unipump 4/HK 50	Centrifugal	10m^3/h	0.2	440	6.4	3.6	3,600	DOL		
109	Engine room crane	1	Danish Crane Building A/S	VL16 3204 b1	Single girder travelling beam	3,000kg								
110	Engine room crane hoist motor	1	Leroy Somer	LS-LSMVR-LSPX-FCR	3-phase synchronous - brake			440	3.7/7.4	1.0/4.2				
111	Engine room crane travel motor	1	Leroy Somer	LS-LSMVR-LSPX-FCR	3-phase synchronous - brake			440	1.6	0.66				
112	Engine room crane traverse motor	1	Leroy Somer	LS-LSMVR-LSPX-FCR	3-phase synchronous - brake			440	2.7	0.9				
113	Main engine top bracing system	1	MAN B&W Diesel A/S											
114	Main engine top bracing pump	2				0.5m^3/h	2.0	440		0.5				
115	Cathodic protection system	1	Cathelco Limited	C-Shield	Marine impressed current			440						
116	Anti-fouling system	1	Cathelco Limited			626m^3/h		220						
117	Intermediate shaft bearing	1	Jiangsu Nanji Machinery Co. Ltd.	CHZ-C430	Self lubricating, water-cooled	430mm dia								
118	Atmospheric condenser	1	Nantong CSEMC Ltd	LNQ-10-00GC	Shell and tube - 10m^2	1,000kg/h	0.7			670				
119	Engine room water mist fire extinguishing system	1	Semco Maritime	SEM-SAFE	High pressure fresh water mist	6.3m^3/h	11.0	440		25	1,750			
120	Engine room CO_2 fire extinguishing system	1	Semco Maritime		High pressure, 105 x 45kg CO_2 cylinders									

Ref No.	Item Name	Qty.	Manufacturer	Model	Type	Capacity / Power	Working Pressure (MPa)	Volt	Amp	kW	rpm	Start Method	Remote Control	Em'cy Stop and Pref. Trip
121	Galley vent trunk CO_2 fire extinguishing system	1	Semco Maritime		High pressure, 1x 54kg CO_2 cylinders									
122	Paint store CO_2 fire extinguishing system	1	Semco Maritime		High pressure, 2 x 45kg CO_2 cylinders									
123	Deck foam fire extinguishing system	1	Unitor ASA		Fixed foam system	2 x 6m^3 foam solution	1.0							
124	Deck foam pump	1	Unitor ASA	DPVF 18	Centrifugal	22m^3/h	1.1	440	26.4	15		DOL		
125	Inert gas generator	1	Smit Gas Systems BV	Gin 3000-0.15 FU	Ultramising combustion system	3,000m^3/h	0.015			3.65				
126	Inert gas generator supply fan	2	Rotodyne	CV-250/1025-P70S	Centrifugal	3,000m^3/h		440		48				
127	Deck water seal	1	Smit Gas Systems BV	DN 250	Water	3,000m^3/h	0.025							
128	Pressure/Vacuum breaker	1	Smit Gas Systems BV	DN 200	Liquid									
129	Pressure valves		Pres-Vac Engineering A/S	2388 -Hugh Velocity	HS-ISO pressure valve									
130	Vacuum valves		Pres-Vac Engineering A/S	2389	HS-ISO vacuum valve									
131	Vapour emission control system		Omicron	OVP 2.1 OP										
132	Tank cleaning heater	1	Nantong CSEMC Ltd	JRQ-110-00GC	Shell and tube - 110m^2	18,000kg/h	0.77							
133	Tank cleaning machine		Scanjet Marine AB	SC 30T-04										
134	Oil discharge monitoring equipment (ODME)	1	Jowa AB	CLEANTOIL 2005	Optical									
135	Hydraulic valve system		Danfoss Marine Systems A/S	SPU 100 FAP	Bosch P3 gear pump x 2	5 litre/minute	13.5							
136	Hydraulic power pack, electric	2	Frank Mohn A/S	A4-V500	Axial piston - swash plate	799 litre/minute	26.5	440	621	405	1,780	Star-Delta		
137	Hydraulic power pack, diesel	1	Frank Mohn A/S	A4-V500	Axial piston - swash plate	819 litre/minute	26.5			440	1,780	Comp. air		
138	Hydraulic oil cooler	1	Frank Mohn A/S	DPK-406/1800-VS7						399				
139	Cargo pump	12	Frank Mohn A/S	SD-150	Centrifugal	385m^3/h	1.2	373 litre/minute 24.3MPa			2,856			
140	Cargo pump	3	Frank Mohn A/S	SD-125	Centrifugal	180m^3/h	1.2	289 litre/minute 22.8MPa			2,903			
141	Cargo pump	1	Frank Mohn A/S	SD-100	Centrifugal	70m^3/h	1.2	113 litre/minute 20.3MPa			3,908			
142	Tank cleaning pump	2	Frank Mohn A/S	MA-200	Centrifugal	120m^3/h	1.2	242 litre/minute 19.8MPa			2,936			
143	Ballast pump	2	Frank Mohn A/S	SB-300	Centrifugal	800m^3/h	0.25	245 litre/minute 19.9MPa			1,183			
144	Portable pump	1	Frank Mohn A/S	TK-150	Centrifugal	250m^3/h	0.6	212 litre/minute 22.0MPa			3,510			
145	Air-driven pump	3	Wilden Pump and Engineering	T15	Diaphragm	5m^3/h	0.2							
146	Tank gauging system		Danfoss Marine Systems A/S											
147	Anchor windlass, W1, W2	2	Hatlapa GmbH	K3	High pressure hydraulic	118kN		185 litre/minute 27.0MPa						
148	Mooring winch, M1, M3, M4	3	Hatlapa GmbH	HP-S	High pressure hydraulic	118kN		185 litre/minute 27.0MPa						
149	Mooring winch, M2, M5, M6	3	Hatlapa GmbH	HP-D	High pressure hydraulic	118kN		185 litre/minute 27.0MPa						
150	Anchors	2	Wuzhou Steel Anchor Factory	Spek	7,350kg									
151	Anchor cable		Zhenjing Marine Chain Works		68mm									
152	Hose handling crane	1	TTS Marine ASA	GP 380-10-22	HP Hydraulic: 162 litre/minute	10 ton x 44/22m	23.0	440	103	63	1,750	DOL		
153	Stores crane	1	Dregen Crane AS		Monorail, 4m outreach port/stbd	5 ton								
					Hoist - two winches	12m/min		440	19.2	10.5	1,710	DOL		
					Travel	10m/min		440	4.5	2.2	1,690	DOL		

Ref No.	Item Name	Qty.	Manufacturer	Model	Type	Capacity / Power	Working Pressure (MPa)	Volt	Amp	kW	rpm	Start Method	Remote Control	Em'cy Stop and Pref. Trip
154	Suez searchlight davit	1	Jingying Marine Machinery		Manual	500kg x 2m								
155	Oil drum davit	1	Jingying Marine Machinery		Manual	300kg x 1.5m								
156	Accommodation ladder	2	Jiangyan City Marine Outfitting	Q264 JYCX-236M	10.80m x 640mm - 35 steps - 55°max.	3,500kg								
157	Lifeboat	1	Jiangyin Xinjiang F.R.P.Co. Ltd.	JY-FF-7.50	Fire protected free fall	34 persons	7.50 x 2.70 x 1.20m							
158	Lifeboat engine	1	SABB Motor AS	L3-139-LB	Four-stroke high speed diesel	29 BHP				21.6	3,000			
159	Lifeboat recovery davit	1	Zhenjiang Marine Machinery	FH-75	Hydraulically positioned A-frame	75/56kN	440			15				
160	Rescue boat	1	Ernst Hatecke GmbH	RB 430 APM	GRP deep-V- mono hull	6 persons	4.55 x 2.01 x 0.25m							
161	Rescue boat engine	1	Yamaha Motor Co. Ltd.	63D-FO	Two-stroke petrol outboard engine	40 BHP				29.4	5,000			
162	Rescue boat davit	1	Zhenjiang Marine Machinery	SAF-21	Single arm slewing davit	21kN x 3.8m	18m/min	440		4/6.3				
163	CABA air compressor	1	Bauer	Mariner 200 E	Air-cooled, reciprocating	200 litre/min at 23MPa	30	440		0.4	1,300			
164	Accommodation air conditioning system		York Novenco Industrivej		Hi-Press single pipe system									
165	Accommodation air conditioning compressor unit	2	York Refrigeration Marine (Sabroe Refrigeration A/S)	SMC 108	Reciprocating, 8 cylinder, R134a	201kW		440		58.6	1,474			
166	Accommodation air handling units (AHU)	2	Novenco Hi-Press	ZCR-18/8	Klingenburg rotating enthalpy heat exchanger	heating 142kW cooling 154kW	0.0025	440		2 x 18	3.490			
167	Package air conditioner - engine control room	1	York Refrigeration Marine	SCU-E20	Danfoss hermetic reciprocating, R134a	heating 15kW cooling 18.8kW		440	27	6.9				
168	Package air conditioner - engine room workshop	1	York Refrigeration Marine	SCU-E6	Danfoss hermetic reciprocating, R134a	heating 4.5kW cooling 5.6kW		440	8	2.34				
169	Package air conditioner - galley	1	York Refrigeration Marine	HIP-5WDE	Danfoss hermetic reciprocating, R134a	heating 15kW cooling 17kW		440	18	4.73				
170	Domestic refrigeration plant		York Refrigeration Marine											
171	Domestic refrigeration compressor unit	2	Sabroe Refrigeration A/S	HGX34P/315-4	Semi-hermetic, 4 cylinder, reciprocating, R407C	3.85kW		440		3.37	1,750			
172	Engine room supply fan S-10, S-11, S-12, S-13	4	Novenco Hi-Press	ACW-1000	Axial	36,000m³/h	0.0007	440	21.6	13.2	1,755			
173	Separator space exhaust fan, E-14	1	Novenco Hi-Press	CAN-500	Centrifugal	10,000m³/h	0.0006	440	8.4	4.8	1,430			
174	Engine room workshop exhaust fan, E-15	1	Novenco Hi-Press	CAN 315R	Centrifugal	3,200m³/h	0.00058	440	3.3	1.8	1,722			
175	IGG room exhaust fan, E-16	1	Novenco Hi-Press	ACD-315/160-4-32°	Axial	2,100m³/h	0.00028	440	1.3	0.66	3,380			
176	Battery room exhaust fan, E-17	1	Novenco Hi-Press	GLU-160	Centrifugal	215m³/h	0.00023	440	1.0	0.45	1,305			
177	Steering flat and emergency fire pump exhaust fan, E-18	1	Novenco Hi-Press	ACD-400/239-6-48°	Axial	9,000m³/h	0.00055	440	6.3	3.6	3,458			
178	Ballast pump room exhaust fan, E-19	1	Novenco Hi-Press	HGP-400/230-6-50°	Axial	7,000m³/h	0.00065	440	6.0	3.6	3,438			
179	Paint store exhaust fan, E-20	1	Novenco Hi-Press	CNA-250/R	Centrifugal, 1,996 rpm	610m³/h	0.00040	440	1.0	0.44	3,360			

Ref No.	Item Name	Qty.	Manufacturer	Model	Type	Capacity / Power	Working Pressure (MPa)	Volt	Amp	kW	rpm	Start Method	Remote Control	Em'cy Stop and Pref. Trip
180	Bow thruster space exhaust fan, E-21	1	Novenco Hi-Press	ACD-250/160-4-45°	Axial	1,500m³/h	0.00040	440	3.2	0.66	3,360			
181	Store room exhaust fan, E-22	1	Novenco Hi-Press	CK-160-C	Duct	215m³/h	0.00035	440	0.6	0.13	2,555			
182	Cargo sample locker exhaust fan, E-23	1	Novenco Hi-Press	HGP-315/160-4-30°	Axial	1,510m³/h	0.00030	440	1.3	0.66	3,348			
183	Foam and hydraulic rooms exhaust fan, E-24	1	Novenco Hi-Press	ACW-250/160-4-48°	Axial	1,620m³/h	0.00045	440	1.3	0.66	3,380			
184	Protective equipment locker, exhaust fan, E-25	1	Novenco Hi-Press	ACW-315/169-4-25°	Axial	1,260m³/h	0.00037	440	1.3	0.66	3,360			
185	Sanitary exhaust fan, ES-2	1	Novenco Hi-Press	CNA-315/R	Centrifugal, 2,505 rpm	2,450m³/h	0.00100	440	3.8/ 0.9	1.8/ 0.4	3,420/ 1,740			
186	Galley exhaust fan, E-3	1	Novenco Hi-Press	CNA-315/R	Centrifugal, 2,529 rpm	4,000m³/h	0.00080	440	5.8/ 1.5	2.6/ 0.7	3,410/ 1,730			
187	Galley supply fan, S-4	1	Novenco Hi-Press	CNA-315/R	Centrifugal, 1,827 rpm	3,000m³/h	0.00040	440	2.0/ 1.0	1.32/ 864	1,768/ 864			
188	Hospital exhaust fan, E-6	1	Novenco Hi-Press	CK-315-C	Duct	840m³/h	0.00035	440	1.4	0.3	2,655			
189	Carbon filter supply fan, S-7	1	Novenco Hi-Press	CNA-400-R	Centrifugal, 1,417 rpm	4,900m³/h	0.00040	440	3.3	1.8	1,722			
190	CO_2 room exhaust fan, E-10	1	Novenco Hi-Press	ACN-250/160-4-35°	Axial	1,440m³/h	0.00025	440	1.7	0.66	3,410			
191	Store room exhaust fan, E-11	1	Novenco Hi-Press	CK-100-C	Duct	145m³/h	0.00027	440	0.42	0.91	2,700			
192	Changing room exhaust fan,	1	Novenco Hi-Press	CK-250-C	Duct	750m³/h	0.00028	440	1.0	0.22	2,645			
193	Store room exhaust fan	1	Novenco Hi-Press	CK-160-C	Duct	360m³/h	0.00027	440	0.6	0.13	2,555			
194	Sludge collecting pump	1												

INTRODUCTION

General

Although this ship is supplied with shipbuilder's plans and manufacturer's instruction books, there is no single document which gives guidance on operating complete systems as installed on board, as distinct from individual items of machinery. The purpose of this 'one-stop' manual is to assist, inform and guide competent ship's staff and trainees in the operation of the systems and equipment on board and to provide additional information that may not be otherwise available. In some cases, the competent ship's staff and trainees may be initially unfamiliar with this vessel and the information in this manual is intended to accelerate the familiarisation process. It is intended to be used in conjunction with shipyard drawings and manufacturer's instruction manuals, bulletins, Fleet Regulations, the ship's Captain's and Chief Engineer's Standing Orders, and in no way replaces or supersedes these publications, all of which take precedence over this manual.

Information relevant to the operation of this vessel has been carefully collated in relation to the systems of the vessel and is presented in two on board volumes, a DECK OPERATING MANUAL and MACHINERY OPERATING MANUAL

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.

The information, procedures, specifications and illustrations in this manual have been compiled by WMT personnel by reference to shipyard drawings and manufacturer's publications that were made available to WMT and believed to be correct at the time of publication. The systems and procedures have been verified as far as is practicable in conjunction with competent ship's staff under operating conditions.

It is impossible to anticipate every circumstance that might involve a potential hazard, therefore, warnings and cautions used throughout this manual are provided to inform of perceived dangers to ship's staff or equipment. In many cases, the best operating practice can only be learned by experience.

If any information in these manuals is believed to be inaccurate or incomplete, the officer must use his professional judgement and other information available on board to proceed. Any such errors or omissions or modifications to the ship's installations, set points, equipment or approved deviation from published operating procedures must be reported immediately to the company's Technical Operations Office, who should inform WMT so that a revised document may be issued to this ship and in some cases, others 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.

- Never continue to operate any machine or equipment which appears to be potentially unsafe or dangerous and always report such a condition immediately.
- Make a point of testing all safety equipment and devices regularly. Always test safety trips before starting any equipment. In particular, overspeed trips on auxiliary turbines must be tested before putting the unit to work.
- Never ignore any unusual or suspicious circumstances, no matter how trivial. Small symptoms often appear before a major failure occurs.
- Never underestimate the fire hazard of petroleum products, whether fuel oil or cargo vapour.
- Never start a machine remotely from the cargo and engine control room without confirming visually that the machine is able to operate satisfactorily.

In the design of equipment, protection devices have been 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 any of these safety devices are bypassed, overridden or neglected, then the operation of any machinery in this condition is potentially dangerous.

Description

The concept of this manual is to provide information to technically competent ship's officers, unfamiliar to the vessel, in a form that is readily comprehensible, thus 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 valves and fittings identifications and symbols used in this manual are the same as those used by the shipbuilder.

Illustrations

All illustrations that are referred to in the text are located either in-text where sufficiently small, or above the text, so that both the text and illustration are accessible when the manual is laid open. When text concerning an illustration covers several pages the illustration is duplicated above each page of text.

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 Mechanical Symbols and Colour Scheme which is detailed on earlier pages in this Front Matter section.

Symbols given in the manual adhere to international standards and keys to the symbols used throughout the manual are also given on previous pages in this Front Matter section.

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.

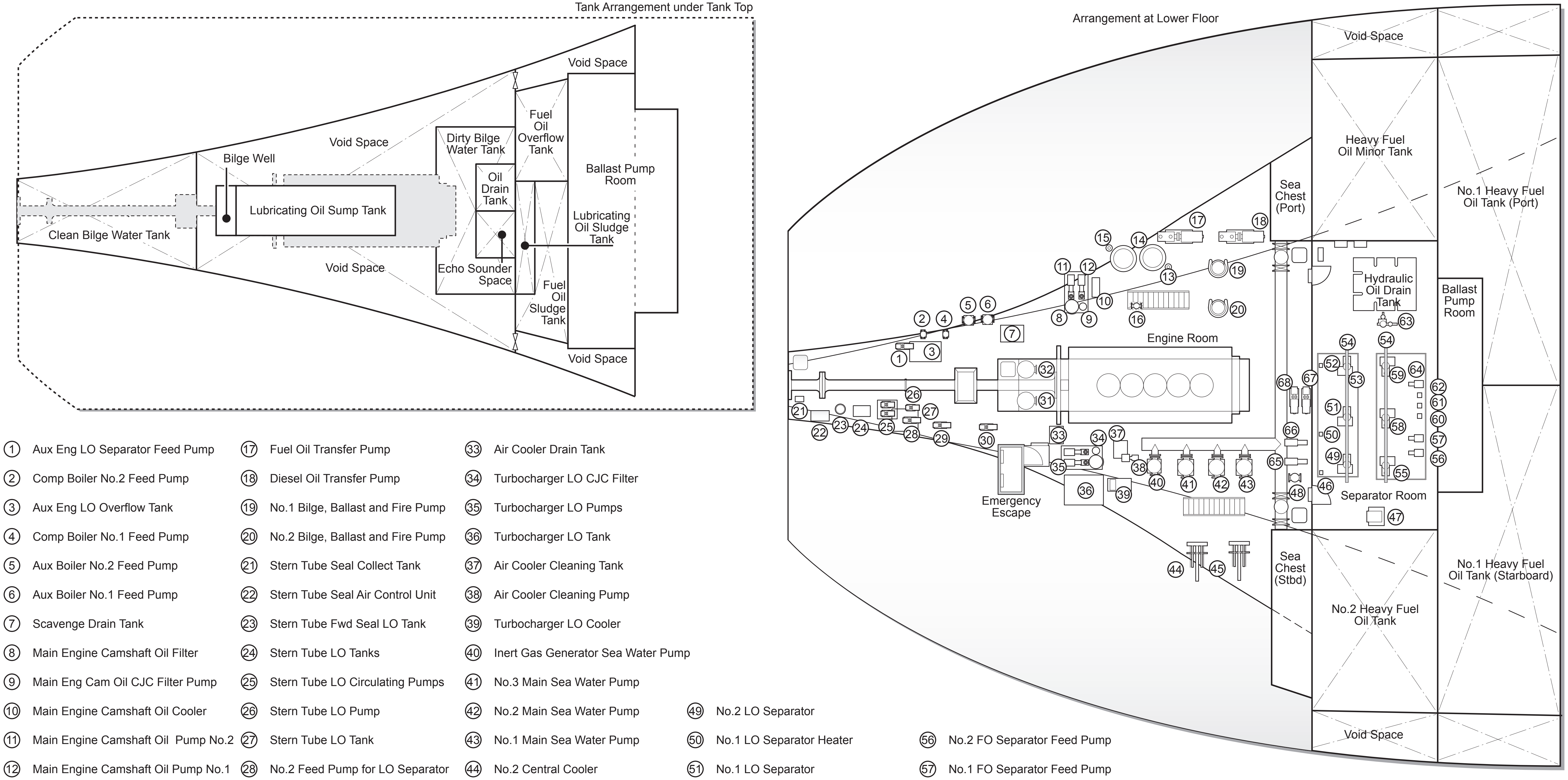
Safety Notice

It has been recorded by International Accident Investigation Commissions that a disproportionate number of deaths and serious injuries occur on ships each year during drills involving lifesaving craft. It is therefore essential that all officers and crew make themselves fully conversant with the launching, retrieval and the safe operation of the lifeboats, liferafts and rescue boats.

SECTION 1: OPERATIONAL OVERVIEW

1.0 ENGINE ROOM ARRANGEMENT

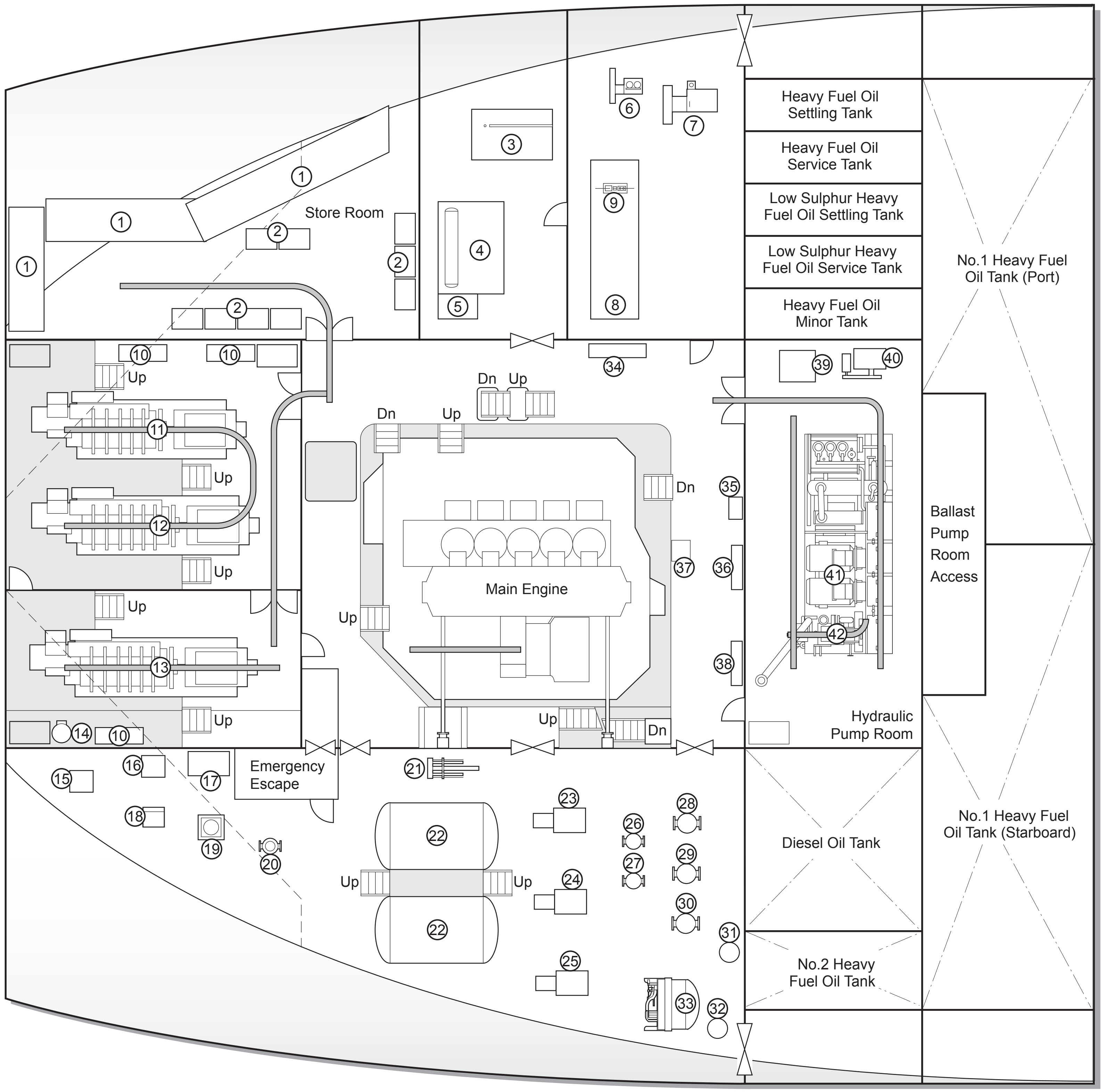
Illustration 1.0.1a Engine Room Arrangement - Tank Top and Lower Floor



1. Aux Eng LO Separator Feed Pump
2. Comp Boiler No.2 Feed Pump
3. Aux Eng LO Overflow Tank
4. Comp Boiler No.1 Feed Pump
5. Aux Boiler No.2 Feed Pump
6. Aux Boiler No.1 Feed Pump
7. Scavenge Drain Tank
8. Main Engine Camshaft Oil Filter
9. Main Eng Cam Oil CJC Filter Pump
10. Main Engine Camshaft Oil Cooler
11. Main Engine Camshaft Oil Pump No.2
12. Main Engine Camshaft Oil Pump No.1
13. Dirty Bilge Pump
14. Bilge Oil-Water Separator
15. Bilge Separator Supply Pump
16. Air Cooler Drain Pump
17. Fuel Oil Transfer Pump
18. Diesel Oil Transfer Pump
19. No.1 Bilge, Ballast and Fire Pump
20. No.2 Bilge, Ballast and Fire Pump
21. Stern Tube Seal Collect Tank
22. Stern Tube Seal Air Control Unit
23. Stern Tube Fwd Seal LO Tank
24. Stern Tube LO Tanks
25. Stern Tube LO Circulating Pumps
26. Stern Tube LO Pump
27. Stern Tube LO Tank
28. No.2 Feed Pump for LO Separator
29. No.1 Feed Pump for LO Separator
30. LO Transfer Pump
31. Main Engine LO Pump No.2
32. Main Engine LO Pump No.1
33. Air Cooler Drain Tank
34. Turbocharger LO CJC Filter
35. Turbocharger LO Pumps
36. Turbocharger LO Tank
37. Air Cooler Cleaning Tank
38. Air Cooler Cleaning Pump
39. Turbocharger LO Cooler
40. Inert Gas Generator Sea Water Pump
41. No.3 Main Sea Water Pump
42. No.2 Main Sea Water Pump
43. No.1 Main Sea Water Pump
44. No.2 Central Cooler
45. No.1 Central Cooler
46. No.2 LO Separator Heater
47. Separator Cleaning Tank
48. FW Generator Ejector Pump
49. No.2 LO Separator
50. No.1 LO Separator Heater
51. No.1 LO Separator
52. Aux Eng LO Separator Heater
53. Aux Eng LO Separator
54. Lifting Beam
55. No.2 FO Separator
56. No.2 FO Separator Feed Pump
57. No.1 FO Separator Feed Pump
58. No.1 FO Separator
59. FO/DO Separator
60. No.2 FO Separator Heater
61. No.2 FO Separator Heater
62. FO/DO Separator Heater
63. Hyd Oil Transfer Unit
64. DO Separator Feed Pump
65. No.2 Deck Seal SW Pump
66. No.1 Deck Seal SW Pump
67. Sludge Transfer Pump
68. Sludge Collecting Pump

Illustration 1.0.1b Engine Room Arrangement - Lower Platform

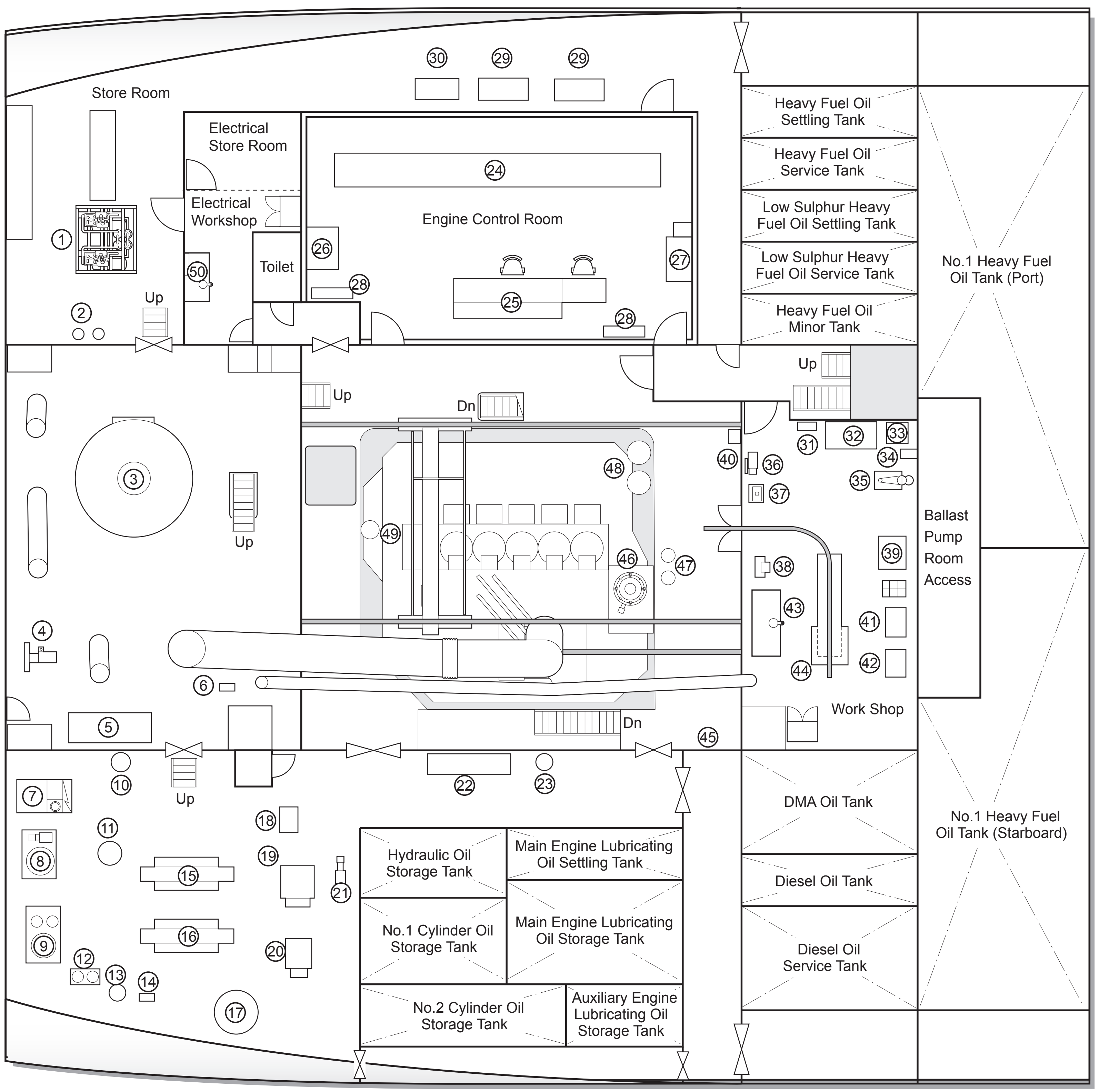
1. Shelving
2. Storage Racks
3. Sewage Treatment Unit
4. Atmospheric Condenser
5. Condensate and Inspection Oil Tank
6. Composite Boiler Fuel Oil Supply Unit
7. Auxiliary Boiler Fuel Oil Supply Unit
8. Main and Auxiliary Engine FO Supply Unit
9. Auxiliary Engine Diesel Oil Supply Pump
10. Auxiliary Engine Control Panels
11. No.1 Auxiliary Engine and Generator
12. No.2 Auxiliary Engine and Generator
13. No.3 Auxiliary Engine and Generator
14. Auxiliary Starting Air Receiver
15. Emergency Air Compressor
16. Cleaning Tank
17. Auxiliary Engine Daily Lubricating Oil Tank
18. Air Compressor Lubricating Oil Tank
19. Main Engine Bypass Lubricating Oil Filter
20. Main Engine Auto Lubricating Oil Filter
21. Main Engine Lubricating Oil Cooler



22. No.1 and No.2 Main Air Receivers
23. No.1 Main Air Compressor
24. No.2 Main Air Compressor
25. No.3 Main Air compressor
26. No.1 High Temperature Cooling Water Pump
27. No.2 High Temperature Cooling Water Pump
28. No.1 Low Temperature Cooling Water Pump
29. No.2 Low Temperature Cooling Water Pump
30. No.3 Low Temperature Cooling Water Pump
31. High Temperature Cooling Water Preheater
32. Fresh Water Generator Chemical Dosing Unit
33. Fresh Water Generator
34. Auxiliary Blower Starter Panel
35. Cathodic Protection Control Unit
36. Lyngso Control System - Outstation
37. Main Engine Exhaust Valve Grinder
38. Diesel Oil Tank for Hydraulic Power Pack Engine
39. Separator Room Exhaust Fan
40. Hydraulic Unit for Remotely Controlled Valves
41. Hydraulic Power Pack - Electric Motor Driven
42. Hydraulic Power Pack - Diesel Engine Driven

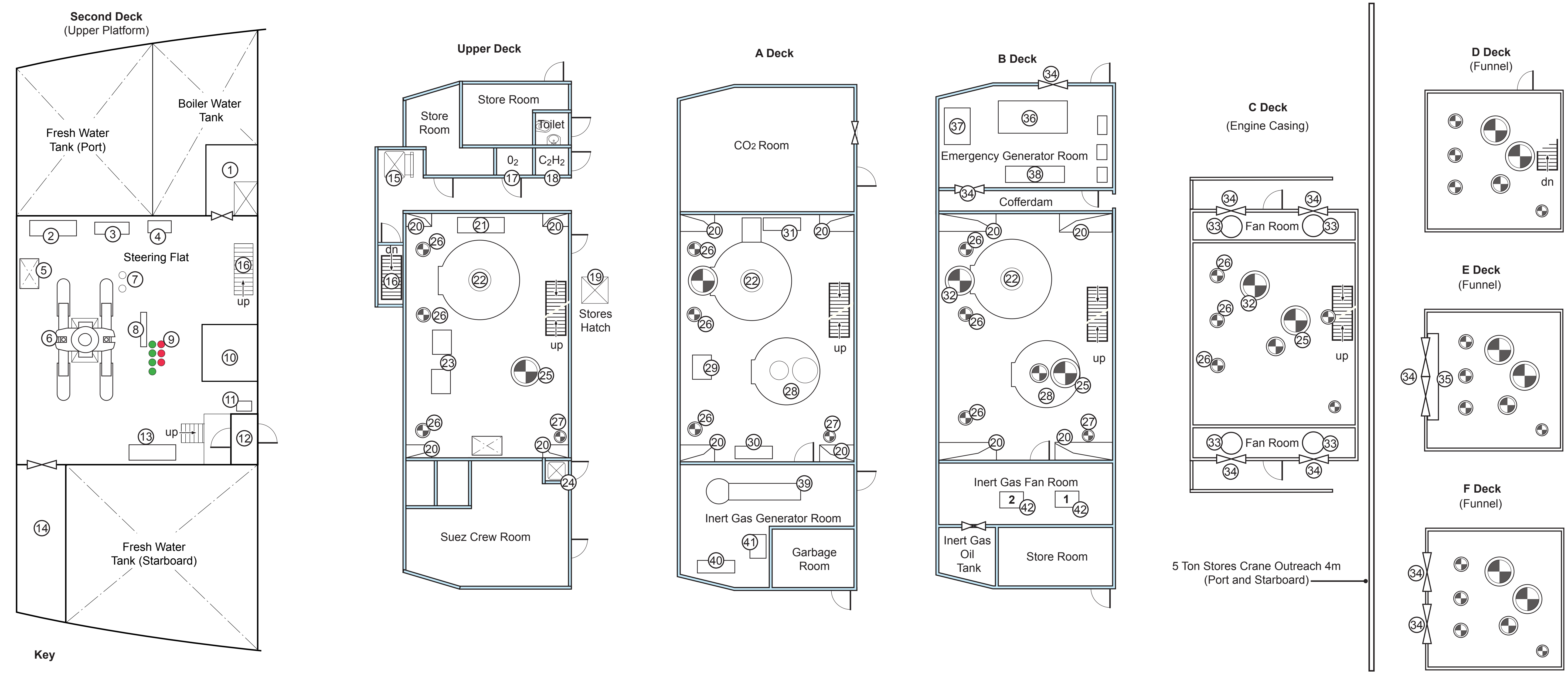
Illustration 1.0.1c Engine Room Arrangement - Upper Platform

1. Provision Refrigeration Compressor Unit
2. Spare Refrigerant Cylinders
3. Auxiliary Boiler
4. Composite Boiler Waste Oil Unit
5. Composite Boiler Waste Oil Tanks
6. Composite Boiler Washing Drain Tank
7. Water Mist Unit
8. Calorifier and Hot Water Circulation Pump
9. Hydrophore Tank and Domestic FW Pumps
10. Inert Gas Generator FW Cooling Pump
11. Control Air Receiver
12. Working Air Dryer
13. FW Rehardening Filter
14. Domestic Fresh Water Steriliser
15. No.1 Air Conditioning Compressor Unit
16. No.2 Air Conditioning Compressor Unit
17. Working Air Receiver
18. Main Engine Cylinder Oil Service Tank
19. Working Air Compressor
20. Control Air Compressor
21. Cylinder Oil Transfer Pump
22. Spare Gear Rack
23. Galley Air Conditioning Cooling Water Pump
24. Main Switchboard
25. Control Console
26. Package Air Conditioning Unit



27. Writing Table and Bookcase
28. UMS2100 Units
29. Main Transformers
30. Heating Transformer
31. Oxy-Acetylene Cabinet
32. Welding Table
33. Electric Welding Machine
34. Mechanical Hacksaw
35. Drilling Machine
36. Extractor Fan - for Welding
37. Sink
38. Pedestal Grinder
39. Package Air Conditioning Unit
40. Drinking Water Fountain
41. Test Bench for Generator Engine Fuel Valves
42. Test Bench for Main Engine Fuel Valves
43. Workbench
44. Lathe
45. Shipside Valve Remote Closing
46. Spare Main Engine Cylinder Cover
47. Spare Main Engine Exhaust Valves
48. Spare Main Engine Cylinder Liner
49. Spare Main Engine Piston
50. Electrical Workbench

Illustration 1.0.1d Engine Room Arrangement - Steering Flat, Upper, A, B, C, D, E and F Decks

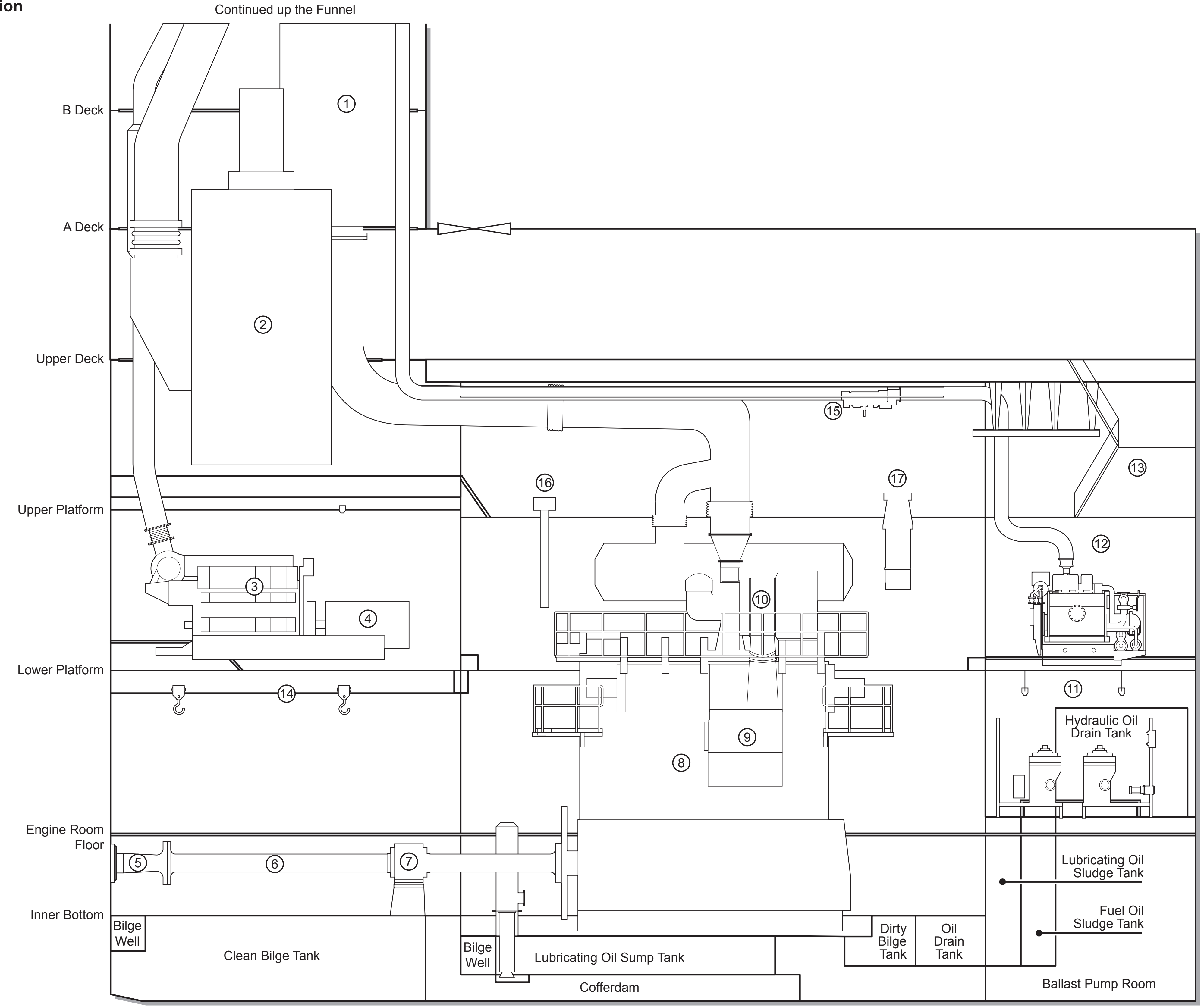


Key

1. Hatch Access/LO Store
2. No. 1 Steering Gear Starter Box
3. Isolation System Control Box
4. Rudder Lubrication Control Box
5. Reserve Hydraulic Oil Tank
6. Steering Gear
7. Rudder Lubrication Pumps
8. Compass Repeater and Telephones
9. Water Mist Back-up Cylinders
10. Emergency Fire Pump Space
11. Emergency Fire Pump Starter Panel
12. Air Lock from Engine Room
13. No.2 Steering Gear Starter Box
14. Chemical Store
15. Hatch to Steering Flat
16. Stairs to Steering Flat
17. Oxygen Store
18. Acetylene Store
19. Hatch to Engine Room
20. Vent Trunking
21. Auxiliary Boiler Combustion Air Fan
22. Auxiliary Boiler
23. Boiler Feed Water Treatment Pumps
24. Engine Room Emergency Escape
25. Main Engine Exhaust
26. Auxiliary Engine Exhaust
27. Framo Engine Exhaust
28. Composite Boiler
29. Boiler Ignition Pumps
30. Composite Boiler Control Panel
31. Auxiliary Boiler Control Panel
32. Auxiliary Boiler Uptake
33. Engine Room Vent Fans
34. Vent Louvres
35. Oil Mist Vent Box
36. Emergency Generator
37. Emergency Generator Fuel Tank
38. Emergency Switchboard
39. Inert Gas Generator
40. Inert Gas Generator Control Panel
41. Inert Gas Generator Fuel Pumps
42. Inert Gas Fans

Illustration 1.0.1e Engine Room Arrangement - Side Elevation

1. Composite Boiler
2. Auxiliary Boiler
3. Auxiliary Engine
4. Generator / Alternator
5. Tail Shaft
6. Intermediate Shaft
7. Intermediate Shaft Bearing
8. Main Engine
9. Main Engine Air Cooler
10. Main Engine Turbocharger
11. Separator Room
12. Hydraulic Power Room
13. Workshop
14. Lifting Beam for Tail and Intermediate Shafts
15. Engine Room Crane
16. Spare Main Engine Piston
17. Spare Main Engine Cylinder Liner



1.1 To Bring Vessel Into Live Condition

DEAD SHIP CONDITION

Shore Supply Available	
Establish shore supply. Check phase sequence, voltage and frequency.	2.13.3

No Shore Supply Available	
Ensure that the emergency generator fuel tank level is adequate.	2.12.2
Start the emergency generator.	2.12.2

Isolate the sequential restart system. All ancillary equipment set to manual to avoid a low pressure automatic start. Supply the emergency 440V switchboard. Supply the emergency 220V switchboard.	2.13
Start the emergency air compressor and top-up the emergency air reservoir if required.	2.10.1
Start a generator engine LO priming pump.	2.12.1
Start the generator engine DO supply pump.	2.6.2
Prepare a diesel generator for starting. Start a diesel generator.	2.12 .1
Supply power to the 440V and 220V switchboards.	2.13
Prepare the low temperature FW cooling systems. Start the duty low temperature CFW pump.	2.5.2
Start up the instrumentation air system.	2.10.3
Disconnect the shore supply.	2.13.2
Place the emergency generator on standby.	2.13.4
Supply power to emergency switchboard from MSB. Restore emergency switchboard services.	2.13.1
Prepare the SW cooling system. Start the duty SW cooling water pump. Reset the preference trips.	2.4.2 2.13.5
Start the engine room and accommodation ventilation fans. Start the air conditioning system.	2.14.3
Ensure the CO_2 and water mist systems are ready for use.	4.2 4.4
Ensure the deck foam system is ready for use.	4.1
Start the IGS deck seal supply pump. Pressurise the fire main.	4.1
Line up the fire pumps for operation.	4.1
Start the sewage treatment plant.	2.14.5

From Previous Page

Put the domestic FW system into operation.	2.14.1
Put the refrigeration system into operation.	2.14.2
Put the starting and working air systems into operation.	2.10.1 2.10.2
Pump any bilges to the dirty bilge tank as required.	2.9.1
Put all ancillary equipment on standby. Restore the sequential restart system. Put the remaining diesel generators on standby.	

PLANT IS NOW IN LIVE CONDITION

One diesel generator in use with the other diesel generators on standby. The emergency generator is on standby. The boiler and steam system is shut down. The SW and CFW systems are in use. The domestic services are in use.	

1.2 To Prepare Main Plant For 'In Port' Condition

PLANT IS IN LIVE CONDITION	
One diesel generator in use with the other diesel generators on standby The emergency generator is on standby. The boiler and steam systems are shut down. The SW and CFW systems are in use. The domestic services are in use.	
Prepare and flash-up the auxiliary boiler, using diesel oil and air atomising.	2.2.1
Start a boiler feed water pump. Line-up the distilled water make-up system.	2.3.3
Supply steam to the steam system.	2.2.4
Supply steam to the HFO tanks and trace heating. Supply steam to the boiler FO heaters. Start the boiler duty FO pump and circulate fuel.	2.2.4
Change the boiler to operate on HFO and atomising steam.	2.2.1
Put the boiler on automatic operation.	2.2.2
Run up the HFO separator system.	2.7.2
Change diesel generator to run on HFO	2.6.2
Start the duty main engine jacket CFW pump. Supply steam to the jacket CFW heater.	2.5.1
Supply steam to the main engine HFO heater. Start the main HFO supply and circulating pumps. Start the viscosity controller. Circulate HFO until the MDO has been expelled.	2.6.1
Maintain the standby generators in a warm condition.	
PLANT IN 'IN PORT' CONDITION	
One diesel generator is in use with the other diesel generators on standby. The emergency generator is on standby. The boiler and steam systems are in use. The diesel generator is running on HFO. The main engine JCW system is in a warm condition. The main engine is being circulated with hot HFO.	

1.3 To Prepare Main Plant For Manoeuvring In Port

PLANT IN 'IN PORT' CONDITION

One diesel generator in use, the other diesel generators on standby. The emergency generator is on standby. The boiler and steam systems are in use. The diesel generator is running on HFO. The main engine JCW systems in a warm condition. The main engine is being circulated with hot HFO	
Start the LO separator systems.	2.8.3
Start the duty main engine LO pump, place the other pump on standby, heat the sump if necessary.	2.8.1
Start the duty camshaft LO pump, place the other pump on standby.	2.8.1
Ensure that the cylinder oil measuring tank is full.	2.8.1
Start the remaining diesel generators and connect to the main switchboard.	2.12.1
Start both steering gear motors. Carry out the steering gear tests.	2.11
Obtain clearance from the bridge and turn the engine two or three revolutions while manually operating the cylinder oil pumps. Take out the turning gear.	2.1.1
Start up both thruster systems. Test the pitch control.	2.13.9
Put the starting air systems into use, supply starting air and control air to the main engine.	2.11.1
Put the auxiliary blowers to AUTO.	2.1.1
Obtain clearance from the bridge, turn the main engine over on starting air from local control stand.	2.1.1
Close the indicator cocks. From the local control stand turn the main engine until it fires in the ahead direction only. Close the turbocharger drains.	2.3
Change control to the engine control room.	2.1.2
Change control to bridge control.	2.1.2
Check the bridge and engine room clocks and communications.	2.1.2
Ensure all standby pumps are on auto.	3.1.7

PLANT IN 'MANOEUVRING' CONDITION

Three diesel generators are in use.
The emergency generator is on standby.
The boiler and steam systems are in use.
The diesel generators are running on HFO.
The main engine is heated and ready for use on bridge control.
The main engine is being circulated with hot FO.
Both steering gears are in use.
The deck machinery is ready for use.
The thrusters are in use.

1.4 To Change Main Plant From Manoeuvring To Full Away

PLANT IN MANOEUVRING CONDITION

Three diesel generators are in use. The emergency generator is on standby. The boiler and steam systems are in use. The diesel generators are running on HFO. The main engine is heated and ready for use on bridge control. The main engine is being circulated with hot FO. Both steering gears are in use. The deck machinery is ready for use. The thrusters are in use.	
Stop the thrusters when they are no longer required.	2.13.9
Shut down the main engine jacket heating system.	2.5.1
Shut down the deck machinery plant and hydraulic power packs pumps.	
Operate the turbocharger cleaning system if required.	2.1.1
When the bridge notifies engine control room of Full Away record the following: Time. Main engine revolution counter. HFO and MDO tank levels. HFO and MDO counters.	
Place the main engine on the automatic run-up program.	2.1.2
Stop one steering gear motor.	2.11
Operate the auxiliary boiler sootblowers.	2.2.3
Ensure the auxiliary blowers stop automatically.	2.1.2
Shut down generators until only one is in use. Place the remaining two generators on standby.	2.13. 3
Start up the evaporator system but do not fill the fresh water tanks while in coastal waters.	2.4.4
Transfer and separate HFO as required.	2.7.2
When the main engine load-up program is complete, check that the pressures and temperatures stabilise.	2.1.2
Reduce the level in the dirty bilge tank through the OWS when legislation limits permit. Reduce the bilge levels through the OWS.	2.9

VESSEL IS FULL AWAY ON BRIDGE CONTROL

1.5 To Prepare For UMS Operation

PLANT IN 'MANNED' CONDITION

Ensure all FO, LO and fresh water tanks/sumps are adequately full.	
All bilges are dry and high level alarms are operational.	2.9.1
Smoke and fire sensors are operational.	4.1 Cargo
All piping systems are tight and not temporarily repaired.	
All alarms and safety cut-outs are operational.	3.1
Compressed air receivers are fully charged.	2.10
Separator feed inlets are suitably adjusted.	2.7.2
The emergency diesel generator is on standby.	2.12.2
The stopped diesel generators are on standby.	2.12.1
All standby pumps and machinery systems are on automatic start, with the sequential restart system operational.	2.13.5
All ventilation fans running as required.	
All combustible material stored in a safe place.	2.14.6
All strainers and filters of running and standby machinery are in a clean condition.	
Engine room and steering gear compartment WT doors, stores hatch and funnel dampers are shut.	
Exhaust gas boiler operating.	2.2.2
All parameters are within normal range.	3.1
ECR air conditioning operating correctly.	2.14.4
Loose Items are secured.	
Workshop welding machine plug is removed.	
Check that the acetylene and oxygen cylinder and pipeline valves are closed.	
Main engine on bridge control.	2.1.2
Control is on the bridge and duty officer is informed of commencement time of UMS.	3.1
Duty officer should be aware of location of the duty engineer.	
Watchkeeper control switch is set to the duty engineer's cabin.	
The engine room is NOT to be left unmanned for more than 8 hours.	

PLANT IN 'UMS' CONDITION.

1.6 To Change From UMS To Manned Operation

PLANT IN 'UMS' CONDITION

↓

Notify the bridge of manned condition.

↓

Inform the bridge why engine room is manned if outside normal hours.

↓

Switch watchkeeping control to the ECR when ship moves to standby conditions.

↓

Examine the latest parameter printout.

↓

Hand over to oncoming duty engineer and inform them of any abnormalities.

↓

Discuss any defects with the senior engineer, who will decide if they warrant inclusion in the work list. The duty engineer should be aware of all maintenance work being carried out, and informed of any changes that occur during the day.

↓

PLANT IN 'MANNED' CONDITION

1.7 To Change Main Plant From Full Away To Manoeuvring Condition

VESSEL IS FULL AWAY ON BRIDGE CONTROL

Ensure that the engine room bilges are empty and dirty bilge tank level is lowered of any water.	2.9
Prepare the sewage treatment system for port operation.	2.14.5
Shut down the evaporator plant.	2.4.4
Start the auxiliary boiler.	2.2
Start the standby diesel generators and connect to the main switchboard.	2.13.3
Supply steam to main engine JCW heater.	2.5.1
Prepare the main starting air compressors for use. Check the starting air system drains for water content.	2.10.1
If required to manoeuvre on MDO, begin change-over 1 hour before end of passage (EOP).	2.6.1
30 minutes before end of passage, bridge begins to reduce speed.	2.1.1
Start the second steering gear motor. Carry out steering gear tests.	2.11
Operate the main engine turbocharger washing system if required.	2.1.1
Bridge informs engine control room of EOP.	
Record the following: Time. Main engine revolution counter. HFO and MDO tank levels. HFO and MDO counters. Fresh water tank levels.	
Prepare and start the hydraulic power pack system for deck machinery for use.	
Check bridge/engine room clocks and communications.	2.1.2
Start the thruster units.	2.13.9

PLANT IN 'MANOEUVRING' CONDITION

Three diesel generators are in use.
The emergency generator is on standby.
The auxiliary boiler is in use.
The diesel generators are running on HFO.
Both steering gears motors are in operation.
Deck machinery is ready for use.
The thrusters are in use.

1.8 To Secure Main Plant at Finished with Engines

Step	Reference
PLANT IN 'MANOEUVRING' CONDITION	
Three diesel generators are in use. The emergency generator is on standby. The auxiliary boiler is in use. The diesel generators are running on HFO. Both steering gears motors are in operation. Deck machinery is ready for use. The thrusters are in use.	
Bridge notifies engine control room of FWE.	
Switch over to engine room control.	2.1.2
Stop the auxiliary blowers.	2.1.1
Isolate the starting air system. Engage the turning gear. Open the indicator cocks. Open turbocharger drains. Vent the main engine starting air and control air systems.	2.1.1
Stop the steering gear motors.	2.11
Maintain the JCW temperature for normal port stay.	2.5.1
Maintain the LO pumps in operation according to the requirements of notice of the main engine. Maintain LO sump temperature using the LO purifier.	2.1.1
Three diesel generators will remain in use if cargo pumps or thrusters are required.	2.12.1
Prepare the plant for IGG operations if required.	2.15
PLANT IN 'IN PORT' CONDITION	

1.9 To Secure Main Plant for Dry Dock

PLANT IN 'IN PORT' CONDITION

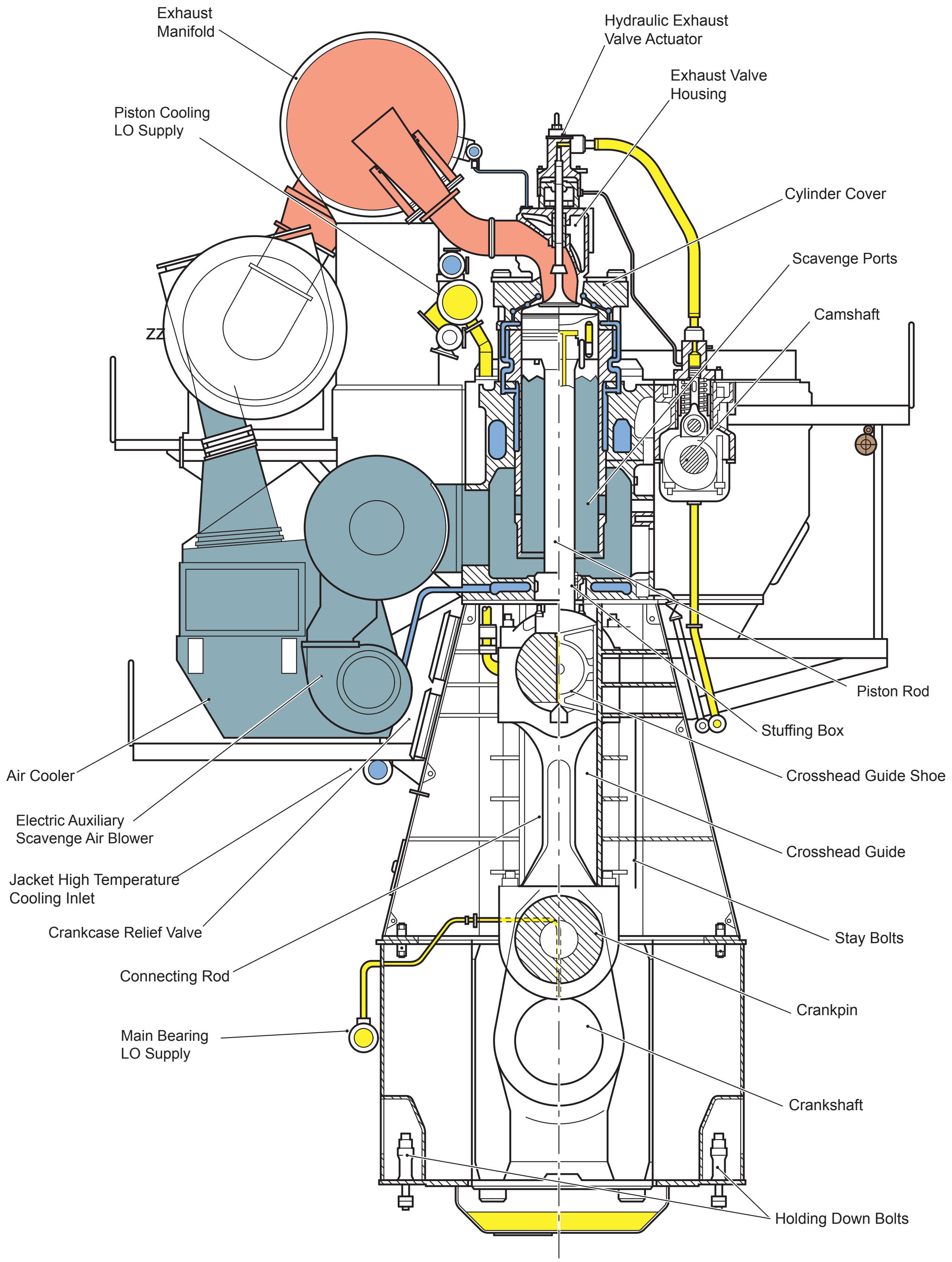
Action	Section
Shut down the diesel generators until only one is in use. Set the emergency generator to manual.	2.12.1
Ensure all tanks are at the required levels to give the vessel the necessary trim, draught and stability for entering dry dock.	
Shut steam off the JCW heaters. Allow the JCW pumps to run until the main engine has cooled.	2.5.1
Transfer the main engine LO sump to the LO settling tank via the separator	2.8.4
Shut down the LO separator system.	2.8.3
Shut down HFO separator system.	2.7.2
The main engine should have been manoeuvred on MDO, if not, change over to MDO and circulate FO back to HFO tank, until the pipeline has been flushed with MDO. Stop the main engine FO pumps and viscosity controllers.	2.1.1
Shut down the deck machinery system.	
Change the diesel generator to run on MDO.	2.6.2
Shut down the auxiliary boiler. Allow to cool naturally, drain if required for maintenance **OR** put into a wet lay-up condition.	2.2.1
Shut down the boiler feed pumps and condensate system. Isolate the distilled water tanks.	2.3
Circulate the boiler FO system with MDO, shut down the boiler FO pumps.	2.6.3
Shut down the stern tube LO systems.	2.8.2
Change the domestic water heating to electric.	2.14.1
Shut down air conditioning and refrigeration systems until shore side CW supply is established.	2.14.2 2.14.3
Shut down the fire pumps. Pressurise the fire main from shore CW supply.	4.1
Isolate the sequential restart system.	2.13.5
Establish shore power. Check the phase sequence, voltage and frequency.	2.13.2
Stop the last diesel generator.	2.13.3
Establish lighting and ventilation and any other essential services.	2.13
Shut down the sea water cooling systems.	2.4.1
Shut down the control and working air systems.	2.10.2
Restart the LT system cooling pump and circulate the diesel generator until cool.	2.5.2
Secure the CO_2 system.	4.2
The dry dock can now be emptied.	

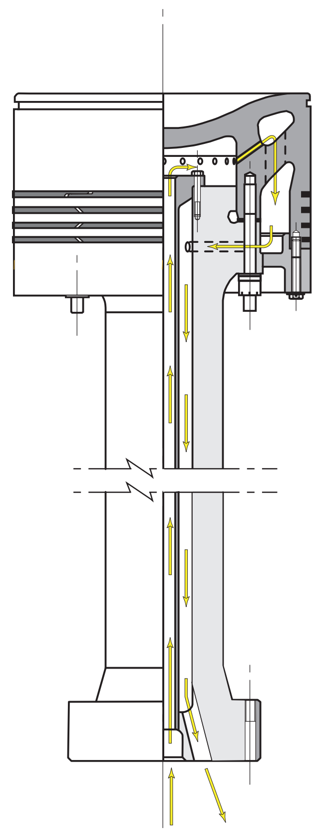
PLANT SECURED FOR DRY DOCK

SECTION 2: MAIN ENGINE AND AUXILIARY SYSTEMS

2.1 Main Engine and Propulsion Systems

Illustration 2.1.1a MAN B&W 5S50MC





Enlarged View of Piston Crown LO Cooling Arrangement

Key	
	Fuel Oil
	Fresh Water
	Lubricating Oil
	Scavenge Air
	Combustion Gas

2.1 MAIN ENGINE AND PROPULSION SYSTEMS

2.1.1 MAIN ENGINE SPECIFICATION

Main Engine

Manufacturer:	Dalian Marine Diesel (DMD) - MAN B&W
Model:	5S50MC (Mark-VI)
No. of sets:	1
Type:	Two-stroke, single-acting, direct reversible, crosshead diesel engine with one constant pressure turbocharger and charge air cooler
Number of cylinders:	5
Cylinder bore:	500mm
Stroke:	1,910mm
Output (MCR):	7,150kW at 127 rpm
Output (CSR):	6,078kW at 120.3 rpm
Specific fuel consumption:	167.5g/kW per hour 123.4g/bhp per hour

Turbocharger

Manufacturer:	MAN-B&W
No. of sets:	1
Type:	TCA55 - 20028

Auxiliary Blowers

Manufacturer:	Jin Zhou Air Conditioning Equipment Plant
No. of sets:	2
Model:	JC53B-50
Capacity:	1.45/2.79m^3/second
Motor manufacturer:	ABB
Motor type:	M3AA 200 MLA2, 3,555 rpm, 35kW

Description

Bedplate and Main Bearing

The bedplate is divided into sections and it consists of welded, longitudinal girders and welded cross girders with cast steel bearing supports. Long elastic holding down bolts tightened by hydraulic tools are used to fit the bedplate to the engine seating on resin chocks.

The oil pan, which is made of steel plate and is integrated in the bedplate, collects the return oil from the forced lubricating and cooling oil system. It is provided with drains with gratings.

The main bearings consist of thick-walled steel shells lined with white metal. The bottom shell can, by means of special tools, be rotated out and in.

The shells are kept in position by a bearing cap and are fixed by long elastic studs, with nuts tightened by hydraulic tools. The chain drive is integrated with the thrust bearing in the after end of the engine.

Thrust Bearing

The thrust bearing is of the B&W-Michell type, and consists primarily, of a thrust collar on the crankshaft, bearing supports, and thrust pads of cast iron with white metal. The thrust shaft is an integrated part of the crankshaft.

The propeller thrust is transferred through the thrust collar, the thrust pads, and the bedplate, to the engine seating and then to the hull of the ship via the chocking system.

Turning Gear and Turning Wheel

The turning wheel has cylindrical teeth and is fitted to the thrust shaft. The turning wheel is driven by a pinion on the terminal shaft of the turning gear, which is mounted on the bedplate. The turning gear is driven by an electric motor with built-in gear and chain drive with brake. The turning gear is equipped with a blocking device that prevents the main engine from starting when the turning gear is engaged. Engagement and disengagement of the turning gear is effected manually by an axial moment of the pinion.

Frame Box

The frame box is of welded design, and is divided into sections. On the exhaust side, crankcase relief valves are provided for each cylinder, while on the camshaft side, it is provided with a large hinged door for each cylinder.

The crosshead guides are attached to the frame box.

A slotted pipe for collecting part of the cooling oil outlet from the piston for visual control is bolted in the frame box. The stay bolts, which are tightened hydraulically, connect the bedplate, frame box and cylinder frame to form a unit. To prevent transverse oscillations, each stay bolt is braced.

Cylinder Frame, Cylinder Liner and Stuffing Box

The cylinder frame units are of cast iron and are mutually assembled with bolts. At the chain drive the cylinder frame is also bolted to the upper part of the chain wheel frame.

The cylinder frame together with the cylinder liners form the cooling water space. The scavenge air space is located below the cylinder block and above the crankcase. On the camshaft side of the engine, the cylinder frame units are provided with access covers for cleaning the scavenge air space and for inspection of the liners and pistons/piston rods through the scavenge ports.

The roller guide housings, the lubricators, and the gallery brackets are bolted onto the cylinder frame units. A telescopic pipe is fitted for the supply of piston cooling oil and lubricating oil.

A piston rod stuffing box is fitted for each cylinder unit at the bottom of the scavenge space. The stuffing box is provided with sealing rings for scavenge air isolation, and with oil scraper rings to prevent oil from entering the scavenge air space and to stop any oil/sludge in the scavenge space from entering the engine sump.

The cylinder liner is made of alloyed cast iron and is suspended in the cylinder frame, with a low-situated flange. The upper part of the liner is surrounded by a cooling jacket. The cylinder liner has scavenge ports and drilled holes for cylinder lubrication.

Cylinder Cover

The cylinder cover is of forged steel, made in one piece, and has bores for cooling water. It has a central bore for the exhaust valve and bores for fuel valves, safety valve, air start valve and indicator valve. The cylinder cover is attached to the cylinder frame with studs and nuts tightened by a hydraulically tightened ring covering all the studs.

Exhaust Valve and Valve Gear

The exhaust valve consists of a valve housing with gas channel, spindle guide, and a valve spindle. The valve housing is water-cooled and made of cast iron. Between the cylinder cover and the valve housing there is a bottom piece. The bottom piece is made of steel with a hardened face for the spindle seat, and is water-cooled on its outer surface. The valve spindle is made of heat resistant steel and is provided with a small vane wheel on which the exhaust gas acts during operation, thus making the spindle rotate slightly. Valve rotation reduces the risk of local overheating and helps to prevent heavy deposits on the valve seating faces.

The hydraulic system consists of an actuator, activated by a cam on the camshaft, a high-pressure pipe, and an oil cylinder for the exhaust valve spindle, mounted on top of the valve housing. The hydraulic system opens the exhaust valve, while the closing of the exhaust valve is carried out via the spring air acting on the underside of the closing piston; the closing action is damped by means of an oil cushion on top of the spindle.

Air sealing of the exhaust valve spindle guide is provided.

Fuel Valves, Starting Valve, Safety Valve and Indicator Valve

Each cylinder cover is equipped with two non-cooled fuel oil valves, one air start valve, one safety valve and one indicator valve.

The opening of the fuel valve is controlled by the fuel oil pressure created by the fuel pump and the valve is closed by a spring. An automatic vent slide allows circulation of fuel oil through the fuel valve and high pressure pipes. This vent slide prevents the compression chamber from being filled up with fuel oil in the event that the valve spindle sticks when the engine is stopped.

The air start valve is opened by pilot control air from the starting air distributor and is closed by a spring. The safety valve is spring-loaded.

The indicator valve allows cylinder pressure readings to be taken in service. During engine shutdown when the engine is being turned on the turning gear, inspection is made at the indicator valve for any water in the cylinder. One indicator drive is fitted for each cylinder. The indicator drive consists of a cam fitted on the camshaft and a spring-loaded spindle with roller, which is able to move up and down, corresponding to the movement of the piston. At the top of the spindle there is an eye to which the indicator cord is fastened after the indicator has been mounted on the indicator valve.

Crankshaft

The crankshaft is of the semi-built type, made from forged or cast steel throws, and made in one part. At the aft end, the crankshaft is provided with a flange for the turning wheel.

Axial Vibration Damper

The engine is fitted with an axial vibration damper, which is mounted on the fore end of the crankshaft. The damper consists of a piston and a split-type housing located forward of the foremost main bearing. The piston is made as an integrated collar on the main journal, and the housing is fixed to the main bearing support. A mechanical device for checking the function of the vibration damper is fitted.

Connecting Rod

The connecting rod is made of forged steel and provided with bearing caps for crosshead and crankpin bearings. The crosshead and crankpin bearing caps are secured to the connecting rod by studs and nuts which are tightened by hydraulic jacks. The crosshead bearing consists of a set of thin-walled steel shells, lined with white metal. The crosshead bearing cap is one piece, with an angular cut-out for the piston rod. The crankpin bearing is provided with thin-walled steel shells, lined with white metal. Lubricating oil is supplied through ducts in the crosshead and connecting rod.

Piston, Piston Rod and Crosshead

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

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

The crosshead is of forged steel and is provided with cast steel guide shoes with white metal on the running surface. A bracket for the oil inlet from the telescopic pipe and another for the oil outlet to a slotted pipe are mounted on the crosshead.

Fuel Pump and Fuel Oil High Pressure Pipes

The engine is provided with one fuel pump for each cylinder. The fuel pump consists of a pump housing, a centrally placed pump barrel, a plunger and a shock absorber. To prevent fuel oil from mixing with the separate camshaft lubrication system, the pump is provided with a sealing device arrangement. The pump is activated by the fuel cam, and the volume injected is controlled by turning the plunger by means of a toothed rack connected to the regulating mechanism. The fuel pumps incorporate Variable Injection Timing (VIT) for optimum fuel economy at part load. The VIT principle uses the fuel regulating shaft position controlling parameter. Adjustment of the pump lead is made by a threaded connection, operated by a toothed rack, which raises or lowers the fuel pump barrel, thus varying the point at which the spill port is covered and hence changing the start of fuel injection. The fuel oil pump is provided with a puncture valve for each cylinder, which quickly prevents high pressure from building up during normal stopping and shutdown.

The fuel oil high-pressure pipes are equipped with protective hoses, and are neither heated nor insulated. Any leakage from the protective hoses is led to a collecting tank which is fitted to the side of each FO pump, each collecting tank is fitted with an alarm, which when activated will raise an alarm on the DMS 2100 alarm and monitoring system, and initiate the operation of the puncture valve on the top of the FO pump. When the puncture valve operates the HP fuel delivery from the pump will stop immediately, this will effectively cut out the cylinder and therefore an immediate response is required to bring the engine speed down to <105 rpm if it is above this value. Cutting out the cylinder will initiate a exhaust temperature deviation alarm on the DMS 2100 alarm and monitoring system as the exhaust gas temperature drops, this deviation alarm will also initiate an alarm/slowdown function directive from the DPS 2100 engine safety monitoring system, indicating that a slowdown of the engine should be carried out by the operator.

Camshaft and Cam

The camshaft consists of a number of sections. Each individual section consists of a shaft piece with exhaust cams, fuel cams, coupling parts and indicator cams. The exhaust cams and fuel cams are of steel, with a hardened roller race, and are shrunk on to the shaft. They can be adjusted and dismantled hydraulically. The cam for the indicator drive can be adjusted mechanically. The coupling parts are shrunk on to the shaft and can be adjusted and dismantled hydraulically. The camshaft bearings consist of one lower half shell mounted in a bearing support which is attached to the roller guide housing by means of hydraulically tightened studs.

Chain Drive

The camshaft is driven from the crankshaft by a chain drive. The engine is equipped with a hydraulic chain tensioner, with the long free lengths of chain supported by guide bars.

The cylinder oil lubricators are driven by a separate chain from the camshaft.

Governor

The engine is provided with an electronic governor. The speed setting of the actuator is determined by an electric signal from the electronic governor based on the position of the main engine regulating handle. The actuator shaft is connected to the fuel regulating shaft by means of a mechanical linkage.

Cylinder Lubricators

The cylinder lubricators, one per cylinder, are MEP dependent and load change dependent. They are controlled by the engine revolution in conjunction with engine load, and are mounted on the roller guide housing, and interconnected with shaft pieces. The lubricators have a 'built-in' capability of adjusting the oil quantity. They are of the 'Sight Feed Lubricator' type and are provided with a sight glass for each lubricating point. The oil is led to the lubricator through a pipe system from an elevated cylinder oil service tank.

Once adjusted, the lubricators will basically have a cylinder oil feed rate proportional to the engine revolutions and engine load. Cylinder lubricators are provided with a no-flow alarm which is activated should the steel ball in a flow sight glass contact the detector at the base of the sight glass; this facility is inhibited when the engine is stopped.

Manoeuvring System

The engine is provided with an electro-pneumatic manoeuvring and fuel oil regulating system. The system transmits orders from the separate manoeuvring console to the engine.

The regulating system makes it possible to start and stop the engine and to control the engine speed. The speed control handle on the manoeuvring console gives a speed setting signal to the governor, dependent on the desired engine rotational speed.

A shutdown function will stop the fuel injection by activating the puncture valves placed in the high pressure fuel system, independent of the speed control handle position.

The engine is provided with a local (emergency) engine control console, mounted at the side of the engine, and an instrument panel for emergency running.

Gallery Arrangement

The engine is provided with gallery brackets, gratings, stanchions and rails. The brackets are placed at such a height that the best possible overhauling and inspection conditions are achieved. Some main pipes of the engine are suspended from the gallery brackets.

The upper gallery brackets on the camshaft side are provided with overhauling holes for stowing pistons. The engine is fitted with a hydraulic top bracing system on the starboard side to transfer transverse thrust to the ship's structure.

Scavenge Air System

The air intake to the turbocharger takes place directly from the engine room through the intake silencer of the turbocharger. From the turbocharger, the air is led via the charging air pipe, air cooler, water separator and scavenge air receiver to the scavenge ports of the cylinder liners.

The charging air pipe between the turbocharger and the air cooler is provided with a compensator and is heat insulated on the outside.

Air Cooler

The engine is fitted with one air cooler of the mono block element type with cleaning nozzles for the air side of the cooler.

A separate tank and circulating pump are supplied for chemically cleaning the air side.

A water mist catcher of the through-flow type is located in the air chamber below the air cooler.

Exhaust Turbocharger

The turbocharger air and gas side casings are cooled by water from the main engine HT jacket cooling water system. A dry cleaning system (compressed air 0.7MPa) is supplied for the turbine side and a fresh water washing system for the compressor side.

The turbocharger is equipped with an electronic tacho system with pick-ups, converter and indicator for mounting in the engine control room.

Exhaust Gas System

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

Compensators are fitted between the exhaust valves and the receiver, and between the receiver and the turbocharger. For quick assembling and disassembling of the joints between the exhaust gas receiver and the exhaust valves, clamping bands are used.

The exhaust gas receiver and exhaust pipes are provided with insulation, covered by galvanised steel sheeting. There is a protective grating between the exhaust gas receiver and the turbocharger.

Auxiliary Blowers

The engine is provided with two electrically-driven blowers. The suction side of the blowers is connected to the scavenge air space after the air cooler. Between the air cooler and the scavenge air receiver, non-return valves are fitted, which automatically close when the auxiliary blowers supply the air. The auxiliary blowers will start operating before the engine is started and will ensure sufficient scavenge air to obtain a safe start.

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

Forced Lubrication and Oil Cooling (Section 2.8.1)

The pipes for the forced lubrication and cooling oil system are made of steel.

The main forced lubrication is led to each main bearing through branches from the main lubrication pipe located along the engine.

Cooling oil is led to the telescopic pipe through branches from the cooling oil main pipe, located alongside the cooling jackets on the exhaust side of the engine, through which the oil is led to the crossheads. From there some of the oil is branched off for lubrication of the crosshead shoes and crosshead bearings, and is led through the bored connecting rod to the crank pin bearing. Some of the oil is led through a pipe in the bore of the piston rod for cooling of the piston crown. The oil returns from here through the piston rod and let out through a duct in the crosshead.

Cooling oil returns from the pistons via sight glasses to the main engine sump.

The camshaft bearings and hydraulically operated exhaust valves are supplied with oil from a separate lubrication system.

The cylinders are each lubricated by six cylinder oil injection pumps which supply oil to injectors spaced around the cylinder liners.

Turbocharger Bearing Oil

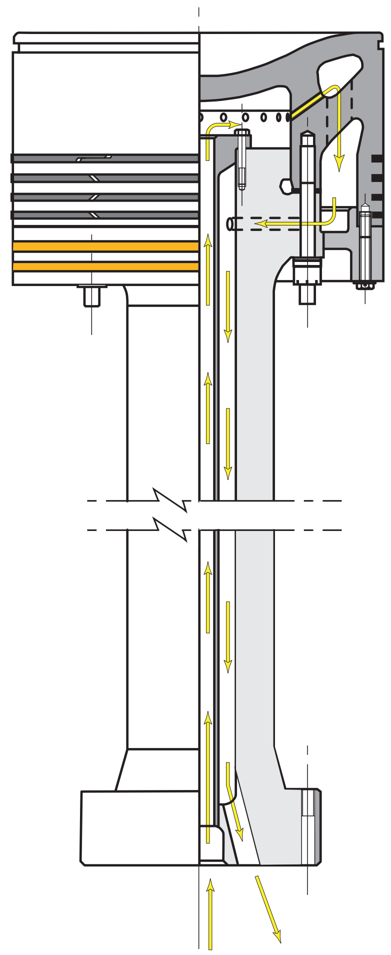
The turbocharger bearings are supplied with lubricating oil from a separate LO system with independent pumps, filters and sump tank.

Fuel Oil Supply System (Section 2.6.1)

The fuel oil is led from the main inlet pipe through branches to the fuel injection pump of each cylinder. In order to keep the fuel oil inlet pressure to the fuel injection pump constant, regardless of the fuel oil consumption during engine running, a spring-loaded overflow valve is provided in an engine fuel bypass line.

The fuel oil is heated to the temperature required to achieve the optimum atomising viscosity. However, prior to prolonged shutdown, and after starting up from cold, the engine will be run on diesel oil in order that the high pressure lines between the fuel injection pumps and fuel injectors do not become clogged with cold fuel oil.

Illustration 2.1.1b Main Engine Piston Cooling Flow Path



Enlarged View of Piston Crown LO Cooling Arrangement

Cooling Water System (Section 2.5.1)

The engine is fresh water cooled, supplied by HT jacket cooling water pumps. The fresh water is led from the cylinder frame of each cylinder to the cylinder cover and through the exhaust valve up to a main outlet pipe, through which it is carried back to the HT cooling water pumps via the fresh water generator if in line, and then via a three-way control valve either to the HT pumps or to the central cooler.

The cooling water is also led to the turbocharger from the main inlet pipe.

The inlet pipes to the cylinders are provided with shut-off valves. The outlet pipes are provided with shut-off valves, a pocket for a thermometer, and a deaeration cock.

The deaeration pipe is fitted to the outlet manifold and led to the fresh water expansion tank.

The fresh water pipes are covered with phosphatic film, 'Parkerising' instead of galvanising in order to avoid reaction with corrosion inhibitors.

Starting Air System (Section 2.10.1)

The starting air system contains a main starting valve, a non-return valve, a bursting disc for the branch pipe to each cylinder, a starting air distributor, and a starting valve on each cylinder.

The main starting valve is connected to the manoeuvring system, which controls the start of the engine.

The starting air distributor regulates the supply of pilot control air to the starting valves, so that these supply the engine cylinders with starting air in the correct firing order. The starting air distributor has one set of starting cams for 'Ahead' and one set for 'Astern', as well as one control valve for each cylinder.

Operation of the Main Engine

Preparations for Starting

Air Systems

a) Drain water, if any, from the starting air system.

b) Drain water, if any, from the control air system at the receivers.

c) Pressurise the air systems.

d) Check the pressures and ensure that the pressures are correct.

e) Ensure that spring air is available to the pneumatic exhaust valves.

Note: Air pressure must be applied before the camshaft lubricating oil pump is started. This is to prevent the exhaust valves from opening too much.

f) Engage the lifting/rotation, check rod mounted on each exhaust valve, and check that the exhaust valves are closed. These should be disengaged when lift/rotation is confirmed when the engine is running.

Lubricating Oil Systems

Start the lubricating oil pumps for the engine and camshaft.

a) Check the oil pressures.

b) Check the oil flow through the sight glasses for piston cooling oil.

c) Check that the cylinder lubricators are filled with the correct type of oil.

d) Operate the cylinder lubricators manually.

e) Check that oil is emitted.

Cooling Water Systems

Note: The engine must not be started if the jacket cooling water temperature is below 20°C.

a) Start the cooling water pumps and check the pressures.

b) Operate the jacket water preheater. Preheat to a minimum of 20°C, or preferably to 50°C.

Turning the Engine

This must be carried out to prevent damage caused by fluid in any of the cylinders. Before turning the engine, obtain permission from the bridge.

Note: Always carry out the turning operation at the latest possible moment and, under all circumstances, within the last 30 minutes before starting.

Turning with the Turning Gear

a) Open the indicator valves.

b) Start the turning gear.

c) Turn the engine at least one full revolution with the turning gear in the ahead direction.

d) Check to see if fluid flows out of any of the indicator valves.

e) Repeat the previous points in the opposite direction of rotation.

f) Close the indicator valves if not slow-turning on air.

g) Disengage the turning gear.

h) Check that it is locked in the OUT position.

i) Check that the indicator lamp for TURNING GEAR ENGAGED extinguishes and the indicator lamp TURNING GEAR DISENGAGED is illuminated.

j) Lift the locking plate of the main starting valve to the SERVICE position.

k) Check the indicator lamp to ensure that the starting air distributor is not blocked.

l) The locking plate must remain in the upper position during running.

m) The locking plate must remain in the lower position during repairs.

Slow-Turn with Air

a) Disengage the turning gear.

b) Check that it is locked in the OUT position.

c) Check that the indicator lamp for TURNING GEAR ENGAGED extinguishes.

d) Lift the locking plate of the main starting valve to the SERVICE position.

e) Check the indicator lamp.

The locking plate must remain in the upper position during running.

The locking plate must remain in the lower position during repairs.

f) Check that the indicator valves are open.

g) Press the MANUAL SLOW-TURNING pushbutton and then move the regulating handle to the START position until the engine has turned over 1.5 complete revolutions.

h) Allow the engine to turn over and check to see if fluid flows out of any of the indicator valves.

i) Check that the individual air cylinders reverse the displaceable rollers for each fuel pump to the outer position.

j) When the engine has moved 1.5 revolutions, move the regulating handle to the STOP position.

k) Close the indicator valves.

Fuel Oil System

a) The fuel oil system feeds the generator engines, therefore the FO supply and circulating pumps should already be in operation.

b) Check the fuel pressures and temperatures.

Checking the Fuel Regulating Gear

a) Close the shut-off valve for the starting air distributor to prevent the engine from turning.

b) Check that the STARTING AIR DISTRIBUTOR BLOCKED indicator lamp is illuminated.

c) Switch over to control at the engine side control console.

See description of the procedure, Emergency Operation of the Main Engine (Section 5.2).

d) Turn the regulating handwheel to increase the fuel pump index, and check that all the fuel pumps follow to the 'FUEL SUPPLY' position.

e) With the regulating handwheel back in the STOP position, check that all the fuel pumps show zero-index.

f) Switch back to NORMAL (REMOTE) control.

g) Open the shut-off valve for the starting air distributor.

h) Check that the STARTING AIR DISTRIBUTOR BLOCKED indicator lamp is extinguished.

Miscellaneous

a) Lubricate the bearings and rod connections in the regulating gear, etc, every 4,000 hours.

b) Switch on the electrical equipment in the control console.

c) Set the switch for the auxiliary blowers in the AUTO position.

d) The blowers will start at intervals of 6 seconds.

The engine is now ready to start.

Starting-Up Procedure

Starting

CAUTION

If the engine has been out of service for some time, starting-up is usually performed as a quay-trial. Prior to this, it must be ascertained that:

1. **The harbour authorities permit quay-trial.**
2. **The moorings are sufficient.**
3. **A watch is kept on the bridge.**

The following modes of starting are available:

- Remote control from engine control room
- Remote control from bridge
- Local (emergency) control

In the engine control room or at the engine side local control station the stop, start and speed setting orders are given manually by moving the regulating handle, corresponding to the order from the bridge.

Checks During Starting

Make the following checks immediately after starting:

- **Direction of Rotation.** Ensure that the direction of propeller rotation corresponds to the telegraph order.
- **Exhaust Valves.** See that all exhaust valves are operating correctly. Disengage the lifting/rotation indicators after checking that they are functioning correctly.
- **Turbocharger.** Ensure that the turbocharger is running and that lubricating oil pressures are normal.
- **Circulating Oil.** Check that the pressure and discharge are in order
- **Cylinders.** Check that all cylinders are firing.
- **Starting Valves on Cylinder Covers.** Feel-over the pipes. A hot pipe indicates a leaking starting valve.
- **Pressures and Temperatures.** Ensure that all pressures and temperatures are normal for the engine speed. In particular, the circulating oil (bearing lubrication and piston cooling), camshaft lubricating oil, fuel oil, cooling water, scavenge air, and control and safety air.
- **Cylinder Lubricators.** Make sure that the lubricators are working with an even 'drop height' level in all the sight glasses.
- Check the oil level in the cylinder oil service tank.

Procedure for Loading the Engine

If there are no restrictions such as running-in after repairs, proceed to increase the load on the engine.

The cooling water should be preheated, but if the temperature is below 50°C, allow the temperature to reach this point before increasing load.

Increase the load gradually to maximum speed over a period of 30 minutes.

Checks During Loading

Feel-Over Sequence

If the condition of the machinery is uncertain (eg, after repairs or alterations), the 'feel-over sequence' should always be followed, ie:

1. After 15-30 minutes' running on 'Slow'.
2. Again after 1 hour's running.
3. At sea after 1 hour's running at service speed.

Stop the engine, open the crankcase, and feel-over the moving parts listed below (by hand or with a 'Thermo-feel') on sliding surfaces where friction may have caused undue heating.

WARNING

During feeling-over, the turning gear must be engaged, and the main starting valve and the starting air distributor must be blocked.

The starting air distributor is blocked by closing the crossover valve.

Feel-Over Sequence Points

- Main, crankpin and crosshead bearings
- Piston rods and stuffing boxes

- Crosshead shoes
- Telescopic pipes
- Chains and bearings in the chain casing
- Camshaft bearing housings
- Thrust bearing/guide bearing
- Axial vibration damper
- Torsional vibration damper

Running-In

For a new engine, or after repair or renewal of the large bearings, renewal or reconditioning of cylinder liners and piston rings, allowance must be made for a running-in period.

Regarding bearings: Increase the load slowly, and apply the feel-over sequence, see 'Checks During Loading'.

Fuel Changeover

The engine is equipped with non-cooled, 'all-symmetrical', lightweight fuel valves with built-in fuel circulation. This automatic circulation of the preheated fuel (through the high-pressure pipes and the fuel valves) during engine standstill, is the background for recommending constant operation on heavy fuel.

However, changeover to diesel oil can become necessary if, for instance, the vessel is expected to have a prolonged inactive period with cold engine, ie, due to:

- A major repair of the fuel oil system etc
- A dry docking
- More than 5 days' period stop
- Environmental legislation requiring the use of low sulphur fuels

Changeover can be performed at any time:

- During engine running
- During engine standstill

In order to prevent fuel pump and injector sticking/scuffing, poor combustion or fouling of the gas ways, it is very important to carefully follow the changeover procedures.

Changeover from Diesel Oil to Heavy Fuel During Running (See Section 2.7.1)

Preparations Prior to Arrival in Port

Decide whether the harbour manoeuvre should be carried out on diesel oil or on heavy fuel oil. The vessel is designed to run on heavy fuel oil at all times.

Changeover should be carried out one hour before the first manoeuvres are expected.

Start an additional generator engine to ensure sufficient power reserve for the manoeuvre.

Drain off any condensed water from the starting air and control air systems just before the manoeuvre.

Stopping

Stop the engine by setting the regulating lever to STOP.

Operations After Arrival in Port

When the FINISHED WITH ENGINES order is received in the control room:

a) Switch over to control room control.

b) Switch off the auxiliary blowers.

c) Test the starting valves for leakage.

d) Obtain confirmation from the bridge that the stern is clear and the ship is secure on its berth.

e) Check that the turning gear is disengaged, as a leaky valve can cause the crankshaft to rotate.

f) Close the valve to the starting air distributor.

g) Open the indicator valves.

h) Change over to emergency (local) control.

i) Activate the START pushbutton. This admits starting air, but not control air, to the starting valves.

j) Check to see if air blows out from any of the indicator valves. If air issues out of a cylinder, the starting valve concerned is leaking.

k) Replace or overhaul any defective starting valves.

l) Lock the main starting valve in its lowest position by means of the locking plate.

m) Close and vent the control air and safety air systems.

n) Wait a minimum of 15 minutes after stopping the engine, then if necessary stop the lubricating oil pumps if maintenance work is to be carried out on the engine, otherwise the pumps may be left on.

The main engine and generator engines are supplied by the same FO supply and circulating pumps, therefore the FO preparation pumps must remain in operation while the main engine is shut down.

Fresh Water Preheating During Standstill

Keep the engine preheated to minimum 50°C, unless harbour stay exceeds 5 days. This counteracts corrosive attack on the cylinder liners during starting-up.

Use the steam heated preheater for preheating of the engine.

Switch off other equipment which need not operate during engine standstill.

WARNING

Special Dangers

Keep clear of areas below loaded cranes.

The opening of cocks and valves may cause discharge of hot liquids or gases.

The dismantling of parts may cause the release of springs.

The removal of fuel valves or other valves in the cylinder cover may cause oil to run onto the piston crown. If the piston is hot an explosion may blow out the valve.

When testing fuel valves do not touch the spray holes as the jets may pierce the skin.

Beware of high pressure oil leaks when using hydraulic equipment, wear protective clothing and equipment, including eye protection.

Arrange indicator cocks with pressure relief holes directed away from personnel. Wear goggles when taking indicator cards.

Do not weld in the engine room if the crankcase is opened before the running gear is fully cooled.

Turning gear must be engaged before working on or inside the engine, as the wake from other ships in port or waves at sea may cause the propeller to turn. Also isolate the starting air supply.

Use gloves when removing O-rings and other rubber/plastic-based sealing materials which have been subjected to abnormally high working temperatures as they may have a caustic effect.

Oil Mist Detector

Manufacturer:	Kidde-Graviner
No. of sets:	1
Model:	Graviner Mk 6

All units are fitted with individual optical detector heads which monitors the crankcase of the associated unit continuously. These detector heads utilise the principle of light scatter to measure the differential between the oil mist in the crankcase and clean air. The control unit scans signals from the detector heads sequentially and all engine detector heads are scanned regularly every 1.2 seconds. The system has an alarm priority so that an alarm condition at any detector head is responded to as soon as it occurs.

It is essential that the oil mist detector system is maintained in a full and effective operating condition and that any alarms are acted upon immediately, as this instrument provides an essential safeguard against a crankcase explosion which can have extremely serious consequences. Activation of the oil mist detector initiates an engine slowdown.

The duty engineer must test the functioning of the mist detector unit according to the company operating policy. Testing of the unit takes place at the control panel, but each detector head is fitted with indicator LEDs, and checks must be made daily to ensure that these are functioning. If a detector head fails or transmits an abnormal signal an alarm is activated.

The control panel for the Kidde-Graviner oil mist detector is located in the engine control room.

Fouling and Fires in the Scavenge Air Spaces

The principal cause of fouling is blow-by of combustion products between piston and cylinder into the scavenge air spaces. The fouling will be greater if there is incomplete combustion of the fuel injected.

Causes of poor combustion:

- The fuel injectors are not working correctly
- The fuel is at too low a temperature
- Poorly adjusted injection pump timing
- Operation with a temporary shortage of air during extreme variations in engine loading and when the charge air pressure dependent fuel limiter in the governor is set too high
- Overloading
- Insufficient supply of air due to restricted engine room ventilation
- Fouling of the air intake filters and diffuser on the air side of the turbocharger
- Fouling of the exhaust gas economiser, the air cooler and of the scavenge ports

Causes of blow-by of combustion products:

- Worn, sticking or broken piston rings
- Individual cylinder lubricating quills are not working
- Damage to the running surface of the cylinder liners
- Excessive liner wear or abnormal wear such as clover-leafing, which can also result in ring collapse and loss of piston ring to liner seal

If one or more of these operating conditions prevail, residues, mainly consisting of incompletely burned fuel and cylinder lubricating oil, will accumulate at the following points:

- Between piston rings and piston ring grooves
- On the piston skirts
- In the scavenge ports
- On the bottom of the cylinder jacket

Causes of the Fires

The blow-by of hot combustion gases and sparks, which have bypassed the piston rings between piston and cylinder liner running surface, enter the space on the piston underside and any residues present can ignite.

If there is after-burning of fuel in the cylinder, due to late injection or poor fuel atomisation, the cylinder pressure when the scavenge ports are uncovered may be higher than the scavenge air pressure and hot combustion gases may enter the scavenge space. A defective piston rod gland may allow oil from the crankcase to enter the scavenge space; the piston rod gland drains should be checked frequently for signs of crankcase system oil, as this indicates defective gland sealing rings.

Indications of a Fire

- Sounding of the respective temperature alarms
- A considerable rise in the exhaust gas temperatures of the cylinder concerned and a general rise in charge air temperature
- The turbocharger may start surging

Fire Fighting Measures

The safety of shipboard personnel should be paramount whenever dealing with fires anywhere aboard ship.

- Inform the bridge of the situation.
- Reduce engine power.
- Cut out the fuel injection pump of the cylinder concerned.
- Increase lubrication to the respective cylinder.
- If the fire is serious, stop the engine and put the scavenge air box fire extinguishing equipment into operation. This is a water spray system with individual cylinder unit supply cocks; the main extinguishing water supply valve is located on the aft, port side of the engine at just above head height when at engine room floor level.

Note: Be aware of possible thermal shock and loss of extinguishing medium through the exhaust. Do not open the scavenge air box or crankcase before the site of the fire has cooled down to under 100°C. When opening, keep clear of possible fresh spurts of flame.

A fire should have died down about 5 to 15 minutes after the fuel has been shut off to the affected cylinder or cylinders. This can be verified by checking the exhaust gas temperatures and the temperatures of the doors to the scavenge space. Afterwards, the engine must be stopped whenever possible and the cause of the fire established.

Checks to be made should include:

- Cylinder liner running surface, piston and piston rings, air flaps in the receiver (to be replaced if necessary), possible leakages, piston rod gland, fuel injection nozzles.
- After a careful check and, if necessary, a repair, the engine can be put back on load with cut-in fuel injection pump(s) and cylinder lubrication returned to normal.
- Should a stoppage of the engine not be feasible and the fire has died down, the fuel injection pump can again be cut-in, the load increased slowly and the cylinder lubrication brought back again to the normal output. Avoid running for hours with considerably increased cylinder lubrication.

Before retightening, normal temperature of all engine parts must be re-established.

Ignition in the Crank Case

Cause

When the engine is running, the atmosphere in the crankcase contains the same types of gas (N_2 - O_2 - CO_2) in the same proportions as the ambient air, however, there is also a large number of coarse oil droplets present.

If abnormal friction occurs between the sliding surfaces, or heat is otherwise transmitted to the crankcase (for instance from a scavenge air fire via the piston rod/stuffing box) or, for some engine types, through the hot uncooled intermediate bottom, hot spots on the heated surfaces can occur.

The hot spots will cause the oil falling on them to evaporate. When the oil vapour condenses again, countless minute droplets are formed which are suspended in the air. This appears as milky-white oil mist, which is able to feed and propagate a flame if ignition occurs.

The ignition can be caused by the same hot spot which caused the oil mist. If a large amount of oil mist has developed before ignition, the burning can cause a rapid and large rise of pressure in the crankcase (explosion), which forces a momentary opening of the crankcase relief valves. This is the primary crankcase explosion. This primary explosion may be mild or severe depending upon the amount of mist actually present. A primary explosion can result in a much more severe secondary explosion. This is because additional oil mist may be generated by the effects of the primary explosion shock wave, and the vacuum which follows the primary can result in a fresh air charge being drawn into the crankcase.

WARNING

The effects of a secondary crankcase explosion, or a severe primary explosion, result in damage in the engine room and serious injury or death to personnel in the engine room.

Note: Similar explosions can also occur in the chain casing and scavenge air box.

Every precaution should therefore be taken to:

1. Avoid ‘hot spots’
2. Detect the oil mist in time

Hot Spots in the Crankcase

Well-maintained bearings only overheat if the oil supply fails, or if the bearing journal surfaces become too rough (due to the lubricating oil becoming corrosive, or being polluted by abrasive particles).

For these reasons, it is very important to:

1. Purify the lubricating oil correctly.
2. Make frequent control analysis.
3. Ensure that the filter gauze is always intact.

Due to the high frictional speed of the thrust bearing, special care has been taken to ensure the oil supply to this bearing.

Monitoring equipment is arranged to give an alarm in cases of low circulating oil pressure and/or high temperature of thrust bearing segments. Keep this equipment in effective operating condition.

Feel-over moving parts (by hand or with a ‘thermo-feel’) at suitable intervals (15-30 minutes) after starting and again at full load. If in doubt, stop and feel-over.

Oil Mist in the Crankcase

In order to ensure a reliable and quick warning of oil mist formation in the crankcase, constant monitoring is obtained with an oil mist detector, which successively samples air from each crankcase compartment.

The detector will give an alarm and a slowdown command at a mist concentration which is only a fraction of the lower explosion limit (LEL), in order to gain time to stop the engine before ignition of the oil mist can take place.

Measures to be Taken When an Oil Mist Detector Alarm Has Occurred

- Do not stand near crankcase doors, or relief valves, corridors or near doors to the engine room casing.
- Reduce speed to slowdown level, if not already carried out automatically.
- Ask the bridge for permission to stop.
- When the engine STOP order is received, stop the engine.
- Switch off the auxiliary blowers.
- Open the stores hatch.
- Leave the engine room.
- Lock the casing doors and keep away from them.
- Prepare the fire-fighting equipment.
- Do not open the crankcase until at least 20 minutes after stopping the engine.
- When opening up the crankcase, keep clear of possible spurts of flame. Do not use naked lights and do not smoke.

- Stop the lubricating oil pump.
- Open all doors on the side of the crankcase.
- Shut off the starting air, and engage the turning gear.
- Locate the 'hot spot'.
- Feel-over by hand or with a 'thermo-feel', all the sliding surfaces (bearings thrust bearing, piston rods, stuffing boxes, crossheads, telescopic pipes, chains, vibration dampers, moment compensators, etc).
- Look for squeezed-out bearing metal, and discolouration caused by heat (blistered paint, burnt oil, oxidised steel).
- Keep any bearing metal found at bottom of oil tray for later analysis.
- Prevent further hot spots by preferably making a permanent repair.
- Ensure that the respective sliding surfaces are in good condition.
- Take special care to check that the circulating oil supply is in order.
- Start the circulating oil pump and turn the engine by means of the turning gear.
- Check the oil flow from all bearings, spray pipes and spray nozzles in the crankcase, chaincase and thrust bearing.
- Check for possible leakages from pistons or piston rods.
- Start the engine. After: 5 minutes, 30 minutes, one hour and then when full load is reached carry out the following:

  Stop and feel-over

  Look for oil mist

Especially feel-over (by hand or with a 'thermo-feel'), the sliding surfaces which caused the overheating.

- There is a possibility that the oil mist is due to 'atomisation' of the circulating oil, caused by a jet of air/gas, eg, by combination of the following:

  Stuffing box leakages (not airtight).

  Blow-by through a cracked piston crown or piston rod (with direct connection to crankcase via the cooling oil outlet pipe).

An oil mist can also develop as a result of heat from a scavenge fire being transmitted down the piston rod or via the stuffing box. Hot air jets or flames could also have passed through the stuffing box into the crankcase.

Alarms and Trips

Automatic Shutdown Functions

Engine overspeed trip.

Manual Shutdown

Emergency stop buttons.

Alarm/Slowdown Functions

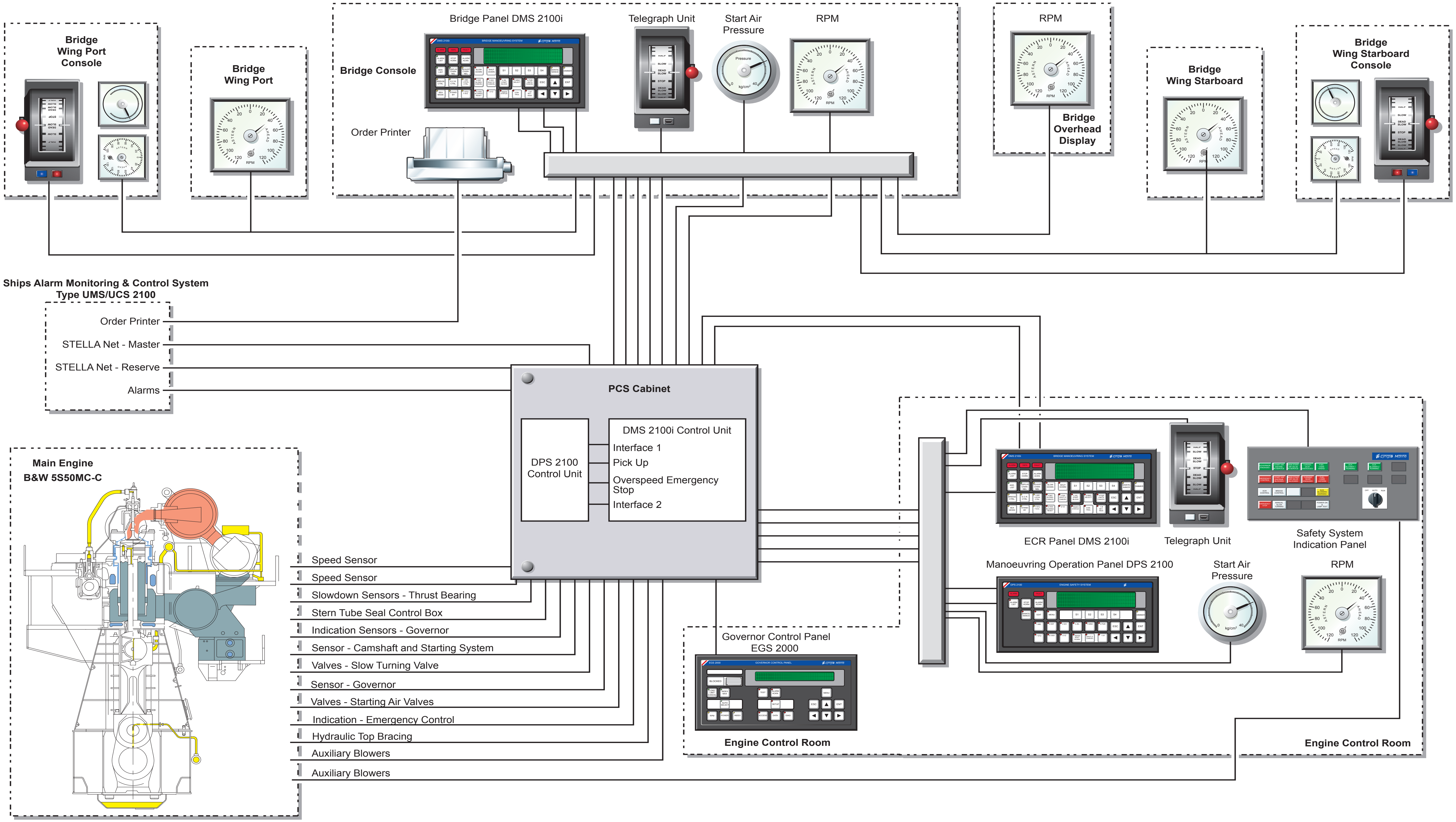
Axial vibration high	
Exhaust deviation alarm, on all units	430°C
Turbocharger exhaust outlet temperature high	320°C
Scavenge air fire alarm, on all units	80°C
Main LO inlet pressure low	0.12MPa
Camshaft inlet pressure low	0.20MPa
Piston cooling oil outlet no flow	No flow
Piston cooling oil inlet pressure low	0.14MPa
Jacket cooling water inlet pressure low	0.20MPa
Jacket cooling water outlet temperature high, on all units	90°C
Exhaust valve spring air pressure low	0.55MPa
Thrust bearing segment temperature high	75°C
Stern tube forward and aft bearing temperature high	67°C
Intermediate shaft bearing temperature high	65°C
Cylinder LO no flow from Nos.1, 2 and 3 cylinder lubrication boxes	No flow

Automatic Slowdown Functions

Thrust bearing temperature high ahead or astern.

Oil mist detection in crankcase level high.

Illustration 2.1.2a Main Engine Manoeuvring Control and Safety System



2.1.2 MAIN ENGINE MANOEUVRING CONTROL

Bridge Manoeuvring System (DMS 2100)

Manufacturer: Lyngsø Marine A/S
Model: DMS2100i/DPS2100

Introduction

The Diesel Manoeuvring System - DMS2100i is a bridge manoeuvring system used for the remote control of the ship's main diesel engine connected to a fixed pitch propeller.

The DMS2100i is operated by means of telegraph levers and standard panels with built-in four-line displays. It is operated as a completely independent stand-alone system, with all information and internal alarms displayed on the DMS operator panels.

The DMS2100i works as an integrated part of the universal control system, the systems being interconnected by means of a communication network, so that alarms, indications and measurement values from the DMS2100i can also be displayed on the graphical operator station (GOS) and alarm panels in the alarm and control system.

The DMS2100i can be configured to provide complete control for:

- Main engine start/stop
- Start blocking indications
- Main engine set point
- Main engine shutdown indications from the main engine safety system
- Main engine slowdown system
- Main engine speed measurement and indication
- Control transfer for bridge/ECR/local changeover
- Sub-telegraph with finished with engine (FWE), standby and sea mode
- Serial interface to the EGS2000 electronic governor
- Alarm announcement and indication

DMS2100i System Overview

The DMS2l00i controls the functions of the MAN-B&W slow-speed engine by means of the DMS2100i programmable logic controller (PLC) which is located in the DMS control cabinet, together with the units for the DPS2100 engine safety system. The main engine safety system is completely independent of the DMS.

The alarm and monitoring part of the machinery components controlled by the DMS2100i are handled by other Gamma programmable logic controllers (PLCs) in the UCS2100 alarm and control system.

The DMS2100i and the UMS/UCS 2100 alarm and control system are independent systems, each with its own PLCs, they are only connected by a network to transfer alarms and information to the graphic operator station (GOS) and printers (Telegraph Order Printer).

Slowdown signals for the main engine are transferred as hard-wired signal lines for safety reasons. The slowdown inputs to the DMS2100i are defined as supervised inputs, which means that a malfunction of the signal transmission cable can be detected. All hardware component and logic circuitry of the DMS2100i and the UCS2100 alarm and control system is independent, which means that it is still possible to control the propulsion machinery even in the event of a total breakdown of the alarm and monitoring system.

The power supply for the DMS2100i is uninterruptible power supply (UPS) protected. There is a separate fuse for the DMS2100i PLC, the DPS PLC and the remaining hardware connected to this system.

DMS Panels for Remote Control

The DMS is connected with DMS operator panels positioned at all control locations. Each panel has instruments for indicating engine rpm and starting air pressure and a pushbutton for emergency stop. Panels are situated as follows:

- One in the engine control room (ECR)
- One on the bridge

DMS Panel Functions

The following are available at the DMS panels:

- Analogue instruments for indication of main engine rpm
- Analogue instruments for indication of main engine starting air pressure
- Dimmer potentiometer for illumination of the analogue instruments (bridge only)
- Emergency stop pushbutton with cover
- A DMS2100i operator panel with the following functions:
    - A four-line display with 40 characters on each line
    - Soft keys S1 to S4 for operation of the DMS functions
    - Six selection keys: ESC, ENT and four arrow keys
- Selection of DMS control functions of status, control, select and settings
- Control location selection and indication for bridge control, ECR control and local control
- Sub-telegraph selection and indication for sea mode, standby and FWE (finished with engine) mode
- Limits cancel indication and operation key
- Slowdown indication, slowdown cancel and slowdown reset operation
- Shutdown indication, shutdown cancel and shutdown reset operation
- Start block indication and key selecting the start locking status list
- UMS2100 keys for the following alarm functions in the DMS computer:
    - Stop Horn and Alarm Acknowledge keys
    - Alarm List and Additional List key
    - Display Channel and Adjust Channel keys
    - Maintenance and Dimmer keys
    - Alarm and Fault indication lamps

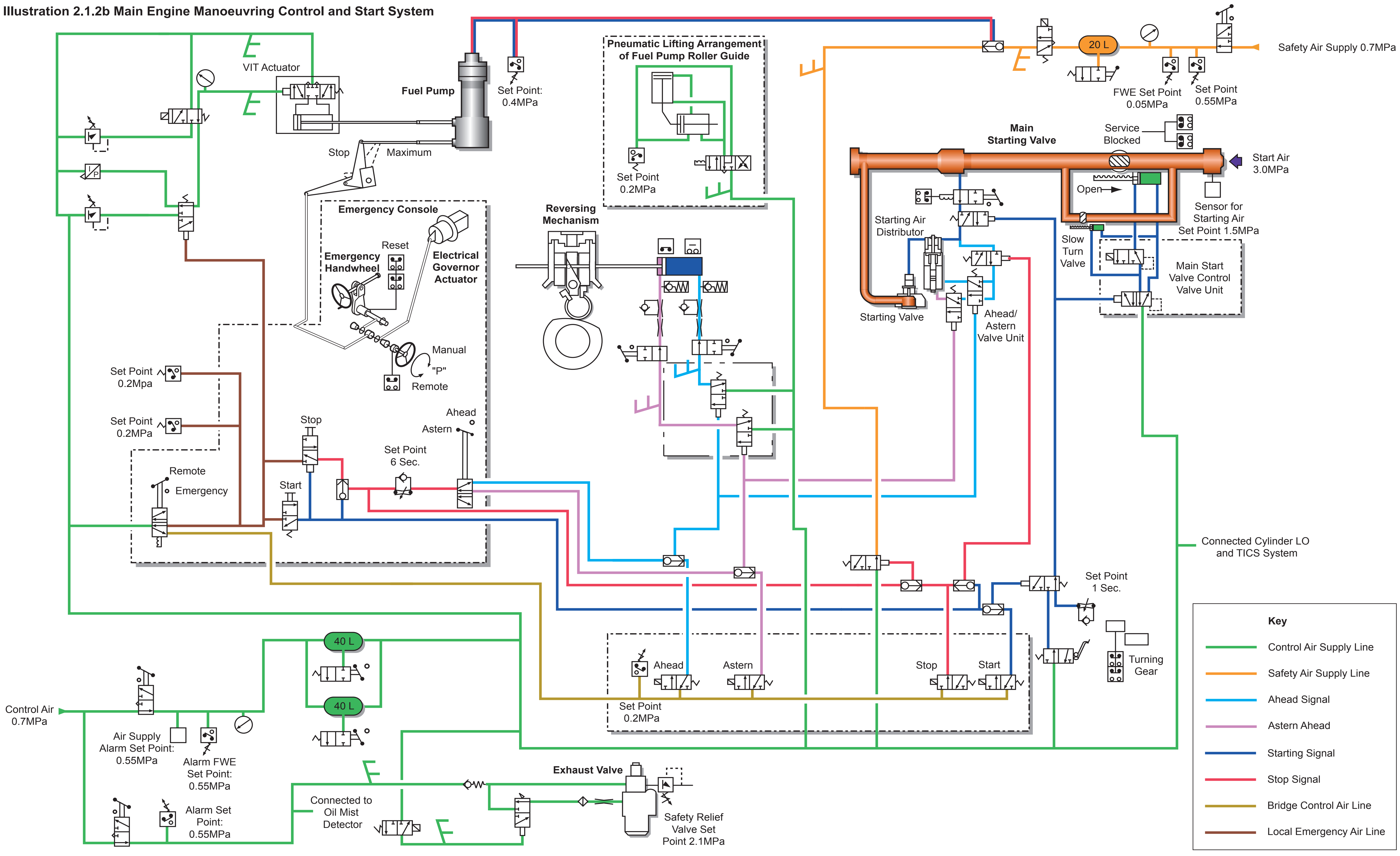
The LIMITS CANCEL key for SHUTDOWN and SLOWDOWN keys only work at the panel which is currently in control, however, the SLOWDOWN RESET can be configured to always have to be reset from the ECR panel.

The STOP HORN and ALARM ACKN. keys can be configured to work under different conditions:

1. Both keys always work in the ECR, when the Chief Engineer always wants to be able to acknowledge alarms. The buzzer and STOP HORN work on the bridge panel for all alarms which are announced on the bridge (configurable), but the ALARM ACKN. key will not work on the bridge
2. Both keys work at the current DMS control location, ie, working at any of the bridge panels and at the ECR panel.

In connection with the integrated UMS alarm system the function of both keys follows the UMS watch station.

Illustration 2.1.2b Main Engine Manoeuvring Control and Start System



Safety System for the Main Engine

The DMS2100i works in conjunction with the independent Diesel Protection System 2100 (DPS2100) for main engine emergency stop, overspeed and shutdown protection.

In the ECR the DPS2100 safety system has its own DPS2100 panel, which displays the relevant information for each shutdown input channel, actual main engine rpm, etc; it is also possible to make adjustments and cut-outs on the shutdown input channels.

Two keys with LED indication on the DPS panel are used for shutdown indication and shutdown cancel functions. At the bridge, the corresponding functions are shown on three keys on the DMS panel.

The following functions are included in the DPS2100 safety system:

- Shutdown stop output for the main engine
- Overspeed stop of the main engine
- Shutdown inputs
- Emergency stop of the main engine
- Alarm outputs to the alarm system
- Tacho output for main engine rpm to instruments
- Cancel and reset inputs from the DMS system, ECR and local control
- Local/remote and DMS control feedback

Main Engine Speed Measurement

The DMS2100i uses a Tacho Adapter Module to interface the tacho pick-ups mounted close to the turning wheel on the engine to one of the CPUs on the serial interface board used for measurement of the main engine speed.

Telegraph Transmitter and RPM Set Point Control

The bridge main operation station is equipped with a telegraph transmitter with a built-in set point potentiometer; this is located in the bridge centre console. The ECR is equipped with a similar telegraph receiver. The bridge centre and ECR telegraph levers are equipped with potentiometers with hardware connection to the DMS system, and they can also be used as the communicating engine telegraph system when running in manual ECR control.

Emergency Telegraph System

For back-up communication of telegraph orders from the bridge to the ECR during ECR control, and/or to the engine side control stand in the engine room during local control, the system is fitted with a separate emergency telegraph system, which is completely independent of the DMS2100i bridge control system and the normal communication telegraph levers.

By means of a dial indicator and lamps for each telegraph order, the communication telegraph indicates the requested order. On the bridge the dial is to the correct position for the new order and the indicator lamp for that direction and speed will start flashing. In the ECR and at the engine side a bell will start sounding, and at the engine side emergency telegraph the light for the desired speed and direction position will start flashing.

To accept the new order the dial at the engine remote control station emergency telegraph must be turned to correspond with the desired engine speed and direction. The lamp will change to a steady light and the bell will stop.

DMS2100i Operational Description

Selection of Control Modes

There are different control modes available to operate the propulsion plant:

- Remote Control from the Bridge (Remote Bridge Control)
- Remote Control from the ECR (Remote ECR Control)
- Manual/Emergency Control from the Local Control Station (LC Control)
- Manual Control from the ECR (Manual ECR Control)

Control modes are selectable/changeable at the:

• Local control station:	LOCAL/REMOTE
	LOCAL/MANUAL
• Engine control room:	REMOTE ECR
	REMOTE BRIDGE
	MANUAL ECR

Note: Only in the remote mode does the bridge manoeuvring system, DMS, have control of the engine.

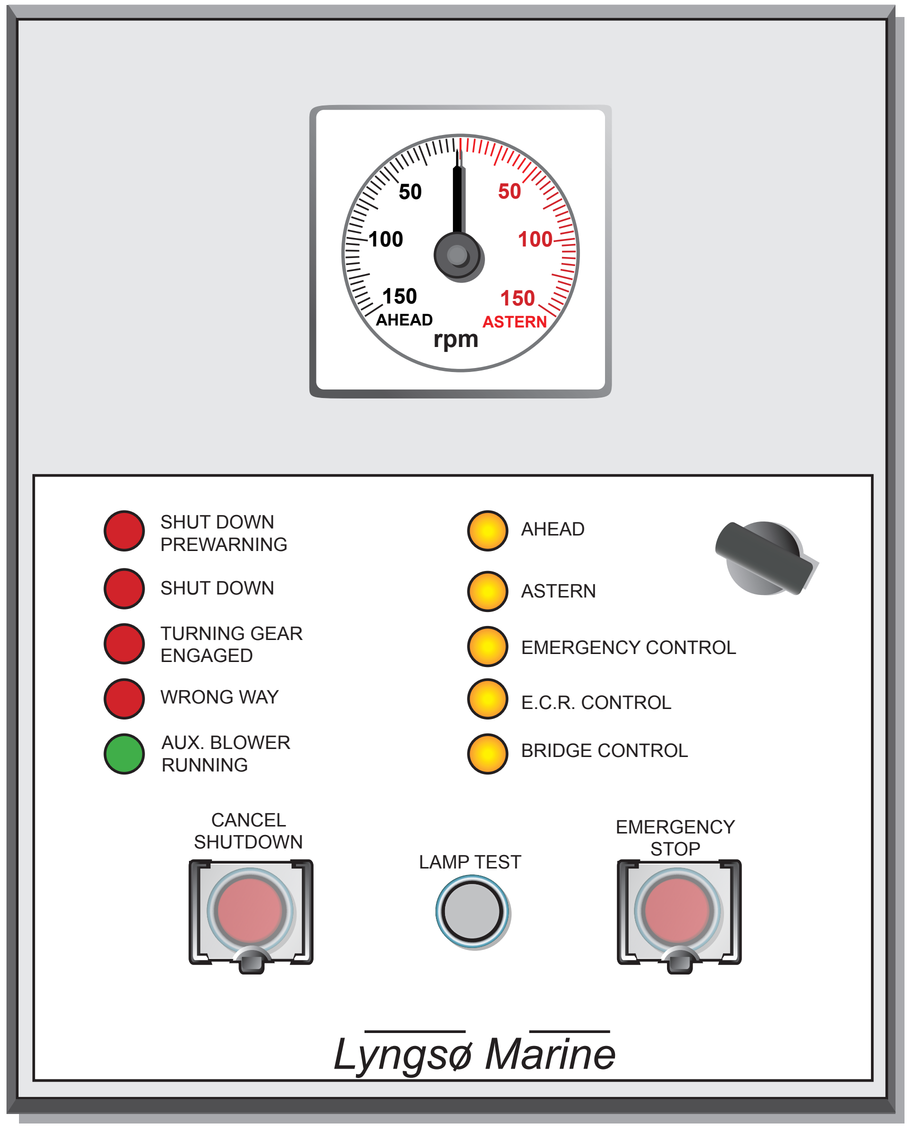
Transfer of control modes may be preselected at the active control stand, but will only be executed after acknowledgement at the requested control station.

The transfer can be:

- Proposed by the active control stand with the higher priority
- Requested by the target control stand with the lower priority

Note: In an emergency the transfer of control to the ECR may be carried out with the changeover switch on the ECR console. This forced changeover can be carried out without acknowledgement from the bridge, although the bridge indicator lamps and buzzer are activated until the changeover has been accepted.

Illustration 2.1.2c Engine Side Control Panel



Remote Mode

Local Control to Remote Mode ECR

Note: Any change of control mode from local control to remote control should be done with the engine at a standstill.

Start condition: Control Mode in Local Control.

The actual control mode is displayed at the operating panel on the bridge and in the ECR. The LED in the button LOCAL CTRL shows a steady yellow. In the first line of the display the text 'LOCAL CTRL' indicates the actual control mode.

To Change the Control Mode to Remote

- Disengage the fuel regulating lever on the local control stand and engage the governor.
- Turn the pneumatic selector valve lever from LOCAL to REMOTE.

This activates the buzzer on the ECR console panel and the ECR CTR button LED will flash.

- Acknowledge the change by pressing the ECR CTR button on the ECR panel.

Following this, the control mode changes to 'AUTOMATIC ECR'. This is indicated at the ECR panel and at the bridge panel. The LED in the button ECR CTRL shows a steady yellow. In the first line of the display the text 'AUTO CR' indicates the actual control mode. Additionally, the remote control position is indicated at the local engine side control box.

Note: A change from local control directly to automatic bridge control is not possible. There is only one exception: If the ECR telegraph potentiometer fault is present at the time of change request, the proposal to change to automatic bridge is automatically given and has to be acknowledged.

ECR to Bridge Control Mode

Start condition: Control Mode in Automatic ECR.

The actual control mode is displayed at the operating panel on the bridge and in the ECR. The LED in the button ECR CTRL shows a steady yellow. In the first line of the display the text 'AUTO CR' indicates the actual control mode.

There are two ways to change control mode to automatic bridge:

- By proposal from the ECR to the bridge
- By request from the bridge to the ECR

To propose the change of control mode from the engine room, the button BRIDGE CTRL has to be pressed at the ECR panel. Following this, the LEDs in the buttons BRIDGE CTRL in:

- The bridge panel starts flashing yellow to indicate the proposal to change operating mode.
- The ECR panel starts flashing yellow to indicate the proposal to change operating mode.

The proposal is audibly signalled at the bridge panel. The proposal has to be acknowledged by pressing the button BRIDGE CTRL at the bridge panel. Following the acknowledgement, the LEDs in the button BRIDGE CTRL in both panels turn to steady yellow and the changeover switch on the ECR console is turned to BRIDGE, and the change to automatic bridge control is completed. Additionally, the text 'AUTO BRIDGE' is displayed.

Note: Pressing the button ECR CTRL at the still active ECR control stand cancels the proposal. The control mode as well as the indications at the operating panels remain in the previous state.

To request the change of control mode from the bridge, the button BRIDGE CTRL has to be pressed at the bridge panel. Following this, the LEDs in the button BRIDGE CTRL in:

- The bridge panel starts flashing yellow to indicate the request to change operating mode.
- The ECR panel starts flashing yellow to indicate the request to change operating mode.

The request is audibly signalled at the ECR panel. The request has to be acknowledged by pressing the button BRIDGE CTRL at the ECR panel. The acknowledgement does not change the control mode. It is only an agreement to the request and results in a proposal to change as described before. If this proposal is acknowledged at the bridge and the changeover switch turned to BRIDGE, the change of control mode takes place.

Bridge Control to ECR Control Mode

Start condition: Control Mode in Automatic Bridge.

The control mode is displayed at the bridge and ECR operating panels. The BRIDGE CTRL. button LED shows steady yellow. In the first line of the display the text 'AUTO BRIDGE' indicates the actual control mode.

There are two ways to change control mode to automatic ECR:

- By proposal from the bridge to the ECR
- By request from the ECR to the bridge

To request the change of control mode from the bridge, the button ECR CTRL. has to be pressed at the bridge panel. Following this, the LEDs in the button ECR CTRL in:

- The bridge panel starts flashing yellow to indicate the request to change operating mode.
- The ECR panel starts flashing yellow to indicate the request to change operating mode.

The request is audibly signalled at the ECR panel. The request has to be acknowledged by pressing the button ECR CTRL at the ECR panel. Following the acknowledgement and the changeover switch is turned to ECR, the LEDs implemented in the button ECR CTRL in both panels turn to steady yellow to indicate the change to Automatic ECR. Additionally, the text 'AUTO CR' is displayed.

Note: Pressing the button BRIDGE CTRL at the still active bridge control stand cancels the proposal. The control mode as well as the indications at the operating panels remain in the previous state.

To request the change of control mode from the ECR, the button ECR CTRL has to be pressed at the ECR panel. Following this, the LEDs in the button ECR CTRL in:

- The bridge panel starts flashing yellow to indicate the request to change operating mode.
- The ECR panel starts flashing yellow to indicate the proposal to change operating mode.

The request is audibly signalled at the bridge panel. The request has to be acknowledged by pressing the button ECR CTRL at the bridge panel. The acknowledgement does not change the control mode. It is only an agreement to the request and results in a proposal to change as described before. If this proposal is acknowledged at the ECR, the change of control mode takes place. Following the acknowledgement and the changeover switch turned to ECR, the LEDs in the button ECR CTRL in both panels turn to steady yellow to indicate the change to Automatic ECR. Additionally, the text 'AUTO CR' is displayed.

Note: In all cases of transfer, the telegraph levers for the two control positions must be in alignment before the transfer may be completed. To assist with this a bar graph showing the two lever positions is automatically displayed during changeover and the telegraph lever in the takeover station should be adjusted as necessary.

Manual ECR Mode

The main engine control position changeover switch allows control to be changed from automatic bridge control to manual control in the cargo and engine control room (ECR) at the engine manoeuvring panel.

Automatic to Manual ECR Mode

Start condition: Control mode in:

- Automatic Bridge or
- Automatic ECR

The actual control mode is displayed in the operating panel on the bridge and in the ECR. The LED implemented in the button BRIDGE CTRL shows a steady yellow light. In the first line of the display the text 'AUTO BRIDGE' indicates the actual control mode.

To change the control mode to MANUAL ECR:

- Put the main engine control position changeover switch in the ECR position. (It will be in the Bridge position when under automatic control from bridge or ECR.)
- Put the local levers to the REMOTE position. (It will always be in this position except when under LOCAL control.)

Note: Before changing the control mode from automatic to manual ECR, the set points should be set to the same value (lever match), because the change from the old set point (Automatic bridge or Automatic ECR) to the new set point (Manual ECR) is done in one step. A big deviation between the set points will result in a rough change of the engine's speed.

The LED implemented in the button ECR CTRL in the not active control stand turns to a steady yellow light the moment the change is carried out to indicate the new control mode:

- The text 'MANUAL CR' is displayed at both operating and indication panels
- The indication lamp MANUAL ECR at the ECR sub-panel lights up

Note: It is not possible to prevent the change at the bridge, because the ECR has the higher priority.

Local Control

The selection of local control is always made directly without any previous request by putting one of the local control levers out of the REMOTE position. Following this, the LED implemented in the button LOCAL CONTROL in the panel of the last active control stand turns to a flashing yellow light to indicate the change of operating mode. The change is also audibly signalled at the last active control stand, and has to be acknowledged there by pressing the button LOCAL CTRL. The LED implemented in the button LOCAL CTRL in the former active control stand turns to a steady yellow light at the moment the change is carried out.

To indicate the new control mode:

- The text 'LOCAL CTRL' is displayed at both operating and indication panels
- The indication lamp LOCAL CONTROL at the ECR sub-panel is illuminated
- The indication lamp EMERGENCY CONTROL at the local control box is illuminated

Note: It is not possible to prevent the change at the bridge, because the local control stand has the highest priority.

Sub-Telegraph

The sub-telegraph is used to give an order to the engineer officers and is a one-way communication system, ie, the bridge gives an order and the engine staff acknowledge it by pressing the panel key associated with the order. The following orders can be signalled:

FWE:	Finished with engines. The main engine is stopped and cannot be started.
Standby:	The main engine is ready or running but engine staff are needed on standby duty.
Sea Mode:	The main engine is running normally and engine staff are no longer required for main engine operations.

There will always be one of these orders present in the system.

When the bridge wants to change to a new order, the desired panel key on the bridge panel must be pressed. The LED in the panel key will start flashing, both on the bridge and the corresponding LED in the ECR panel. The changeover buzzer will also sound and the LED indicating the old order will remain as a steady light.

When the engineer has pressed the flashing panel key, the changeover buzzer will stop, but the LED will continue flashing until all the conditions for the order have been fulfilled. When the conditions for the order have been fulfilled, the LED will switch to a fixed light and the LED indicating the old order will be extinguished.

If the order is not acknowledged, the flashing LED in the key can be pressed again to cancel the change of order.

Note: Direct change from FWE to Sea Mode is disabled.

Conditions for Finished With Engine (FWE)

The following conditions are necessary for FWE:

- Control air pressure off
- Safety air pressure off
- Main start valve blocked

Conditions for Standby

The following conditions are necessary for standby:

- Control air pressure on
- Safety air pressure on
- Main start valve not blocked
- Starting air distributor not blocked
- Turning gear not engaged.

Conditions for Sea Mode

The following conditions are necessary for sea condition:

- Control air on
- Safety air on
- Main start valve not blocked
- Starting air distributor not blocked
- Turning gear not engaged

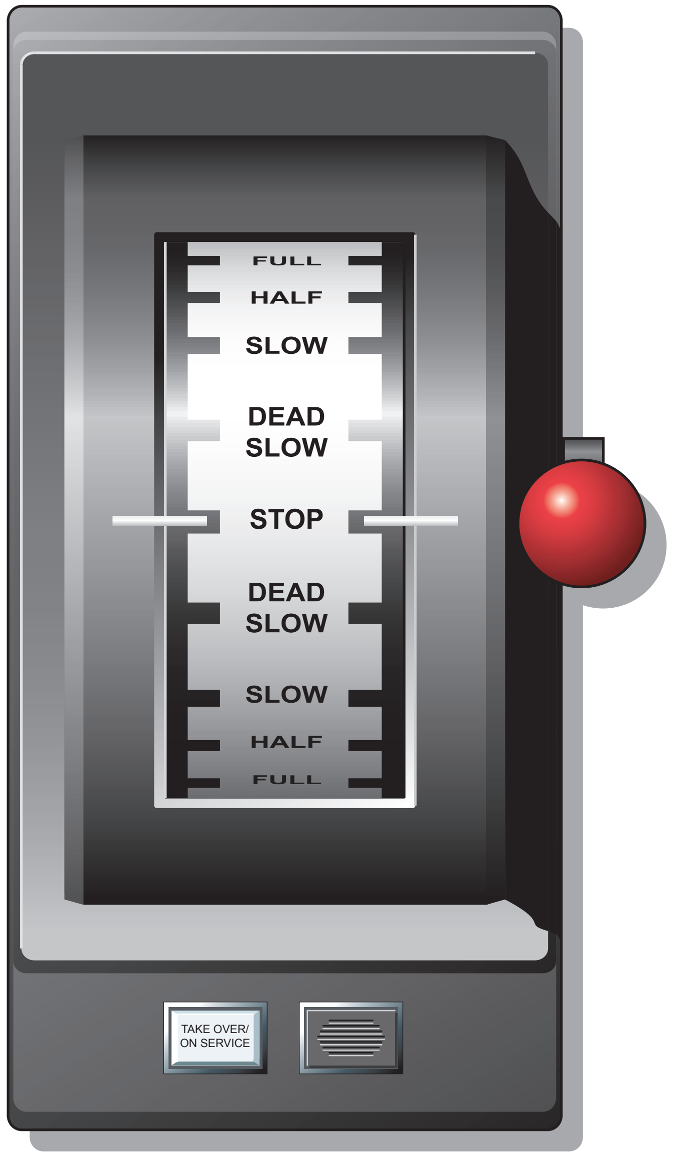
Note: The conditions for the sub-telegraph can be customised from the customising tool.

Main Engine Start/Stop

Automatic Bridge Control

When bridge control is selected and the system is not in FWE mode, starting, stopping and control of the main engine speed is controlled by the position of the bridge telegraph handle. Moving the telegraph handle from stop to ahead or astern will cause the starting sequence to be activated, ie, starting air will be supplied until the main engine rpm has reached starting level. At this point starting air is removed and fuel is supplied for approximately 8 seconds at a preset speed setting level. If the rpm is increased in this period the start is considered successful and the rpm is set to the telegraph set point value (except when limits are set by a slowdown, load-program, or other limiting programs).

Illustration 2.1.2d Engine Control Room Telegraph Unit



If the main engine start attempt failed, a new repeated start will automatically be executed after a delay of 8 seconds. After three failed start attempts a start blocking occurs, and the bridge has to move the telegraph handle to the stop position before a new start can be performed.

If the main engine is ordered to move in the opposite direction whilst still rotating, starting air will not be supplied until the engine's speed has decreased below the reversing level. This may take several minutes depending on the ship's speed, propeller size, loading condition and other ship parameters.

The speed may be set to any speed on the telegraph scale, eg, dead-slow, slow, half and full in both directions, in addition to stop.

ECR Control

When ECR control is selected, the starting, stopping, reversing and speed-control of the main engine is handled from the ECR telegraph handle located in the ECR control console.

When the bridge requests a speed change, the main engine direction and speed is altered by moving the bridge telegraph control handle to the desired position, and this will initiate the telegraph alarm. An engineer in the ECR moves the ECR telegraph handle to the same position as that of the bridge telegraph. This performs the necessary speed and direction change and at the same time acknowledges the telegraph alarm.

Start Blocking

If the engine is not ready for a start, ie, it is start blocked, the start block LED on the panel is illuminated and a START BLOCK indication is displayed on line two of the Start/Stop control display, ie, on the line above the soft keys. When the engine is ready for a start, the indication changes to either STOPPED or SLOWD REQ., indicating if the next start will be with or without slow-turning.

Start blocking is activated by the following:

- Main engine local control on
- Main engine safety system shutdown or emergency stop
- Start failure (start air time-out or maximum number of failed start attempts)
- Slow turning failure (time-out)
- Main start valve blocked
- Start air distributor blocked
- Turning gear engaged
- Control air pressure low
- Safety air pressure low
- Start air pressure low
- Auxiliary blowers not in automatic mode
- Engine running

Reversing

During a normal ahead or astern start from standstill, the DMS will activate the main engine ahead or astern reversing valve, together with the start valve, when the bridge telegraph handle is moved to an ahead or astern start position.

The ahead or astern valve will activate the pneumatic cylinders used to reverse the camshaft roller guides and also reverse the starting air distributor.

Pneumatic interlocks on the engine ensure that starting air is not supplied to the engine before the starting air distributor is reversed to the correct position.

All camshaft roller guides will not be completely reversed before the engine starts turning on starting air, so there are no interlocks from the camshaft roller guides to the DMS.

Slow Turning

Slow turning of the main engine is normally used before the engine is started after a prolonged period of standstill, and is done by turning the engine for 1-2 revolutions on reduced starting air.

The engine is automatically slow turned when it has been stopped for more than 30 minutes by releasing the governor stop and activating the start valve and stop valve as for a normal start. At the same time the slow turning valve is activated. When the engine has turned a of minimum 1.5 revolutions the slow turning valve is released and the start sequence continues as a normal start sequence.

If the slow turning is not completed within the preset time the engine is stopped again by activating the governor stop and deactivating the start valve; a 'Slow turning time-out alarm' is released, giving a start blocking which must be reset by the operator before a new start attempt can be executed.

Slow turning is requested by pressing the MANUAL SLOW TURNING pushbutton at the operator panel.

Start/Stop

The engine is started by releasing the governor stop and activating the start valve and the ahead direction valve (or the astern valve if reversing), whilst the stop valve is still activated. When the engine rpm passes the firing speed limit the start and stop valve is deactivated and, after the stabilising time has expired, the ahead direction valve is deactivated (or astern valve if reversing) and the engine is running.

Crash Stop

The pre-conditions for a crash stop detection is that the telegraph lever set point must be above 75 rpm ahead for more than 60 seconds when the operator makes a reverse order to more than 20 rpm astern. The telegraph lever set point must be below 75 rpm ahead again for more than 15 seconds before the pre-conditions for detection of a crash stop is reset again. The crash stop condition is then maintained until either the astern set point order is moved below a speed of 10 rpm astern, or the actual rpm comes within 5 rpm of the astern set point limit of 20 rpm, or a maximum time-out of 300 seconds.

Note: The speeds and times are adjustable.

When the operator initiates a crash stop, the DMS will activate the governor stop and stop valve to stop the engine.

When the propeller speed has dropped below the reversing level of 20-25 rpm, the astern valve will be activated to reverse the engine and, after a further 5 second delay, the governor stop is released and the start valve will be activated to brake the ahead turning of the engine and start it up in the astern direction.

When the engine speed rises above the firing speed in the astern direction, the start and stop valves are released and the engine starts up on fuel.

After an 8 second stabilising time, the astern valve is deactivated and a further 8 seconds later the cancel limits to the governor are deactivated.

Repeated Start

If the start attempt is unsuccessful, a second start attempt is initiated and REP. START is indicated in the display and a repeated start alarm is released.

When the engine speed drops down below the firing speed the stop valve, governor stop and governor cancel limits are activated, a ‘Repeated Start Alarm’ is released, and after a 6-8 second time delay a new start is initiated, releasing the governor stop and activating the start valve again.

If the engine stops again after the maximum number of start attempts (normally three), the start sequence is terminated with an alarm for three start attempts and a start blocking, which must be reset by putting the telegraph lever to the stop position before any further start attempts can be made.

Main Engine Shutdown

The DPS2100 safety system takes care of the engine shutdown in case of a shutdown, overspeed or emergency stop alarm, by activating the emergency stop valve directly. All the shutdown inputs are connected directly to the DPS, and then sent as group alarms to the DMS, for indication on the DMS panels.

Two keys on the DPS panel are used for the following functions:

- SHUTDOWN, indicating shutdown activated (steady light) and activates the shutdown status list display.
- SHUTD. CANCEL, indicating shutdown pre-warning (flashing light) or activates and indicates if the shutdown is cancelled (steady light).

At the DMS panels on the bridge and in the ECR, the shutdown information is shown on similar keys, corresponding to the two keys on the DPS panel in the ECR.

In case of a shutdown, operators at the bridge and ECR are given a shutdown pre-warning alarm before the shutdown is executed by the safety system.

During the pre-warning delay for the shutdown, the LED in the SHUTD. CANCEL key on the DMS panel will flash. After the pre-warning delay time-out, the LED in the SHUT DOWN key on the DMS panels changes to steady illumination and the main engine is stopped by the safety system.

To silence the alarm buzzer the STOP HORN key must be activated, and to acknowledge the alarm the ALARM ACKN. key is pressed. If more alarms are present, the ALARM ACKN. key is pressed again until all alarms are acknowledged.

During the pre-warning delay the operator is able to cancel/override the shutdown, by pressing the SHUTD. CANCEL key; the LED at the key changes to a steady red light.

If the engine is already stopped before the SHUTD. CANCEL key is activated, the shutdown must also be reset before it is possible to start the engine again. To remove the cancel/override shutdown function, the SHUTD. CANCEL key must be activated once more.

When the shutdown memory has been activated, the reason for the shutdown must be removed and the shutdown reset, before a new start of the engine is possible. When the reason for the shutdown has been removed, the shutdown must be reset from the operating control location; in bridge control the bridge telegraph must be placed in the stop position to reset, in ECR control the manual control lever must be placed in the stop position to reset, and in local emergency control the regulating handle must be put to the zero fuel index position to reset the shutdown.

The emergency stop function is also a part of the safety system, with independent pushbuttons on the bridge and in the ECR, each wired in parallel to the safety system. Activation of one of the pushbuttons will cause an emergency stop of the engine even if the panel is not in control.

When the engine has been stopped by use of the emergency stop function, restart of the engine is blocked until the emergency stop pushbutton has been released again and the shutdown memory is reset from the present control location.

Main Engine Slowdown

The main engine slowdown system is an integrated part of the DMS system. The slowdown inputs are connected directly to the DMS.

The slowdown information is shown on three keys at the DMS panel, both in the ECR and on the bridge. It is also possible to see the status information about each slowdown on the slowdown status display. The slowdown inputs are treated like an alarm input to the alarm system.

The three keys on the DMS panel are used for the following functions:

- SLOW DOWN key indicates slowdown activated (steady light), and activates the slowdown status list display.
- SLOWD.CANCEL key indicates slowdown pre-warning (flashing light) and indicates if the slowdown is cancelled.
- SLOWD.RESET key activates reset of the slowdown memory.

In the event of a slowdown the operator at the bridge and/or ECR receives a slowdown pre-warning alarm, before the slowdown is executed by the DMS system. Only one slowdown function results in an automatic slowdown, the oil mist detector, the others activate an alarm and the duty engineer then decides whether to slow the engine or not.

During the pre-warning delay for the slowdown, the LED in the SLOWD. CANCEL key on the DMS panel will flash. After the pre-warning delay time-out, the LED in the SLOW DOWN key on the DMS panel will change to a steady light, and the main engine rpm set point will be reduced to the slowdown level by the DMS set point system. To silence the buzzer the STOP HORN key must be activated, and to acknowledge the alarm the ALARM ACKN. key pressed.

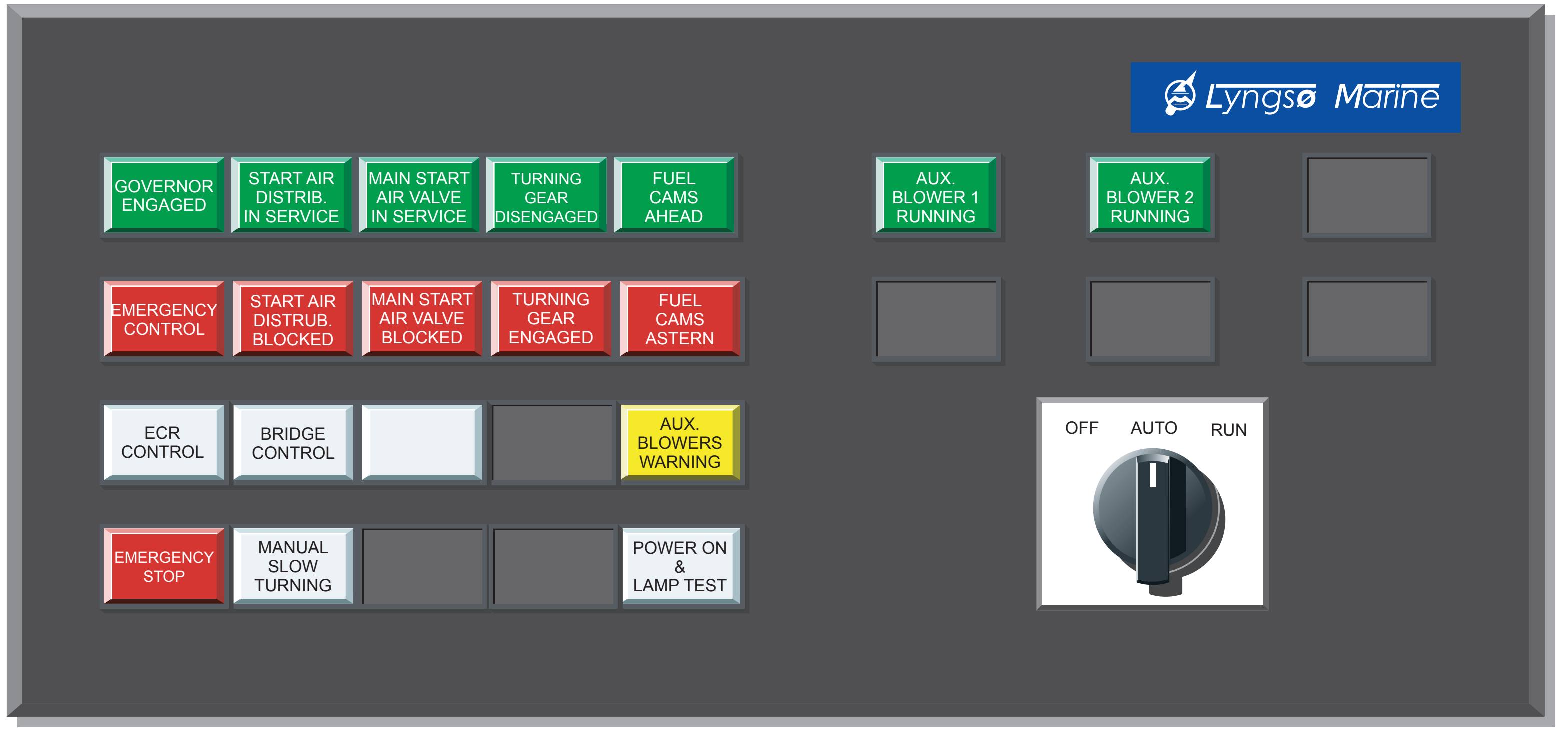
During the pre-warning delay the operator is able to cancel/override the slowdown by pressing the SLOWD. CANCEL key.

To remove the cancel/override slowdown function, the SLOWD. CANCEL key must be activated once more.

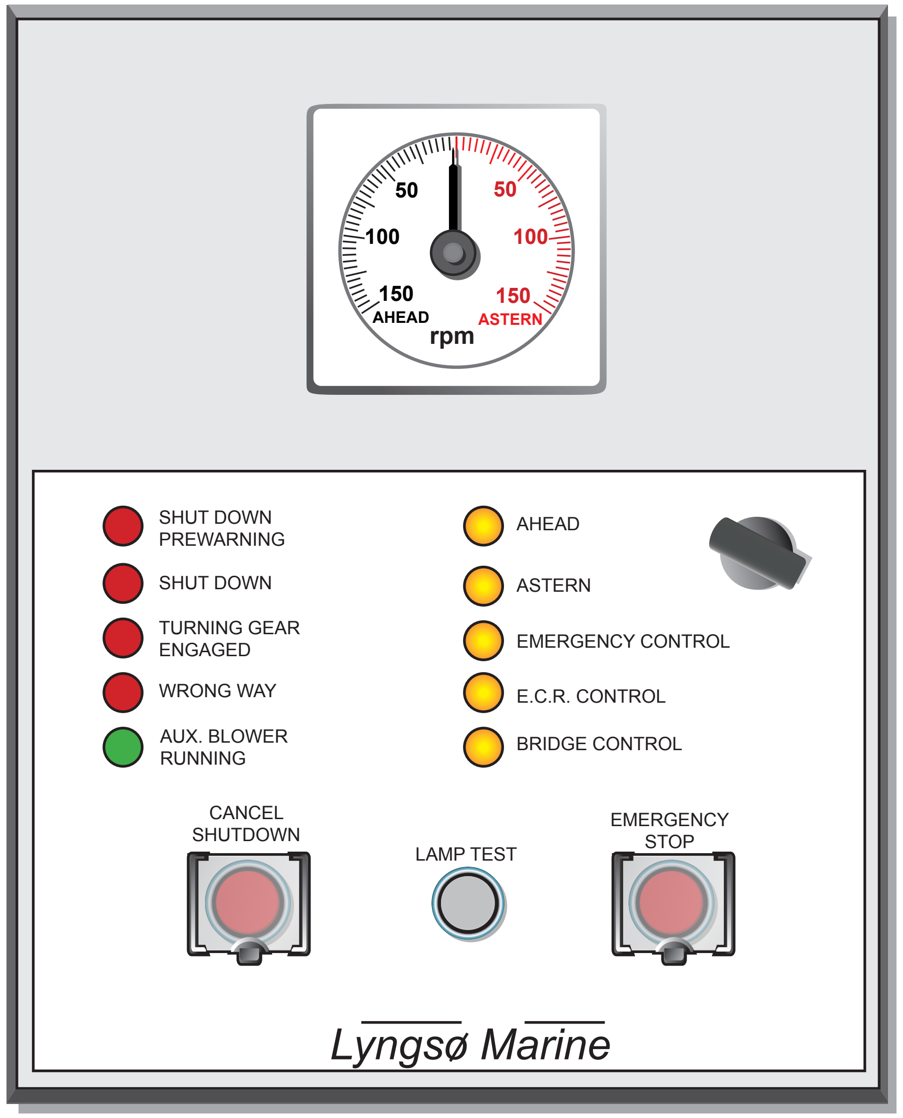
When a slowdown has been activated, the reason for the slowdown must be removed and the system reset before the load on the engine can be increased to the command level. When the reason for the slowdown has been removed, the slowdown memory is reset by pressing the SLOWD. RESET key on the DMS panel, or by moving the set point lever in command down below the limit for slowdown and then increasing it again. A slowdown is also reset if the engine is stopped by putting the telegraph lever in the stop position.

Illustration 2.1.2e Manoeuvring System Panels

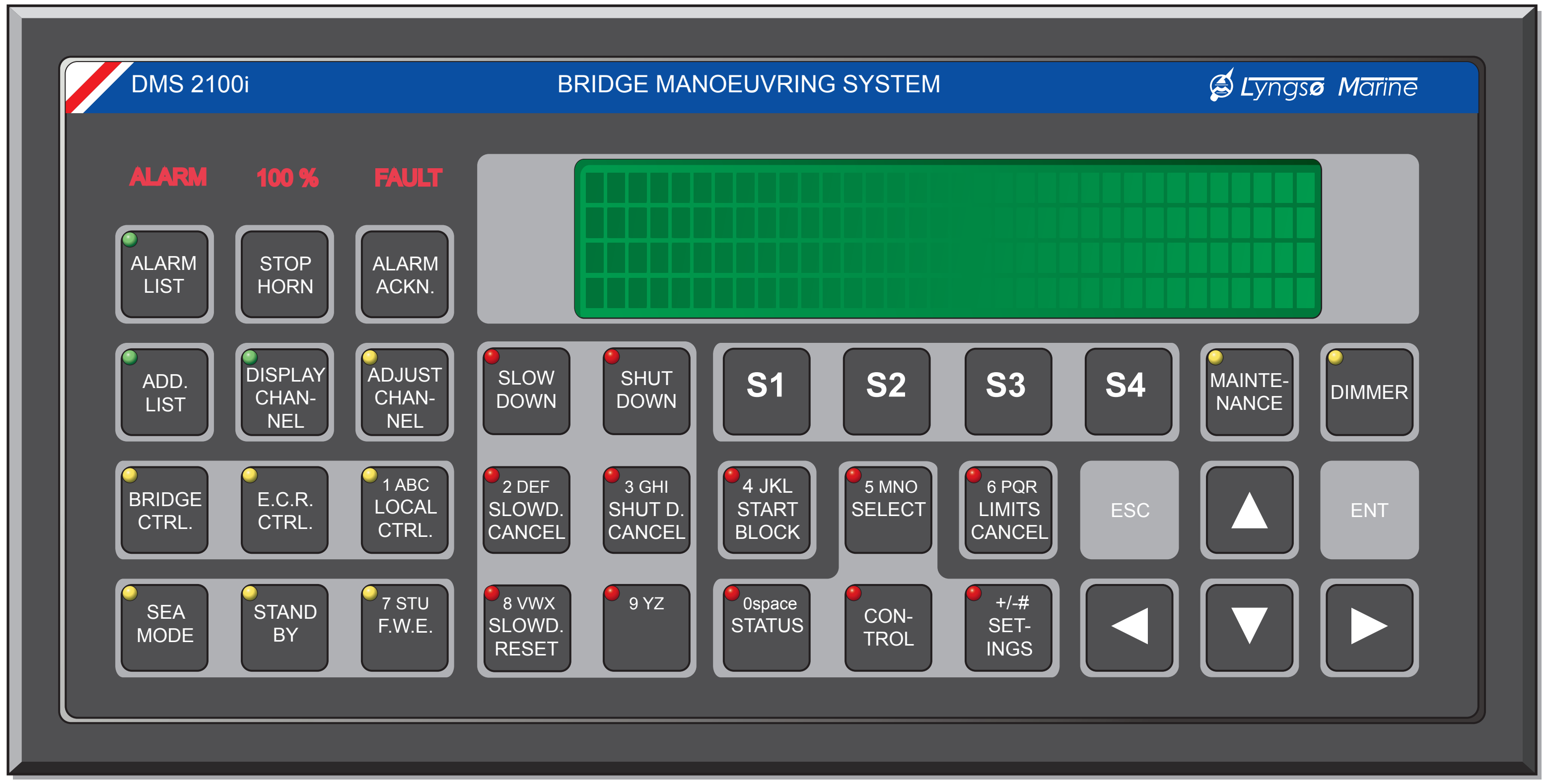
Control Room Indication Panel



Local Control Station Indication Panel



Control Room Manoeuvring Panel



Set Point System

The set point system converts the potentiometer set points from the telegraph levers mounted on the bridge and in the ECR, to the main engine rpm set point output for the governor. This conversion is made in accordance with the speed request curves set-up in the DMS system. No adjustments should be made without just cause or without the authority of the Chief Engineer.

Set Point Lever Adjustments

It is possible to adjust the following set point inputs, but adjustments are password protected and must only be made by approved personnel:

1. Telegraph lever rpm set point (bridge)
2. Telegraph lever rpm set point (ECR)

Main Engine RPM Governor Set Point

The main engine rpm is controlled by an electronic governor. The input to the electronic governor is normally a 4-20mA current signal corresponding to the requested rpm range. Adjustment must only be made by approved personnel.

Slowdown RPM Set Point

When the main engine slowdown is active, the rpm set point is limited to the adjustable slowdown limit after a certain time delay (adjustable).

RPM Set Point Slope

Acceleration and deceleration rates are specified by a fixed setting which is adjustable by the customising tool, and specified in shaft rpm/sec.

Barred Speed Range

The main engine has a barred speed range between 70 - 84 rpm.

Governor Output Scaling

To enable the engineer to readjust the governor rpm output, the DMS allows for re-scaling from the DMS panel (password protected), where it is possible to adjust the rpm set point/mA relationship for the following values:

1.	Minimum rpm, eg, 20 - 25%	
2.	Dead Slow rpm,	35 rpm
3.	Slow rpm,	65 rpm
3.	Half Ahead rpm,	87 rpm
4.	Full Ahead rpm,	100 rpm
5.	Maximum rpm,	127 rpm

Slow Turning

Slow turning of the engine is possible by pressing the MANUAL SLOW TURNING pushbutton on the ECR console operating panel. If the engine has been stopped for longer than a preset period (adjustable) a slow turning is initiated by the control system upon the next start. On the display the message SLOW TURNING REQUESTED is displayed and the LED on the request button is illuminated when in automatic mode. If a slow turning has been initiated by pressing the MANUAL SLOW TURNING button, the LED in the button flashes.

The DMS monitors slow turning by counting the speed pulses, if the crankshaft does not achieve the desired full revolution within 30 seconds the slow turning failure alarm is initiated. Slow turning failure results in a start interlock. Acknowledging the alarm at the operating panel resets the interlock and enables a new slow turning or engine start to be activated.

Note: If slow turning failure occurs, the engine must not be started until the reason for failure has been determined and corrected. In an emergency situation the start interlock can be cancelled by the cancel limits at the bridge panel and the engine can be started.

Automatic Start of the Engine

The engine may be started in automatic mode if the BRIDGE CTRL or ECR CTRL has been selected at the main panel. When the engine has been prepared for sea and no start interlock is active, the engine may be started via one of the telegraph units in the ECR or on the bridge.

Start interlocks are activated by the following conditions:

- Starting air pressure low
- Turning gear engaged
- Line break of valves
- Loss of automatic power signal
- Loss of manual power signal
- Loss of sensor power signal
- Actuator blocked
- Electronic governor fault
- Safety system off
- Serial interface to safety system lost
- Slow turning failure
- Plant interlock

A start interlock is alarmed and indicated at the control panels on the bridge and in the ECR. A start is carried out by moving the lever of the active telegraph unit from the STOP position to another position in the ahead or astern direction. If reversing is required, this is undertaken by the system as explained above. Auxiliary blowers are preselected by the DMS when the engine is ordered to start, provided that the selector switch is set to AUTO. The auxiliary blower selector switch may also be set to STOP or to MANUAL if required. A further start sequence only proceeds when at least one auxiliary blower sends an ON signal.

The start sequence energises the start solenoid valve and the start ahead or astern solenoid valve. This activates the starting air distributor, repositioning it if necessary. Air supply to the cylinders is initiated and the engine will begin to turn on starting air.

When the DMS senses the correct rotational speed (in the desired direction) the DMS enables fuel admission by de-energising the FUEL ZERO ORDER and the GOVERNOR STOP signal. The engine then runs on starting air and fuel.

When the ignition speed is exceeded, the starting air is shut off by de-energising the start cut-off valve and the engine runs on fuel only. The start and start ahead or start astern valves remain open, and any necessary restart is activated by the start cut-off valve only. At the end of the start settling period, about 6 to 8 seconds, when the possible need for a restart has passed, the start and start ahead or start astern valves are de-energised, causing the main start valve to close. Some 3 seconds later the start cut-off valve is de-energised.

The DMS allows for 3 attempts to start the engine at any start request.

After the start settling period has expired the DMS accelerates the engine to the telegraph set point by adjusting the fuel supply according to preset rates. When decelerating the engine, the fuel supply is adjusted according to similar set rates.

Failure to Start

If the engine fails to start when the starting sequences is initiated the following measures are taken.

If no engine speed is sensed within the maximum starting time the start valve is de-energised and the start fault alarm is triggered on the operating panels.

If the engine turns but does not reach ignition speed or falls below ignition speed again, the repeat start alarm is triggered and two further attempts at starting are carried out. If these attempts fail the start fault alarm is triggered.

If the engine exceeds the ignition speed but stops within 20 seconds, a further start attempt takes place. Another attempt may also take place if this fails to produce the desired speed. If the engine stops unintentionally after this time the engine stopped alarm is triggered.

The start fault and engine stopped alarms are automatically reset when the active telegraph lever is moved to the stop position.

Restarting the Engine in the Same Direction

When the active telegraph lever is moved to the stop position the fuel zero order is energised. If the active telegraph lever is moved out of the stop position to a position in the same direction as the engine is turning, and the engine is still turning above the ignition speed (due to the drag effect of the water on the propeller), the fuel zero order is de-energised and fuel admission to the engine is allowed.

If the engine has stopped or is turning at a speed below the ignition speed a normal automatic start is carried out as described above.

Similar conditions apply for deceleration, but the rates for deceleration are different from those for acceleration.

Governor Speed Set Point

The position of the telegraph handle creates the desired value in the form of a milli-voltage, this signal is processed in the DMS and sent as the speed set point to the electronic speed governor EGS2000 via the serial interface.

The telegraph lever covers the range between STOP to FULL AHEAD and FULL ASTERN.

Sub-Telegraph Commands

Three keys on the operating panels are provided for additional telegraph functions, these being:

- Finished with engines (FWE)
- Standby
- Sea mode

Commands which are given at the bridge panel have to be acknowledged at the ECR panel. Unintentionally given commands at the bridge operating panel pushbuttons can be cancelled by pressing the pushbutton again, as these have an on/off function.

The FWE order can only be ordered if the control lever is in the stop position and the main engine has already stopped.

The condition sea mode will automatically be cancelled when FWE is ordered.

Sensing of Engine Speed

For safe and reliable operation of the engine, three speed threshold values are defined.

The RPM is Above Ignition Speed

This value is important for the start procedure, as it defines fuel admission and the cut-off of starting air.

Overspeed

This is essential for engine safety, and if the engine speed exceeds this value the engine is stopped immediately.

Bad Weather Speed Limitation

A reduced maximum speed is defined to prevent excessive engine speed in bad weather conditions due to the propeller coming out of the water. The above values are adjustable.

Main Engine Limitations

To protect the propulsion plant against damage caused by events such as overload, faulty operating conditions or heavy sea states, the DMS or Engine Safety System (DPS) automatically activates limitations. The individual limits are set by the respective parameters and ramp functions control the acceleration/deceleration program.

Slowdown

The engine safety system (DPS) and/or the alarm and monitoring system can request an automatic reduction in speed by a signal to the DMS. The slowdown level is set by means of a parameter, and it acts as a limitation for the speed set point in the ahead and astern directions. Indications on the bridge and ECR DMS panels show:

Bad Weather Condition

Bad weather speed limitation is intended to prevent engine shutdown due to overspeed. If the engine speed reaches approximately 105% of the set speed three times or more within two minutes, the speed set point value is automatically limited to a value of approximately 85%.

The condition is indicated on the bridge and ECR operating panels. The limitation remains active until the telegraph lever is moved to a position representing a speed value below the speed limit value.

It is possible to suppress the bad weather limitation using the menu item Bad Weather Monitoring on the control panel.

Manual Limitations

It is possible to activate a limitation manually at the ECR panel by pressing the pushbutton RPM LIMIT and using the cursor keys on the ECR DMS panel to define the desired manual speed limit. The pushbutton is illuminated and the text SPEED SET LIMITED is displayed.

Engine Supervision

The DMS carries out supervision of the engine pneumatic system, the fuel rack and the functioning of the operating control modes:

- Feedback of the control modes
- The start sequence
- The stop sequence
- The reversing sequence
- The unintended engine stop

Other operating data for the engine, such as lubricating oil and cooling water are monitored by the DPS and UMS systems.

Starting Air

An analogue input channel is provided for starting air pressure, and loss of air pressure will produce an alarm condition which will be displayed at the DMS panel in the ECR and on the bridge. A start interlock will also be activated when operating in automatic mode from the bridge.

Feedback of the Active Control Mode

The following inputs are provided for control mode feedback:

- Automatic control selected
- Manual ECR selected
- Local engine control selected

The selected and activated control mode is indicated:

- At the local control box
- At the ECR sub-panel
- At the displays of the DMS panels

An alarm is triggered when:

1. The DMS is on bridge control mode, but the signal disappears after initial successful transfer.

2. The DMS is on automatic ECR control mode, but the signal disappears after initial successful transfer.

Start Sequence

The automatic start sequence has already been described. A start failure will trigger an alarm at the DMS panels after:

1. The first start attempt without any restart if no speed impulses have been sensed.

2. The third attempt when the engine was not able to reach minimum speed and remained turning on air.

3. A start failure has to be reset by moving the telegraph lever to the stop position.

Unintended Engine Stop

The alarm is triggered and the engine stopped signal is displayed at the DMS panel if, after a successful start with the engine operating for at least 20 seconds or during normal engine operation, the engine speed falls below the ignition speed and the engine stops without an active stop command. The alarm is reset by moving the active telegraph lever to the STOP position.

System Supervision and Fault Indication

The DMS hardware and peripherals are constantly monitored by the DMS in order to identify any faults which might develop. Supervision is carried out for:

- The bridge telegraph and ECR telegraph
- The speed sensing circuit
- The electronic governor
- The auxiliary voltages
- The solenoid valves
- The internal analogue/digital, as well as the digital/analogue converters
- The memory check
- The computer cycle

If a fault becomes active it is sensed by the DMS and this triggers audible and visual alarms; these are indicated at the operating panels on the bridge and in the ECR. The audible alarm is only activated at the station in control.

To comply with classification society rules, the system freezes the momentary operating conditions as far as possible. In a frozen condition the operator has to transfer control to manual mode in the ECR or at the local station. A reset can only be made in manual mode.

The above is a description of the features of the engine manoeuvring system. For details of the operation of the control system see Section 3.1, Main Machinery Control and Monitoring System.

Telegraph Order Printer TOP2100

The TOP2100 is a sub-system of the DMS system. Internal calculations from the DMS and the DPS systems are transmitted to the printer module and output to the telegraph order printer.

There are parameters to control the information output to the printer within DMS and a printer test facility in the MAINTENANCE menu within the DMS.

The following items are recorded from the DMS:

- Date and time
- Bridge, ECR and emergency telegraph orders
- Engine speed
- Control mode
- Sub-telegraph orders
- Limitations
- Cancel limits/cancel limits (wings)
- RPM load program
- ‘Frozen’ conditions
- Electronic governor fault
- Electric shaft or telegraph fault
- Serial interface to governor lost fault

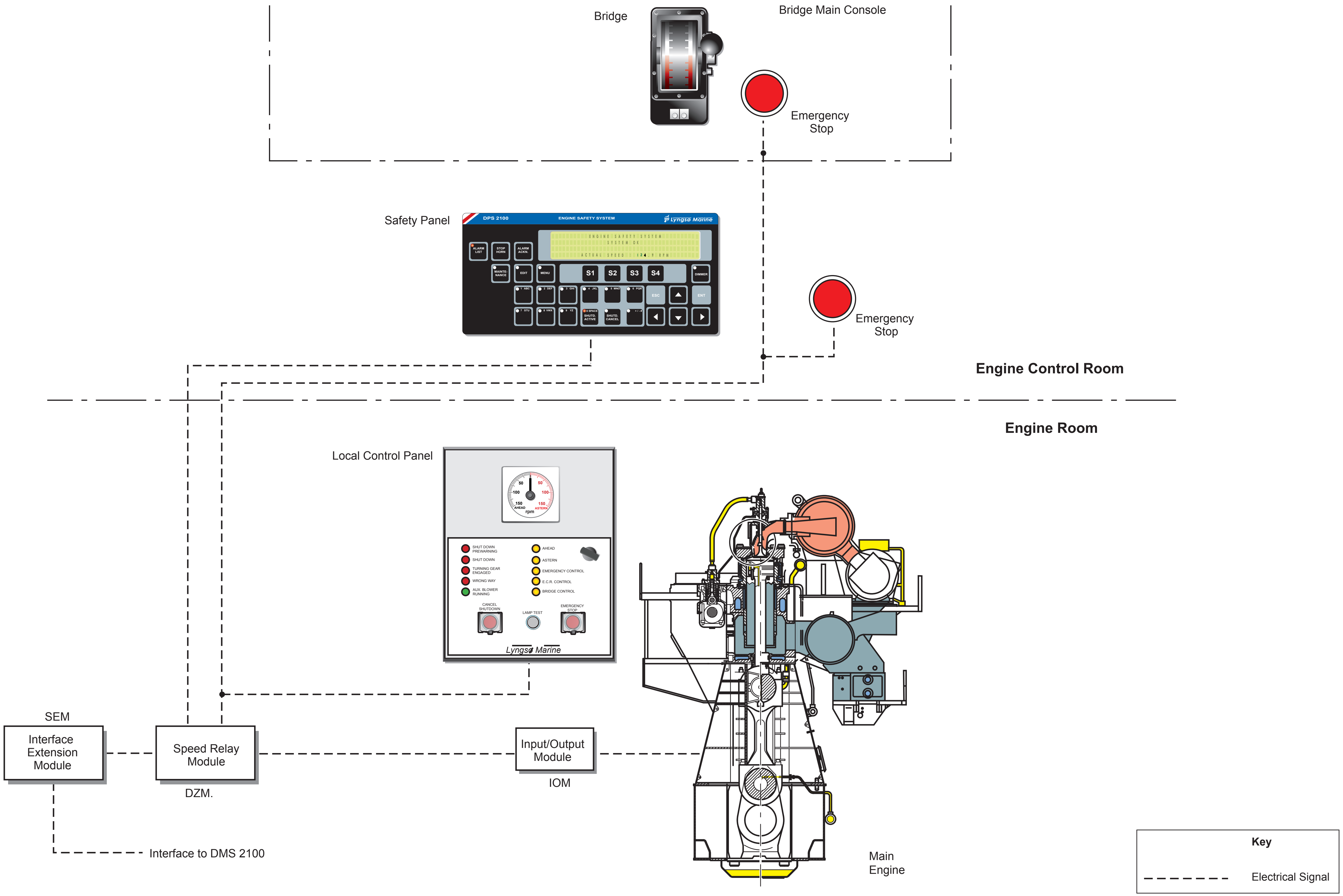
The following items are recorded from the DMS:

- Automatic slowdown
- Automatic shutdown
- Emergency stop with position of activation
- Cancel slowdown (slowdown override activated)
- Cancel shutdown (slowdown override activated)

Common abbreviations used on the printer:

- OBR: Order bridge
- REC: Response engine room telegraph
- OBL: Order bridge with limitations
- ACT: Actual speed

Illustration 2.1.3a Main Engine Safety System



2.1.3 MAIN ENGINE SAFETY SYSTEM

Main Engine Safety Equipment

Manufacturer:	Lyngsø Marine A/S
Model:	DPS 2100
Type:	Electronic
No. of sets:	1

Introduction

The engine safety system (DPS) is designed to monitor the ship's main engine performance and speed, then control the safety functions, such as shutdown and slowdown, if the engine's monitored operations exceed defined limits. The safety system provides the following control and monitoring facilities:

Control of:

- Emergency stop
- Engine shutdown
- Engine slowdown

Monitoring of:

- Engine speed
- Engine overspeed
- Engine shutdown sensors
- Engine slowdown sensors
- RPM detectors
- Emergency stop switches
- Emergency stop (auto-stop) solenoid valve

Main Operating Features

The engine safety system (DPS) is installed in parallel with the bridge manoeuvring system (DMS). It monitors, controls and protects the propulsion plant absolutely independently from the DMS. It protects the plant against inadmissible operating states in such a way that an alarm is not created until one of the limit values is exceeded. All limits are set to a value that poses no danger to the propulsion engine if they are exceeded. The alarms are visually indicated on the assigned operating panel, and in the ECR, audibly by buzzer. The limit values, delay times and consequences of the individual measuring points are written in the form of parameters. The parameters are part of the software and stored on the DZM (speed relay) module. In case of exceeding very important or, at least, dangerous limit values such as high cooling water temperature, low lubricating oil pressure etc, the DPS will activate an audible and a visual alarm. In such cases the DPS will also send the two following signals to the bridge manoeuvring system:

1. A SLOWDOWN request and a SLOWDOWN alarm and/or
2. A SHUTDOWN request and a SHUTDOWN alarm

The alarm is activated before the slowdown or shutdown action is carried out by the DPS in parallel with the DMS.

DPS Hardware

The hardware configuration of the DPS consists of:

- A group of electronic modules installed in the propulsion control cabinet (PCC)
- The operating panel, located in the ECR
- The illuminated emergency stop pushbuttons, located in each wing console, on the bridge console, on the ECR console and on the local panel in the engine room.

The DPS Electronic Modules

The electronic components consist of four electronic modules. They are also located inside the PCC. The electronic modules are:

1. The Interface Extension Module, SEM 402
   This module creates additional connections to the internal (DMS) and external (Monitoring System) serial bus system.
2. The Speed Relay Module, DZM 402
   This module is the central module of the DPS and contains the software for the DPS2100. It is also responsible for speed sensing and overspeed monitoring.
3. The Input (A1011)/Output(A1012) Modules, IOM 402
   This module has 32 digital inputs and 24 solid state outputs. The inputs and outputs are designed for line break monitoring.
4. Filter Module FIM 405
   This module filters the 24 volt supply.

The Operating Panel

Using the operating panel, the operator is able to communicate with the DPS. The panel is located in the ECR console with the front panel being divided into three parts:

- The display, located in the upper part
- Three rows of keys below the display
- A group of 2 signal lights and 3 columns of keys at the left side

The display is able to show on 4 rows, each with 40 segments or characters, containing information about the engine system operating state. It is possible to read all nominal and actual values, and other operating data, or the contents of lists. The request to change the operating state and condition is carried out by using the keys, the requests are shown on the display. Alarms and internal faults are shown on the display and, additionally, by signal lights, and they are audibly signalled via a buzzer.

At the left side of the display are 2 signal lights:

- Signal light ALARM illuminated if a limit value is exceeded.
- Signal light FAULT illuminated if an internal hardware or interface failure exists.

Directly below the signal lights are 3 keys for selecting the alarm list, stop horn and alarm acknowledge.

Key Functions Description

ALARM LIST	All active alarms, if acknowledged or not, are recorded in the alarm list. They are shown on the display after pressing this key.
STOP HORN	Audible acknowledge.
ALARM ACKN	Visual acknowledge.
MAINTENANCE	A menu is shown on the display after pressing this key and it is possible to carry out lamp test and dimmer activities.
EDIT	This key is only used for changing parameters.
CURSOR KEYS	The four cursor keys are used for scrolling up and down lists and to select the digit position of numbers.
MENU	After pressing this key, S1 Suppression S2 Operating values S3 Parameter is shown on the display.

The function must be selected by pressing the relevant key Sl to S3.

SHUTD	This key is without function. It is used only as an indication light in case of a shutdown.

SHUTD CANCEL — Pressing this key activates the shutdown cancel, ie, the shutdown signal will be suppressed as long as the cancel is active. Further pressing of the key deactivates this function, and the shutdown signal becomes active again.

Note: A shutdown initiation is reset by means of a signal from the bridge control lever, when control is active from the bridge panel, or by a signal from the manual control lever in the ECR or the handwheel at the local control station. The pre-condition for shutdown reset is that the fault has been eliminated before the reset signal is activated. The engine can then be restarted.

Emergency Stop (Pushbuttons)

For the manual release of an emergency stop of the propulsion engine, several pushbuttons are available. The manually released emergency stop is hard-wired from one contact of each pushbutton to the solenoid. A second contact is wired to the electronic modules as an input and re-routed to the solenoid via an output.

Engine Speed Sensing

Measuring Principle

Impulse transmitters sense teeth on the flywheel. Two sensors with a 90° (electrical) phase shift are necessary for calculation of speed and sense of rotation. For the frequency range used for slow speed engines the time interval between impulses is used as the basis for calculation of speed as well as direction. Both sensors are used for calculation of speed, so that if one sensor fails no interruption of speed calculation will occur.

Sensor Supervision

Standard three-wire proximity sensors are used where monitoring for signal line wire breakage is difficult. Therefore, the two sensors monitor each other crosswise for missing impulses, additionally, a plausibility check monitors for loss of impulses when there should be impulses according to the operating condition of the engine.

Margins for supervision are sufficiently high to prevent alarms during non-continuous engine shaft movement, eg, before stopping. Sensor failure is alarmed.

Fast Filtering

The speed signal is represented by the mean value of the engine speed for one ignition. Therefore, the time sum for 360° per cylinder is used for the calculation of the speed signal.

One-Turn Counter

A one-turn signal is necessary for slow turning purposes and for stroke counting. The signal is set to come on after a complete turn continuously in one direction.

Parameter, Suppressions and Operating Values

To display and/or change parameters, suppression and operating values, the MENU key is pressed and this activates the sub-menu system which requires keys S1, S2 or S3 to be pressed.

S1 Opens the list of inputs to the DPS2100 and allows the switching on or off of single inputs

S2 Operating values are displayed

S3 Opens the parameter list recorded in the DZM402 central module, allowing for parameter display or change

S4 Has no specific function

Note: When in the menu or sub-menu the display is shut down if the operator does not intervene within the 20 second time-out period.

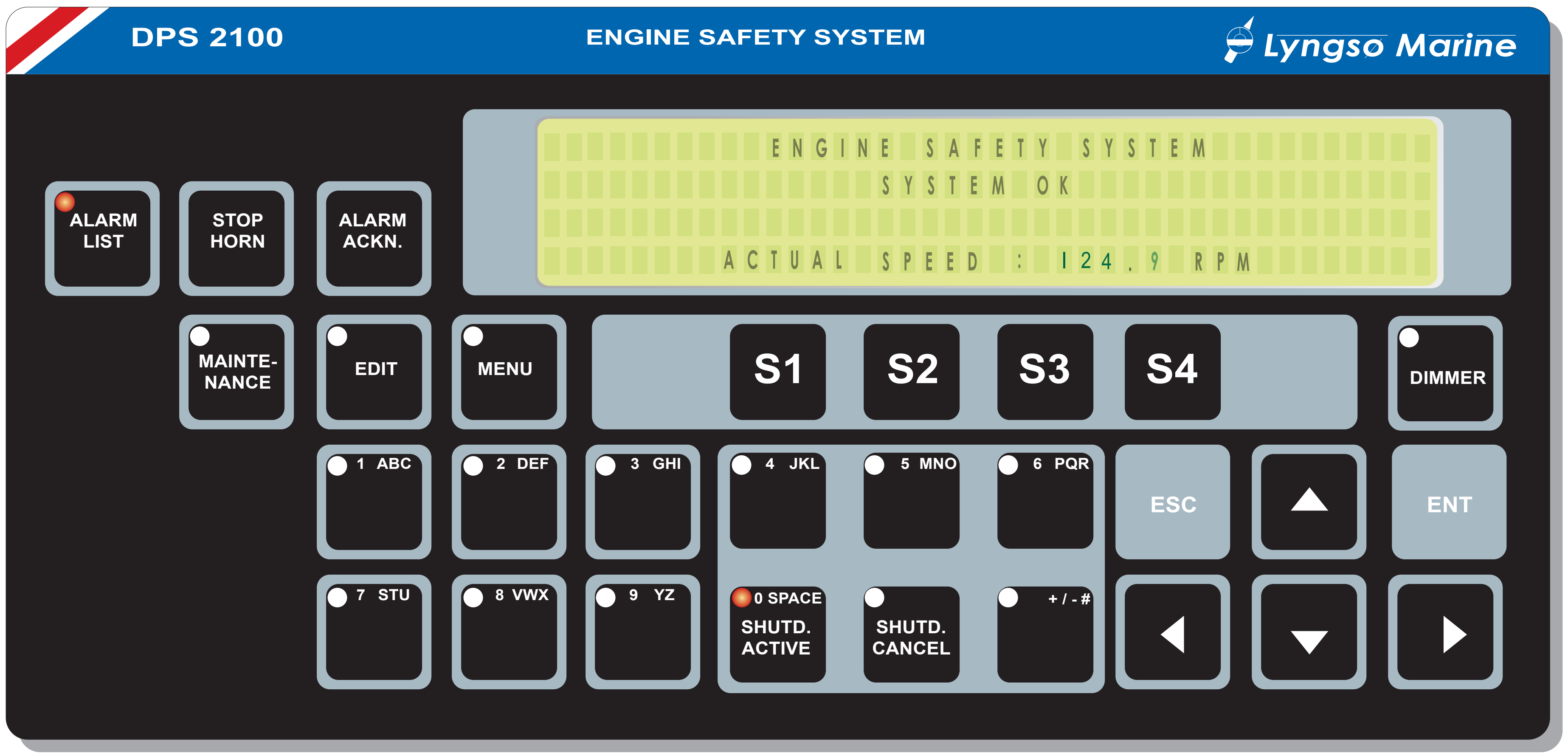
Parameter Changing

In the parameter list the operator may scroll through the list using the up and down arrow keys, alternatively, a numerical value for the parameter may be keyed in followed by pressing the ENT key. Pressing the ESC key allows an entered parameter number to be ignored.

Parameters are password protected and cannot be changed except by the password holder. No parameters should be changed without authority. There are three password levels:

Service Password	Only used by commissioning personnel
Expert Password	Used by restricted personnel
User Password	Used by authorised operators

Illustration 2.1.3b Engine Safety System Panel



Changing Parameter Values

To release a parameter for value setting the parameter is first selected from the menu and the EDIT key must then be pressed. If the adjustment of parameters is not released the operator is requested to enter the password; the level of password requested depends upon the selected parameter. After entering the four-digit password the ENT key is pressed. If the password was correct the previously selected parameter is displayed and may be opened for editing by pressing the EDIT key.

The parameter value may be changed by one of two means:

1. By actuating the up and down arrow keys to increase or reduce the selected digit in the parameter value. The selected digit is chosen by use of the left and right arrow keys.

2. By entering the desired numerical value for the parameter. To set the value the 0 key has first to be pressed to open the parameter value for changing. The desired new parameter value is entered using the numerical keys.

When the desired value has been keyed in the parameter change process must be completed by pressing the ENT key to save the new value. By pressing the ESC key the new value is not accepted.

To leave the parameter adjusting procedure the ESC key is pressed and the menu is displayed again.

Note: If the parameter adjustment session is not completed by pressing the ESC key the session is automatically completed at the expiry of the time-out period. The new parameter value is automatically accepted. This is also the case if the parameter change is not completed by pressing the ENT key and the parameter was still open for changing.

Suppressions

The shutdown and slowdown activities of individual sensors, except for all emergency stop inputs, may be suppressed. When a shutdown or slowdown is suppressed, the monitoring system remains active and alarm signals will still appear on the operating panel when a sensor responds to a condition.

To activate suppression the MENU key is pressed to bring up the menu; to leave the menu the ESC key is pressed, alternatively, the menu will be left at expiry of the time-out period.

Pressing the S1 key opens the suppression list and it is possible to change suppression states. This can be done at the bridge and ECR panels.

In the suppression list, pressing the up or down arrow keys allows the operator to scroll though the suppression list. When the desired sensor input appears in line 2 of the display, the operator can suppress shutdown or slowdown activation by pressing S1 or re-enable shutdown or slowdown by pressing S2.

Operating Values

The process is initiated by pressing the MENU key. The operating value list is opened by pressing S1; the up and down arrow keys allow for scrolling through the list to select an operating value. The operating values at a fault occurring are displayed on the list and these can be reset by pressing S1.

To leave the menu or sub-menus the ESC key is pressed.

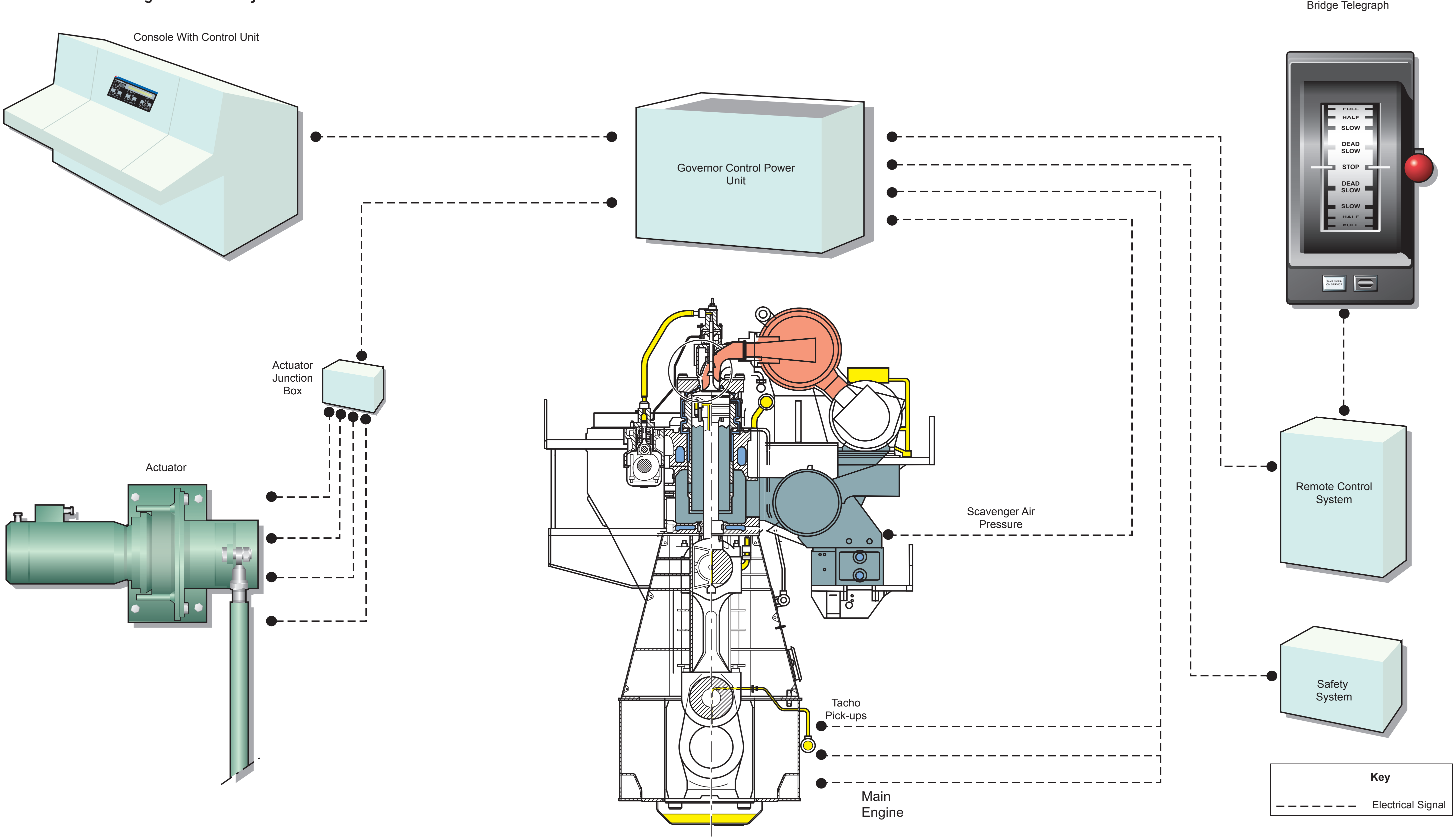
Slowdowns

A number of engine operating conditions cause an automatic slowdown if defined limits are exceeded.

A slowdown is initiated when the following parameter defined conditions are exceeded:

- Exhaust gas temperature (cylinders 1 to 5)
- Jacket cooling water outlet temperature (cylinders 1 to 5)
- Turbocharger LO outlet temperature
- Scavenge fire detected (cylinders 1 to 5)
- Thrust bearing segment temperature
- Main bearing LO inlet temperature
- Cylinder oil non-flow (cylinders 1 to 5)
- Jacket cooling water inlet pressure
- Turbocharger LO inlet pressure

Illustration 2.1.4a Digital Governor System



2.1.4 MAIN ENGINE DIGITAL GOVERNOR

Manufacturer:	Lyngsø Marine A/S
Model:	EGS 2000
Type:	Electronic
No. of sets:	1

Introduction

The Electronic Governor System EGS 2000 is a control system designed to accurately maintain the output shaft speed of the main propulsion engine to a given order.

The EGS 2000 controls engine output power automatically in accordance with weather conditions. This enables the engine to be run at maximum speed without risk of engine overload in adverse weather conditions. Should weather conditions permit, the EGS 2000 will automatically select a less active mode of operation to reduce wear and tear on the fuel pumps and fuel racks, as well as on the EGS 2000 actuator.

The governor contains a program module which functions as a super-fast high-speed protection while maintaining fully automatic shaft speed control. This enables the engine to be run closer to its design limits.

All parameters and readings used in daily operation can be accessed from the front panel of the control unit by the operator. Authorised operators can change the operational parameters of the governor after entering a password. The basic commissioning data for the EGS 2000 may be programmed on board either by PC equipment or via the control unit. In both cases, this can only be done by authorised Lyngsø Marine service personnel.

Main Components

The EGS 2000 consists of a number of components installed in the engine control room (ECR) and in the engine room. These components and their basic functions are as follows.

Power Unit

This unit located in the ECR contains all the electronics required to convert incoming signals and orders into correct movements of the fuel linkage depending upon the situation. This unit also contains the Lyngsø Marine A/S Stella Gamma computer.

Control Unit

The control unit is installed in the engine control room console and provides all the facilities required for operation of the EGS 2000 system. In addition, it provides the operator with extensive facilities for diagnosis, test and simulation. It displays messages in plain language, and contains dedicated lights, light emitting diodes (LEDs), which instantly show the overall condition of the EGS 2000 system.

It is not necessary to make regular checks on the EGS 2000 system functions, as this is performed by the Stella computer. The control unit front panel is composed of a splash-proof tactile keyboard and Liquid Crystal Display (LCD).

The flow of information between the control unit and the power unit occurs on a network consisting of a twisted pair connecting cable.

Actuator

Located at the engine, this electro-mechanical device converts electrical control signals from the power unit to mechanical action. It exerts the required force on the fuel rod to cause it to move to the correct position. The actuator contains a rugged, brushless servomotor for very fast response and a high torque braking system, which is able to lock the actuator during specific fault conditions. Gearboxes are sealed and no periodic maintenance is required.

The actuator is protected against overload and other errors which could cause it to malfunction.

Tacho System

This system allows the EGS 2000 power unit to detect the speed of the engine output shaft. It is therefore located very close to the engine turning gear wheel. The system comprises two induction pick-ups mounted in a bracket. These pick-ups sense the passing of the teeth. The remainder of the system is located within the power unit. It comprises a dedicated computer for rapid processing of the tacho pick-up pulses.

Scavenging Air Sensor

Available engine output power is a function of the scavenging air pressure. The EGS 2000 includes a sensor which senses this air pressure and allows the power unit to restrict engine output power to avoid an incorrect air to fuel ratio. This sensor is placed in the scavenging air system.

Power Unit

The power unit contains the Stella computer and all the electronics required to translate the signals received from the control unit ECR speed setting handle, engine remote control system and external sensors into a movement of the actuator. The actuator movement causes the engine fuel pumps to deliver the correct amount of fuel to the injectors.

The power unit contains facilities which allow the connection of a personal computer (PC), via a special adapter, enabling both adjustment and fault diagnosis to be carried out. Once installed, the unit requires no periodic maintenance.

Internal Circuitry

Tachometer

The EGS 2000 system contains a tachometer system for measurement of the engine speed. This tachometer system consists of two electromagnetic pick-ups installed close to the engine flywheel. Only one pick-up is necessary to sense the engine speed, so each pick-up is the back-up for the other. These pick-ups sense the passing of each tooth on the flywheel and give a pulse to the tacho input circuits in the power unit. The frequency of these pulses are converted to numbers representing the shaft speed in a dedicated internal computer in the EGS 2000. Read-out of the shaft speed is available at the control unit display. An output for an analogue rpm instrument is also supplied for remote display, eg, at the bridge.

The EGS 2000 system is equipped with inputs which enable it to receive two speed-setting signals simultaneously. These signals normally originate from the bridge telegraph and the ECR manoeuvring handle. The EGS 2000 system, however, may only use one of these signals at any time to control the speed of the engine. The changeover is synchronised with the change of control position between bridge and ECR.

Speed Setting

The control unit is able to present both the bridge speed setting signal value and the ECR speed setting signal value at the same time on its display. This enables the operator to adjust one of the speed setting signals to match the other before the changeover takes place.

Functions Within EGS 2000

EGS 2000 includes a number of functional blocks which are described below:

- The actuator control loop
- The tacho system
- The set point selector
- The shaft speed control loop
- The engine limit curves module
- The start/stop system
- Minimum selector
- A failure detection module

The actuator is situated upon the engine, whilst the actuator control loop is contained in the power unit. The rpm loop is also situated in the EGS 2000 power unit, using the tacho pick-ups for sensing engine speed. These are situated on the engine in proximity to the turning gearwheel.

The engine limits curve module is a software module situated within the Gamma computer. Access to the limit curve characteristics and related parameters is available from the control unit.

Actuator Control Loop

The actuator control loop consists of a position control loop which in turn uses fast speed control and current control loops to drive the actuator motor. A power drive for control of the actuator current and speed, is located on the inside of the door to the EGS 2000 power unit. Alongside is the Stella Gamma computer, which contains the position control loop. The actuator control loop power electronic block requires 3-phase 172V AC, which is supplied by the main 380/440V AC 3-phase supply via a transformer at the right-hand side of the main part of the power unit cabinet.

The actuator of the EGS 2000 comprises a motor, brake, tacho generator, position transmitter and gearbox. The EGS 2000 actuator motor is a brushless servomotor which means that no periodical service is required.

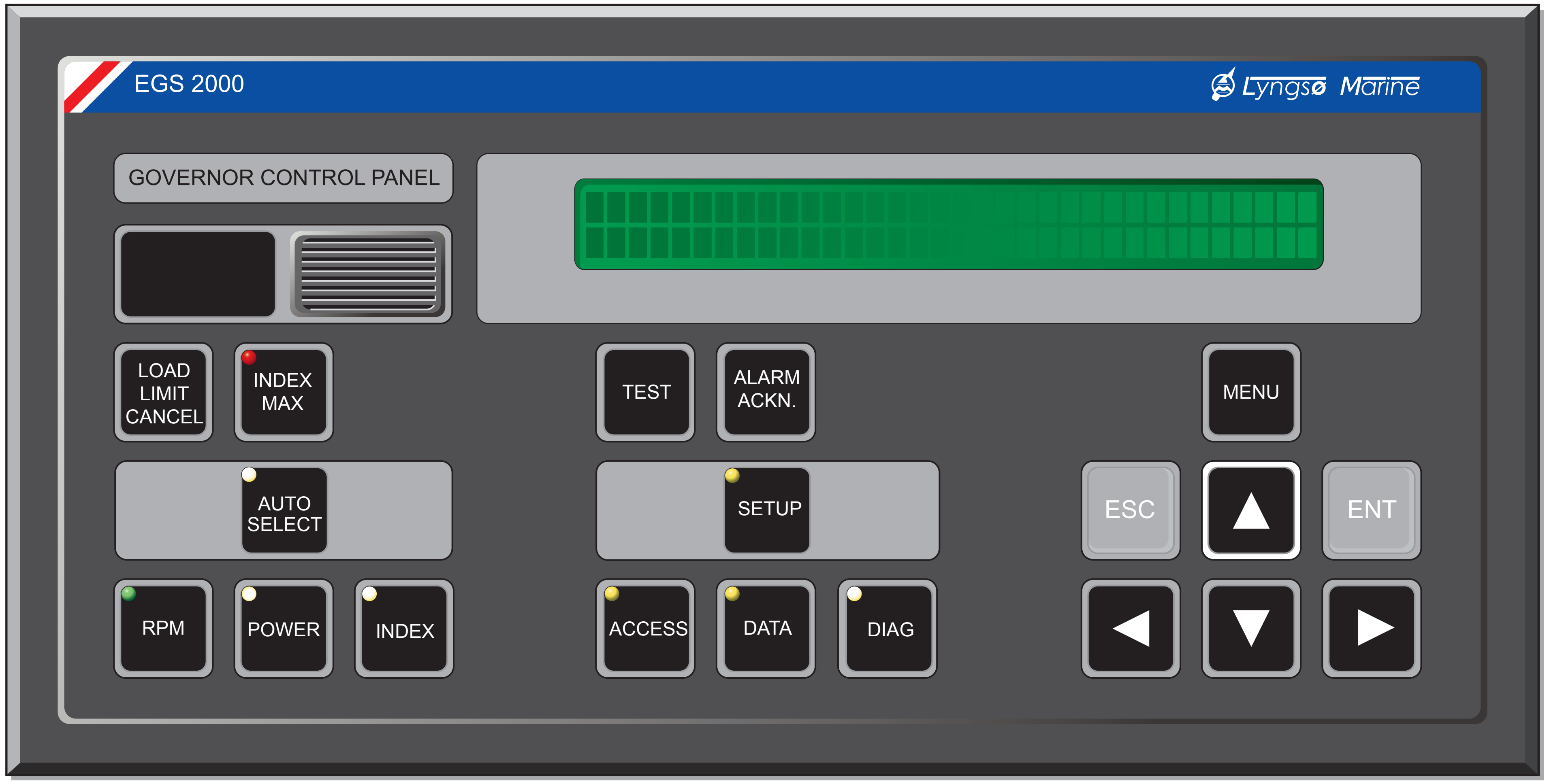
The EGS 2000 actuator gear is a high precision epicyclic gear containing rotating pinions which transmit power to a common, central pinion. The pinions are supported so that the gear retains a very large part of its surface in contact during rotation, and an extremely small backlash on its output. The gear requires no periodical lubrication.

The actuator has a built-in brake included as a safety feature. Such large mechanical powers are involved in the EGS 2000 actuator, that during servicing of the unit the actuator must be blocked to avoid the possibility of injury to personnel working on it. The brake requires 24V DC in order to release it. If this supply fails, or is disconnected, then the brake will be engaged immediately, blocking the actuator in its present position. This is the case when the power links in the EGS 2000 power unit are removed by service personnel, if a mains power failure occurs, or if the EGS 2000 should malfunction.

If the actuator is blocked whilst the engine is running then, although the EGS 2000 will be unable to control the speed of the engine, the engine will neither stop nor overspeed. In any case, when the actuator brake is engaged and the actuator blocked, an alarm is given by the EGS 2000. The brake current is monitored continuously by the EGS 2000 computer.

The tacho generator in the EGS 2000 actuator provides the power drive with information regarding the speed at which the actuator motor is rotating. A position transmitter provides the Gamma computer with details of the position of the actuator. These two signals allow the precise control of the actuator, enabling it to move to a desired position with very little overshoot.

Illustration 2.1.4b Governor Control Panel



The power drive combines several inputs and produces the necessary power for the actuator motor in order to move it. Apart from the tacho generator and the position transmitter, the power drive also handles the following signal inputs:

Index Demand:

The Index Demand, modified by the MIN selector, is the reference to which the actuator power drive sets and maintains the actuator index.

Limit Switches:

The MIN and MAX limit switches detect the extremes of mechanical travel allowed to the actuator. If the actuator reaches a limit switch, the actuator power drive will then stop the actuator and ignore all commands which would otherwise cause the actuator to continue moving in the same direction. The actuator will only be able to move in the opposite direction.

Tacho System

Engine speed is measured by a tacho system, using two independent pick-ups, Tacho 1 and Tacho 2. The pick-ups are located close to the turning gearwheel. Tacho signal processing is carried out by a dedicated input processor on the S1/O unit of the Gamma computer, and from here the rpm signal for the speed control of the main engine is passed on to the Gamma CPU unit.

The tacho selector selects which of the two signals is to be used. This is done by checking that the two signals are within the valid range. If both signals are in order, but slightly different, then the tacho selector will choose the signal which is the highest of the two and use this for the calculation of the rpm value.

Real-time signal processing is used to detect malfunction of a pick-up signal which is automatically disregarded if a fault is detected. In nearly all cases where a tacho fails, the signal goes to zero. In these cases, the failed tacho will be disregarded and the other tacho is automatically selected.

The Set Point Selector

The set point selector receives the rpm set point signals from both the bridge and the ECR continuously. In order to determine which of these signals is to be considered as the actual order (they may be different from each other), the set point selector also receives information from the attached remote control unit which informs it of control location status. The selected set point is considered as the rpm set point. This is fed to a slope unit which keeps track of the order and performs various functions within the EGS 2000. If a cable error on the selected input is detected, or if the manoeuvring system is off-line whilst in bridge control, the set point selector maintains the set point value being used prior to the occurrence of the error. The fault will cause an alarm on the EGS 2000 control unit and will be visible on the EGS control unit. An EGS alarm is further generated to the ordinary alarm system.

Shaft Speed Control

The optimal controller takes care of filtering the input signals and calculation of the actuator index demand. The parameters within the optimal controller vary constantly as a result of engine condition. The result is that the controller provides four separate modes of operation.

Modes of Operation

The EGS 2000 system has four modes of normal operation.

Auto Select

Auto Select allows the EGS 2000 system computer to automatically select either the rpm mode or power mode of operation, depending upon prevailing engine running conditions. The changeover criterion due to the weather conditions is ‘Seastate 3’, ie, in rough weather POWER mode is selected, and in calm weather RPM mode is chosen. Index mode is manually selected and allows the EGS 2000 system to fix the engine fuel rack index as long as rpm variations stay within predefined limits.

RPM Mode

In RPM mode the EGS 2000 will maintain constant shaft speed even in rough weather with small fluctuations imposed from the weather.

POWER Mode

In Power mode the EGS 2000 will maintain approximately constant shaft power. This gives optimum engine performance in moderate to rough weather conditions.

INDEX Mode

In Index mode the EGS 2000 will maintain a fixed fuel index. This mode is mainly used when measuring the engine performance through the cylinder pressure indication. RPM control is automatically retained if the rpm becomes too high or the speed order is altered.

Engine Limits Module

The filtered scavenge air pressure (P_s) signal is transmitted to the scavenge air limit block. The filtered rpm is transmitted to the engine torque limit block and the actuator index demand is passed to the MIN selector.

The scavenge air limit function in the EGS 2000 ensures that the correct amount of fuel is provided for each cylinder in relation to how much scavenge air is available. This ensures clean burning of the fuel injected. During periods of acceleration the normal lack of sufficient turbocharger speed in relation to engine speed makes the fuel to air ratio within each cylinder too rich. This means that not enough air is available to burn all the fuel injected which results in poor combustion and the production of smoke containing pollutants. Restricting the actuator fuel index in accordance with the available scavenge air alleviates this problem.

The EGS 2000 contains an engine torque limitation function, the purpose of which is to protect the engine against torque overload.

The values determining the limit curves may be altered by authorised user access only.

The Minimum Selector

The MINIMUM selector limits the actuator index demand (from the optimal controller) before passing on the final value of the actuator index demand to the actuator via the actuator power circuits. The actuator index demand is limited by three signals:

Scavenge air limit

Engine torque limit

Index MAX (the maximum index set by use of this function)

If the actuator index demand is limited for any of the above reasons, then the condition will be indicated on the LCD display of the EGS 2000 control unit. The index will be limited to zero whenever a STOP or SHUTDOWN signal is active.

Start/Stop System

The EGS 2000 START/STOP system controls the index during start and stop of the engine.

When a STOP or SHUTDOWN signal is received, the EGS 2000 immediately gives an index zero demand to the actuator. When a START request is received the EGS 2000 causes the actuator to move to a predetermined index value. This value will be maintained for a length of time unless the actual rpm exceeds the desired rpm, in which case the index will be controlled by the optimal controller. When this time expires, the actuator index control will go on-line if the rpm has not reached the ordered value.

If the EGS 2000 is started up after a mains supply failure, and the engine is already running at an rpm value above start level rpm, this function is automatically bypassed. The function is also bypassed if the cancel limits function is in operation, such as during a repeated start situation.

At the control unit or by an external signal from the remote control system a higher value of start level index can be selected, such as when a first start attempt was not successful.

Failure Detection Module

The following categories of failure detection exist:

- Cable failure for all analogue input signals
- Pick-up errors for the tacho system
- System supervision including remote control system, tacho system, control unit, actuator power drive system and changeover system
- Actuator supervision including motor temperature and position error
- Supervision of the input/output system for the Gamma computer covering conversion errors and connection errors of input/output units
- Power source supervision including internally generated direct current supply voltages and battery supply
- All types of Gamma computer memory circuits as well as the CPU function are supervised
- Alarm released for EGS 2000 subject to test
- Alarm for illegal parameter set-up in the Gamma computer
- Alarm for VIT option safety limit active

If a cable failure occurs in any monitored connection between the EGS 2000 and the environment to which it is connected, this will be indicated on the control unit LCD display in the alarm list and an alarm will be given. Generally, no change will occur in engine operation. Certain special cases exist, however, where a change is needed for reasons of engine safety.

A circuit exists within the EGS 2000 which monitors the operation of the Gamma computer for computer hardware failure. If an error is detected, then the actuator will immediately be blocked, an EGS malfunction alarm given and all program execution terminated. If an error is detected during the start-up procedure, the EGS 2000 will not start, the actuator will be blocked and an EGS malfunction alarm will be given.

Additional EGS 2000 Features

Variable Injection Timing (VIT)

The Variable Injection Timing (VIT) system is developed to fulfil the requirement of keeping the cylinder maximum pressure P_{max} constant in the high load range to save fuel.

This is achieved by a mechanism which automatically adjusts the timing of fuel injection, such that the maximum pressure P_{max} is kept constant as the engine load is reduced from 100% down to a pre-specified part load, known as the breakpoint (about 80% 0f MCR).

The electronic control by the EGS 2000 is only active during remote control when running in the ahead direction. During manoeuvring, astern running and emergency control, the control is taken over by a pneumatic system at the engine.

There is no cable supervision for the analogue output signal operating the variable injection timing. A failure message at the control unit causes an external EGS alarm, when illegal parameters are entered for the VIT system from the external de-bugger. The alarm text is VIT SETUP ERROR.

In the event of manual cancellation of the VIT control, running astern, being in a STOP or SHUTDOWN situation, having a general BLOCKED situation for the actuator or a cable failure to the scavenging air pressure signal, the output signal for the I/p-converter is set to the minimum value.

In the event of a system failure within the EGS 2000 causing the 80186 CPU to go into a HALT situation, the output to the I/p-converter will drop to 0mA.

Readjustments of the VIT System During Service

Due to variations in fuel quality and wear to the fuel pumps it may be necessary to adjust the maximum pressure P_{max}, when the ship is in service.

Before the adjustment is carried out, indicator diagrams must be taken covering running conditions in the area above the breakpoint.

It will then be possible to adjust P_{max} by changing the value of P_{offset} by the same amount as P_{max} is to be adjusted.

The new adjustments can be checked by taking new indicator diagrams.

Cancellation of the VIT Function

It is possible to cancel the function of the VIT system by setting the injection timing to zero (late injection, low maximum pressure in cylinder). This is done from the keyboard of the control unit.

Lubricating Oil Dosing (LOD)

The LOD system offers a binary signal which can be used for activation of an increased amount of LO for the cylinders of the main engine based on significant changes in the actual fuel pump index. This binary signal is maintained for a certain period of time, after the change in the fuel pump index has taken place.

The criterion for extra lubrication of the cylinders is specified as the minimum ramp, which, regardless of the sign, just requires the extra lubrication to be made, ie, uploading or downloading the engine by a certain percentage fuel index during a period of time will trigger the request for extra lubrication of the cylinders. If a larger change in fuel index takes place or the change takes place faster than the prescribed time period, this will also result in the request for extra lubrication. Extra lubrication will be active as long as the LOD level is above 100% and the time-out given by the timer will start the instant that the LOD level passes below 100%.

The Load Program

Normal Function of the Load Program

The RPM load programme system ensures that load up and load down of the engine is carried out over a certain period of time.

The RPM load program limits acceleration during running-up of the main engine. The load program is active in the range from 90 to 100% of the specified 100% rpm for the engine. Running-up from 90 to 100% rpm takes place in a minimum of 30 minutes, and is only active when both the speed setting command and the actual rpm have reached their limit.

The program is designed so that any increase of rpm within the program will follow the outlined limitation curve, ie, the maximum acceleration is 1% of the specified 100% rpm for each 3 minutes.

The load down functions in a similar manner to the running-up situation with individually adjustable parameters.

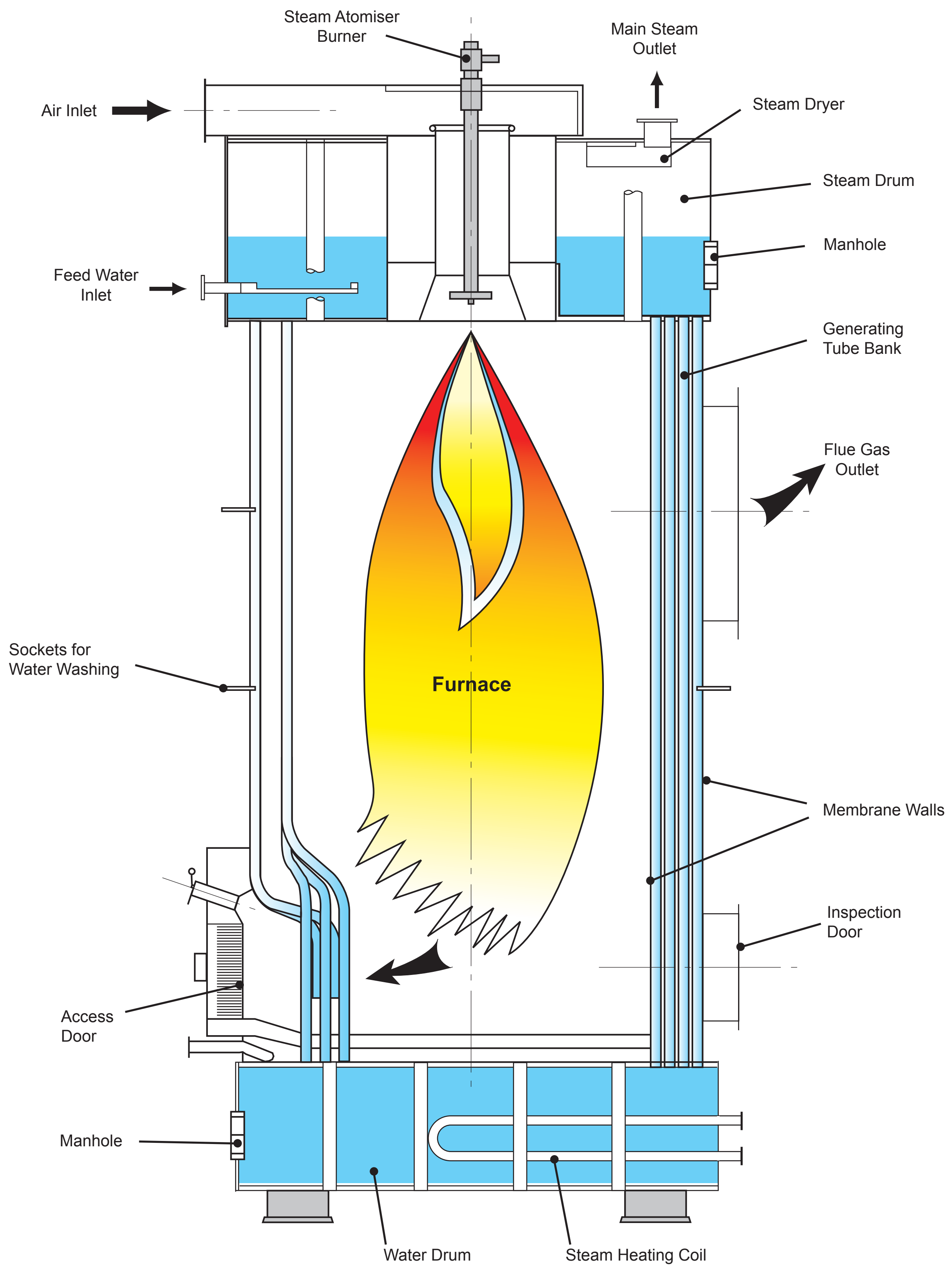
The load program is cancellable, ie, included with the load limit cancel function of the EGS 2000. If the load down function is included and active, when the load program is cancelled the resulting speed setting command follows the control handle's RPM speed setting command; if this is smaller than the load program's low limit, the resulting output of the load program is the low limit.

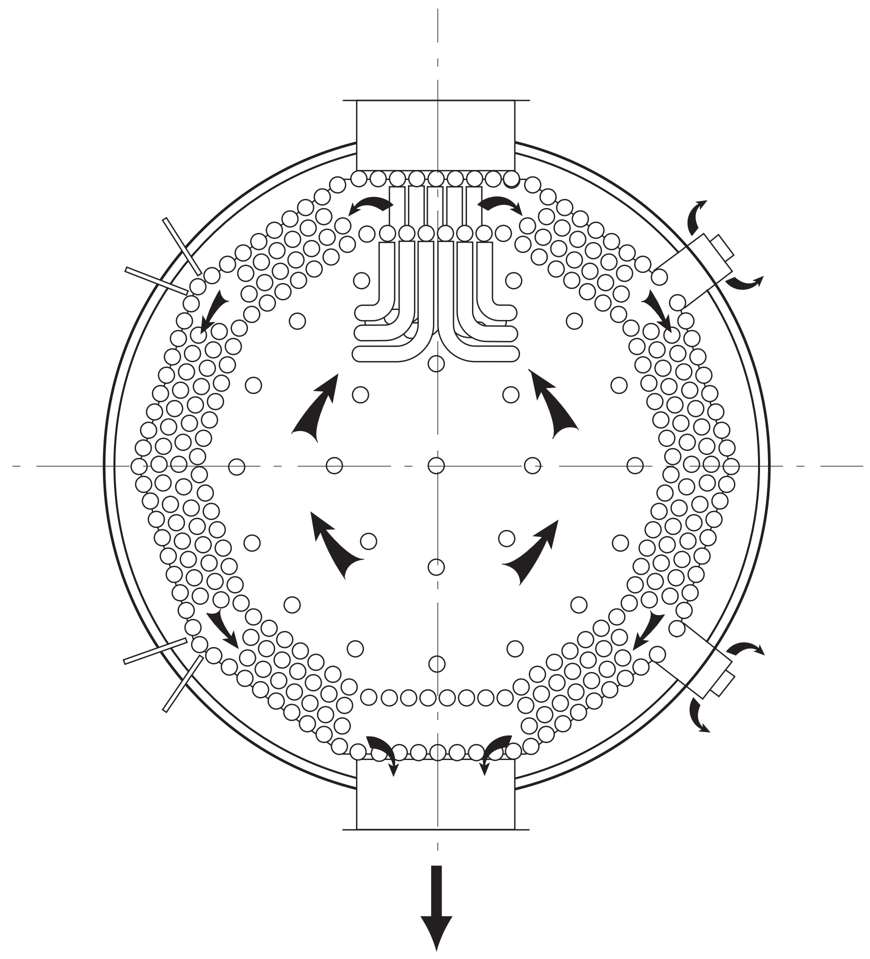
Hour and Revolution Counters

The hour and revolution counters as well as their associated trip counters, can be observed and adjusted from the control unit. These functions comply with the counter definitions of the Universal Control System UCS 2000 and can therefore be remotely controlled from the UCS 2000.

2.2 Boilers and Steam Systems

Illustration 2.2.2a Oil-Fired Boiler - Type AQ18





Cross-Sectional View Showing Gas Flow

2.2 BOILERS AND STEAM SYSTEMS

2.2.1 GENERAL DESCRIPTION

The steam generating plant consists of one oil-fired auxiliary boiler and one composite oil-fired/exhaust gas boiler. The steam demand of the plant in port is served by the oil-fired boilers, at sea the steam demand is usually met by the exhaust gas side of the composite boiler. The composite boiler is arranged in the funnel to take advantage of the waste heat from the main engine exhaust.

The auxiliary boiler may be required at sea in low temperature areas, as well as during reduced power operation of the main engine, such as during manoeuvring or slow steaming on passage. Cargo tank heating and tank cleaning operations requiring the use of the tank cleaning heater at sea will also require the auxiliary boiler to supplement the steam supply.

2.2.2 OIL-FIRED AUXILIARY BOILER

Manufacturer:	Aalborg Industries
No. of sets:	1
Model:	AQ-18
Type:	Oil-fired vertical water tube marine boiler
Weight excluding water:	26,900kg
Weight including water:	37,900kg
Evaporation:	18,000kg/h
Steam condition:	O.7MPa saturated steam at 175°C
Fuel oil:	HFO up to 700cSt at 50°C
Fuel oil consumption, HFO, steam atomising:	155kg/h minimum firing capacity, 1,355kg/h maximum capacity
Fuel oil consumption, MDO, air atomising:	155kg/h minimum firing capacity, 1,291kg/h maximum capacity
Safety valve setting:	0.87MPa
High steam pressure alarm and burner stop:	0.85MPa
Steam dump operating pressure:	0.83MPa
Burner start steam pressure:	0.72MPa
Burner stop steam pressure:	0.80MPa
Low steam pressure alarm:	0.40MPa
High water level alarm:	+150mm
Low water level alarm:	-120mm
Too low water level alarm and burner stop:	-145mm

General Construction

The boiler is of a two drum type construction, with one steam drum and one water drum. It also includes a boiler casing, fuel firing equipment, mountings, fittings and other accessories. The boiler structure is supported with the water drum acting as a supporting basis. The whole boiler construction is designed to be able to withstand the rolling and pitching of the ship. Careful consideration is also given to the movement by thermal expansion of the boiler.

Combustion gas leaves the furnace through the deflected water tubes at the bottom and passes through the generating bank before leaving the boiler. Efficient circulation in the boiler is achieved because a number of tubes in the cooler areas act as downcomers.

Furnace

Closely spaced waterwall tubes are arranged in a staggered configuration and constitute the furnace sides, except for the burner opening. The furnace roof is formed by the bottom of the steam drum and the base of the furnace is formed by the water drum. This arrangement increases the heat absorption in the furnace and makes it strong enough to withstand vibration etc.

The side waterwall tubes are welded to the water and steam drums with no headers provided. The boiler is downward fired from the roof using a steam/air assisted pressure jet burner.

Boiler Casing

The furnace of the boiler is made completely gas tight by the adoption of a welded waterwall construction. The welded waterwall construction is also adopted in the front and rear walls of the rear evaporating tube section where tubes are exposed to the combustion gas.

Insulation is provided on the outer surface of the furnace waterwalls.

Insulation is applied to the outer surface of the waterwalls and the outermost surface of the furnace is covered with a galvanised steel casing, except for the furnace roof and floor.

Steam Drum and Fittings

The steam and water drums are cylindrical with two flat plates on the top and bottom. In order to withstand the internal pressure, the flat plates are mutually connected by vertical solid stays.

A steam dryer is provided to remove water droplets from the steam. This may be dismantled for removal through the access manhole.

The steam drum also has an internal feed water pipe, a surface scumming pipe and a water sampling connection.

Operating Procedures

The following steps should be taken before attempting to flash-up the boiler:

a) All foreign materials are to be removed from internal pressure parts.

b) Ensure all gas side-heating surfaces are clean and in good condition.

c) The furnace bottom and the burner wind box are to be cleaned of oil and other debris.

d) Ensure all personnel are clear.

e) All manhole covers are to be securely tightened.

f) Inspect safety valves and see that gags have been removed and that the easing levers are free and in good condition.

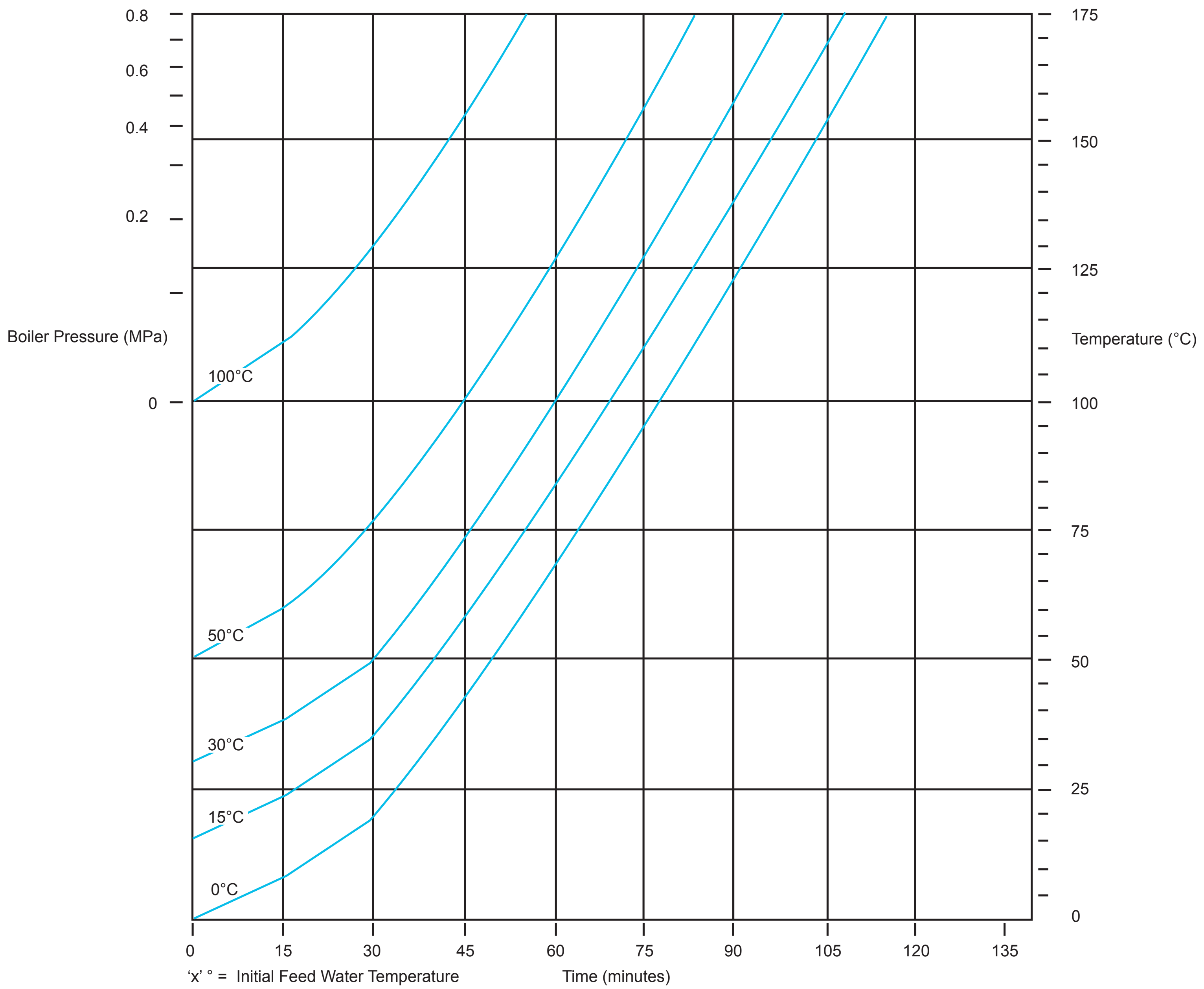
g) Open root valves for all instruments and controls connected to the boiler.

h) Open the vent valve of the steam drum.

i) Open all pressure gauge valves and ensure that all valves on the pressure gauge piping are open.

j) Check and close all blow-off valves and drain valves.

Illustration 2.2.2b Firing Rate



k) Fill the boiler slowly until the water level is approximately 50mm below the normal operating level in order to allow for swell in the level after firing.

l) Check the operation of the gauge glasses and compare with remote reading instruments.

Raising Pressure With No Steam Available (Initial Start)

a) Set up the fuel system for diesel oil burning (see Section 2.6.3) and circulate the fuel until all heavy fuel has been discharged from the fuel lines.

b) Set the burner for air atomising, using an air pressure of 0.40MPa and fuel pressure of 0/30MPa. Purge the furnace with the forced draught fan for one minute with vanes fully open.

c) Reduce the air pressure at the wind box to between 10 and 20mmWG.

d) Light the burner and adjust the air and fuel pressures, to ensure stabilised combustion; use the furnace observation port to check the combustion.

e) When raising the pressure, keep the burner firing for 5 minutes and out of service for 15 minutes repeatedly at the lowest oil pressure (0.25MPa) for one hour. Again, repeatedly light and shut down the burner to raise the pressure as recommended by the manufacturer. The graph below indicates the lighting-up curve for the boiler which should be followed.

f) When the drum pressure has risen to about 0.15MPa and the steam from the vent valve is free of air, close the drum vent valve.

g) Drain and warm-through all steam supply lines to ancillary equipment before putting the boiler on load.

h) Supply steam to the HFO settling tank. When the tank is of sufficient temperature to be pumped by the boiler HFO pumps, supply steam to the boiler FO heater and prepare to change over from MDO to HFO, see Section 2.6.3 for details. Continue circulating fuel as before.

i) At working pressure, switch to automatic operation.

Raising Pressure with Steam Available from the Exhaust Gas Economiser

a) Start the forced draught fan, open the inlet vanes and purge the furnace.

b) Start the FO supply pump and circulate oil through the heater and burner manifold. Open the recirculating valve and discharge the cold heavy oil in the line.

Note: At normal seagoing condition, the boiler FO system will be continually circulating heated FO.

c) Reduce the air pressure at the wind box to between 10 and 20mmWG.

d) Light the burner and adjust the air and fuel pressure to ensure stabilised combustion using the furnace observation port.

When raising the pressure, keep the burner firing for 5 minutes and out of service for 15 minutes repeatedly at the lowest oil pressure (0.25MPa) for one hour. Again, repeatedly light and shut down the burner to raise pressure as recommended by the manufacturer's lighting-up curve.

e) When the drum pressure has risen to about 0.15MPa, close the steam drum vent valve.

f) Drain and warm-through the steam supply line from the auxiliary boiler to the steam range before coupling up to the exhaust gas economiser and putting the boiler on load.

Shutting Down

a) Operate the sootblowers before shutting down the boiler whenever possible.

b) Shut down the burner.

c) Continue the operation of the forced draught fan for a short while after shutting down, keeping an air pressure of 150mmWG at the burner inlet and purge the furnace of combustible gases.

d) Maintain the water level visible at about 50mm in the gauge glass.

e) Open the drum vent valve before the boiler reaches atmospheric pressure.

f) Change the fuel system to diesel oil and circulate back to the tank.

Note: If steam is available from the economiser, the boiler HFO system should remain in use.

g) When the fuel oil has been purged, shut down the fuel system.

After the boiler has been shut down for 4 hours the forced draught fan may be used to assist cooling down, but to avoid damage to refractory, allow the boiler to cool down naturally if possible.

CAUTION

Do not attempt to cool down the boiler by blowing down and then by filling with cold water.

Shutting Down in an Emergency

Should the boiler trip (when the burner is in use) due to the low low water level alarm (-135mm), shut down the steam stop valve, feed valve and forced draught fan after purging the furnace.

Note: Never attempt to supply feed water until the boiler has cooled sufficiently.

Taking the Boiler Out of Service

When taking a boiler out of service, the wet lay-up method is preferable, as it requires less preparation and the boiler can be quickly returned to service.

When the boiler is in the cooling down process following shutdown, inject into the drum appropriate quantities of boiler chemicals, using the boiler chemical injection device. To ensure adequate protection of the boiler, follow the guidelines given by the chemical supplier.

When the pressure is approaching atmospheric pressure, open the steam drum air vent valve.

When the pressure is off the boiler, supply distilled water until it issues from the vent valve, then close the vent valve.

Put a hydrostatic pressure of 0.35 to 0.50MPa on the boiler. Hold this pressure until the boiler has cooled to ambient temperature. Bleed the boiler using the vent valve to be sure all the air is out. Maintain a hydrostatic pressure of 0.20 to 0.35MPa on the boiler.

Take a periodic boiler water sample and replenish any spent chemicals.

Before returning the boiler to service, drain the boiler to the normal working level and return the chemical content concentration to the normal level by blowing down.

Maintaining the Boiler in a Warm Condition

At sea, the auxiliary oil-fired boiler should be maintained in a warm condition by supplying steam to the heating element in the water drum. This is done by opening the heating coil drain valve and the steam inlet valve. The boiler pressure should be maintained at 0.05MPa or above. When the heating element is not in use the steam inlet valve is closed and the drain is left open.

Illustration 2.2.3a Boiler Control Panel - AQ18

Operating Instructions For Burner

AUTOMATIC OPERATION:

Start of Burner (Emergency Operation key switch in position AUTOMATIC)
1. Start Combustion Air Fan on START/RUN if AUTO-MAN switch is selected to MANUAL.
2. Refer to Combustion Mode Instructions for the Burner below for setting of Combustion Control.
3. Select BURNER MODE switch to START/RUN. The Burner will automatically be started and stopped by a signal from the Start/Stop Pressure Switch.

Stop of Burner
1. Select BURNER MODE switch to STOP.

EMERGENCY OPERATION:
Start of Burner (Emergency Key Switch Activated)

1. Select Combustion Air Fan AUTO-MAN switch to Manual and START/RUN switch to START.
2. Select TA1 on Oil/Air Combustion Controller to position AUTO.
3. Adjust Air Flow to Purge position, minimum 50% air flow, by TA2 and TA3. - allow minimum of **60 seconds** purge.

WARNING: Insufficient Purging May Cause Danger of Furnace Explosions.

4. The Air and Oil flow to be adjusted to Ignition position, approximately 25% oil flow, by TA2 and TA3.
5. For manual ignition sequence, refer to instructions on local Emergency box.
6. When the flame is established - supervision is by the emergency flame scanner and air/oil flow to the burner can be adjusted by TA2/TA3 on the air/oil combustion controller to desired fuel rate.

WARNING: In Emergency Operation the Safety Interlocks are Reduced to Too Low Water level and Flame Failure.

THEREFORE THE BOILER MUST BE CAREFULLY AND UNINTERRUPTEDLY SUPERVISED BY SHIP'S ENGINEERING PERSONNEL.

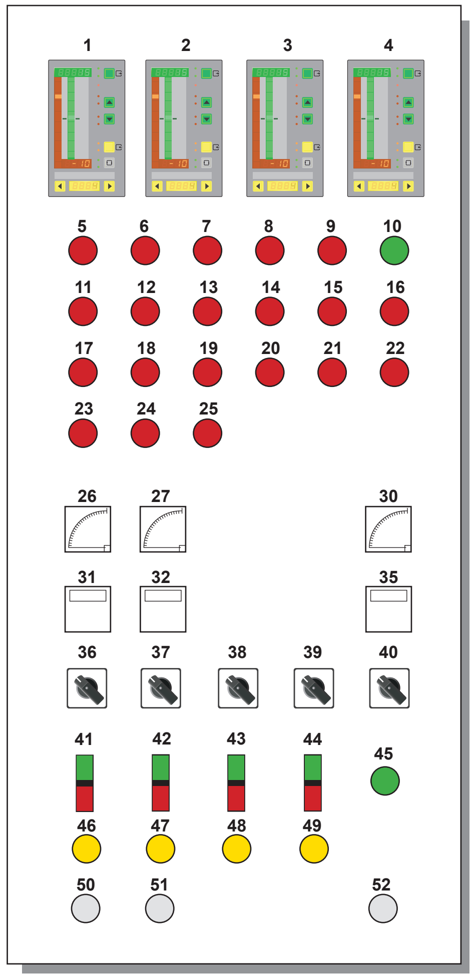
Stop of Burner
1. Firing is stopped by turning the emergency Operation switch to the AUTOMATIC position or by pressing the OIL VALVE CLOSE pushbutton on the local emergency operation box.

Combustion Mode Instructions For Burner

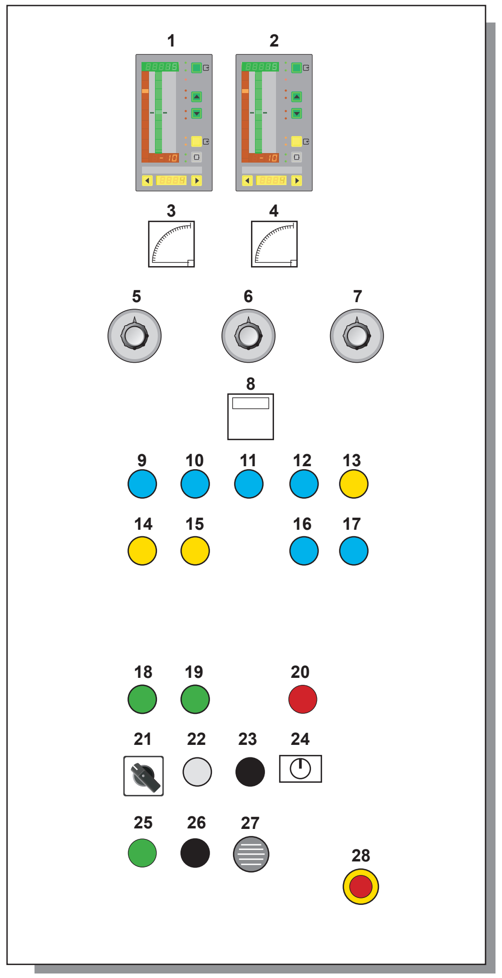
Automatic Cascade Mode (steam load depending firing rate)
1. Select TA1 in position CASC. The master output will be set point for Oil and Air Flow Controllers.
2. Select TA5 in position AIR and TA4 in position AUTO.
3. Select TA5 in position Oil and TA4 in position AUTO. The set point from Master Steam Pressure Controller decides the boiler steam pressure. Air and oil ratio is automatically controlled.

Oil and Air Automatic Mode (constant firing rate)
1. Select TAI in position AUTO. The set point for Oil and Air are selected manually on TA2 and TA3.
2. Select TA5 in position AIR and TA4 in position AUTO.
3. Select TA5 in position OIL and TA4 in position AUTO. The firing rate is selected manually on TA2 and TA3. Air and oil ratio is automatically controlled.

Oil and Air in Manual Mode
1. Select TA5 in position AIR and TA4 in position HAND.
2. Select TA5 in position OIL and TA4 in position HAND.
3. Air flow is increased on TA6 or decreased on TA7 with TA5 in position AIR.
4. Oil flow is increased on TA6 or decreased on TA7 with TA5 in position OIL.



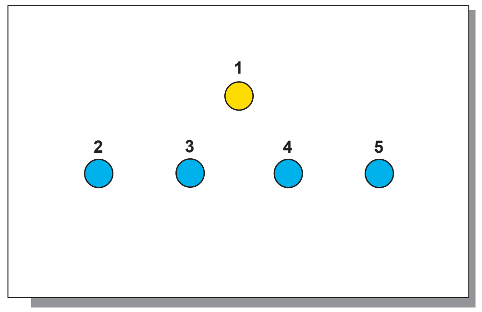
1. Water Level Controller
2. Fuel Oil Temperature Controller
3. Fuel Oil Pressure Controller
4. Atomising Steam Pressure
5. Oil Valves Not In Position
6. High Water Level
7. High Steam Pressure
8. High Oil Temperature
9. Overload Ignition Burner Pump
10. Interlocks OK
11. Flame Failure
12. Low Water Level
13. Overload Combustion Air Fan
14. Low Oil Temperature
15. Lance Not In Position
16. Sequence Failure
17. Low Steam Pressure
18. Too Low Water Level
19. Atomising Steam Pressure Low
20. Low Oil Pressure
21. Fuel Oil Standby Pump Started
22. Fire in Windbox
23. High Temperature In Uptake
24. Low Combustion Air Flow
25. Automatic Standby Feed Water Pump Started
26. Ammeter No.1 Feed Water Pump
27. Ammeter No.2 Feed Water Pump
30. Ammeter Combustion Air Fan
31. Hour Meter No.1 Feed Water Pump
32. Hour Meter No.2 Feed Water Pump
35. Hour Meter Combustion Air Fan
36. Feed Water Pump No.1 Mode Selector Standby - Off - Manual
37. Feed Water Pump No.2 Mode Selector Standby - Off - Manual
38. Fuel Oil Pump No.1 Mode Selector Standby - Off - Manual
39. Fuel Oil Pump No.2 Mode Selector Standby - Off - Manual
40. Combustion Air Fan Mode Selector Auto - Off - Manual
41. Feed Water Pump No.1 - Stop/Start Pushbuttons
42. Feed Water Pump No.2 - Stop/Start Pushbuttons
43. Fuel Oil Pump No.1 - Stop/Start
44. Fuel Oil Pump No.2 - Stop/Start
45. Combustion Air Fan Run
46. Feed Water Pump No.1 - Standby
47. Feed Water Pump No.2 - Standby
48. Fuel Oil Pump No.1 - Standby
49. Fuel Oil Pump No.2 - Standby
50. Space Heating Feed Pump No.1
51. Space Heating Feed Pump No.2
52. Space Heating Combustion Air Fan



1. Air/Oil Controller
2. Main Steam Pressure Controller
3. Combustion Air Flow Indicator
4. Fuel Oil Flow Indicator
5. Air Flow Setting Potentiometer 0 - 100%
6. Oil Flow Setting Potentiometer 0 - 100%
7. Air/Fuel Ratio Potentiometer -50% - +50%
8. Oil Flow Totaliser
9. Atomising Steam Valve
10. Ignition On
11. Oil Valve Open
12. Steam Purge Valve
13. Burner Normal Stop
14. Combustion Controller Off
15. Ignition Lance Inserted
16. Heavy Fuel Oil
17. Diesel Oil
18. Burner On
19. Chemical Dosing Unit Oil-Fired Boiler
20. Emergency Operating Mode
21. Control Voltage Selection Switch
22. Control Voltage indication Lamp
23. Lamp Test Button
24. AUTO / MANUAL Burner Mode Selection Key Switch
25. Sootblower Start/Run
26. Stop Buzzer
27. Buzzer
28. Emergency Stop

CPU Back-up Battery Inside (27A2A)

Burner Emegency Operation Panel (on Burner Unit)



1. Flame ON Indicator lamp
2. Atomising Steam Valve
3. Ignition
4. Oil Valves Open
5. Oil Valve Closed / Steam Purge

2.2.3 OIL-FIRED BOILER CONTROL SYSTEM

Manufacturer: Aalborg Industries, Denmark

This system provides operation, control and interlock devices required for the running of the boiler at a steam pressure of 0.70MPa. It performs the automatic and manual operation of the boiler and will give an alarm to warn the operator if an abnormality occurs during operation of the following modes:

Emergency/Automatic Mode

A key switch located on the boiler control panel allows the burner to be operated either in Automatic or Manual (emergency) mode. In the manual (emergency) mode the boiler will be operating with reduced safety interlocks. With the automatic sequence controller bypassed, the burner must be operated at the local control position at the boiler top.

Normal 0.7MPa Mode

In this mode the boiler pressure will start to rise and will follow the actual steam load. If the steam demand decreases, and the boiler steam pressure rises to the automatic burner stop point, the burner will cut-out. The burner will remain off until the steam pressure falls to the point of automatic start, which is slightly below the pressure set point. An automatic start will be performed and the boiler pressure will be brought back up to its set point.

Control Panel

The panel contains the controllers, which are electronic microprocessors, and allow automatic/manual operation of output and set point adjustment of the following systems:

Fuel Oil Temperature

This is kept at a steady predetermined value by controlling the steam flow to the fuel oil heaters.

Burner Fuel Oil Pressure

This is required to keep the fuel oil pressure at the desired value and is achieved by controlling the recirculation to the suction side of the oil pumps.

Boiler Water Level

The desired liquid level in the boilers is achieved by controlling the feed water flow to the boiler. (See Section 2.3.3, Boiler Feed Water System.)

Atomising Steam Pressure

To keep the pressure at the preset value, the steam flow is controlled down-stream of the control valve.

Main Line Steam Pressure

This is achieved by controlling the oil flow and, in accordance with this, the air flow to the burner.

Operating Procedures

Procedure for the Preparation of Boiler Control System

a) Turn on the power switches of the boiler control panel.

b) Check the action of each pilot lamp and buzzer using the buzzer and lamp test switch on the control panel.

c) Supply air to all the control devices.

d) Reset the boiler interlock alarm.

e) Check that all alarm lamps are out.

Procedure for Operating the Burner

The Emergency Operation key switch must be in the AUTO position.

Note: The air/oil combustion controller will automatically drive the air and oil control valves to the minimum purge and ignition position according to the activated burner sequence step.

For Automatic Mode (steam load determining firing rate) proceed as follows:

a) Start the combustion air fan on START/RUN if the AUTO-MAN switch is selected to MANU.

In AUTO the air fan is automatically started and will run for a minimum of 20 minutes to avoid more than 3 starts per hour.

b) Turn the burner mode switch to START/RUN.

The burner will automatically be started and stopped by a signal from the start/stop steam pressure switch.

To stop the burner manually, select the mode switch to STOP.

Manual (Emergency) Operation Procedure

Ensure that the Combustion Air Controller is OFF, illuminated yellow pushbutton No.14 on panel 2, as shown above.

a) Turn the combustion air fan control switch to MAN.

Note: The set point for the air/oil combustion controller is, by default, left in minimum and must be adjusted to purge, ignite and firing position by hand operation as described below. See illustration 2.2.3b on the following page for the operation legend for the air/oil combustion controller.

b) Turn the Automatic/Manual burner selection key switch to the No.1 (emergency) position.

c) Set TA1 on the air/oil combustion controller to AUTO.

d) Adjust the air and oil on TA2/TA3 to the PURGE position; this gives a minimum of 50% air flow.

Allow the boiler furnace to be purged for a minimum of 60 seconds.

WARNING

Insufficient purging may cause a dangerous furnace explosion.

e) Adjust the air and oil flow on TA2/TA3 to an ignition position of approximately 25%.

f) Replace the auto flame scanner with the emergency flame scanner.

g) Press the pushbutton for OPEN ATOMISING STEAM VALVE.

h) Press the IGNITION pushbutton and keep depressed. Check that the ignition burner is on.

i) With the pilot ignition operation successful, press the OPEN OIL VALVE pushbutton, check that the flame indication is given on the local operation panel (yellow indication lamp), the OPEN OIL VALVE pushbutton must only be held in for a maximum of 5 seconds.

j) With the main burner ignited release both pushbuttons (IGNITION and OPEN OIL VALVE), check that the main burner flame is stable. If the flame fails to ignite, the furnace must be purged for a minimum of 60 seconds before a new burner ignition start is made.

When the flame is established, supervision is made by the emergency flame scanner. Air/oil flow to the burner can be adjusted by TA2/TA3 on the air/oil combustion controller to the desired flow rate.

WARNING

In emergency operation, the safety interlocks are reduced to TOO LOW WATER LEVEL and FLAME FAILURE only. Therefore the boiler must be carefully and continually supervised by the ship's engineering staff.

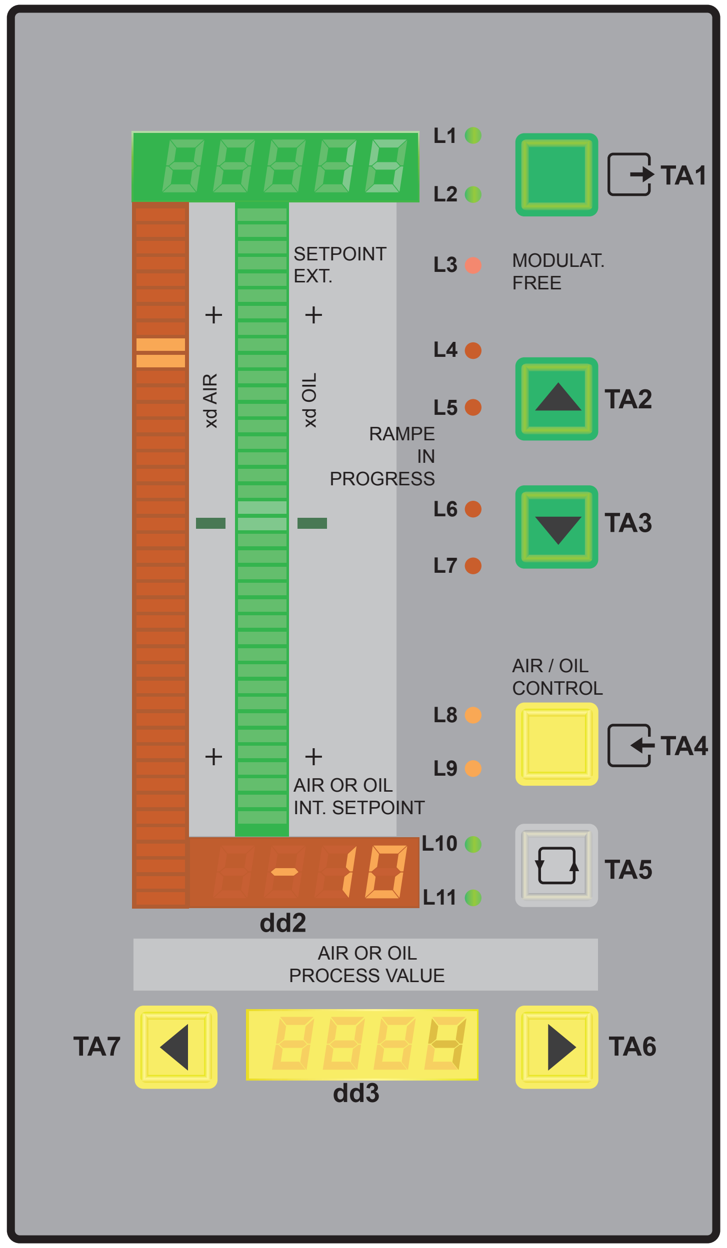
The burner firing can be stopped by turning the Automatic/Manual burner selection key switch to the No.2 position, or by pressing the OIL VALVE CLOSE/STEAM PURGE VALVE OPEN pushbutton for 15 seconds on the local emergency operation box.

Boiler Cold Start

In cold start operations when burner atomising steam and the FO heating steam are not available, diesel oil fuel is used along with atomising air.

With the HFO/DO crossover valves set for DO operation, the FO low temperature alarm and trip is inhibited, additionally, the motorised valve for the steam supply to the burner from the boiler is locked closed, the burner control and ACC operation reverts to manual.

Illustration 2.2.3b Boiler Air/Oil Combustion Control Panel



The Air/Oil combustion control panel identification legend is given below.

TA1 - Soft key used by the operator to toggle between CASCADE and AUTOMATIC mode.
L1 - When illuminated indicates that CASCADE mode is in operation.
L2 - When illuminated indicates that AUTO mode is in operation.

L3 - When illuminated indicates that the boiler is running in Modulation Free mode.

TA2 - Soft key used by the operator for fast increase the set point for the air and oil when the system is running in AUTOMATIC mode.
L4 - When illuminated indicates that TA2 is activated.
L5 - Ramp increase in progress.

TA3 - Soft key used by the operator for fast decrease the set point for the air and oil when the system is running in AUTOMATIC mode.
L6 - Ramp decrease in progress.
L7 - When illuminated indicates that TA3 is activated.

TA4 - Soft key used by the operator for the selection of AUTO or HAND of the air or oil controller which is chosen by TA5.
L8 - When illuminated indicates that AUTO is selected.
L9 - When illuminated indicates that HAND is selected.

TA5 - Soft key used by the operator for the selection of the AIR or OIL controller.
L10 - When illuminated indicates that the AIR controller is selected.
L11 - When illuminated indicates that the OIL controller is selected.
dd2 - Indicates the set point for the air or oil controller.

TA6 - Soft key used by the operator for increasing the controller output of the selected control function, ie, either air or oil as selected by TA5 when the system is in HAND mode as selected by TA4.

TA7 - Soft key used by the operator for decreasing the controller output of the selected control function as previously described for TA6.
dd3 - Indicates the set point for the air or oil controller selected by TA5.

2.2.4 OIL-FIRED BOILER SOOTBLOWERS

Auxiliary Boiler Sootblowers

Manufacturer:	Aalborg Industries, Denmark
No. of sets:	4
Air supply:	2.0-3.0MPa
Working pressure:	1.20-1.50MPa
Air consumption:	14.8m^3/min
Blowing time/sequence:	16 seconds

Sootblowing has to be carried out at regular intervals to ensure that the heat transfer surfaces are kept clear of deposits, as these retard heat transfer and can constitute a fire hazard.

Sootblowing should be operated daily when the boiler is in use, bearing in mind the position of the vessel and any local legislation concerning pollution and clean air. The sootblowers should be operated when leaving port prior to the boiler shutting down as the exhaust gas boiler takes over steam production.

Before operation, request permission from the bridge and notify the bridge on completion.

Procedure for the Operation of the Auxiliary Boiler Sootblowers

a) The boiler should be at a minimum of 50% of full load.

b) Open the air supply valve.

c) Start sootblowing sequence by pressing the sootblower START pushbutton on the boiler control panel.

The sequence is automatic and will consist of either one or two operations of the sootblowers.

d) At the completion of sootblowing, shut the master valve.

Note: The main air pressure must be kept in the 2.0-3.0MPa range to maintain the nozzle pressure at 1.20 -1.50MPa. An orifice is fitted in the air supply line to create a pressure reduction at the nozzle.

Illustration 2.2.4a Sootblowing

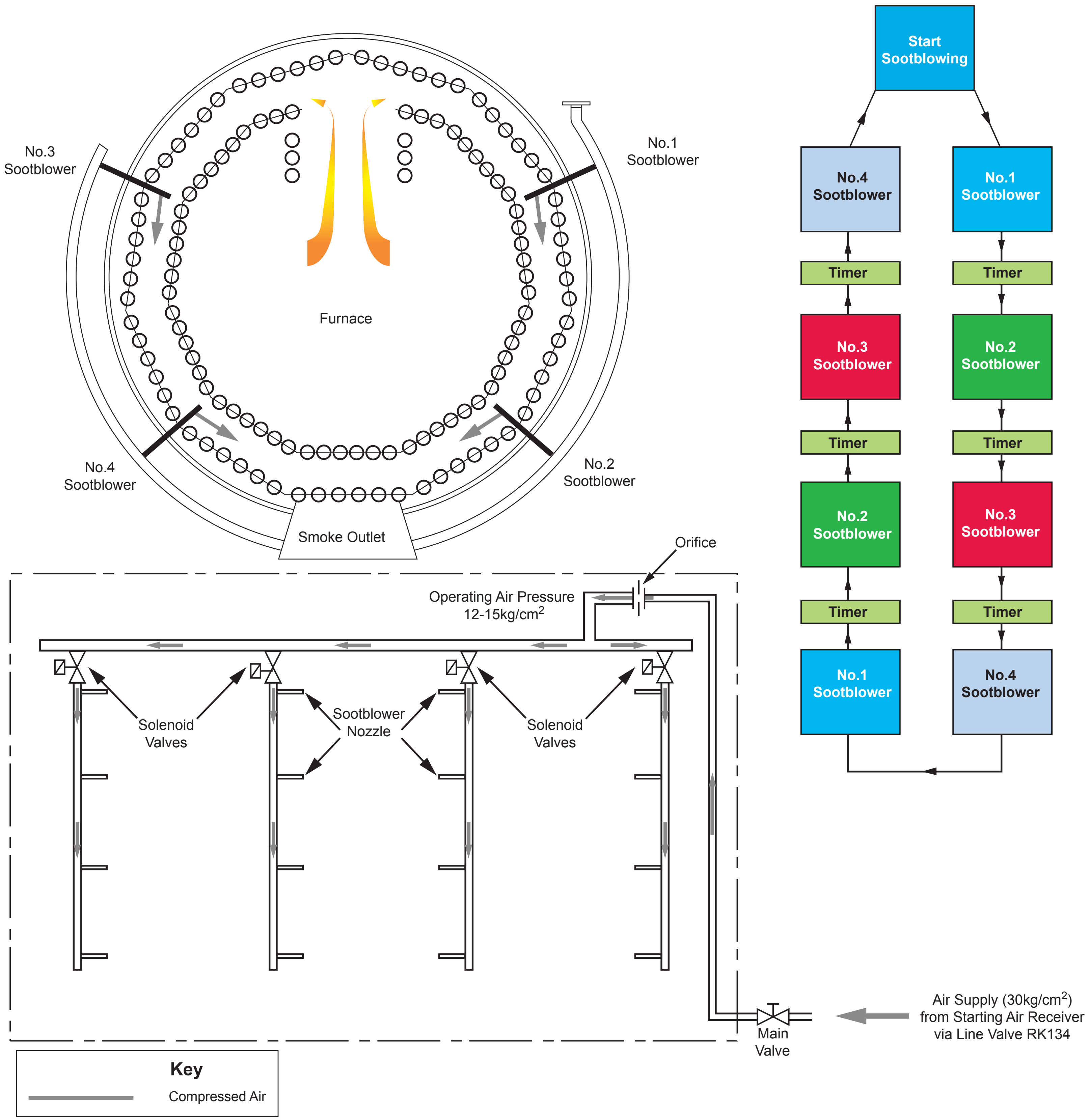
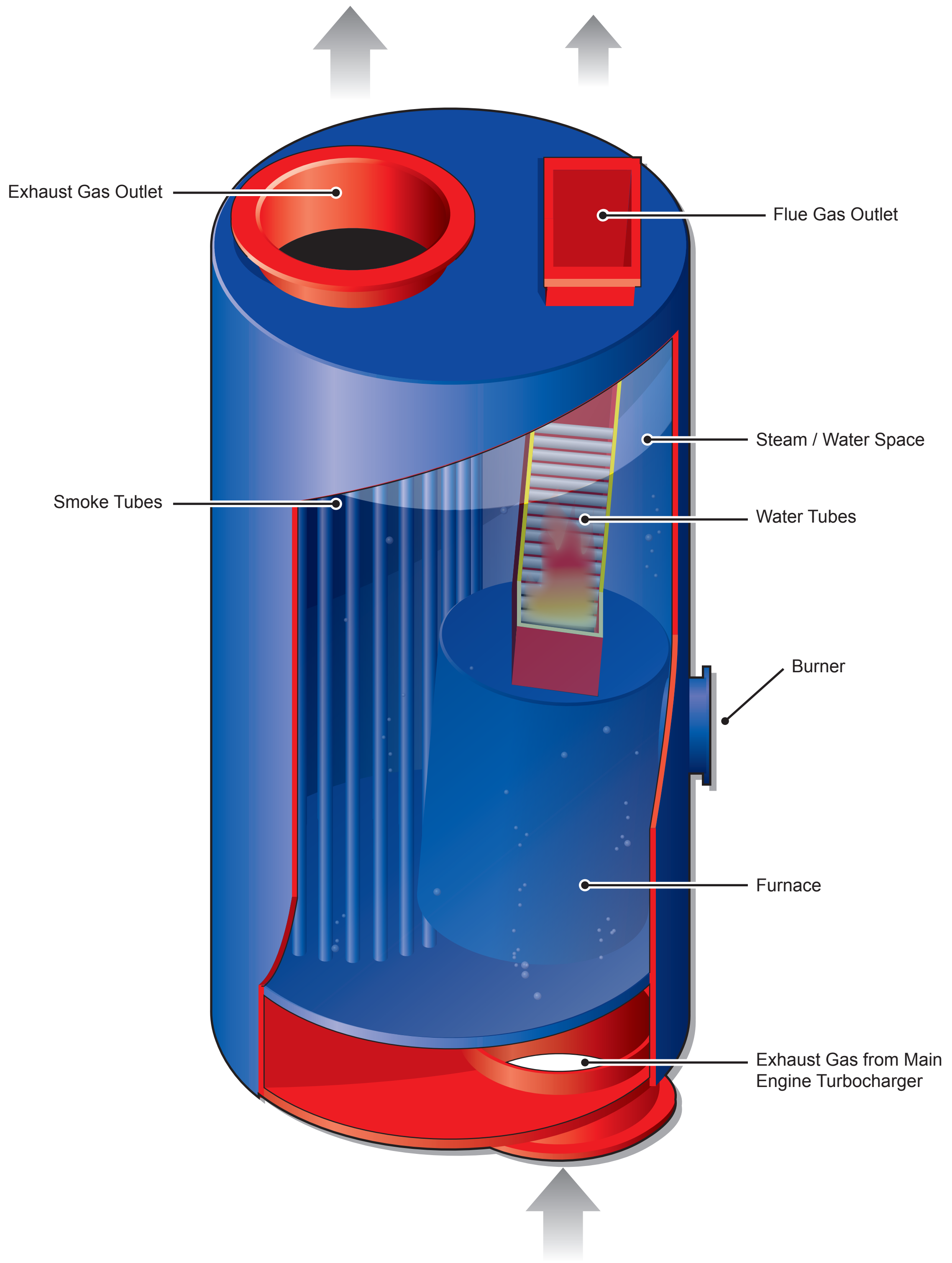


Illustration 2.2.5a Composite Boiler



2.2.5 COMPOSITE BOILER - TYPE AQ10/16

Manufacturer:	Aalborg Industries, Denmark.
No. of sets:	1
Model:	AQ-10/16
Type:	Combined oil-fired vertical water tube and exhaust gas smoke tube marine boiler
Weight excluding water:	21,000kg
Weight including water:	35,000kg
Evaporation, oil-fired:	3,000kg/h
Evaporation, exhaust gas:	1,000kg/h
Steam condition:	0.70MPa saturated steam at 175°C
Fuel oil:	HFO up to 700cSt at 50°C
Fuel oil consumption, HFO:	58kg/h minimum firing capacity, 224kg/h maximum firing capacity
Fuel oil consumption, MDO:	55kg/h minimum firing capacity, 214kg/h maximum firing capacity
Waste oil consumption:	80kg/h minimum firing capacity, 305kg/h maximum firing capacity
Safety valve setting:	0.87MPa
High steam pressure alarm and burner stop:	0.76MPa
Burner start steam pressure:	0.62MPa
Burner stop steam pressure:	0.70MPa
Steam dump operating pressure:	0.73MPa
Low steam pressure alarm:	0.40MPa
Too high water level:	+200mm
High water level alarm:	+150mm
Low water level alarm:	-120mm
Too low water level alarm and burner stop:	-145mm

Description

The composite boiler is arranged in the funnel casing and comprises an exhaust gas boiler integrated with an oil-fired furnace and separate flue. The composite boiler produces steam by utilising the waste heat from the main engine exhaust gas, by oil-firing or by a combination of both methods of heating. It may be operated independently or in conjunction with the auxiliary oil-fired boiler.

The boiler is all welded in construction, consisting of a shell integral furnace and two independent sets of tubes. With vertical smoke tubes for heating by the exhaust gases and horizontal water tubes for the furnace flue gases.

It is possible to lower the water level or even empty the boiler completely and run with the boiler dry, provided the gas temperature does not exceed 400ºC.

Excess generated steam is dumped to the atmospheric condenser. The composite boiler has its own independent feed pumps which draw from the common feed water system, which also supplies the auxiliary boiler.

General Construction

The boiler is of a single drum type construction, with two sets of heating tubes and the furnace inside the drum. It also includes a boiler casing, fuel firing equipment, mountings, fittings and other accessories. The whole boiler construction is designed to be able to withstand the rolling and pitching of the ship. Careful consideration is also given to the movement by thermal expansion of the boiler.

Combustion gases from the water-cooled furnace pass upwards through the horizontal water tubes before leaving the boiler through a separate uptake. The exhaust gas from the main engine passes through the boiler in vertical smoke tubes and then continues up the funnel. The two sets of tubes are designed to be water washed and/or mechanically cleaned from the respective uptakes.

The furnace is totally cooled by the surrounding boiler water and is constructed without the need for any refractory.

The furnace is equipped a single horizontally firing rotary cup burner which is designed to allow the burning of waste oil as an alternative to fuel or diesel oil. The burner cup is rotated at high speed by an electric motor through a V-belt drive. Oil is introduced into the cup at low pressure. The centrifugal force imparted by the rotation of the cup throws the oil out from the cup rim in a fine uniform film. Combustion air, delivered at high velocity around the cup, converts the film into a fine mist and forces it into the combustion zone where it burns in a conical flame. Secondary air required for complete combustion is supplied for the forced draught fan through the wind box and burner air register. The rotary cup burner is ignited by an independent diesel oil ignition burner.

Insulation is provided on the outer surface of the boiler shell and then covered with galvanised steel cladding.

A dryer is fitted below the steam outlet to remove water droplets from the steam. This may be dismantled for removal through the access manhole.

The boiler also has an internal feed water pipe, a surface scumming pipe, blowdown and sampling connections.

Operating Procedures

The following steps should be taken before attempting to operate the boiler:

a) All foreign materials have been removed from the steam/water spaces, furnace and gas spaces.

b) All gas side-heating surfaces are clean.

c) Ensure that combustion chamber and wind box are clean and free of oil.

d) All personnel are clear.

e) All manhole covers and access doors are securely tightened.

f) Inspect safety valves and see that gags have been removed and easing levers are free and in good condition.

g) Open root valves for all instruments and controls connected to the boiler.

h) Open the vent valve at the boiler top.

i) Open all pressure gauge valves and check to see that all valves on the pressure gauge piping are open.

j) Check and close all blowdown valves and drain valves.

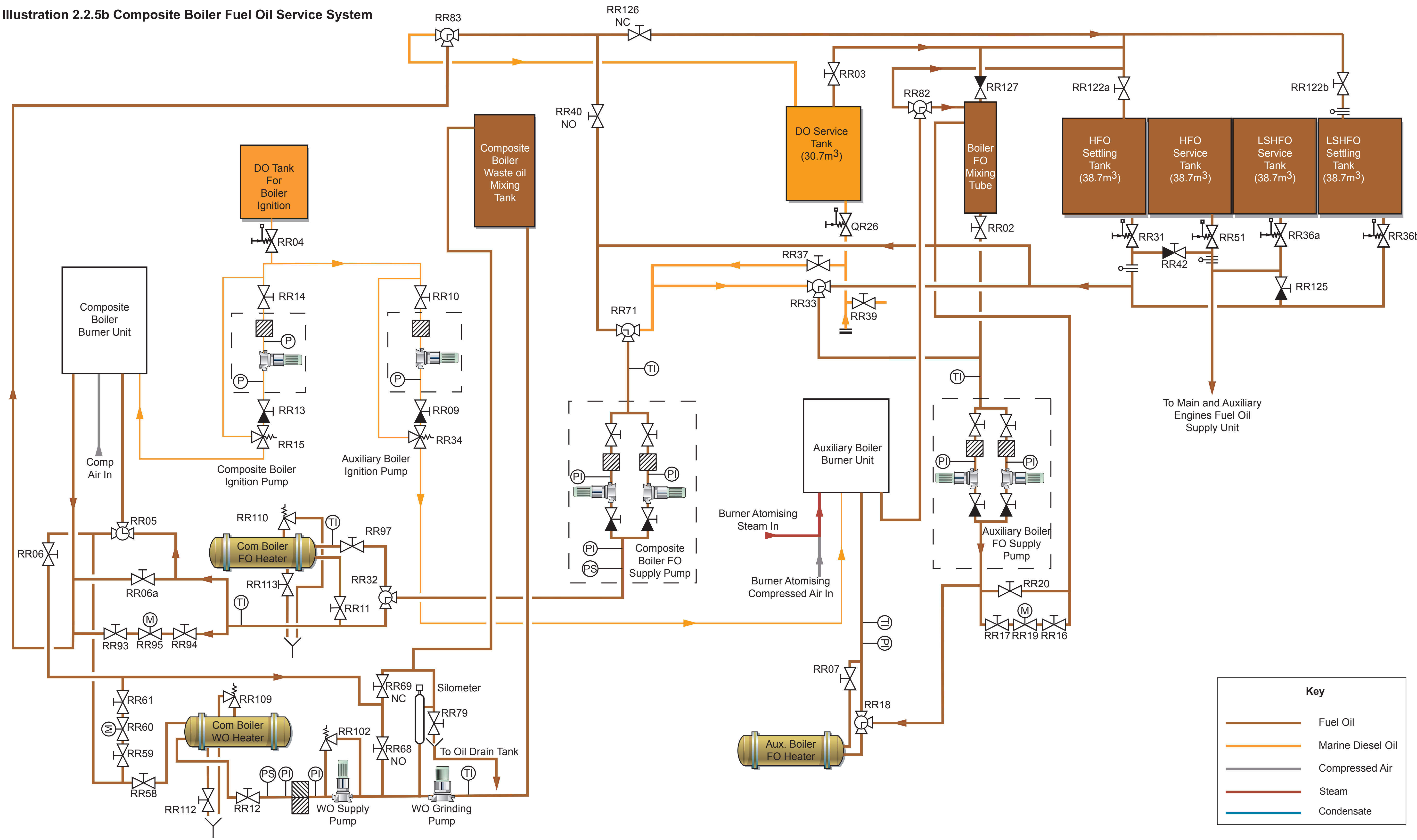
k) Slowly fill the boiler with water until the level in the gauge glasses is approximately 50 to 70mm below the normal working level (to allow for expansion when heated).

l) Check the operation of the gauge glasses.

m) Set up the valves as in the following table:

Position	Description	Valve
Open	No.1 feed pump suction valve	RL8
Open	No.1 feed pump discharge valve	RL10
Open	No.2 feed pump suction valve	RL9
Open	No.2 feed pump discharge valve	RL11
Open	Boiler feed inlet valves (1)	RL28
Open	Boiler feed inlet valves (2)	RL29
Operational	Feed water level controller	RL55
Open	Feed water controller outlet valve	RL56
Closed	Steam outlet valve	QE97

Illustration 2.2.5b Composite Boiler Fuel Oil Service System



CAUTION

To avoid thermal shock to the boiler, feed water should be preheated, particularly if the unit has been heated by engine exhaust gas. If preheating is not possible, feed water should be introduced slowly.

n) The boiler may now be heated either by the main engine exhaust or by firing the oil-fired burner on low flame.

o) Monitor the water level and pressure in the boiler as it heats up, close the top vent valve when the pressure is approximately 0.15 MPa and set the duty feed pump to RUN when the swell has been taken up. The second feed pump can now be set to standby operation. The level of water in the boiler will now be maintained according to the control signal from the level transmitter.

p) Check the operation of the gauge glasses and compare their levels to the remote instrumentation.

q) Increase the rate of heating by increasing main engine speed or burner firing accordingly and raise the steam pressure slowly to avoid local overheating in the boiler.

r) When boiler pressure is at 0.70MPa, slowly open the steam outlet valve QE97.

When the load from the main engine has increased to normal, the exhaust gas should now provide sufficient heat to generate enough steam to supply the vessel's services. If this is not the case, the heating may be supplemented by use of the rotary cup burner. When the composite boiler is able to cover the steam load the auxiliary boiler may be shut down and the heating coil brought into service.

Operation on Waste Oil

The rotary cup burner is designed to burn waste oil with a high water content and the alarm is set at 18% water. The waste oil is stored in a separate heated mixing tank where excess water is drained off. As the water content has to be kept within narrow limits it may be necessary to adjust this by adding either water or oil to the mixing tank. The waste oil is circulated through a parallel system by the mixing/grinder pump before being pumped through the heater and then to the boiler by the eccentric screw supply pump. Excess oil being returned to the mixing tank.

Change over from fuel oil to waste oil is carried out on the control panel, the HFO/WO changeover switch is turned to WASTE. If the boiler load is sufficient the pneumatic three-way valves will change over and waste oil is supplied to the burner.

Change over from HFO to waste oil is carried out when the compound regulator is at 4.2 or above, reverting to HFO when the regulator setting drops to 3.0 or below.

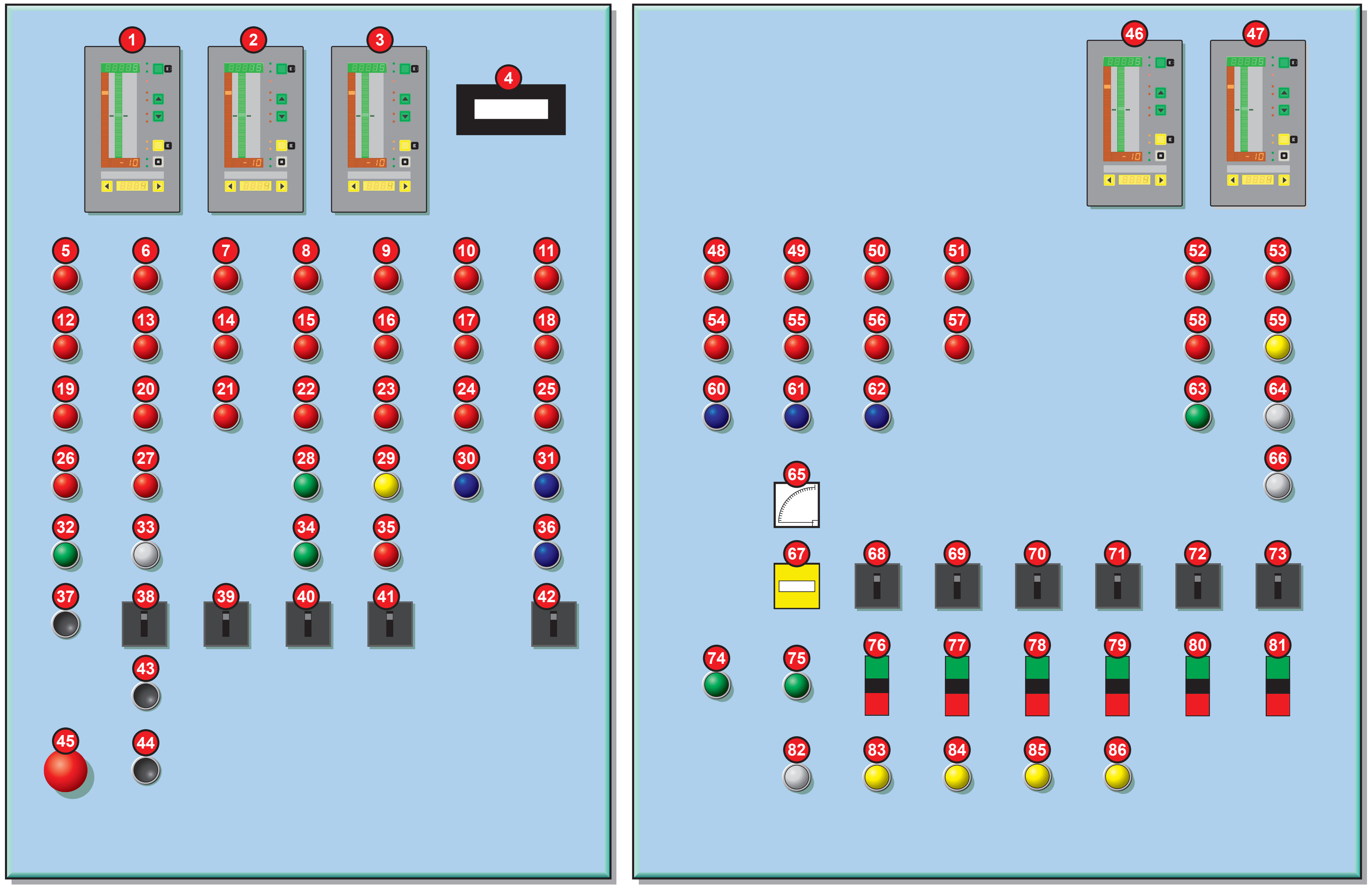
In order to burn waste oil certain criteria must be maintained:

- Boiler steam load sufficient
- Boiler burner operating on HFO
- Waste oil water content within limits
- Waste oil tank level adequate
- Waste oil temperature and pressure within limits

If these criteria are not met the burner will remain on heavy oil and if already burning waste oil will automatically revert to burning heavy oil.

See Section 2.6.4, Composite Boiler Fuel Oil Service System, for more details of the fuel oil system.

Illustration 2.2.6a Composite Boiler Control Panel



Key

1. Steam Pressure Controller
2. Water Level Controller
3. Steam Dump Controller
4. Water % in Waste Oil
5. High Steam Pressure
6. High Oil Temperature
7. High Oil Content in Feed Water
8. Burner Swing Out
9. Atomising Air Pressure Low
10. Low Water Level
11. Too High Water Level
12. Low Steam Pressure
13. Low Oil Temperature
14. Low Oil Pressure Burner Inlet
15. Overload Burner Motor
16. Overload Combustion Air Fan
17. Too Low Water Level
18. High Water Level
19. Flame Failure
20. Combustion Air Pressure Low
21. High Water Content in Waste Oil
22. High Salinity
23. Auto Standby Feed Water Pump - Start
24. Low Level in Mixing Tank
25. High Level in Mixing Tank
26. High Temperature in Uptake
27. Low Oil Pressure Waste Oil
28. Safety Interlock OK
29. Set Point
30. Ignition Pump and Traffo
31. Oil Valve
32. Chemical Dosing Pump
33. Control Voltage
34. Burner Operation
35. Manual Operation
36. Heat Tracing
37. Lamp Test
38. Control Votage: Off - On / Reset
39. Modulation Module: Man - Auto
40. Burner: On - Off
41. Manual Operation: Auto - Man
42. Heat Tracing: On - Off
43. Burner Modulation Manual Increase
44. Burner Modulation Manual Decrease
45. Emergency Stop
46. Fuel Oil Temperature Controller
47. Waste Oil Temperature Controller
48. Auto Standby Fuel Oil Pump - Started
49. Overload Fuel Oil Pump No.1
50. Overload Combined Pump and Grinder
51. High Temperature Heavy Fuel Oil Preheater
52. Overload Sootblower
53. Too Low Air Pressure (Sootblower)
54. Overload Ignition Burner Pump
55. Overload Fuel Oil Pump No.2
56. Overload Waste Oil Transfer Pump
57. High Temperature Waste Oil Preheater
58. Sequence Not Completed (Sootblower)
59. Low Air Pressure (Sootblower)
60. Diesel Operation
61. Heavy Fuel Operation
62. Waste Oil Operation
63. Sootblower Operation
64. Air Valve Open (Sootblower)
65. Ammeter Combustion Air Fan
66. Air Valve Closed (Sootblower)
67. Combustion Air Fan Hour Meter
68. Fresh Water Pump No.1: Off - Man - Stby
69. Fresh Water Pump No.2: Off - Man - Stby
70. Fuel Oil Pump No.1
71. Fuel Oil Pump No.2
72. Oil Type
73. Sootblower
74. Burner Motor
75. Combustion Air Fan
76. Feed Water Pump No.1: Start - Stop
77. Feed Water Pump No.2: Start - Stop
78. Fuel Oil Pump No.1
79. Fuel Oil Pump No.2
80. Combined Pump and Grinder
81. Waste Oil Transfer Pump
82. Space Heating Combustion Air Fan
83. Feed Water Pump No.1 Selected as Auto Standby
84. Feed Water Pump No.2 Selected as Auto Standby
85. Fuel Oil Pump No.1 Selected as Auto Standby
86. Fuel Oil Pump No.2 Selected as Auto Standby

2.2.6 COMPOSITE BOILER CONTROL SYSTEM

Boiler Burner

Manufacturer: Aalborg Industries, Denmark
Type: Rotary cup
Model: KB 250W

The burner is of the rotary cup type and so does not require any atomising steam or air supply. Control air is needed for valve actuation and purging and an electrical supply is required to operate the rotary cup. Combustion air is supplied by means of an electrically-driven forced draught fan. The air supply is regulated by means of dampers. The forced draught fan is situated on top of the wind box and it supplies air for the primary fan which is an integrated part of the burner. Primary air represents about 10% of the total air supplied, the remaining 90% being secondary and tertiary air from the forced draught fan. The secondary air for combustion is supplied to the wind box and is directed into the flame by means of vanes.

Correct control of the secondary air is essential to efficient combustion throughout the entire turn-down range of the burner. Draught control is performed by means of a secondary air damper connected to the compound regulator by a rod linkage. The fuel oil compound regulator is the final control element which meters out fuel oil and combustion air to the burner.

The rate of fuel flow is controlled in a linear manner by a rotary valve in the compound regulator. A cam is used to regulate the air damper control lever to compensate for the non-linear operation of the secondary air control damper.

Ignition of the burner is by means of a diesel oil igniter inserted through the wind box and air register. The ignition burner lance and nozzle are automatically purged with air when the ignition period has ended.

Water Level Control

Feed water supply to the boiler is handled by a single element control system. It is designed to maintain the boiler water level and provide an alarm and safety shutdown should the level not stay within set limits. A transmitter is mounted on the boiler which sends a signal to the controller, which in turn regulates the opening of the feed water control valve.

The feed water control valve has an electro-pneumatic valve positioner for automatic operation. The feed pump(s) operate continuously and the feed control valve regulates the amount of water directed to the boiler, depending upon the current water level. A set of direct feed valves is provided to be used in the event of failure of the feed water controller.

The safety system consists of two independent means of shutting off the fuel supply to the burner if the water level in the boiler falls to an unacceptably low level. A separate low level float switch shuts off the fuel supply when the water level falls to a low value. Limit switches located on the boiler control panel, are connected to the differential pressure transmitter which operates the feed water controller.

These provide for the following:

- Shut off the fuel supply to the burner at low water level
- A low water level alarm
- A high water level alarm
- Stop the feed water pump at too high a water level

The Boiler Control Panel

The boiler control panel provides operation, control and interlock devices required for the running of both the oil-fired and exhaust gas boilers. This control panel performs the automatic and manual operation of the boiler plant and it gives an alarm to warn the operator if an abnormality occurs during operation.

There are two control panel sections for the oil-fired boiler, one for the exhaust gas boiler and a common section for the feed water system. These sections are interlinked. The boiler feed water regulator operates continuously when the boiler is operating, and acts to open or close the automatic boiler feed water supply valve in response to the level of water in the boiler.

The boiler control system stops the boiler in an emergency mode, by immediately shutting down the fuel oil supply to the boiler, if such an abnormality should be too serious to continue running any longer.

Master Boiler Control Panel

This panel contains the system power supply unit and controller for the burner control and automatic process control plus various relay units.

The system has alarms and trips which provide for safe operation of the boiler. The alarms bring any abnormality in operation to the notice of the engineer and a trip initiates a shutdown. The alarm and control panel is provided with a lamp test pushbutton which enables the lamps to be tested; this should be carried out daily in order to enable failed indicator lamps to be detected and replaced.

Burner Control System

This system controls the manual and automatic operations of the burner in the boiler. The unit contains a sequence control, which operates the furnace purge, pilot burner and the automatic operation of the burner piston valve.

The burner sequence control unit is designed for control and supervision of the oil burner in automatic operation. A motor-driven camshaft activates electric switches which control the burner servomotor, burner motor, ignition and solenoid valves. The control unit is connected to a photocell and in normal operation it controls the flame supervision circuit.

Note: The burner sequence control unit has no function when the oil burner is running in manual mode.

During start-up the control unit operates the oil burner in a pre-selected start-up sequence. In the event of fault during start-up or in normal operation, the fuel supply is instantaneously interrupted, and the sequence control unit stops the oil burner.

Features

The control unit is provided with the following additional safety features:

- The flame detector and extraneous light test is restarted immediately following the allowed after-burn time. This means that open or not fully closed fuel valves initiate a lock-out immediately after this time has elapsed. The test ends only on completion of the pre-purge time of the next burner start-up.
- The correct functioning of the flame supervision circuit is automatically checked during each burner start-up sequence.
- The unit permits burner operation with or without post-purge.
- The control contacts for fuel release are checked for welding during the post-purge time.
- A built-in unit fuse protects the control contacts against overload.
- Separate control outputs for OPEN, CLOSE and MIN (low flame position) of the air damper actuator.
- Supervised air damper control to ensure pre-purge with the nominal amount of air. Checked positions for CLOSED or MIN (low flame position) at the start, OPEN at the beginning and MIN on completion of the pre-purge time. If the actuator does not drive the air damper in the required position, the burner start-up sequence will be interrupted.
- Functional test of the air pressure monitor at the start-up and supervision of the air pressure from the beginning of the required pre-purge time until the controlled shutdown.
- Separate control output for an ignition fuel valve which is closed after the second safety time has elapsed.
- Two control outputs for release of the second output stage or the burner load control.
- When load control is enabled, the control outputs for the air damper actuator are galvanically separated from the control section of the unit.
- Connection facilities for the remote lock-out warning device, remote reset and remote emergency shutdown.

Mode of Operation

The control programme sends the necessary input signals to the control section of the control unit and the flame supervision circuit. If the required input signals are not present, the control unit interrupts the start-up sequence and initiates a lock-out where this is required by the system safety regulations.

Operating Procedure

- The START command is given by the pressure switch of the installation.
- Start-up sequence.
- The burner is in operation, according to the control commands of the load controller.
- Controlled shutdown through the pressure switch.
- The sequence mechanism runs into the start position for the post-purge.

Note: During burner off periods the flame supervision circuit is undervoltage in order to carry out the flame detector and extraneous light test.

Prerequisites for Burner Start-Up

- Burner is not interlocked in the lock-out position.
- Air damper is closed.
- The control contacts for the fuel valves CLOSED must be in the closed position.
- The normally closed contact for the air pressure monitor must be closed.
- The contacts of the gas pressure monitor and those of the limit thermostat or pressure switch must also be closed.

Start-Up Sequence

Start Command by the Pressure Switch

a) The pressure switch closes and the sequence mechanism starts to run. At the same time the fan motor is started on pre-purge.

b) After a preset time has elapsed the fan motor is activated in pre-purge and post-purge mode.

c) On completion of a further time interval the control command to open the air damper is given. During the running time of the actuator, the sequence mechanism stops. Only after the air damper has fully opened does the sequence mechanism continue to run.

d) Pre-purge time with the fully opened air damper. During the pre-purge time the correct functioning of the flame supervision circuit is tested. The control unit goes into the lock-out position in case of an incorrect function of the relay.

e) After completion of the pre-purge time, the control unit drives the air damper into the low flame position. During the damper running time the sequence mechanism stops again.

f) Pre-ignition time. The process of ignition is started with air and fuel being supplied in the correct proportion and the pilot burner operated.

g) Safety time. This delay period allows for ignition of the main burner and the photocell to detect the flame before the end of the safety time. The flame must be continuously present, otherwise the control unit initiates a lock-out and interlocks itself in the lock-out position.

h) Second safety time. On completion of the second safety time the main burner must have been ignited by the pilot burner.

i) End of the start-up programme. After a preset time interval has elapsed, the load controller is released. This ends the start-up sequence of the control unit. The sequence mechanism switches itself off, either immediately or after a few idle steps, ie, steps without change of the contact positions, depending on the times.

Burner Operation

During burner operation the load controller drives the air damper into nominal load or low flame position, depending on the demand for heat. The release of the nominal load is carried out by the auxiliary switch in the air damper actuator.

Controlled Shutdown

a) The fuel valves are closed immediately. At the same time the sequence mechanism starts again.

b) Post-purge time. Shortly after the start of the post-purge time the air damper is driven into the MIN position.

c) The complete closing of the damper starts shortly before the post-purge time has elapsed. This is initiated by a control signal which also remains undervoltage during the following burner-off period.

d) Permissible after-burn time. During this time the flame supervision circuit may still receive a flame signal without initiating burner lock-out.

End of control program.

e) On completion of the post-purge time the detector and extraneous light test starts again, as soon as the sequence mechanism has reset the control contacts into the start position.

f) During the burner-off period a faulty flame signal of a few seconds only initiates lock-out. Short ignition pulses of the UV-tube, eg, caused by radiation, do not initiate burner lock-out.

The boiler is normally operated on HFO with MDO being used for the igniter. It is possible to burn waste oil/sludge oil in the boiler and the boiler control panel has a facility for changing to waste oil operation.

Procedure for Automatic Burner Operation

The description below assumes that the fuel system is ready for operation with heated HFO available.

a) Check the fuel and burner system for leaks and ensure that the boiler is ready for operation.

b) Turn on the main power source to the burner control panel and check that the fuel supply valves are open.

c) Turn the CONTROL VOLTAGE switch to the ON position and the HEATING ON BURNER switch to the ON position.

d) Check all panel lamps by pressing the LAMP TEST pushbuttons.

e) Check that the water level in the boiler is within acceptable limits, with one feed pump selected as the operating pump and the other as the standby pump.

f) Select one fuel pump as the operating pump and the other as the standby pump. When burning waste/sludge oil the grinding pump would be started in order to ensure an even temperature in the waste oil service tank and an even distribution of water droplets. Gravity supplies waste oil to the boiler burner pump and heater module (see Section 2.6.4).

g) Turn the BOILER MODULATING MODE switch to the AUTO position.

h) Select automatic operation by turning the key operated BURNER OPERATION MODE switch to the AUTO position.

i) Turn the BURNER ON/OFF switch to the ON position; the burner will start and stop automatically by a signal from the start/stop pressure switch. The start-up sequence and flame supervision (by means of the automatic flame scanner) are controlled by the burner sequence controller.

When the start-up sequence is completed the burner will be modulated according to the setting of the burner modulation mode switch. There are two burner modulation modes, automatic and manual.

Auto Modulation

The BURNER MODULATION mode switch is in the AUTO position and the burner load is controlled automatically by the load controller.

Manual Modulation

The BURNER MODULATION mode switch is in the MANUAL position and the burner is controlled by the MANUAL INCREASE BURNER LOAD and MANUAL DECREASE BURNER LOAD pushbuttons.

In an emergency, the control system shuts off the fuel supply to the burner for the boiler protection. An emergency stop button is provided at the boiler control panel to enable the operator to stop the burner operating should that be necessary.

The boiler control panels provide visual indication of existing alarm conditions by means of indicator lamps. These lamps must be tested daily by pressing the LAMP TEST pushbutton.

The sootblower is also controlled from the burner control panel.

Manual Operation

The manual operation system allows for firing of the boiler, in the event of faults in the automatic sequence control or components of safety monitoring equipment.

Procedure for Changing to Manual Operation

a) Turn the BURNER ON/OFF switch to the OFF position.

b) Turn the BURNER MODULATION MODE switch to the MAN position.

c) On the boiler front, replace the Auto Flame Scanner with the Manual Flame Scanner.

d) Turn the key operated BURNER OPERATION MODE switch to the MAN position. The burner servo unit is now moved to the minimum position. When it reaches that position the burner rotating cup motor and the combustion air fan motor are started. With the fan in operation the manual increase and manual decrease burner load pushbuttons become active.

e) Press the MANUAL INCREASE pushbutton until the fan air damper reaches it maximum position.

f) Allow the boiler furnace purge to operate for at least 60 seconds.

WARNING

It is essential that the boiler furnace be purged correctly in order to reduce the risk of furnace explosion.

g) After purging the furnace, press the MANUAL DECREASE pushbutton until the fan air damper reaches its minimum position.

h) Check that the boiler fuel oil pressure and temperature are correct.

i) Press the IGNITION FOR MANUAL OPERATION pushbutton and the OIL VALVES pushbutton on the manual operation box and keep them depressed. The manual operation box is located at the burner and not at the control panel. Check visually that the ignition flame is established before continuing.

j) If there is a good ignition flame, keep both pushbuttons depressed for a maximum period of 5 seconds.

k) Release both pushbuttons, a steady flame should be established. The burner will remain firing, the oil valve and flame will be supervised by the manual flame scanner. The burner modulation may be selected as auto or manual.

l) If no flame is established when the ignition and oil valve pushbuttons are released, the start-up sequence must be repeated from step e) above.

m) Burner firing is stopped by turning the BURNER OPERATION MODE switch to the AUTO position.

CAUTION

In manual operation mode the safety interlocks are reduced to:

- **Too low water level**
- **High steam pressure**
- **Burner swing out**
- **Overload combustion air fan and burner motor**
- **Flame failure**

It is essential that the boiler is constantly supervised by a competent person when operating in manual mode.

2.2.7 COMPOSITE BOILER SOOTBLOWER

Manufacturer:	Aalborg Industries, Denmark
No. of sets:	1
Type:	G9B
Operation:	Electric
Medium:	Compressed air
Supply pressure:	> 2.50MPa
Compressed air consumption:	56m^3/min
Element length:	2,143mm
No. of nozzles:	12
Scavenge air consumption:	0.70m^3/min

Sootblowing should be carried out at regular intervals to ensure that the heat transfer surfaces are kept clear of deposited products of combustion. These will reduce heat transfer and may constitute a fire hazard.

The recommended frequency of sootblowing is once every 4 hours when the boiler is in use. However, this may be varied depending upon the operating conditions. It is important that the sootblowers should only be operated where local legislation allows this procedure and it is carried out with the full knowledge of the navigating officer on watch.

The water tubes of the oil-fired section of the composite boiler are provided with one electrically-driven sootblower, this uses high pressure compressed air from the main starting air receivers as the cleaning medium. The sootblower motor turns a single lance, provided with 12 nozzles, in a sequence that takes 25 seconds to complete one revolution.

Cleaning of the exhaust heated section of the boiler is carried out when both the boiler and the main engine are out of service. The access doors in the exhaust trunking above and below the boiler are opened. The exhaust inlet from the main engine blanked/covered and the drain to the cleaning tank opened. The boiler tubes may then be water washed. Alternatively, the tubes may be mechanically cleaned with the appropriate tube brushes and the deposits removed by hand.

Sootblower Operating Procedure

The sootblower is controlled from a dedicated control panel, which once initiated will control the blowing sequence automatically.

a) Ensure that the main air receivers are at full pressure and the air compressors are available for operation. To prevent the pressure in the air receivers from dropping too low, a pressure switch is incorporated into the control system which will inhibit the blowing cycle if the pressure drops below a set point.

b) Ensure that the compressed air valves are in the positions shown in the following table:

Position	Description	Valve
Open	Control air supply to sootblower air supply valve	QK31
Open	Air supply to sootblower	RK115

c) Initiate the automatic blowing sequence at the control panel.

d) Monitor the pressure in the main air receivers.

e) On completion of the sequence, close the compressed air valves listed above.

Illustration 2.2.7a Composite Boiler Sootblower

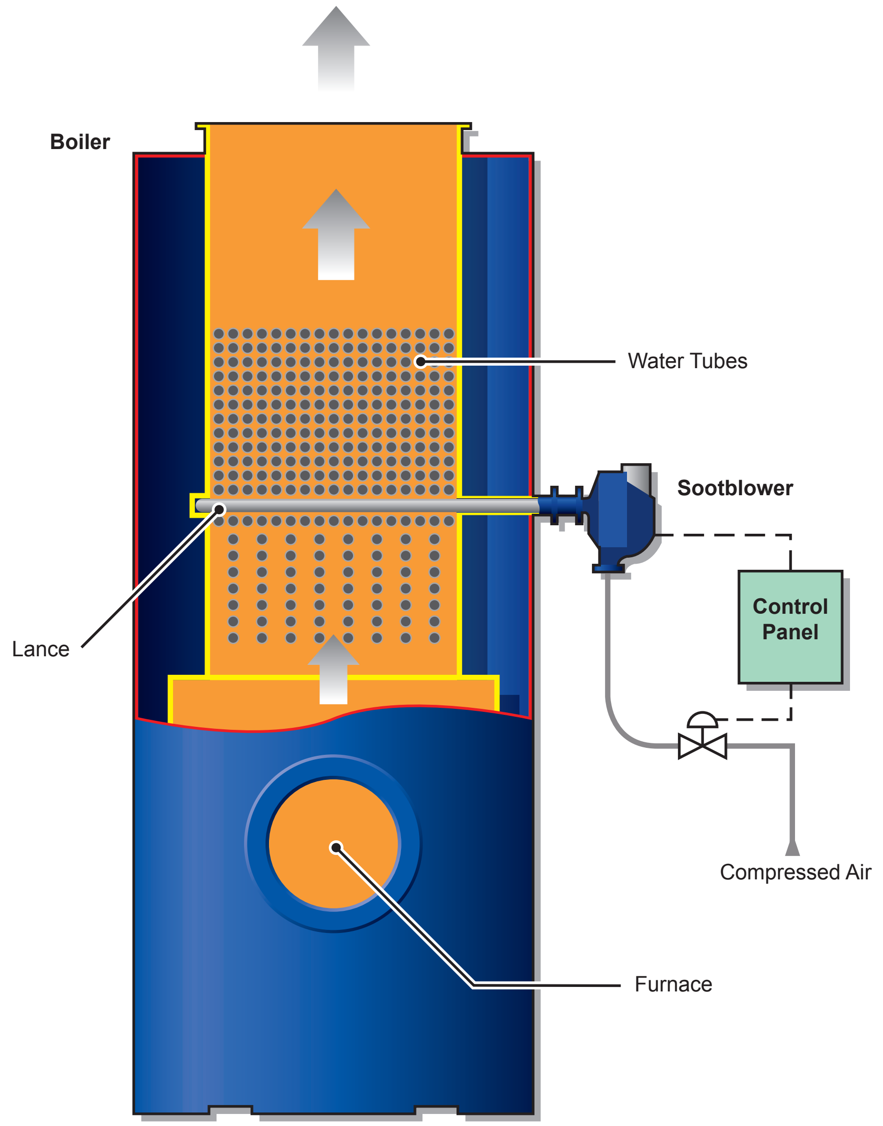
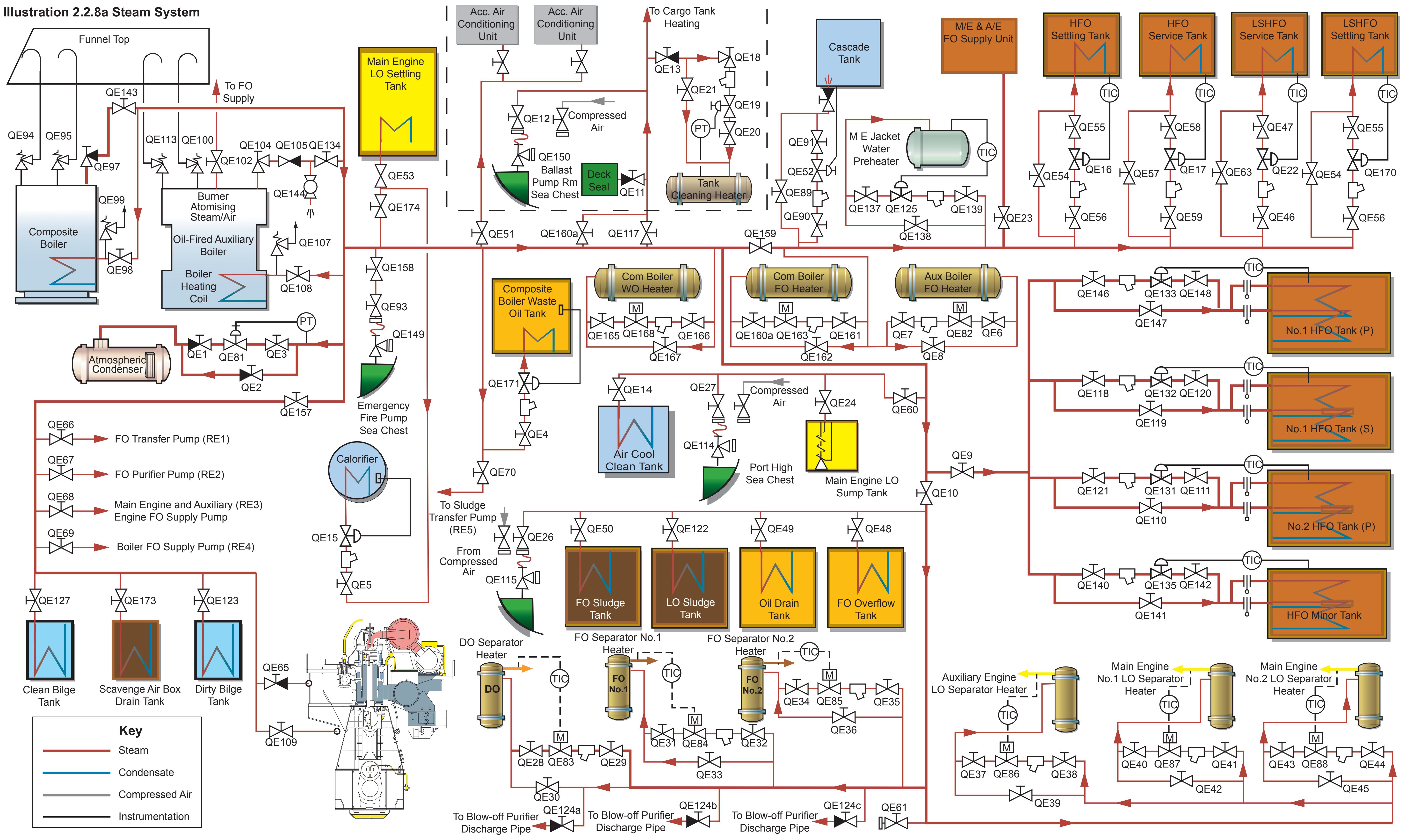


Illustration 2.2.8a Steam System



2.2.8 STEAM SYSTEM

General Description

Saturated steam is supplied to the steam system by the oil-fired auxiliary boiler and composite boiler at a working pressure of 0.70MPa. The auxiliary boiler can produce a maximum of 18 tonnes of steam per hour, and the composite boiler 3 tonnes of steam per hour when oil-fired or 0.9 tonnes per hour when heated by the main engine exhaust gas.

When the vessel is at sea the composite boiler can generate sufficient steam for normal operations utilising the waste heat from the main engine exhaust. This is supplemented when required by the oil-fired element of the composite boiler.

The auxiliary boiler may be operated in parallel with the composite boiler if required, for example, when tank cleaning or operating the main engine at reduced load.

Excess steam generated by the composite boiler when at sea is dumped to the atmospheric condenser. The services and equipment supplied by the steam system, with their associated isolating valves are listed below:

Description	Valve
Auxiliary boiler heating coil	QE108
Composite boiler heating coil	QE98
Header isolating valve	QE157
Steam tracing supply	QE66
Steam tracing supply	QE67
Steam tracing supply	QE68
Steam tracing supply	QE69
Clean bilge water tank heating coil	QE127
Scavenge air box drain tank heating coil	QE173
Dirty bilge water tank heating coil	QE123
Main engine	QE65
Main engine scavenge drain line	QE109
Emergency fire pump	QE158
Header isolating valve	QE174
Main engine lubricating oil settling tank heating coil	QE53
Hot water calorifier	QE5
Accommodation air conditioning units	QE51
Waste oil (for composite boiler) tank heating coil	QE4
Sludge transfer pump trace heating	QE70
Header isolating valve	QE60

Description	Valve
Air cooler cleaning tank heating coil	QE14
Port main sea chest weed clearing, HSV(P)	QE27
Main engine lubricating oil sump tank heating coil	QE24
Starboard main sea chest, weed clearing, LSV (S)	QE26
Fuel oil sludge tank heating coil	QE50
Lubricating oil sludge tank heating coil	QE122
Oil drain tank heating coil	QE49
Fuel oil overflow tank heating coil	QE48
Upper deck isolating valve	QE160
Upper deck isolating valve	QE117
Purifier plant isolating valve	QE10
Auxiliary engine LO separator heater control valve inlet	QE37
Auxiliary engine LO separator heater control valve outlet	QE38
Auxiliary engine LO separator heater control valve bypass	QE39
Main engine No.1 LO separator heater control valve inlet	QE40
Main engine No.1 LO separator heater control valve outlet	QE41
Main engine No.1 LO separator heater control valve bypass	QE42
Main engine No.2 LO separator heater control valve inlet	QE43
Main engine No.2 LO separator heater control valve outlet	QE44
Main engine No.2 LO separator heater control valve bypass	QE45
No.2 fuel oil separator heater control valve inlet	QE35
No.2 fuel oil separator heater control valve outlet	QE34
No.2 fuel oil separator heater control valve bypass	QE36
No.2 fuel oil separator sludge discharge blow-off valve	QE124c
No.1 fuel oil separator heater control valve inlet	QE32
No.1 fuel oil separator heater control valve outlet	QE31
No.1 fuel oil separator heater control valve bypass	QE33
No.1 fuel oil separator sludge discharge blow-off valve	QE124b
Diesel oil separator heater control valve inlet	QE29
Diesel oil separator heater control valve outlet	QE28
Diesel oil separator heater control valve bypass	QE30
Diesel oil separator sludge discharge blow-off valve	QE124a
Hose connection valve	QE61
HFO storage tanks heating coils isolating valve	QE9
No. 1 HFO tank (P) heating coil control valve inlet	QE146
No. 1 HFO tank (P) heating coil control valve outlet	QE148

Description	Valve
No. 1 HFO tank (P) heating coil control valve bypass	QE147
No. 1 HFO tank (S) heating coil control valve inlet	QE118
No. 1 HFO tank (S) heating coil control valve outlet	QE120
No. 1 HFO tank (S) heating coil control valve bypass	QE119
No. 2 HFO tank heating coil control valve inlet	QE121
No. 2 HFO tank heating coil control valve outlet	QE111
No. 2 HFO tank heating coil control valve bypass	QE110
HFO minor tank heating coil control valve inlet	QE140
HFO minor tank heating coil control valve outlet	QE142
HFO minor tank heating coil control valve bypass	QE141
Header isolating valve	QE159
Composite boiler fuel oil heater control valve inlet	QE161
Composite boiler fuel oil heater control valve outlet	QE160
Composite boiler fuel oil heater control valve bypass	QE162
Composite boiler waste oil heater control valve inlet	QE166
Composite boiler waste oil heater control valve outlet	QE165
Composite boiler waste oil heater control valve bypass	QE167
Auxiliary boiler fuel oil heater control valve inlet	QE7
Auxiliary boiler fuel oil heater control valve outlet	QE6
Auxiliary boiler fuel oil heater control valve bypass	QE8
Oil inspection/cascade tank control valve inlet	QE90
Oil inspection/cascade tank control valve outlet	QE91
Oil inspection/cascade tank control valve bypass	QE89
Main engine jacket water preheater control valve inlet	QE139
Main engine jacket water preheater control valve outlet	QE137
Main engine jacket water preheater control valve bypass	QE136
Main and auxiliary engines FO unit inlet valve	QE23
HFO settling tank heating coil control valve inlet	QE56a
HFO settling tank heating coil control valve outlet	QE55a
HFO settling tank heating coil control valve bypass	QE54a
HFO service tank heating coil control valve inlet	QE59
HFO service tank heating coil control valve outlet	QE58
HFO service tank heating coil control valve bypass	QE57
LSHFO service tank heating coil control valve inlet	QE46
LSHFO service tank heating coil control valve outlet	QE47
LSHFO service tank heating coil control valve bypass	QE63

Description	Valve
LSHFO settling tank heating coil control valve inlet	QE56b
LSHFO settling tank heating coil control valve outlet	QE55b
LSHFO settling tank heating coil control valve bypass	QE54b

Procedure for Operating the 0.70MPa Steam System

a) The system would normally be warmed-though when raising steam after a boiler shutdown.

b) Line drain valves to the bilge should be open when the system is shut down and closed after warming-through when steam vents from the valves.

c) All services should be shut down when not required.

d) Ensure that the drain cocks are open.

e) The system is warmed-through by opening the warming-through valve QE106 on the auxiliary boiler, which bypasses the boiler main steam stop valve QE104, until all steam lines are thoroughly warmed-through. The warming-through valve should be opened gradually. If the steam system is already warm, care is still required when putting the oil-fired auxiliary boiler on-line, as water trapped in the main steam line may be forced through the system at high speed. Therefore, ensure that the drain line to the bilge on the main steam line is opened before opening the steam stop valve.

f) Before putting the composite boiler into service, open the steam dump control inlet valve QE3 and outlet valve QE1, ensure that the atmospheric condenser is operational before allowing steam dumping. Check the pressure setting of the steam dump valve so that it does not open when the auxiliary boiler is firing.

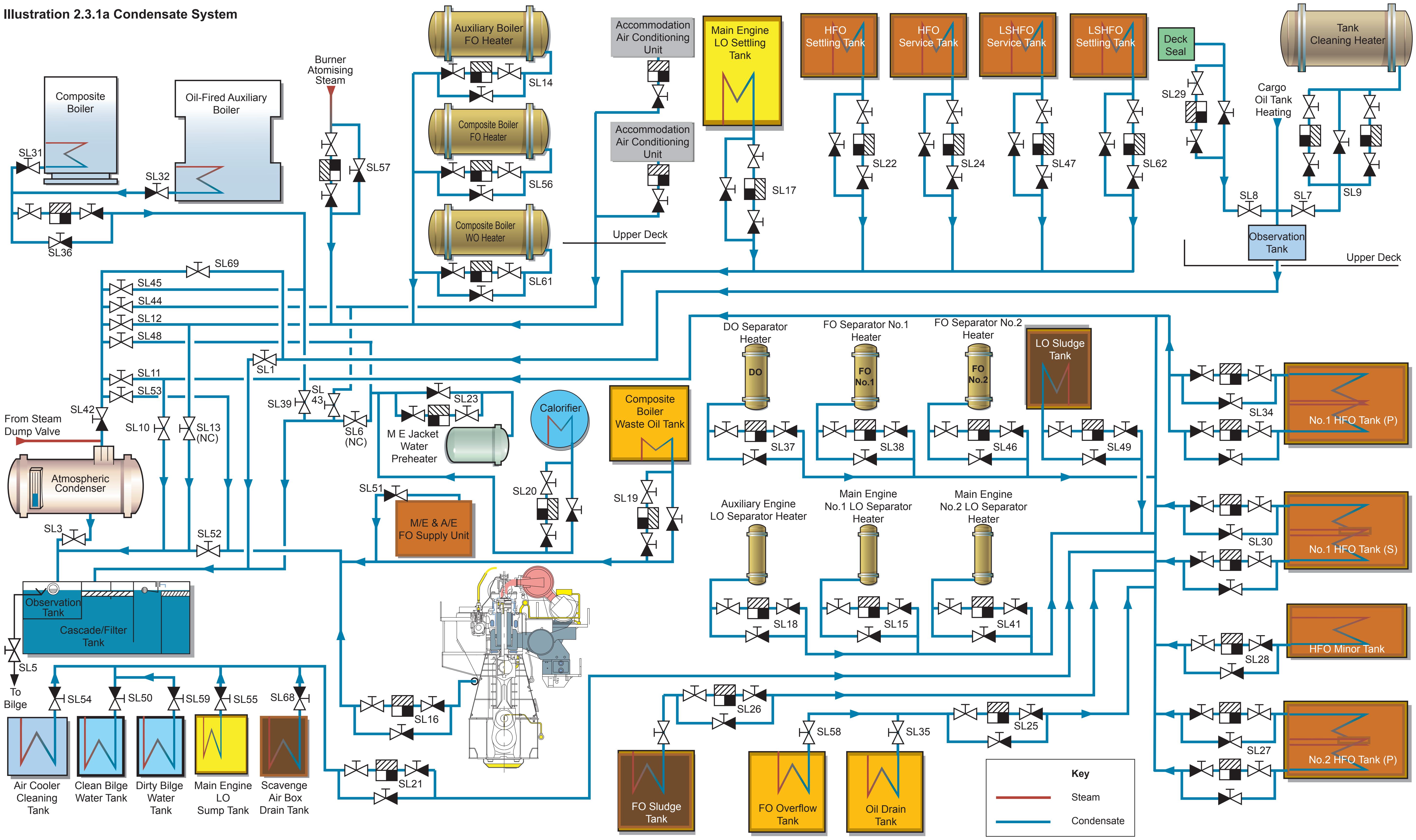
g) Supply steam to services as required.

WARNING

Water hammer can occur if steam lines are not warmed-through correctly. Steam entering a cold line will condense and vacuum pockets can form due to the condensation of the steam. Such vacuum pockets cause the condensate to move through the steam pipes at very high speed and when this water impacts valves, pipe bends etc, it can result in severe damage and even pipe failure.

2.3 Condensate and Feed Systems

Illustration 2.3.1a Condensate System



2.3 CONDENSATE AND FEED SYSTEMS

2.3.1 CONDENSATE SYSTEM

Description

The condensate system is that part of the steam and feed water cycle between the atmospheric condenser, via the observation tank and the cascade/filter tank, and the boiler feed pump suction headers.

In normal operation, all drains from the steam services are led to the atmospheric condenser, which is cooled by the low temperature (LT) cooling water system. Any excess steam, generated by the composite boiler when the main engine is running, is also dumped to the atmospheric condenser.

Water from the atmospheric condenser passes to the inspection tank and then into the cascade tank. A float valve is located in the last chamber of the cascade tank, which operates to provide make-up water from the boiler water storage tank. The float valve line is fitted with a manually operated isolating valve. Additionally, the cascade tank may be replenished manually by using the float valve bypass valve (RL18). The cascade tank is also fitted with a low level alarm.

It is also possible to top-up the cascade tank from the domestic/engine room fresh water system through valve RL47.

The observation tank is fitted with an oil alarm sensor to detect any hydrocarbon contamination. Any floating oil or sediment should be removed through the scum line to the engine room bilge. A weir in the observation tank outlet to the cascade tank reduces the possibility of any oil being carried over.

Water from the cascade tank provides the auxiliary boiler and composite boiler feed pumps, located on the engine room floor deck level, with a positive suction head.

The condensate outlet temperature from the atmospheric condenser should be maintained between 75°C and 90°C. The temperature of the condensate in the cascade tank is maintained via a thermostatically controlled steam injection line into the tank.

An observation tank with sight glasses is fitted on deck and the drains from the cargo heating system, the tank cleaning heater and the deck seal pass through this before entering the engine room. When these services are in use, this tank should be checked for visible traces of oil at regular intervals.

Procedure for Preparing the Main Condensate System for Operation

a) Ensure that the pressure gauge and instrumentation valves are open.

b) Ensure that the level in the cascade tank is within normal limits. Top-up the level from the boiler water tank if required.

c) Confirm that the level control valve operates correctly.

d) With the LT cooling system in operation, open the LT cooling water inlet and outlet valves on the atmospheric condenser.

e) Position the valves as shown below:

Position	Description	Valve
Open	LT cooling water inlet valve to the atmospheric condenser	QB117
Open	LT cooling water outlet valve from the atmospheric condenser	QB118
Open	Outlet valve from atmospheric condenser	SL3
Closed	Atmospheric condenser bypass valves	SL10, SL13, SL52, SL1, SL6, SL39, SL43
Closed	Cascade tank drain valve to bilge	RL46
Open	FW make-up float valve isolator valve to the cascade tank	RL9
Closed	FW make-up float valve bypass valve to cascade tank	RL18
Open	Run-down valve from boiler water tank	RL17
Closed	Observation tank scum valve to bilge water tank	SL5
Open	Cascade tank outlet to feed pump suction header.	RL1
Closed	Cascade tank emergency filling valve from service water system.	RL47
Open	Steam dump valves to the atmospheric condenser	QE3, QE1
Set	Steam dump control valve	QE81
Closed	Steam dump control bypass valve	QE2

f) The auxiliary and composite boiler feed pumps and boilers may now be brought into operation.

Oil Contamination

If oil contamination should occur, the oil must be drained from the observation tank to bilge water tank through scum valve SL5.

To investigate the cause of the contamination the drain traps on all of the steam services should be inspected, then isolated for repair. Each drain trap outlet should be opened carefully by a small amount until oil is detected.

The faulty service should be isolated for repair, then flushed until clear of all traces of oil.

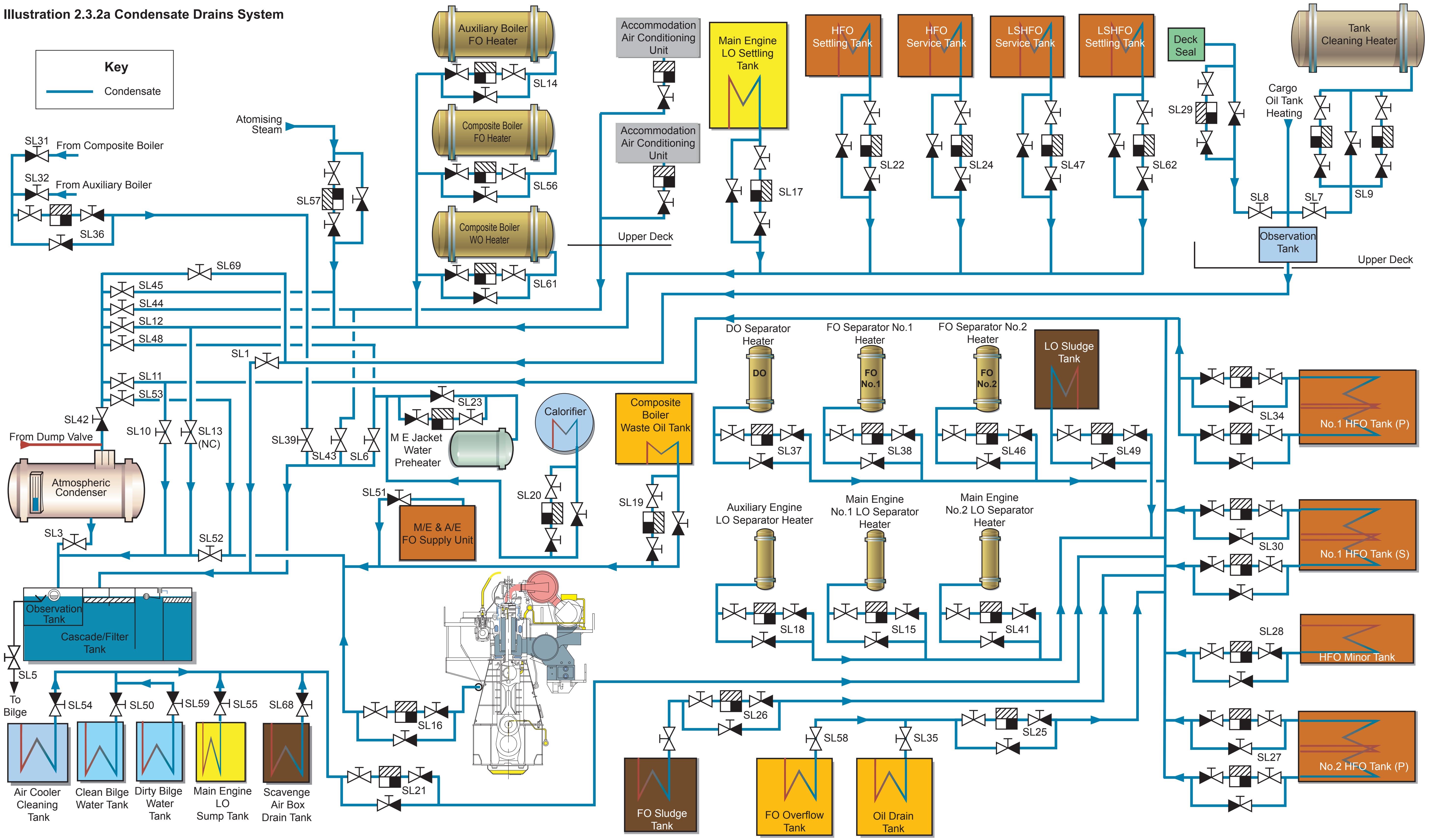
If contaminated feed water has reached the boilers, the firing rate on the auxiliary boiler should be reduced and the main engine speed reduced for the composite boiler. Chemical dosing of the boilers should be increased accordingly and the frequency and duration of scumming also increased.

Boiler water sampling and testing should be carried out at more frequent intervals.

Depending upon the level of contamination, the boiler(s) may have to be taken out of service at the earliest opportunity for inspection and a boil-out/cleaning operation carried out. See the manufacturer's manual for details on the procedure for boiling-out/cleaning of the boilers.

Both the observation tank and the cascade tank, together with the filters, should be thoroughly cleaned to remove all traces of oil contamination and then refilled with clean water. The probe for the oil contamination detector should also be cleaned and tested before returning the system to service.

Illustration 2.3.2a Condensate Drains System



2.3.2 HEATING DRAINS SYSTEMS

Description

Condensate from the auxiliary steam services is returned to the observation tank and cascade/filter tank via the atmospheric condenser. The condensate is then returned to the feed water system.

As there is a possibility of contamination from hydrocarbons from the oil heating services, the drains are monitored in the observation tank, visually through a sight glass and automatically by an ultrasonic oil sensor unit.

The cascade tank is fitted with a temperature controlled steam injection line to maintain the temperature of the feed water at an optimal level. However, clean drains, not associated with any oil heating services, may be led directly to the cascade tank to maintain the operating temperature of the feed water without the need for steam injection, improving the overall efficiency of the system.

The cooling water supply to the atmospheric condenser is not provided with automatic temperature control.

If it is necessary for the atmospheric condenser to be bypassed for maintenance purposes, the oil heating drains should be directed to the observation tank, while the other services which are considered to be clean drains are led directly to the cascade tank.

The illustration 2.3.2a above shows the flow of condensate returns into the observation tank via the atmospheric condenser. The illustration 2.3.2b shows the crossover line configuration if the atmospheric condenser is bypassed, with the returns from the oil tanks and heaters being directed to the inspection side of the tank, and the clean drains directed to the cascade side of the tank.

If the atmospheric condenser is shut down for maintenance purposes whilst at sea, it will not be possible to have the steam dump valve operational as there will be no cooling on the condenser.

Procedure for Preparing the Drains System for Operation

It is assumed that the LT cooling system is in operation, the inlet and outlet valves on the atmospheric condenser are open and the cooler is vented.

Position	Description	Valve
Open	Atmospheric condenser cooling water inlet valve	QB117
Open	Atmospheric condenser cooling water outlet valve	QB118

a) Ensure that the pressure gauges and instrumentation valves are open.

b) Set up the valves for the services required as in the following table:

Position	Description	Valve
Open	Atmospheric condenser outlet valve.	SL3
Operational	Atmospheric condenser inlet swing check valve.	SL42
Open	Manifold drain valve from deck seal and cargo tank cleaning heater.	SL69
Open	Burner atomiser drain from auxiliary boiler.	SL45
Open	Manifold drain valve from boiler accommodation air conditioning units.	SL44
Open	Manifold drain valve from auxiliary boiler burner atomiser drain, auxiliary boiler FO heater, composite boiler FO heater, composite boiler waste oil heater, main engine LO settling tank, HFO & LSHFO settling and service tank heating.	SL12
Open	Manifold drain valve from main engine jacket water heater and hot water calorifier.	SL48
Open	Manifold drain valve from HFO storage and minor tank heating, purifier/separator heating, FO sludge, overflow and drain tank heating. Air cooler cleaning tank, clean water and bilge tanks, main engine sump tank, scavenge air box drain tank.	SL11
Open	Manifold drain valve from composite boiler waste oil tank, main and auxiliary engines FO unit, and main engine jacket water heater.	SL53
Open	Drain trap inlet and outlet valves on the FO system steam tracing return at the condensate return manifold area.	

c) Steam services can now be put into operation as required, by opening the associated drain trap inlet and outlet valves.

Excessive temperature at the cascade tank would indicate a defective drain trap. Services should be isolated in turn until the defective trap is located. A defective drain trap may be detected by the high outlet temperature from the drain trap (the outlet pipe will be very hot). A drain trap is designed to only allow condensate to pass, thus all steam will be condensed in the heating coil or heater and the efficiency of the system will be at maximum. If a drain trap is defective it will allow live steam to pass, thereby reducing the efficiency of the heating operation and increasing the outlet temperature from the steam trap.

Illustration 2.3.2b Bypassing the Atmospheric Condenser

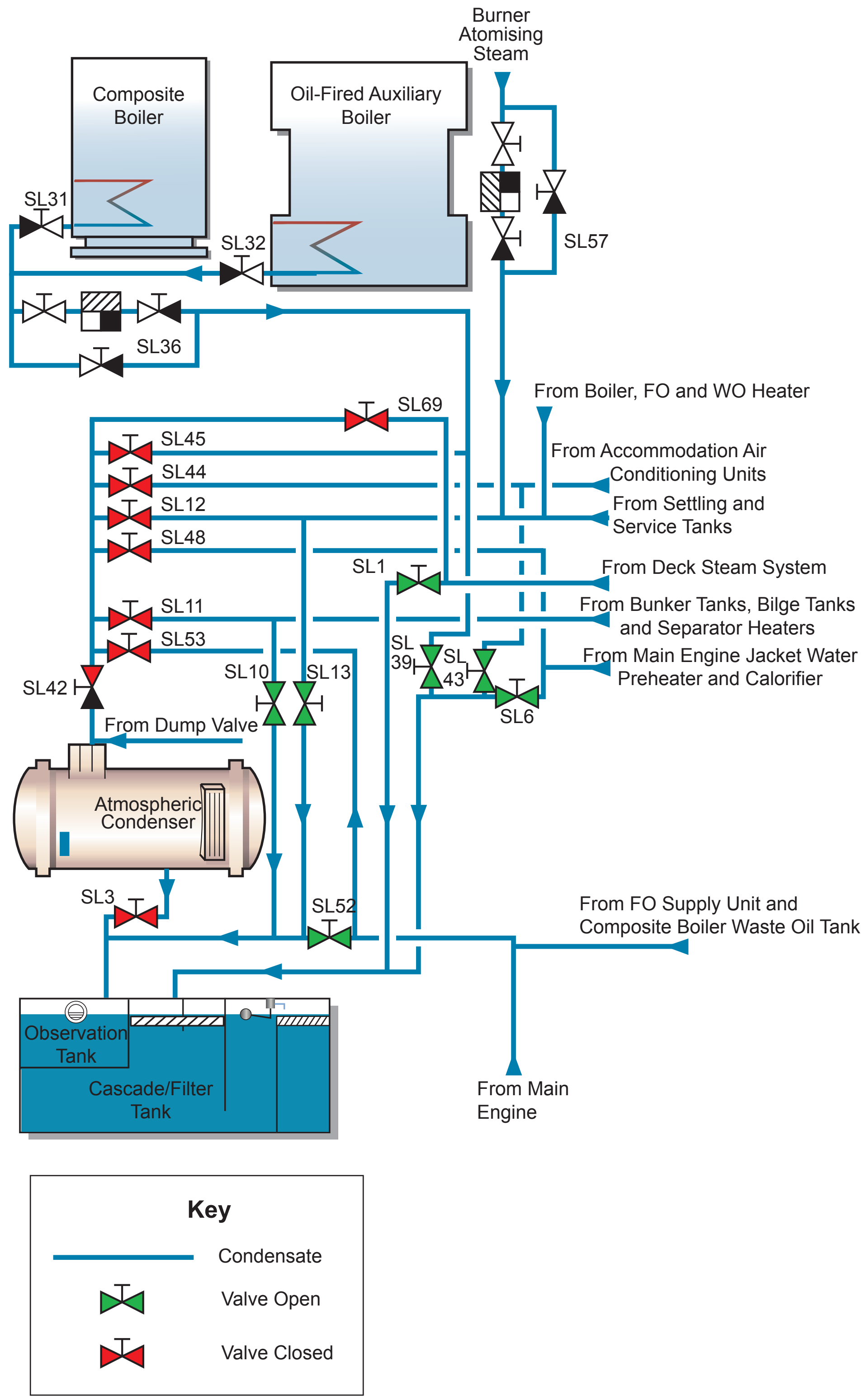
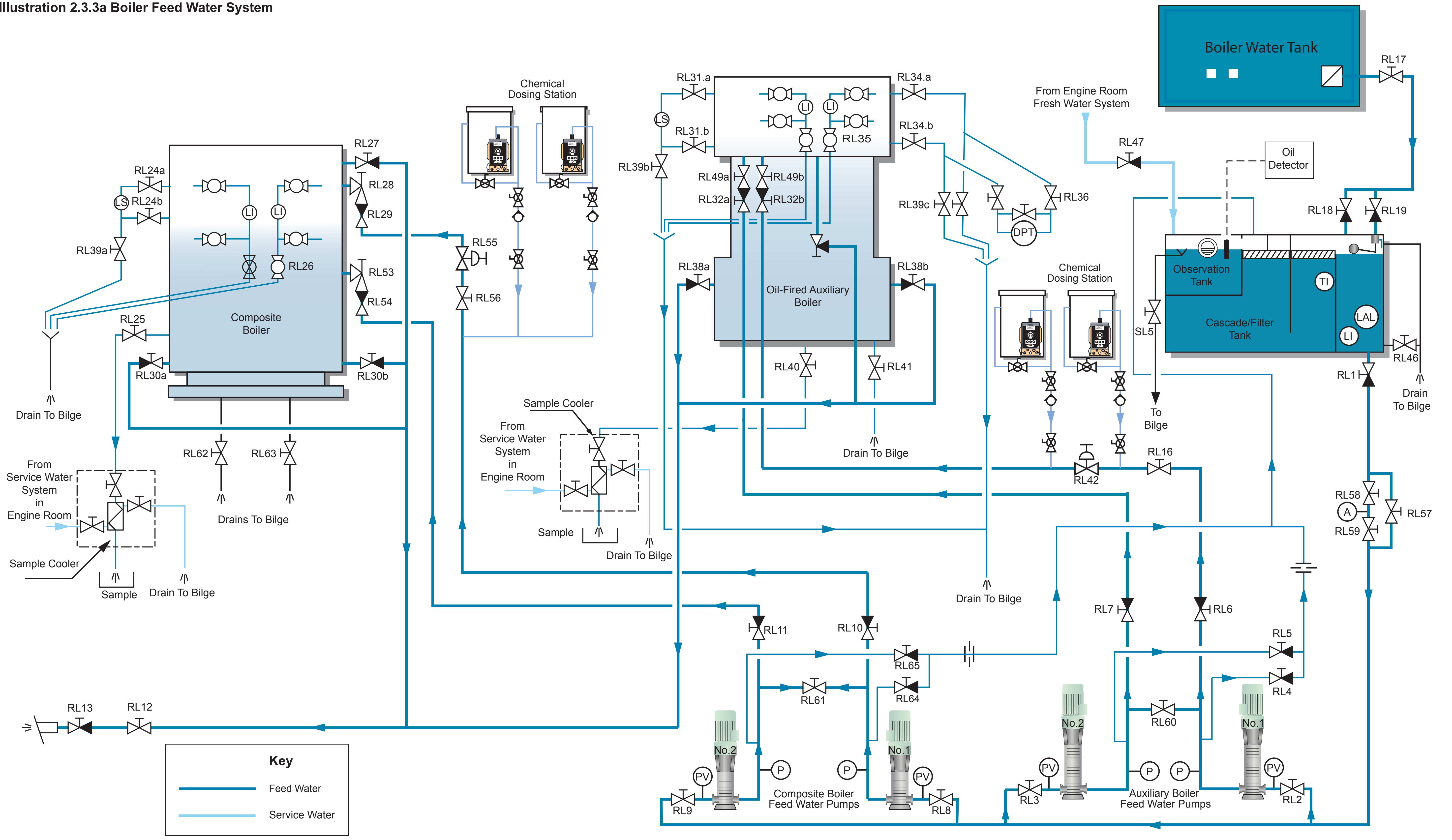


Illustration 2.3.3a Boiler Feed Water System



2.3.3 BOILER FEED WATER SYSTEM

Auxiliary Boiler Feed Water Pump

Manufacturer:	Grundfos
Type:	Vertical, multi-stage, centrifugal
Model:	CR 32-5-2
No. of sets:	2
Capacity:	$24m^3/h$
Speed:	3,500 rev/min
Power consumption:	15kW

Composite Boiler Feed Water Pump

Manufacturer:	Grundfos
Type:	Vertical, multi-stage, centrifugal
Model:	CR 5-13
No. of sets:	2
Capacity:	$4m^3/h$
Speed:	3,500 rev/min
Power consumption:	4kW

Description

The boiler feed system supplies feed water from the cascade tank to the steam drums of the auxiliary and composite boilers via dedicated feed water pumps. Feed water flow to each boiler is automatically controlled by a dedicated regulating valve in proportion to the variation in water level in the steam drum.

Each boiler has a pair of feed pumps operating as duty/standby, with duty selection being made at the respective boiler control panel. The pumps take feed water from the cascade tank, via a common suction header fitted with an actuated rundown valve.

The discharge pipework of each pump has a return line to the cascade tank. This allows a proportion of the discharge, limited by an orifice, to circulate back to the cascade tank, preventing pump overheating and gassing-up when the feed water regulator is closed and when the boiler is on low load.

In normal operation, feed water is supplied to the each boiler through their respective feed water regulators. However, both boilers have a separate discharge from the feed water pumps which bypasses the feed water regulator. In an emergency, feed water can be supplied directly to the boilers by this route.

CAUTION

The use of the feed water bypass line is a manual operation which must be supervised at all times, it is in use to prevent overfilling the boiler drum.

Boiler water chemical treatment is administered by injecting directly into the boiler feed water supply lines using two chemical dosing units for each boiler.

Operating Procedures

Procedure for Preparing the Auxiliary Boiler Feed System for Operation

a) Ensure that the pressure gauge and instrumentation valves are open.

b) Position the valves as shown below:

Position	Description	Valve
Open	Outlet valve from cascade tank	RL1
Open	Feed pump suction header actuated valve inlet valve	RL58
Open	Feed pump suction header actuated valve outlet valve	RL59
Operational	Feed pump suction header actuated valve	
Closed	Feed pump suction header actuated valve bypass valve	RL57
Open	No.1 auxiliary boiler feed pump suction valve	RL2
Open	No.1 auxiliary boiler feed pump recirculating valve	RL4
Open	No.1 auxiliary boiler feed pump discharge valve	RL6
Open	No.2 auxiliary boiler feed pump suction valve	RL3
Open	No.2 auxiliary boiler feed pump recirculating valve	RL5
Open	No.2 auxiliary boiler feed pump discharge valve	RL7
Open	Crossover between main and auxiliary feed line	RL60
Open	Feed regulator inlet valve	RL16
Operational	Feed water regulator	RL42
Open	Main feed check valve	RL32a
Open	Main feed valve	RL9a
Closed	Emergency feed check valve	RL32b
Closed	Emergency feed valve	RL49b
Closed	Auxiliary boiler chemical dosing pump No.1 suction valve	RL43a
Closed	Auxiliary boiler chemical dosing pump No.1 discharge valve	RL14a
Closed	Auxiliary boiler chemical dosing pump No.2 suction valve	RL43b
Closed	Auxiliary boiler chemical dosing pump No.1 suction valve	R-14b

CAUTION

The feed pumps should be primed with water and vented before initial start.

c) For initial start only, shut the discharge valve of the selected feed pump.

d) Start the pump and slowly open the discharge valve until the discharge line reaches working pressure.

e) Check the operation of feed regulating valve.

f) Fill the boiler to its working level.

g) At the boiler control panel switch the second feed water pump to standby.

The boiler can now be brought into operation.

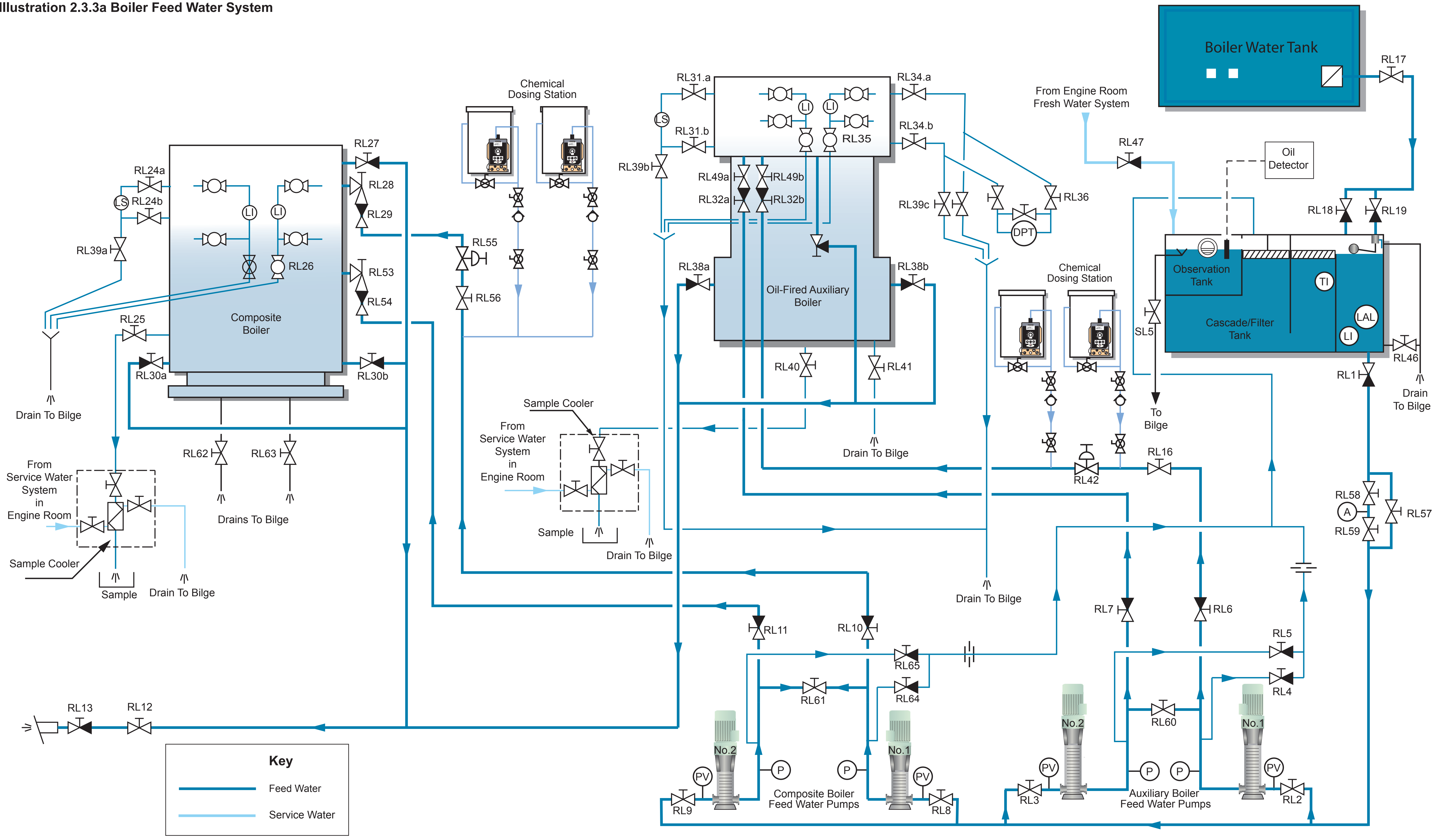
Procedure for Preparing the Composite Boiler Feed System for Operation

a) Ensure that the pressure gauge and instrumentation valves are open.

b) Set up the valves as shown below:

Position	Description	Valve
Open	Outlet valve from cascade tank	RL1
Open	Feed pump suction header actuated valve inlet valve	RL58
Open	Feed pump suction header actuated valve outlet valve	RL59
Operational	Feed pump suction header actuated valve	
Closed	Feed pump suction header actuated valve bypass valve	RL57
Open	Composite boiler No.1 feed pump suction valve	RL8
Open	Composite boiler No.1 feed pump recirculating valve	RL64

Illustration 2.3.3a Boiler Feed Water System



Position	Description	Valve
Open	Composite boiler No.1 feed pump discharge valve	RL10
Open	Composite boiler feed pump suction valve	RL9
Open	No.2 composite boiler No.2 feed pump recirculating valve	RL65
Open	Feed regulator inlet valve	RL56
Operational	Feed water regulator	RL55
Open	Main feed check valve	RL29
Open	Main feed valve	RL28
Closed	Emergency feed check valve	RL54
Closed	Emergency feed valve	RL53
Closed	Composite boiler chemical dosing pump No.1 suction valve	RL44a
Closed	Composite boiler chemical dosing pump No.1 discharge valve	RL15a
Closed	Composite boiler chemical dosing pump No.2 suction valve	RL44b
Closed	Composite boiler chemical dosing pump No.2 discharge valve	RL15b

CAUTION
The feed pumps should be primed with water and vented before initial start.

c) For initial start only, shut the discharge valve of the selected feed pump.

d) Start the pump and slowly open the discharge valve until the discharge line reaches working pressure. Set the pump to automatic operation.

e) At the composite boiler control panel switch the second feed water pump to standby.

Water Sampling and Treatment System

A sample of boiler water should be taken and analysed daily, using the test kit provided.

The auxiliary boiler and composite boiler are each provided with a sample cooler from where a representative sample of the boiler water is obtained. The sample coolers are cooled by water from the service water system, with the cooler outlet drained to the bilge.

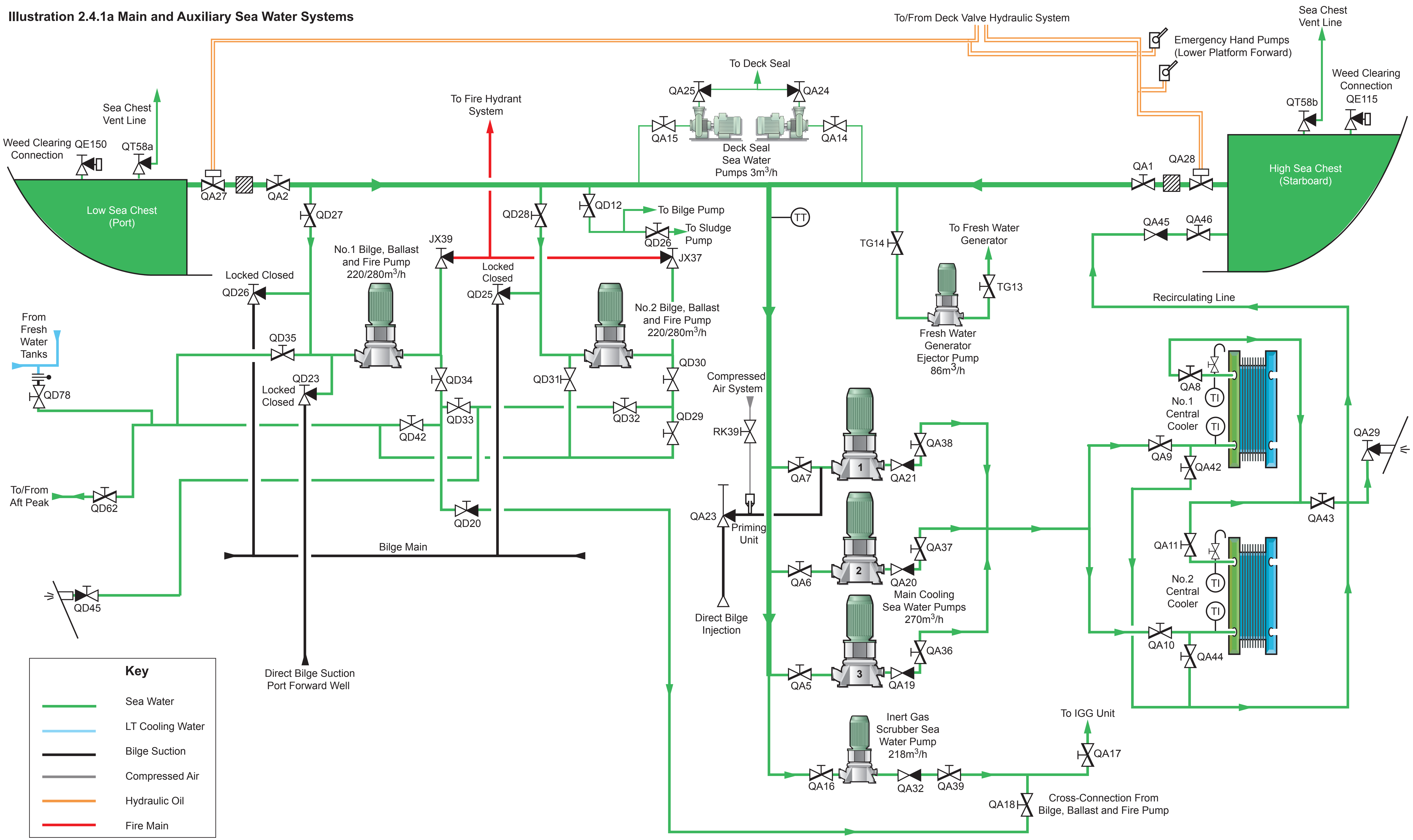
Before a sample is taken, it must be ensured that the cooling water is passing through the cooler. With the cooling on, the sample drain line valve at the bottom of the cooler must be opened, before the boiler shell sample valve is opened slowly.

Sufficient boiler water should be allowed to pass through the cooler to obtain a representative sample. The boiler shell sample valve must be closed before the cooling water supply is shut off.

Each boiler is provided with a chemical dosing station comprising two metering pumps with integral chemical tanks. The metering pumps inject treatment chemicals into the main feed water supply line to the boilers from their chemical tank. Chemicals should be added to the chemical tanks daily, the amount depending upon the results of the daily boiler water test and according to the manufacturer's instructions.

2.4 Sea Water Systems

Illustration 2.4.1a Main and Auxiliary Sea Water Systems



2.4 SEA WATER SYSTEMS

2.4.1 MAIN AND AUXILIARY SEA WATER SYSTEMS

Sea Water Pumps

Main Cooling Sea Water Pump

Manufacturer:	Shinko
Model:	SVS200M
No. of sets:	3
Capacity:	270m^3/h x 0.25MPa

Inert Gas Scrubber Pump

Manufacturer:	Shinko
Model:	SVS200M
No. of sets:	1
Capacity:	220m^3/h x 0.37MPa

Deck Seal Sea Water Pump

Manufacturer:	Shinko
Model:	Hj40-2M
No. of sets:	2
Capacity:	3.0m^3/h x 0.35MPa

Marine Growth Prevention System

Manufacturer:	Cathelco
Model:	CA 18551
Type:	Electrolysis of sea water
Flow rate:	626m^3/h (max)

Main System

The main cooling sea water system is supplied by three main cooling sea water pumps, one would normally be in use when the sea water temperature is less than 24°C, above this figure, two pumps may be required for operation depending upon the total cooling requirement, the third pump will then be acting as standby. One pump will be selected as the duty pump and another will act as the standby pump; the standby pump will start automatically in the event of the duty pump failing to maintain the desired sea water supply pressure, or the running pump fails. When a pump is started, the next numbered pump is automatically selected as standby if it is available; ie, if No.1 pump is started, No.2 pump is automatically selected as the standby pump. The selection of a pump for standby is indicated by the 'Standby' indicator lamp being illuminated on the pump control panel at the main switchboard. To allow for automatic changeover, pumps must be selected for AUTO CHANGE at its respective main switchboard group starter control panel.

Note: When the pumps are set for AUTO CHANGE, the standby pump will automatically cut-in on failure of a running pump, or if the system pressure is too low. However, if the duty pump is stopped on command (or inadvertently) from any of its start/stop positions, then the standby pump will not start, as the control system will recognise the shutting down of the pump as a human command function and not a system failure. It is not necessary to have the duty pump set in MANUAL mode when it is in operation.

All pumps take suction from a common sea water suction crossover main, using either the low (starboard) suction or the high (port) suction. The low suction will normally be in use at sea, or when surface contamination, such as weed, is present. It will also be in use in light ballast conditions when ingress of air is likely. The high suction should be used when in silted or shallow water conditions. Both sea chests are fitted with vent lines and ship side isolating valves, the isolation valve should be open when the sea chest is in service. A suction strainer is fitted at both suctions, the suction strainer lid also houses the MGPS elements. Steam and air connections are provided at the sea chests for weed clearing.

The ship side sea suction valves are hydraulically operated, they are supplied from the cargo and ballast valve hydraulic system. Operation of the valves is normally carried out via a selection switch in the ECR on the main console, the valve actuator switch on the console has OFF, OPEN and CLOSE positions, the switch is turned to the relevant position in order to open or close the valve. When the valve has reached its full movement, the switch is turned to the OFF position. An illuminated indicator shows when a sea suction valve is open (green) or closed (red).

Additionally, there is an emergency handpump unit for each valve located adjacent to the spare cylinder liner on the lower platform forward. The remote handpump unit has an operating positioner with positions for OPENING, CLOSING and LOCKED. If the valve is to be opened, the position lever is turned to the OPENING position and the handpump operated until resistance to pumping is felt, verify the valves position locally, or, via the illuminated indicator on the engine control room console. When the valve is fully open or closed, the positioner is turned to the LOCKED position so that the valve cannot be moved.

The sea water suction chests are each provided with a copper anode and an aluminium cathode for the Marine Growth Prevention System (MGPS), the anode/cathode for a particular sea suction chest, the port or starboard, should be operating whenever that sea chest is in use. The operating set of anode/cathode is selected and put into service at the MGPS control panel which is located on the port side, forward at the bottom platform level. The copper acts as an anti-fouling anode and aluminium acts as an anti-corrosion cathode. The anodes and cathodes release ions into the sea water and these have the effect of destroying marine organisms. The ions dissolve in the sea water to form a gelatinous floc which is carried throughout the sea water circulating system. The floc forms a thin coating on all surfaces in the sea water system which has the effect of preventing corrosion. The MGPS thus controls marine growth and corrosion in the entire sea water system, however, the correct currents must be applied to the anode and the cathode in order to produce the desired effect for the volume of water flowing through the system.

The current at the anode and cathode should be adjusted within the normal operating range for the sea water flow through the sea suction chest, and a daily check made to ensure that the correct current is applied.

The main cooling sea water pumps discharge to the low temperature system fresh water coolers and then through the overboard valve. A backflushing system is provided at the coolers in order to remove silt and debris from the coolers so that operational efficiency may be maintained.

In areas of low sea temperature it is possible to raise the sea water circulation temperature by use of the recirculation line. This returns warm water from the cooler discharge to the high (starboard) sea chest. This warm water mixes with the cold water being drawn in from the sea to replace the water discharged overboard through the fresh water generator, and other users such as the deck seal and inert gas system. The amount of recirculated water may be controlled by regulating the overboard discharge valve from the central coolers.

No.1 main CSW pump has a direct emergency bilge suction via valve QA-23, this valve in normal operations is maintained in a closed and locked position by a chain and breakable seal. This bilge suction line is also fitted with an air operated priming unit.

The pumps are started and stopped locally, or remotely from the ECR at the respective group starter panel on the main switchboard. Pressure switches on the discharge side of the pumps operate the start signal for the selected standby pumps.

Operating Procedures

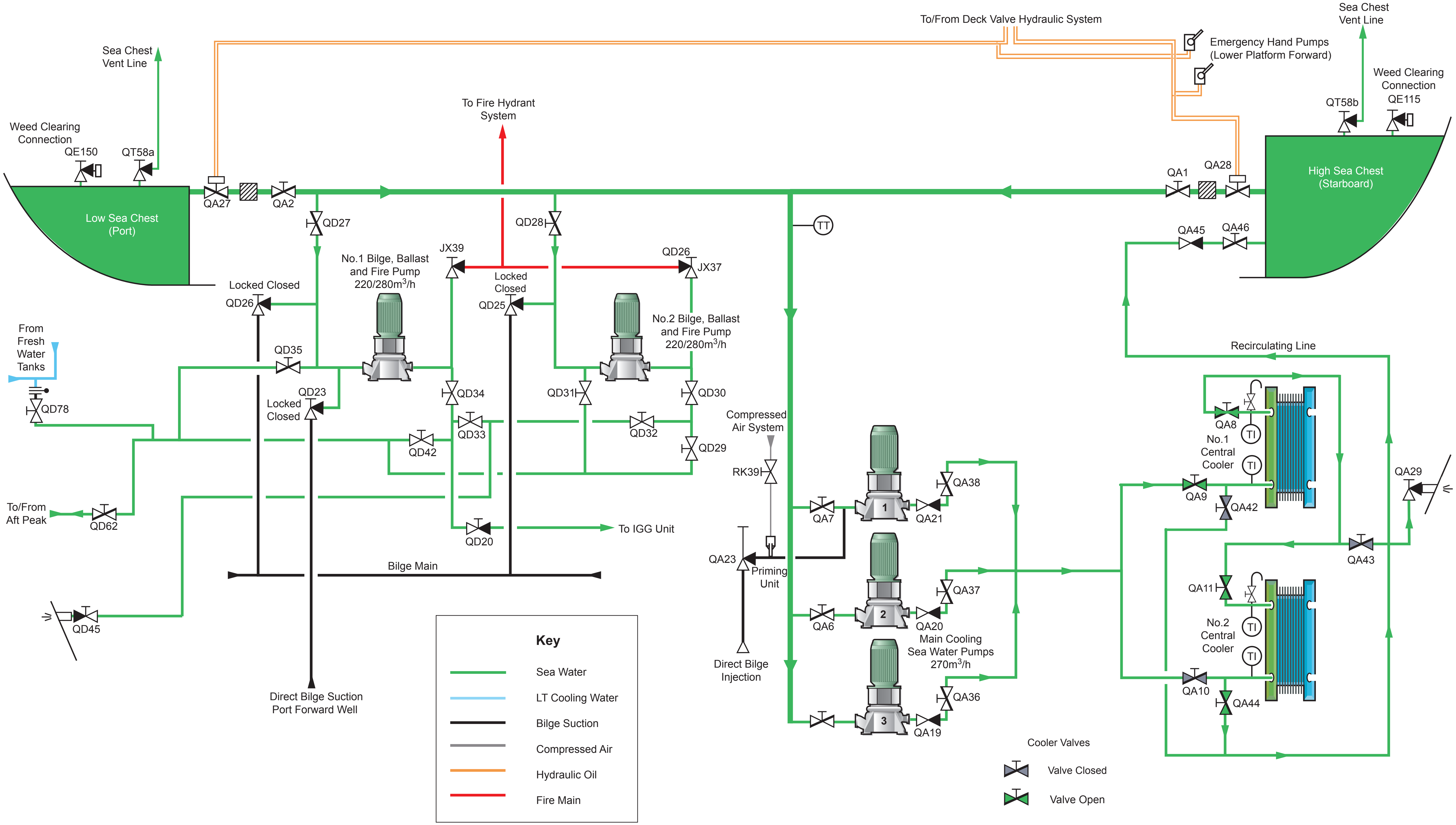
Procedure for Operation of the Sea Water Crossover Main

The description assumes that the low (starboard) suction is to be used.

a) Ensure that the sea chest vent line valve is open. With the cargo and ballast hydraulic valve system in operation, open the low sea suction hydraulic valve QA28 by moving the valve selection switch to the OPEN position. When full travel of the valve has taken place the indicator light will show green, set the switch to the OFF position. Vent the low sea suction strainer and when clear of air, locally open the low suction strainer outlet valve QA1.

b) Ensure that the high sea suction valve QA27 and the high suction strainer valve QA2 are both closed.

Illustration 2.4.1b Backflushing a Central Cooler



c) The sea suction crossover main is now operational.

Note: The sea suction strainers must be cleaned at frequent intervals whenever the suction pressure drop across the strainer increases to a predetermined level.

CAUTION

Before cleaning the suction strainers, check for pressure at the vent to prove the vent is clear, then isolate the strainer by closing the inlet sea valve and the strainer outlet valve. Check the vent again, if it indicates that the valves are tight, slacken the filter cover securing bolts without removing them. Break the joint. If the valves again prove tight, remove the cover.

Procedure for Operation of the Cooling Sea Water System

a) Ensure that the sea water crossover main is operating as described above, either the low or high sea suction may be used.

b) Set up valves as shown in the following tables:

Position	Description	Valve
Open	No.1 main CSW pump suction valve	QA7
Closed	No.1 main CSW pump discharge valve	QA38
Open	No.2 main CSW pump suction valve	QA6
Closed	No.2 main CSW pump discharge valve	QA37
Open	No.3 main CSW pump suction valve	QA5
Closed	No.1 main CSW pump bilge suction valve	QA23
Closed	No.3 main CSW pump discharge valve	QA36
Open	No.1 central cooler inlet valve	QA9
Open	No.1 central cooler outlet valve	QA8
Closed	No.2 central cooler inlet valve	QA10
Closed	No.2 central cooler outlet valve	QA11
Open	Discharge valve from coolers to overboard line	QA43
Closed	No.1 cooler backflush valves	QA42
Closed	No.2 cooler backflush valves	QA44
Open	Overboard discharge valve	QA29
Closed	Recirculation valve	QA46

The above valve settings assume that No.1 central cooler is to be in service, however, the valves for No.2 central cooler may be opened if the sea water temperature is above 25°C and additional cooling is required.

c) Ensure all pressure gauge and instrumentation valves are open.

d) Start one main cooling sea water pump locally with the discharge valve closed, then slowly open the discharge valve.

e) Open the other main cooling sea water pump discharge valves.

f) Vent the central coolers to ensure a full flow of sea water through each cooler.

g) In the ECR stop the running sea water pump, then set the selection switch for all three pumps to the AUTO CHANGE position. Restart the duty pump.

h) Start the Marine Growth Prevention System operating for the working sea chest. It is essential that the MGPS is only operated for a sea chest when water is flowing through that sea chest.

Note: The MGPS electrodes are provided with a wear detection system which will show when the electrodes require replacing. The detection system provides a time-out period after the wear indicator is activated, and this time-out period gives approximately 8 weeks of continuous operation before the control system trips the circuit-breaker which shuts down the MGPS panel. It is essential that the operator takes action to obtain replacement electrodes as soon as the wear indicator lamp on the control panel is activated. Should the worn electrode not be replaced or isolated during the time-out period the MGPS panel will trip and the system become inoperative.

Procedure for Backflushing of the Central Coolers

The central coolers are backflushed when the pressure drop across the cooler increases to an unacceptable level. The pressure drop will increase when silt and debris becomes lodged in the sea water channels of the cooler and the in-line filter, this debris must be removed in order to restore the operational efficiency of the cooler. Backflushing is the forcing of sea water backwards through the cooler from the normal cooler outlet pipe to the normal cooler inlet pipe. In the backflushing operation the sea water flow through the coolers is acting in a series configuration. Sea water from the outlet pipe of the cooler which is operating normally is forced backwards through the other cooler being backflushed, the sea water is then discharged overboard.

Each central cooler has a backflush water valve QA42; a single valve QA43 is used to redirect the water flow through the other cooler rather than directly overboard. The illustration above shows an example of backflushing No.2 cooler; valves which are shaded in grey in the diagram are closed.

a) With the main cooling sea water circulation system operating normally, open the cooler backflushing valve for the cooler being backflushed (in this example QA44 for No.2 cooler), and close the normal sea water inlet valve to the same cooler being backflushed; valve QA10 for No.2 central cooler.

b) Close the cooler system discharge valve QA43.

c) Sea water leaving the cooler which is operating normally (in this example No. 1 cooler) cannot flow directly overboard as the backflushing system valve QA43 is closed. This water flows into the cooler being backflushed (in this example No.2 cooler) through that cooler's sea water outlet pipe and leaves the cooler through the inlet connection. The backflushing water flows to the overboard discharge valve via the cooler backflushing valve QA44.

d) When backflushing is complete, open the cooler's inlet valve QA9, open the backflushing system valve QA43, and close the cooler backflush valve QA42.

e) No.1 central cooler may also be backflushed in a similar manner as required.

Auxiliary Sea Water Systems

Other sea water systems taking suction from the main sea suction line are:

- Bilge, ballast and fire pumps
- Main bilge pump
- Sludge pump
- Inert gas scrubber supply pump
- Deck water seal pumps
- Fresh water generator ejector/feed supply pump

The scrubber pump supplies the inert gas generator scrubber, with a back-up supply available from the bilge, fire and ballast pumps.

The deck seal pumps supply the inert gas deck seal on deck. One pump is normally selected as the duty pump and the other pump is selected for automatic standby; the standby pump will cut-in automatically should the duty pump fail to maintain the desired pressure in the system. The pumps are started and stopped manually from the local starter box or from the IGG room.

2.4.2 SEA WATER SERVICE SYSTEM

The following pumps supply the auxiliary sea water services:

Bilge, Ballast and Fire Pumps

Manufacturer:	Shinko
Model:	RVP300MS, self-priming
No. of sets:	2
Capacity:	220/280m^3/h at 1.0/0.45MPa

The one bilge, ballast and fire pump is normally set up for foam and fire main service, with the discharge and suction valves normally open. The other bilge, ballast and fire pump is used to ballast/deballast the aft peak and supply the deck wash system. By selection of the suction and valves, both pumps can perform similar duties.

Under emergency conditions where the safety of the ship is at risk due to flooding in the engine room, the pumps can be used to discharge bilge water from the machinery space bilge wells directly overboard, drawing from either the common bilge main or through the direct suction in the port forward bilge well. The bilge suction valves on each pump are normally locked closed with a breakable seal. The pumps also provide a back-up supply for the inert gas scrubber system.

When used as ballast pumps, both pumps discharge to or draw from the aft peak ballast tank.

The pump suctions draw from the sea water suction crossover main.

Additionally, there is a connection via valve QD78 and a removable spool piece, which allows either of the two pumps to draw from the domestic fresh water tanks when it is necessary to supply fresh water for cargo tank washing/cleaning operations.

Illustration 2.4.2a Auxiliary Sea Water System

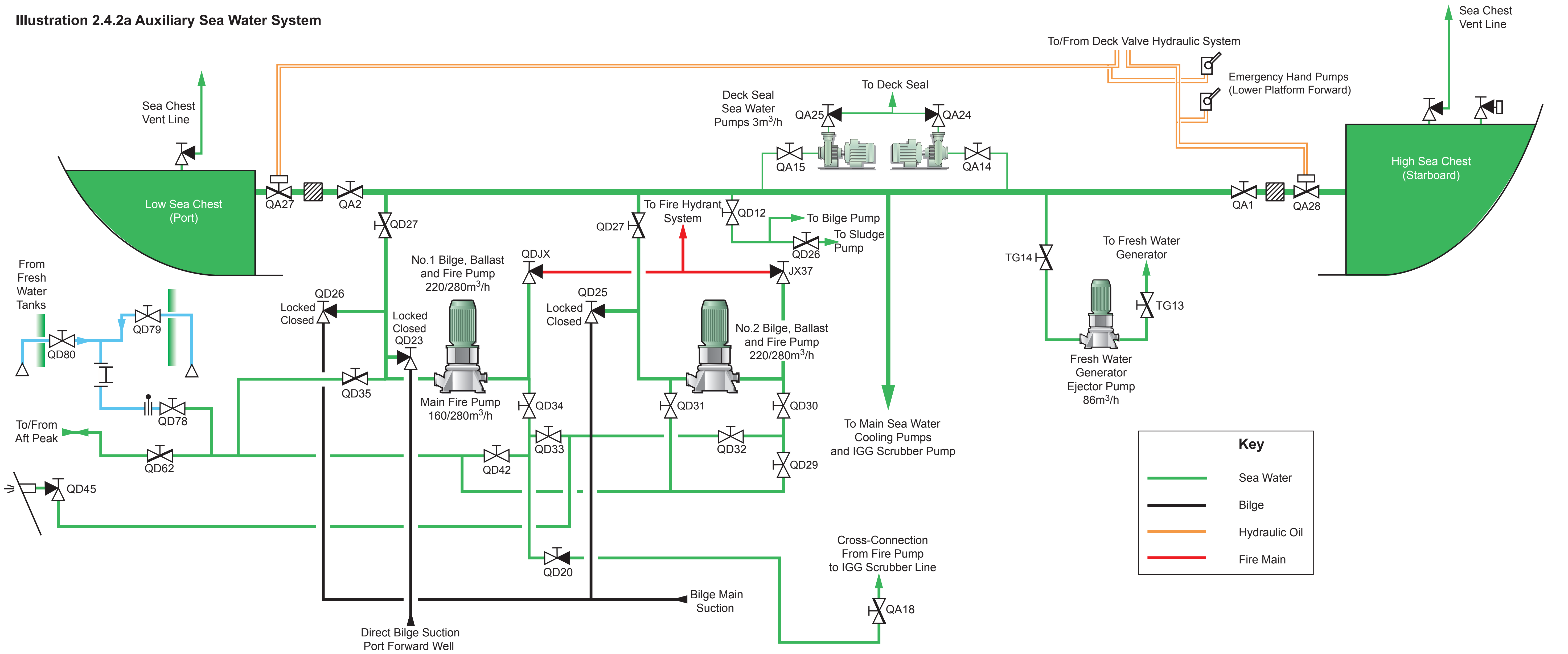
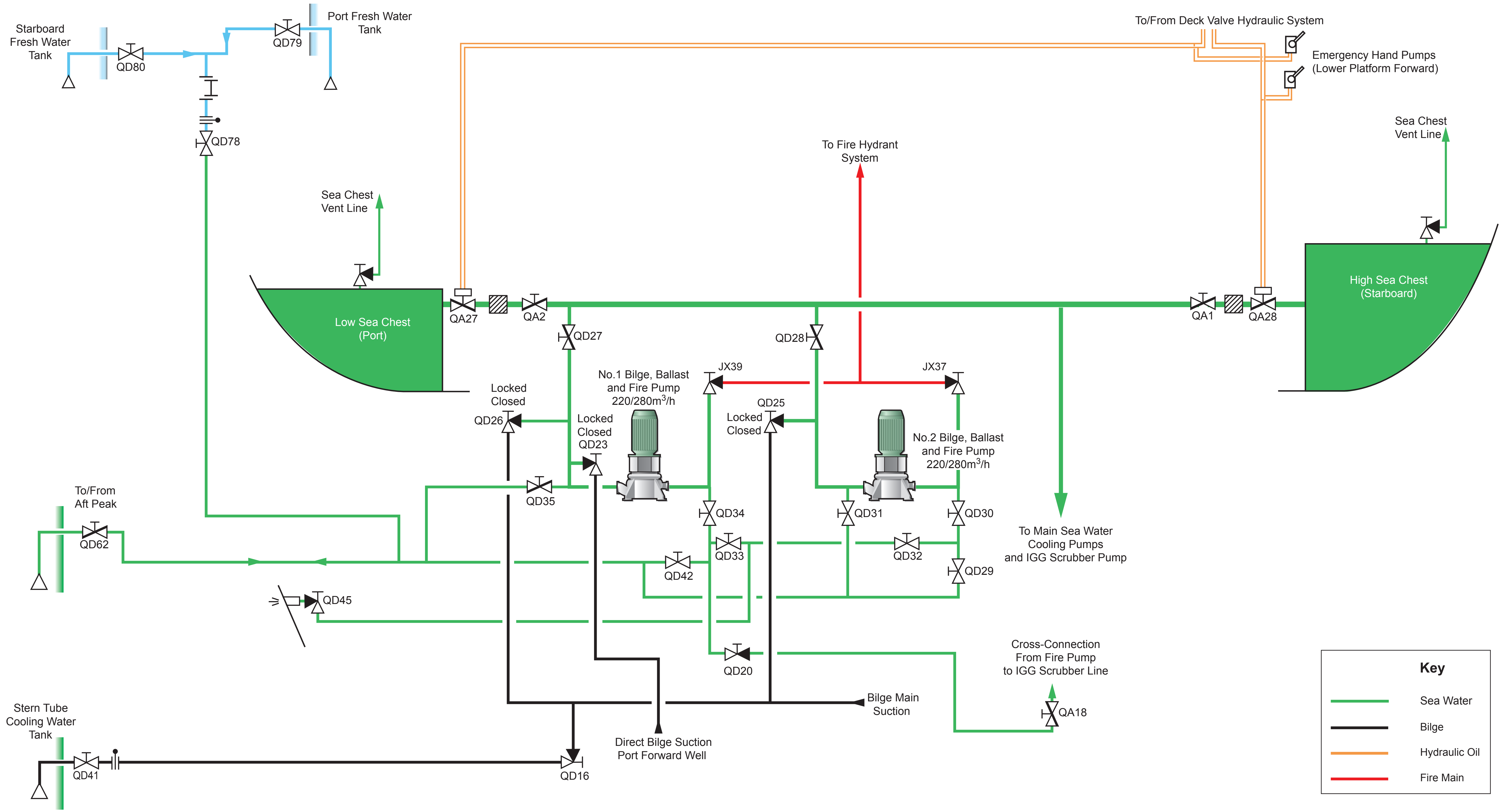


Illustration 2.4.3a Engine Room Ballast System



2.4.3 ENGINE ROOM BALLAST SYSTEM

The aft peak tank can be used as a ballast tank, it is used in conjunction with the main ballast system to trim the vessel. It can also be used during certain loaded conditions to provide optimum trim for efficient operation of the main engine.

The aft peak tank is serviced by the bilge, ballast and fire pump with the main fire pump available, if required. The aft peak tank has a filling/suction valve, which is normally used during ballast operations.

Procedure for Ballasting/Deballasting the Aft Peak Tank

Ballasting

a) Ensure that the transmitters for the remote reading gauges are in operation.

b) Ensure that the sea water suction crossover main is operating.

c) Set up the valves as shown below. All valves are initially in the closed position including fire main valves.

No.1 Bilge, Ballast and Fire Pump

Position	Description	Valve
Open	Aft peak ballast tank suction/filling valve	QD62
Closed	Port forward direct bilge well suction valve	QD23
Closed	Bilge main suction valve	QD26
Open	Sea suction valve	QD27
Closed	Discharge valve	QD34
Open	Discharge valve to aft peak tank	QD42
Closed	Discharge valve to fire main	JX39
Closed	Discharge valve to inert gas system	QD20
Closed	Discharge valve to overboard	QD33
Closed	Fresh water suction rundown to bilge, ballast and fire pump (ensure that the spectacle blank isolating the fresh water tanks is in the CLOSED position)	QD78

d) Start No.1 bilge, ballast and fire pump.

e) Open the discharge valve QD34 slowly until the discharge piping is pressurised.

f) Fill the after peak tank to the required level.

g) Shut the pump discharge valve and stop the pump and close all valves.

No.2 Bilge, Ballast and Fire Pump

Position	Description	Valve
Open	Aft peak ballast tank suction/filling valve	QD62
Closed	Bilge main suction valve	QD25
Open	Sea suction valve	QD28
Closed	Discharge valve	QD30
Open	Discharge valve to aft peak tank	QD29
Closed	Discharge valve to fire main	JX37
Closed	Discharge valve to overboard	QD32
Closed	Discharge valve to inert gas system	QD20
Closed	Fresh water suction rundown to bilge, ballast and fire pump (ensure that the spectacle blank isolating the fresh water tanks is in the CLOSED position)	QD78

d) Start No.2 bilge, ballast and fire pump.

e) Open the discharge valve QD30 slowly until the discharge piping is pressurised.

f) Fill the aft peak tank to the required level.

g) Shut the pump discharge valve and stop the pump and close all valves.

Deballasting

a) Ensure that the transmitters for the remote reading gauges are in operation.

b) Set up the valves as shown below. All valves are in the closed position including fire main valves. It is assumed that the aft peak ballast line is initially flooded.

CAUTION

The ballast tank suction valve must not be opened onto an empty pipeline in order to stop pressure shock and possible damage in the pump and lines.

No.1 Bilge, Ballast and Fire Pump

Position	Description	Valve
Open	Aft peak ballast tank suction valve	QD62
Closed	Sea suction valve	QD27
Closed	Discharge valve	QD34
Open	Ballast main suction valve	QD35
Closed	Discharge valve to ballast main	QD42
Closed	Discharge valve to fire main	QD39
Closed	Discharge valve to inert gas system	QD20
Open	Discharge to overboard	QD33
Open	Overboard discharge valve	QD45

c) Start No.1 bilge, ballast and fire pump.

d) Open the discharge valve QD34 slowly until the discharge piping is pressurised.

e) Empty the aft peak tank, taking care that the pump is not run dry.

f) Shut the pump discharge valve and stop the pump and close all valves.

No.2 Bilge, Ballast and Fire Pump

Position	Description	Valve
Open	Aft peak ballast tank suction valve	QD40
Closed	Sea suction valve	QD28
Closed	Discharge valve	QD30
Open	Ballast main suction valve	QD31
Closed	Discharge valve to ballast main	QD29
Closed	Discharge valve to fire main	QD37
Open	Discharge to overboard	QD32
Closed	Discharge valve to inert gas system	QD20
Open	Overboard discharge valve	QD45

c) Start No.2 bilge, ballast and fire pump.

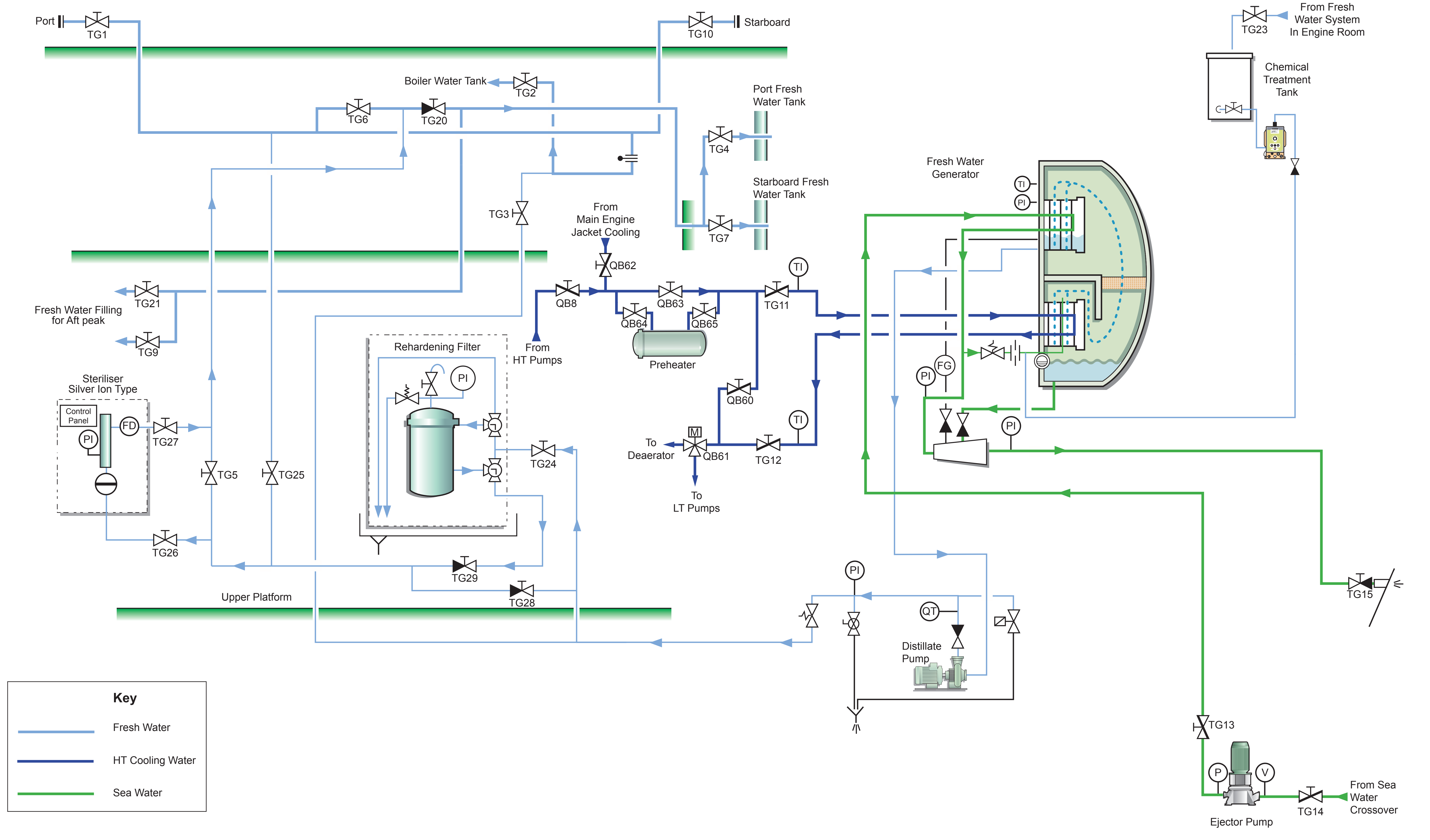
d) Open the discharge valve QD30 slowly until the discharge piping is pressurised.

e) Empty the after peak tank, taking care that the pump is not run dry.

f) Shut the pump discharge valve and stop the pump and close all valves.

g) Line-up the pump for fire main duty.

Illustration 2.4.4a Fresh Water Generator



2.4.4 FRESH WATER GENERATOR AND DISTILLED WATER TRANSFER AND DISTRIBUTION

Fresh Water Generator

Manufacturer:	Alfa Laval
Type:	Dpu-36-C100
Capacity:	24/36m^3/day

Sea Water Ejector Pump

Manufacturer:	Alfa Laval
Model:	CNL-80-80/200
Capacity:	86m^3/h x 0.42MPa

A fresh water generator is installed which utilises the heat from the main engine jacket cooling water system to produce fresh (distilled) water.

A combined brine/air ejector, driven by the ejector pump, creates a vacuum in the system in order to lower the temperature at which evaporation of the feed water takes place. The ejector pump takes suction from the sea water crossover main. The feed water is introduced into the evaporator section through an orifice and is distributed into every second plate channel (evaporation channels).

The main engine jacket cooling water is distributed into the remaining channels, thus transferring its heat to the feed water circulating in the evaporation channels. Having reached the boiling temperature, which is lower than at atmospheric pressure, the feed water undergoes a partial evaporation. The mixture of generated vapour and brine then enters the separator vessel, where 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 combined cooling/ejector water pump, is circulated through the remaining channels of the condenser section, thus absorbing heat from the vapour which is condensed.

The distilled water produced in the fresh water generator is extracted by the distillate pump and led to the fresh water tanks and boiler distilled water tank.

Fresh Water Quality

To continuously check the quality of the produced distilled water, a salinometer is provided and this has a sampling connection on the distillate pump delivery side. If the salinity of the distilled water produced exceeds the set value, the dump valve and alarm are activated to automatically dump the distilled water to the bilge via a scupper line.

Main Components

The fresh water generator consists of the following components:

Evaporator

The evaporator consists of a plate heat exchanger and is enclosed in the separator vessel.

Separator Vessel

The separator separates the brine from the vapour. It houses the evaporator and condenser heat exchangers.

Condenser

The condenser section, like the evaporator section, consists of a plate heat exchanger enclosed in the separator vessel.

Combined Brine/Air Ejector

The ejector extracts brine and incondensible gases from the separator vessel.

Ejector Pump

The ejector pump is a single-stage centrifugal pump which supplies the condenser with sea water and the brine/air ejector with jet water, it also supplies feed water for evaporation.

Distillate Pump

The distillate pump is a single-stage centrifugal pump which extracts the produced fresh water from the condenser, and pumps the water to the fresh water storage tanks.

Salinometer

The salinometer continuously checks the salinity of the produced water. The alarm set point is adjustable.

Control Panel

The control panel contains pump motor starter, running lights, salinometer and contacts for remote alarms.

Operating Procedures

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

a) Open the ejector pump suction valve TG14 and discharge valve TG13.

b) Open the overboard discharge valve TG15 for the combined brine/air ejector.

c) Close the air screw (vacuum release valve) on the top of the separator.

d) Start the ejector pump to create a 90% minimum vacuum.

Pressure at the combined brine/air ejector inlet should be a minimum of 3.0kg/cm^2. Back-pressure at the combined brine/air ejector outlet should be no more than 0. 6kg/cm^2.

Evaporation

When there is a minimum of 90% vacuum (after a maximum 10 minutes) conditions are right for the evaporation of heated feed water.

e) Open the valve for feed water treatment. Ensure that the chemical dosing tank is full, then start the dosing pump.

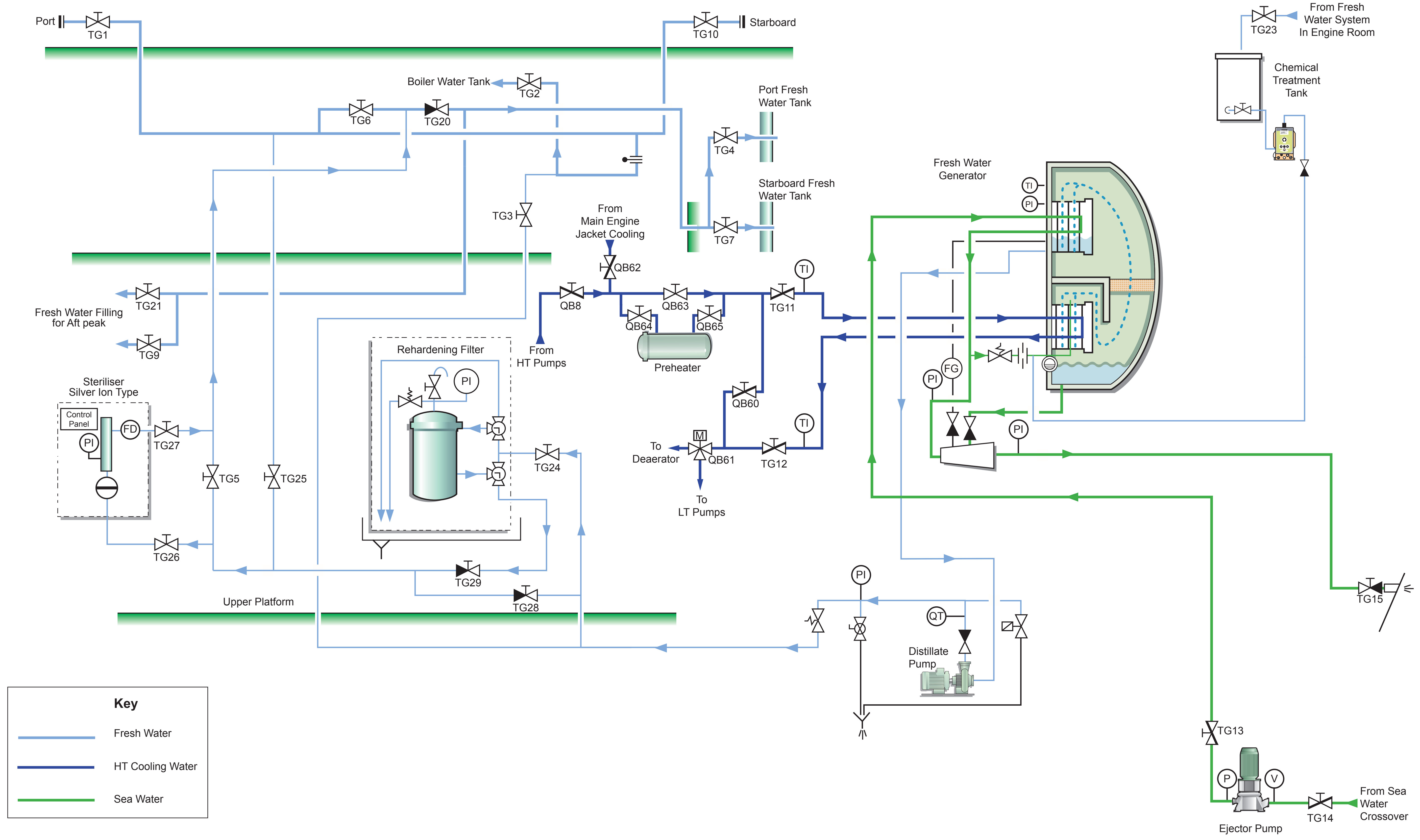
f) Open the jacket water inlet valve TG11 and the outlet valve TG12; the evaporator bypass valve QB60 should be open as this is used to regulate the flow of jacket water through the evaporator.

g) Adjustment of the jacket water bypass valve should be made so that the flow of jacket water through the evaporator gradually increases and the temperature in the evaporator rises.

The boiling temperature in the evaporator will rise, whilst the obtained vacuum drops to approximately 85%.

This indicates that evaporation has started.

Illustration 2.4.4a Fresh Water Generator



Condensation

After approximately 5 minutes the boiling temperature will drop again and a normal vacuum is re-established.

h) Open the valve to the selected fresh water storage tank and the system valves for the steriliser and rehardener (see below). If the water is to be directed to the boiler water tank, open line valve TG3 adjacent to the stores area on the upper level on the port side.

i) Switch on the salinometer.

j) Start the distillate pump.

Note: The distillate pump discharge pressure must be maintained between 0.12 and 0.16 MPa.

Adjustment of Jacket Water Flow

In order to obtain the specified flow of main engine jacket water to the evaporator, it is necessary to adjust the bypass valve QB60 until the desired flow is achieved. For maximum output the outlet temperature of the jacket water from the evaporator should be about 68.5ºC. It must be remembered that the evaporator acts as a cooler for the jacket water and care must be taken to ensure that the main engine jacket water is not under-cooled.

Adjustment of Sea Water Flow

The sea water flow is correct when the inlet pressure at the inlet to the brine/air ejector is between 3.0 - 4.0kg/cm^2.

Stopping the Plant

a) Stop the distillate pump. Shut down the steriliser if water was being directed to the domestic fresh water tanks.

b) Switch off the salinometer.

c) Fully open the jacket cooling water bypass valve QB60 and close the jacket water inlet valve TG11 and outlet valve TG12.

d) Stop the ejector pump.

e) Stop the feed water treatment dosing pump and close the supply valve from the feed water treatment unit.

f) Open the air screw (vacuum release valve) on the top of the separator.

g) Close the ejector pump inlet valve TG14 and outlet valve TG13.

h) Close the overboard valve TG15 for the combined brine/air ejector.

i) Close the valve to the fresh water tank being filled.

CAUTION

All valves must be shut while the generator is out of operation, except the air screw release valve.

The fresh water generator distillate pump discharges through a salinometer and a flow meter. Positioned before the flow meter is a solenoid valve. This opens when the salinometer detects too high a salinity level, dumping the distillate pump output to the bilge.

The discharge from the pump leads to the filling valves of both fresh water tanks (via the rehardening filter and steriliser), distilled water tank and if necessary, the aft peak tank.

Procedure for Operation of the Distilled Water Transfer System

a) Set up the valves as in the following table. All valves are initially closed.

Position	Description	Valve
Open	Filling valve for port FW tank or starboard FW tank inlet valve or boiler water tank inlet valve or aft peak tank filling valve	TG4 TG7 TG2 TG9, TG21
Open	Outlet valve from port FW tank	QG5
	or outlet valve from starboard FW tank	QG8
Open	Rundown valves from boiler water tank to the boiler feed water condensate/inspection tank	RL17 RL19

If Filling the Fresh Water Tanks

Position	Description	Valve
Open	Rehardening filter inlet valve	TG24
Open	Rehardening filter outlet valve	TG29
Set	Rehardening filter three-way ball valves for flow into and out of the unit	
Closed	Rehardening filter bypass valve	TG28
Operational	Steriliser automatic outlet valve	

Position	Description	Valve
Open	Steriliser inlet valve	TG26
Open	Steriliser outlet valve	TG27
Closed	Steriliser bypass valve	TG5
Closed	Line valve to/from deck connections	TG6
Open	Line valve to fresh water storage tanks	TG20
Open	Filling valve for selected fresh water tank	TG4 / TG7

b) Ensure that the rehardening filter is correctly charged with dolomite.

c) Ensure that the steriliser is being supplied with power. The inlet solenoid valve to the steriliser will only open if the steriliser is switched on.

d) Start-up the fresh water generator as described above.

e) Open the filling valve of the selected tank.

f) Start the distillate pump. Discharge should be to the bilge.

g) Switch on the salinometer.

If the reading is satisfactory, the discharge will change over to fill the tank.

h) Switch on the steriliser.

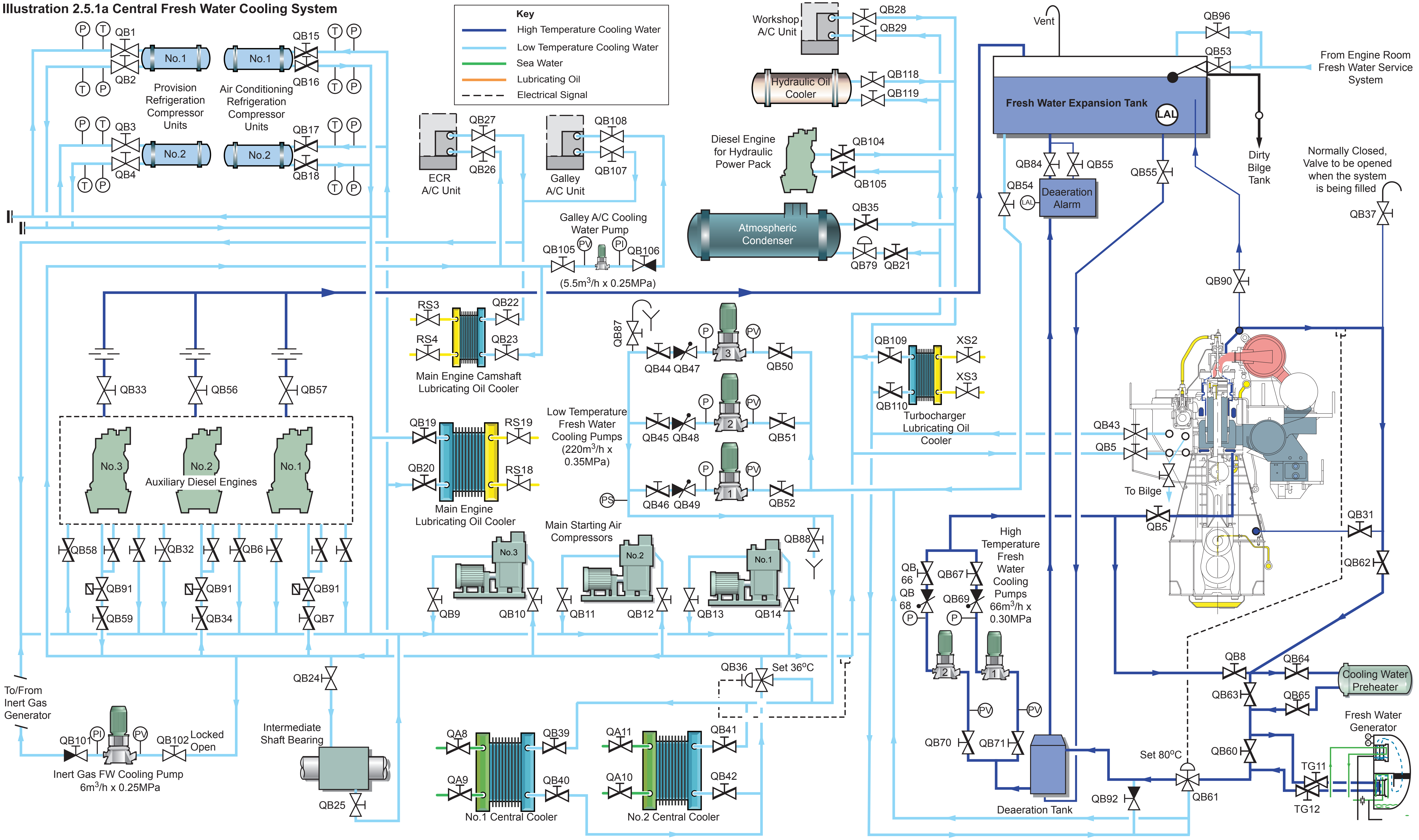
Distilled water from the fresh water generator will flow to the selected fresh water storage tank via the rehardening filter, where essential minerals are added to the water to ensure that it is fit for human consumption, and via the steriliser, where harmful bacteria are destroyed before the water flows to the storage tank.

It is essential that the steriliser is operating as the low temperature at which the distillate is produced will not destroy all the bacteria which may be in the sea water feed.

When it is necessary to change over the production from the fresh water generator to the boiler water tank, it is important to ensure that the inlet to the rehardening filter is closed, with the bypass valve open and the direct filling valve to the boiler water tank TG3 is open.

2.5 Fresh Water Cooling Systems

Illustration 2.5.1a Central Fresh Water Cooling System



2.5 FRESH WATER COOLING SYSTEMS

2.5.1 MAIN ENGINE JACKET (HT) FRESH WATER COOLING SYSTEM

High Temperature (HT) Fresh Water (FW) Cooling Pumps

Manufacturer:	Shinko
Model:	SVS 100M
No. of sets:	2
Capacity:	$66m^3/h$ at 0.30MPa
Power:	11kW

The closed-circuit, main engine high temperature (HT) cooling water system is provided with two circulating pumps. The system supplies cooling water to the main engine cylinder jackets, cylinder heads, exhaust valves and turbocharger casing. In normal operation the pumps operate with one as duty and the other on standby. To allow for automatic changeover both the pumps must be selected for AUTO CHANGE at their group starter panel on the main switchboard.

Note: When the pumps are set for AUTO CHANGE, the standby pump will automatically start on failure of the running pump or if the system pressure is too low. However, if the duty pump is stopped from any of its start/stop positions (even by accident), then the standby pump will not start, as the control system will recognise the shutdown signal as an operator command function and not a system failure.

It is not necessary to have the duty pump set in MANUAL mode when it is in operation.

The circulating pumps supply cooling water to the main engine inlet header, with a proportion diverted to either the jacket water heater or fresh water generator. The cooling system is continually vented from its highest point to the fresh water expansion tank, which the high temperature section of the fresh water system shares with the low temperature section. The main engine cooling water inlet header supplies each cylinder jacket, and this water then passes through the exhaust valve before joining the outlet header. Isolating valves are fitted to the jacket inlet and exhaust valve outlet lines for each unit, to allow each cylinder to be individually isolated if required. The individual units being fitted with separate drain valves connected to a common line draining to the aft bilge well.

When the engine is shut down or running on low load the jacket water temperature is maintained by a proportion of the HT fresh water being circulated through the jacket cooling water preheater, this utilises a thermostatically controlled supply of 0.70MPa steam as the heating medium. At sea, when the main engine is operating at normal load, the preheater will be bypassed and the water directed through the fresh water generator, which acts as a jacket water cooler whilst producing fresh water for the ship by means of low pressure evaporation.

If required, it is possible to maximise fresh water production by using the preheater to increase the heat available for the fresh water generator.

A thermostatically controlled three-way valve is located in the return line to the high temperature cooling water pumps. This valve provides an interconnection between the high temperature and the low temperature section of the central cooling system. This valve operates by diverting water from the high temperature side of the system to the low temperature side in order to maintain the temperature of the cooling water leaving the exhaust valves to between 80 to 85ºC.

A make-up water is provided from the low temperature section of the system to the high temperature section of the system via valve QB92, which is kept open whenever the main engine is operating or available to run.

To reduce the entrapment of air in the central cooling system, water returns to the high temperature cooling water pump suctions through a deaerator, this vents to the fresh water expansion tank. An alarm is fitted between the deaerator and the expansion tank, which will be initiated if excess air or gas is vented, indicating a malfunction of the main engine, such as a cracked cylinder liner. The water trap has a filling/make-up connection from the fresh water expansion tank through valve QB55.

The $1m^3$ fresh water expansion tank, which is common to both sections of the central cooling system, provides a positive suction head to the pumps of both systems. The tank also provides allowance for thermal expansion of the cooling water over the temperature differences experienced between shutdown and full load. The water level in the tank is maintained automatically by a supply from the engine room fresh water service system via a float valve and is fitted with a low level alarm.

If the level in the tank rises too far an overflow line leading to the dirty bilge water tank is provided.

To reduce the possibility of corrosion the cooling water in both systems is treated with inhibitor chemicals. The cooling water should be tested according to the supplier's requirements and according to company procedures, any chemical treatment required should be added to the header tank and the amount recorded.

Procedure for the Operation of the Main Engine Jacket Cooling Water System

a) Ensure that the level in the expansion tank is correct.

b) Ensure all pressure gauge and instrumentation valves are open.

c) Ensure the fresh water generator is bypassed.

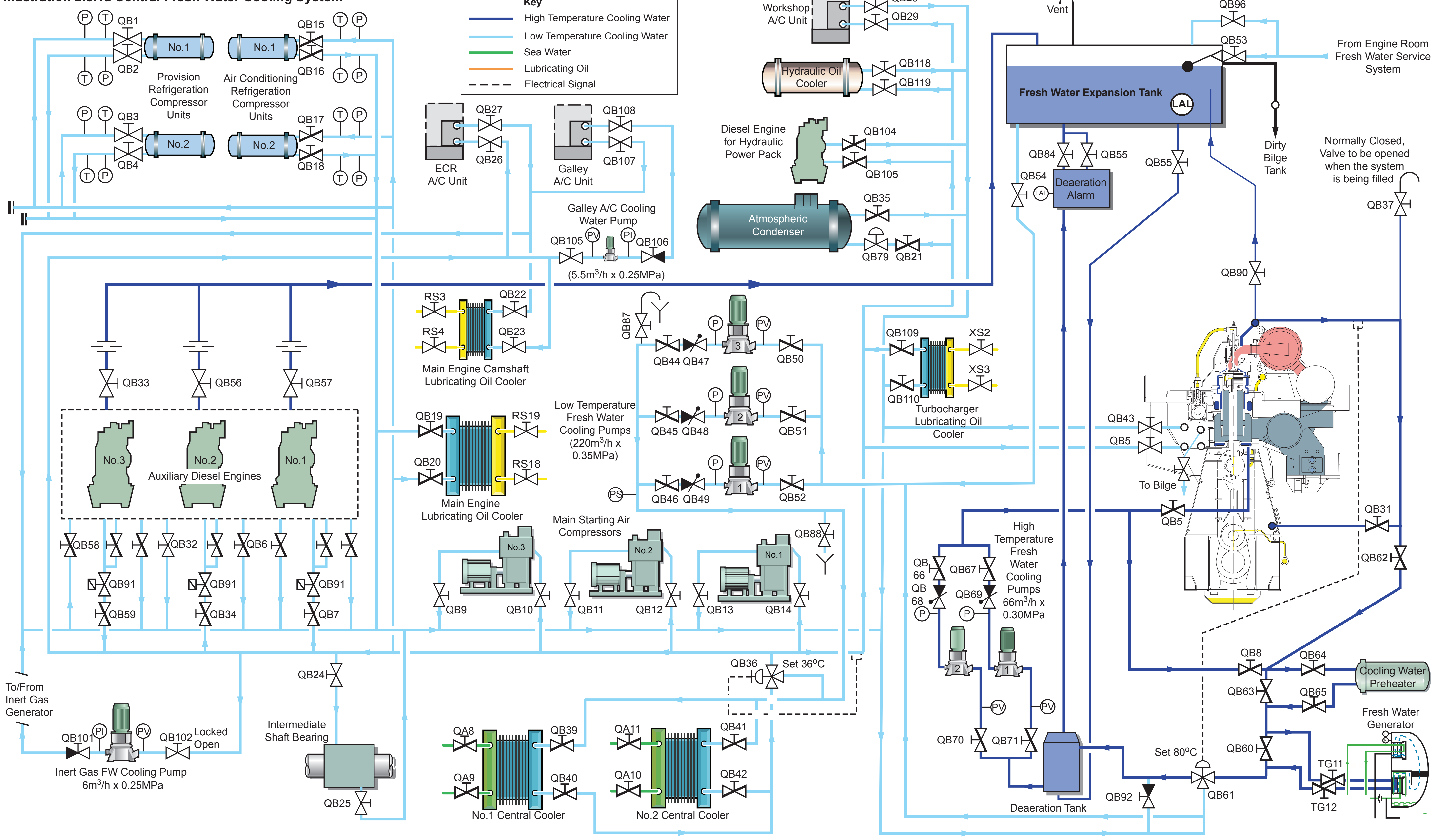
d) Ensure that all individual main engine cylinder inlet and outlet valves are open, and that the isolating valves on the turbocharger casing are open and all vent valves are shut.

e) Ensure that all individual main engine cylinder vent and drain valves are closed.

f) Position the valves as shown in the following table:

Position	Description	Valve
Open	Fresh water expansion tank float valve isolating valve	QB53
Closed	Fresh water expansion tank float valve bypass valve	QB96
Open	No.1 HT FW circulating pump suction valve	QB71
Open	No.1 HT FW circulating pump discharge valve	QB67
Open	No.2 HT FW circulating pump suction valve	QB70
Open	No.2 HT FW circulating pump discharge valve	QB66
Open	Main engine inlet valve	QB5
Open	System vent valve to expansion tank	QB90
Open	Expansion tank run down valve	QB55
Closed	Priming/vent valve	QB37
Open	Main engine fuel oil drain line heating outlet valve	QB31
Open	Main engine outlet valve	QB62
Closed	Main engine bypass valve	QB8
Open	Preheater inlet valve	QB64
Open	Preheater outlet valve	QB65
Closed	Preheater bypass valve	QB63
Open	FW generator bypass valve	QB60
Closed	FW generator inlet valve	TG11
Closed	FW generator outlet valve	TG12
Operational	Temperature controlled three-way valve	QB61
Open	Make-up valve from LT system	QB92

Illustration 2.5.1a Central Fresh Water Cooling System



g) Ensure that the low temperature central fresh water cooling system is operating correctly.

h) Vent the system by opening valve QB37 and then closing the valve when all air has been released.

i) Start one high temperature cooling water circulating pump and select the other pump for automatic standby.

j) Vent the preheater.

k) Ensure that the condensate drain valve from the preheater is open and supply steam to the preheater.

l) Slowly bring the cooling water temperature up to the operating temperature via the temperature setting on the steam regulating valve. Check the system for leaks and correct any that occur.

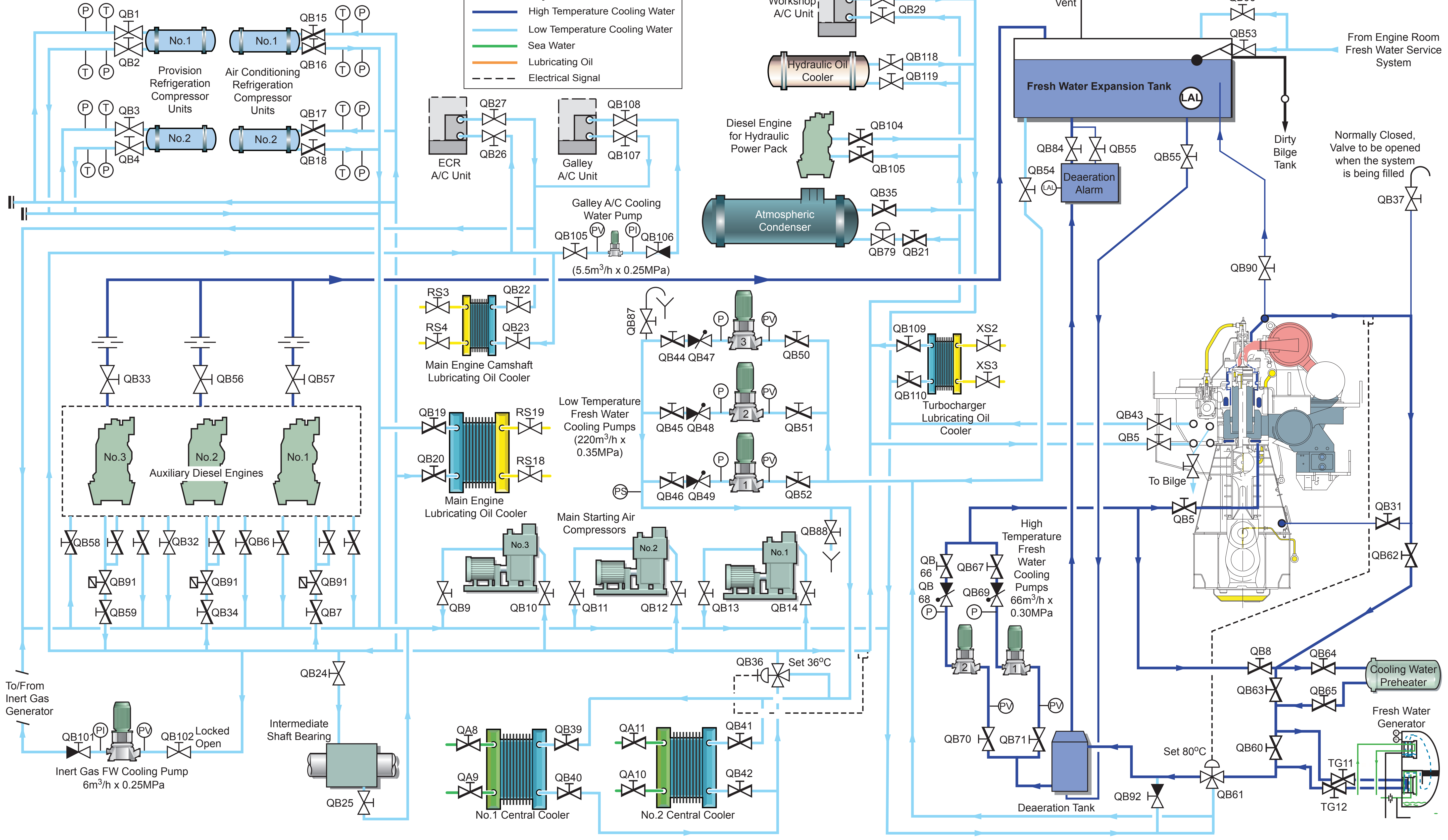
m) Test the cooling water system for inhibitor concentration and add chemicals as required.

n) When the main engine is at sufficient power the high temperature cooling water can be circulated through the fresh water generator if necessary. Refer to Section 2.4.4 for details of operating the fresh water generator.

o) Open the preheater cooling water bypass valve QB63.

p) Close the preheater cooling water inlet and outlet valves QB64 and QB65.

Illustration 2.5.2a Central Fresh Water Cooling System



2.5.2 CENTRAL (LT) FRESH WATER COOLING SYSTEM

Low Temperature Fresh Water Pump (LTFWP)

Manufacturer:	Shinko
Model:	SVS 200M
No. of sets:	3
Capacity:	220m^3/h at 0.35MPa
Power:	37kW

The closed-circuit, low temperature (LT) central fresh water cooling system is provided with three circulating water pumps which supply water, via two sea water cooled central coolers, to the following equipment:

- Generator diesel engines x 3
- Main engine lubricating oil cooler
- Main engine camshaft lubricating oil cooler
- Main engine (scavenge) air cooler
- Main engine turbocharger lubricating oil cooler
- Main (starting) air compressors x 3
- Atmospheric condenser
- Hydraulic power pack diesel engine
- Hydraulic oil cooler
- Intermediate shaft bearing
- Engine control room and workshop air conditioning units
- Accommodation air conditioning units x 2
- Galley air conditioning unit
- Provisions refrigeration compressors x 2
- Inert gas cooling system

The central coolers operate as one duty and one standby when the sea temperature is below 24°C. Above that figure, or at times of high cooling demand, both coolers will be required. The coolers are put into service by the manual positioning of their respective inlet and outlet valves.

In normal operation, with the sea temperature below 25°C, one circulating pump will be run as duty with the remaining two as selectable standby units. A pump selected as standby is identified by its standby light on the switchboard control panel being illuminated.

Above 25°C two pumps will be required. A pressure switch on the pump discharge header will operate to start the selected standby pump at a set (low) pressure.

When a pump is selected as the duty pump the next numbered pump is automatically selected as the standby unit, for example:

Duty pump 1	Standby pump 2
Duty pump 2	Standby pump 3
Duty pump 3	Standby pump 1

To allow for automatic changeover, the pumps must be selected for AUTO CHANGE at the switchboard control panel.

The low temperature FW pumps receive suction from the low temperature system and the high temperature bleed-off from the jacket cooling water system. The pumps discharge directly to the central coolers.

A thermostatically controlled three-way valve, set at 36°C, fitted to the central modulates the flow of water to the cooler(s), controlling the temperature of the circulating fresh water.

The 1m^3 fresh water expansion tank, which is common with the LT cooling system, provides a positive head to both systems, as well as allowing for thermal expansion. The water level in the tank is maintained automatically by a supply from the service water system via a float valve and is fitted with a low level alarm. To prevent corrosion the cooling water in both systems is treated with inhibitor chemicals. The cooling water should be tested according to company procedures, and any chemical treatment required added to the header tank.

Procedure for the Operation of the Central Cooling Water System

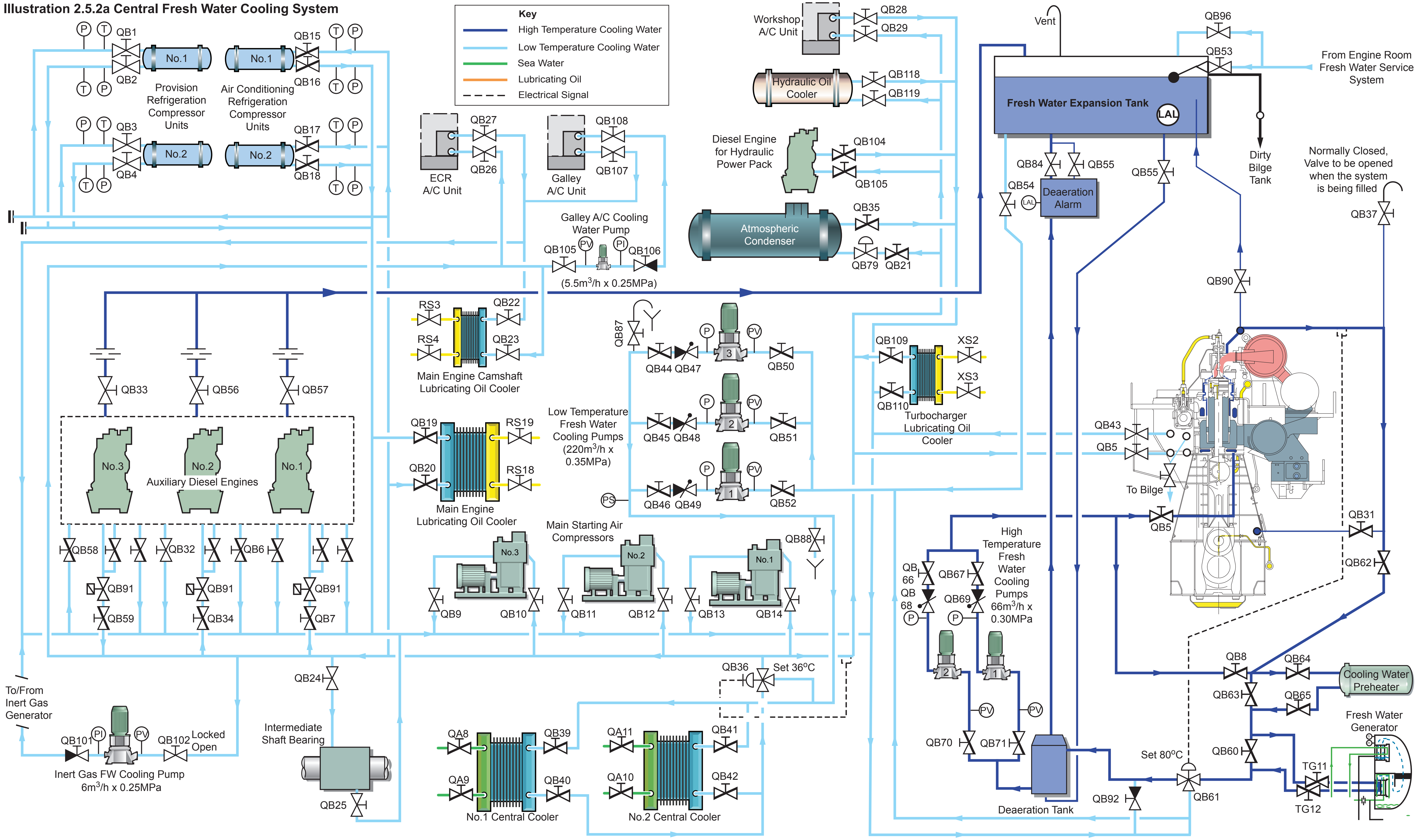
a) Ensure that the level in the FW expansion tank is correct.

b) Ensure all pressure gauge and instrumentation valves are open.

c) Position the valves as shown in the following table:

Position	Description	Valve
Open	No.1 LTFW pump suction valve	QB52
Open	No.1 LTFW pump discharge valve	QB46
Open	No.2 LTFW pump suction valve	QB51
Open	No.2 LTFW pump discharge valve	QB45
Open	No.3 LTFW pump suction valve	QB50
Open	No.3 LTFW pump discharge valve	QB44
Open	No.1 central cooler inlet valve	QB41
Open	No.1 central cooler outlet valve	QB42
Closed	No.2 central cooler inlet valve	QB39
Closed	No.2 central cooler outlet valve	QB40
Open	Main engine LO cooler inlet valve	QB20
Open	Main engine LO cooler outlet valve	QB19
Open	Main engine scavenge air cooler inlet valve	
Open	Main engine scavenge air cooler outlet valve	
Open	Shaft bearing inlet valve	QB24
Open	Shaft bearing outlet valve	QB25
Open	Camshaft LO cooler inlet valve	QB23
Open	Camshaft LO cooler outlet valve	QB22
Open	No.1 generator engine inlet valve	QB7
Open	No.1 generator engine outlet valve	QB6
Open	No.1 generator engine vent valve	QB57
Open	No.2 generator engine inlet valve	QB34
Open	No.2 generator engine outlet valve	QB32
Open	No.2 generator engine vent valve	QB56
Open	No.3 generator engine inlet valve	QB59
Open	No.3 generator engine outlet valve	QB58
Open	No.3 generator engine vent valve	QB33
Open	Fresh water expansion tank run-down valve	QB54
Open	No.1 main air compressor inlet valve	QB14
Open	No.1 main air compressor outlet valve	QB13
Open	No.2 main air compressor inlet valve	QB12
Open	No.2 main air compressor outlet valve	QB11
Open	No.3 main air compressor inlet valve	QB10
Open	No.3 main air compressor outlet valve	QB9
Operational	Hydraulic oil cooler inlet temperature controlled valve	QB79
Open	Hydraulic oil cooler inlet valve	QB35
Open	Hydraulic oil cooler outlet valve	QB21
Open	Hydraulic oil power pack diesel engine cooler inlet valve	QB104
Open	Hydraulic oil power pack diesel engine cooler outlet valve	QB103
Open	Provision refrigerator No. 1 inlet valve	QB1
Open	Provision refrigerator No. 1 outlet valve	QB2
Open	Provision refrigerator No. 2 inlet valve	QB3
Open	Provision refrigerator No. 2 outlet valve	QB4
Open	Engine control room A/C unit inlet valve	QB26
Open	Engine control room A/C unit outlet valve	QB27
Open	Engine room workshop A/C unit inlet valve	QB28
Open	Engine room workshop A/C unit outlet valve	QB29

Illustration 2.5.2a Central Fresh Water Cooling System



Position	Description	Valve
Open	Make-up valve to HT cooling system	QB92
Open	Atmospheric condenser inlet valve	QB117
Open	Atmospheric condenser outlet valve	QB118
Open	Inert gas FW cooling pump inlet valve	QB102
Open	Inert gas FW cooling pump outlet valve	QB101
Open	Galley A/C unit cooling pump suction valve	QB105
Open	Galley A/C unit cooling pump discharge valve	QB106
Open	Galley A/C unit inlet valve	QB108
Open	Galley A/C unit outlet valve	QB107

d) Start one LT fresh water pump.

e) Start the sea water cooling system, if not already running, and supply sea water to a central FW cooler (refer to Section 2.4.1).

f) Check the system for leaks and rectify any which occur.

g) Check the level of inhibitor and add chemical treatment as necessary.

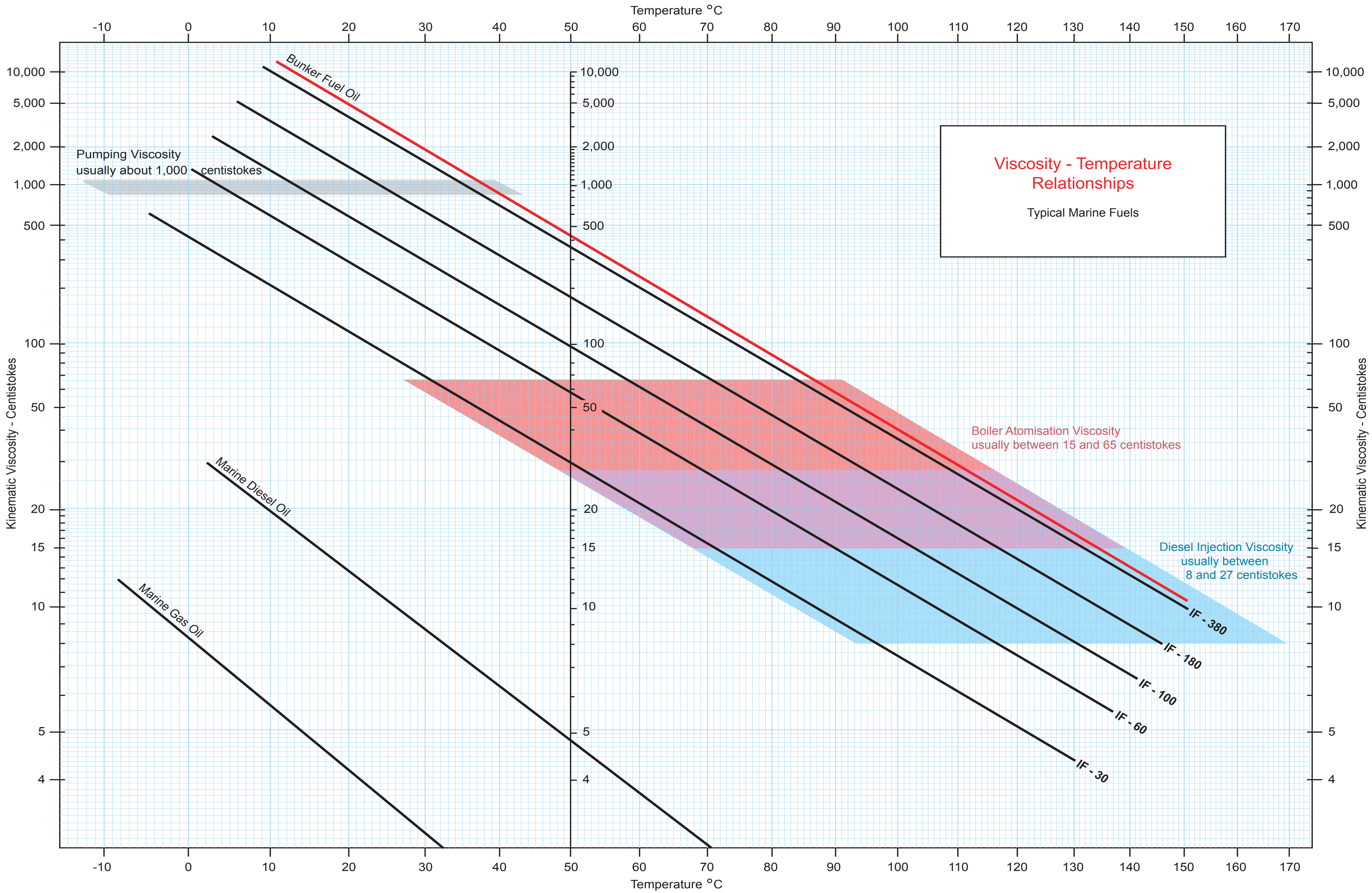
h) Check that one of remaining two LTFW pumps is selected for automatic standby.

Note: When the pumps are set for AUTO CHANGE, the standby pump will automatically start on failure of a/the running pump or if the system pressure is too low. However, if the duty pump is stopped from any of its start/stop positions (even by accident), then the standby pump will not start, as the control system will recognise the shutdown signal as an operator command function and not a system failure.

It is not necessary to have the duty pump set in MANUAL mode when it is in operation.

2.6 Fuel Oil and Diesel Oil Service Systems

Illustration 2.6a Viscosity-Temperature Graph



2.6 FUEL OIL AND DIESEL OIL SERVICE SYSTEMS

2.6.1 MAIN ENGINE FUEL OIL SERVICE SYSTEM

Fuel Oil Supply/Booster Unit

Manufacturer:	Aura Marine
Model:	AMB-M-07-SS
No. of sets:	1

Fuel Oil Supply Pump

Manufacturer:	IMO
Model:	ACE032/L3 NTBP
No. of sets:	2
Capacity:	4.0m^3/h at 0.50MPa
Viscosity:	75cSt
Power:	2.5kW

Fuel Oil Booster Pump

Manufacturer:	IMO
Model:	ACE032N3/NTBP
No. of sets:	2
Capacity:	5.3m^3/h at 0.50MPa
Viscosity:	75cSt
Power:	2.5kW

Marine Diesel Oil Supply Pump

Manufacturer:	IMO
Model:	ACE025N3/NVBP
No. of sets:	1
Capacity:	2.25m^3/h at 0.60MPa
Viscosity:	7cSt
Power:	1.3kW

Notes on Low Sulphur Fuels

Regulations for the Prevention of Air Pollution from Ships were adopted in the 1997 Protocol to MARPOL 73/78 and are included in Annex VI of the Convention. The Protocol adopted in 1997 included the new Annex VI of MARPOL 73/78, which entered into force on 19 May 2005.

MARPOL Annex VI sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances. The annex includes a global cap of 4.5% on the sulphur content of fuel oil.

Annex VI contains provisions allowing for special Sulphur Emission Control Areas (SECAs) to be established with more stringent controls on sulphur emissions. In these areas, the sulphur content of fuel oil used on board ships must not exceed 1.5%.

The designated areas and commencement dates are:

- The Baltic Sea — May 2006
- The North Sea — November 2007

Additionally, Port State Authorities may require that ships berthed in designated areas consume low sulphur fuel oil.

Care must be taken when changing over from heavy fuel oil (HFO) to low sulphur heavy fuel oil (LSHFO) due to possible incompatibility. This may result in asphalt-based sludges precipitating out of the fuel and blocking filters. It may be necessary to change over to marine diesel oil (MDO) as an intermediate stage and flushing out all heavy fuel oil before introducing the low sulphur fuel oil into the system.

The use of low sulphur fuel oil with standard alkaline crankcase and cylinder oils may result in lacquering of the cylinder lines with resultant scuffing, together with increased deposits on piston crowns and rings. If low sulphur fuel oils are to be used for a prolonged period it may be necessary to change the grade/type of both the main engine cylinder oil and the auxiliary engine crankcase oil.

The tank layout provides separate settling and service tanks for low sulphur heavy fuel oil. Storage is in bunker tanks as required, due regard should be taken to incompatibility and the tank(s) to be filled with low sulphur fuel oil drained as far as possible before bunkering.

Description

Heavy fuel oil (HFO) is carried in four bunker tanks on board the vessel:

- No.1 HFO tank port — 558m^3
- No.1 HFO minor tank (port) — 125m^3
- No.1 HFO tank starboard — 519m^3
- No.2 HFO tank starboard — 121m^3

Heavy fuel oil settling and service tanks are arranged on the port side of the engine room upper platform from outboard to inboard as follows:

- HFO settling tank — 38.7m^3
- HFO service tank — 38.7m^3
- Low sulphur HFO settling tank — 38.7m^3
- Low sulphur HFO service tank — 38.7m^3

Marine diesel oil (MDO) is carried in one bunker tank:

- MDO storage tank (stbd) — 97m^3

Marine diesel oil settling and service tanks are arranged on the starboard side of the engine room upper platform as follows:

- MDO service tank (outboard) — 30.7m^3
- DMA (settling tank) (inboard) — 30.7m^3

Heavy fuel oil is transferred to the fuel oil settling tank from the storage tanks by the fuel oil transfer pump. Any water and sediment may be drained off from the settling tank via the manually operated, self-closing test cock.

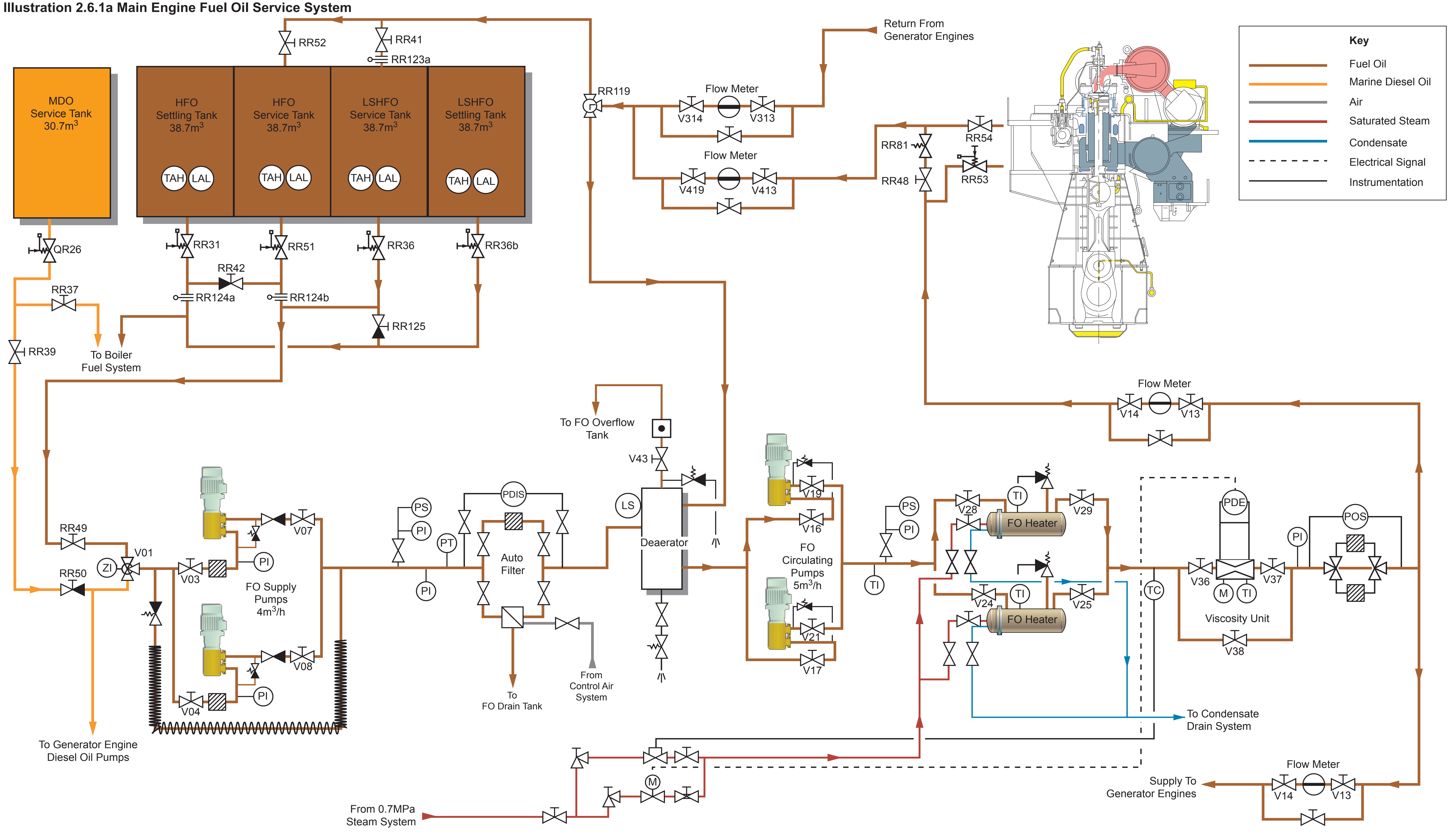
Heavy fuel oil is transferred from the settling tank to the service tank with the fuel oil separators, which remove any remaining water and suspended solids.

Heavy fuel oil is supplied to the main and generator diesel engines from the heavy fuel oil service tank. In normal operation the auxiliary and composite boilers draw from the heavy fuel oil settling tank, although if required they are able to draw from the service tank. However, the returns from the boiler burner units are only to the settling tank.

The low sulphur heavy fuel oil (LSHFO) settling and service tanks are located adjacent to the heavy fuel oil tanks and are connected in parallel to the fuel system through normally closed valves. The return pipework to both tanks is fitted with spectacle blanks and isolating valves.

The main engine, generator engines and auxiliary boiler are designed to run on heavy fuel oil at all times. The composite boiler may be fired with either heavy fuel oil or waste oil and/or heated by the main engine exhaust gases.

Illustration 2.6.1a Main Engine Fuel Oil Service System



In normal operation one or more fuel oil separators will be running, with throughput balanced to be slightly in excess of the fuel consumption of the operating plant. Excess oil overflowing from the service tank back to the settling tank.

Outlets from all fuel tanks are fitted with remote quick-closing valves with a collapsible bridge, these are pneumatically operated remotely from the panel in the fire control station. After being operated the individual valves must be reset manually at each tank.

All fuel settling and service tanks are fitted with self-closing test cocks, which are used to test for and drain any water present at the bottom of the tank, the drain lines are led to the fuel oil drain tank.

Note: Settling and service tanks should be checked for water daily, bunker tanks should be checked before bringing into service. Any water present is to be drained through the self-closing cocks to the fuel oil drain tank.

Steam heating coils are fitted in all heavy fuel oil tanks and all pipework is provided with steam trace heating.

Fuel oil is supplied to the main engine and generator engines via the fuel oil supply/booster unit, which comprises duty/standby fuel oil supply pumps, duty/standby fuel oil booster pumps, filters, heaters, supply flow meters, return flow meters and the viscosity control unit. The module also includes the single marine diesel oil supply pump.

The fuel inlet to the fuel oil supply unit is arranged via a three-way valve, which depending on its position, will allow heavy fuel oil or marine diesel oil into the unit. Fuel is then led through suction strainers to a pair of duty/auto standby fuel oil supply pumps. The supply pump recirculation line is fitted with a pressure control valve set at 0.4MPa and a fin cooler.

From the supply pumps fuel is discharged through an auto backflush filter to the deaerator vessel. The auto backflush filter is an automatic self-cleaning unit with an air operated cleaning mechanism initiated at a set differential pressure. The backflush filter may be bypassed through a basket filter during maintenance. Waste oil from the backflush filter is discharged to the fuel oil drain tank.

From the filter, fuel passes to the deaerator vessel. Fuel oil returns, led through dedicated flow meters, from the main engine and generators may be mixed with the fresh oil in the deaerator or returned to the heavy fuel oil settling tank, depending on the positioning of a three-way valve. The deaerator vessel vents any vapours to the fuel oil overflow tank and is fitted with a relief valve, set to operate at 1.0MPa, which also vents to the same tank.

Fuel oil is drawn from the deaerator vessel by one of two duty/auto standby fuel oil booster pumps. The fuel oil booster pumps discharge through pipework fitted with a relief valve, set to operate at 0.8 MPa, to duty/standby fuel oil heaters, where the oil is heated to a temperature corresponding to a viscosity of 12cSt using steam as the heating medium. The oil side of the heaters are fitted with relief valves, set to operate at 1.5 MPa, which vent to the deaerator vent line.The heated fuel oil then passes through the viscosity meter which controls the oil temperature by controlling a motorised steam inlet valve to the heaters. From the viscosity meter, fuel oil passes through a duplex strainer before discharging from the supply/booster unit to the main engine and generators through dedicated flow meters.

Fuel oil is supplied to the main engine fuel rail through the engine inlet manifold quick-closing valve. A pressure regulating valve maintains the correct fuel pressure at the engine inlet by allowing excess fuel to bypass the engine and return to the supply/booster unit.

The fuel consumption of the main engine and generator engines is determined by the difference between the supply and return flow meter readings for each system.

The main engine high pressure fuel pipes between the high pressure fuel injection pumps and the fuel valves are sheathed with a steel braided hose. Any leakage is led to a collecting tank fitted to the side of each fuel oil pump. The collecting tanks are each fitted with a liquid level alarm, when activated this raises an alarm on the DMS 2100 alarm and monitoring system and initiates the operation of the puncture valve on the top of the injection pump.

CAUTION

When the puncture valve operates, the high pressure fuel delivery from the pump will stop immediately, taking the unit out of operation.

The engine speed must be reduced immediately to less than 105 rpm.

Preparation for the Operation of the Main Engine Fuel Oil Service System

The following procedure is to start the main engine from a cold, shutdown condition with the system primed with diesel oil and all other ship's services available.

a) Put the heavy fuel oil separator(s) into operation, filling the service tank from the settling tank.

b) Ensure that the filters are clean.

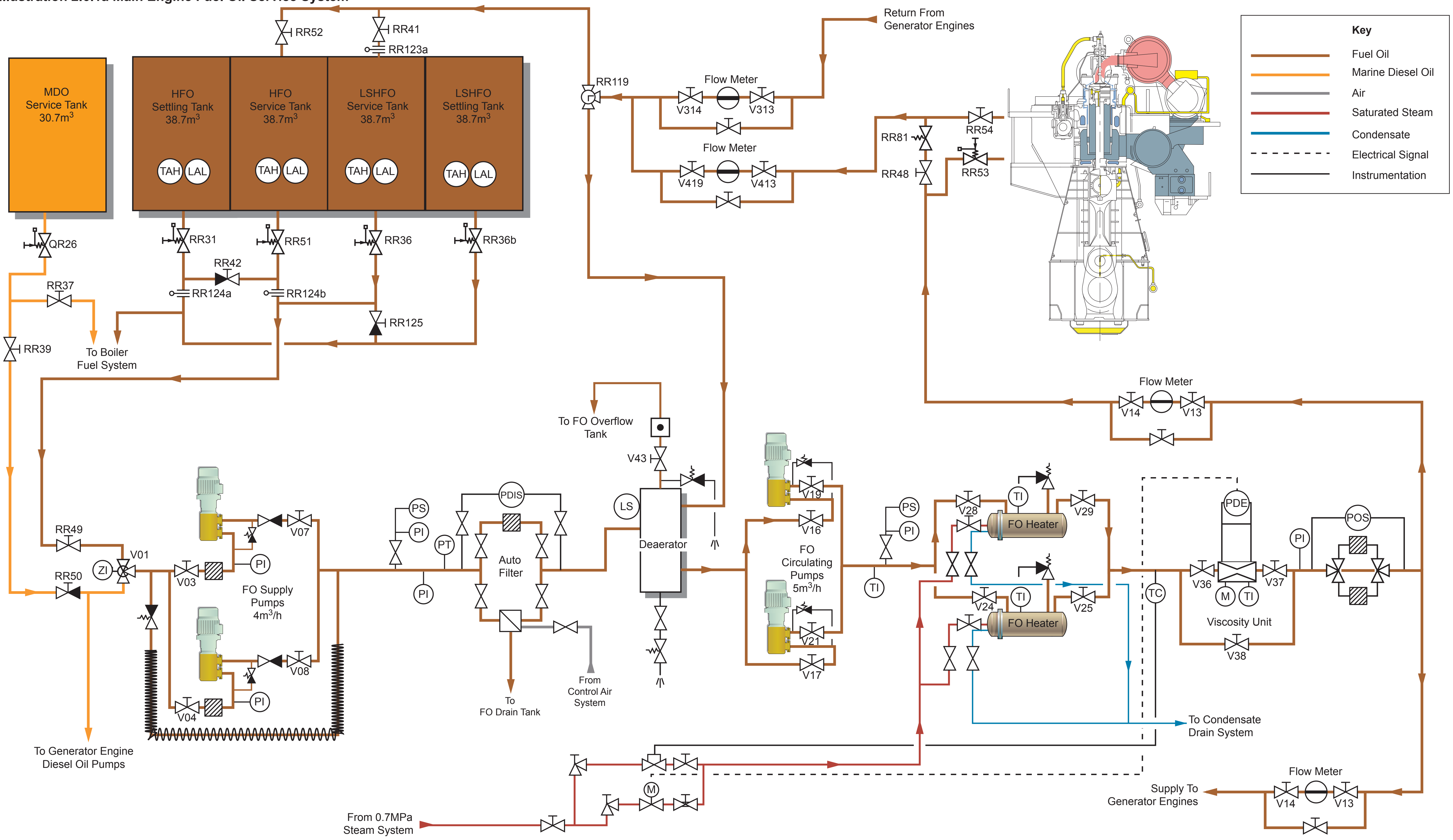
c) Ensure that all instrumentation valves are open.

d) Ensure that service steam and control air are available.

e) Position the valves as shown in the following table:

Position	Description	Valve
WHEN USING LOW SULPHUR HEAVY FUEL OIL		
Closed	HFO service tank quick-closing outlet valve	RR51
Closed	HFO service tank outlet spectacle flange	RR124b
Closed	HFO service tank returns inlet valve	RR52
Open	LSHFO service tank quick-closing outlet valve	RR36a
Open	LSHFO service tank returns inlet spectacle flange	RR123a
Open	LSHFO service tank returns inlet valve	RR41
WHEN USING NORMAL HEAVY FUEL OIL		
Open	HFO service tank quick-closing outlet valve	RR51
Open	HFO service tank outlet spectacle flange	RR124b
Open	HFO service tank returns inlet valve	RR52
Closed	LSHFO service tank quick-closing outlet valve	RR36a
Closed	LSHFO service tank returns inlet spectacle flange	RR123a
Closed	LSHFO service tank returns inlet valve	RR41
Open	HFO/LSHFO inlet valve to supply/booster unit	RR49
Open	Diesel oil service tank quick-closing valve	QR26
Open	Diesel oil service tank rundown valve to supply/booster unit	RR39
Open	Diesel oil inlet valve to HFO booster unit	RR50
Set to HFO settling tank	Supply/booster unit inlet three-way changeover cock	V01
Open	No.1 FO supply pump suction valve	V03
Open	No.1 FO supply pump discharge valve	V07
Open	No.2 FO supply pump suction valve	V04
Open	No.2 FO supply pump discharge valve	V08
Set	Auto backflush filter inlet three-way valve	
Set	Auto backflush filter outlet three-way valve	
Open	Mixing stack/deaerator vent valve	V43
Open	No.1 FO booster pump suction valve	V16
Open	No.1 FO booster pump discharge valve	V19
Open	No.2 FO booster pump suction valve	V17
Open	No.2 FO booster pump discharge valve	V21
Open	No.1 FO heater inlet valve	V28
Open	No.1 FO heater outlet valve	V29
Closed	No.2 FO heater inlet valve	V24
Closed	No.2 FO heater outlet valve	V25
Open	Viscosity controller inlet valve	V36
Open	Viscosity controller outlet valve	V37

Illustration 2.6.1a Main Engine Fuel Oil Service System



Position	Description	Valve
Closed	Viscosity controller bypass valve	V38
Open	Main engine supply flow meter inlet valve	V13
Open	Main engine supply flow meter outlet valve	V14
Closed	Main engine supply flow meter bypass valve	
Open	Main engine master HFO quick-closing inlet valve	RR53
Open	Main engine outlet valve	RR54
Operational	Main engine fuel pressure regulating valve	RR81
Open	Main engine fuel pressure regulating valve, manual isolating valve	RR47
Open	Main engine return flow meter inlet valve	V413
Open	Main engine return flow meter outlet valve	V414
Closed	Main engine return flow meter bypass valve	
Set to mixing tank	Fuel return three-way valve	RR119

Fuel Oil Changeover

The main and generator engines are designed to run on heavy fuel oil at all times. However, due to operational circumstances it may be necessary to change over to diesel oil if, for example, the vessel is expected to have a prolonged period with the main engine stopped or shut down when, for example:

- The vessel is in port or at anchor.
- Repairs are required to the heavy fuel oil system or associated systems.
- Operating in a sulphur emission control area when no LSHFO is available.

The changeover may be performed at any time, whether the engine is running or stopped. In order to prevent fuel pump and fuel valve sticking/scuffing, poor combustion and fouling of the gas ways, it is important to follow the changeover procedures carefully.

Procedure to Change Over the Main Engine Fuel System from Diesel Oil to Heavy Fuel Oil with the Engine Stopped

a) Supply steam heating to heavy fuel oil service tank.

b) Open all the individual fuel inlet valves on the main engine fuel inlet rail.

c) Turn on the trace heating to the fuel oil service system pipelines.

CAUTION
Trace heating should not be applied to sections of pipeline isolated by closed valves, as expansion of the contents could cause damage.

d) Start one fuel oil supply pump.

e) Start one fuel oil booster pump.

f) Open steam supply to the duty fuel oil heater.

g) Manually raise the temperature of the fuel oil heater to about 75ºC.

h) Start the viscosity control unit and close the bypass valve (V38).

i) Open the return valve to the heavy fuel oil service tank (RR52).

j) Position the return three-way valve (RR119) to direct the return oil to the heavy fuel oil service tank.

k) Marine diesel oil will now be discharged from the system to the heavy fuel oil service tank. At the same time heavy fuel oil will be drawn in to the system from the service tank. When all the diesel oil has been expelled, reposition the three-way return valve RR119 to the deaerator vessel.

l) Continue to raise the temperature manually at the fuel oil heater.

m) When the set point is reached on the viscosity control unit, change its setting to AUTO.

n) Change the operation of the steam control valve to AUTO. Open the steam inlet valve fully.

o) Select the second fuel oil supply pump to standby.

p) Select the second fuel oil booster pump to standby.

Procedure to Change Over from Diesel Oil to Heavy Fuel Oil with the Engine Running

To protect the injection equipment against rapid temperature changes, which may cause sticking/scuffing of the fuel valves, fuel pump plungers and suction valves, the changeover should be carried out manually as follows:

a) Ensure that the temperature of the heavy oil in the service tank is at normal operating level.

b) Reduce the engine load to 75% of normal. Then, by means of the thermostatic valve in the steam system, or by manual control of the viscosity regulator, the diesel oil is should be heated to a maximum of 50ºC. This temperature will maintain the lubrication properties of the diesel oil and minimises the risk of fuel pump plunger scuffing and sticking.

Note: Fuel heating should be regulated to give a temperature rise of about 2ºC per minute.

c) The temperature of the heavy fuel oil in the service tank should be no more than 25ºC higher than the heated diesel oil in the system at the time of changeover.

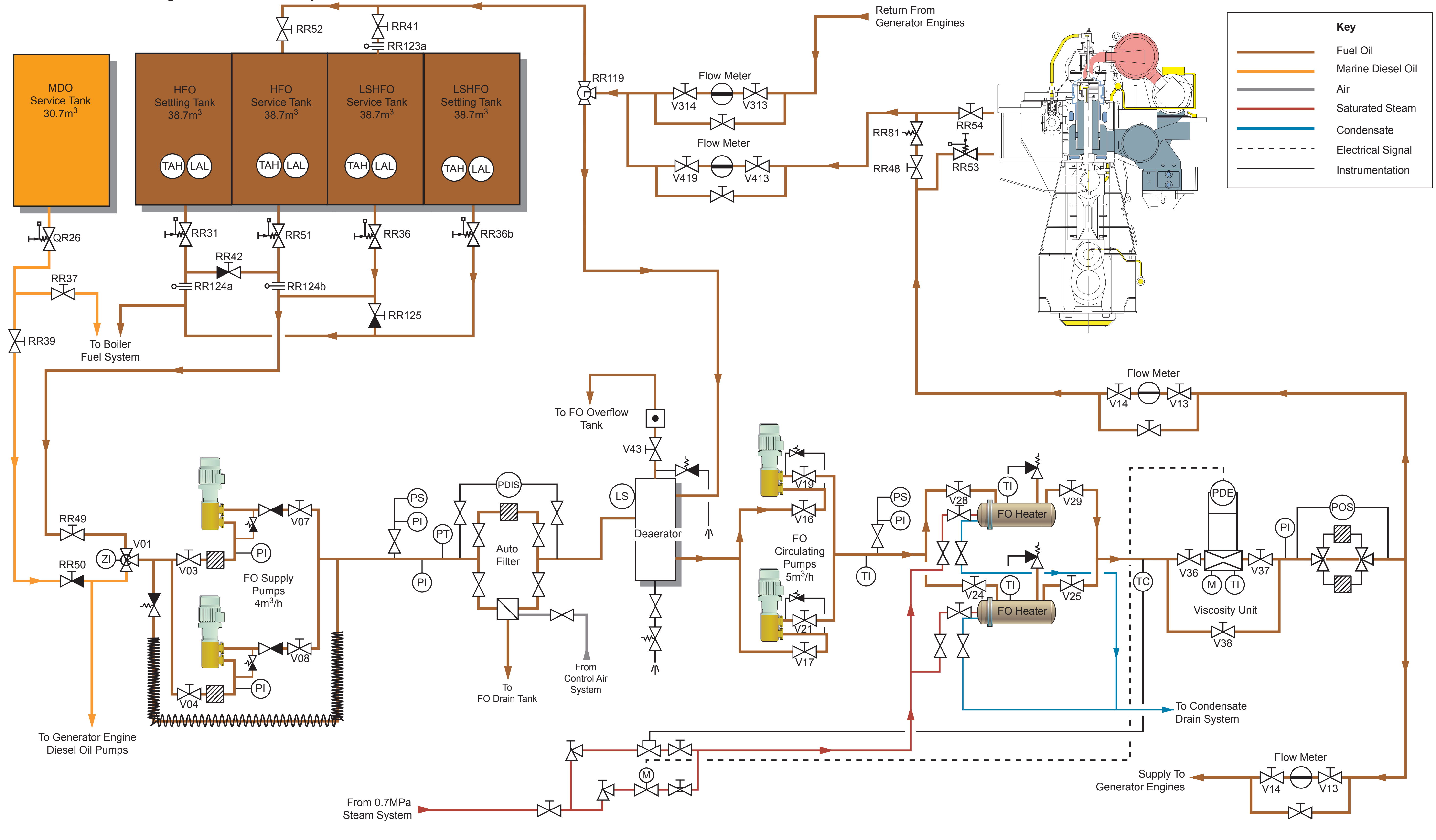
Note: The diesel oil viscosity should not drop below 2cSt, as this might cause fuel pump and fuel valve scuffing, with the risk of sticking. For some light diesel oils (gas oil), this will limit the upper temperature to below 80ºC.

d) When the diesel oil has been heated to the required temperature, the changeover to heavy oil is performed by opening the fuel oil supply valve from the heavy fuel oil service tanks (RR49). Turn the fuel oil supply/booster unit three-way changeover cock to take suction from the heavy fuel oil service tank.

e) Close the diesel oil supply valve (RR50).

Continue raising the temperature of the fuel oil at a rate of about 2ºC per minute until the required viscosity is achieved.

Illustration 2.6.1a Main Engine Fuel Oil Service System



Procedure to Change Over from Heavy Fuel Oil to Marine Diesel Oil with Engine Running

To protect the injection equipment against rapid temperature changes, which may cause sticking/scuffing of the fuel valves, fuel pump plungers and suction valves, the changeover should be carried out manually as follows:

a) Shut off the steam supply to the fuel oil preheater, return fuel pipe and steam tracing.

b) Reduce the engine load to 75% of MCR.

CAUTION
The temperature of the HFO should not be allowed to fall below 75ºC.

c) Change over to diesel oil when the temperature of the HFO in the heater has dropped to approximately 25ºC above the temperature of the fuel in the diesel oil service tank.

d) Open the diesel oil supply valve (RR50). Turn the fuel oil supply/ booster unit three-way changeover valve to take suction from the diesel oil service tank.

e) Close the heavy fuel oil supply valve (RR49).

Diesel oil is now being supplied to the main and generator engines.

Note: If the temperature of the fuel at the preheater drops by a large margin, steam heating should be applied to moderate the temperature reduction.

Procedure to Changeover from Heavy Fuel Oil to Diesel at Finished with Engines

a) Shut off the steam supply to the fuel oil preheater, return fuel pipe and steam tracing.

b) Open the diesel oil supply valve to the fuel oil supply/ booster unit (RR50).

c) Change over the fuel oil supply/booster unit three-way inlet valve to take suction from the marine diesel oil service tank.

d) Close heavy fuel oil supply valve to the fuel oil supply/booster unit (RR49).

e) Open the return valve to the heavy fuel oil service tank RR52.

f) Ensure that there is sufficient marine diesel oil in the service tank.

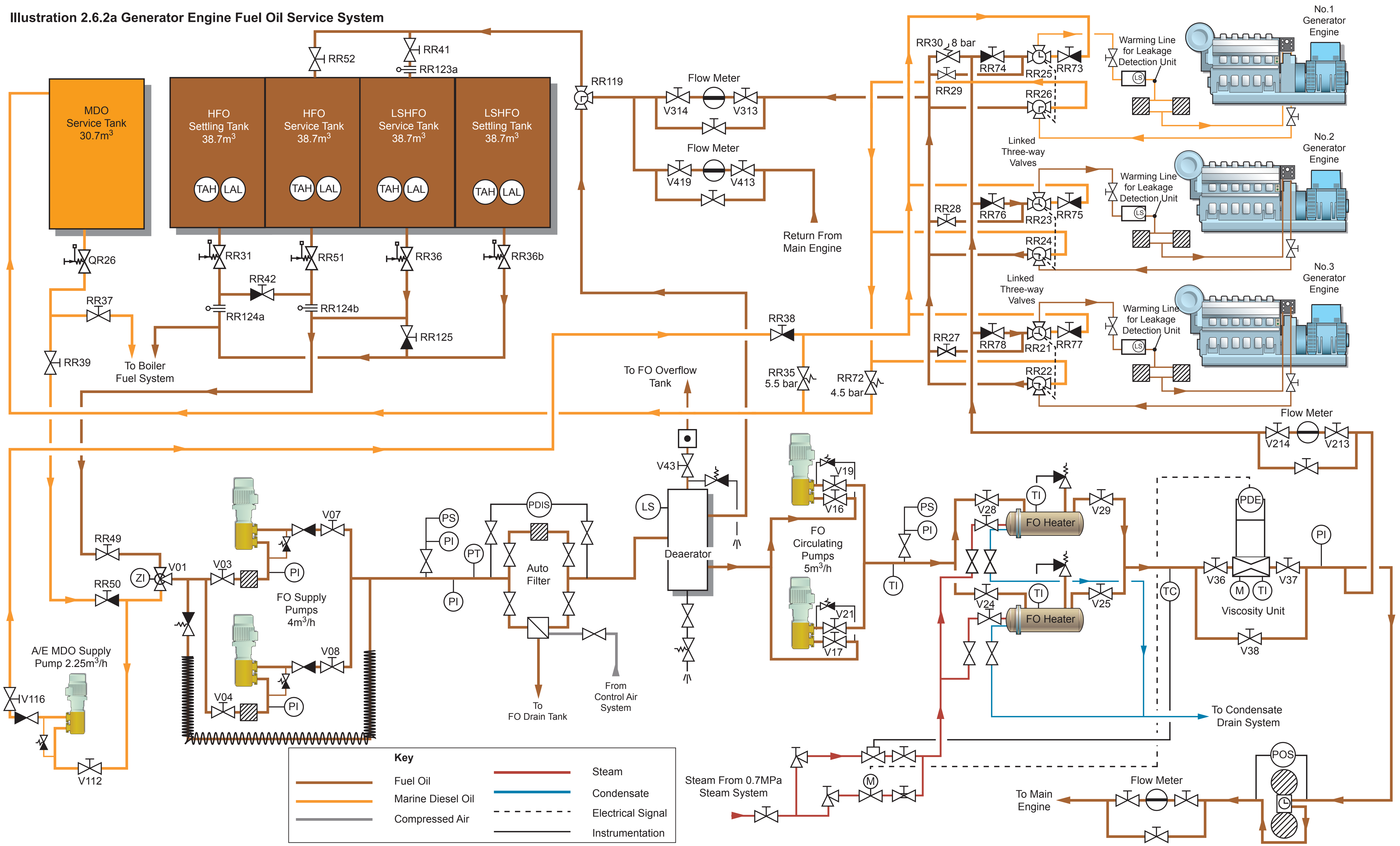
g) Position the return three-way valve (RR119) to direct the return heavy fuel oil to the service tank.

h) When the heavy fuel oil is replaced by diesel oil, reposition the return three-way valve (RR119) to the mixing unit.

i) The viscosity control unit may now be stopped.

Diesel oil is now being supplied generator engines and available to the main engine.

Illustration 2.6.2a Generator Engine Fuel Oil Service System



2.6.2 GENERATOR ENGINE FUEL OIL SERVICE SYSTEM

Fuel Oil Supply/Booster Unit

Manufacturer:	Aura Marine
Model:	AMB-M-07-SS
No. of sets:	1

Fuel Oil Supply Pump

Manufacturer:	IMO
Model:	ACE032/L3 NTBP
No. of sets:	2
Capacity:	4.06m^3/h at 0.50MPa
Viscosity:	75cSt
Power:	2.5kW

Fuel Oil Booster Pump

Manufacturer:	IMO
Model:	ACE032N3/NTBP
No. of sets:	2
Capacity:	5.34m^3/h at 0.50MPa
Viscosity:	75cSt
Power:	2.5kW

Marine Diesel Oil Supply Pump

Manufacturer:	IMO
Model:	ACE025N3/NVBP
No. of sets:	1
Capacity:	2.25m^3/h at 0.60MPa
Viscosity:	7cSt
Power:	1.3kW

Operation Using Heavy Fuel Oil

In normal operation the three generator engines are designed to operate at all times on heavy fuel oil. However, there is a provision to operate them on diesel oil when required, such as when:

- Repairs are required to the heavy fuel oil system or associated systems.
- Operating in a sulphur emission control area when no LSHFO is available.

Fuel oil is supplied to the generator diesel engines from the heavy fuel oil service tanks using the same system as the main engine, described previously in Section 2.6.1.

Heated and filtered fuel oil is supplied to the generator engines via a dedicated flow meter at the outlet from the fuel oil supply/booster unit.

Each generator engine has a pair of mechanically linked three-way valves at their fuel inlet and outlet. This facility ensures that heavy fuel oil cannot be returned to the diesel oil service tank and that diesel oil cannot be returned to the heavy fuel oil system.

Excess fuel oil is returned to the deaerator vessel through the flow meter and three-way valve RR119, which diverts the fuel oil to the heavy fuel oil service tank for flushing purposes.

The high pressure fuel oil lines on the generator engines are sheathed. Any leakage from the annular spaces, formed by the sheathing, is led to a fuel oil leakage tank fitted with a high level alarm.

To prevent cold spilled fuel causing drain blockage, the fuel oil leakage alarm tank on each engine is maintained in a warm condition by the hot fuel supply being piped through it.

Procedure to Operate Generators Using Diesel Oil

The following procedure is to start No.1 generator:

a) Ensure that the marine diesel oil service tank is at an operational level or transfer fuel from the marine diesel oil storage tank using the diesel oil separator.

b) Position valves as shown in the table below:

Position	Description	Valve
Open	MDO service tank outlet valve	QR26
Open	MDO service tank to supply/booster unit supply valve	RR39
Open	MDO inlet valve to fuel oil supply/booster module	RR50
Open	MDO supply pump suction valve	V112
Open	MDO supply pump discharge valve	V116
Set for MDO	Fuel oil supply/booster unit inlet three-way valve	V01
Open	MDO inlet valve to generator engines	RR38

c) Start the marine diesel oil supply pump.

d) Position the generator engines linked three-way changeover valves (RR21/RR22) from heavy fuel oil to marine diesel oil. Any heavy fuel oil in the generator fuel rail will be directed into the marine diesel oil service tank.

e) If heated heavy fuel oil has been circulated in the generator fuel system, allow the marine diesel oil to circulate to allow the fuel pumps to cool down.

The generator engines are now ready for starting on marine diesel oil.

Procedure to Operate Generators Using Heavy Fuel Oil

The following procedure is to start No.2 and No.3 generator engines with the system charged with diesel oil, No.1 generator in operation and all other ship's services available:

a) Bring a heavy fuel oil separator into operation, filling the service tank from the settling tank.

b) Ensure that the filters are clean.

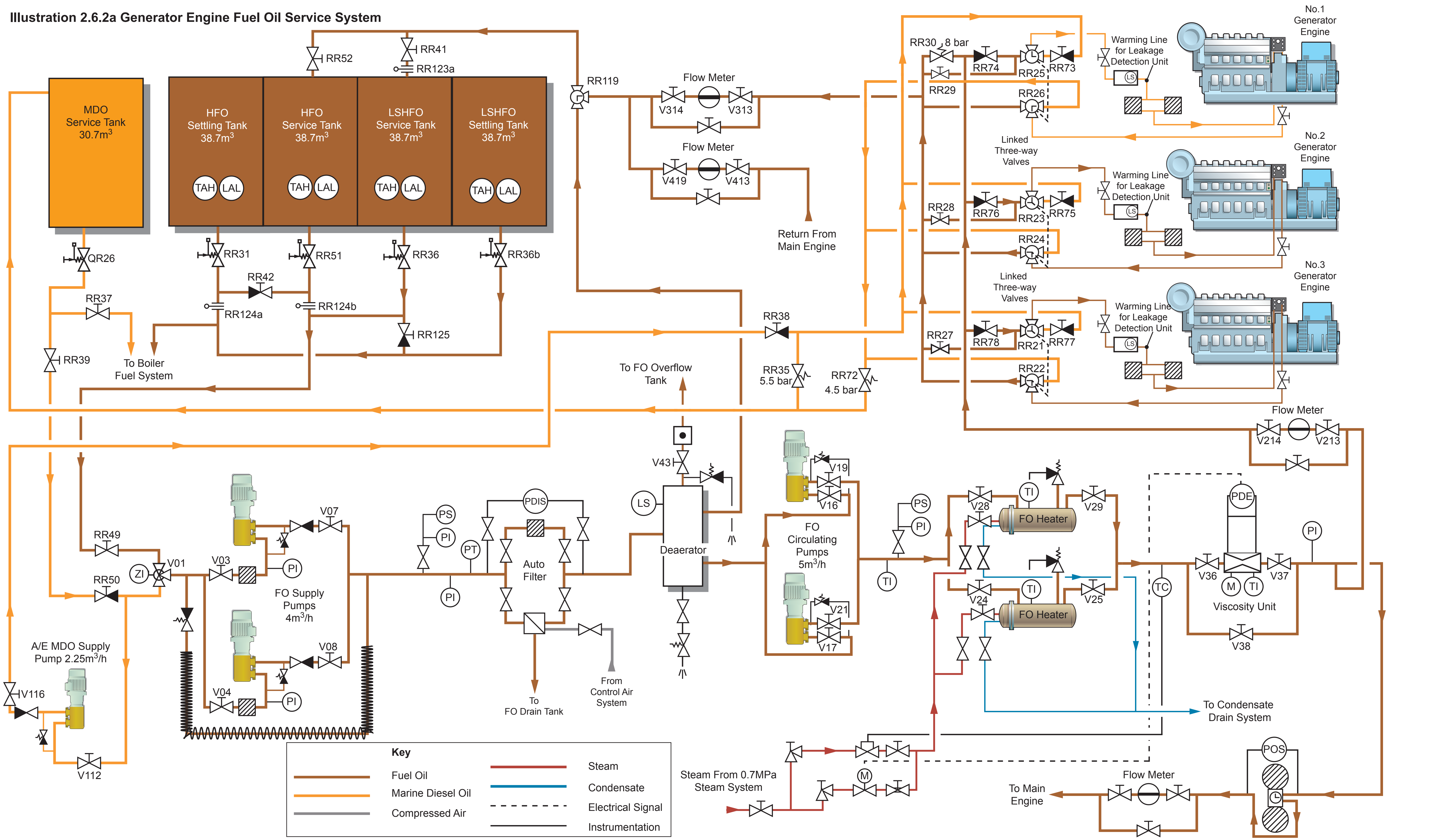
c) Ensure that all instrumentation valves are open.

d) Start up the main heavy fuel oil system as described in Section 2.6.1.

e) Position the valves as shown in the following table:

Position	Description	Valve
WHEN USING LOW SULPHUR HEAVY FUEL OIL		
Closed	HFO service tank quick-closing valve	RR51
Closed	HFO service tank outlet spectacle blank	RR124b
Closed	HFO service tank return inlet valve	RR52
Open	LSHFO service tank quick-closing outlet valve	RR36a
Open	LSHFO service tank return inlet spectacle blank	RR123a
Open	LSHFO service tank return inlet valve	RR41
WHEN USING NORMAL HEAVY FUEL OIL		
Open	HFO service tank quick-closing outlet valve	RR51
Open	HFO service tank outlet spectacle blank	RR124b
Open	HFO service tank return inlet valve	RR52
Closed	LSHFO service tank quick-closing outlet valve	RR36a
Closed	LSHFO service tank return inlet spectacle blank	RR123a
Closed	LSHFO service tank return inlet valve	RR41
Open	HFO/LSHFO inlet valve to fuel oil supply/ booster unit	RR49

Illustration 2.6.2a Generator Engine Fuel Oil Service System



Position	Description	Valve
Set to HFO settling tank	Fuel oil supply/booster unit inlet three-way valve	V01
Open	No.1 FO supply pump suction valve	V03
Open	No.1 FO supply pump discharge valve	V07
Open	No.2 FO supply pump suction valve	V04
Open	No.2 FO supply pump discharge valve	V08
Set	Auto backflush filter inlet three-way valve	
Set	Auto backflush filter outlet three-way valve	
Open	Mixing stack/deaerator vent valve	V43
Open	No.1 FO circulating pump suction valve	V16
Open	No.1 FO circulating pump discharge valve	V29
Open	No.2 FO circulating pump suction valve	V17
Open	No.2 FO circulating pump discharge valve	V21
Open	No.1 FO heater inlet valve	V28
Open	No.1 FO heater outlet valve	V29
Closed	No.2 FO heater inlet valve	V24
Closed	No.2 FO heater outlet valve	V25
Open	Viscosity controller inlet valve	V36
Open	Viscosity controller outlet valve	V37
Closed	Viscosity controller bypass valve	V38
Open	Generator engine supply flow meter inlet valve	V213
Open	Generator engine supply flow meter outlet valve	V214
Closed	Generator engine supply flow meter bypass valve	
Open	No.1 generator engine HFO inlet valve	RR78
Closed	No.1 generator engine HFO bypass valve	RR27
Open	No.2 generator engine HFO inlet valve	RR76
Open	No.2 generator engine HFO bypass valve	RR28
Open to HFO	No.2 generator linked three-way inlet and outlet valves	RR24 & RR23
Open	No.3 generator engine HFO inlet valve	RR74
Open	No.3 generator engine HFO bypass valve	RR29
Open to HFO	No.3 generator linked three-way inlet and outlet valves	RR26 & RR25
Open	Generator return flow meter inlet valve	V313
Open	Generator return flow meter outlet valve	V314
Closed	Generator return flow meter bypass valve	
Set to HFO service tank	Fuel oil return three-way valve	RR119

f) Circulate heavy fuel oil until the fuel at the generator engines is at operating temperature.

g) Close No.2 generator fuel oil bypass valve (RR28).

h) Start up No.2 generator engine and ensure that it is running normally.

i) If only one generator is required, transfer electrical load from No.1 generator to No.2 generator.

j) Shut down the No.1 generator engine and change over its fuel supply from marine diesel oil to heavy fuel oil and open the fuel oil bypass valve (RR27). When all of the marine diesel oil has been displaced, supply trace heating steam to the fuel oil lines.

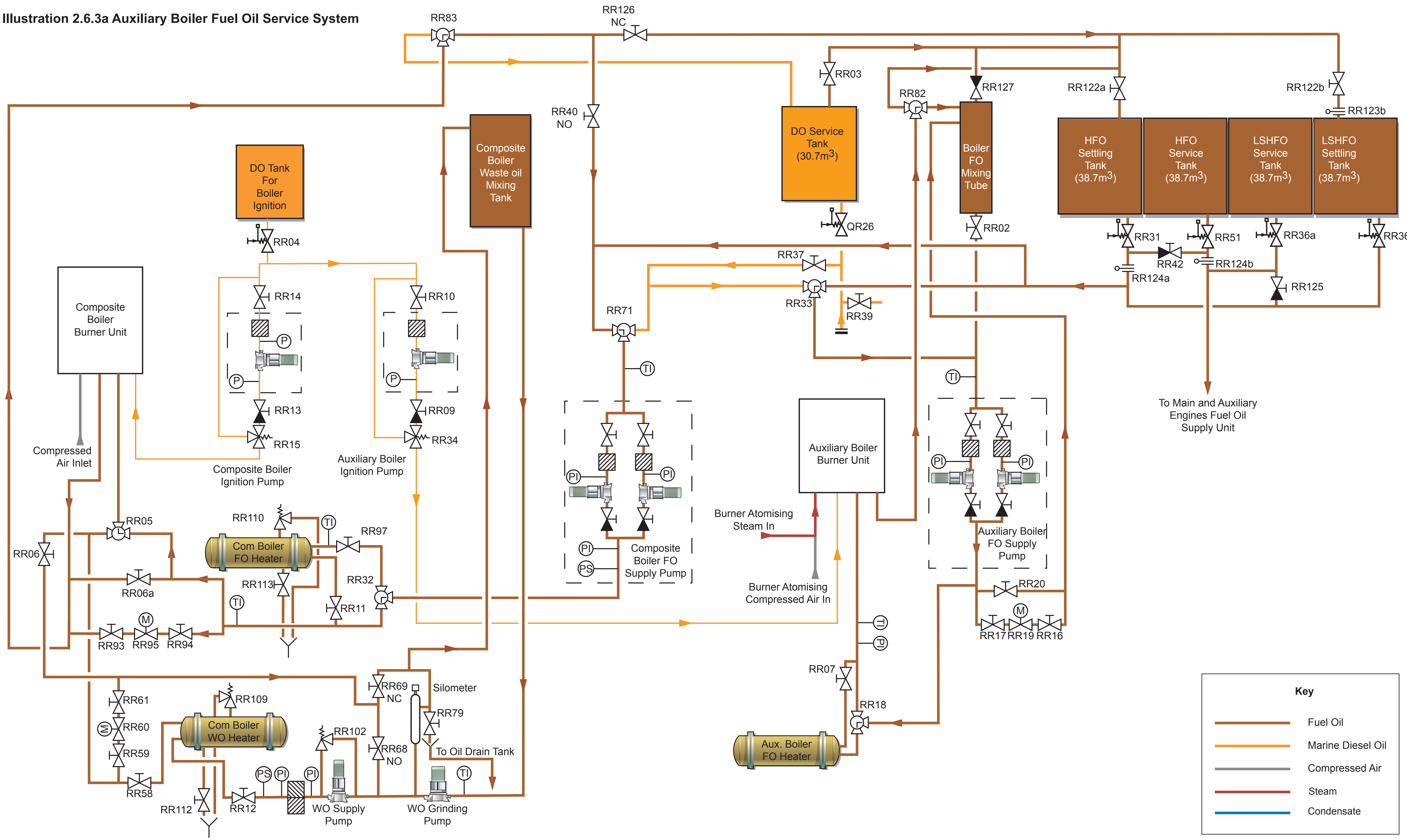
k) Stop the marine diesel oil supply pump.

No.2 generator is operating on heavy fuel oil. The remaining two generators are stopped with heated heavy fuel oil being circulated through them and ready to be started when required.

Fuel Changeover When Generator Engine(s) Are Running

Procedures similar to those used for the main engine may be used, but it is advisable to change over the fuel supply when the engine is running off-load or shut down in order to minimise the risk of instability in the electrical supply.

Illustration 2.6.3a Auxiliary Boiler Fuel Oil Service System



2.6.3 AUXILIARY BOILER FUEL OIL SERVICE SYSTEM

Auxiliary Boiler Fuel Oil Pump

Manufacturer:	Allweiler
Model:	SPZ 20-R46 G8.3 FW8 screw pump
No. of sets:	2
Capacity:	2.15/2.80m^3/h at 4/380cSt

Auxiliary Boiler Ignition Pump

Manufacturer:	Danfoss
Model:	G145 RSA gear pump
No. of sets:	1
Capacity:	61 litres/h

Description

In normal operation fuel oil is supplied to the auxiliary boiler from the heavy fuel oil settling tanks, but may be drawn from the heavy fuel oil service tanks if required.

Diesel oil for firing the boiler from cold, when no steam heating for heavy fuel oil is available, is supplied from the marine diesel oil service tank.

Fuel is supplied to the boiler burner unit by one of the pair of auto duty/standby supply pumps. The discharge header is provided with a fuel oil heater, with a bypass for operation on marine diesel oil together with pressure and temperature monitoring instrumentation.

Pressure in the system is modulated to 2.5MPa by a motorised control valve fitted to the return line to the fuel oil mixing tank. Fuel from the mixing tank is returned to the pump suction header. The mixing tank may be vented to either the heavy fuel oil settling tanks or the marine diesel oil service tank, depending on which type of fuel is being used.

Fuel oil is heated to operational temperature by steam, modulated by a temperature controller. Fuel oil is fed to the boiler via a pressure control valve, controlled by the boiler steam pressure. When the boiler is in a standby condition, a solenoid valve on the return line opens automatically to circulate fuel back to the mixing tank, keeping the fuel oil at working temperature immediately before the burner.

The mixing tank may be bypassed when fuel is required to be circulated through the boiler burner unit, for fuel heating or flushing purposes. In this situation fuel is returned from the burner unit to either the heavy fuel oil settling tanks or marine diesel oil service tank, depending on which fuel is being used.

A steam connection is fitted to the fuel oil line to the burner after the double shut-off solenoid valves, and is used for automatic purging of the burner prior to shutdown.

The auxiliary boiler is provided with an ignition burner pump, supplied from the boiler ignition diesel tank. The ignition burner is only used when lighting the main burner. It is inserted and withdrawn from the furnace by means of a pneumatic cylinder operated by the boiler control system.

The boiler is designed to operate continuously using heavy fuel oil. Marine diesel oil is only required for flushing the fuel system prior to maintenance or extended shutdown periods.

Procedure for Operating the Auxiliary Boiler Fuel Oil System

The following procedure is to prepare the boiler for operation from a cold shutdown condition with the system primed with diesel oil.

a) Ensure that the suction strainers and filters are clean.

b) Ensure that all instrumentation valves are open.

c) Ensure that working air is available for fuel atomisation.

Position the valves as shown in the following table:

Position	Description	Valve
Closed	HFO service tank/settling tank crossover valve	RR42
Closed	HFO settling tank outlet quick-closing valve	RR31
Closed	LSHFO service/settling tank crossover valve	RR125
Closed	LSHFO settling tank outlet quick-closing valve	RR36b
Open	Diesel oil service tank outlet quick-closing valve	QR26
Open	Diesel oil service tank rundown valve to boiler systems	RR37
Set to DO service tank	MDO/HFO three-way rundown valve to auxiliary boiler system	RR33
Open	Composite boiler return to supply pump suction header	RR40
Closed	Composite boiler return to storage tanks	RR126
Open	Mixing tank rundown valve	RR02
Set to mixing tank	Auxiliary boiler fuel returns three-way valve	RR82
Open	Mixing tank vent valve	RR127
Open	Diesel oil service tank return valve	RR03
Open	Auxiliary boiler fuel supply pump suction valves (two)	
Open	Auxiliary boiler fuel supply pump discharge valves (two)	
Set to heater bypass	Fuel header inlet three-way valve	RR18
Closed	Fuel oil heater outlet valve	RR07
Open	Fuel pressure control valve inlet valve	RR17
Operational	Fuel pressure control motorised valve	RR19
Open	Fuel pressure control valve outlet valve	RR16
Closed	Fuel pressure control valve bypass valve	RR20
Open	Boiler ignition diesel oil tank outlet quick-closing valve	RR04
Open	Auxiliary boiler ignition pump suction valve	RR10
Open	Auxiliary boiler ignition pump discharge valve	RR09

d) Refer to Section 2.2.3 of this manual for details of firing the boiler.

Procedure to Change Over the Auxiliary Boiler Fuel Oil System from Marine Diesel Oil to Heavy Fuel Oil

The following procedure assumes that the boiler has been firing on diesel oil, that steam has been raised and heating has been applied to the heavy fuel oil settling tank. Air atomisation is in operation.

a) Open the supply trace heating to the fuel oil service system.

CAUTION

Trace heating should not be applied to sections of pipeline isolated by closed valves on the HFO side as damage could occur due the expansion of the contents.

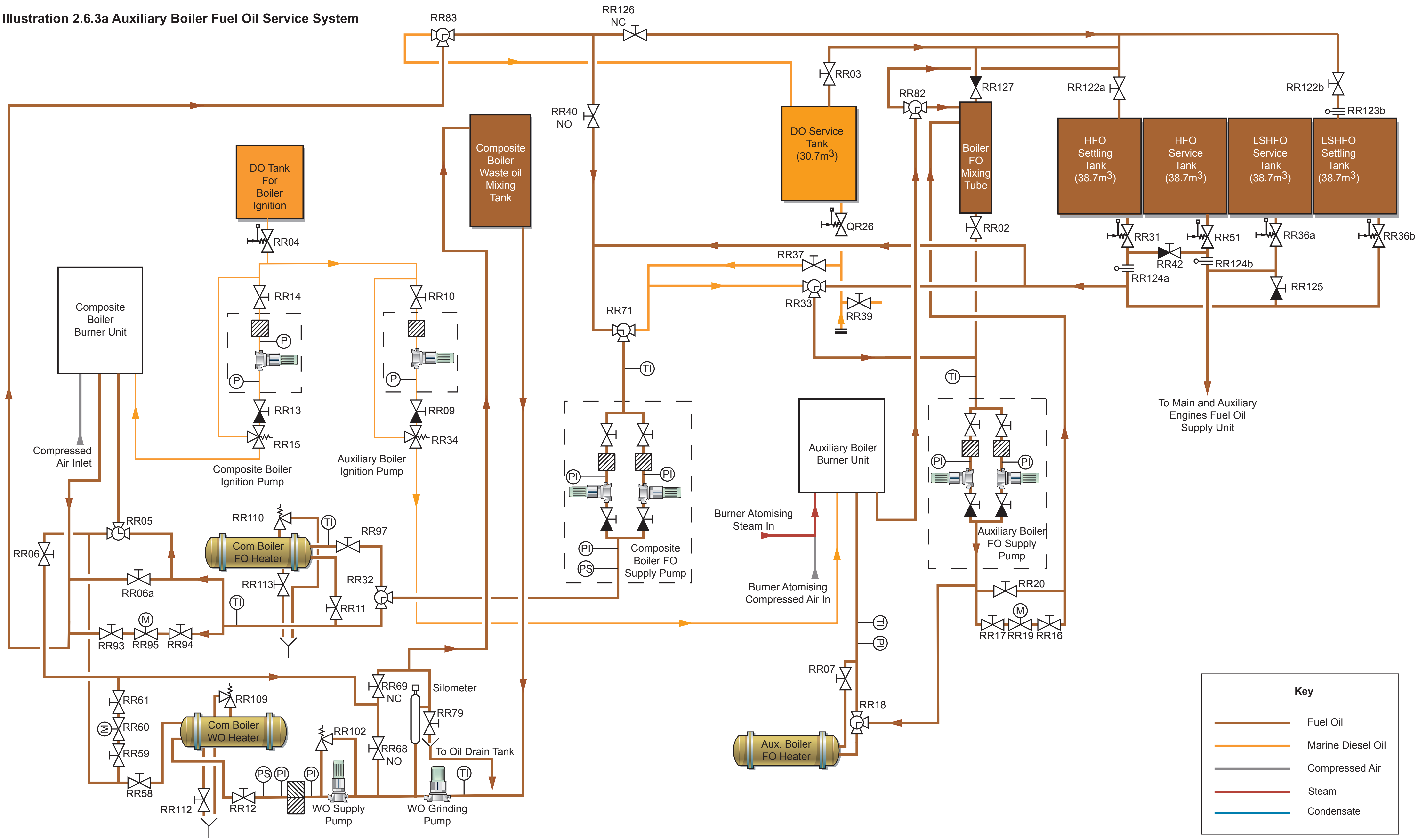
b) Stop firing the boiler on marine diesel oil.

c) Open the heavy fuel oil settling tank quick-closing valve (RR31) and marine diesel oil/heavy fuel oil three-way rundown valve to auxiliary boiler system (RR33).

The microswitch on the changeover cock will now activate the mixing tank three-way direction control valve RR64, directing heavy fuel oil to the mixing tank. On the boiler control board the system indication light will now indicate that the system is operating on heavy fuel oil

d) Open the fuel oil heater outlet valve (RR07).

Illustration 2.6.3a Auxiliary Boiler Fuel Oil Service System



e) Position the fuel header inlet three-way valve to admit heavy fuel oil (RR18).

f) Manually open the steam supply to the fuel oil heater and monitor the fuel temperature.

g) Ignite the boiler and continue firing as required. The marine diesel oil in the fuel line will gradually be replaced by heavy fuel oil. There may be some change in combustion as the heavy fuel oil replaces the diesel oil and the fuel temperature changes.

h) Change over the operation of the heater steam control valve to automatic by fully opening the steam inlet valve.

CAUTION
Do not change to steam atomising until the system is charged with heavy fuel oil and is firing under stable conditions.

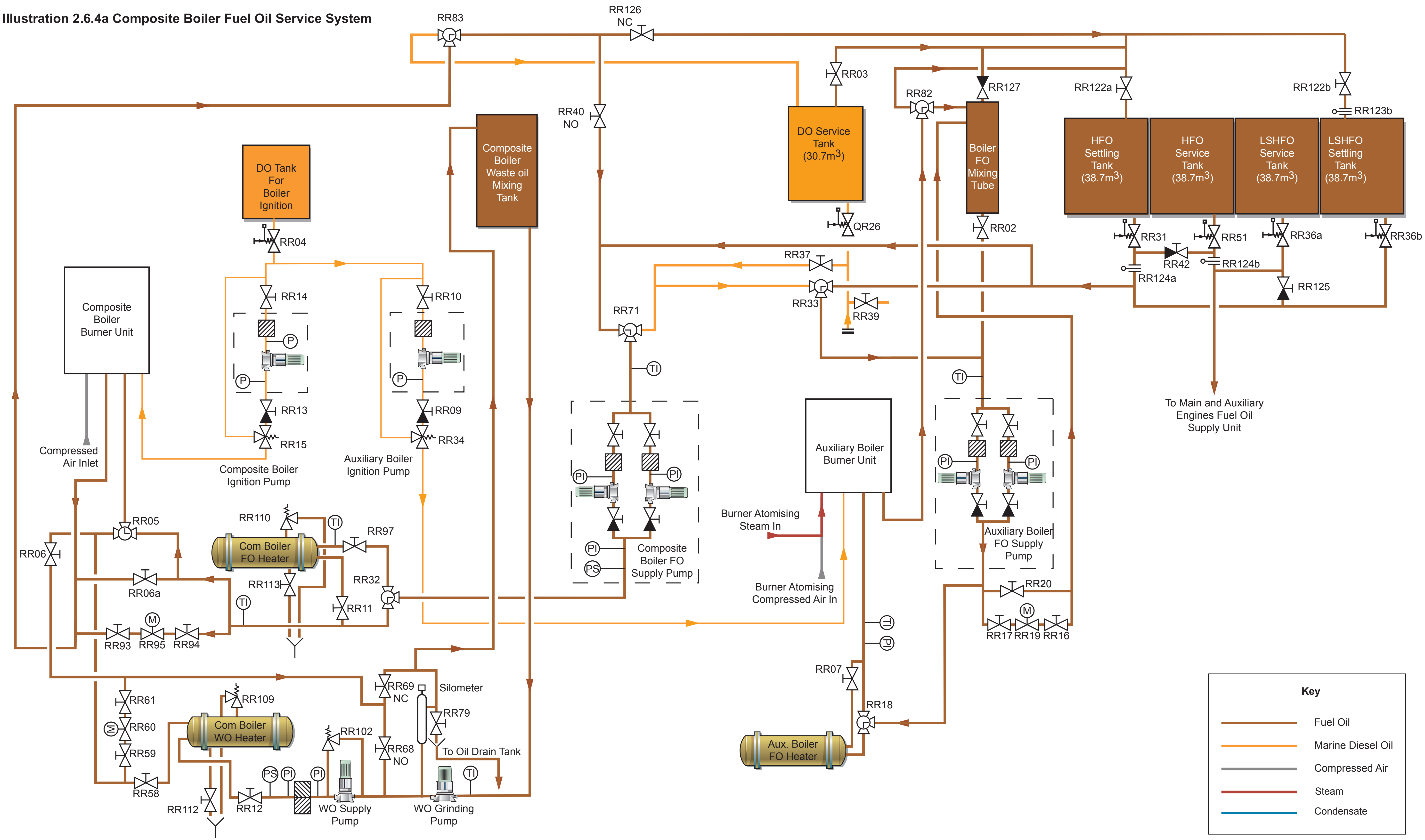
i) Stop firing the boiler and change over to steam atomisation. Open the steam atomising valve on the boiler steam drum and close the air atomising valve.

j) Reignite the boiler burner.

k) Change over the boiler burner to automatic control when the boiler is firing on heavy fuel oil under stable combustion conditions.

l) Put the standby fuel oil supply pump to automatic.

Illustration 2.6.4a Composite Boiler Fuel Oil Service System



2.6.4 COMPOSITE BOILER FUEL OIL SERVICE SYSTEM

Composite Boiler Fuel Oil Supply Pump

Manufacturer:	Allweiler
Model:	ZASV 850 G8.3FW8 screw pump
No. of sets:	2
Capacity (min):	0.96/1.05m^3/h at 4/380cSt
Power:	0.35/0.77kW at 4/380cSt

Composite Boiler Ignition Pump

Manufacturer:	Danfoss
Model:	G145 RSA gear pump
No. of sets:	1
Capacity:	61 litre/h

Composite Boiler Waste Oil Grinding Pump

Manufacturer:	Aalborg Industries
Model:	PU-5 Centrifugal 6mm mill pump
No. of sets:	1
Capacity:	25.9m^3/h

Composite Boiler Waste Oil Pump

Manufacturer:	Aalborg Industries
Model:	ANBP12 eccentric screw
No. of sets:	1
Capacity:	0.7m^3/h

Description

The composite boiler can generate steam utilising heat from the main engine exhaust or by oil-firing using heavy fuel oil, diesel oil or waste oil.

In ‘normal’ operation when raising steam using fuel firing, heavy fuel oil is supplied to the composite boiler from the heavy fuel oil settling tanks.

Diesel oil for firing the boiler from cold, when no steam heating is available for the heavy fuel oil, is supplied from the marine diesel oil service tank.

Waste oil created by vessel operations, comprising drainings from drip trays under various lubricating oil and fuel equipment, engine sumps, separator plant sludge, bilge separator etc, may be pumped to the boiler waste oil tank from where it is introduced into the composite boiler fuel system.

Heavy fuel oil and diesel oil are supplied to the boiler burner unit via a pair of auto duty/standby supply pumps. The discharge header is provided with a fuel oil heater, with a bypass for operation on diesel oil, together with pressure and temperature monitoring instrumentation.

Pressure in the system is modulated by a motorised control valve fitted to the return line, which discharges to the diesel oil service tank or heavy fuel oil settling tank, depending on which fuel is being used.

Heavy fuel oil is heated in the fuel oil heater to operational temperature by steam, modulated by a temperature controller. Fuel oil is fed to the boiler through a pressure control valve, controlled by the boiler steam pressure.

The system incorporates two, mechanically linked three-way valves, fitted at the suction and discharge of the fuel supply pumps. The valves are arranged to ensure that, when lined-up to the diesel oil service tank the fuel oil heater is bypassed, and when lined-up to the settling tanks, fuel will be directed through the heater.

A three-way valve is fitted to the burner unit return line, which can be positioned to direct circulating oil to either the diesel oil service tank or the supply pump suction header.

Waste oil is supplied to the composite boiler burner from the waste oil storage tank via a grinding pump, fitted with a macerator impeller, a transfer pump and a waste oil heater. A pocket tube with silometer, fitted to the discharge side of the grinding pump, monitors the waste oil supply available to the burner. The major part of the waste oil passing through the grinding pump returns to the waste oil tank through the silometer pocket tube, and the water content measured by means of a capacitance probe. The remainder of the waste oil is drawn off by the transfer pump and then passes through the fine filter and waste oil heater before reaching the burner unit. If the pressure drops to a predetermined low level, an alarm will be initiated and the boiler will stop firing on waste oil and change over to fuel oil without interruption.

Pressure in the waste oil system is modulated by a motorised control valve fitted to the return line, which in normal operation is led to the suction side of the transfer pump. As an alternative, return waste oil can be recirculated to the waste oil storage tank.

An air operated, three-way valve is fitted to the inlet of the composite boiler burner unit. This valve is arranged to allow fuel from either the main fuel system or the waste oil system into the burner unit.

The composite boiler is provided with an ignition burner pump, supplied from the boiler ignition diesel tank. The ignition burner is used when lighting the main burner.

Procedure for Operating the Composite Boiler Fuel Oil System

The following procedure is to prepare the boiler for operation from a cold shutdown condition with the system primed with diesel oil and main engine shut down.

a) Ensure that the suction strainers and filters are clean.

b) Ensure that all instrumentation valves are open.

c) Ensure that service air is available for fuel atomisation.

d) Position the valves as shown in the table:

Position	Description	Valve
Closed	HFO service tank/settling tank crossover valve	RR42
Closed	HFO settling tank outlet quick-closing valve	RR31
Closed	LSHFO service/settling tank crossover valve	RR125
Closed	LSHFO settling tank outlet quick-closing valve	RR36B
Open	Diesel oil service tank outlet quick-closing valve	QR26
Open	Diesel oil service tank rundown valve to boiler systems	RR37
Set to DO service tank	MDO/HFO linked, three-way rundown valve to composite boiler system	RR71
Set to heater bypass	MDO/HFO linked, three-way inlet valve to fuel heater header	RR32
Open	Composite boiler fuel supply pump suction valves (two)	
Open	Composite boiler fuel supply pump discharge valves (two)	
Open	HFO heater inlet valve	RR97
Open	HFO heater outlet valve	RR11
Open	Fuel pressure control valve inlet valve	RR94
Operational	Fuel pressure control motorised valve	RR95
Open	Fuel pressure control valve outlet valve	RR93
Closed	Fuel pressure control valve bypass valve	RR06
Open	Boiler ignition diesel oil tank outlet quick-closing valve	RR04
Open	Composite boiler ignition pump suction valve	RR14
Open	Composite boiler ignition pump discharge valve	RR13
Set to MDO/HFO	Composite boiler burner unit three-way inlet valve	RR05
Closed	Waste oil recirculating return valve	RR06

Position	Description	Valve
Set to Diesel oil service tank	Fuel oil returns three-way valve	RR83
Closed	Composite boiler return to storage tanks	RR126
Open	Composite boiler return to supply pump suction header	RR40

e) Refer to Section 2.2.6 of this manual for details of firing the boiler.

Procedure to Change Over the Composite Boiler Fuel Oil System from Marine Diesel Oil to Heavy Fuel Oil

The following procedure assumes that the boiler has been firing on diesel oil, that steam is available from the steam system and heating has been applied to the heavy fuel oil settling tank.

a) Open the supply trace heating to the fuel oil service system.

CAUTION
Trace heating should not be applied to sections of pipeline isolated by closed valves on the HFO side as damage could occur due the expansion of the contents.

b) Stop firing the boiler on marine diesel oil.

c) Open the heavy fuel oil settling tank quick-closing outlet valve (RR31).

d) Close the marine diesel oil service tank rundown valve (RR37).

e) Reposition marine diesel oil/heavy fuel oil three-way rundown valve to composite boiler system to heavy fuel oil settling tanks (RR71). The fuel oil header inlet three-way valve (RR32) will be repositioned to admit fuel to the fuel oil heater.

f) Manually open the steam supply to the fuel oil heater and monitor the fuel temperature.

g) Ignite the boiler and continue firing as required. Marine diesel oil in the fuel line will gradually be replaced by heavy fuel oil.

There may be some change in combustion as the heavy fuel oil replaces the marine diesel oil and the fuel temperature changes.

h) Change over the operation of the heater steam control valve to automatic by fully opening the steam inlet valve.

i) Change over the boiler burner to automatic control when the boiler is firing on heavy fuel oil under stable combustion conditions.

j) Put the standby fuel oil supply pump to automatic.

Procedure to Change Over the Composite Boiler Fuel Oil System from Marine Diesel Oil/Heavy Fuel Oil to Waste Oil

The following procedure assumes that the boiler has been firing on heavy fuel oil or diesel oil, that steam is available from the steam system and heating has been applied to the composite boiler waste oil tank if required.

a) Open the steam supply to the trace heating for the waste oil system.

CAUTION
Trace heating should not be applied to sections of pipeline isolated by closed valves on the HFO side as damage could occur due the expansion of the contents.

b) Ensure that all instrumentation valves are open.

c) Position the valves as shown in the table:

Position	Description	Valve
Open	Composite boiler waste oil tank quick-closing outlet valve	RR01
Open	Waste oil heater inlet valve	RR12
Open	Waste oil heater outlet valve	RR58
Set to waste oil	Composite boiler burner unit three-way inlet valve	RR05
Open	Waste oil recirculating valve	RR06
Open	Waste oil pressure control valve inlet valve	RR59
Operational	Waste oil pressure control motorised valve	RR60
Open	Waste oil pressure control valve outlet valve	RR61
Open	Waste oil return valve to waste oil tank	RR69
Closed	Waste oil recirculating valve to transfer pump suction	RR68
Closed	Silometer vent/test valve	RR79

d) Start the waste oil grinding and transfer pumps.

e) Manually open the steam supply to the waste oil heater and monitor the fuel temperature.

f) Allow waste oil to recirculate back to the waste oil tank until any cold oil has been displaced.

g) Open the waste oil recirculating valve to transfer pump suction (RR68), close return and recirculating valves (RR06 and RR69).

h) Change selector switch from HEAVY to WASTE.

i) Ignite the boiler and continue firing as required.

j) Change over the operation of the heater steam control valve to automatic by fully opening the steam inlet valve.

CAUTION
Monitor combustion conditions closely. Combustion will vary, depending on the mixture of the contents in the waste oil tank.

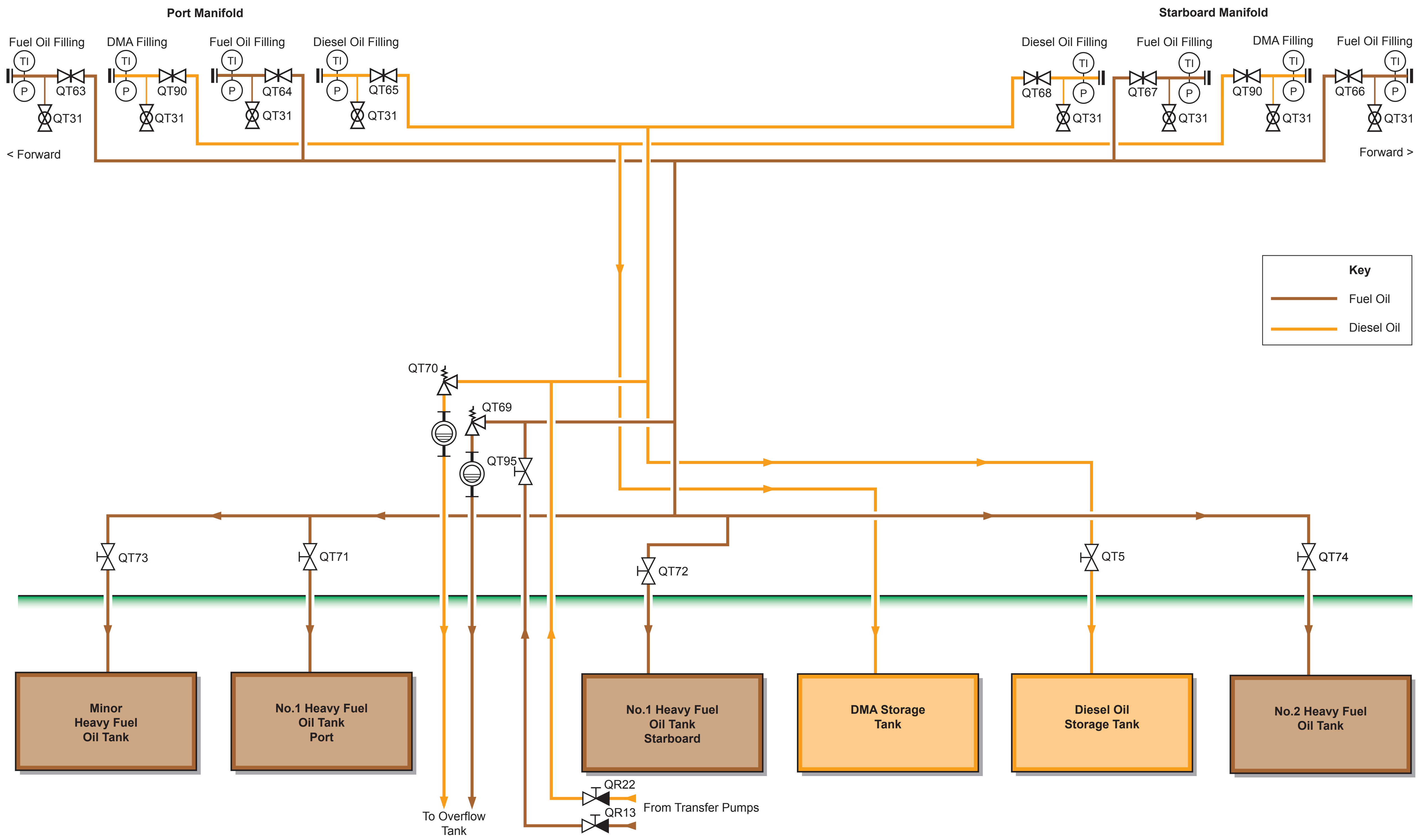
k) Change over the boiler burner to automatic control when the boiler is firing on waste oil under stable combustion conditions.

l) Monitor the level in the waste oil tank and prepare to change back to heavy fuel oil when the tank level is reduced.

Note: The burner will automatically change back to burning heavy fuel oil if the following criteria are met:
1) Waste oil pressure drops below set limit.
2) Water contents of waste oil exceeds set limit.
3) Burner load (compound regulator) is too low.
4) Selector switch is changed from WASTE to HEAVY.

2.7 Fuel Oil and Diesel Oil Transfer Systems

Illustration 2.7.1a Fuel Oil and Diesel Oil Bunkering System



2.7 FUEL OIL AND DIESEL OIL TRANSFER SYSTEMS

2.7.1 FUEL OIL AND DIESEL OIL BUNKERING AND TRANSFER SYSTEM

Heavy Fuel Oil Transfer Pump

Manufacturer: Allweiler GmbH
Model: SNF 940 ER 46 E8.9 W1 DS47A
No. of sets: 1
Capacity: 56m^3/h at 0.40MPa
Rating: 440V, 20.3kW at 1,750 rpm

Diesel Oil Transfer Pump

Manufacturer: Allweiler GmbH
Model: SNF 940 ER 46 E8.9 W1 DS47A
No. of sets: 1
Capacity: 56m^3/h at 0.40MPa
Rating: 440V, 20.3kW at 1,750 rpm

Introduction

Heavy Fuel Oil (HFO) and Low Sulphur Heavy Fuel Oil (LSHFO) for all on board purposes, is stored in four HFO bunker tanks at the forward end of the engine room. From the bunker tanks the oil is transferred to the HFO and LSHFO settling tanks where it is allowed to settle prior to being purified into the HFO and LSHFO service tanks. HFO is supplied to the main engine, generator engines and boilers from these service tanks. The HFO bunker tanks and DO storage tanks are filled from bunkering lines located at the cargo manifolds on the port and starboard sides of the ship. DO is stored in one storage tank on the starboard side. DMA oil for the hydraulic power pack engine is stored in a separate tank, also on the starboard side. There are two HFO bunkering connections on each side of the vessel, forward and aft of the manifold. There is one DO connection, together with the DMA oil filling connection, on each side at the aft end of the manifold. Sampling valves are fitted at each bunker pipe connection point before the bunkering manifold valve on each pipe. The bunkering lines are fitted with relief valves set at 0.45MPa, which discharge into the FO overflow tank.

There is one HFO transfer pump which is used to transfer HFO from the bunker tanks to the HFO settling tank, or for transferring HFO between bunker tanks at a maximum rate of 56m^3/h and a pressure of 0.4MPa. The diesel oil (DO) transfer pump of capacity 56m^3/h and a pressure of 0.4MPa is dedicated to the transfer of DO from the DO storage tanks to the DO service tank. In the event of failure of either pump the other may be used, provided that the two crossover blanks are swung into the open position.

The HFO transfer pump is started and stopped automatically by means of level switches on the HFO settling tank. The DO transfer pump is started and stopped manually depending on the demand at the DO service tank. HFO is transferred to the HFO service tank by the HFO separators.

A FO overflow tank of 17.7m^3 capacity is provided and is designed to collect any overflow from the HFO settling tanks in the event of overfill. The DO and HFO bunker line relief also drain to this tank. The tank is fitted with high and high-high level alarms to warn of excess level in the tank. The HFO transfer pump is used to pump the contents of the overflow tank to the HFO bunker or settling tanks.

Fuel oil can be transferred from one bunker tank to another for trim or other purposes, using the transfer pump and the bunkering line.

The outlet valves from the fuel tanks are all remote operated quick-closing valves with a collapsible bridge which are pneumatically operated from the 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 and drain any water present. Tundishes under these test cocks drain any liquid to the FO drain tank.

All of the tanks are provided with local temperature gauges, but in addition, remote level indicators are available on the ship's control centre (SCC) workstation PC.

All HFO tanks are fitted with heating coils, the heating steam being supplied at 0.7MPa from the steam system. Condensate from the heating coils flows to the atmospheric condenser and then to the cascade tank via an oil detector and observation tank. All HFO transfer lines are trace heated by steam also at 0.7MPa.

Fuel Oil System Tanks

Tank	Capacity (m^3)
No.1 Heavy Fuel Oil Tank (port)	558.2
No.1 Heavy Fuel Oil Tank (starboard)	519.6
No.2 Heavy Fuel Oil Tank (starboard)	121.3
Heavy Fuel Oil Minor Tank	124.9
Heavy Fuel Oil Settling Tank	38.7
Heavy Fuel Oil Service Tank	38.7
Low Sulphur Heavy Fuel Oil Settling Tank	38.7
Low Sulphur Heavy Fuel Oil Service Tank	38.7
Fuel Oil Overflow Tank	17.7
Fuel Oil Drain Tank	3.4

Note: All bunkering and transfer operations are to be carried out with due regard to Company policy and requirements.

Preparation and Procedure for the Loading and Transfer of Bunkers

Prior to bunkering, the Chief Engineer should confirm that the specification of the fuel oil being delivered is the same as that ordered, and that the quantity being supplied is also that which was requested. Before and during bunkering, the following steps should be complied with:

a) The purpose of this procedure is to ensure that bunkers of the correct specification and quantity are received on board in a safe and efficient manner, which minimises the risk of pollution.

b) Shore and barge tanks should be checked for water content.

c) Representative samples are to be drawn using the continuous drip method for the duration of the loading operation and they are to be immediately dispatched for laboratory analysis.

d) Where possible, new bunkers are to be segregated on board prior to use until results of the laboratory analysis are received.

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/soundings, prior to the starting of loading.

g) HFO storage tanks should not exceed 95% full and all bunker tank high level alarms should be function tested prior to bunkering and kept operational at all times.

h) Any bunker barges attending the vessel are to be safely moored alongside before any part of the bunker loading operation begins.

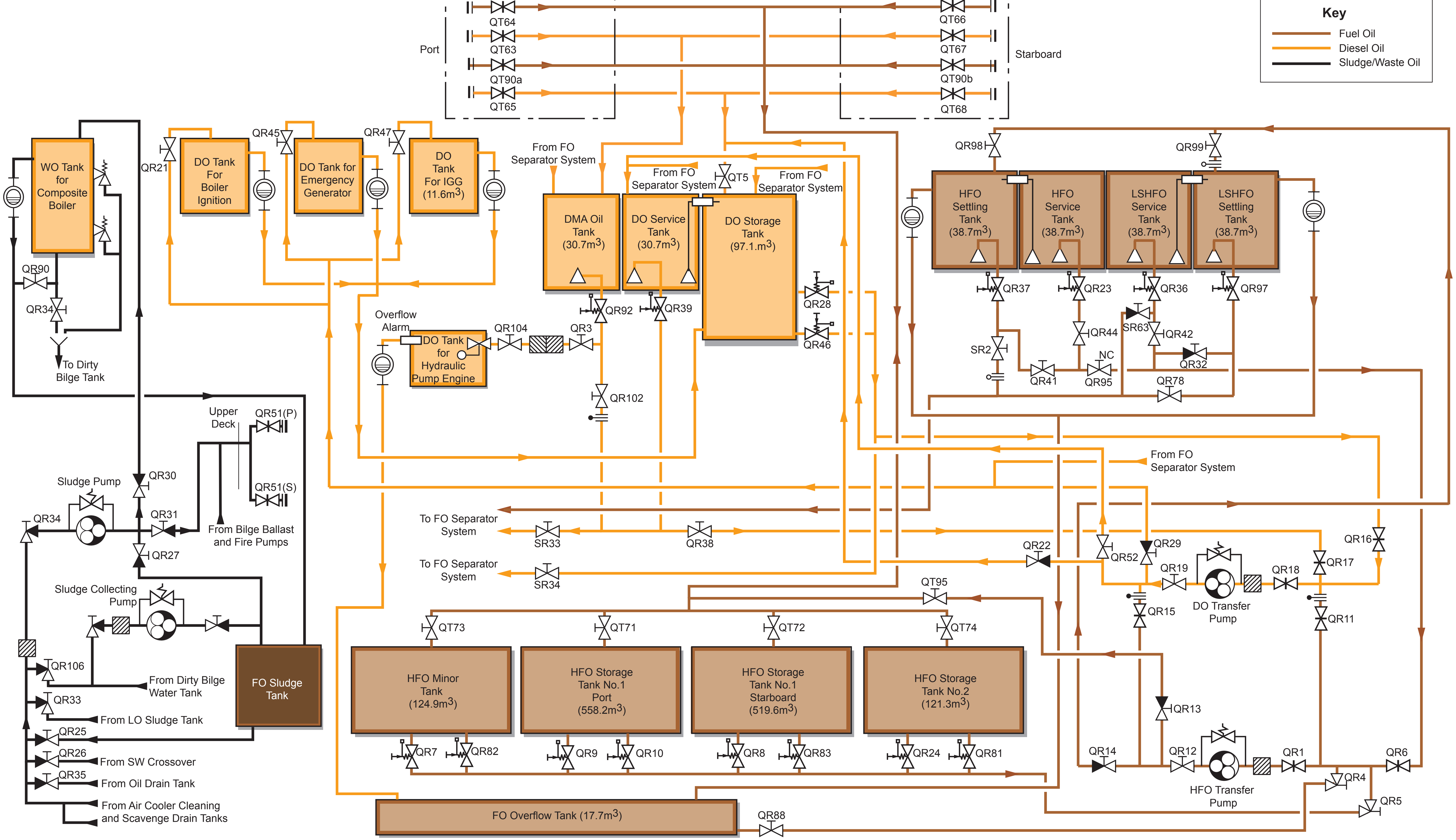
i) The FO overflow tank should be empty prior to commencing bunker operations.

j) Verify that all lines are sound, by visual inspection.

k) Complete the pre-transfer checklist.

l) All personnel involved should be aware of the contents of the Chief Engineer's bunker loading plan.

Illustration 2.7.1b Fuel and Diesel Oil Transfer System



m) 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.

n) A watch for signs of leakage should be kept at the manifold during loading.

o) All personnel involved should be in radio contact, the radios being tested prior to the bunkering operation.

p) The maximum pressure in the bunker line should be below 0.4MPa, well below the point the line relief valve will discharge to FO overflow tank.

q) Safe means of access to barges/shore shall be used at all times.

r) Scuppers and save-alls (including those around bunker tank vents) should be effectively plugged.

s) Drip trays are provided at bunker hose connections.

t) Oil spill containment and clean-up equipment must be deployed and ready for use.

u) Loading should start at the agreed minimum loading rate. Only upon confirmation of no leakage and fuel going only into the nominated tanks, should the loading rate be increased.

v) When topping-off, the flow of oil to the tank in question should be reduced by diverting the flow of oil to another tank. In the case of the final tank, the loading rate should be reduced to the agreed minimum at least 20 minutes before the finishing ullage is reached.

w) Prior to bunkering, the operation must be discussed by the ship's management team where any matters which are likely to interfere with the bunkering operation should be raised. All shipboard personnel must be made aware that bunkering is to take place.

CAUTION
At least one bunker tank filling valve must be fully open at all times during the bunkering operation.

All relevant information is to be entered in the Oil Record Book on completion of the bunkering operation.

Procedure to Load Bunkers from Shore/Barge

a) At the bunker connection to be used, remove the blank and connect the bunkering hose. Ensure that the joint being used is in good condition.

b) Ensure that the blanks on the other bunkering connections are secure and that the valves are closed, with drain and sampling valves closed and that the drip tray is empty and drain closed.

c) Open the required tank filling valve:

Description	Valve
No.1 HFO tank port	QT71
No.1 HFO tank starboard	QT72
No.2 HFO tank starboard	QT74
HFO minor tank	QT73

d) Open the valve at the selected bunkering connection at the cargo manifold:

Description	Valve
Manifold port forward	QT63
Manifold port aft	QT64
Manifold starboard forward	QT66
Manifold starboard aft	QT67

e) Establish effective communication between the control room and the bunker barge or bunkering shore station.

f) Signal to the bunker barge or shore station to commence bunkering fuel oil at an agreed slow rate.

g) Check the ship to barge or shore connection and entire pipeline for leaks.

h) Check that fuel oil is flowing into the required HFO bunker tank(s), and not to any other tank. Check that the drip sampler unit is operating at the required rate.

i) Increase bunkering to the agreed maximum rate.

j) As the level in the first fuel oil bunker tank approaches 90%, first open another tank filling valve (if not already open), then close in the filling valve to top-up the first tank slowly, then close the filling valve completely when the required level is reached. Always ensure another bunker tank filling valve is open before closing in to top a tank off.

k) Repeat the above until only two tanks remain open, then signal to bunker barge/shore to reduce the pumping rate.

l) When filling the final tank, signal a further flow reduction until the tank is at the required level and then signal to stop.

m) Once the supplier has agreed that it is safe to do so, close the valve at the bunkering connection, then open the vent and allow the hose to drain back to the supplier.

n) Once the supplier has agreed that it is safe to do so, disconnect the hose connection and replace the blank.

o) Close the tank filling valves.

p) Collect and label samples and send ashore for laboratory testing.

q) When the oil bunkering is completed, close all valves and record the transfer in the Oil Record Book.

Procedure for the Transfer of Heavy Fuel Oil from the Bunker Tanks to the Settling Tank Using the Heavy Fuel Oil Transfer Pump

Under normal circumstances the HFO transfer pump is set to automatic operation to fill the HFO settling tank. The pump is started and stopped by float switches in the tank. Pump and line valves will be set to allow for automatic operation. The duty engineer must ensure that there is sufficient HFO in the operating HFO bunker tank when the vessel is operating in UMS mode. If there is insufficient HFO the engineer must be prepared to change over HFO bunker tanks. The procedure below is for transfer of HFO to the HFO settling tank with the transfer pump switched for manual operation:

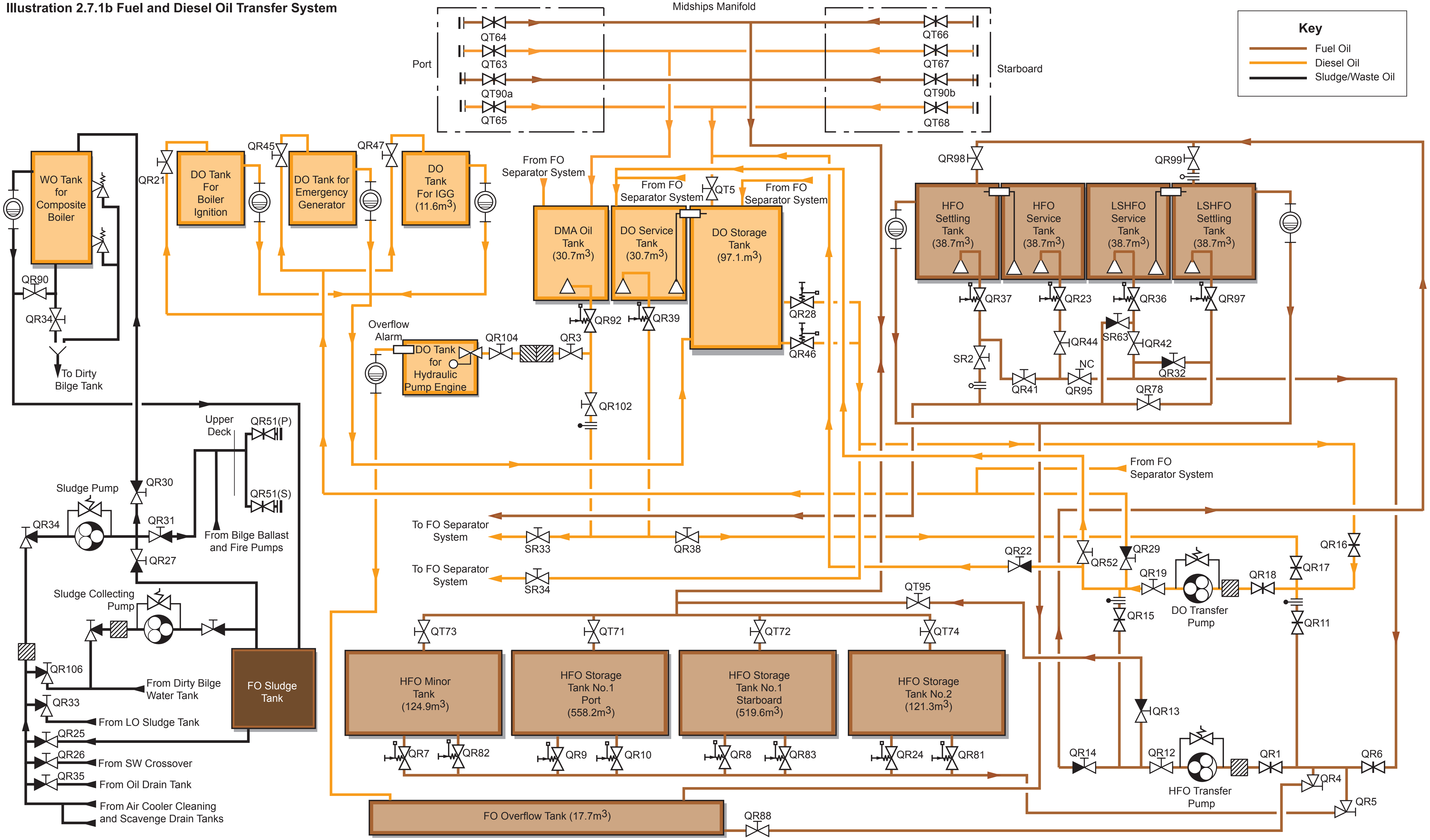
a) Check the levels in the tanks from which oil is to be taken and transferred and calculate the amount to be transferred.

b) Open the suction valves from the bunker tank as required:

Description	Valve
No.1 HFO tank port	QR9
No.1 HFO tank starboard	QR8
No.2 HFO tank starboard	QR24
HFO minor tank	QR7

c) Set the remaining HFO transfer system valves as shown in the following table:

Illustration 2.7.1b Fuel and Diesel Oil Transfer System



Position	Description	Valve
Closed	DO/HFO transfer pumps suction crossover valve	QR11
Closed	DO/HFO transfer pumps discharge crossover valve	QR15
Closed	HFO transfer pump discharge valve to bunker manifold	QR13
Closed	FO overflow tank suction valve	QR88
Closed	LSHFO settling tank inlet valve	QR99
Closed	HFO transfer pump suction valve from settling tanks	QR95
Closed	HFO transfer pump suction valve from FO overflow tank	QR4
Open	HFO settling tank inlet valve	QR98
Open	HFO transfer pump suction valve from bunker tanks	QR5
Open	HFO transfer pump suction valve	QR1
Open	HFO transfer pump discharge valve	QR12
Open	HFO transfer pump discharge valve to settling tanks	QR14

d) Start the heavy fuel oil transfer pump manually at the local control panel.

e) Check that fuel oil is being correctly transferred.

f) Stop the pump when the required amount of oil has been transferred.

g) Close all valves at the end of the operation.

Under normal operation the transfer pump will remain lined-up to the settling tank and for automatic operation at the pump controller.

Procedure for the Transfer of Heavy Fuel Oil Between the Bunker Tanks

HFO may be transferred between bunker tanks if required in order to adjust the trim of the vessel. The procedure is similar to that for manual transfer of HFO from bunker tanks to the HFO settling tank.

The following procedure assumes the HFO is to be transferred from No.1 HFO port bunker tank to No.1 starboard HFO bunker tank using the heavy fuel oil transfer pump:

a) Set the valves as shown in the following table:

Position	Description	Valve
Closed	DO/HFO transfer pumps suction crossover valve	QR11
Closed	DO/HFO transfer pumps discharge crossover valve	QR15
Open	HFO transfer pump discharge valve to deck bunker line	QR13
Open	Cross-connection valve from HO transfer line to deck bunker line	QT95
Closed	FO overflow tank suction valve	QR88
Closed	HFO transfer pump discharge valve to settling tank	QR14
Closed	HFO transfer pump suction valve from settling tanks	QR95
Closed	HFO transfer pump suction valve from FO overflow tank	QR4
Closed	Bunker manifold valve, port forward	QT63
Closed	Bunker manifold valve, port aft	QT64
Closed	Bunker manifold valve, starboard forward	QT66
Closed	Bunker manifold valve, starboard aft	QT67
Closed	No.1 HFO tank port filling valve	QT71
Open	No.1 HFO tank starboard filling valve	QT72
Closed	No.2 HFO tank starboard filling valve	QT74
Closed	HFO minor tank filling valve	QT73
Open	No.1 HFO tank port suction valve	QR9
Closed	No.1 HFO tank starboard suction valve	QR8
Closed	No.2 HFO tank starboard suction valve	QR24
Closed	HFO minor tank suction valve	QR7
Open	HFO transfer pump suction valve from bunker tanks	QR5
Open	HFO transfer pump suction valve	QR1
Open	HFO transfer pump discharge valve	QR12
Open	HFO transfer pump discharge valve to bunker manifold	QR13

b) Check that all other bunker line valves are closed and that the blanks are securely attached at the bunker station.

c) Determine how much HFO is to be transferred.

d) Start the HFO transfer pump manually and check that HFO is being pumped between the correct bunker tanks.

e) When the desired amount of HFO has been transferred, stop the HFO transfer pump, close all valves associated with the transfer and complete the Oil Record Book.

Diesel Oil System

There is one diesel oil (DO) storage tank and one DO service tank. The DO is transferred from one to the other using the DO transfer pump. Additionally, there are four further small storage tanks for the inert gas generator, boiler and the emergency diesel generator. The DO storage tank is filled from a dedicated DO bunkering line located at the cargo manifolds on the port and starboard sides of the vessel. The bunkering line is fitted with a relief valve set at 0.45MPa and discharges into the FO overflow tank. The DO transfer pump is used to transfer oil from the storage tank to the service tank at a rate of 56m^3/h and a pressure of 0.4MPa. The pump is started and stopped manually. The inert gas generator, boiler and emergency generator diesel oil tanks are normally filled using the DO purifier, however, it is possible to fill the tanks with the transfer pump if required

There is a further storage tank for DMA oil used by the diesel-driven hydraulic power pack, together with a small gravity filled daily use fuel tank. The DMA storage tank is filled from a dedicated DMA bunkering line located at the cargo manifolds on the port and starboard sides of the vessel. If required, the daily tank may be filled by running oil down from the DO service tank.

Diesel Oil System Tanks

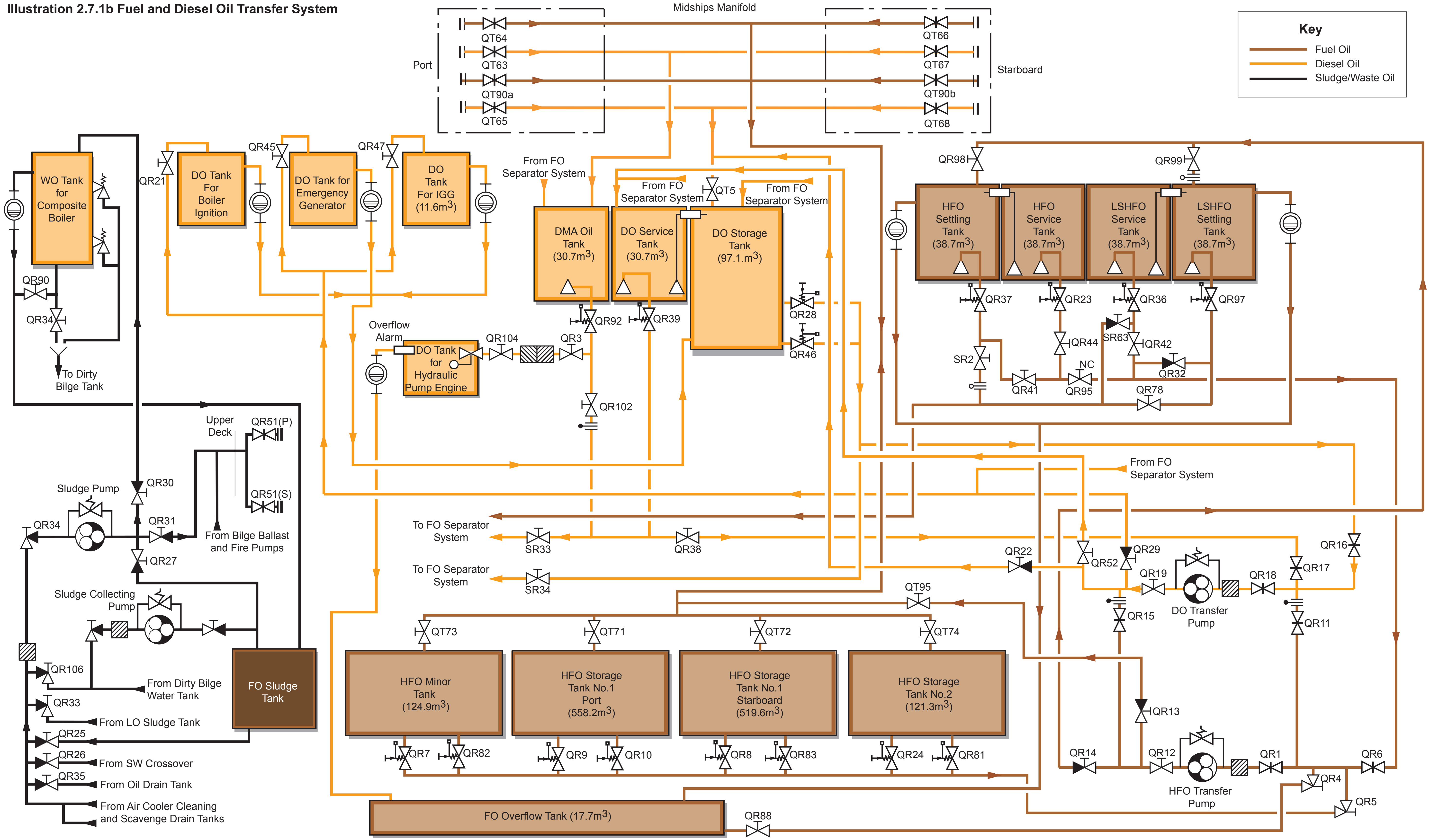
Tank	Capacities (m^3)
DO storage tank	97.1
DO service tank	30.7
Inert gas generator diesel tank	11.6
Boiler ignition diesel oil tank	0.5
Emergency diesel generator diesel oil tank	1.4
DMA oil storage tank	30.7
DMA oil daily tank	0.5

All of the outlet valves on the diesel tanks are remotely operated quick-closing valves with a collapsible bridge which are pneumatically operated from the fire control station. After being tripped from the fire control station the valves must be reset locally. The emergency diesel generator diesel oil tank quick-closing valve is operated by a remote wire located outside the emergency diesel generator room on ‘A’ deck. The service tank is 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 FO drain tank. The storage and service tanks are provided with local level indication, plus remote level/capacity indication.

Preparation for the Bunkering of Diesel Oil

The procedures for bunkering DO are as described for HFO.

Illustration 2.7.1b Fuel and Diesel Oil Transfer System



Procedure to Load Bunkers from Shore/Barge

a) At the bunker connection to be used, remove the blank and connect the bunkering hose. Ensure that the joint being used is in good condition.

b) Ensure that the blanks on the other bunkering connections are secure and that the valves are closed, with drain and sampling valves closed and that the drip tray is empty and drain closed.

c) Set the system valves as per the following table for diesel oil:

Position	Description	Valve
Open	DO storage tank filling valve	QT5
Open	Bunker manifold, port	QT65
Closed	Bunker manifold, starboard	QT68
Closed	DO transfer pump discharge valve to manifold	QR22

d) Set the system valves as per the following table for DMA oil:

Position	Description	Valve
Open	Bunker manifold, port	QT90a
Closed	Bunker manifold, starboard	QT90b

e) Establish effective communication between the control room and the bunker barge or bunkering shore station, then signal to the bunker barge or shore station to commence bunkering diesel oil at an agreed slow rate.

f) Check the ship to barge or shore connection and entire pipeline for leaks.

g) Check that fuel oil is flowing into the required DO storage tank(s), and not to any other tank. Check that the drip sampler unit is operating at the required rate.

h) Increase bunkering to the agreed maximum rate.

i) As the level in the first storage tank approaches 90%, first open another tank filling valve (if not already open), then close in the filling valve to top-up the first tank slowly, then close the filling valve completely when the required level is reached. Always ensure the other tank filling valve is open before closing in to top a tank off.

j) When filling the final tank, signal a flow reduction until the tank is at the required level and then signal to stop.

k) Once the supplier has agreed that it is safe to do so, close the valve at the bunkering connection, then open the vent and allow the hose to drain back to the supplier.

l) Once the supplier has agreed that it is safe to do so, disconnect the hose connection and replace the blank. Close the tank filling valves.

m) Collect and label samples and send ashore for laboratory testing. When the oil bunkering is completed, close all valves and record the transfer in the Oil Record Book.

Failure of a Transfer Pump

Should either the DO or HFO transfer pump fail, the other may be used to complete the duties of the failed pump. To achieve this, the suction and discharge crossover blanks should be opened and the crossover valves QR11 and QR15 opened.

The damaged pump should then be isolated and the transfer operation started using the serviceable pump, with extra checks on system valves to ensure that no cross-contamination occurs. In either case, the transfer must be completed manually. Once repairs have been completed, the system can be returned to normal, with special care to ensure that no HFO is passed into the MDO system. Temporary discharge of DO to the HFO system is preferable to any HFO entering the MDO system.

Emergency Generator, Inert Gas Generator and Boiler Diesel Oil Systems

The emergency generator engine uses DO which is stored in the emergency diesel generator oil storage tank. The tank has a capacity of $1.4m^3$ which is sufficient for at least 24 hours full load running of the emergency diesel generator engine ($0.7m^3$ = 18 hours). The boilers have a dedicated diesel oil tank for the ignition burners of $0.5m^3$ capacity and the inert gas generator has a fuel tank of $11.6m^3$. The DO separator is normally used to transfer DO from the DO storage tank to the boiler, inert gas generator and emergency generator DO tanks. These tanks overflow directly back to the DO storage tank if overfilled.

Procedure for Transferring Diesel Oil to the Emergency Diesel Generator Service Tank

Before this procedure is carried out, the DO purifier must be isolated and stopped if necessary:

a) Check the level of oil in the emergency generator engine DO tank and determine how much DO is to be transferred.

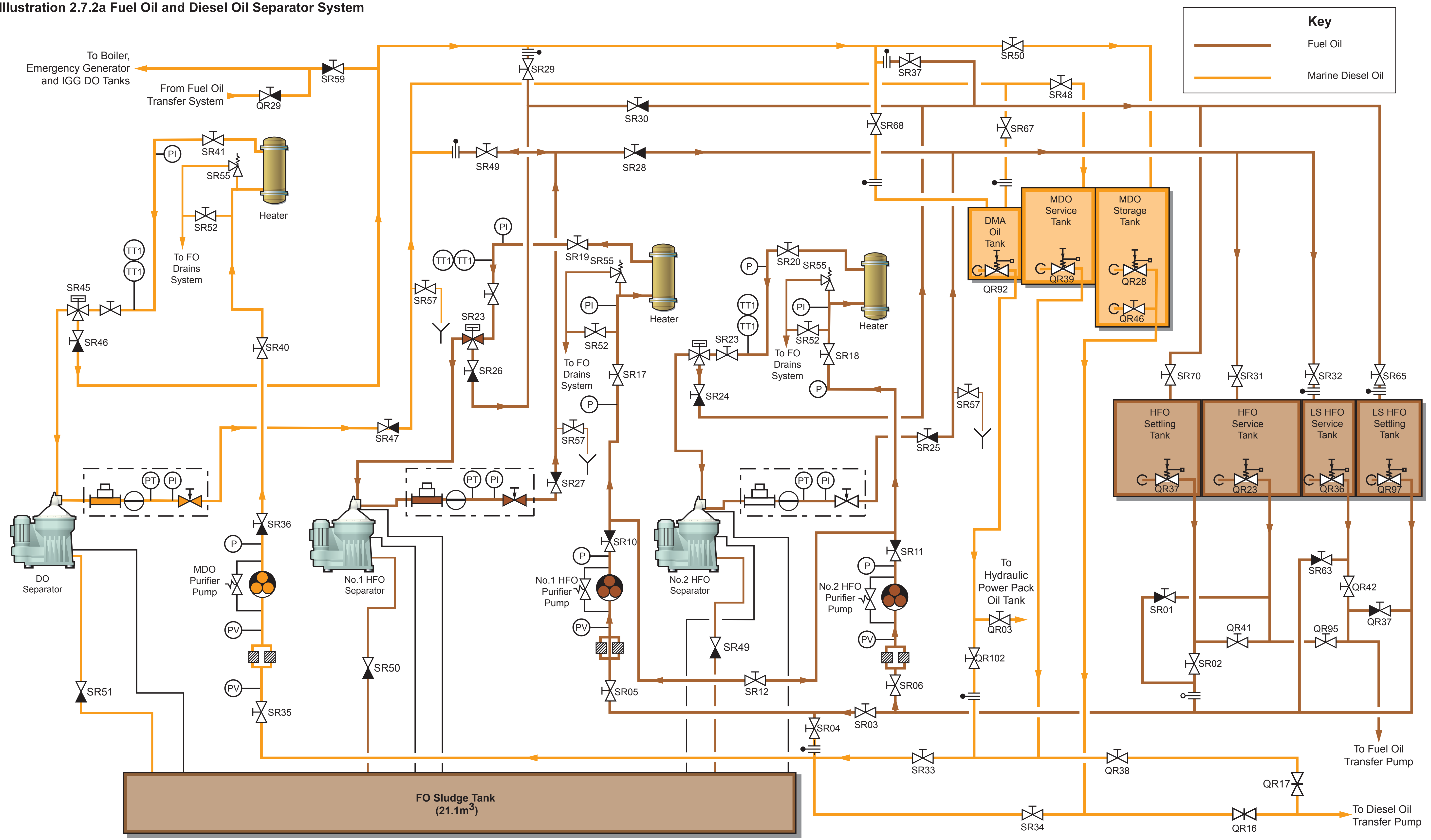
b) Set the valves as per the following table:

Position	Description	Valve
Closed	Line valve to bunkering manifold	QR22
Closed	HFO crossover suction valve	QR11
Closed	HFO crossover discharge valve	QR15
Closed	Line valve from DO storage tank	QR16
Closed	Line valve to FO separator system	SR33
Closed	DMA oil tank crossover to DO system	QR102
Open	DO service tank outlet valve	QR39
Open	In-line isolation valve from DO service tank	QR38
Open	DO transfer pump suction valve	QR18
Open	DO transfer pump discharge valve	QR19
Open	Line valve to DO tanks	QR29
Open	Emergency generator DO tank inlet valve	QR45
Closed	Boiler ignition DO tank inlet valve	QR21
Closed	Inert gas generator DO tank inlet valve	QR47

c) Start the DO transfer pump.

d) Stop the DO transfer pump when the required amount of DO has been transferred and complete the Oil Record Book.

Illustration 2.7.2a Fuel Oil and Diesel Oil Separator System



2.7.2 FUEL OIL AND DIESEL OIL SEPARATOR SYSTEM

Fuel Oil Separators

Manufacturer:	Westfalia
No. of sets:	3
Capacity:	$1.8m^3/h$
Model:	OSD18-0136-067 design 15
Motor:	440V, 5.5kW at 3,600 rpm
Bowl speed:	9,600 rpm
Separating temperature:	98°C
Control panel:	Simatic C7-623

Fuel Oil Separator Pumps

Manufacturer:	Rickmeier
No. of sets:	2
Model:	R35/25 FL-DBI-G
Capacity:	$2.31m^3/h$ at 0.20MPa
Motor:	440V, 1.3kW at 3,600 rpm

Introduction

The HFO separation system incorporates two centrifugal separators with a further identical unit provided for DO purification. Under normal circumstances, one separator will be operating to fill the HFO service tank from the HFO settling tank as fuel is consumed by the main and generator engines. The DO separator will be used intermittently to refill the DO service tank.

All three FO separation systems are identical and comprise a centrifugal separator with its own dedicated supply feed pump and heater with a common sludge tank being provided for the separator system. The separators have a maximum throughput of $1.8m^3/h$ and the supply pumps are rated at $2.31m^3/h$ at 0.20MPa.

The separators are of the self-cleaning type and the bowls automatically open to discharge sludge at timed intervals.

Centrifugal separation is improved when the difference in relative density between the fuel, water and solids in the fuel are as great as possible and the difference in relative densities can be increased if the temperature of the fuel being treated is raised. Manufacturer's recommendations with respect to operating temperatures should always be followed. The temperature of the fuel flowing to the separators can be adjusted by the thermostat control on the purifier control panel.

Separator Operation

WARNING

Care must be taken when operating the separator 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.

CAUTION

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 may result in disintegration at high rotational speed. All operating and maintenance precautions stipulated by the manufacturer in the maintenance manual must be observed.

Liquid mixtures and solid/liquid mixtures may be separated by two methods, the gravity field of a settling tank or the centrifugal field of a separator bowl. Both systems rely on the product components having different densities. Since the centrifugal force of a separator is considerably more effective than the gravity field of a settling tank, it is usual practice to favour the centrifugal force method. The heated dirty oil enters the separator and the centrifugal force created by the rotating bowl causes the liquid mixture to separate into its different constituents within the disc stack.

The solid particles suspended in the oil settle on the underside of the discs and slide down into the solid holding space. The smooth disc surfaces allow the solids to slide down and provides self-cleaning of the discs. Each bowl assembly is fitted with a separating disc which can be configured in order for the separator to act as either a clarifier or a separator. There are two locations in the separating disc in which threaded pins can be inserted. When they are in place the unit acts as a clarifier and when they are removed the unit acts as a separator.

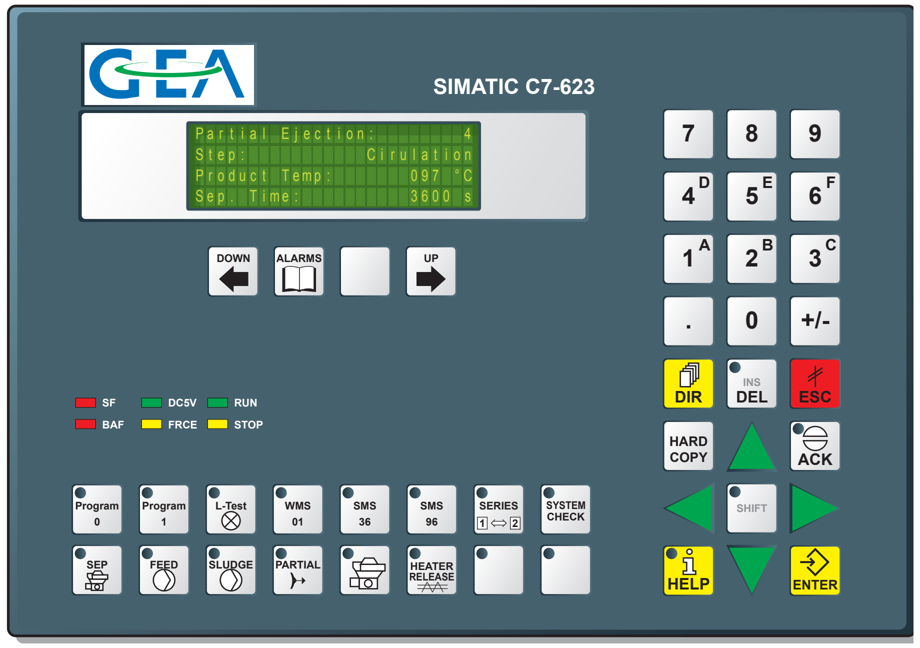
Being of the self-cleaning type, the accumulation of solids within the holding space will be ejected at predetermined intervals depending on the quality of the oil. This is achieved automatically by the control panel and a number of solenoid valves which will bypass the oil supply and open the bowl for a set period of time by the use of high pressure water.

Control Panel

The C7-623 control unit shown in illustration 2.7.2b is used for the automatic ejection control and condition monitoring of the FO separator. The control unit has three modes of operation:

1) Partial ejections
2) Total ejections
3) Pre-selected partial ejections followed by total ejection

Illustration 2.7.2b Fuel and Diesel Oil Separator Control Panel



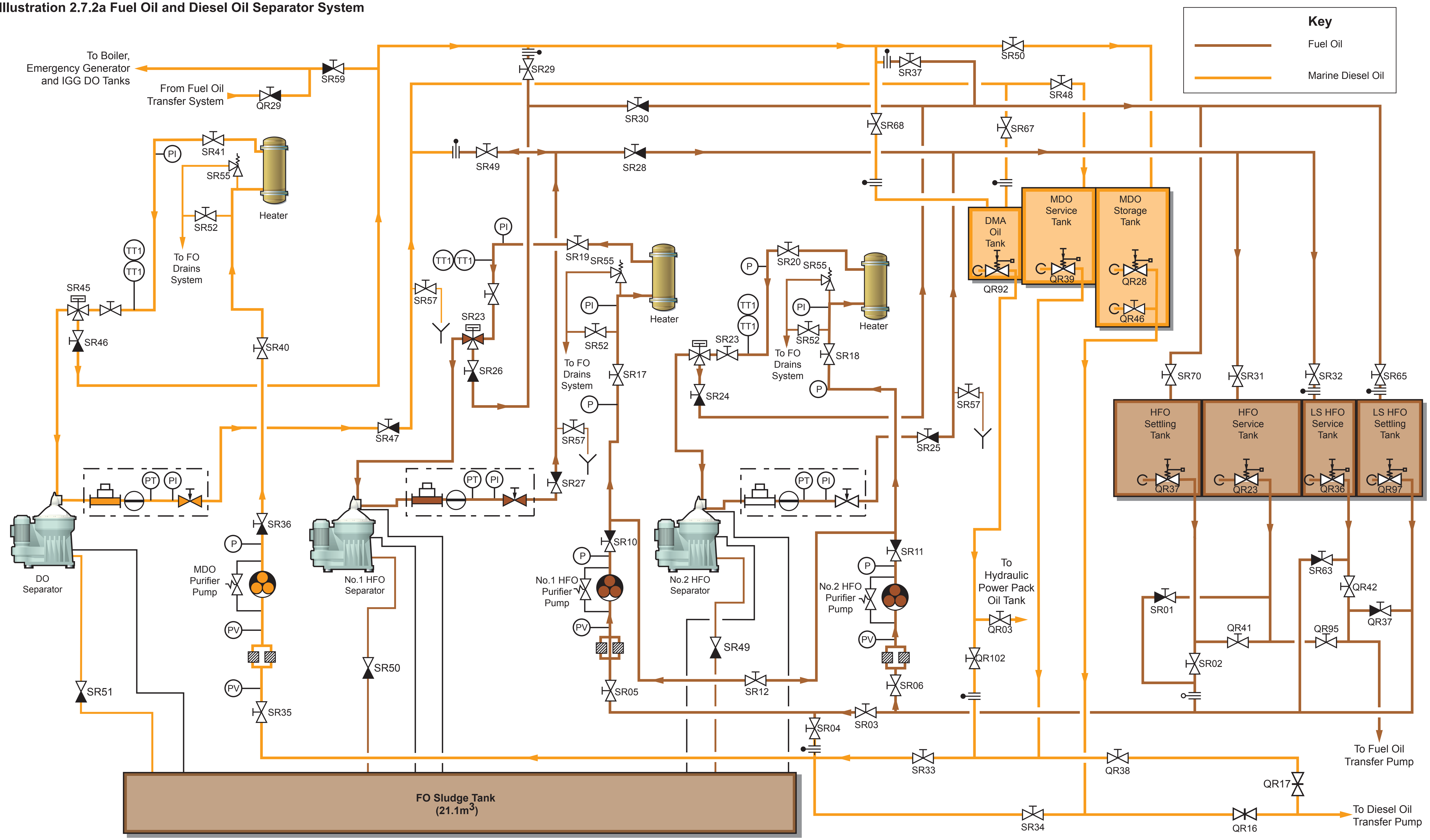
With the time-dependent program cycle, it is important for high clarifying efficiency to avoid desludging losses and that the separable solids content in the product do not fluctuate widely. The UNITROL system provides two basic monitoring systems.

1) Water content monitoring system (WMS)
2) Sludge space monitoring system (SMS)

The illuminated Liquid Crystal Display (LCD) provides information about the operating and malfunction condition of the separator, and displays all the relevant process data. In addition to the control cabinet, the control system comprises all the complete line fittings incorporating electrical components which are controlled or monitored by the control unit which include:

- Dirty oil connection
- Water connection
- Operating water connection
- Circuit and water discharge valve

Illustration 2.7.2a Fuel Oil and Diesel Oil Separator System



- Water sensor
- Thermometer for monitoring the dirty oil temperature
- A klaxon for sounding an audible alarm

Software assignment for a each separator is carried out in the factory using a password function. Any alterations to the set parameters should only be carried out by a person authorised to make such changes.

The FO separators require compressed air and fresh water supplies for control and bowl operation/flushing. Supply systems for these are covered in the relevant control air system and fresh water sections, 2.10.3 and 2.14.1 respectively.

There are three centrifugal self-cleaning FO separators fitted, with one being dedicated to the purification of DO. Each of the two separators dedicated to the purification of HFO has a supply pump which directs HFO through the steam heater. The separators, supply feed pumps and heaters are located in the separator room. Instrument air is supplied to the separators to control the supply of oil to the bowl and the automatic discharge facility. Domestic fresh water is supplied for sealing and flushing purposes.

The individual FO supply feed pumps discharge to the separator through the steam heaters which maintain a constant temperature of 98ºC for optimum separation of both solids and water. The oil is then discharged to the HFO service tank.

Preparation for the Operation of the Heavy Fuel Oil Separating System

CAUTION

Before operating a separator, a second check must be made to ensure that the correct valves are open for the separator, heater and pump to be operated, as well as the tank system from which the HFO is to be drawn and the tank system to which the purified HFO is to be sent.

Separator heaters are supplied with steam as the heating medium and the drain valve from the heater must always be open. The steam supply valve is controlled by the control system and the main separator control system regulates the steam supply to give an oil temperature after the heater of 98ºC.

The two FO separators operate on the same principle using the same type of controller and so the operating procedures are the same. The following description has assumed that the No.1 FO separator and No.1 FO separator supply feed pump are to be used for separating oil from the HFO settling tank and discharging to the HFO service tank:

a) Ensure that the HFO settling tank contains HFO in sufficient quantity to enable the separator to function correctly.

b) Check and record the level of oil in all fuel tanks.

c) Open the self-closing test cock on the HFO settling tank, closing it again when all water has drained.

d) All valves in the separator system are to be initially closed. Open any control air and operating water valves to the separator. Ensure power is available to the separator controller.

e) Set up the valves as shown in the following table:

Position	Description	Valve
Open	HFO settling tank quick-closing suction valve	QR37
Open	HFO settling tank suction line valve	SR02
Closed	Crossover valve to DO separator feed pump	SR04
Closed	Separator suction crossover valve	SR03
Open	No.1 FO separator supply pump suction valve	SR05
Open	No.1 FO separator supply pump discharge valve	SR10
Open	No.1 FO separator heater inlet valve	SR17
Open	No.1 FO separator heater outlet valve	SR19
Closed	No.1 FO separator heater drain valve	SR52
Open	No.1 FO separator three-way recirculation valve inlet valve	
Operational	No.1 FO separator three-way recirculation valve	SR23
Open	No.1 FO separator three-way recirculation valve return valve	SR26
Open	Line valve to settling tanks	SR30
Open	Return valve to HFO settling tank	SR70
Closed	Return valve to LSHFO settling tank	SR65
Closed	Crossover to DO separator discharge	SR29
Closed	Crossover to DO separator discharge	SR37
Closed	Crossover to DMA oil tank	SR67
Set	No.1 FO separator outlet valve	
	No.1 FO separator outlet valve to tanks	SR27
Open	No.1 FO separator outlet valve to HFO service tank	SR28
Closed	Crossover to DO separator discharge	SR49
	No.2 FO separator three-way recirculation valve return valve	SR24
Closed	No.2 FO separator outlet valve to service tanks	SR25
Open	Return/filling valve to HFO service tank	SR31

Position	Description	Valve
Closed	Return/filling valve to LSHFO settling tank	SR32
Closed	HFO settling/service tank crossover valve	SR01
Closed	HFO settling/service tank crossover valve	SR41
Closed	LSHFO settling/service tank crossover valve	SR95
Closed	LSHFO settling/service tank crossover valve	SR32
Closed	LSHFO service tank outlet line valve	SR43
Closed	LSHFO service tank outlet line valve	SR63
Closed	Drain valves	SR57

Note: The separator heater steam valves, air supply valves and water supply valves must be operated as required.

The separator regulating discharge valve should be set for the desired discharge pressure and should not be adjusted during normal running conditions.

f) Ensure the separator brake is off and that the separator is free to rotate.

g) Check the separator gearbox oil level.

h) Start the No.1 FO separator supply feed pump. The three-way valve will ensure the oil bypasses the separator and returns to the settling tank

i) Start the separator and ensure that the bowl is up to speed before continuing.

j) Switch on the control unit.

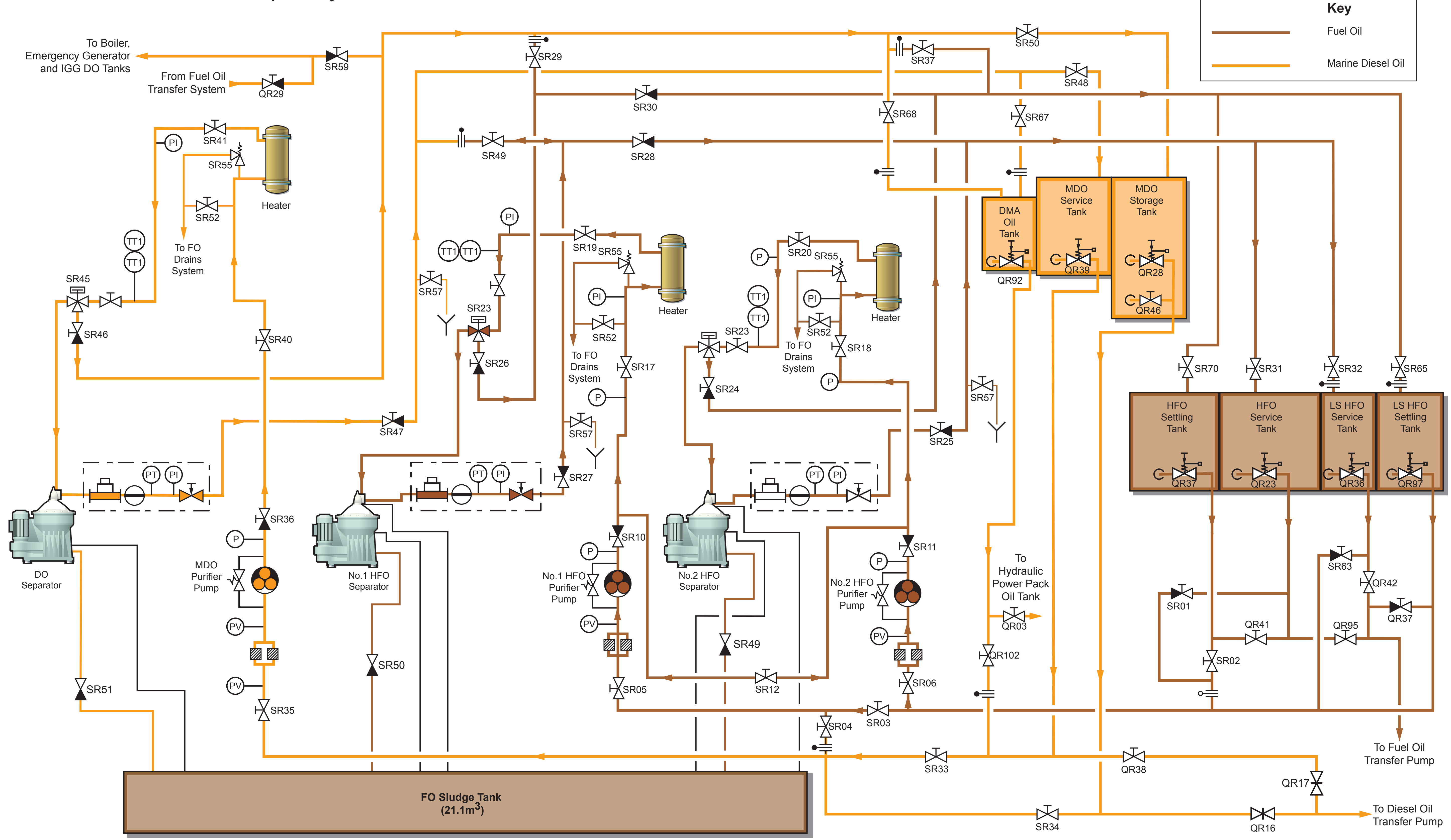
k) Using the F0 pushbutton on the control panel, ensure the operating water opens and closes the bowl.

l) Slowly open the steam supply and return to the No.1 FO heater.

m) Check that the automatic controller has taken control of the system and is maintaining the oil at the correct temperature.

n) Once the HFO temperature is above the minimum setting, start the programme by pressing PROGRAM 1 soft key on the control panel. This will initiate a start sequence including a sludge and discharge test and operate the separator in automatic mode. Once the separator is running and no signs of abnormal vibrations are evident, all temperatures and pressures should be recorded and the levels of the tanks in use checked.

Illustration 2.7.2a Fuel Oil and Diesel Oil Separator System



Procedure to Stop the Purifier

a) Press the PROGRAM 0 key. Two total ejections will be triggered and the separator will stop automatically. The HFO will be automatically recirculated through the three-way valve back to the settling tank.

b) Regulate the steam to the heater and allow the oil to cool.

c) The feed pumps will need to be stopped if they are running in manual mode.

d) Close the control air and operating water valves to the separator along with any other valves opened prior to start-up.

e) Once the separator has come to a complete stop the brake can be applied and preparations made for cleaning if required.

The above description of the separation process has been related to the operation of No.1 FO separator. Should No.2 FO separator be required, careful consideration to piping diagrams and valve positions should be given before any operations are started. Refer to illustration 2.7.2a above.

Note: It is essential that the separator manufacturer's instructions regarding the stopping and dismantling of the separator are followed exactly to avoid the risk of damage. Separator bowls rotate at very high speed and any imbalance or loose connection can have serious consequences.

Procedure for Operating the Diesel Oil Separator

The dedicated DO separator is identical to the HFO separators, and thus operates on the same principle, using the same type of controller and so the operating procedures are identical. Therefore, only the valve settings will be different. The following list has assumed that the DO separator and supply pump are to be used for separating oil from the DO storage tank and discharging to the DO service tank.

Position	Description	Valve
Open	DO storage tank quick-closing suction valve	QR46
Closed	Line valve to DO transfer pump	QR16
Open	Line valve to separator system	SR34
Closed	DO service tank in-line isolation valve	SR33
Closed	HFO separator system in-line isolation valve	SR04
Open	DO separator supply pump suction line valve	SR35
Open	DO separator supply pump discharge valve	SR36
Open	DO separator heater inlet valve	SR40
Open	No.3 FO separator heater outlet valve	SR41
Closed	No.3 FO separator heater drain valve	SR52
Open	Three-way recirculation valve inlet valve	
Operational	Three-way recirculation valve	SR45
Open	Three-way recirculation valve return valve to DO storage tank	SR46
Open	Isolating valve to DO transfer system	SR59
Closed	Return valve to DO storage tank	SR50
Closed	Return valve to HFO return line	SR29
Closed	Isolating valve to HO separator system	SR49
Closed	Isolating valve to HO separator system	SR37
Set	DO separator outlet valve	
Open	DO separator outlet valve to DO service tank	SR47
Open	Return/filling to DO service tank	SR48
Closed	Drain valve	SR57

Note: Care should be taken with the heating of the diesel oil. The temperature control should be set at the correct temperature of the grade of diesel oil and it should be checked that the controller takes control of the temperature as the steam is applied.

Procedure to Stop the Diesel Oil Purifier

Stopping the DO separator is an identical process to stopping the HFO purifiers.

Cross-Connecting the Separator Systems

The DO separator may be operated as a heavy oil separator. Direct suction from the settling tank can be established for the feed pump through SR04 and discharge to the tank filling line through valve SR49. The return line from the three-way valve SR29 will also require opening. In all cases the normally closed isolating blanks will require swinging into the open position.

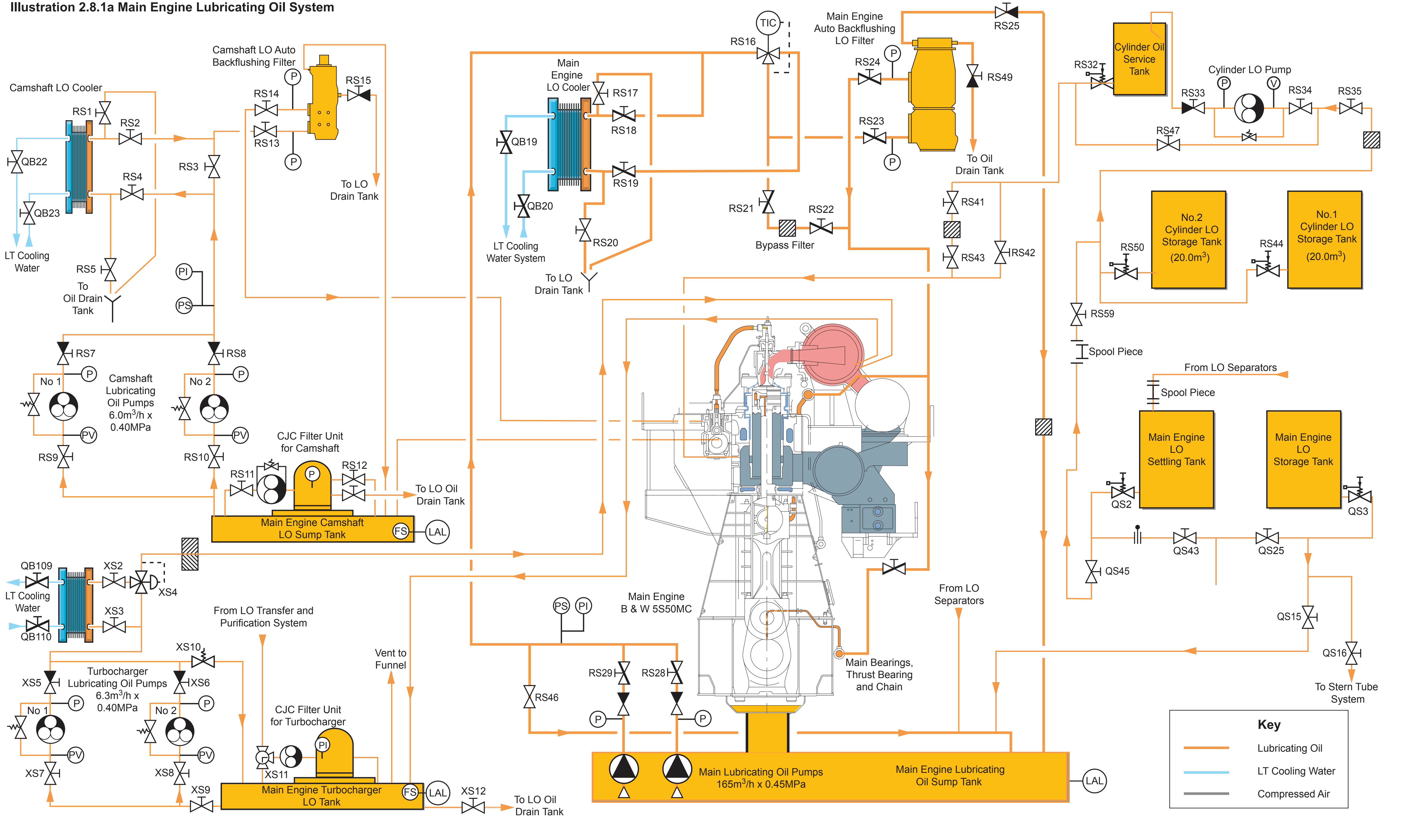
It is also possible to run No.1 HO separator as a DO separator in a similar manner.

CAUTION

Whilst running separator systems cross-connected, the operator must take particular care over the valve settings to ensure that the separator operates in the desired fashion. Particular care should be taken when cross-connecting the DO separator to ensure that no HFO contamination of the DO system occurs, or that any overheating of DO occurs. Care should also be taken to ensure that the separator is operating with the correct gravity disc.

2.8 Lubricating Oil Systems

Illustration 2.8.1a Main Engine Lubricating Oil System



2.8 LUBRICATING OIL SYSTEMS

2.8.1 MAIN ENGINE LUBRICATING OIL SYSTEM

Main Engine Lubricating Oil Pump

Manufacturer:	Shinko
Model:	SAE 150-2
No. of sets:	2
Capacity:	165m^3/h at 0.45MPa
Power:	45kW

Camshaft Lubricating Oil Pump

Manufacturer:	Allweiler
Model:	SPF40R46 U8.3-W20
No. of sets:	2
Capacity:	6.0m^3/h at 0.40MPa

Turbocharger Lubricating Oil Pump

Manufacturer:	Allweiler
Model:	SPF40R46 U8.3 20
No. of sets:	2
Capacity:	6.3m^3/h at 0.40MPa

Cylinder Lubricating Oil Transfer Pump

Manufacturer:	Allweiler
Model:	SPF10R56 G8.3-W20
No. of sets:	1
Capacity:	1.0m^3/h at 0.30MPa

Main Engine Lubricating Oil Auto Filter

Manufacturer:	Alfa Laval
Model:	Protector X280D30/4A06
No. of sets:	1
Capacity:	181.5m^3/h

Main Engine Lubricating Oil Bypass Filter

Manufacturer:	Alfa Laval
Model:	Protector L280/261A06
No. of Sets:	1
Capacity:	187m^3/h

Camshaft Auto Backflush Filter

Manufacturer:	Alfa Laval
Model:	Protector T150D12/6A05
No. of sets:	1
Capacity:	5.2m^3/h at 0.40MPa

Camshaft CJC Filter Unit

Manufacturer:	CC Jensen
Model:	HDU 27/27PH
No. of sets:	1
Capacity:	0.3m^3/h

Turbocharger CJC Filter Unit

Manufacturer:	CC Jensen
Model:	HDU 27/27PH
No. of sets:	1
Capacity:	0.3m^3/h

Introduction

The main engine has four independent lubricating oil systems:

- The main lubricating oil system, which supplies oil under pressure from the main engine sump to the crankshaft, crankpin and crosshead bearings. This oil also lubricates the chain drive and thrust bearings in addition to providing cooling for the pistons.
- A camshaft lubricating oil system, which supplies oil from a dedicated tank to the camshaft bearings, cams and cam-followers and the exhaust valve hydraulic system.
- A turbocharger lubricating oil system, which supplies oil from a dedicated tank to the turbocharger shaft bearings.
- A cylinder oil system, which supplies oil from a dedicated service tank to lubricate the cylinder liners and piston rings. It is a 'once through' total loss system.

Main Lubricating Oil System

Two duty/standby vertical, submerged, centrifugal pumps are located in the engine sump tank, aft of the main engine at floor level. Oil is supplied to the main bearings, connecting rod, crosshead bearings and other internal running gear, such as the chain drive and thrust bearing.

The oil to the crossheads is supplied by means of telescopic pipes and is used to lubricate the crosshead bearing and guides, and through bores in the connecting rods to the crankpin bearings. Oil from the bearings drains to the lower crankcase, which then drains through mesh strainers to the double bottom sump tank.

The oil supply for piston cooling passes up a central pipe in the bore within the piston rod to the piston crown cooling space. After cooling the piston the oil flows down the outside of the pipe in the piston rod back to the crosshead and is then led down to the lower crankcase. The individual piston cooling returns are provided with flow switches which activate an alarm signal in case of non-flow. The temperature is also monitored.

Note: When the pumps are set for AUTO CHANGE, the standby pump will automatically start on failure of the running pump or if the system pressure is too low. However, if the duty pump is stopped from any of its start/stop positions (even by accident), then the standby pump will not start as the control system will recognise the shutdown signal as an operator command function and not a system failure.

It is not necessary to have the duty pump set in MANUAL mode when it is in operation.

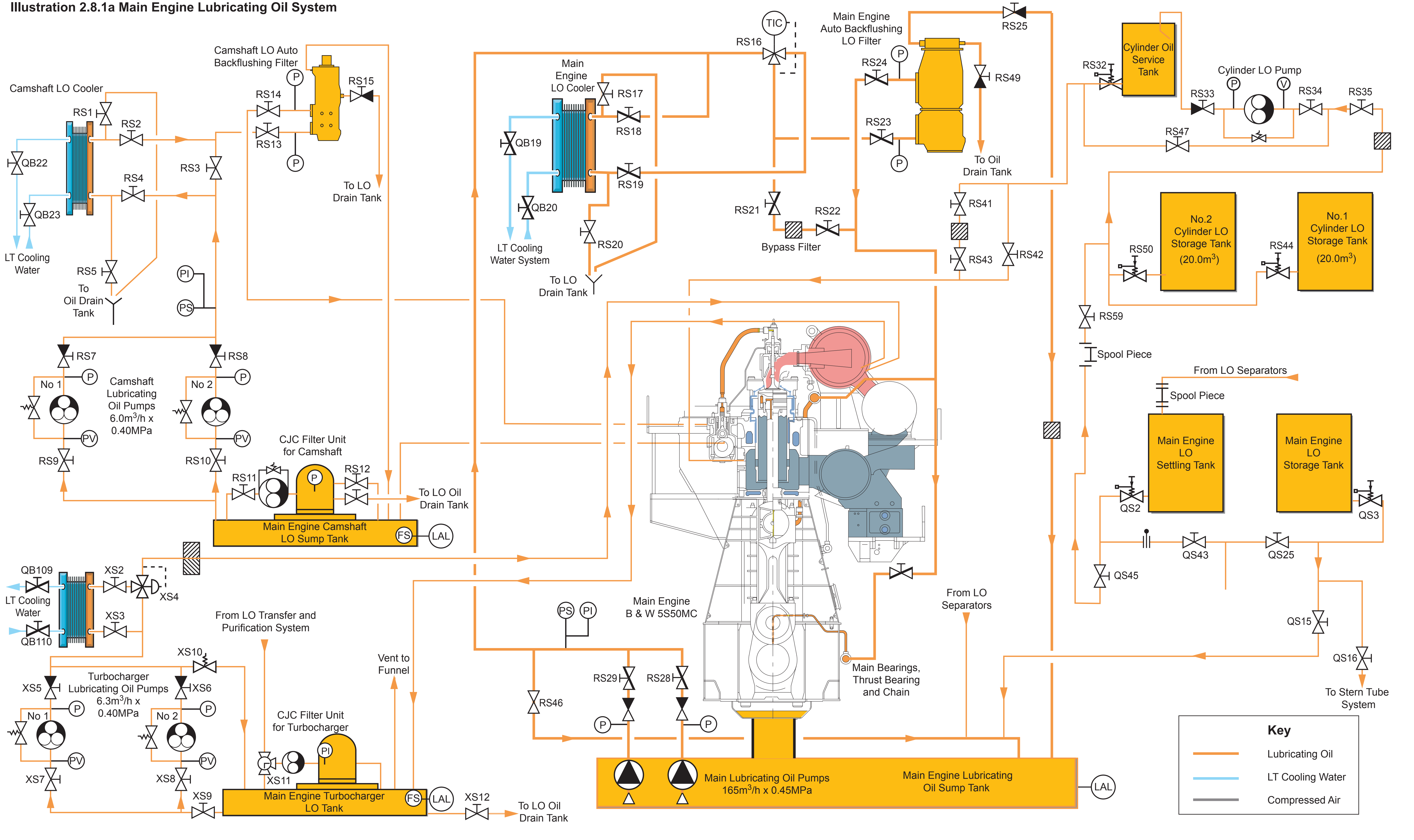
The main lubricating oil pumps discharge through the single-plate cooler which is cooled by the low temperature section of the central cooling system. The temperature of the oil is controlled by a thermostatically modulated three-way valve directing sufficient oil through the cooler to achieve the set temperature. From the cooler, oil passes through the automatic backflushing filter unit before being supplied to the main engine.

The filter backflushes continuously, preventing adhesion of retained solids to filter surfaces. The entire surface area of the filter is cleaned every few minutes ensuring a long service life for the reinforced filter disc elements.

An alarm is activated if the differential pressure reaches 0.9kg/cm².

A bypass filter is provided for use when the backflush filter is shut down for maintenance.

Illustration 2.8.1a Main Engine Lubricating Oil System



Procedure for Operation of the Main Engine Lubricating Oil System

a) Check the level of oil in the main engine sump and top-up to the desired level if required.

b) Supply steam to the main engine sump heating coil. (This assumes that the oil has not been circulating through the purifying system and requires additional heating.)

c) Ensure all pressure gauge and instrumentation valves are open.

d) Position the system valves as shown in the following table:

Position	Description	Valve
Open	No.1 LO pump discharge valve	RS28
Open	No.2 LO pump discharge valve	RS29
Closed	LO pump discharge to main engine sump	RS46
Open	LO cooler inlet valve	RS18
Open	LO cooler outlet valve	RS19
Open	Auto filter inlet valve	RS23
Open	Auto filter outlet valve	RS24
Open	Auto filter backflush drain valve	RS49
Open	Auto filter sump return valve	RS25
Closed	Bypass filter inlet valve	RS21
Closed	Bypass filter outlet valve	RS22
Open/set	Main engine LO inlet valve to the main bearings, thrust collar and chain case	

e) Set the duty pump selection switch on its group starter panel to the AUTO CHANGE position, then start the lubricating oil pump.

f) Bring the auto backflush filter into service.

g) Check that all pressures are in the normal operating range.

h) Supply cooling to the lubricating oil cooler from the fresh water cooling system (refer to Section 2.5.2. of this manual).

i) Select the second pump for standby operation by placing its control operation mode selector switch to the AUTO CHANGE position.

j) Close the steam supply to the heating coil.

k) Check the system for leaks.

Camshaft Lubricating Oil System

Two duty/standby, triple-lobe screw pumps supply oil to the camshaft bearings and cam followers from a dedicated sump tank, through a full-flow cooler and auto backflushing filter unit, similar to that used in the main lubricating system.

The cooler is circulated with cooling water from the central low temperature fresh water cooling system. No automatic temperature control is provided, and the oil temperature is adjusted by means of the cooler bypass valve (RS3) and the cooler inlet valve (RS4).

A CJC fine filter draws from and returns to the camshaft lubricating oil sump tank. Oil returning from the main engine to the sump tank passes through a magnetic strainer.

Preparation for the Operation of the Camshaft Lubricating Oil System

a) Check the level of oil in the camshaft sump tank and top-up if necessary.

b) Ensure all pressure gauge and instrumentation valves are open.

c) Position the valves as shown in the following table:

Position	Description	Valve
Open	No.1 camshaft LO pump suction valve	RS9
Open	No.1 camshaft LO pump discharge valve	RS7
Open	No.2 camshaft LO pump suction valve	RS10
Open	No.2 camshaft LO pump discharge valve	RS8
Open	LO cooler inlet valve	RS4
Open	LO cooler outlet valve	RS2
Closed	LO cooler bypass valve	RS3
Open	Auto filter inlet valve	RS13
Open	Auto filter outlet valve	RS14
Open	Auto filter backflush drain valve	RS15
Open	CJC fine filter inlet valve	RS11
Open	CJC fine filter outlet valve	RS12
Closed	CJC fine filter drain valve	

d) Supply cooling water to the camshaft LO cooler (refer to Section 2.5.2. of this manual).

e) Set the duty pump selection switch on its group starter panel to the AUTO CHANGE position, then start the camshaft lubricating oil pump. When the pressure has stabilised set the standby pump to the AUTO CHANGE position.

f) Start the CJC fine filter circulating pump and bring the filter into service.

Cylinder Lubricating Oil System

High alkaline lubricating oil is supplied to the main engine cylinders on a once through basis in order to lubricate the piston rings and cylinder liner, reducing wear on the rings and liner as well as counteracting the acidity of the products of combustion. Each cylinder of the engine is fitted with a shaft load-dependent lubricator with six individual oil injection pumps, these pumps deliver a metered quantity of oil through a single port in the cylinder liner to supply oil to the surface of the liner and the piston rings.

The oil is injected when the piston rings are passing the injection ports on each compression stroke. Operation is monitored by a no-flow detection system which activates an alarm if no discharge is detected at a pump unit.

Cylinder oil is supplied to the lubricator boxes under gravity from the cylinder oil service tank. The cylinder oil service tank is replenished as required from one of the two cylinder oil storage tanks, by use of the cylinder oil transfer pump.

A service tank and transfer pump bypass is arranged to allow oil to be supplied directly to the engine from the cylinder oil storage tanks if required .

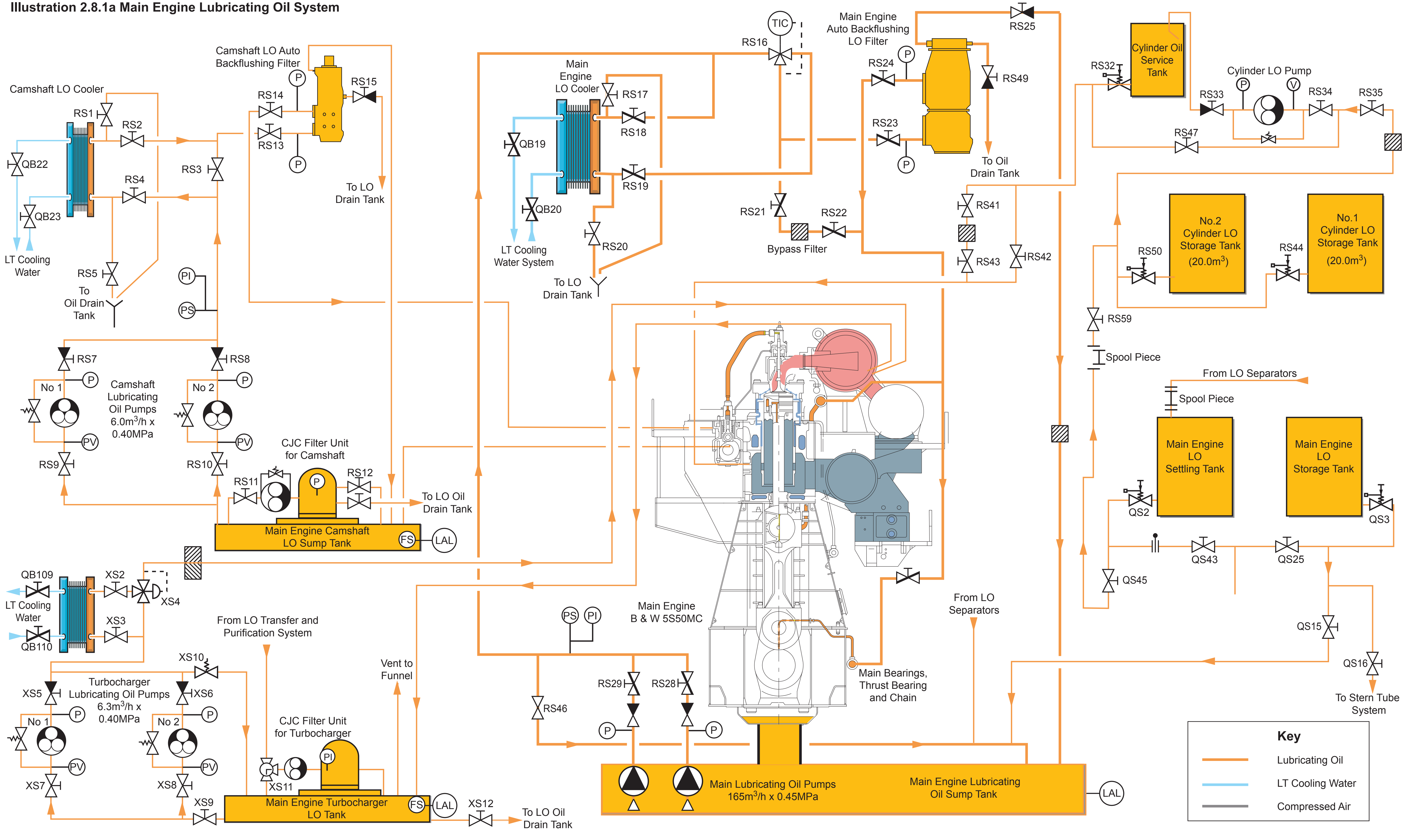
Note: During prolonged running on low sulphur fuel (LSHFO or MDO) it may be necessary to change the grade of cylinder oil in order to prevent excessive alkaline deposits forming on the piston crowns or in the piston ring grooves.

Extra Cylinder Oil Capacity

Should it prove necessary for commercial or practical reasons, the main engine lubricating oil settling tank may be used to store additional cylinder lubricating oil. To facilitate this, the tank is provided with a blanked filling connection from the cylinder oil filling line and a spool piece connection to the cylinder lubricating oil system.

The outlet to the lubricating oil system from the main engine lubricating oil settling tank has a spectacle blank provided adjacent to valve QS-43 on the pipeline to the separator system.

Illustration 2.8.1a Main Engine Lubricating Oil System



Preparation for the Operation of the Main Engine Cylinder Lubricating Oil System

a) Position the valves as shown in the following table:

Position	Description	Valve
Open	No.1 cylinder oil storage tank quick-closing outlet valve	RS44
Closed	No.2 cylinder oil storage tank quick-closing outlet valve	RS50
Closed	Main LO system crossover isolating valve	RS59
Open	Storage tanks run-down valve	RS35
Closed	Cylinder oil service tank and transfer pump bypass valve	RS47
Open	Cylinder oil transfer pump suction valve	RS34
Open	Cylinder oil transfer pump discharge valve	RS33
Open	Outlet valve from cylinder oil service tank	RS32
Open	Filter inlet valve	RS41
Open	Filter outlet valve	RS43
Closed	Filter bypass valve	RS42

b) Ensure that the storage tank outlet filter is clean (RS31).

c) Start the cylinder oil pump and transfer the required quantity of cylinder oil to the cylinder oil service tank. The cylinder oil transfer pump is started and stopped locally. It must be ensured that the service tank is not overfilled.

d) Record the volume in the service tank for measuring later consumption.

e) Ensure the cylinder oil service tank outlet filter (RS38) is clean.

Oil will flow by gravity from the cylinder oil service tank to the cylinder lubricator boxes on the engine, each of which has a float actuated filling valve.

f) When the engine is operating, check the cylinder oil consumption daily. Ensure that the consumption does not drop below the manufacturer's recommendations. Reducing consumption below the recommended level will result in excessive wear to the piston rings and cylinder liners, additionally the piston rings may stick due to accumulation of products of combustion.

g) Ensure that all the injection points are receiving equal quantities of cylinder oil.

Each lubricator pump has a ball in the discharge sight glass which acts as a flow indicator. In normal operation the balls will be evenly positioned approximately half way up the sight glasses. If a pump output reduces, this level will fall, and when there is no discharge the ball falls to the bottom of the glass, activating a no-flow alarm.

The condition of the liner and piston rings should be checked according to the engine manufacturer's recommendations to ensure that sufficient oil is being delivered to each unit.

Turbocharger Lubricating System

Two duty/standby, triple-lobe screw pumps supply oil to the turbocharger shaft bearings from a dedicated turbocharger lubricating oil tank, via a cooler and 32 micron double filter unit. The temperature of the oil is controlled by a thermostatically modulated three-way valve directing sufficient oil through the cooler to achieve the set temperature. The system is protected from over-pressure by a relief valve fitted in a return line from the discharge side of the pumps to the lubricating oil tank.

A CJC fine filter unit is fitted to the lubricating oil tank, comprising a gear pump and filter stack. In normal operation the fine filter unit constantly circulates and filters the contents of the lubricating oil tank. The fine filter unit pump takes suction from the bottom of the tank through a three-way valve fitted to the combined pump suction/tank filling line. When filling, this cock is changed over to draw from the main engine lubricating oil storage tank. The oil passing through the filter before entering the system.

Preparation for the Operation of the Main Engine Turbocharger Lubricating Oil System

a) Position the valves as shown in the table below:

Position	Description	Valve
Closed	Turbocharger LO tank drain valve	XS12
Open	Turbocharger LO tank outlet valve	XS9
Open	No. 1 turbocharger LO pump suction valve	XS8
Open	No. 1 turbocharger LO pump discharge valve	XS6
Open	No. 2 turbocharger LO pump suction valve	XS7
Open	No. 2 turbocharger LO pump discharge valve	XS5
Open	Turbocharger LO cooler inlet valve	XS3
Open	Turbocharger LO cooler outlet valve	XS2
Operational	Turbocharger LO temperature control valve	XS4
Set to tank suction	Fine filter pump suction/tank filling three-way valve	XS11

b) Start the fine filter unit.

c) Start one turbocharger lubricating oil pump.

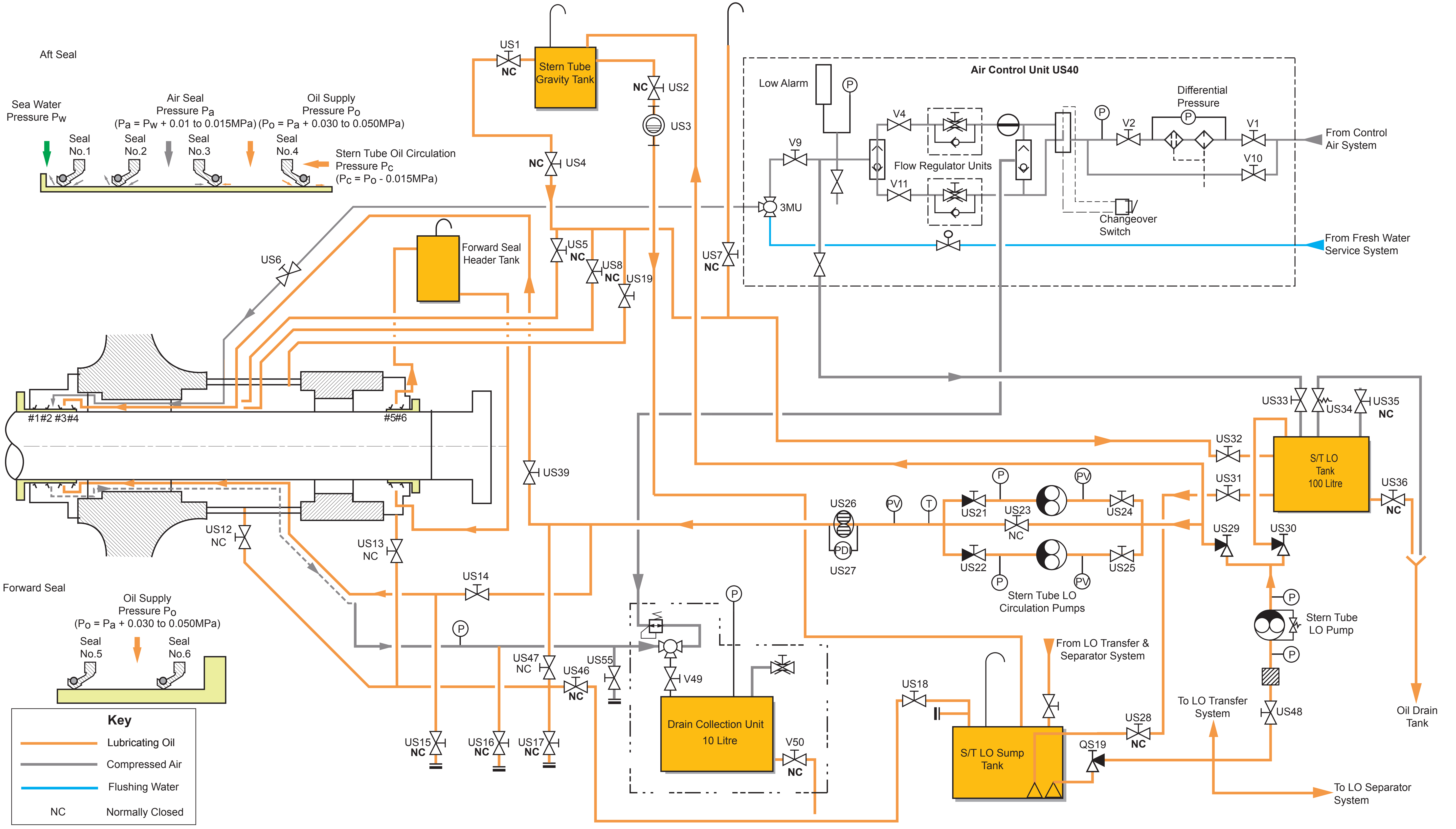
d) Check that oil pressure is in the normal operating range.

e) Supply cooling water to the turbocharger lubricating oil cooler from the central water cooling system (refer to Section 2.5.2. of this manual).

f) Select the second turbocharger lubricating oil pump for standby operation by placing its control operation mode selector switch to the AUTO CHANGE position.

g) Check the system for leaks.

Illustration 2.8.2a Stern Tube Lubricating Oil System



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2.8.2 STERN TUBE LUBRICATING OIL SYSTEM

Stern Tube Seal

Manufacturer:	Kobelco Eagle Marine Engineering Ltd.
Type:	AX560-3A Air Seal

Stern Tube Lubricating Oil Circulating Pump

Manufacturer:	Allweiler
Model:	SPF10R56 G8.3 W20
No. of sets:	2
Capacity:	$2.0m^3/h$ x 0.26MPa

Stern Tube Lubricating Oil Pump

Manufacturer:	Allweiler
Model:	SPF10R38 G8.3
No. of sets:	1
Capacity:	$0.5m^3/h$ x 0.30MPa

Introduction

The stern tube assembly is designed to provide support for the propeller shaft in two oil lubricated bearings, with forward and aft seals to prevent the leakage of lubricating oil from the stern tube into the engine room and into the sea respectively. The aft stern seals are also designed to prevent the ingress of sea water into the stern tube which would result in contamination of the lubrication system, corrosion and damage to the bearings.

Stern Tube Lubrication

The stern tube bearings are lubricated by oil circulated in a closed loop circuit by duty/standby pumps, which in normal operation take suction from the 100 litre stern tube lubricating oil tank and discharge into the stern tube assembly. The oil then passes through the stern tube and around the forward and aft bearings, and back to the stern tube lubricating oil tank. The tank is sealed and pressurised and situated approximately two metres above the centre line of the propeller shaft.

The oil both lubricates and cools the bearings. The heat absorbed by the oil is dissipated in two distinct ways:

- By cooling water that is held in the stern tube tank and fully surrounds the stern tube. This water is cooled in turn by the sea water flowing past the stern area of the hull.
- By conduction through the propeller shaft to the propeller and subsequently to the passing sea water.

It is essential that an adequate supply of oil is maintained to the stern tube to reduce friction and to carry away the heat. The oil in the stern tube system should be periodically sampled and tested to ensure that its properties remain within the manufacturer's specification.

The presence of water in the oil indicates leakage at the after stern seal, which will be detected by the presence of sea water in the drain collecting tank. The presence of any metal particles in the oil indicates a breakdown of one or both of the stern tube bearings.

If the quality of the oil has deteriorated to the level that it needs to be renewed, the contaminated oil can be drained down to the $0.5m^3$ stern tube lubricating oil sump tank.

The stern tube sump tank has a suction outlet to the lubricating oil separator and the lubricating oil transfer pump for direct purification, transfer to the main engine lubricating oil settling tank or lubricating oil sludge tank. The stern tube lubricating oil sump tank is topped-up from the main engine lubricating oil storage tank.

A stern tube gravity tank is located at a height of approximately 15m above the propeller centre line. This tank is used to prime and vent the oil system when recommissioning after dry dock maintenance. It may also be used in an emergency if both of the stern tube circulating pumps are not available. In this case oil will move through the stern tube by natural circulation. The vessel may need to operate at reduced power in order to prevent the stern tube from overheating.

Aft Stern Tube Seal

The aft seal comprises a casing fixed to the hull structure and a chrome steel liner, which is bolted to and rotates with the propeller shaft. The casing itself comprises a flange ring, intermediate ring and cover ring, which are bolted to each other. Four lip seal rings are located in the casing rings, with their lips in contact with the chrome steel liner. The lip seals are numbered from 1 to 3(a) starting from the propeller end and maintain a seal against the liner by a combination of water pressure, oil pressure, air pressure, the elasticity of the seal material and the tension of the seal ring springs.

No.1 seal ring protects the stern tube from foreign matter in the sea water and, in conjunction with No.2 seal, prevents sea water ingress. No.3 and 3(a) seals prevent the escape of the stern tube lubricating oil to the sea.

The chamber between No.1 and 2 seals is packed with grease during installation. The chamber between No.2 and 3 seals is pressurised with compressed air. The chamber between seals 3 and 3(a) is pressurised with oil.

The aft seal utilises a compressed air sealing system, derived from the control air system and controlled by a flow regulator to approximately 40 litre/min. Air is applied to the chamber between No.2 and 3 seals.

The system is designed to allow a small volume of the compressed air to escape to the sea, stabilising the pressure in the chamber to 0.01 to 0.015MPa above sea water pressure, preventing any water ingress. Any change in draught of the ship is automatically detected by the air control unit and the air supply regulated accordingly so as to maintain this differential value. At the same time, the pressure applied to the stern tube lubricating oil unit tank is adjusted automatically in order to maintain the correct pressure differential on the seal ring No.3 and in the chamber between No.2 and No.3 seals.

Oil is directed to the sealing chamber via a flow meter at approximately 120 litre/h. The stern tube lubricating oil circulating pressure acting on the No.3 seal is also automatically maintained to 0.015MPa less than the pressure in the seal chamber between No.2 and 3 seals. This is designed to maintain the life of the seal. Any oil leaking past the seal will drain to the drain collection unit, not the sea.

Any leakage past Nos.1 and 2 sealing rings will be dependent on the general condition of the seals and the surface of the liner. Any oil or sea water that may enter this chamber will drain to the drain collecting unit. The drain collection tank has a vent regulator fitted to the top of the unit set at 4 litres/min. Any seal leakage problems will be indicated by liquid in the drain collection unit. If the tank contains sea water, seal No.1 is leaking. If oil is present, seal No.2 is leaking.

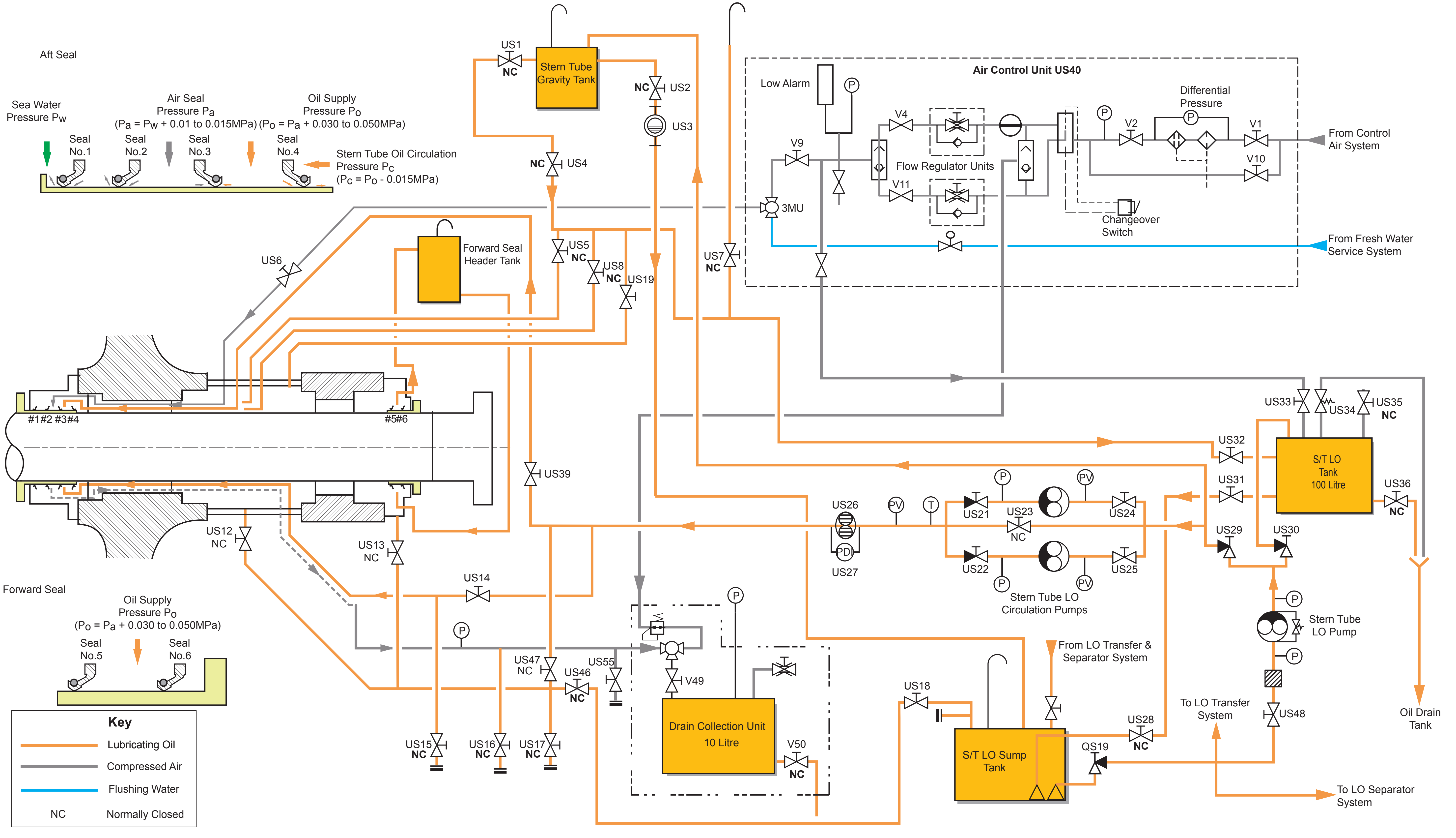
Forward Stern Tube Seal

The forward seal is of similar construction to the aft seal except that it has only two lip seal rings, numbered 4 and 5. The forward chrome liner that the lip seals work against is bolted to a split clamp ring mounted on the propeller shaft. The forward seals prevent the escape of lubricating oil from the stern tube into the engine room. The oil system for the forward seal is self-contained and does not connect with either the stern tube lubricating or the aft seal systems.

The seal is provided with a 15 litre header tank located immediately above the stern tube. The tank is fitted with a level switch that will initiate an alarm at a set low level.

The oil circulates from the tank and around the seal area by convection and the natural pumping action created by the rotating propeller shaft. Cooling of the oil is achieved by convection from the corrugated surface of the header tank.

Illustration 2.8.2a Stern Tube Lubricating Oil System



Procedure for the Operation of the Stern Tube Bearing Lubricating Oil and Aft Stern Seal Oil System

The following procedure assumes that the system is vented and fully primed with oil, and the stern tube lubricating oil tank is at operating level with the tank vent closed.

a) Confirm that all of the instrumentation valves are open and that the instruments are reading correctly.

b) Ensure that the control air supply is available and that electrical power is available to the circulating oil pump motors.

c) Ensure that the recirculating oil filters (US-26/27) are clean.

d) Ensure that the forward seal header tank is at operating level or top-up manually as required. Note that there are no valves on the forward seal system.

e) Position the valves as shown in the tables:

Aft Seal

Position	Description	Valve
Air system between seals No.1 and 2		
Open	Engine room control air supply to air control unit (ACU) isolating valve	QK28
Open	ACU inlet filters inlet valve	V1
Open	ACU inlet filters outlet valve	V2
Closed	ACU inlet filters bypass valve	V10
Open	ACU flow controller FC1 outlet valve	V4
Open	ACU flow controller FC2 outlet valve	V11
Open	ACU outlet valve to stern tube assembly	V5
Open	ACU outlet to stern tube LO tank	V9
Set to air	ACU three-way outlet valve	3MU
Open	Air valve to the aft seal	US6
Open	Drain collection unit inlet valve	V49
Closed	Drain collection unit drain valve	V50
Oil system between seals No.2 and 3 and stern tube bearing circulating system		
Open	Stern tube LO tank outlet valve	US31
Closed	Stern tube LO tank drain valve	US36
Closed	Stern tube LO tank vent valve	US35

Position	Description	Valve
Open	Stern tube LO tank ACU control air inlet valve	US33
Open	No.1 stern tube circulating pump suction valve	US24
Open	No.1 stern tube circulating pump discharge valve	US21
Open	No.2 stern tube circulating pump suction valve	US25
Open	No.2 stern tube circulating pump discharge valve	US22
Closed	Stern tube circulating pumps bypass valve	US23
Open	Stern tube aft seal top inlet valve	US39
Open	Stern tube aft seal bottom inlet valve	US14
Open	Stern tube outlet valve	US19
Open	Stern tube LO tank circulation return valve	US32
Closed	Stern tube outlet valve	US5
Closed	Stern tube outlet valve	US8
Closed	Stern tube gravity tank outlet valve to LO tank	US1
Closed	Stern tube gravity tank outlet valve to sump tank	US2
Closed	Stern tube gravity tank run-down valve	US4
Closed	System top vent valve	US7
Closed	Stern tube drain valves	US15, US16 US17
Closed	Stern tube gravity circulation valves	US12, US13 US47
Closed	Drain collection tank inlet valve	V49
Closed	Drain collection tank drain valve	V50
Closed	Stern tube LO sump tank returns valve	US46
Closed	Stern tube LO sump tank inlet valve	US18
Closed	Stern tube LO sump tank circulating pump suction valve	US28
Closed	Stern tube LO pump suction valve from sump tank	US48
Closed	Stern tube LO pump discharge valve to gravity tank	US29
Closed	Stern tube LO pump discharge valve to LO tank	US30

f) Set the duty LO circulating pump to AUTO CHANGE on the local control panel and start the pump.

Note: When the pumps are set for AUTO CHANGE, the standby pump will automatically start on failure of the running pump, or if the system pressure is too low. However, if the duty pump is stopped on command (or by accident) from any of its start/stop positions, then the standby pump will not start as the control system will recognise the shutting down of the pump as an operator intervention and not a system failure.

It is not necessary to have the duty pump set in MANUAL mode when it is in operation.

g) Ensure that the oil pressure as indicated on gauge P13 is 0.03 to 0.05MPa higher than the air pressure shown on gauge P4.

h) Ensure that the air flow controller is supplying air at 40 litres/min.

i) Check the system for water daily.

j) Take a sample for analysis from the sampling cock at intervals dictated by the company's operating policy.

k) Check the level of oil in the forward seal header tank and replenish the tank manually if required.

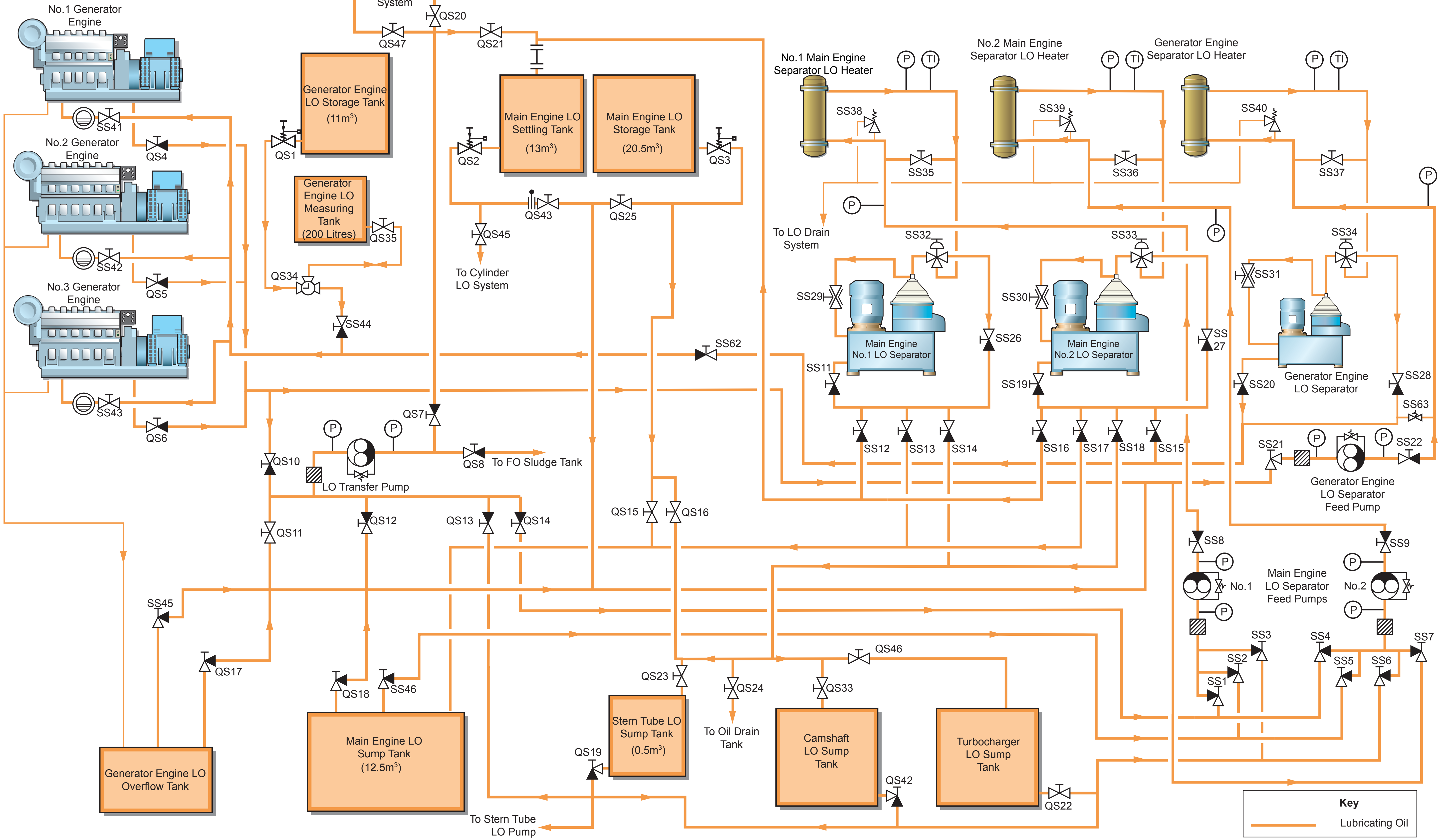
l) The air regulator lines should be changed over regularly to ensure that they are both working correctly.

m) Check the filter drains regularly and ensure any accumulated moisture is removed.

Normal operating parameters for the stern tube system are shown in the table below:

	Oil consumption litre/day	Oil temperature ºC	% Sea water content
Stern tube bearing system oil	4.0	55	2
Forward seal	1.0	80	0

Illustration 2.8.3a Lubricating Oil Separating System



2.8.3 LUBRICATING OIL SEPARATING SYSTEM

Main Lubricating Oil Separators

Manufacturer:	Westfalia
No. of sets:	2
Model:	OSD6-91-067/5
Type:	Centrifugal, self-cleaning, gravity disc
Capacity:	1350 litres/h

Main Lubricating Oil Separator Supply Pumps

Manufacturer:	Westfalia
Model:	R25/16
No. of sets:	2
Capacity:	1200 litres/h

Generator Engine Lubricating Oil Separator

Manufacturer:	Westfalia
No. of sets:	1
Model:	OSD6-91-067/3
Type:	Centrifugal, self-cleaning, gravity disc
Capacity:	550 litres/h

Generator Engine Lubricating Oil Separator Supply Pump

Manufacturer:	Westfalia
Model:	R25/6.3
No. of sets:	1
Capacity:	450 litres/h

Lubricating Oil Separator Control Units

Manufacturer:	Westfalia
No. of sets:	3
Model:	C7-623

Introduction

The lubricating oil separating system comprises three centrifugal, self-cleaning separators designed to remove water and suspended solids from the lubricating oil. The three separators are located in the separator room at the forward end of the floor level of the engine room. All the separators are mounted above the lubricating oil sludge tank, along with the associated dedicated motor-driven supply pumps, the steam oil heaters and the starter panels/control modules. Control air is supplied to the separators for operation of the control valves for the supply of oil and the automatic bowl discharge facility. Fresh water from the engine room service water system is supplied for bowl sealing and flushing purposes.

The separators feature a flat belt drive, this allows for easier maintenance through the reduced number of components, and low noise and vibration when in operation.

Two separators designated No.1 and 2, of the same capacity, are used for the main engine lubricating oil systems and the stern tube system.

The third, smaller separator is used for the auxiliary (generator) engines and associated lubricating oil overflow tank.

The separators may be run simultaneously on different services, for batch purification or for continuous purification.

In normal operation one main lubricating oil separator should be in service on the main engine sump whenever the main engine is running. When the engine is shut down, use of the separator ensures that the lubricating oil remains warm.

The oil in the generator engine sumps is cleaned individually, during this operation the engine may be either in operation or shut down.

No.1 and 2 separators are able to clean the oil in the following:

- Main engine lubricating oil settling tank
- Main engine lubricating oil sump tank
- Main engine camshaft lubricating oil sump tank
- Main engine turbocharger lubricating oil sump tank
- Stern tube lubricating oil sump tank

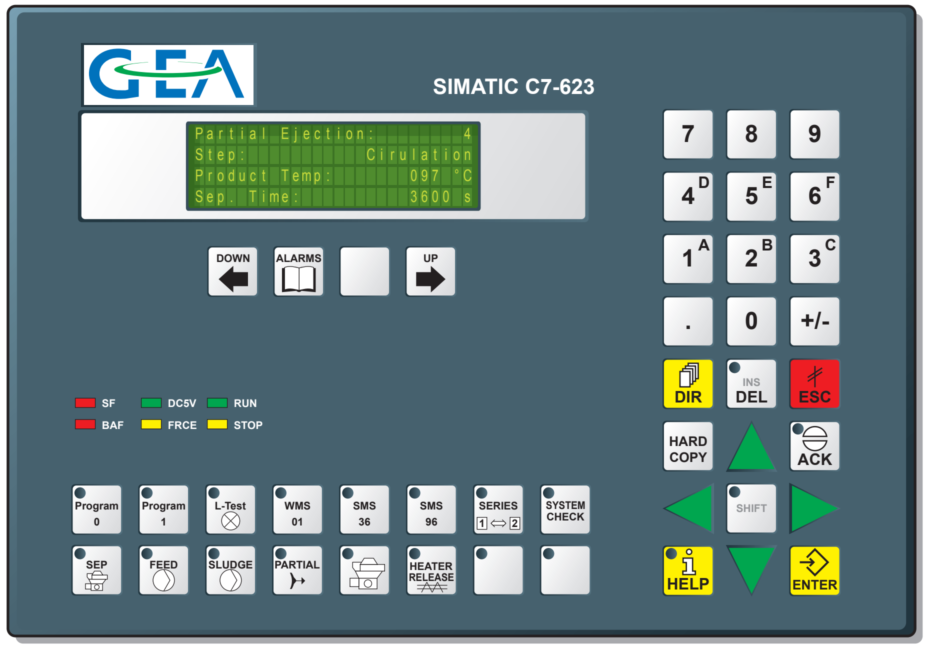
A cross-connection allows No.2 separator only, to service:

- Auxiliary (generator) engine lubricating oil overflow tank
- Generator engine sumps

Operating Process

Oil is supplied to each separator through a dedicated heater. When the oil is introduced into the rotating separator bowl, centrifugal force causes the oil to separate from any water or suspended solids due to their differing specific gravities. Oil and water are discharged from the separator through individual outlets. Sludge accumulates on the outer rim of the separator bowl, from where it is removed during an automatic cleaning cycle and discharged to the lubricating oil sludge tank.

Illustration 2.8.3b Lubricating Oil Purifier Control Panel



The C7-623 control unit supervises the operation of the entire separation operation, monitoring the separator output, initiates the cleaning cycle and activates alarms as necessary.

The correct size of gravity disc must be fitted to the separator to suit the specific gravity of the lubricating oil being treated. In operation a specific amount of water is added to the separator bowl to form a water seal.

At timed intervals during the separation process the oil feed to the bowl is stopped, displacement water is added to reducing the oil loss and the bowl is opened discharging accumulated sludge. The bowl then closes, sealing water re-introduced and the oil supply resumed to begin separation process.

The interval between sludge discharge may be varied at the control unit depending upon the condition of the oil being treated and operator experience. A one hour interval is recommended for crosshead engine lubricating oil and 30 minutes for trunk piston engine lubricating oil.

The separator should be dismantled for a visual inspection of the bowl after one week of operation for crosshead engine lubricating oil and after two days for trunk piston engine lubricating oil. These sludging and manual bowl cleaning intervals may be adjusted with regard the amount of sludge found inside the bowl on opening up and operating experience.

The heater temperature must be set at the control unit to give a viscosity of 100cSt at 40ºC for the main engine lubricating oil, and 150cSt at 40ºC for the diesel generator engine lubricating oil.

WARNING

Care must be taken when operating the separator system. Hot oil and steam are present and may result in serious injury if leakage occurs. There is a fire risk from the presence of hot oil and all fire prevention precautions must be observed at all times.

The separator room must maintained in a clean oil-free condition.

The operation of the fixed fire extinguishing systems should be checked regularly.

CAUTION

Centrifuges operate on an automatic desludging system. Failure of the system to operate correctly may cause imbalance, overload and catastrophic damage to the separator bowl, which rotates at high speed. After manual cleaning, it must be ensured that the bowl is assembled correctly to prevent imbalance. All operating and maintenance precautions stipulated by the manufacturer must be observed.

CAUTION

Extreme care must be taken when separating lubricating oil to ensure that different grades of oil do not become mixed. The position of all valves must be checked prior to starting separator operations.

Preparation for Batch Operation of the Separating System

a) Check and record the level of oil in all lubricating oil tanks before any operation commences.

b) Operate the test cock on the tank in use to drain any water or sediment.

c) Position the valves as shown in the table below, depending on the system and separator selected.

Note: The valves are shown as open, but only those valves associated with a particular procedure should be opened. A careful check must be made of the valve path so that oil is taken from the intended tank/sump and discharged to the desired location.

Main Engine Lubricating Oil System

Using each separator and its associated pump.

Separator System Suction Valves

Position	Description	Valve
From Main Engine Sump		
Open	Separator No.1 feed pump suction valve from main engine sump	SS2
Open	Separator No.2 feed pump suction valve from main engine sump	SS5
Open	Main engine sump suction valve	SS46
From Auxiliary System Tanks		
Open	Separator No.1 feed pump suction valve from auxiliary system tanks	SS3
Open	Separator No.2 feed pump suction valve from auxiliary system tanks	SS6
Open	Separator feed pump suction valve from stern tube sump tank	QS19
Open	Separator feed pump suction valve from main engine camshaft LO sump tank	QS42
Open	Separator feed pump suction valve from main engine turbocharger LO tank	QS22
From Main Engine LO Storage Tank		
Open	Separator No.1 feed pump suction valve from main engine LO storage and settling tanks	SS1
Open	Separator No.2 feed pump suction valve from storage and settling tanks	SS4
Open	LO storage tank quick-closing outlet valve	QS3
Open	LO storage tank crossover valve	QS25
From Main Engine LO Service Tank		
Open	Separator No.1 feed pump suction valve from main engine LO storage and settling tanks	SS1
Open	Separator No.2 feed pump suction valve from storage and settling tanks	SS4
Open	LO service tank quick-closing outlet valve	QS2
Open	LO service tank run-down valve	QS43
From Generator Engine System (No.2 separator only)		
Open	Separator No.2 feed pump suction valve	SS7
Open	No.1 generator engine sump suction valve	QS4
Open	No.2 generator engine sump suction valve	QS5
Open	No.3 generator engine sump suction valve	QS6

Position	Description	Valve
Separator Valves		
Open	No.1 separator feed pump discharge valve	SS8
Closed	No.1 separator heater bypass/drain valve	SS35
Open	No.1 separator inlet bypass valve	SS26
Open	No.1 separator outlet valve	SS11
Open	No.2 separator feed pump discharge valve	SS9
Closed	No.2 separator heater bypass/drain valve	SS36
Open	No.2 separator inlet bypass valve	SS27
Open	No.2 separator outlet valve	SS19

Separator System Discharge Valves

Position	Description	Valve
To Main Engine Sump		
Open	No.1 separator discharge valve to main engine sump	SS13
Open	No.2 separator discharge valve to main engine sump	SS17
To Main Engine Settling Tank		
Open	No.1 separator discharge valve to main engine settling tank	SS12
Open	No.2 separator discharge valve to main engine settling tank	SS16
To Auxiliary Systems		
Open	No.1 separator discharge valve to auxiliary systems	SS14
Open	No.2 separator discharge valve to auxiliary systems	SS18
Open	Stern tube sump tank inlet valve	QS23
Open	Main engine camshaft LO tank inlet valve	QS33
Open	Main engine turbocharger inlet valve	QS46
To Generator Engine Lubricating Oil Sumps		
Open	No.2 separator discharge to generator engines isolating valve	SS15
Open	Separator dischargw to generator engines	SS62
Open	Inlet valve to No.1 generator engine sump	SS41
Open	Inlet valve to No.2 generator engine sump	SS42
Open	Inlet valve to No.3 generator engine sump	SS43
Closed	Generator engine LO storage tank outlet valve	QS1
Closed	Generator engine LO measuring tank outlet valve	QS35
Closed	Generator engine LO storage tanks isolating valve	SS44

Auxiliary (Generator) Engine Separator Suction Valves

Position	Description	Valve
Open	Feed pump suction valve	SS21
Open	Feed pump discharge valve	SS22
Open	No.1 generator engine sump suction valve	QS4
Open	No.2 generator engine sump suction valve	QS5
Open	No.3 generator engine sump suction valve	QS6
Auxiliary (Generator) Engine Separator Valves		
Closed	Separator heater bypass/drain valve	SS37
Open	Separator inlet bypass valve	SS28
Open	Separator outlet valve	SS20
Open	Inlet valve to No.1 generator engine sump	SS41
Open	Inlet valve to No.2 generator engine sump	SS42
Open	Inlet valve to No.3 generator engine sump	SS43

d) Open the control air and service water supplies to the separator to be used.

e) Ensure the separator brake is off and the separator is free to rotate.

f) Ensure that the correct gravity disc is fitted.

g) Check that the pump suction strainers are clean.

h) Start the separator feed pump. Oil will bypass the separator via the three-way solenoid valve.

i) Slowly open the steam supply to the separator heater.

j) Start the separator and check for any abnormal noise as it accelerates up to operating speed.

k) Initiate operation by pressing the PROGRAM 1 soft key on the control unit. The separator will run through a start-up sequence, including a sludge discharge, before going on-line.

l) Check that the separator is operating correctly and that the throughput is adequate.

m) Ensure that there is no abnormal discharge from either the water outlet or the sludge discharge.

n) Ensure that the water outlet alarm is set correctly, allowing only nominal water discharge. If set incorrectly, losing the seal will result in a loss of oil to the sludge tank.

The separator will now operate to a set programme, discharging sludge at preset intervals.

Procedure to Stop the Separator

a) Press the Program 0 soft key. A sludge discharge will be triggered and the separator will stop automatically. The lubricating oil will automatically be recirculated through the three-way valve back to the main engine sump tank.

b) Regulate the steam to the heater and allow the oil to cool.

c) The feed pump will need to be stopped if running in manual mode. In auto mode the pump will stop after 15 minutes (adjustable).

d) Close the control air and operating water valves to the separator along with any other valves opened prior to start-up.

e) Once the separator has come to a complete stop the brake can be applied and preparations made for cleaning if required.

WARNING
Do not attempt to loosen any part of the bowl until it has stopped rotating. **Check for bowl rotation at the drive belt sight glass.** **The bowl may take 30 minutes to come to a complete standstill.**

Illustration 2.8.3b Lubricating Oil Purifier Control Panel

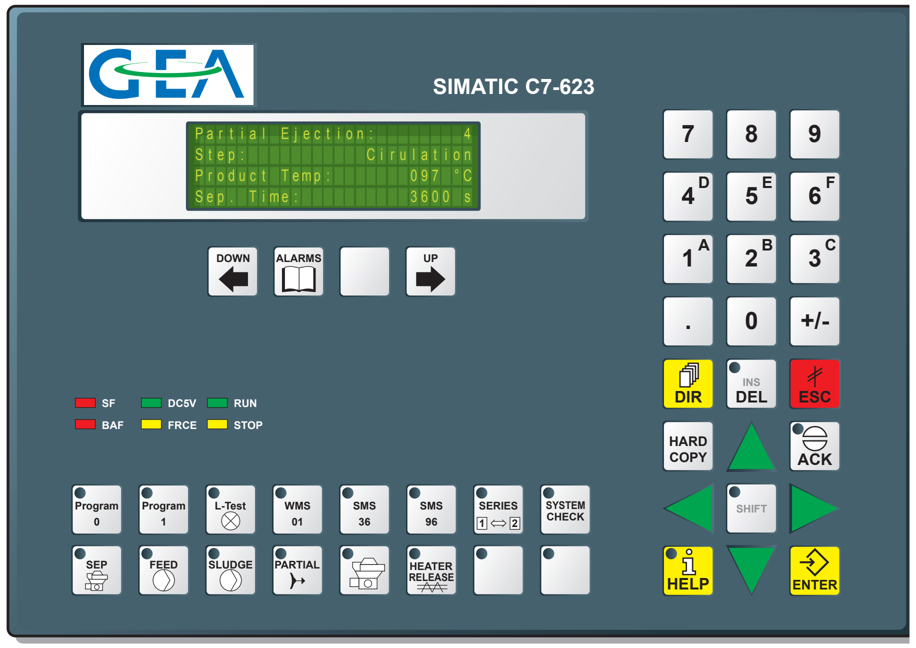
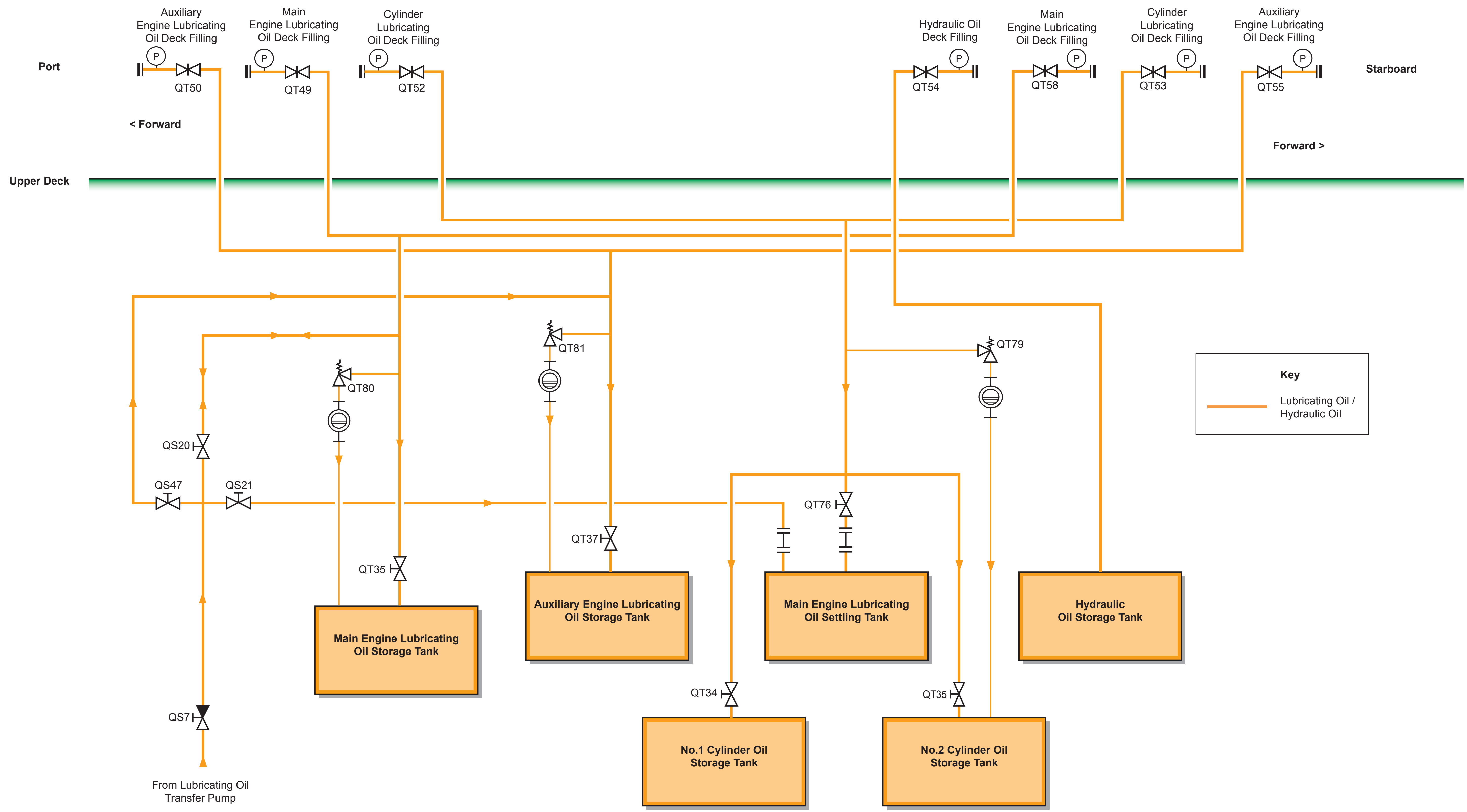


Illustration 2.8.4a Lubricating Oil Filling System



2.8.4 LUBRICATING OIL FILLING AND TRANSFER SYSTEM

Lubricating Oil Transfer Pump

Manufacturer:	Allweiler
Model:	SPF40 R46 U8.3-W20
No. of sets:	1
Capacity:	$5.0m^3/h$ x 0.30MPa

Lubricating oil is stored in the following storage tanks, located in the engine room:

- Main engine LO storage tank ($27m^3$)
- Main engine LO settling tank ($13m^3$)
- Auxiliary (Generator) engine storage tank ($8m^3$)
- No.1 cylinder oil storage tank ($18m^3$)
- No.2 cylinder oil storage tank ($19m^3$)

The main engine sump has a capacity of $10m^3$.

Outlet valves from all storage tanks are of the remote quick-closing type with a collapsible bridge, which can be operated remotely from the fire control station. After being operated the valves must be reset locally.

Each tank is also fitted with a self-closing test cock to test for and drain any water that may be present. Lubricating oil is transferred by gravity from the storage tanks to their associated equipment such as the main engine, generator diesel engine sumps and other machinery services.

The main engine lubricating settling tank is used to allow the contents of the main engine sump to be transferred and settled prior to the oil being returned to the engine sump, or recirculated through the centrifugal separator system. To aid separation, heating coils are fitted to the settling tank.

The storage tanks are filled from dedicated connections on the port and starboard sides of the upper deck.

The lubricating oil transfer pump draws from:

- Main engine sump
- Main engine lubricating oil storage tank
- Main engine lubricating oil settling tank
- Main engine camshaft LO sump tank
- Main engine turbocharger LO tank
- Stern tube LO drain tank
- Generator engine sumps (3)
- Generator engine lubricating oil overflow tank

The LO transfer pump discharges to:

- Lubricating Oil (separator) sludge tank
- Main engine lubricating oil settling tank
- Main engine lubricating oil storage tank (through deck filling connection)
- Generator engine lubricating oil storage tank (through deck filling connection)
- Main engine deck filling connections (port and starboard)
- Generator engine deck filling connections (port and starboard)

Procedure to Transfer Lubricating Oil by Transfer Pump

CAUTION

Extreme care must be taken when transferring lubricating oil to ensure that main engine oil and generator diesel engine oil do not become mixed. The position of all valves must be checked prior to starting a transfer operation.

a) Check and record the level of oil in all lubricating oil tanks.

b) Ensure that all transfer valves are closed when not in use

c) Check that the lubricating oil transfer pump suction filter is clean.

d) Ensure that there is sufficient capacity in the tank being filled for the intended transfer.

e) Position the valves as shown in the following table:

Position	Description	Valve
From Main Engine Sump to Lubricating Oil Settling Tank		
Open	Suction valve from sump tank	QS18
Open	Sump tank isolating valve	QS12
Open	Transfer pump suction valve	QS9
Open	Transfer pump discharge valve to LO tanks	QS7
Open	Settling tank inlet valve	QS21
Closed	Discharge valve to LO sludge tank	QS8
Closed	Discharge valve to main engine LO tank	QS20
Closed	Discharge valve to generator LO tank	QS47
Closed	Suction valve from generator engines	QS10
Closed	Suction valve from G/E LO overflow tank	QS11
Closed	Suction valve from stern tube, camshaft and turbocharger tanks	QS13
Closed	Suction valve from main engine settling and storage tanks	QS14
From Generator Engine Sumps to LO Sludge Tank		
Open	Generator engine sump pump-out valve, (depending on which engine sump is being emptied)	QS4 or QS5 or QS6
Open	Generator engine system suction check valve	QS10
Open	LO transfer pump suction valve	QS9
Open	LO transfer pump discharge valve to sludge tank	QS8
Closed	All other valves	
From Generator Engine LO Overflow Tank to LO Sludge Tank		
Open	Generator engine LO overflow tank isolating valve	QS17
Open	LO transfer pump LO overflow tank suction header valve	QS11
Open	LO transfer pump suction valve	QS9
Open	LO transfer pump discharge valve to sludge tank	QS8
Closed	All other valves	

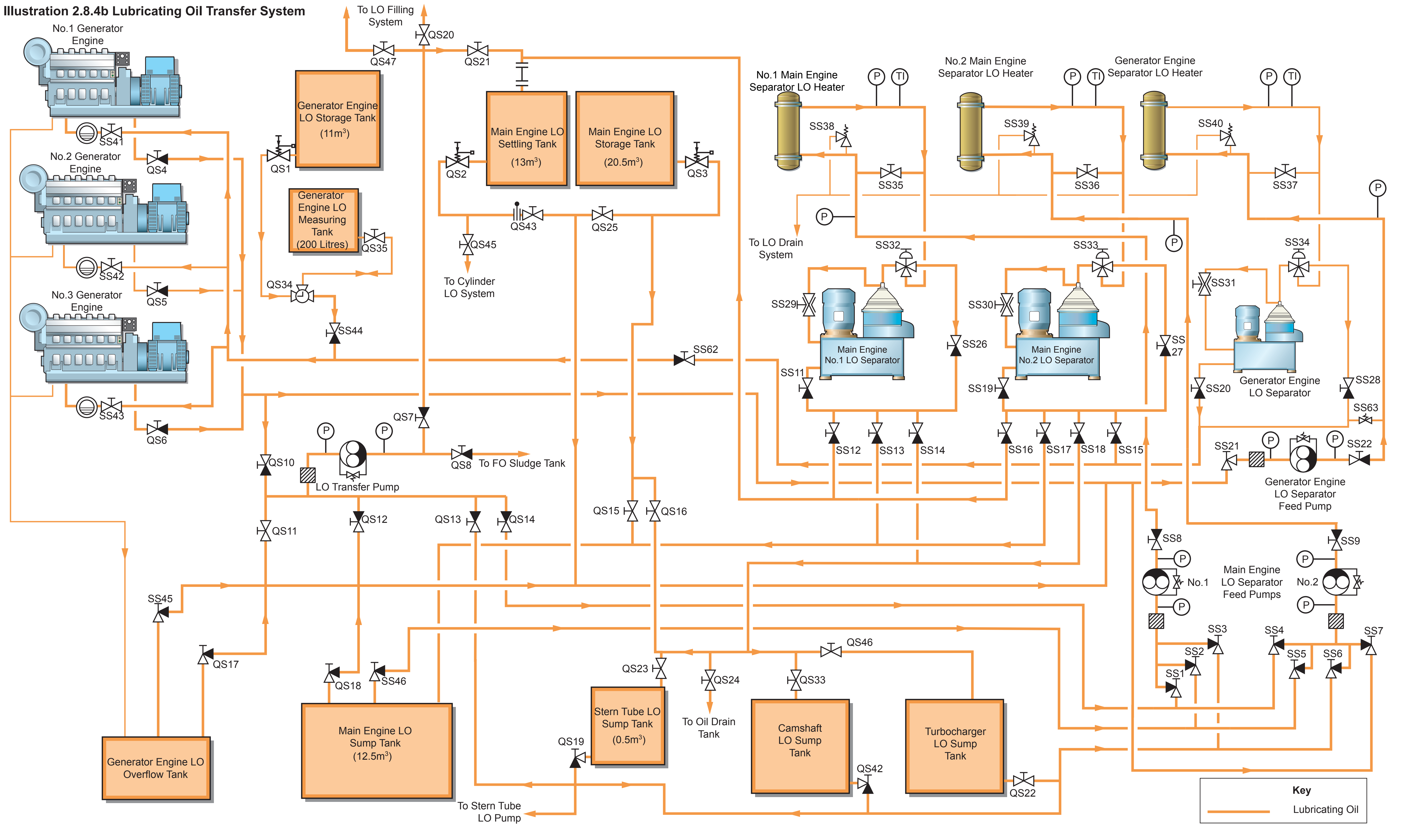
f) Start the lubricating oil transfer pump.

g) Ensure that oil is being transferred to the intended destination.

h) When the required quantity of oil has been transferred, stop the pump and close all valves.

i) Check the levels in all lubricating oil tanks and record the amount of oil transferred.

Illustration 2.8.4b Lubricating Oil Transfer System



Gravity Transfer from Lubricating Oil Storage Tank to the Main Engine Sump

a) Check and record the level of oil in the lubricating oil storage tank and main engine sump tank.

b) Ensure that all transfer valves are closed when not in use.

c) Ensure that there is sufficient space in the main engine sump tank for the intended transfer.

d) Position the valves as shown in the table below:

Position	Description	Valve
Open	Main engine LO storage tank quick-closing outlet valve	QS3
Closed	Main engine LO storage tank/settling tank crossover valve	QS25
Closed	Auxiliary LO tanks header inlet valve	QS16
Open	Main engine sump tank inlet valve	QS15

e) Close all valves when the transfer is complete.

f) Check and record the levels in the storage tank and sump.

Gravity Transfer of Generator Engine Lubricating Oil Storage Tank

Lubricating oil for the generator engines is stored in the generator engine lubricating oil storage tank and is transferred to the generator engine lubricating oil measuring tank from where it is transferred directly into the engine sumps.

a) Check and record the level of oil in both lubricating oil tanks.

b) Ensure that all transfer valves are closed when not in use.

c) Ensure that there is sufficient space in the tank to be filled for the intended transfer.

d) Position the valves as shown in the following table:

CAUTION
Only one generator sump at a time should be topped-up or filled.

Position	Description	Valve
From Generator Engine LO Storage Tank to LO Measuring Tank		
Set to fill tank	Generator engine three-way LO run-down valve	QS34
Open	Generator engine measuring tank inlet/outlet valve	QS
Closed	Generator engine LO tanks run-down valve to generator engines	SS44
Open	Generator engine LO storage tank quick-closing outlet valve	QS1
From Generator Engine LO Measuring Tank to Generator Sumps		
Set to generators	Generator engine three-way LO run-down valve	QS34
Closed	Return valve from LO separator	SS62
Open	Generator engine measuring tank inlet/outlet valve	QS35
Open	Generator engine LO tanks run-down valve to generator engines	SS44
Open	Generator engine (No. 1, 2 or 3) sump filling valve	SS1, SS42 or SS43
Closed	Generator engine (No. 1, 2 or 3) sump filling valve	SS1, SS42 or SS-43

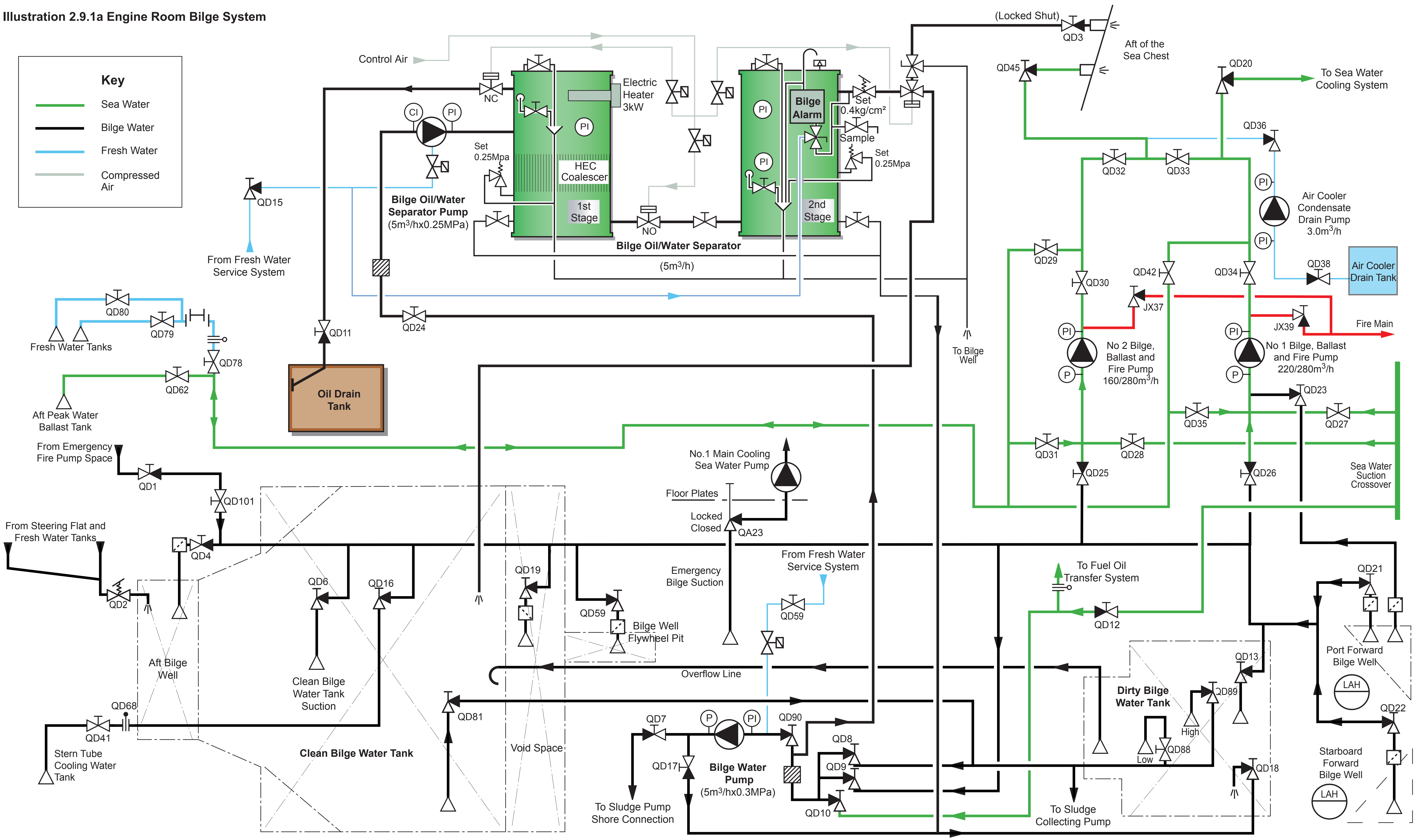
e) Close all valves when the transfer is complete.

f) Check and record the levels in the measuring tank and engine sump(s).

Note: If the lubricating oil separator is in use, care should be taken to ensure that the correct sump is filled. If in doubt stop separation during the filling procedure.

2.9 Bilge Systems

Illustration 2.9.1a Engine Room Bilge System



2.9 BILGE SYSTEMS

2.9.1 ENGINE ROOM BILGE SYSTEM AND BILGE SEPARATOR

Bilge Water Pump

Manufacturer:	Blohm & Voss/ Waserkobold
Model:	GLZ5000 double-acting reciprocating
No. of sets:	1
Speed:	126 strokes/min
Capacity:	5.0m^3/h at 0.30MPa

Bilge Oil/Water Separator

Manufacturer:	ThyssenKrupp - Blohm & Voss
Model:	Turbulo TCS 5 HD
No. of sets:	1
Capacity:	5.0m^3/h at 0.23MPa

Bilge Water Discharge Monitor

Manufacturer:	DeckmaHamburg, ThyssenKrupp - Blohm & Voss
Model:	OMD2005
No. of sets:	1
Range:	0 ~ 15 ppm
Alarm point:	5 ppm

Bilge Water Separator Pump

Manufacturer:	ThyssenKrupp - Blohm & Voss
Model:	Turbulo TSP helical rotor
No. of sets:	1
Capacity:	5.0m^3/h at 0.23MPa

Bilge, Ballast, Fire & General Service Pump

Manufacturer:	Shinko
Model:	RVP300-MS, self-priming
No. of sets:	2
Capacity:	220/280m^3/h at 1.0/045MPa

Description

The engine room bilge system comprises various engine bilge well and void space suctions, a dirty bilge tank, a clean bilge tank, a bilge pump and the bilge oil/water separator with integral pump.

The engine room bilge system suctions comprise:

- Port forward bilge well
- Starboard forward bilge well
- Port forward void space
- Starboard forward void space
- Centre line bilge - aft of main engine
- Aft engine room void space
- Port aft bilge well
- Stern tube cooling water tank
- Emergency fire pump room drain scupper
- Dirty bilge water tank
- Clean bilge water tank

High level alarms are fitted in each bilge well.

In normal operation the engine room bilge wells and void spaces are pumped out through the bilge oil/water separator using the integral pump. The contents of the bilge wells are drawn by the pump through the separator, where oil is separated from the water and transferred to the oil drain tank, and the clean water then discharged overboard.

The bilge water pump is used when the vessel is in port or coastal waters to transfer the contents of bilge wells and void spaces to the dirty bilge tank or via the sludge pump shore connection, for disposal ashore.

During extended times in port or restricted waters the contents of the dirty bilge tank may be pumped through the oily water separator. In this case, any oil separated out will pass to the oil drain tank as normal, but the cleaned water will be transferred to the clean bilge water tank. When the vessel is at sea, the contents of the clean bilge water tank will be discharged overboard through the oily water separator.

CAUTION

Direct overboard discharge of machinery space bilge water is prohibited except under emergency conditions.

In the territorial waters of the USA the discharge of oily water is illegal. Due to the methods that the USA use to determine the oily content of discharged water the following CAUTION should be carefully considered.

CAUTION

Discharge of oil is prohibited. The Federal Water Pollution Control Act prohibits the discharge of oil or oily waste into or upon the navigable waters of the United States or the waters of contiguous zones, or which may effect natural resources belonging to, appertaining to, under exclusive management of the United States, if such discharge causes a film or discolouration of the surface of the water or cause a sludge or emulsion beneath the surface of the water. Violators are subject to substantial civil penalties and / or criminal sanctions including fines and imprisonment.

If circumstances permit and a slop barge or shore reception facilities are vavailable the bilge tanks may be discharged using the bilge water pump and the sludge pump shore discharge connection. The dirty bilge tank may also be discharged with the sludge collecting pump.

Bilge Oil/Water Separator

When operating the oily bilge water separator and the overboard oil monitoring system, the date, quantity and location of the discharge overboard is to be recorded in the Oil Record Book. All pumping operations and discharges are also to be in accordance with the latest MARPOL Regulations Annex I Regulations 9, 10, 11 and 16.

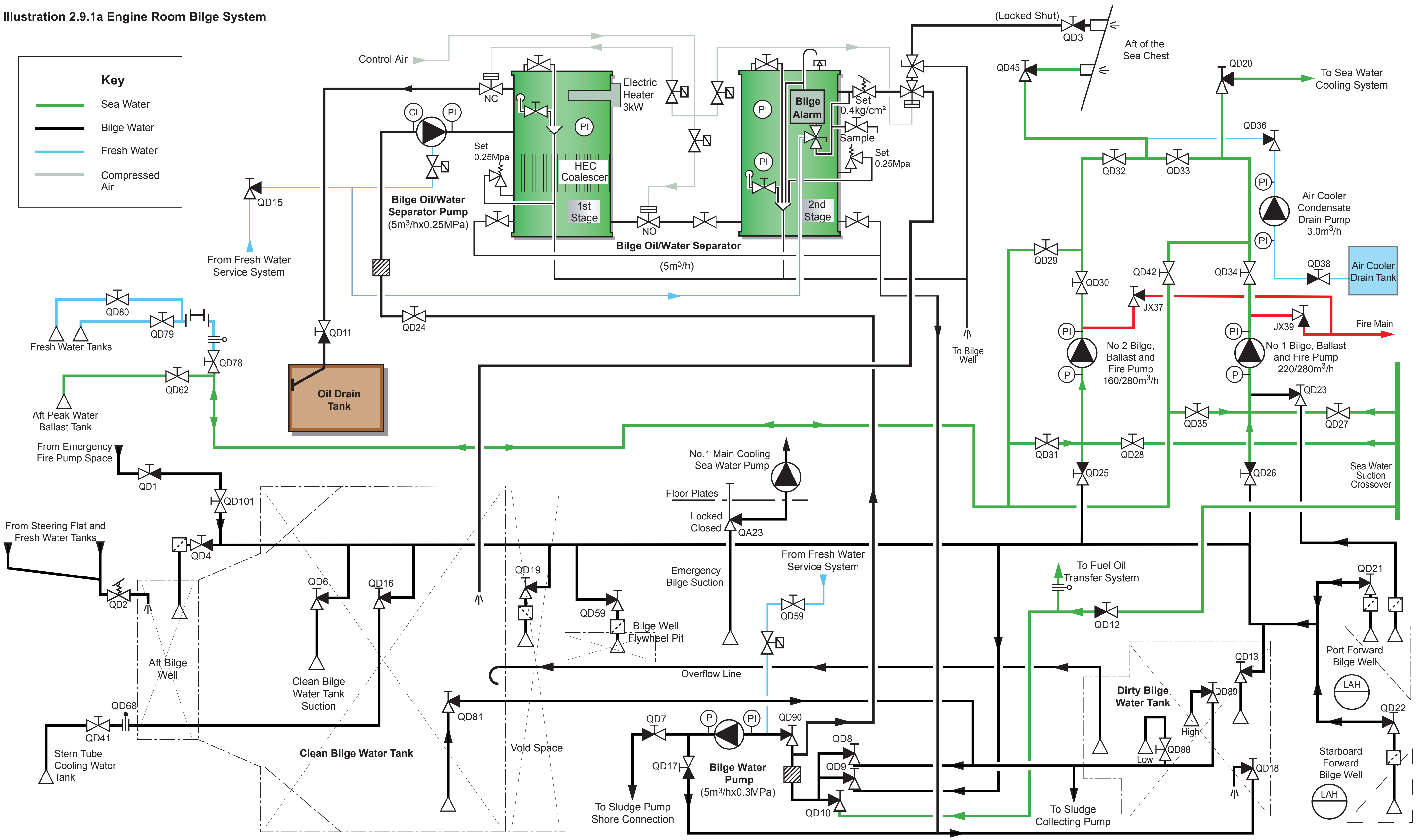
The bilge separator operates automatically and discharges water overboard and separated oil to the oil drain tank. Bilge water is drawn from the bilge main by the attached pump and into the bilge separator where it passes through a two-stage separation process. The separator uses the difference in density and surface tension between oil and water in two stages that are housed separately and comprise the following.

- Stage 1 - The HEC (High Efficiency Coalescer) housing
- Stage 2 - HycaSep (Hydrocarbon Separator) housing

The separator is initially filled with clean water before admitting bilge water. The pump supplies the oil water mixture to the HEC stage where most of the oil is retained. Oil droplets are attracted to the coalescer surface forming into increasingly larger drops until they float. The coalescer has a very large open pore surface area and a very low pressure loss and is stable against suspended matter found in bilge water, hence these particles have no detrimental effect on the coalescer. This means that the coalescer will still continue to operate effectively even with considerable fouling.

Following separation in the HEC, the water, now with a very low oil content, is passed into the second stage HycaSep chamber. This chamber contains a second coalescer filter to separate out any remaining oil particles, leaving water that may now be discharged overboard. The HycaSep filter elements have a finite operating life and should be renewed when the differential pressure across the unit exceeds the manufacturer's limit of approximately 1.4 bar.

Illustration 2.9.1a Engine Room Bilge System



A capacitance oil/air sensing probe at the top of the first stage (HEC) chamber constantly monitors the oil level in the separator, the length of the probe's electrode determining the operating range. When oil (or air) is detected the valve to the oil drain tank opens and the valve to the second stage (HS) chamber closes and the oil is discharged to the oil drain tank. The supply pump remains running during the oil discharge. When most of the oil has been displaced, the oil sensing probe is again immersed in water and activates the control system to resume the separating operation.

The separator works automatically and will operate as long as there is water in the bilge holding tank. Heating may be applied in order to improve separation, but the heater will only operate when the separator is full of liquid. The separator is fitted with sampling valves which allow oil samples to be drawn and enable the oil/water interface level to be determined. The two housings are designed as pressure vessels and each is fitted with a relief valve set to lift at 2.5 bar.

The oil content discharge (OCD) monitor (type OMD-2005) samples the bilge water as it passes out of the separator. Should the oil content exceed 5ppm, the three-way valve changes the output flow from the overboard discharge to discharge to the clean bilge tank. An audible alarm sounds to warn the operator of the alarm condition. The 5ppm setting can be adjusted from 1ppm up to the maximum 15ppm, but cannot be set higher. The monitor sensing element may be flushed through with fresh water when in operation by moving the supply lever from the SAMPLING to the FLUSHING position. This action automatically operates the three-way valve on the discharge line and returns the water to the bilge holding tank. The monitor contains a memory card recording the monitor readings for a period of 18 months, after which the data is automatically overwritten. The card is not to be removed from the instrument as it records the following information.

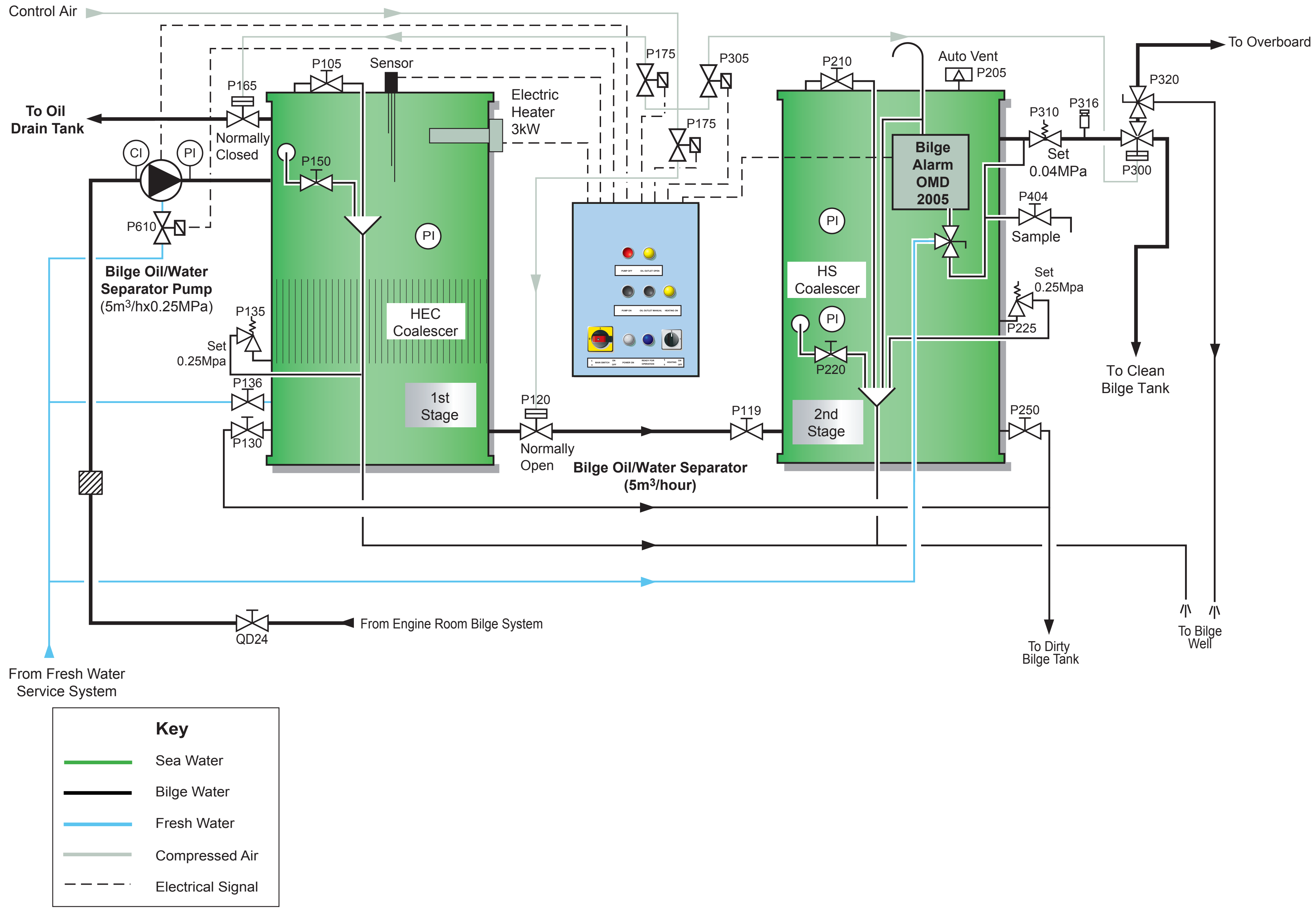
- Time
- Date
- Oil content greater than 15ppm
- Separator status

CAUTION
The oily water separator is designed to separate oil from water, not water from oil. Therefore, if the bilge water 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 bilge pump 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.

The separator is able to operate automatically, however in normal operation it should be only be operated under close manual supervision.

Illustration 2.9.1b Bilge Oil/Water Separator



Procedure for Transferring Bilges to the Dirty Bilge Water Tank

a) Check that the strainers and strum boxes are clean.

b) Ensure that port and starboard bilge system sea chest valves (QD-102 and QD-93) are closed.

c) Open one of the following suction valves:

Description	Valve
Port forward bilge well	QD21
Starboard forward bilge well	QD22
Port forward engine room void space	QD96
Starboard forward engine room void space	QD97
Flyweel pit bilge well	QD59
Aft engine room void space	QD19
Aft bilge well	QD4
Stern tube cooling water tank, the following to be open	
Suction valve	QD41
Spectacle blank	QD68
Isolating valve	QD16
Emergency fire pump space, the following to be open	
Suction valve	QD1
Isolating valve	QD101

The steering gear room bilge wells are drained to the aft engine room bilge well through self-closing valve QD2.

d) Open the bilge water main suction header valve (QD9).

d) Open the bilge water pump suction valve (QD90).

e) Ensure that the shore discharge valve (QD7) is closed.

f) Open the bilge water pump discharge valve (QD17).

g) Open the bilge water pump discharge valve (QD18) to the dirty bilge water tank.

h) Open the service water priming line valve (QG59) and start the bilge water pump. The service water priming valve will open for a short period to prime the pump.

i) Before the bilge well in use loses suction, open the valve on another bilge well and close the one in use, before the pump loses suction.

CAUTION

Bilge pumping operations should be monitored constantly, as running dry will damage the pump.

j) When the bilge wells/void spaces are dry, stop the pump and close all valves.

CAUTION

The bilge water separator is designed to separate oil from water, not water from oil. The separator will not operate if there are excessive amounts of oil in the bilge fluid.

The dirty water bilge tank is provided with high and low suctions and a cross-connection to the sludge pump suction. Large volumes of oil accumulating in the tank should be removed by the sludge pump, via the high suction, and discharged to the composite boiler waste oil tank.

Procedure for Pumping the Dirty Bilge Water Tank Via the Bilge Water Separator

a) Position the valves as shown in the table:

Position	Description	Valve
Closed	Dirty bilge water tank high suction valve	QD88
Open	Dirty bilge water tank low suction valve	QD89
Open	Dirty bilge water tank suction header valve	QD8
Closed	Bilge main suction header valve	QD9
Closed	Sea water suction header valve	QD10
Closed	Clean bilge water tank suction valve	QD81
Closed	Bilge water pump suction valve	QD90
Open	Bilge water separator inlet valve	QD24
Operational	Bilge water separator three-way solenoid operated discharge valve	QD76
Closed	Three way solenoid operated discharge valve bypass valve to clean bilge water tank	QD43
Open	Bilge water separator overboard discharge valve	QD3
Open	Clean bilge water tank inlet valve	QD5
Open	Oil drain tank inlet valve	QD11
Open	Bilge water separator service water inlet valve	QD15

b) Ensure that control air is available to the bilge oil/water separator.

c) Supply power to the oil/water separator control unit.

d) Check the operation of the oil content monitor by passing fresh water through the sensor. Check the reading and shut off the fresh water supply.

e) Start the separator pump.

Oil in excess of 5ppm in the discharged water will activate an alarm and automatically reposition the three-way discharge valve (QD76) to direct the flow to the clean bilge water tank, until the water is clean enough to discharge overboard. Oil collected in upper section of the oil/water separator will be automatically discharged to the oil drain tank.

f) When the water level in the bilge water tank has been reduced as far as possible, flush the separator through with clean water before stopping and closing all valves.

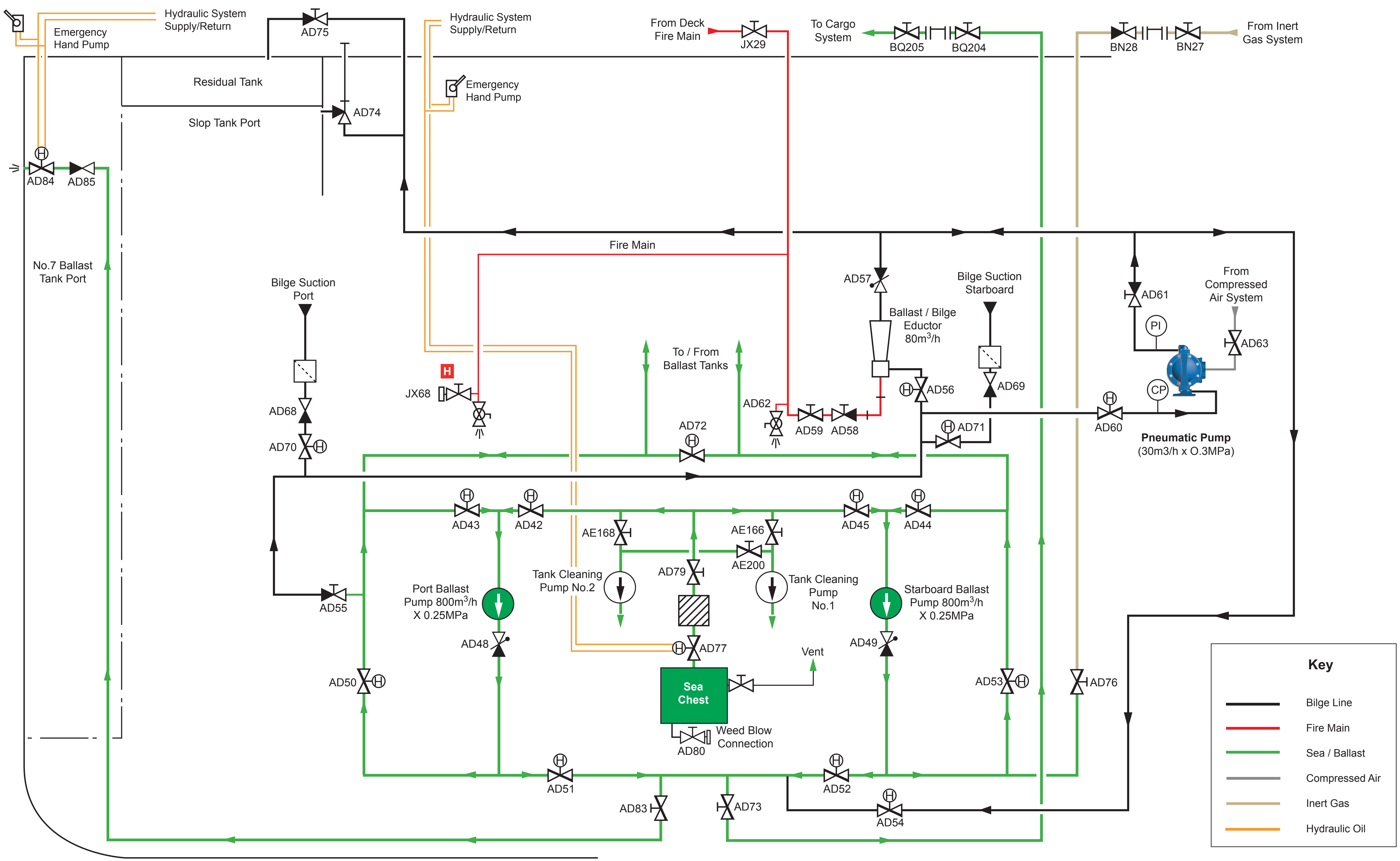
Emergency Bilge Pumping

The two engine room bilge, ballast and fire pumps are provided with suction valves, connecting to the bilge suction main. Additionally, No. 1 bilge, ballast and fire pump has a direct suction from the port forward bilge well. The suction valves are normally closed and sealed with a breakable tag. In bilge operation the pumps discharge directly to the sea and must only be used in the event of an emergency or failure of the bilge water pump and separator system.

After pumping bilges, the pump and discharge pipelines must be thoroughly flushed clean with sea water before being returned to use on other services.

Further emergency pumping capacity is provided by No.1 main cooling sea water pump, this has a 200mm direct emergency bilge suction line. The valve is located on the inboard side of the pump and forward of No.2 pump. The valve is below floor level with the suction drawing from the tank top on the starboard side, and is fitted with an extended spindle with the handwheel located some 460mm above the floor plates. The valve is normally closed and sealed with a breakable tag. The pump discharges overboard through the central coolers and is intended for use only in the case of major flooding in the engine room. (See Section 5.1 for more detail.)

Illustration 2.9.2a Pump Room Bilge System



2.9.2 BALLAST PUMP ROOM, BOW THRUSTER SPACE, BOSUN'S STORE AND CHAIN LOCKER BILGE SYSTEMS

Pump Room Bilge System

Pneumatic Pump

Manufacturer: Wilden Pump and Engineering Co.
Model: T 15
No. of sets: 1
Capacity: 30m^3/h at 0.30MPa

Ballast/Bilge Eductor

Manufacturer: Jiang Sui Zhen Hua Pump Industry Co. Ltd.
Model: 2½
No. of sets: 1
Capacity: 80m^3/h at 0.25MPa

The ballast pump room is provided with port and starboard bilge wells. The bilges may be emptied by either the pneumatic pump rated at 30m^3/h, or via a bilge eductor rated at 80m^3/h. The discharge from either can be directed to the residual tank or port slop tank.

In normal operation the pneumatic pump is used to empty the ballast pump room bilges to the residual tank. The bilge eductor is operated by a water supply from the fire main/deck wash system. The drive water is supplied via a spool piece, which should be removed when the eductor is not in use.

The suction line from each bilge well is provided with a manually operated check valve and a hydraulic motorised isolating valve, controlled from the cargo control room.

The ballast pump room is normally closed and secured when the vessel is at sea. The room is not designated as an enclosed space, permission should be sought from the duty navigating officer and the space ventilated before entry.

The pump room fan should be started 10 to 15 minutes before entry and the lighting system switched on.

Procedure for Draining the Pump Room Bilges Using the Pneumatic Pump

a) Ensure that the service air supply and hydraulic valve remote control system are available.

b) Ensure that the bilge well strainers are clean.

c) Position the valves as shown in the following table:

Position	Description	Valve
Open	Port bilge suction valve	AD70
OR		
Open	Starboard bilge suction valve	AD-71
Open	Pneumatic bilge pump suction valve	AD60
Open	Pneumatic bilge pump discharge valve	AD61
Closed	Slop tank inlet valve	AD74
Open	Residual tank inlet valve	AD75
Open	Pneumatic bilge pump air supply valve	AD63

d) Control the pump speed by regulating the air supply.

e) Close all valves when the operation is complete.

Procedure for Draining the Pump Room Bilges Using the Bilge Eductor

a) Ensure that the fire water/deck wash system and hydraulic valve remote control system are available.

b) Ensure that the bilge well strainers are clean.

c) Fit the spool piece on the water supply to the eductor.

d) Position the valves as shown in the table below:

Position	Description	Valve
Open	Port bilge suction valve	AD70
OR		
Open	Starboard bilge suction valve	AD71
Open	Eductor motorised suction valve	AD56
Open	Eductor discharge valve	AD57
Closed	Slop tank inlet valve	AD74
Open	Residual tank inlet valve	AD75
Closed	Eductor spool piece drain valve	AD62
Open	Fire water/deck wash water isolating valve	AD58
Open	Fire water/deck wash water eductor inlet valve	AD59

e) Ensure that the eductor is operating correctly.

f) Close all the valves when the operation is complete.

Bosun's Store, Chain Lockers and Bow Thruster Space Bilge System

Bilge Eductor

Manufacturer:	Jiang Sui Zhen Hua Pump Industry Co. Ltd.
Model:	1½
No. of sets:	3
Capacity:	$8m^3/h$ at 0.25MPa discharge

There are three bilge eductors, each with a capacity of $8m^3/h$ and driven by sea water from the fire main, these are provided for the drainage of the bosun's store, chain lockers and bow thruster machinery space. Each suction point is equipped with a suction strainer and non-return valve. High level alarms are fitted in the bosun's store and the bow thruster space.

Ensure that there is no oil contained in the bilges before they are discharged overboard. If there is any oil present, then alternative methods must be used to discharge the bilge wells, for example, into used empty drums and then transferred to the dirty bilge tank in the engine room, etc.

Procedure for the Operation of the Forward Bilge Systems

a) Ensure that the suction strainers are clean and the cover is correctly fitted.

b) Start the duty fire pump and pressurise the fire main.

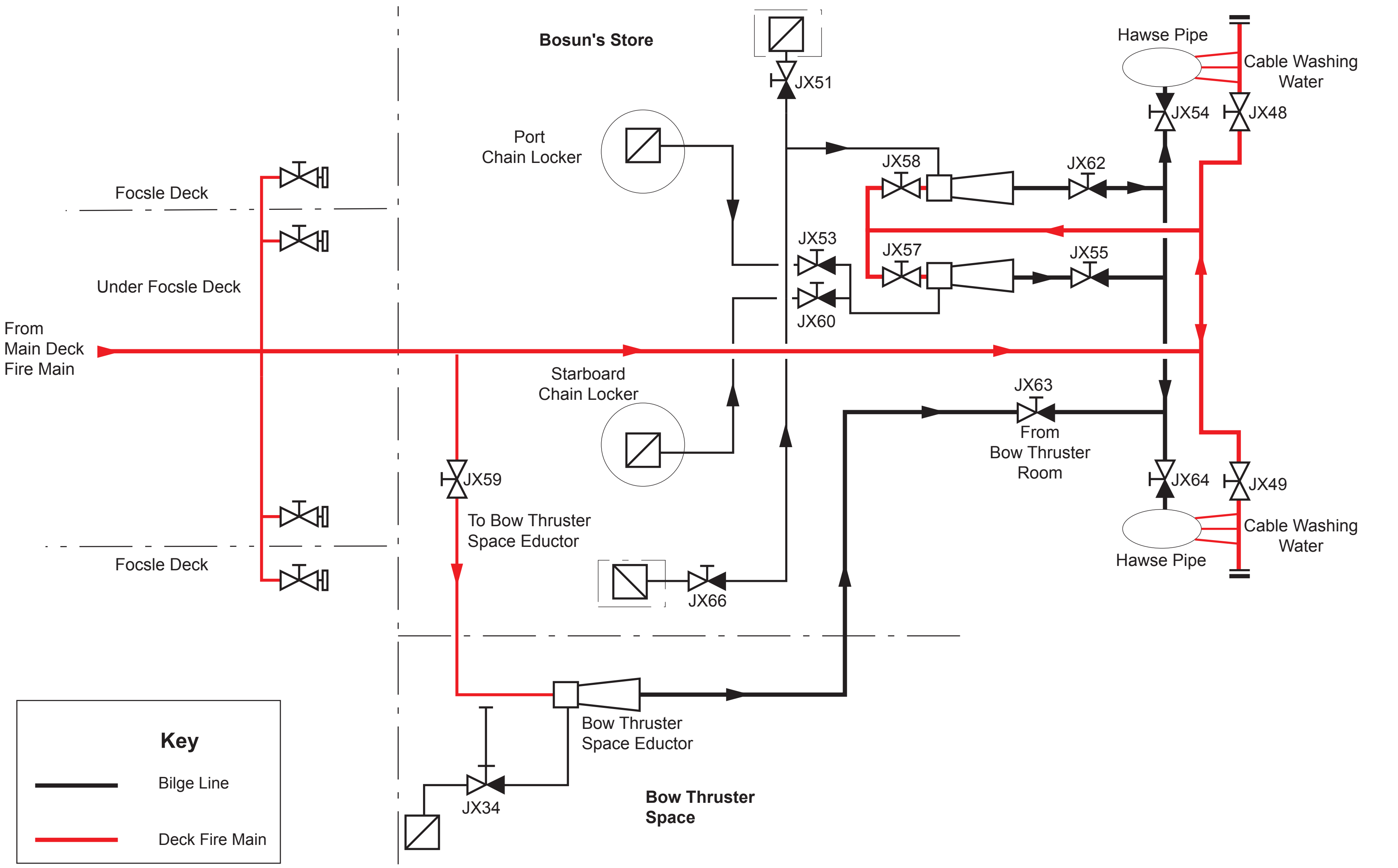
c) Open the appropriate overboard discharge valve, either through the port or starboard hawse pipe.

d) Open the appropriate eductor suction valves.

e) Open the appropriate eductor drive water supply valve.

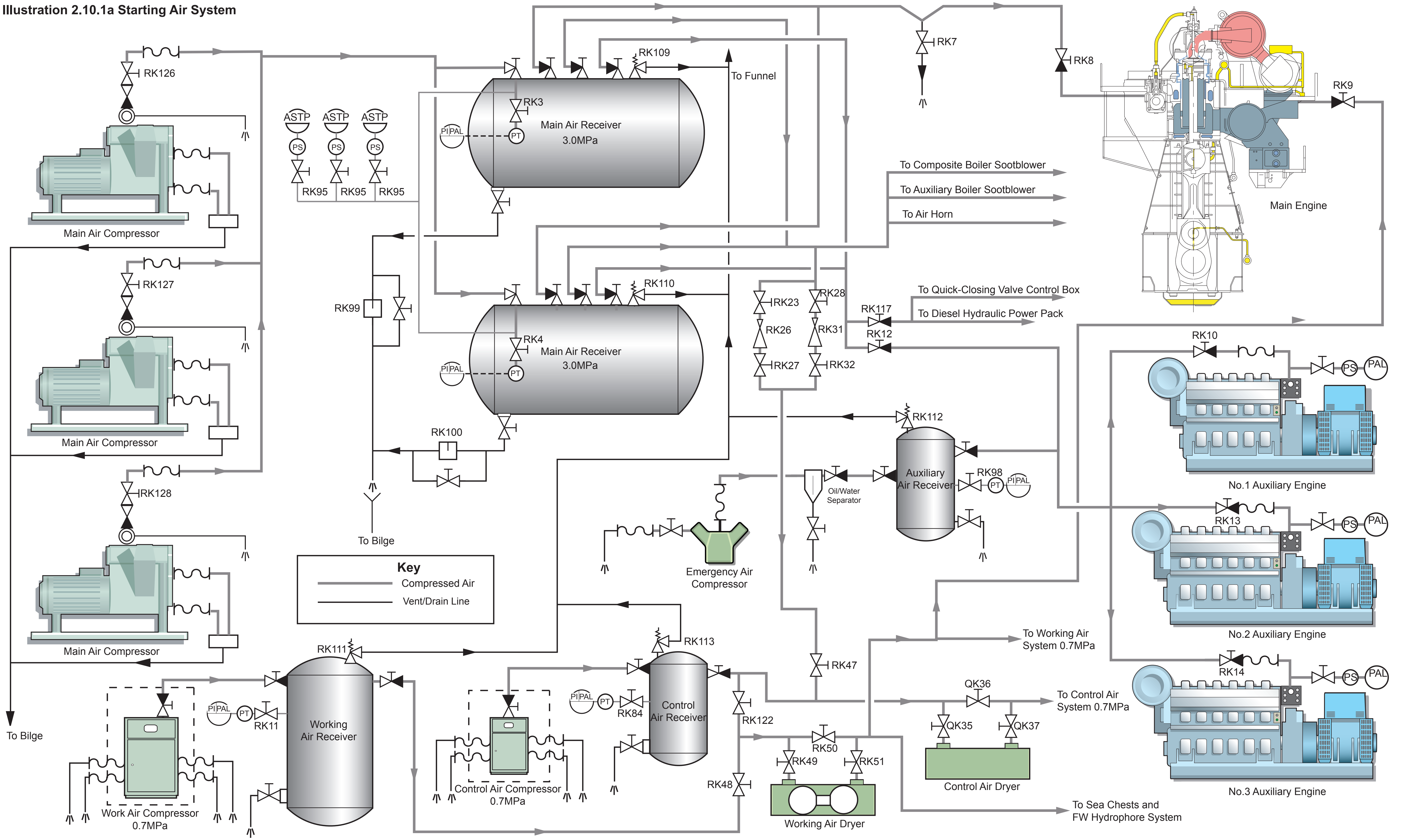
f) On completion, close all the above valves and stop the fire pump.

Illustration 2.9.2b Bosun's Store, Chain Locker and Bow Thruster Space Bilge System



2.10 Compressed Air Systems

Illustration 2.10.1a Starting Air System



2.10 COMPRESSED AIR SYSTEMS

2.10.1 STARTING AIR SYSTEM

Main Air Compressors

Manufacturer:	Hatlapa-Sperre Industri AS, Norway
Model:	HV2-200
No of sets:	3
Type:	Two-stage water-cooled
Capacity:	$136m^3$/h at 3.0MPa
Speed:	875 rev/min
Power:	25kW

Emergency Air Compressor

Manufacturer:	Hatlapa-Sperre Industri AS, Norway
Model:	H12-77
No of sets:	1
Type:	Two-stage air-cooled
Capacity:	$20m^3$/h at 3.0MPa
Speed:	1,150 rev/min
Power:	4.8kW

Main Air Receivers

Manufacturer:	Jiujiang Marine Machinery, China
Model:	B7.0 - 3.0
No of sets:	2
Capacity:	$7.0m^3$
Working pressure:	3.0Pa

Auxiliary Air Receiver

Manufacturer:	Jiujiang Marine Machinery, China
Model:	A0.25 - 3.0
Capacity	$0.25m^3$
Working pressure:	3.0MPa

Description

The compressed air used to start both the main engine and the three diesel generator engines is provided by three main air compressors. These compressors supply two $7.0m^3$ main air receivers, which act as reservoirs to allow for the high consumption of compressed air when manoeuvring. The water-cooled compressors are two-stage reciprocating units with both inter-cooler and after-cooler, cooling water being provided by the central fresh water cooling system.

The air-cooled emergency compressor is also a two-stage reciprocating machine and is supplied with electrical power from the emergency switchboard and provides compressed air to the auxiliary air receiver. This receiver provides starting air to the diesel generator engines if compressed air from the main air receivers is unavailable. The auxiliary air receiver is normally kept at full pressure with all valves closed and should be available for use at all times.

Each main air compressor has an automatic drain fitted to the water separator on the high pressure discharge, this opens when the compressor stops and closes at a set time after the compressor runs up to speed. This allows the compressor to both start and stop in the unloaded condition. The compressors are started and stopped by pressure switches connected to the main air receivers and will operate automatically as duty(lead)/ first follow-up/second follow-up. The duty or lead compressor will start first. When the duty compressor is unable to meet the demand for compressed air the first follow-up compressor will start, followed by the second follow-up if the air pressure continues to fall.

The duty and follow-up compressors are selected by a selector switch on the compressor control panel.

The main air receivers are each fitted with a local pressure gauge and a pressure relief valve, set to operate at 3.3MPa. A drain connected to an automatic drain trap is provided at the bottom of the receiver to remove accumulated liquids.

The starting air system supplies compressed air at 3.0MPa to:

- Main engine starting air
- Generator engine starting air
- Auxiliary boiler sootblowers
- Composite boiler sootblower
- Quick-closing valve control system air reservoir

Compressed air is also supplied at 1.0MPa via pressure reducers to the air whistle and as starting air for the diesel-driven hydraulic power pack.

Further pressure reducing valves allow the starting air system to supply both the control air and working air systems.

Procedure for the Operation of the Starting Air System

In normal operation, both receivers may be in use. However, consideration should be given to maintaining one receiver fully pressurised and off-line to act as reserve capacity.

The following procedure assumes that all valves are initially closed and that all three main compressors will be available for use.

a) Ensure all pressure gauge and instrumentation valves are open.

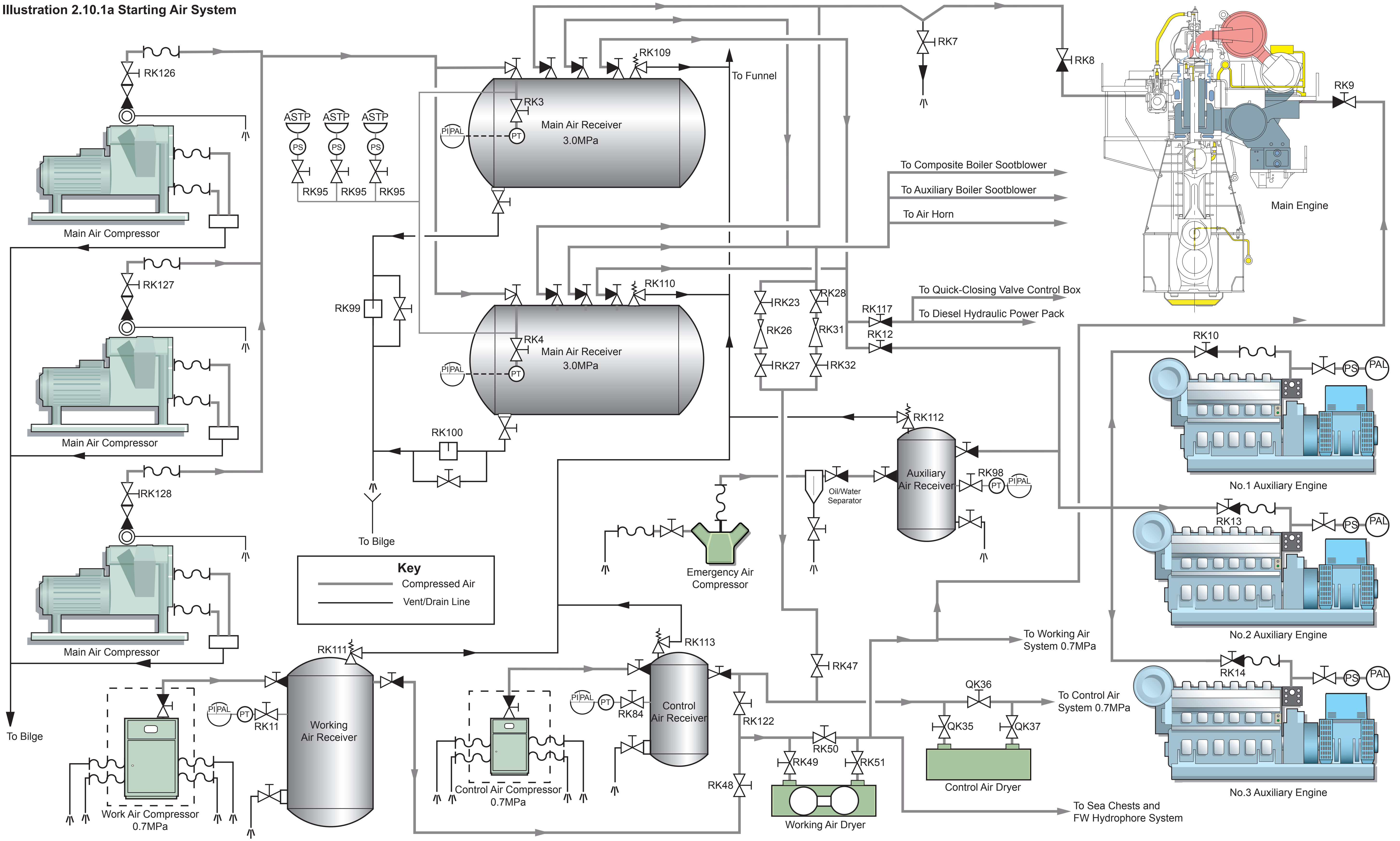
b) Check the oil level in the compressors and check the sump for water.

c) Ensure that the central fresh water cooling system is available.

d) Position the valves as shown in the table:

Position	Description	Valve
Open	No.1 main air compressor discharge valve	RK126
Open	No.2 main air compressor discharge valve	RK127
Open	No.3 main air compressor discharge valve	RK128
Open	No.1 main receiver inlet valve	
Open	No.1 main receiver drain valve	
Operational	No.1 main receiver drain trap/separator	RK99
Closed	No.1 main receiver drain trap/separator bypass valve	
Open	No.1 main receiver outlet valve to main engine starting air	
Open	Main engine air start inlet valve	RK8
Open	No.1 main receiver outlet valve to quick-closing valves, hydraulic power pack diesel engine, air whistle, and crossover to control and work air systems	
Open	No.1 receiver outlet valve to generator engines start air	
Open	No.2 main receiver inlet valve	
Open	No.2 main receiver drain valve	
Operational	No.2 main receiver drain trap/separator	RK100
Closed	No.2 main receiver drain trap/separator bypass valve	
Open	No.2 main receiver outlet valve to main engine starting air	

Illustration 2.10.1a Starting Air System



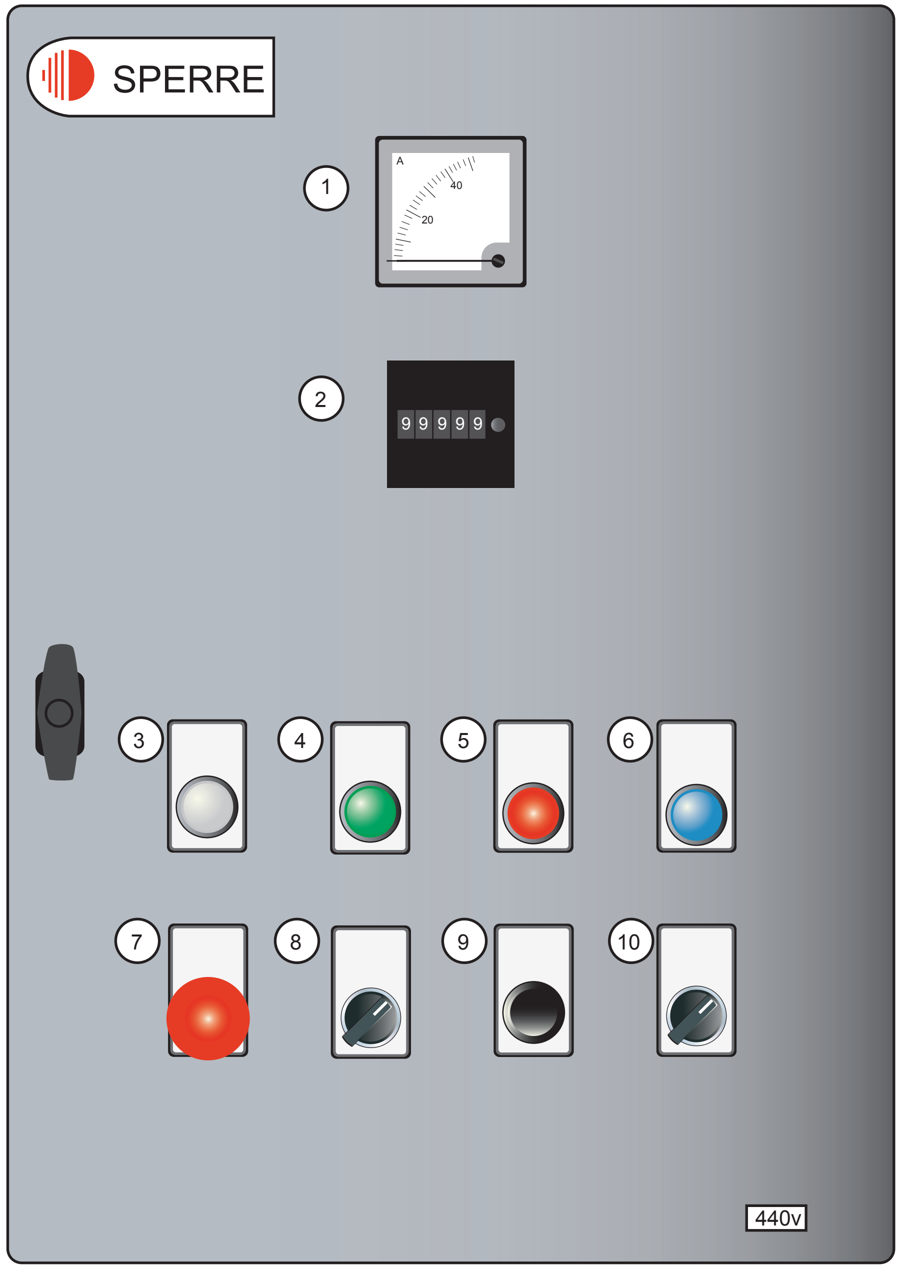
Position	Description	Valve
Open	No.2 main receiver outlet valve to quick-closing valves, hydraulic power pack diesel engine, air whistle, and crossover to control and work air systems	
Open	No.1 receiver outlet valve to generator engines start air	
Open	Quick-closing valve control system and hydraulic power pack diesel engine air start supply valve	RK117
Open	Generator engines start air supply valve	RK12
Open	No.1 generator air start inlet valve	RK10
Open	No.2 generator air start inlet valve	RK13
Open	No.3 generator air start inlet valve	RK14
Open	Hydraulic power pack diesel engine pressure reducing valve inlet valve	RK105
Open	Hydraulic power pack diesel engine pressure reducing valve outlet valve	RK106
Closed	Hydraulic power pack diesel engine pressure reducing valve bypass valve	RK104
Open	Hydraulic power pack diesel engine air start inlet valve	RK103
Open	Composite boiler sootblower supply valve	RK115
Open	Auxiliary boiler sootblower supply valve	RK114
Open	Air whistle pressure reducing valve inlet valve	RK16
Open	Air whistle pressure reducing valve outlet valve	RK20
Closed	Air whistle pressure reducing valve bypass valve	RK15
Open	Control/work air No.1 pressure reducing valve inlet valve	RK23
Open	Control/work air No.1 pressure reducing valve outlet valve	RK27
Open	Control/work air No.2 pressure reducing valve inlet valve	RK28
Open	Control/work air No.2 pressure reducing valve outlet valve	RK32
Closed	Control/work air crossover isolating valve	RK47

e) Select the compressors for operation as duty/first follow-up and second follow-up.

f) Check the operation of the main air receiver automatic drain traps.

The air receivers will be under-pressure and the starting air system is now in service.

Illustration 2.10.1b Air Compressor Control Panel



Key

1 Ammeter
2 Hours Run Meter
3 Power On
4 Running
5 Alarm
6 Heater
7 Stop Pushbutton
8 Man 0 Auto
9 Reset
10 Heater (0 - I)

Procedure for the Operation of the (Generator Engine) Emergency Starting Air Compressor

The air-cooled emergency air compressor is started and stopped from a local control panel, which contains local and automatic functions similar to the main air compressors. The compressor discharge line is fitted with a liquid separator which traps oil and water condensate carried over from the compressor. The discharge valve to the auxiliary air receiver is fitted after this separator.

The auxiliary air receiver is fitted with a relief valve (RK112) set to operate at 3.3MPa, a compressor stop pressure switch and manual drain valve.

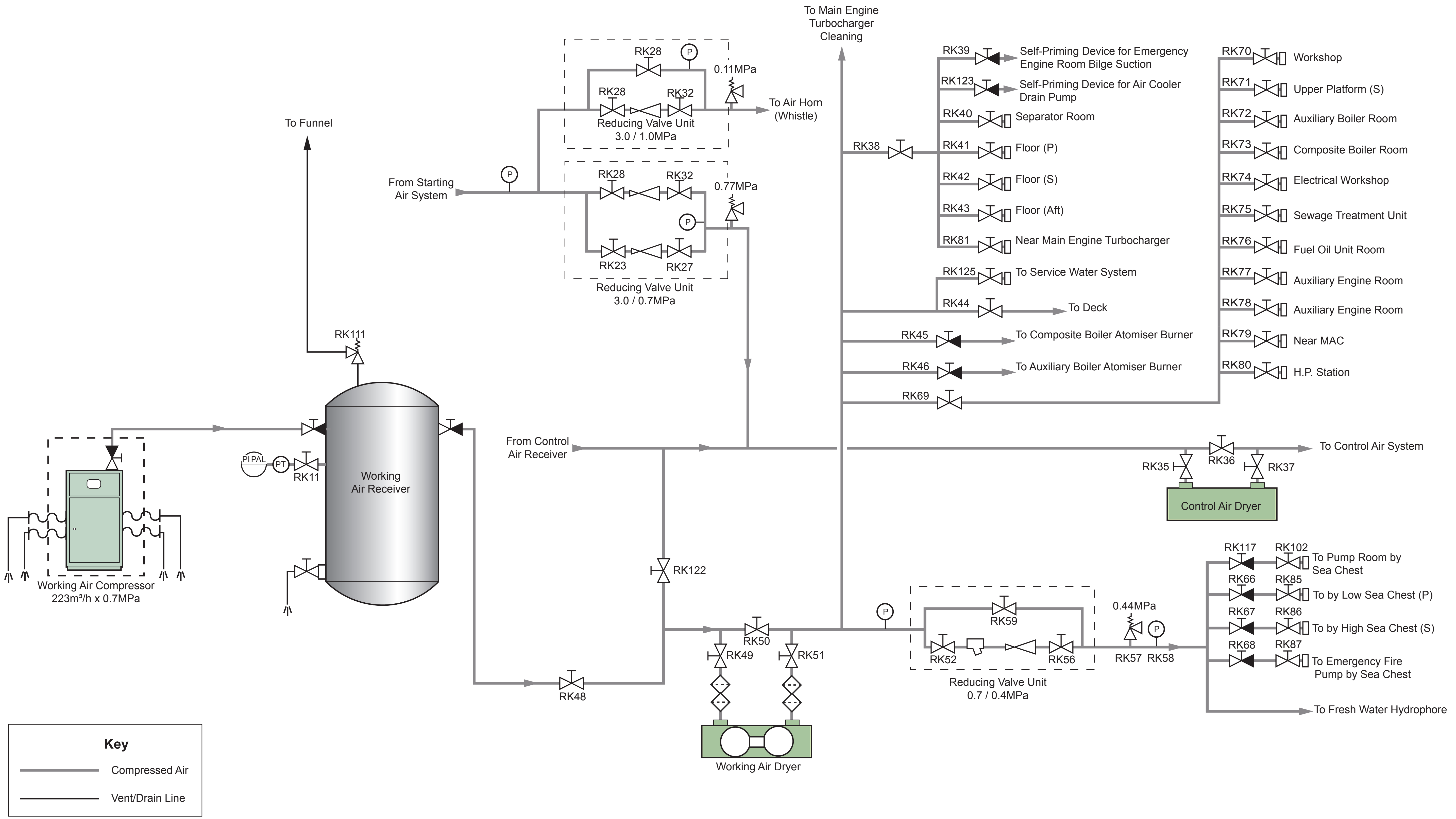
To operate the emergency air compressor the valves should be positioned as shown in the table:

Position	Description	Valve
Open	Discharge valve from drain trap/liquid separator	
Operational	Drain valve on drain trap/liquid separator	
Open	Auxiliary air receiver inlet valve	
Open	Auxiliary air receiver outlet valve	
Closed	Auxiliary air receiver drain valve	
Open	No.1 generator air start inlet valve	RK10
Open	No.2 generator air start inlet valve	RK13
Open	No.3 generator air start inlet valve	RK14

The auxiliary air receiver is normally maintained at full pressure, with the shell valves closed. This allows the diesel generator engine to be started even if the main starting air receivers have been drained.

In the case of a first start situation the emergency generator will provide power to the emergency air compressor and the auxiliary air receiver filled prior to starting a diesel generator.

Illustration 2.10.2a Working Air System



2.10.2 WORKING AIR SYSTEM

Working Air Compressor

Manufacturer:	Tamrotor Marine Compressors AS, Norway
Model:	TMC 20/8 SANA
No. of sets:	1
Type:	Screw, air-cooled
Capacity:	$201m^3$/h at 0.80MPa (max)
	$71m^3$/h at 0.80MPa (min)
Power:	25kW (max)
Speed:	3720 rev/min

Compressed Air Dryer

Manufacturer:	SPX-Hankison
Model:	HHL-165
No. of sets:	1
Capacity:	$276m^3$/h at 0.70MPa
Type:	Desiccant (Activated Alumina)

Working Air Receiver

Manufacturer:	Jiujiang Marine Machinery, China
Model:	A.25 - 0.7
Capacity	$0.25m^3$
Working pressure:	0.70MPa

Description

The working air system is provided with compressed air by a single-screw type working air compressor and $2.5m^3$ receiver. A crossover and reducing valves enables the working air system to be supplied from the starting air system in the event of compressor maintenance or failure.

The working air system may also be supplied from the control air system via a crossover line fitted with an isolating valve (RK122). This crossover also allows the working air system to supply the control air system.

The working air system supplies compressed air to the following services through the desiccant air dryer:

- Auxiliary boiler air atomisation
- Composite boiler burner unit
- Accommodation services
- Deck services
- Engine room services
- Pump room services
- FO and LO separators
- Emergency suction priming device
- Air cooler drain pump priming device
- Sewage treatment unit
- Domestic fresh water hydrophore unit
- Sea chests

The working air compressor is a motor-driven, single-stage screw compressor with oil cooler. Meshing rotors take in air between their ridges as they rotate past an intake opening. As the rotors turn the connection to the intake opening closes, and the space between the ridges starts decreasing and the air is forced along the screw under steadily increasing pressure. At the end of the compression phase, the design pressure has been reached, and the connection to the receiver opens.

The air in the compressor unit is cooled by oil that is injected into the compressor unit. The oil cools the air and the compressor unit, lubricates the bearings and seals the clearances between the rotors and the rotor housing.

From the compressor unit the mixture of pressurised air and oil mist is ducted into a separating receiver, where the oil is separated from the compressed air. The separating process has two phases. In the receiver the majority of the oil is separated in a centrifugal cyclone, the remainder of the oil is separated by oil separating cartridges. The oil separated at the cartridges is returned to circulation through an oil return pipe, which is provided with an orifice plate that prevents excess air recirculating to the compressor.

From the receiver, the hot oil is led through a cooler and oil filter, and returned to circulation. The receiver is provided with a thermostat for bypassing the cooler when the oil is cold. The forced oil circulation is maintained by the pressure difference between the receiver and the compressor unit. To guarantee oil circulation whenever the compressor produces pressurised air, an output valve prevents the receiver pressure from dropping below the set minimum value of 0.30MPa.

The oil-free air is led from the receiver to the after-cooler. The major part of the water is then removed from the cooled air by a water separator. An electromagnetic valve opens at set regular intervals to drain water from the separator.

The air from the compressor then passes to the air dryer where the remaining water is removed. The air dryer has two adsorber units, which remove any water from the air. One adsorber unit is in operation whilst the other is undergoing regeneration. Air drying is achieved by the entrained molecules of water being attracted to and bound by the surface of the desiccant.

At regeneration the adsorber pressure is reduced to atmospheric and some dried air from the working adsorber is expanded through the adsorber undergoing regeneration. The expansion of the air through the chamber removes moisture from the desiccant. At the end of the regeneration process the adsorber is ready for use. The changeover of the adsorbers is automatically controlled by a timer and once in operation the dryer continues in service as long as compressed air is supplied.

Procedure for Preparing the Work Air System for Operation

The following procedure assumes that all valves are initially closed.

a) Ensure that all instrumentation valves are open.

b) Check the oil level in the compressor.

c) Position the valves as shown in the following table:

Position	Description	Valve
Open	Working air compressor discharge valve	
Open	Working air receiver inlet valve	
Open	Working air receiver outlet valve	
Closed	Working air receiver drain valve	
Open	Working air system inlet valve	RK48
Closed	Crossover valve to/from control air system	RK122
Open	Air dryer inlet valve	RK49
Open	Air dryer outlet valve	RK51
Closed	Air dryer bypass valve	RK50
Open	0.7MPa header isolating valve	RK38
Open	0.7MPa header isolating valve	RK69
Open	Main engine working air supply	RK9
As required	0.70MPa services isolating valves	various
Open	0.40MPa reducing valve inlet valve	RK52
Open	0.40MPa reducing valve outlet valve	RK56
Closed	0.40MPa reducing valve bypass valve	RK59
As required	0.40MPa services isolating valves	various

d) Start the working air compressor, ensuring the loading and unloading system operates correctly.

e) Check that the system drain traps are operational.

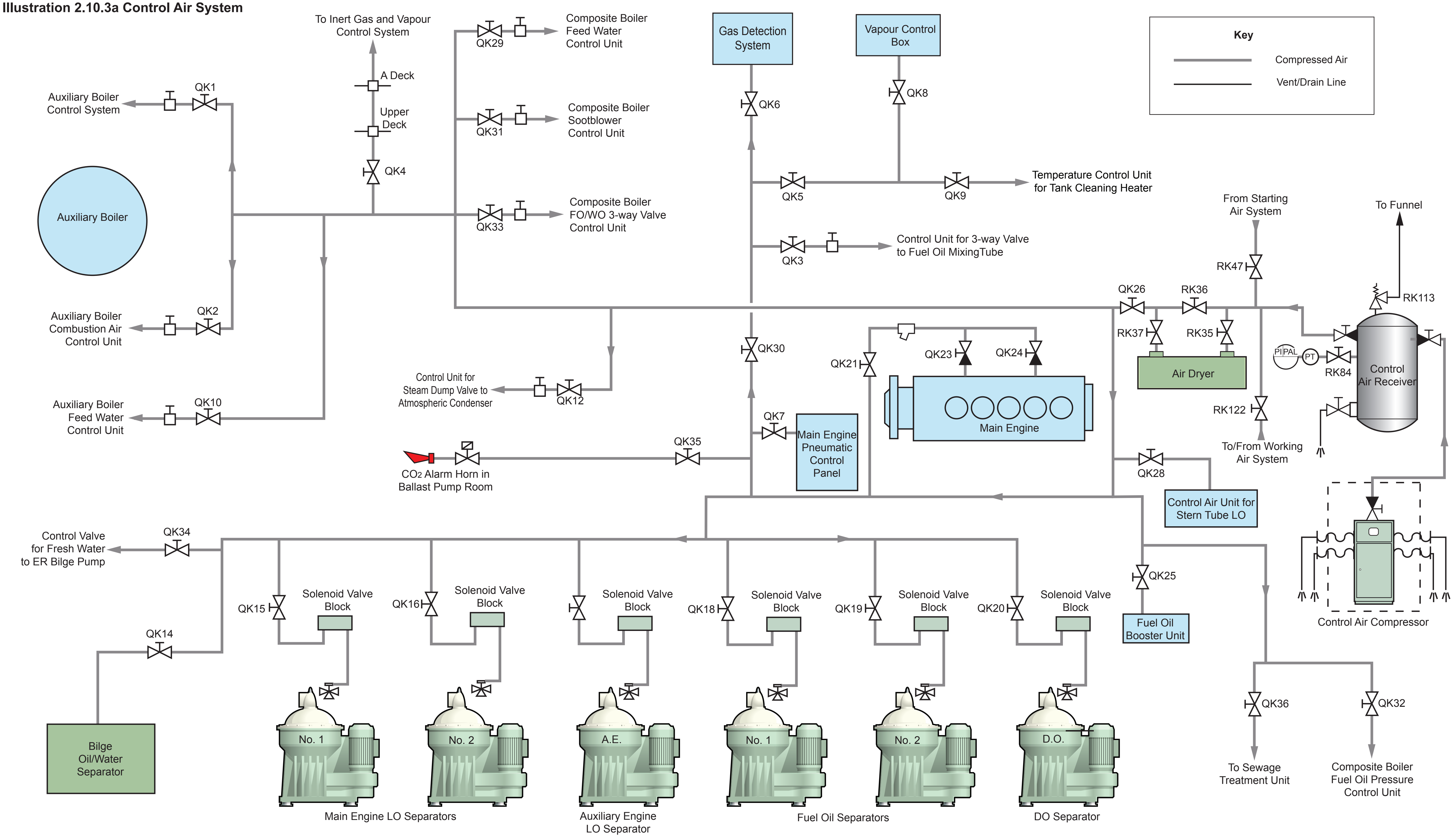
f) Start the air dryer and ensure that it operates automatically.

The working air system is now operational and ready for service.

WARNING

Care must be taken when working with compressed air. Air hoses must be properly connected to the outlet attachment before the valve is opened.

Illustration 2.10.3a Control Air System



2.10.3 CONTROL AIR SYSTEM

Control Air Compressor

Manufacturer:	Tamrotor Marine Compressors AS, Norway
Model:	TMC 6/8 EANA
No. of sets:	1
Type:	Screw, air-cooled
Capacity:	51m^3/h at 0.70MPa (max)
Power:	9.6kW (max)
Speed:	3700 rev/min

Control Air Dryer

Manufacturer:	Hankison-USN
Model:	HPRP50
No. of sets:	1
Capacity:	60m^3/h
Type:	Refrigerant (R-134a)

Control Air Receiver

Manufacturer:	Jing Jiang River and Sea Marine Fitting Works
Model:	A.25 - 0.7
Capacity	0.25m^3
Working pressure:	0.70MPa

Description

The control air system is provided with compressed air by a single control air compressor and 0.25m^3 receiver. A crossover valve (RK47) and reducing valves enables the control air system to be supplied from the starting air system in the event of compressor maintenance or failure.

The control air system may also be supplied from the working air system via a crossover line fitted with an isolating valve (RK122). This crossover also allows the control air system to supply the working air system.

The control air system supplies the following services through the refrigerant type air dryer:

- Bilge oil/water separator
- Lubricating oil purifiers and control systems
- Fuel and diesel oil purifiers and control systems
- Sewage treatment plant
- Stern tube seal system
- Inert gas control system
- Remote sounding system
- Main engine safety air system
- Main engine control air system
- Main engine auto backflushing lubricating oil filters
- Fuel oil supply unit
- Auxiliary and composite boiler control systems
- Auxiliary systems pressure and temperature control systems
- Cargo tank cleaning heater control system
- Gas detection system
- Vapour control system
- Pump room CO_2 alarm

The control air compressor is a motor-driven, single-stage screw compressor with oil cooler. Meshing rotors take in air between their ridges as they rotate past an intake opening. As the rotors turn the connection to the intake opening closes, and the space between the ridges starts decreasing and the air is forced along the screw under steadily increasing pressure. At the end of the compression phase, the design pressure has been reached, and the connection to the receiver opens.

The air in the compressor unit is cooled by oil that is injected into the compressor unit. The oil cools the air and the compressor unit, lubricates the bearings and seals the clearances between the rotors and the rotor housing.

From the compressor unit the mixture of pressurised air and oil mist is ducted into a separating receiver, where the oil is separated from the compressed air. The separating process has two phases. In the receiver the majority of the oil is separated in a centrifugal cyclone, the remainder of the oil is separated by oil separating cartridges. The oil separated at the cartridges is returned to circulation through an oil return pipe, which is provided with an orifice plate that prevents excess air recirculating to the compressor.

From the receiver, the hot oil is led through a cooler and oil filter, and returned to circulation. The receiver is provided with a thermostat for bypassing the cooler when the oil is cold. The forced oil circulation is maintained by the pressure difference between the receiver and the compressor unit. To guarantee oil circulation whenever the compressor produces pressurised air, an output valve prevents the receiver pressure from dropping below the set minimum value of 0.30MPa.

The oil-free air is led from the receiver to the after-cooler. The major part of the water is then removed from the cooled air by a water separator. An electromagnetic valve opens at set regular intervals to drain water from the separator.

It is essential that only dry-air is supplied to the control air system, as moisture can have a detrimental effect on the operational efficiency of control devices.

The refrigerant dryer uses a refrigeration system and heat exchanger to lower the temperature of the compressed air to 2 to 5°C, below the dew point of the air.

Excess water vapour condenses and is separated from the air. The refrigerated air is then heated before being supplied to the control air system.

Procedure for Preparing the Control Air System for Operation

The following procedure assumes that all valves are initially closed:

a) Ensure that all instrumentation valves are open.

b) Check the oil level in the compressor.

c) Position the valves as shown in the table:

Position	Description	Valve
Open	Control air compressor discharge valve	
Open	Control air receiver inlet valve	
Open	Control air receiver outlet valve	
Closed	Crossover valve to/from working air system	RK122
Closed	Supply valve from starting air system	RK47
Open	Control air dryer inlet valve	RK35
Open	Control air dryer outlet valve	RK37
Closed	Control air dryer bypass valve	RK36
Open	Control air system isolating valve	QK26

d) Open the individual inlet valves to all control systems.

e) Start the control air compressor, ensuring the loading and unloading system operates correctly.

f) Start the control air dryer. It will take a short while for the full drying effect to take effect. Vent to atmosphere until only moisture-free dried air is available for the control air system.

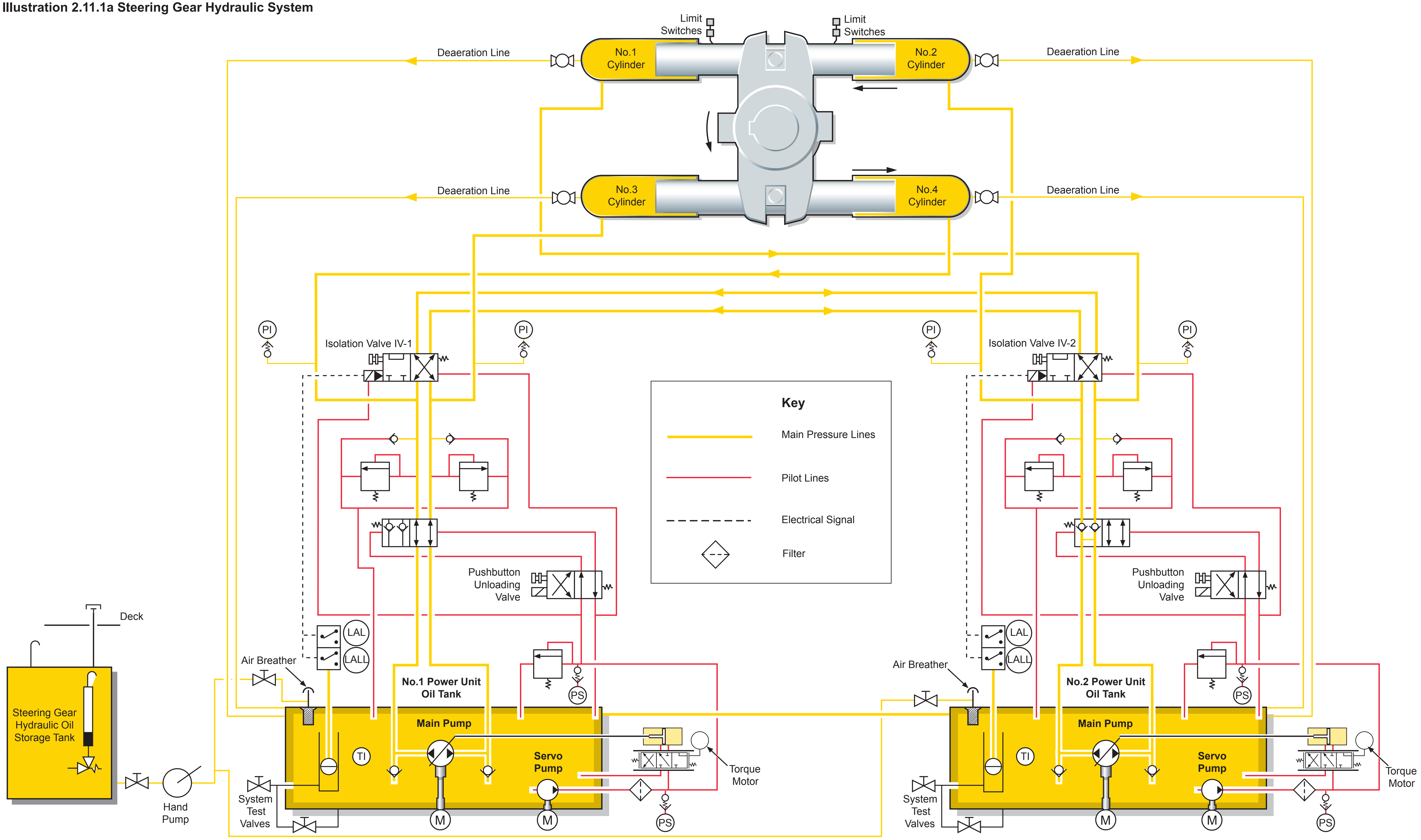
The control air system is now operational and ready for service.

See over for list of valves and services supplied.

Position of Valve	Description of Service
QK1	Auxiliary boiler burner control system
QK2	Auxiliary boiler combustion air fan control unit
QK3	Fuel oil mixing tube 3-way valve control unit
QK4	Inert gas and vapour control system
QK5	Line valve to vapour control panel and tank cleaning heater
QK6	Gas detection system
QK7	Main engine pneumatic control panel
QK8	Vapour control panel
QK9	Tank cleaning heater temperature control unit
QK10	Auxiliary boiler feed water control unit
QK12	Steam dump valve to atmospheric condenser control unit
QK14	Bilge oil/water separator unit
QK15	No.1 lubricating oil separator
QK16	No.2 lubricating oil separator
QK17	Auxiliary engine lubricating oil separator
QK18	No.1 Fuel oil separator
QK19	No.2 Fuel oil separator
QK20	Diesel oil separator
QK21	Main engine control air line valve
QK23	Main engine safety air (Emergency Stop)
QK24	Main engine control air
QK25	Fuel oil supply unit control unit
QK26	Line valve from control air dryer
QK28	Line valve to air control unit for stern tube LO system
QK29	Composite boiler feed water control unit
QK30	Line valve to deck control systems
QK31	Composite boiler sootblower control unit
QK32	Composite boiler fuel oil pressure control unit
QK33	Composite boiler fuel oil / waste oil 3-way valve control unit
QK34	Engine room bilge pump fresh water priming valve
QK35	Line valve to CO_2 alarm in pump room
QK36	Line valve to sewage treatment unit

2.11 Steering Gear and Bow Thruster

Illustration 2.11.1a Steering Gear Hydraulic System



2.11 STEERING GEAR AND BOW THRUSTER

2.11.1 STEERING GEAR

Steering Gear

Manufacturer:	Kawasaki-Wuhan
Type:	Two ram, four cylinders, Rapson-slide
Model:	FE21-064-T050
Torque:	628kN.m
Working pressure:	23.5MPa (max)
Relief valve pressure:	29.4MPa

Hydraulic Pumps

Manufacturer:	Kawasaki-Wuhan
Type:	Axial piston, variable displacement
Model:	LV-060-410R10
Capacity:	62.3 litre/minute
Power:	18.5kW

Servo Pumps

Manufacturer:	Kawasaki-Wuhan
Type:	Trochoid pump
Model:	TOP-203Haf
Power:	0.4kW

Description

The major components of the steering gear comprise two rams with four hydraulic cylinders driven by oil supplied by two electrically-driven pumps. The pumps are of the variable displacement axial piston type and are contained within separate hydraulic oil tanks.

The steering gear is capable of operating as two totally separate steering systems. Each pump unit is capable of putting the rudder through the working angle in the specified time. In normal operation at sea only one pump is required, but the second pump unit can be connected at any time by starting the motor. When manoeuvring both pumps are operational.

The steering gear is provided with an automatic isolation system. Both hydraulic systems are interconnected by solenoid operated isolating valves, which in normal circumstances allow both systems to operate together to produce the torque necessary for moving the rudder. In the event of a failure that results in a loss of hydraulic fluid from one of the systems, the float switches in the affected hydraulic tank are actuated. This initiates a signal to the isolation system which automatically divides the steering gear into two separate systems. The defective system is isolated and the pump stopped, whilst the intact system remains fully operational. Steering capability is maintained, but with only 50% of the rudder torque available. This situation demands that the ship's speed to be reduced to half speed.

The steering gear is remotely controlled by the autopilot control or by hand steering from the wheelhouse. All orders from the bridge to the steering compartment are transmitted electrically. Steering gear feedback transmitters supply the actual position signal for the systems. The rudder's operational angle of movement is restricted to between 35° port and 35° starboard, mechanical stops are fitted that physically limit any movement more than 37° port or starboard.

The variable-flow pumps are operated by a control lever which activates the tilting lever of the pump cylinder. This causes oil to be discharged to a particular pair of hydraulic rams whilst suction is taken from the other pair. As the rudder turns, the feedback linkage causes the pump's tilting lever to move, thus reducing the stroke on the pump. When the rudder reaches the desired angle the tilting lever is restored to the neutral position and oil delivery from the pump ceases.

No.2 steering gear pump unit is supplied with electric power from the emergency switchboard and No.1 pump unit from the main switchboard.

In normal operation all four rams will be in use, with one pump unit running and the second pump unit ready to start automatically. When manoeuvring or operating in confined waters, it is compulsory that both pump units are running, in order to obtain the IMO recommended total tiller movement of 70° within 28 seconds (56 seconds with one pump).

Tests of the steering gear should be carried out by the duty engineer, in the steering gear compartment, and by the duty navigating officer in the wheelhouse before the vessel departs. The steering gear can be started from the bridge, but the duty engineer should be present in the steering gear room when the pumps are started and the system tested from the wheelhouse.

Procedure for Putting the Steering Gear into Operation

The system valves are assumed set for normal operation:

a) Check the level and condition of the oil in the tanks and refill with the correct grade as required.

b) Check that the feedback linkage and control system are all connected correctly.

c) Ensure the rudder is in the mid position.

d) Select LOCAL at the starter panel and start each electro-hydraulic pump unit.

e) Carry out pre-departure tests.

f) Check for any leakage and rectify as required.

g) Check for any abnormal noise and pressure.

h) Switch the starter selector to REMOTE so that the duty navigating officer can carry out pre-departure steering gear tests.

Automatic Isolation System

Description

The steering gear is arranged that in the event of a loss of hydraulic fluid from one system, the loss can be detected and the defective system automatically isolated within 45 seconds. This allows the other actuating system to remain fully operational with 50% torque available.

Construction

This system comprises the following equipment:

- Two isolating valves
- Two level switches, set at 'LOW' and 'LOW-LOW' level
- Two oil tanks, each with a chamber for level switches and system test valves
- Electrical control panel for the automatic isolation system
- Alarm panel for automatic isolation system

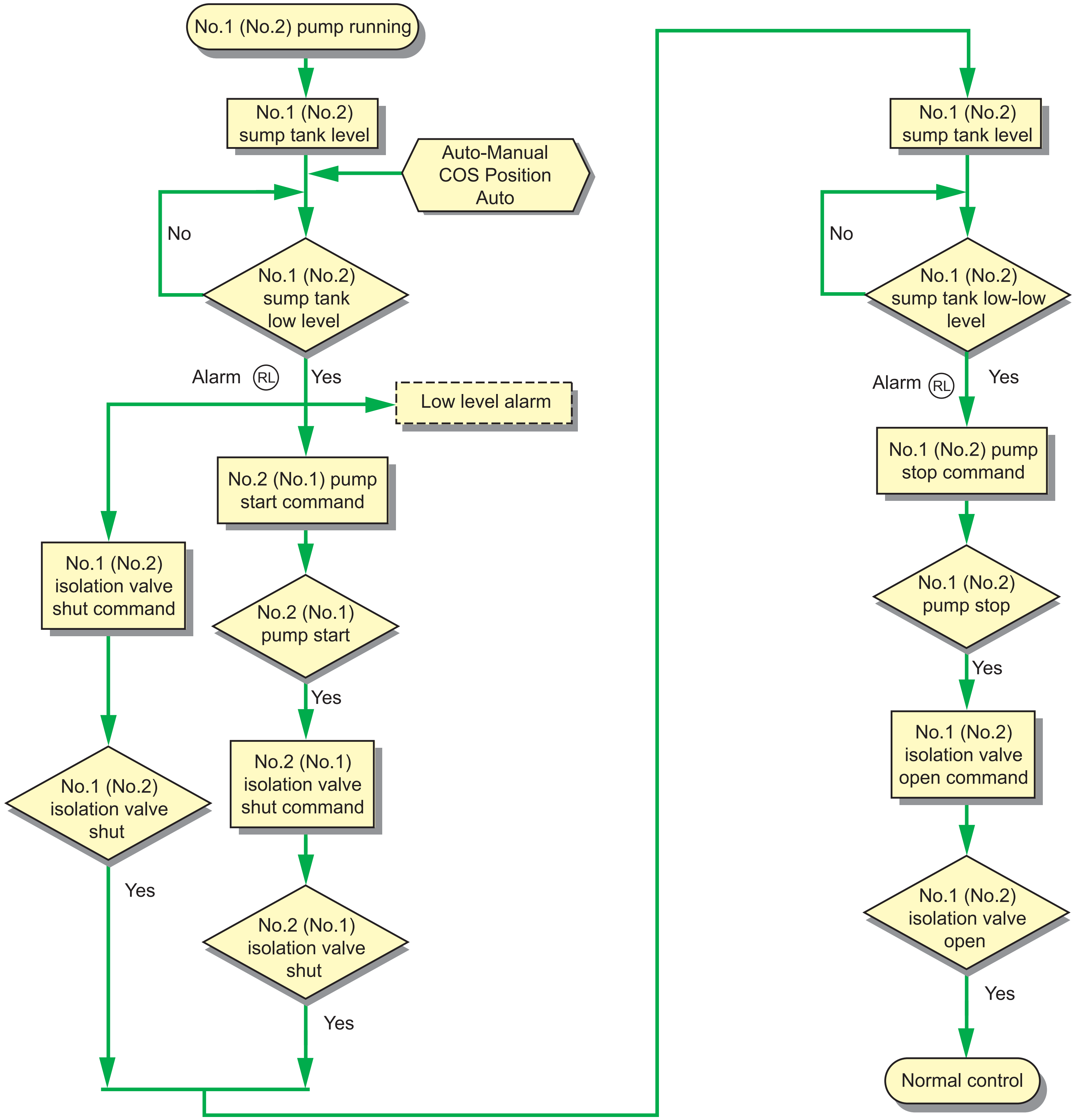
Operation

Failure Sequence with One Pump Running

If loss of oil occurs, with No.1 pump running and No.2 pump stopped, the following sequence will take place:

1. If a system leakage occurs the oil level in No.1 oil tank falls to the LOW position. Audible and visual alarms are given in the wheelhouse and in the machinery space.
2. No.1 isolating valve (IV-1) is energised and the hydraulic systems associated with No.1 and No.2 pumps are isolated.
3. If the oil level goes down to the LOW-LOW position this indicates that the leak is in No.1 system. No.1 isolating valve (IV-1) is de-energised and No.1 pump is automatically stopped; No.2 isolating valve (IV-2) is energised and No.2 pump is automatically started. The hydraulic system associated with No.1 pump is isolated. Steering is now carried out by No.2 pump and its two related cylinders (No.3 and No.4) with 50% torque.

Illustration 2.11.1b Isolation Flow Chart for No.1 or No.2 Pump Running (Automatic Control)



4. If however, the oil leak is in No.2 hydraulic system the Low-Low level alarm is not activated and steering continues to be carried out by No.1 pump and its two related cylinders (No.1 and No.2) with 50% torque. No.2 hydraulic system is isolated and so there will be no further leakage from that system apart from the oil in the pipes.

If No.2 pump is running and No.1 pump is stopped when the LOW level and LOW-LOW level alarms are activated the sequence of events is identical to that detailed above, except that initially No.2 isolating valve is energised first, isolating the lines from No.1 pump unit. The systems will be isolated and the system without the leak will operate.

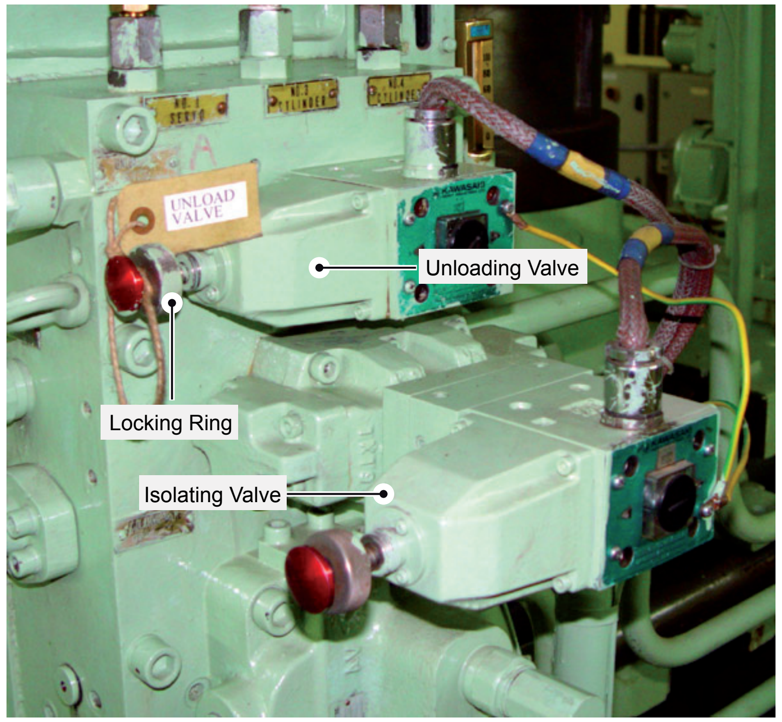
Failure Sequence with Both Pumps Running

When both pumps are running, the hydraulic oil tank that first registers a LOW oil level will trigger the alarms in the wheelhouse and in the engine room. A signal will be sent to energise its isolation valve. Both pump units will remain in operation.

When the oil level in No.1 or No.2 oil tank falls to the 'LOW-LOW' level, the associated isolating valve will operate and the respective pump will be stopped automatically.

System Testing

The float chamber can be isolated and drained to test the system operation. The function test period for the LOW and LOW LOW alarms should be carried out according to company procedures.



Steering Gear Unloading Valve Block

Emergency Steering

If failure occurs in the remote operating system from the wheelhouse, the steering can be operated from the steering gear room, either on the respective autopilot control panel through the Non-Follow-Up (NFU) pushbuttons or via the torque motor control knob located on top of the torque motor.

Under these conditions, it is only possible for one pump unit to be operated in hand steering mode.

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 is supplied from the emergency switchboard.

Procedure for Operation of Steering Gear on Loss of Remote Wheelhouse Control

a) On loss of steering gear control from the wheelhouse, 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.

b) On the pump unit to be used, lift up the locking plate and turn the LOCAL/REMOTE control switch to LOCAL control.

This switch is on the NFU panel in the steering gear room.

Note: Only one pump unit can be operated in this mode, the other pump unit should be shut down.

c) For the pump unit on local control, operate the pushbuttons PORT or STARBOARD to turn the steering gear in the direction requested by the wheelhouse. The pushbutton (PORT or STARBOARD) is depressed for as long as required in order to turn the rudder through to the requested angle. When the requested angle is achieved the pushbutton is released, the rudder will remain at that angle.

If this system should fail, manual operation can be carried out as follows:

a) Only one pump unit may be operated and the operational pump unit selector switch must be turned to the LOCAL position.

Switch off the torque motor power.

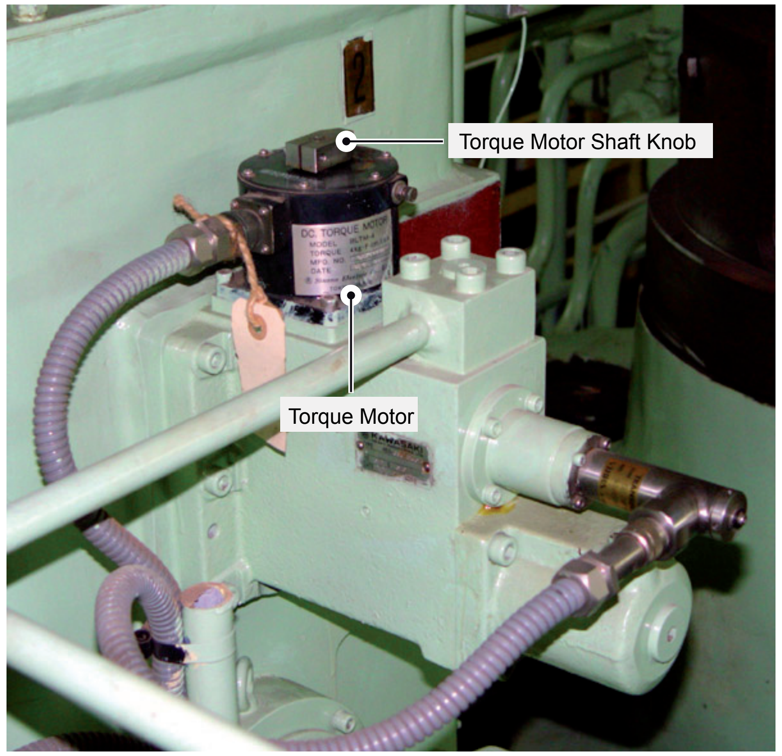
b) Push in the pushbutton on the unloading device and lock it in place.

c) The tiller can be moved in accordance with the steering command from the bridge by turning the torque motor shaft knob located on the top of the torque motor. This puts a stroke on the pump to produce the desired angle of rudder movement. When the rudder reaches the desired angle, feedback from the tiller will remove stroke from the pump.

Emergency Steering Drill

Emergency steering drill should be carried out at according to company procedures when traffic and navigational restrictions permit.

It will consist of the direct operation of the main steering gear by using the manual control within the steering gear room. This operation is to be directed from the navigation wheelhouse. After each drill, details and the date it was carried out are to be entered in the Official Log Book, and Particulars and Records Book.



Steering Gear Torque Motor

Illustration 2.11.2a Bow Thruster System

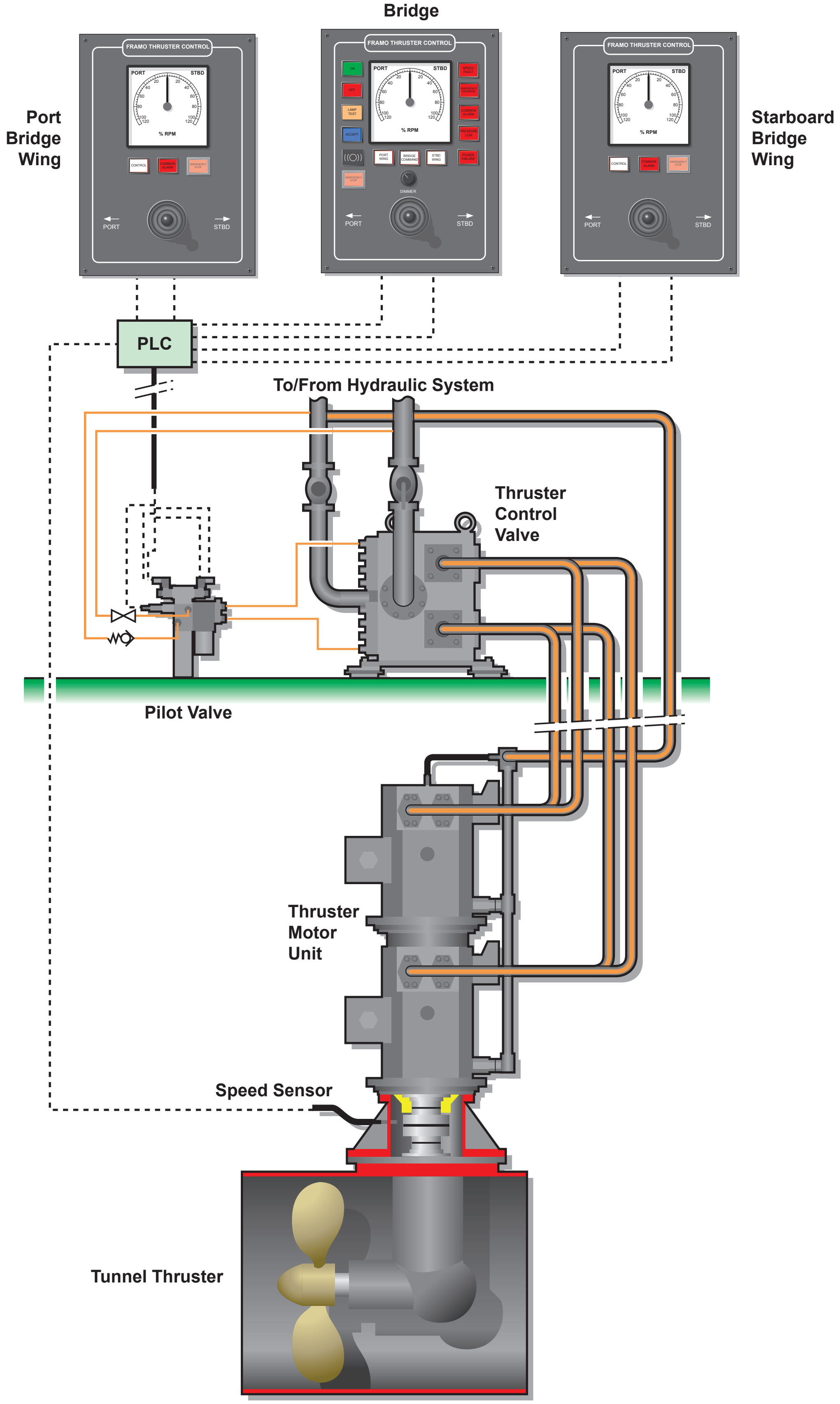
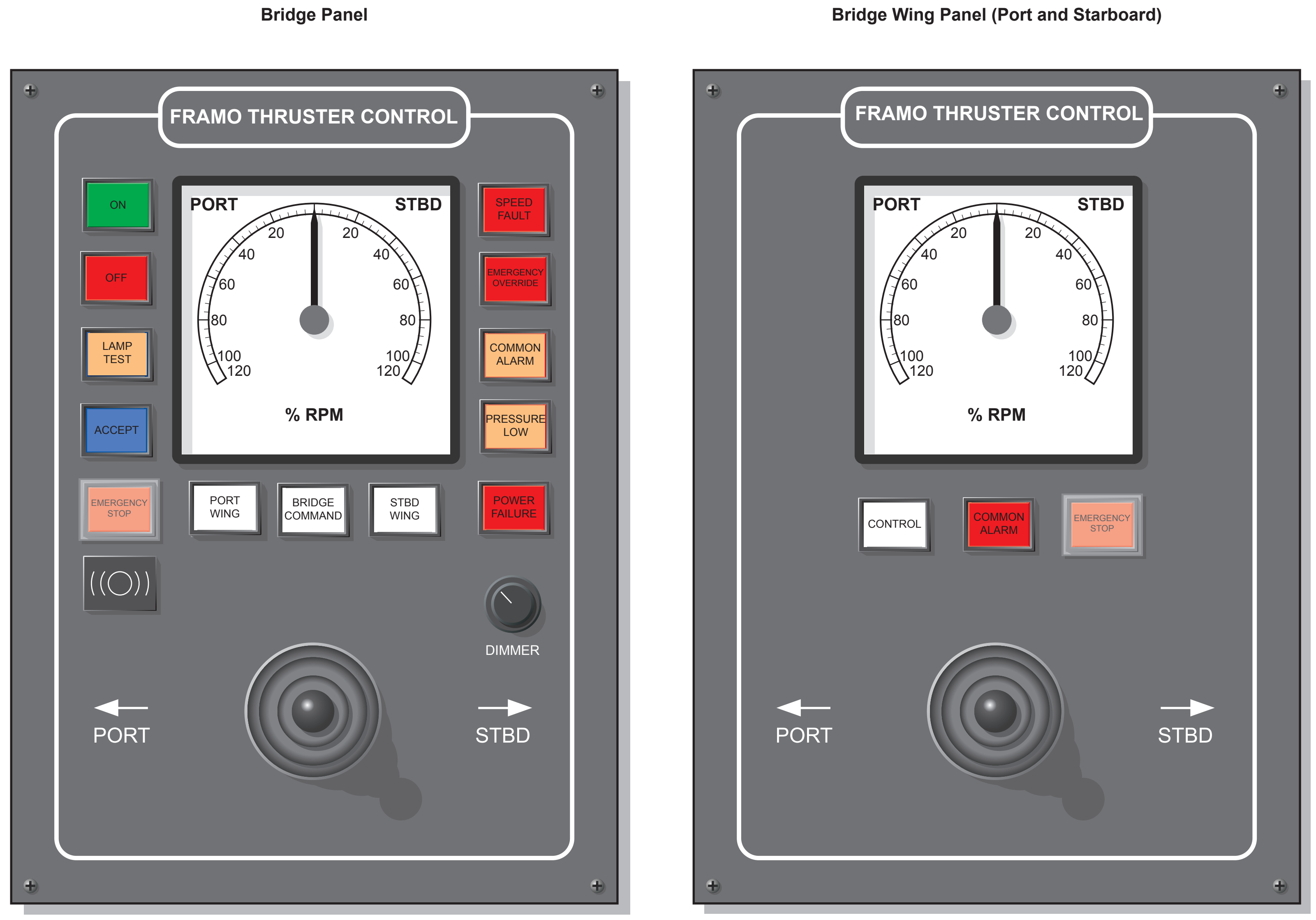


Illustration 2.11.2b Bow Thruster Control Panels



2.11.2 BOW THRUSTER

Manufacturer:	Brunvoll AS, Molde, Norway
Type:	FU-63-LTA-1750
No. of units:	1
Drive power:	760kW
Drive motor speed:	1,480 rpm
Propeller speed:	378 rpm
Propeller disc diameter:	1,750mm
No. of blades:	4

Overview

The vessel is equipped with a single bow thruster, power for the drive motor is supplied from the deck hydraulic system through a directional control valve, the system consists of four main parts:

- A tunnel with propeller unit, a driving motor, a hydraulic power system and an electric control system.
- The fixed pitch propeller unit is driven by two reversible variable speed hydraulic motors operating in tandem. The direction of rotation and the varying speed of the propeller makes it possible to vary the magnitude and direction of thrust.
- The tunnel thruster facilitates the manoeuvring of the vessel to a great extent when speeds are low or zero. The ship's bow thruster is also a useful complement to the ship's rudder at speeds up to 5 knots. The thruster and the rudder together give an increased steering effect.

  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 hunting of the motor tachometer and should be avoided.
- As starboard and port thrust must be equal, the blades are designed with a symmetrical blade section.

Note: When a stationary vessel is turned with a tunnel thruster, the vessel is also given a sideways motion. The simultaneous turning and crabbing results in a slow longitudinal motion of the vessel, ahead when the tunnel thruster is located in the bow, astern when it is located at the stern. This should be kept in mind when manoeuvring in narrow harbours.

The propeller unit comprises a propeller tunnel in which a single stay gear housing is bolted. A four-bladed propeller and shaft assembly are mounted in bearings in the gear housing. The main part of the tunnel thruster is the propeller hub with blades, and the propeller shaft. A shaft seal prevents the ingress of water and leakage of oil outwards.

Power for the thruster is provided by the main hydraulic power system, this also provides power to the cargo and ballast pumps as well as the deck machinery. See Section 2.16.1 for more details.

Remote Control System

The control system is a microprocessor-based remote control system used to control the speed and direction of the hydraulic motor unit. The PLC initiates the control signal to the thruster pilot valve, which in turn controls the output of the thruster hydraulic control valve. This valve controls both the direction and rate of flow of the hydraulic oil supply to the thruster motor. Changing the direction of rotation directs the thrust to either port or starboard and increasing or reducing the speed of rotation varies the side thrust delivered.

The manoeuvring is performed from a control station equipped with a joystick control lever. When ordering thrust with the joystick, the system applies the correct speed and direction setting according to a curve in the computer, for the thrust to be proportional to the lever position. When manoeuvring, the load of the drive motor is controlled by the system by automatic regulation of the oil flow. The maximum allowed load is determined by the 'load limit'.

As there is more than one control station available, a responsibility system is included, this allows only one control station at a time to be 'IN CONTROL'.

On each control station the speed of the tunnel thruster motor is continuously indicated.

Control of the system is either from the bridge manoeuvring control console (BMCC) or the bridge wings. The control panels have the following features:

- Control of motor speed and direction
- Indication of motor speed and direction
- Emergency stop
- Command select
- Common alarm
- On/off of control system (BMCC only)
- Emergency override (BMCC only)
- Lamp test (BMCC only)
- System hydraulic pressure low (BMCC only)
- Power failure (BMCC only), electrical power failure to control system
- Speed fault (BMCC only), control or feedback failure

Operation Procedures

Before Starting the Tunnel Thruster

a) Call the ECR and ensure that sufficient hydraulic power is available to allow starting the thruster.

b) Check that no alarm exists.

Normal Operation

a) Push the ON button on the bridge main control panel. The lamp will be steady on, indicating that the system is ready for service. System pressure will be at minimum and drive motor stopped.

b) Use joystick to select direction and amount of thrust required. The PLC control system will operate the control valve to reach this without excess pressure peaks.

c) If required, change over operating station by pressing the CONTROL button on the required panel, with both the joysticks in the zero position.

d) Stop the thruster by setting the joystick to the zero position.

e) When the thruster is no longer required the system is stopped by pushing the OFF button on the bridge main panel. The hydraulic power packs may then be shut down as operational conditions permit.

Starting/Stopping Operations of the Hydraulic Power Units

Starting and stopping of the hydraulic power packs may be carried out at the hydraulic system control panel in the ship's control centre or locally in the hydraulic machinery space. Prior to starting the electrically-driven power packs ensure that there is sufficient reserve electrical power available.

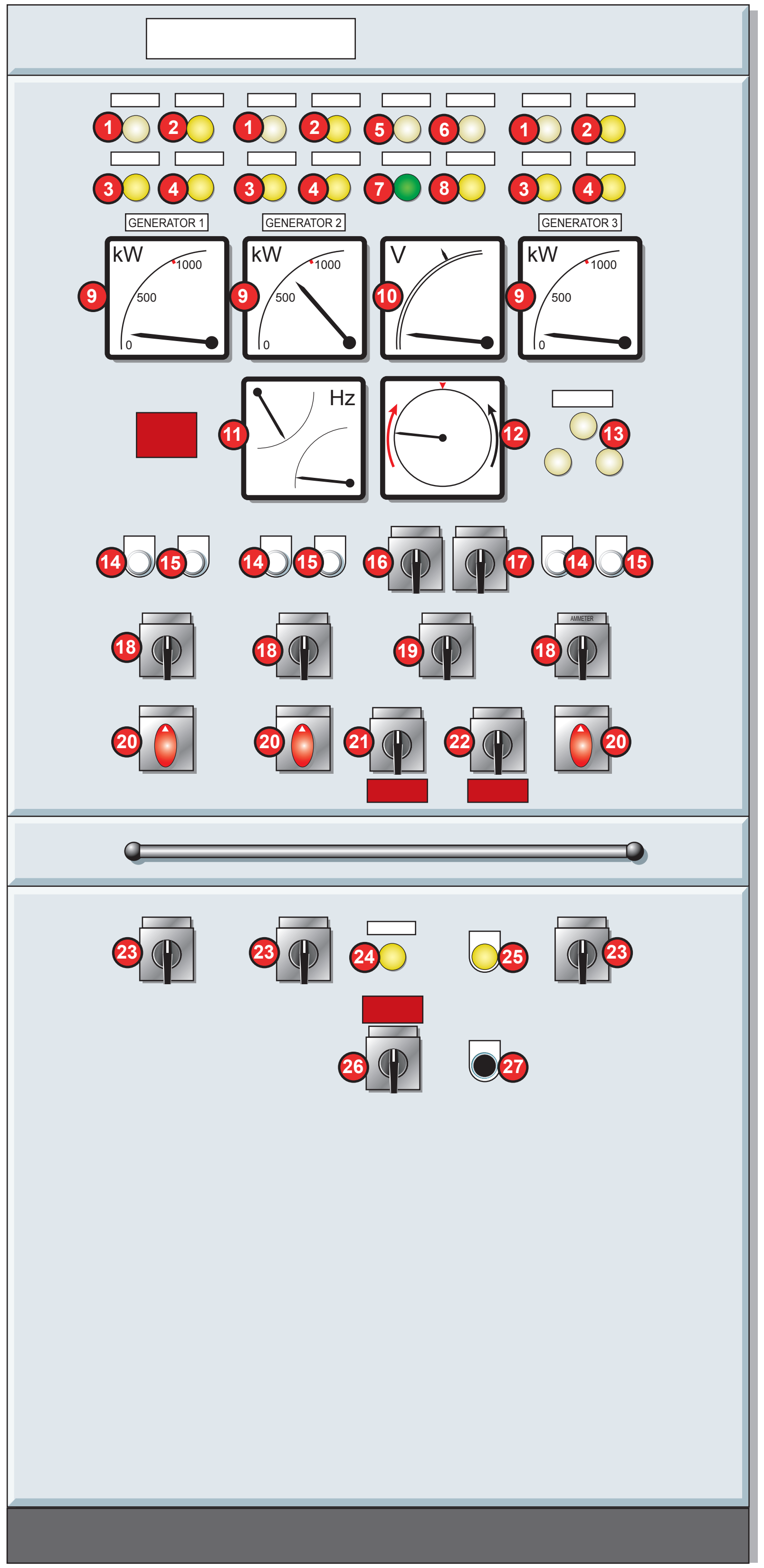
See Section 2.16 of this manual for details of the hydraulic system and power packs.

2.12 Electrical Power Generators

2.12.1 Diesel Generators

2.12.2 Emergency Diesel Generator

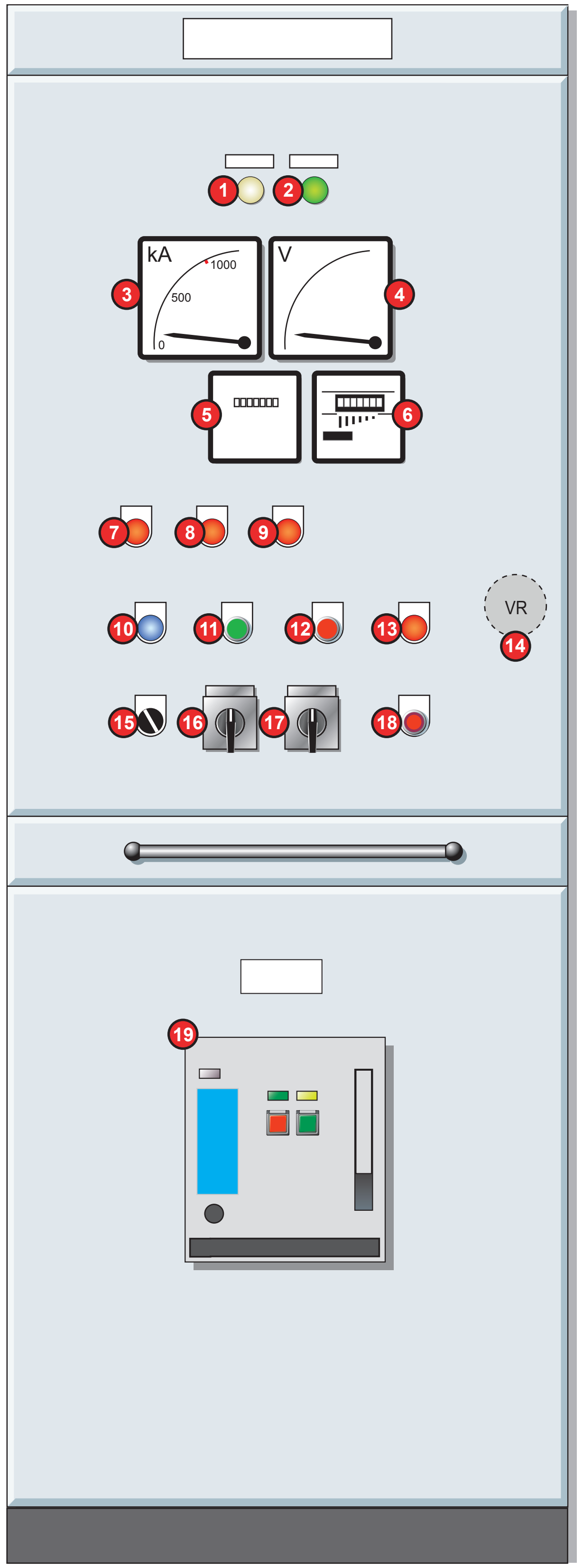
Illustration 2.12.1a Control Room Diesel Generator Control Panels



Synchronising Panel

Synchronising Panel Key

1. Generator 'Master' Indicator Lamp
2. Generator 'Ready To Start' Indicator Lamp (The above indicator lamp positions may be reversed on some vessels)
3. Generator 1st Standby Indicator Lamp
4. Generator 2nd Standby Indicator Lamp
5. 24V DC Source Indicator Lamp
6. Preference and Emergency Stop Source Lamp
7. Emergency Generator ACB On Indicator Lamp
8. Emergency Generator Standby Indicator Lamp
9. Generator Wattmeter
10. Generator and Bus Voltmeter
11. Generator and Bus Frequency Meter
12. Synchroscope
13. Synchronising Lamps
14. Auto Synchro Start Illuminated Pushbutton (ASS)
15. Load Shift Start Illuminated Pushbutton (LSS)
16. Frequency/Voltmeter Switch (FVS1)
17. Frequency/Voltmeter Selector Switch (FVS2)
18. Generator Mode Selector Switch (MSS)
19. Synchroscope Selector Switch SYS
20. Generator ACB Control Switch (BCS)
21. Generator Standby Selector Switch (COS-A)
22. Synchro and Power Control Switch COS-P
23. Generator Governor Control Switch (GCS)
24. Auto Stop Blocking Indicator Lamp
25. Short Circuit Trouble Indicator Lamp (STR)
26. Auto Stop Blocking Switch COS-B
27. Lamp Test Pushbutton



Generator Panel

Generator Panel Key

1. Power Available Indicator Lamp
2. Generator ACB Closed Indicator lamp
3. Generator Ammeter
4. Generator Voltmeter
5. Running Hour Meter
6. Running Watt Hour Meter
7. Turning Gear Engaged Indicator Lamp (TGE)
8. Start Fail Indicator Lamp (SF)
9. Common Shutdown Indicator Lamp (CS)
10. Space Heater IndicatorLamp
11. Engine Start Pushbutton (PB1)
12. Engine Stop Pushbutton (PB2)
13. Reverse Power Indication Lamp
14. Voltage Regulator (Inside Panel)
15. Space Heater (Off - On) Switch
16. Ammeter Phase Selection Switch
17. Voltmeter Phase Selection Switch
18. Generator ACB Abnormal Reset
19. Generator ACB

2.12 ELECTRICAL POWER GENERATORS

2.12.1 DIESEL GENERATORS

Generator Engine No.1

Manufacturer:	ZLMD - MAN B&W
Type:	5L23/30H
No. of sets:	1
No. of cylinders:	5
Bore:	225mm
Stroke:	300mm
MEP:	1.915MPa
Speed:	720 rev/min
Power:	690kW

Alternator No.1

Manufacturer:	Hyundai
Type:	HFJ6-508-14K-EB
Voltage:	450V at 60Hz
Power:	812.5kVA
	650kW

Generator Engines No.2 and No.3

Manufacturer:	ZLMD - MAN B&W
Type:	6L23/30H
No. of sets:	2
No. of cylinders:	6
Bore:	225mm
Stroke:	300mm
Speed:	720 rev/min
Power:	825kW

Alternators No.2 and 3

Manufacturer:	Hyundai Heavy Industries, Ulsan, Korea
Type:	HFJ6-508-14K-EB
Voltage:	450V at 60Hz
Power:	957kVA
	780kW

Description

Electrical power for the vessel is produced by three medium speed diesel generator sets. The engines are of the same model type, except that two are six cylinder in-line and the third is a five cylinder in-line.

The engines are turbocharged, uni-directional, four-stroke, trunk piston and normally operate on heavy fuel oil. They may also be supplied with diesel oil, which is utilised for flushing through, prior to shutting down for maintenance and for running when the steam system is shut down.

One diesel generator is normally used during seagoing conditions. Three generators may be required when manoeuvring or during cargo discharge operations.

Starting Air System

Each engine is started by an air-driven starter motor. When the start valve is opened by a remote control solenoid, air is supplied to the air start motor. The air supply activates a piston, causing the pinion to engage with the gear rim on the flywheel. When the pinion is fully engaged pilot air opens the main air valve, which supplies air to the air start motor, causing the engine to turn.

When the engine revolutions exceed about 110 rev/min, conditions are normal and firing has taken place, the start valve is closed and the piston and main air valve are vented. A return spring disengages the pinion from the flywheel and the air motor stops.

During starting, a pneumatic cylinder operates a stop arm to limit the fuel-regulating shaft.

An on-line air lubricator is fitted to lubricate the start air motor.

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.

Cooling Water System

All cooling water requirements for the generator engines are provided by water from the central low temperature fresh water cooling system.

An engine-driven pump circulates the jacket spaces and cylinder heads. The jacket (high temperature) cooling water pump, discharges through the engine cylinder jacket and cylinder head 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 thermostat will direct the cooling water back to the pump suction. When the cooling water outlet temperature reaches operating temperature, the thermostat will direct the water to the central fresh water cooling system in a proportion to maintain a constant temperature.

A motorised valve in the cooling water supply line to the engine is closed when the engine stops, this prevents the circulation of the cool water from the low temperature central cooling system through the engine cooling water system. The valve control is thermostatically activated and the valve opened when the engine is running and the jacket cooling water system reaches normal operating temperature.

This provision helps maintain an engine in a warm condition when it is stopped and it ensures that the engine reaches operating temperature quickly after starting. If necessary, the valves may be opened and closed locally by means of OPEN and CLOSED pushbuttons on the local operating panel.

The charge air cooler, LO cooler and alternator air cooler are supplied from the LT central cooling FW system and are not circulated by the jacket water circulation pump.

Fuel System

The engine fuel supply rail is supplied with heavy fuel oil or diesel oil from the combined main engine and generator engine fuel oil service system. 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.

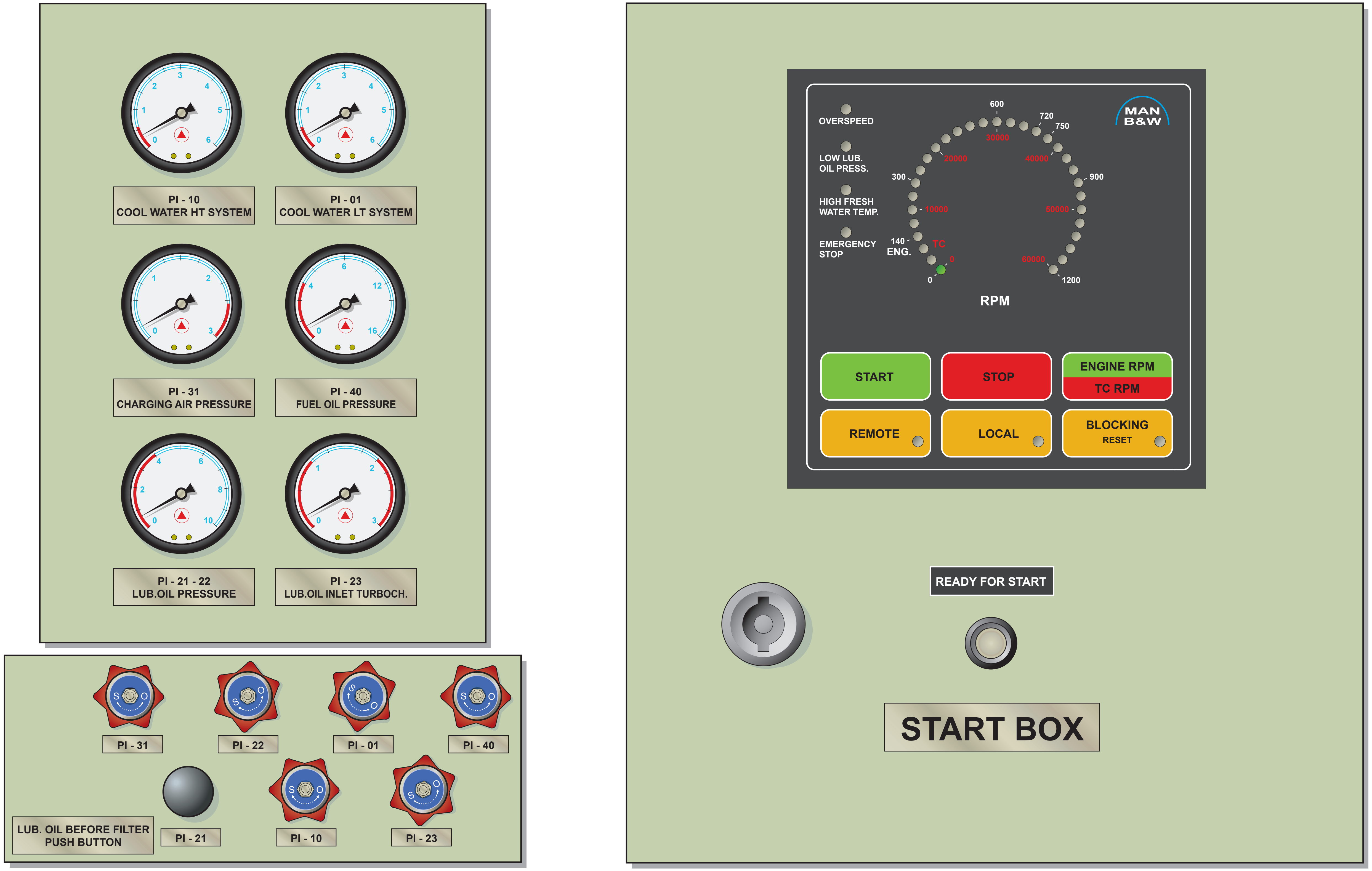
With an engine stopped, fuel from the fuel preparation unit will circulate along the fuel supply rail and back to the deaerator. This will maintain a supply of hot HFO at the engine supply rail ready for use when the generator is required.

The fuel feed pump discharge 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 and any sediment can be drained off.

Excess fuel not needed by the injection pumps is passed through the overflow pipe and delivered into a header, which returns it to the main fuel oil circulation system (see Section 2.6.2). This principle ensures that:

- There is always an adequate amount of pressurised fuel available at the fuel injection pumps.
- The heated fuel can be circulated for warming-up the piping system and the injection pumps prior to engine starting.
- The necessary fuel oil temperature can be better maintained.

Illustration 2.12.1b Generator Engine Local Control Panel and Gauge Board



Lubricating Oil System

All engine running gear is force lubricated by the engine-driven gear type pump. The pistons are also supplied with oil as a cooling medium. A prelubrication pump is fitted to supply oil to the bearings and other running gear before the engine starts, this reduces wear on the engine in the period between the engine starting and the engine-driven pump building up oil pressure. The prelubrication pump runs continuously while the engine is on automatic standby provided that it is selected for AUTO at the priming pump starter panel. The pump may also be selected for manual operation via the selection switch.

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 control valve on the pump discharge, which relieves any excess pressure back to the sump, controls the pressure. The temperature is controlled by a three-way thermostatic control valve, which regulates how much of the oil passes through the cooler.

The turbocharger is supplied from the main lubricating oil circuit. An orifice in the LO supply line to the turbocharger regulates the oil flow.

The cooler is a plate heat exchanger, with the oil circulating through the flow channels and water from the central fresh water cooling system circulating through the parallel channels in the opposite flow direction.

The main LO filter is supplemented by two bypass centrifugal filters mounted at the engine base frame. During operation, a proportion of the lubricating oil supplied from the engine-driven LO pump enters the centrifugal filter and the returns to the engine sump. The filter is driven by the oil supply pressure and relies on centrifugal force to remove high-density sub-micron particles.

Procedure to Prepare a Generator Engine for Starting

Before working on a generator, place the engine in LOCAL control.

a) Operate the fuel oil service system as described in Section 2.6.2.

b) Operate the low temperature central cooling water system as in Section 2.5.2.

c) Check the level of oil in the engine sump and top-up as necessary with the correct grade of oil from the generator engine LO measuring tank.

d) Prime the fuel oil system.

e) Switch the generator engine prelubrication oil pump to automatic operation and check that the lubricating oil pressure rises. The engine should be prelubricated for a minimum of 2 minutes prior to start.

f) Check the governor oil level.

g) Turn the engine at least one complete revolution using the turning bar with the cylinder indicator cocks open.

h) Close the cylinder indicator cocks.

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.

i) 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 as detailed below before switching the engine to automatic operation.

j) Check that all fuel pump indices are at index ‘0’, when the regulating shaft is in the stop position.

k) Check that all fuel pumps can be pushed by hand to full index and return to ‘0’ when pressure is removed.

l) Check the spring-loaded pull rod operates correctly.

m) Check that the stop cylinder for the regulating shaft operates correctly when shutting down normally and at overspeed and shutdown. The overspeed shutdown is checked by reducing the setting of the overspeed value temporarily.

WARNING
It is essential that the correct overspeed level is reset after any test.

n) Switch the engine to automatic operation.

Procedure to Start a Generator Engine

a) Complete the pre-start checks. Start the engine from the local control panel and allow it to run on idle speed.

b) 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.

c) Switch the engine over to REMOTE operation.

d) Check the oil pressures and temperatures.

e) Check the pressure drop across the LO filters.

f) Check the FO pressure and temperature.

g) Connect to the switchboard and load the engine.

h) Ensure that the thermostatically operated valves on the cooling water systems operate correctly as the cooling water temperature rises.

i) Ensure that the engine temperatures and pressures remain within normal limits as the load is applied to the engine and the engine heats up.

j) Check the exhaust gas temperatures for any deviation from normal.

k) Check the exhaust gas for smoke.

l) Keep the charge air pressure and temperature under control.

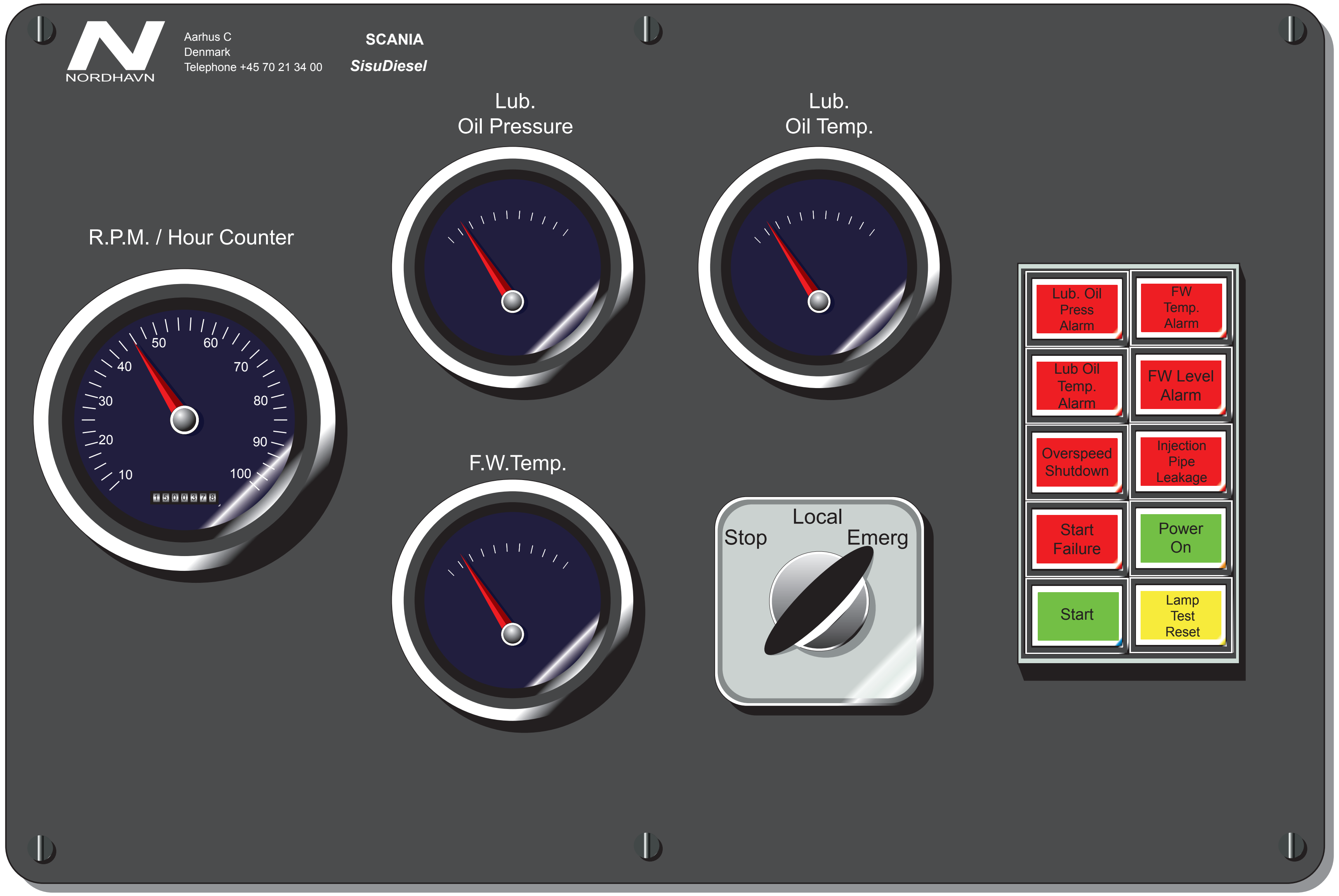
Procedure to Stop a Diesel Generator Engine

a) Unload and disconnect the alternator from the switchboard.

b) Allow the engine to run at idle speed for 5 minutes until temperatures have cooled and stabilised.

c) Operate the remote stop device.

Illustration 2.12.2a Emergency Diesel Generator Control Panel



2.12.2 EMERGENCY DIESEL GENERATOR

Generator Set:

Manufacturer:	Nordhavn
Model:	GA S 7-06

Engine

Manufacturer:	Sisu Diesel
Model:	634 DSBG
Power:	140kW
Speed:	1800 rev/min

Alternator

Manufacturer:	Newage Stamford
Model:	UCM 274 F2
Output:	120kW, 150kVA, 450V, 60Hz

Introduction

The emergency generator is a self-contained diesel engine and generator set located in the emergency generator room on the port side of B deck, aft. The generator set will start automatically on power failure at the main switchboard and connect to the emergency switchboard to maintain power supplies to essential services.

The emergency generator is also used to get the ship under power from 'dead ship' condition. It will enable power to be supplied to essential services selectively such as the starting air, gas oil supply and cooling water systems, without the need for external services. The engine is an in-line, six-cylinder turbocharged unit with a self-contained cooling water system. Cooling water is circulated by an engine-driven pump through the engine and fan-cooled radiator. A thermostat maintains a water outlet temperature of between 82 and 93ºC. Air is drawn across the radiator by an engine-driven fan.

The cooling water is also circulated through the lubricating oil cooler. An electric heater is fitted to keep the cooling water at 40 to 50ºC 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 discharging it through the cooler and a filter before being supplied to the lubricating oil rail.

The engine is normally started by a battery powered starter motor. The batteries are maintained under a constant trickle charge while the ship is in service.

An alternative starting arrangement is provided to ensure that the generator can be started even in the event of a battery failure. Starting is achieved by a manually loaded spring inertia starter, permanently fitted above the electric starter motor. The inertia starter utilises the potential energy of a loaded spring to drive a gear train which engages with the flywheel. The spring system can be utilised when starting the engine from the dead ship condition. The engine may be manually started using either the electric or spring starter.

In normal operation the engine should be started once per week, and run up to full load every month. Whenever the engine has been started, the gas oil tank must be checked and refilled with wax free (arctic) gas oil, if the level has dropped below the 24 hour operation level.

The spring starter should be tested regularly according to company policy.

Operating Procedures

Procedure to Prepare the Emergency Diesel Engine for Automatic Starting

a) Switch the engine to local control.

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 gas oil in the emergency generator gas oil service tank and top-up as required.

f) Check that the fuel oil supply to the diesel engine is open.

g) At the switchboard, turn the local selector switch to the EMERG operation position, the engine is then set for automatic standby operation.

Procedure to Start the Emergency Diesel Engine Manually (Using the Electric Starter)

a) Ensure that the engine is switched to LOCAL control.

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 gas oil in the emergency generator gas oil service tank and top-up as required.

e) Press the START pushbutton on the engine control panel.

f) Check that the engine starts and is firing smoothly.

g) Check the engine oil pressure, cooling water pressure and speed are normal. Investigate any abnormalities.

h) If required, load the engine, otherwise allow it to run idle or stop it by turning the control switch on the engine panel to the STOP position.

i) Check that the heater switches are on when the engine stops.

j) Turn the local switch to the EMERG position to restore the engine to automatic standby.

If the engine is to be loaded undertake the following:

k) At the emergency switchboard, turn the BUS TIE ACB CONTROL to the OPEN position, the ACB CONTROL switch will close.

The emergency generator will now be connected to the emergency switchboard and can be loaded as required.

Additional procedures may be undertaken to load the emergency generator and these are explained below. These procedures should be carried periodically in order to test the equipment fully.

Procedure to Start the Emergency Diesel Engine (Using the Spring Starter)

To start a cold engine, excess fuel must be set. The excess fuel setting varies on different pumps and instructions in the 'Engine Operators Manual' should be followed.

Carry out procedures a) to d) detailed above, then:

a) Depress and release the reset button on the spring starter.

b) Fit the winding handle to the winding adaptor and rotate it in a clockwise direction until the white springs are visible through the inspection window. For a warm engine the starter is now sufficiently charged. For a cold engine, wind until red springs are visible. Remove winding handle after compressing the spring discs.

c) Turn the trip lever through 90° in the direction shown by the arrow on the trip lever boss.

d) Check that the engine starts and is firing smoothly.

e) Check the engine oil pressure, cooling water pressure and speed are normal. Investigate any abnormalities.

f) If required, load the engine, otherwise allow it to run idle or stop it by turning the control switch on the engine panel to the STOP position.

Procedure for Testing Automatic Starting (A)

This procedure describes the procedure to start the emergency generator and close its circuit-breaker without disconnecting the voltage between the main switchboard and emergency switchboard.

The emergency generator must be ready to start with the local selector switch set in the EMERG. position.

a) Turn the BUS TIE ACB CONTROL switch to the OPEN position.

b) Turn the Cos-T selector switch (located inside the cabinet on the emergency switchboard and marked EM'CY GEN TEST) to the TEST position. The emergency generator will start and the emergency ACB will close automatically.

c) Check the emergency generator voltage and frequency.

d) Turn the Cos-T selector switch to the NORMAL position.

e) Turn the emergency generator ACB CONTROL switch to the OPEN position and the ACB will open.

f) The emergency generator will now stop automatically.

CAUTION
The BUS TIE ACB CONTROL switch for the emergency generator must not be operated unless the emergency generator has come to a standstill.

g) When the emergency generator has completely stopped turn the BUS TIE ACB CONTROL switch to the CLOSED position.

Procedure for Testing Automatic Starting (B) - Off-Load Test

This procedure describes the procedure to start the emergency generator without closing the emergency generator circuit-breaker.

The emergency generator must be ready for operation with the local selector switch set in the EMERG. position.

a) Turn the Cos-T selector switch to the TEST position and the emergency generator will start.

b) Check the voltage and frequency of the emergency generator.

c) Turn the Cos-T selector switch to the NORMAL position and the emergency generator will stop automatically.

Procedure for Testing Automatic Starting (C) - Blackout

This procedure describes the procedure to start the emergency generator with automatic closing of the circuit-breaker as a blackout condition.

The emergency generator must be ready to start with the local selector switch set in the EMERG. position.

a) Turn the Cos-T selector switch to the TEST (BLACKOUT) position and the bus tie ACB will trip. The emergency generator will start and the emergency generator ACB will close automatically.

b) Check the voltage and frequency of the emergency generator.

c) Turn the Cos-T selector switch to the NORMAL position.

d) Turn the emergency generator ACB CONTROL switch to the OPEN position. The bus tie ACB at the emergency switchboard will close automatically and the emergency generator will stop automatically.

Re-establishing Normal Supply to the Emergency Switchboard After a Blackout

The emergency generator must be ready to start with the local selector switch set in the EMERG. position.

a) Check that normal power supply is available.

b) Turn the emergency generator ACB CONTROL switch to the OPEN position and the ACB will open.

c) The bus tie ACB for the emergency switchboard will close automatically and the emergency generator will stop automatically.

d) Check that the emergency generator Auto Standby lamp is illuminated.

Procedure for Stopping the Emergency Generator After Running On-Load

a) Unload the generator and open the circuit-breaker.

CAUTION
Damage may be caused to the turbocharger bearings and seals due to excessive temperatures if the generator engine is stopped without being allowed to cool down.

b) Allow the engine to run on no load for 5 minutes before shutting down.

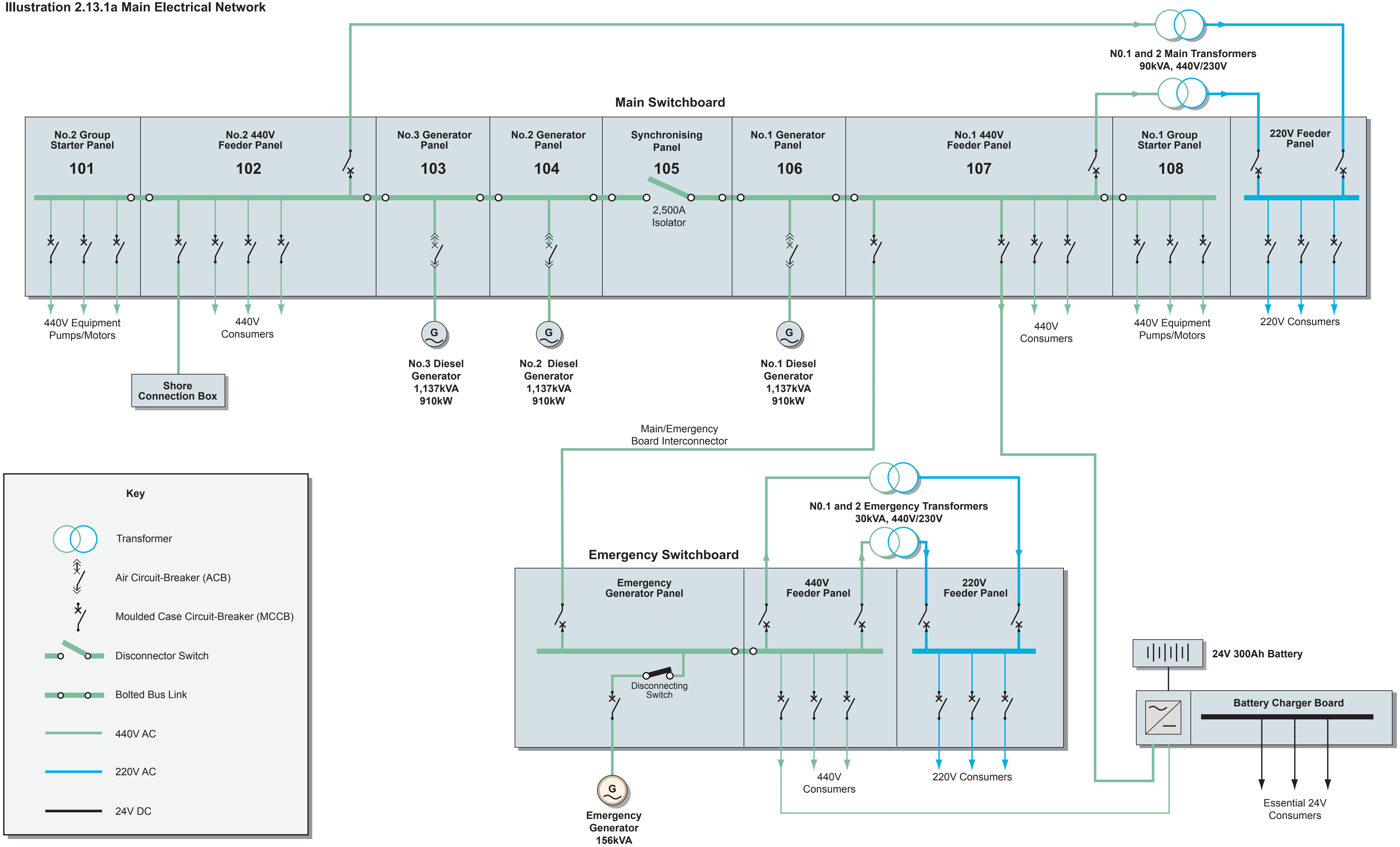
CAUTION
Allowing the engine to run too long under no load will result in poor combustion and a build-up of carbon deposits, leading to a reduction in performance and excessive maintenance.

c) Turn the control switch on the engine panel to the STOP position.

d) When the engine has stopped turn the control switch to the EMERG. position restoring the engine to automatic standby.

2.13 Electrical Power and Distribution

Illustration 2.13.1a Main Electrical Network



2.13 ELECTRICAL POWER AND DISTRIBUTION

2.13.1 ELECTRICAL EQUIPMENT OVERVIEW

Generating Plant

The electrical power generating plant consists of the following:

Diesel Generators

No. of sets:	3 (G1, G2, G3)
Rating (G1):	440V, 3-phase, 60Hz, 650kW, 1,043A, 812.5kVA
Rating (G2 and G3):	440V, 3-phase, 60Hz, 780kW, 1,251A, 957kVA

Emergency Diesel Generator

No. of sets:	1
Rating:	450V, 3-phase, 60Hz, 120kW, 192A, 150kVA

Description

The diesel generators are situated in the engine room, on the lower platform deck level. The generators supply 440V at 60Hz to the main switchboard which is situated in the engine control room on the upper platform deck level of the engine room.

The number of generators connected to the switchboard at one time depends on the electrical consumer load of the ship at that time. The generators may be manually run-up and connected to the main switchboard as required, but in normal operation the automatic control system controls the operation of the generators and major operational aspects of the main switchboard.

The recommended number of generators for the various conditions is as follows:

- Under way on passage 1
- Manoeuvring 2
- Cargo operations 2 (load-dependent)
- Emergency conditions 1 (emergency generator)

The emergency generator is located in a separate compartment, the emergency generator room, located on the port side of B deck. This generator is entirely self-supporting with its own dedicated fuel, cooling and starting equipment.

The emergency generator has sufficient capacity to supply the auxiliaries required to start a main diesel generator in the event of total power failure. All three main generators can operate in parallel, but not with the emergency generator.

Main Power Distribution System

The main switchboard consists of:

- Three generator panels
- The synchronising panel
- Two 440V feeder panels (No.1 and No.2)
- Two group starter panels (No.1 and No.2)
- One 220V feeder panel

The main switchboard feeds the main 440V group starter panels (GSP), No.1 and No.2, located either side of the main switchboard.

In addition to the group starter panels, 440V power distribution panels are located throughout the vessel to supply the vessel's 440V equipment. Eight panels (41D, 43D, 45D, 47D, 49D, 4AD, 4BD and 4DD) are fed from the main switchboard No.1 440V feeder panel, five panels (42D, 44D, 46D, 4CD and 4FD) are fed from the main switchboard No.2 440V feeder panel, and two panels (4ED and 48D) are fed from the emergency switchboard 440V feeder panel. The 440V power distribution board 48D supplies power for workshop equipment. In the event of a blackout condition resulting in the emergency generator running-up and feeding the emergency switchboard, a normally closed contact in the supply line to the distribution board will open and the distribution board will remain without power. If, during this blackout, it is required that power is supplied to the workshop equipment, a switch is provided inside the emergency switchboard emergency generator panel. This switch may be closed to supply power to 48D power distribution board.

The main switchboard normally feeds the emergency switchboard, located in the emergency generator room, via the main/emergency switchboard bus tie line.

A 3-phase isolator is located in the rear of the main switchboard synchronising panel. In the event of a fault developing on one side of the switchboard (eg, bus short circuit), the isolator can be opened to isolate the side of the switchboard at fault. When opened, the MAIN BUS CONTROL SOURCE switch (COS-F), located in the rear of the synchronising panel must be turned to the bus bar that is not in the fault condition ((G2/3 or G1).

WARNING
The bus tie isolator must only be closed when one side is known to be in a dead condition.

Links are also fitted between the main switchboard cubicle bus sections as shown in illustration 2.13.1a. These links are intended for emergency situations where isolation of a faulty bus section is required.

WARNING
The bus links must only be opened or closed when both sides are known to be in a dead condition.

The main engine room and machinery spaces motors and pumps etc, are fed from the main switchboard group starter panels No.1 and No.2, and also from individual starter panels. Other engine room equipment and machinery space and deck 440V consumers are fed from the 440V feeder panels No.1 and No.2, and also from some of the 440V power distribution panels.

The engine room, machinery space, deck and accommodation 220V lighting and other auxiliary consumers are fed from nine 220V distribution panels L/1D to L/9D. These are all fed from the main switchboard 220V feeder panel. In addition to the 220V lighting distribution panels, five 220V power distribution panels (21D, 22D, 23D, 24D and 25D) are provided in various locations to supply 220V equipment. These are all fed from the main switchboard 220V feeder panel, with the exception of 21D which is fed from the main switchboard No.2 440V feeder panel via a 450/230V, 50kVA transformer. This panel feeds the air conditioning reheaters.

The galley 440V consumers are fed from 47D power distribution panel, and the galley 220V consumers are fed from 23D 220V power distribution panel.

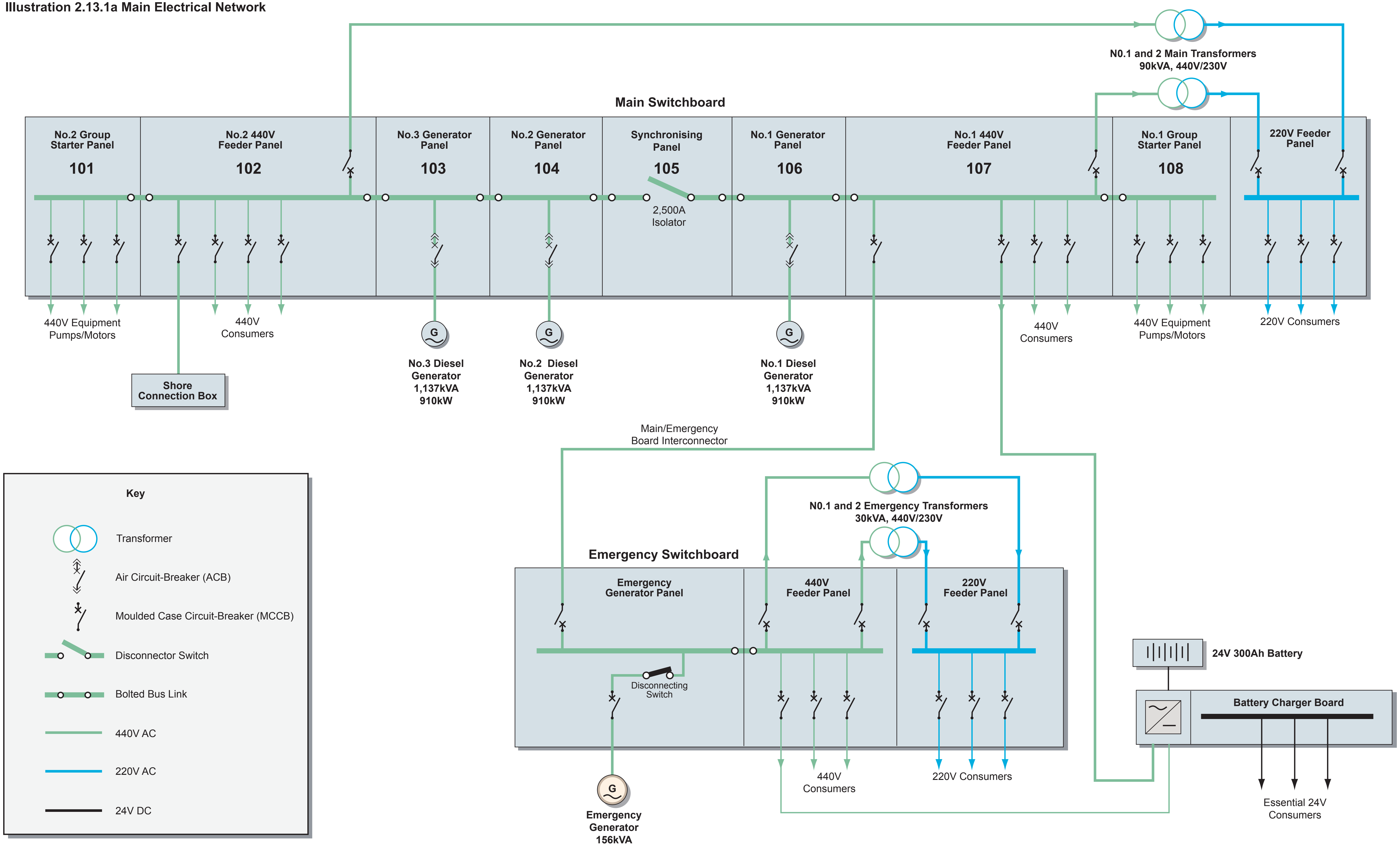
The laundry 440V consumers are fed from 4BD power distribution panel, and the laundry 220V consumers are fed from 24D 220V power distribution panel.

The main switchboard 220V feeder panel is fed from the No.1 or No.2 main switchboard 440V feeder panels via one of two 90kVA transformers. The output of these transformers is fed to the 220V feeder panel via two moulded case circuit-breakers (circuits L16 and L17); these moulded case circuit-breakers (MCCB) are mechanically interlocked to prevent both breakers being closed simultaneously.

The switchboards are of dead front box frame construction without a bottom plate and have hinged front panels that can be opened without disturbing the meters, lamps, etc, mounted on them. The switchboards are rated for 450V, 60Hz with a main bus capacity of 2,500A.

Shore power may be provided to supply basic consumers (lighting, etc) when the ship is alongside for an extended period or when in refit/dry dock. The shore connection box is located in the emergency generator room and connects to the main switchboard via a moulded case circuit-breaker mounted inside the main switchboard No.2 440V feeder panel. Please refer to Section 2.13.5 for further details concerning shore connection procedures.

Illustration 2.13.1a Main Electrical Network



Main Switchboard Monitoring

Each main switchboard generator panel is equipped with an ammeter and voltmeter to measure the output of the generator. Preferential trips, reverse power relays, overcurrent relays and undervoltage trips are provided for generator protection.

The main switchboard synchronising panel is equipped with dual frequency meters and dual voltmeters for comparing the output of the generator to the main bus bar. Generator wattmeters are also fitted to monitor the load on the generators. A synchroscope and synchronising lamps are provided for paralleling operations.

Generator status and general bus status (insulation alarms, etc) are displayed on indicator lamps mounted on the synchronising panel and each generator panel.

Automatic control of the generators is provided by the vessel's power management system (PMS). This system ensures a continuous power supply and also ensures that sufficient power is available at the switchboard. Automatic and manual control of the main switchboard is described in Section 2.13.2.

General

The group starter, power and lighting distribution panels are provided in suitable positions to supply the normal power supplies to heating, ventilation, lighting, machinery, communication and navigation equipment throughout the ship. Each 440V and 220V distribution circuit is protected against overcurrent and short-circuit current by a moulded case circuit-breaker (MCCB). These are fitted on the switchboard or panel board with overload trip, instantaneous magnetic trip and short-circuit current interruption features.

Each of the following supply systems is provided with monitoring equipment for continuously monitoring the insulation level to earth, giving an audible and visual indication of an abnormally low insulation level:

- Main switchboard 440V network
- Main switchboard 220V network
- Emergency switchboard 220V network
- 220V power distribution panel 21D
- The 24V DC battery charging board system

Emergency Power Distribution System

The emergency switchboard consists of:

- The emergency generator panel
- The 440V feeder panel
- The 220V feeder panel

The emergency generator will start automatically in the event of a blackout and supply the emergency switchboard. The emergency switchboard supplies essential navigation and machinery equipment which require the security of a backed-up power supply. It is designed to restore power within 45 seconds.

The emergency 220V consumers are fed from the emergency switchboard 220V panel. This panel is fed from the emergency 440V switchboard feeder panel via two 30kVA transformers. The output of these transformers is fed to the emergency 220V feeder panel via two moulded case circuit-breakers (circuits LM1 and LM2). These moulded case circuit-breakers (MCCB) are mechanically interlocked to prevent both breakers being closed simultaneously.

Emergency 220V lighting is provided via five emergency lighting distribution boards (L/E1D, L/E2D, L/E3D, L/E4D and L/E5D). These are all fed from the emergency switchboard 220V feeder panel. The emergency power distribution network is shown in illustration 2.13.4b.

Essential safety and communication equipment is fed from the battery charge and discharge board located in the converter room aft of the bridge on E deck. This board supplies items of equipment such as the ECR, cargo and bridge control consoles, bow thruster panel etc. This board is normally fed from the main or emergency switchboard 440V feeder panels, but will change over automatically to a battery supply if the emergency supply fails. The 300Ah 24V back-up battery consists of four 150Ah 12V sealed batteries located in the battery room on E deck. See Section 2.13.9, UPS and Battery Systems, for further details.

Electric Motors

The ship's 440V electric motors are in general of the standard frame, squirrel cage induction type designed for AC 440V three-phase 60Hz. The exceptions are the motors for domestic service and small capacity motors of 0.4kW or less, some of these motors may be single-phase 220V 60Hz operation. Where continuously rated motors are used, the overload setting ensures the motor trips at 100% of its full load current. The motors in the engine room are of the totally enclosed fan-cooled type. Standby motors will start when zero voltage is detected on the in-service motor or when the process pressure is low (see Section 2.13.8).

The two steering gear motors are each fed independently; No.1 steering motor is fed from No.1 440V main switchboard feeder panel (circuit 2P9), and No.2 steering motor is fed from the emergency switchboard 440V feeder panel (circuit EP9).

440 Volt Starters

The starters are generally fitted in the group starter panels with some equipment supplied from individual starters. Important, duplicated equipment starters are split between No.1 and No.2 main switchboard group starter panels. Interlocked door isolators are provided for all starters. On the group starter boards, this switch is the moulded case circuit-breaker which functions as both isolator and overcurrent protection for 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. These motors 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. For further detailed information, please refer to Section 2.13.8.

Preferential Tripping

Non-essential loads are interrupted automatically, in the case of overcurrent of any one of the main diesel generators, to prevent the more serious tripping of the generators. For further detailed information, please refer to Section 2.13.8.

Main 450/230V Transformers

The 440V at the main switchboard is transformed down to 230V via two 450/230V, 90kVA transformers to supply the main switchboard 220V feeder panel. The two moulded case circuit-breakers at the main switchboard 220V feeder section (circuits L16 and L17) are mechanically interlocked to ensure that only one transformer may feed the 220V section at any time. The transformers are located on the upper platform deck outboard of the engine control room.

Manufacturer:	Zhenjiang Marine Electric Appliance Co. Ltd.
Model:	CSD-90
Rating:	3-phase, 90kVA
Primary voltage:	450V
Secondary voltage:	230V
Frequency:	60Hz
Cooling:	Natural air
Ambient temperature:	45^{o}C
Insulation class:	B
Protection level:	IP44

Emergency 450/230V Transformers

The 440V at the emergency switchboard is transformed down to 230V via two 440/230V, 30kVA transformers to supply the emergency switchboard 220V feeder panel. The two moulded case circuit-breakers at the emergency switchboard 220V feeder panel (circuits LM1 and LM2) are interlocked to ensure that only one transformer may feed the 220V panel at any time. Both transformers are located in the emergency generator room:

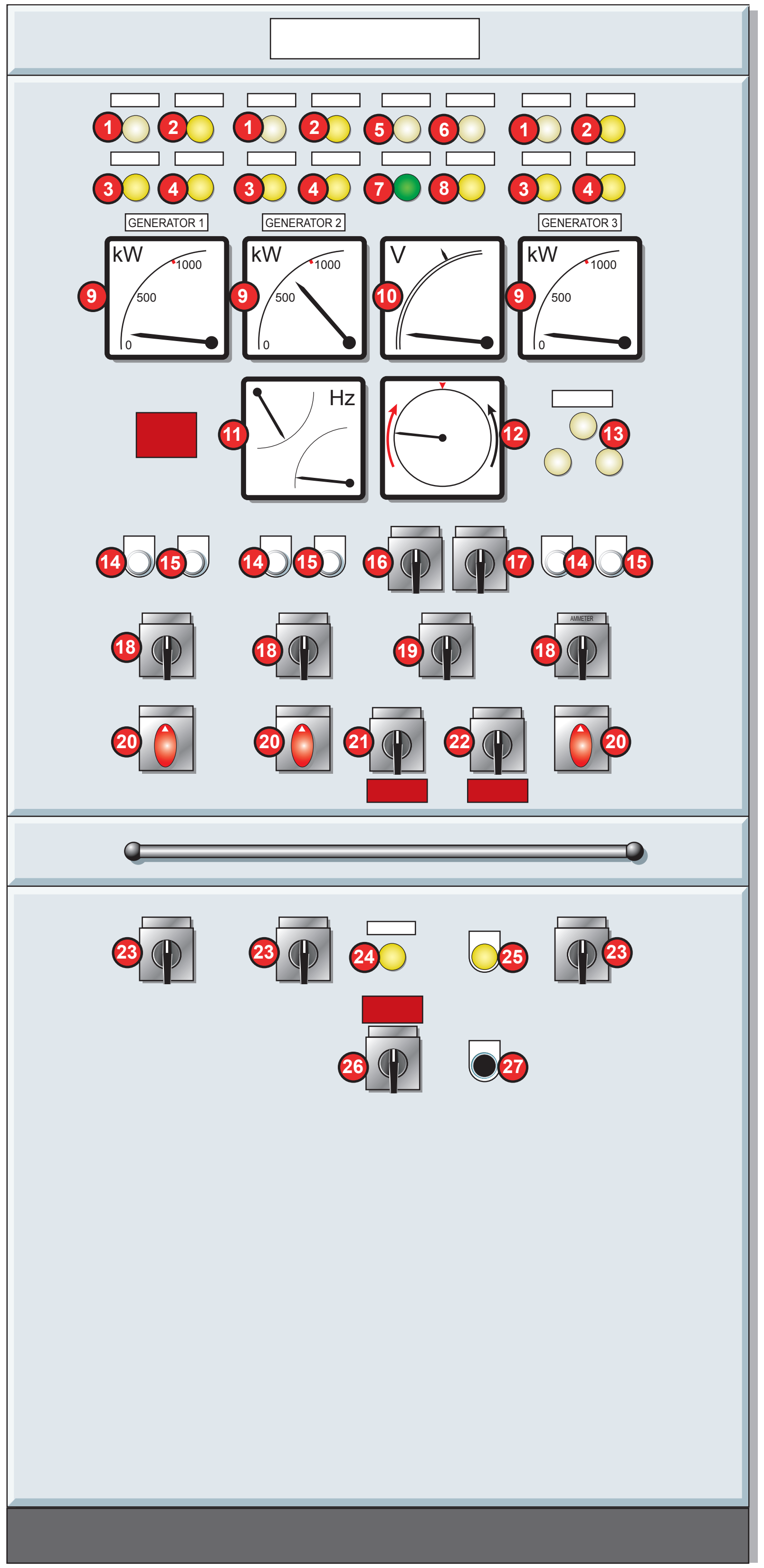
Manufacturer:	Zhenjiang Marine Electric Appliance Co. Ltd.
Model:	CSD-30
Rating:	3-phase, 30kVA
Primary voltage:	450V
Secondary voltage:	230V
Frequency:	60Hz
Cooling:	Natural air
Ambient temperature:	45^{o}C
Insulation class:	B
Protection level:	IP44

AC Re-heater Transformer

The 220V AC re-heater power distribution board 21D is supplied from the main switchboard No.2 440V feeder panel (circuit 2P3) via a 450/230V, 50kVA transformer. The transformer is located on the upper platform deck outboard of the engine control room.

Manufacturer:	Zhenjiang Marine Electric Appliance Co. Ltd.
Model:	CSD-90
Capacity:	50kVA, 3-phase
Primary voltage:	450V
Secondary voltage:	230V
Frequency:	60Hz
Cooling:	Natural air
Ambient temperature:	45^{o}C
Insulation class:	B
Protection level:	IP44

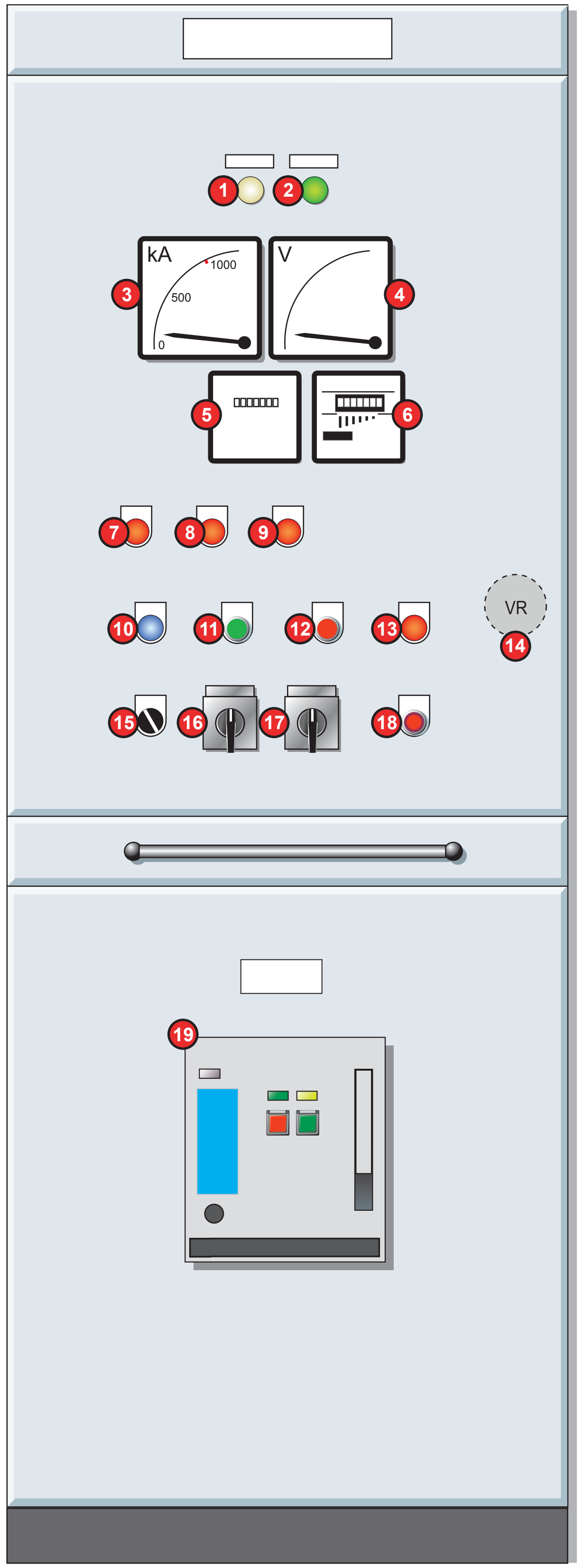
Illustration 2.13.2a Generator and Synchronising Panels



Synchronising Panel

Synchronising Panel Key

1. Generator 'Ready To Start' Indicator Lamp
2. Generator 'Master' Indicator Lamp
   (The above indicator lamp positions may be reversed on some vessels)
3. Generator 1st Standby Indicator Lamp
4. Generator 2nd Standby Indicator Lamp
5. 24V DC Source Indicator Lamp
6. Preference and Emergency Stop Source Lamp
7. Emergency Generator ACB On Indicator Lamp
8. Emergency Generator Standby Indicator Lamp
9. Generator Wattmeter
10. Generator and Bus Voltmeter
11. Generator and Bus Frequency Meter
12. Synchroscope
13. Synchronising Lamps
14. Auto Synchro Start Illuminated Pushbutton (ASS)
15. Load Shift Start Illuminated Pushbutton (LSS)
16. Frequency/Voltmeter Switch (FVS1)
17. Frequency/Voltmeter Selector Switch (FVS2)
18. Generator Mode Selector Switch (MSS)
19. Synchroscope Selector Switch SYS
20. Generator ACB Control Switch (BCS)
21. Generator Standby Selector Switch (COS-A)
22. Synchro and Power Control Switch COS-P
23. Generator Governor Control Switch (GCS)
24. Auto Stop Blocking Indicator Lamp
25. Short Circuit Trouble Indicator Lamp (STR)
26. Auto Stop Blocking Switch COS-B
27. Lamp Test Pushbutton



Generator Panel

Generator Panel Key

1. Power Available Indicator Lamp
2. Generator ACB Closed Indicator lamp
3. Generator Ammeter
4. Generator Voltmeter
5. Running Hour Meter
6. Running Watt Hour Meter
7. Turning Gear Engaged Indicator Lamp (TGE)
8. Start Fail Indicator Lamp (SF)
9. Common Shutdown Indicator Lamp (CS)
10. Space Heater IndicatorLamp
11. Engine Start Pushbutton (PB1)
12. Engine Stop Pushbutton (PB2)
13. Reverse Power Indication Lamp
14. Voltage Regulator (Inside Panel)
15. Space Heater (Off - On) Switch
16. Ammeter Phase Selection Switch
17. Voltmeter Phase Selection Switch
18. Generator ACB Abnormal Reset
19. Generator ACB

2.13.2 MAIN SWITCHBOARD AND GENERATOR OPERATION

Automatic and Manual Operation of the Main Switchboards and Generators

The generators may be controlled manually from the main switchboard synchronising panel or automatically from the main switchboard power management system (PMS).

Manual control is selected by turning the SYNCHRO AND POWER CONTROL switch (COS-P) at the main switchboard synchronising panel to the MANUAL position. Automatic control is selected by turning this switch to the AUTO position. When manual control is selected, the PMS has no control of any generating set. Manual control means that the generators are given commands via the operator from the main switchboard mounted controls.

Generators will be included in the PMS provided their MODE SELECTION SWITCH (MSS) on the synchronising panel is set to the AUTO position.

Automatic control means that the generators will be controlled automatically by the PMS with no operator intervention required. The automatic starting, stopping, connection, synchronising and loading of the main generators is normally controlled by the PMS operating in the automatic mode.

A generator engine may be operated locally at the engine control panel or remotely at the main switchboard. Diesel generator local control is selected by means of the LOCAL/REMOTE keys at the generator engine local control panel. This switch must be set to the REMOTE position to enable either manual starting and stopping from the main switchboard or automatic starting and stopping from the PMS.

The PMS controls the following features:

- Automatic blackout start and connection of the standby diesel generator.
- Automatic start, connection and load-share for the standby diesel generator due to bus abnormality.
- Automatic start, connection and load-share for the standby diesel generator due to an overload of a running generator.
- Automatic start, connection and load-share for the standby diesel generator due to a high load on a running generator.
- Automatic load reduction, disconnection and stop of the last-connected diesel generator due to a low load on the running generators.
- Automatic synchronising.
- Automatic frequency control.
- Automatic load-sharing.

Note: For further details of the flow charts referred to in the following descriptions, please see drawing No. J-7560~3/M - Main Switchboard.

1. Automatic Control Available for the Diesel Generator (Flow Chart FC11)

The procedure for automatic control of the diesel generators is as follows:

a) It is assumed that the diesel engine is ready to start, engine start conditions are normal.

b) Turn the generator control position selection switch on the generator local control panel at the engine to the REMOTE position. The READY TO START indicator at the main switchboard synchronising panel will be illuminated.

c) Turn the SYNCHRO AND POWER CONTROL switch (COS-P) at the main switchboard synchronising panel to the AUTO position.

d) Turn the generator MODE SELECTION switches (MSS) on the synchronising panel to the AUTO position.

e) Set one of the generators to standby using the STANDBY SELECT switch (COS-A) located on the synchronising panel.

Automatic control of the diesel generators is now possible.

2. Remote Control Available from Switchboard for the Diesel Generator (Flow Chart FC11)

The diesel generator may be remotely controlled at the main switchboard as follows:

a) It is assumed that the diesel engine is ready to start, engine start conditions are normal.

b) Turn the generator control position selection switch on the generator local control panel at the engine to the REMOTE position. The READY TO START indicator at the main switchboard synchronising panel will be illuminated.

3. Local Control Available for the Diesel Generator (Flow Chart FC11)

The diesel generator may be locally controlled at the generator engine as follows:

a) It is assumed that the diesel engine is ready to start, engine start conditions are normal.

b) Turn the generator control position selection switch (COS-L) on the generator local control panel at the engine to the LOCAL position.

Local control from the generator local control panel is now available.

4. Manual Diesel Generator Engine Start and Stop - Local (Flow Chart FC12)

The diesel generator engine may be started locally from the generator engine local control panel. It is assumed that the diesel generator is stopped and is ready to start.

a) To start locally from the generator engine local control panel, select for LOCAL control by pressing the pushbutton on the generator local control panel at the engine.

b) Start the generator by pressing the START pushbutton on the local panel. The generator receives a start command and starts. If the engine fails to start within 20 seconds, a START FAIL alarm is activated at the relevant main switchboard generator panel and at the engine control console operator station. Once started, observe the running lamp, frequency meter and voltmeter on the main switchboard.

c) To stop the generator engine, press the STOP pushbutton on the local control panel.

5. Manual Diesel Generator Engine Start and Stop - Remote Switchboard (Flow Chart FC12)

a) It is assumed that the diesel engine is ready to start, engine start conditions are normal.

b) Turn the generator control position selection switch on the generator local control panel at the engine to the REMOTE position. The READY TO START indicator at the main switchboard synchronising panel will be illuminated.

c) Press the ENG START pushbutton (PB1) at the relevant main switchboard generator panel.

d) The engine receives a start command and starts. If the engine fails to start within 20 seconds, a START FAIL alarm is activated at the relevant main switchboard generator panel and at the engine control console operator station. Observe the running lamp, frequency meter and voltmeter on the main switchboard.

e) To stop the generator engine, press the ENGINE STOP pushbutton (PB2) at the relevant main switchboard generator panel.

6. Diesel Generator Running - Manual ACB Closure onto a Dead Bus (Flow Chart FC12)

The procedure to close the generator circuit-breaker to supply a dead bus is as follows. It is assumed that the generator is running as described in procedure No.4 or No.5.

a) Turn the STANDBY SELECT switch (COS-A) at the main switchboard synchronising panel to the MANU position.

b) Turn the relevant ACB CONTROL switch (BCS) at the main switchboard synchronising panel to the CLOSE position.

c) The ACB will receive a close command and will close. The ACB CLOSED lamp at the relevant main switchboard generator panel is illuminated.

The diesel generator is now supplying the main switchboard.

7. Manual Parallel Running of Diesel Generator from Switchboard (Flow Chart FC13)

It is assumed that the generator engine has been started and the correct voltage established at the relevant main switchboard generator panel as described in procedure No.4 or No.5, and that a generator is already running and connected to the main switchboard.

a) Confirm that the MODE SELECTION switch (MSS) for the relevant generator to be synchronised is in the MANU position.

b) Turn the SYNCHRO SELECT switch (SYS) at the main switchboard synchronising panel to the incoming generator position (GEN1, GEN2, GEN3).

c) Adjust the relevant GOVERNOR CONTROL SWITCH (GCS) (raise/lower) until the synchroscope is moving slowly in the clockwise direction (approximately one revolution every three to four seconds).

d) As the synchroscope approaches the twelve o'clock position (synchronism), turn the relevant ACB CONTROL switch (BCS) at the main switchboard synchronising panel to the CLOSE position.

e) The ACB will receive a close command and will close. The ACB CLOSED lamp at the relevant main switchboard generator panel is illuminated.

f) To carry out load balancing manually, turn the SYNCHRO AND POWER CONTROL switch (COS-P) at the main switchboard synchronising panel to the MANU position. Load balancing is achieved by adjustment of the GOVERNOR CONTROL SWITCHES (GCS).

g) To carry out load balancing automatically, turn the SYNCHRO AND POWER CONTROL switch (COS-P) at the main switchboard synchronising panel to the AUTO position.

8. Manual Load Shift and ACB Disconnection and Stop for the Diesel Generator from the Switchboard (Flow Chart FC13)

It is assumed that the MODE SELECTION switch (MSS) for the generator to be stopped is in the MAN position.

a) Adjust the GOVERNOR CONTROL SWITCH (GCS) for the generator to be removed from service to reduce the load on the diesel generator. The governor control switches are located on the main switchboard synchronising panel.

b) When the load on the generator is at or close to zero, turn the relevant ACB CONTROL switch (BCS) at the main switchboard synchronising panel to the OPEN position.

c) The ACB will receive an open command and will open.

d) After a predetermined cooling down period, the generator engine may be stopped by pressing the ENGINE STOP pushbutton (PB2) at the relevant main switchboard generator panel. The engine may also be stopped at the engine local control panel by pressing the ENGINE STOP pushbutton.

9. Automatic Diesel Generator Engine Start and Parallel Running - Operator Initiated (Flow Chart FC32)

It is assumed that automatic control of the generators is available as described in procedure No.1 (FC11), and that at least one generator is already running and connected to the main switchboard.

a) The operator presses the relevant AUTO SYNCHRO START pushbutton (ASS) at the main switchboard synchronising panel for the generator to be paralleled up.

b) The engine receives a start command and starts. If the engine fails to start, a start fail alarm is activated at the main switchboard and at the engine control console.

c) Once voltage is established an automatic synchronising command will be issued and the diesel generator will synchronise with the bus bar.

d) Upon synchronising, the diesel generator ACB will receive a close command and will then close. If the ACB does not close an alarm will be activated at the engine control console.

e) Upon closing of the ACB, an automatic load-sharing command will then be issued and automatic load-sharing will be carried out.

10. Automatic Load Shift, ACB Disconnection and Stop for the Diesel Generator - Operator Initiated (Flow Chart FC41)

It is assumed that automatic control is available as described in procedure No.1 (FC11), and that the AUTO STOP BLOCKING (COS-B) at the main switchboard synchronising panel is in the NORMAL position.

a) The operator presses the relevant LOAD SHIFT START pushbutton (LSS) at the main switchboard synchronising panel for the generator to be unloaded.

b) The power management system assesses the consequences of removing the generator from service. If the load on the remaining generator would be greater than or equal to 80% of its rating, the load shift and ACB disconnection will be blocked and normal load-sharing will resume.

c) If the loading is within the allowed limit, then an automatic load shift command is issued and the FULL AUTO STOP indicator at the relevant main switchboard generator panel is illuminated.

d) When the load is at or close to zero, an automatic open command is issued to the diesel generator ACB and the ACB opens. The ACB CLOSED indicator on the relevant main switchboard generator panel is extinguished.

e) After a predetermined cooling down period, the generator engine receives an automatic stop command and stops.

11. Automatic Diesel Generator Engine Start and ACB Closure onto the Dead Bus Due to Blackout (Flow Chart FC52)

A generator ACB abnormal trip may occur as a result of the following:

- Engine emergency/manual stop
- Short-circuit current
- Undervoltage
- Overcurrent
- Reverse power
- Nuisance (mechanical) trip

In the event of a blackout the following procedure will commence. It is assumed that automatic control is available as described in procedure No.1 (FC11) and that two generators are available to start and set as 1st and 2nd standby.

a) The 1st standby diesel generator will receive a start command and will start.

b) If the engine fails to start within 15 seconds a START FAIL alarm will be activated at the relevant main switchboard generator panel and at the engine control console operator station, and a start command will be given to the 2nd standby diesel generator.

c) Once voltage is established (95% of its normal rating), the diesel generator ACB will receive a close command and will close. The diesel generator will now be supplying the main switchboard. If voltage is not established within 20 seconds of the engine starting or if the ACB fails to close within 3 seconds of the ACB close command, an ACB NON CLOSE alarm will be activated at the engine control console operator station, and a start command will be given to the 2nd standby diesel generator.

Note: If the original generator ACB trip was a result of a bus short-circuit, and the bus short-circuit is still present when the 1st standby generator ACB closes, the ACB will trip and an alarm will be generated at t the engine control console operator station. The 2nd standby generator will not be started.

12. Automatic Generator Engine Start and Synchronising Due to Overload (Flow Chart FC61)

If the generator in use registers a high load (85% of the rated power) for five seconds, the first standby generator will go through the following sequence. It is assumed that automatic control is available as described in procedure No.1 (FC11) and that two generators are available to start and set as 1st and 2nd standby.

a) The 1st standby diesel generator will receive a start command and will start.

b) If the engine fails to start within 15 seconds a START FAIL alarm will be activated at the relevant main switchboard generator panel and at the engine control console operator station, and a start command will be given to the 2nd standby diesel generator.

c) Once voltage is established (≥ 95% of the rated voltage) an automatic synchronising command will be issued and the diesel generator will synchronise with the bus bar.

d) Upon synchronising, the diesel generator ACB will receive a close command and will then close.

e) If voltage is not established within 20 seconds of the engine starting or if the 1st standby generator ACB fails to close within 60 seconds of voltage being established, an ACB NON CLOSE alarm will be activated at the engine control console operator station, and a start command will be given to the 2nd standby diesel generator. Upon synchronising, the 2nd standby diesel generator ACB will receive a close command and will then close.

f) Upon closing of the ACB, an automatic load-sharing command will then be issued and automatic load-sharing will be carried out.

13. Automatic Load Shift and ACB Disconnection Due to Light Load (Flow Chart FC61)

When two or three generators are on-load and the total load falls below preset values, an automatic load shift and diesel generator breaker disconnection procedure will be activated. The generator to be released for stopping will be the least priority generator, ie, the second standby generator when running on three generators or the standby generator when running on two generators.

The designated generator will be unloaded and stopped if the total load on the remaining generator(s) would be 80% or less for 10 minutes.

The procedure is as follows. It is assumed that automatic control is available as described in procedure No.1 (FC11), the AUTO STOP BLOCKING selection switch on the main switchboard synchronising panel is in the NORMAL position, and that at least two generators are paralleled up and connected to the main switchboard.

a) An automatic load shift command is issued by the automatic control system and the load is reduced on the diesel generator.

b) When the load is at or close to zero, an automatic open command is issued to the diesel generator circuit-breaker (GEN1, GEN2 or GEN3) and the breaker opens.

c) After a predetermined cooling down period, the diesel generator engine will receive a stop command and will stop.

Note: If the AUTO STOP BLOCKING selection switch on the main switchboard synchronising panel is in the BLOCK position, automatic load shift and ACB disconnection due to light load will be blocked.

The automatic stopping due to light load function operates to different settings when the cargo hydraulic power pack is in operation. If two generators are on-load and one hydraulic pump is running, the standby generator will be released for stopping if the load is less than 125kW (GEN1 and GEN2 or GEN1 and GEN3) or 255kW (GEN2 and GEN3) for 10 minutes.

If three generators are on-load and one or two hydraulic pumps are running, the last standby generator will be released for stopping if the load is less than 905kW (for one pump running) or 380kW (for two pumps running) for 10 minutes.

14. Automatic Parallel Running in Response to Large Motor Start (Hydraulic Power Pack) (Flow Chart FC82)

If the load on a running generator is too high to permit the safe starting of the vessel's cargo hydraulic power pack (HPP), the 1st standby diesel generator will be started and paralleled to provide adequate capacity. The motor will have its start delayed until the standby generator is connected and the load is equally shared.

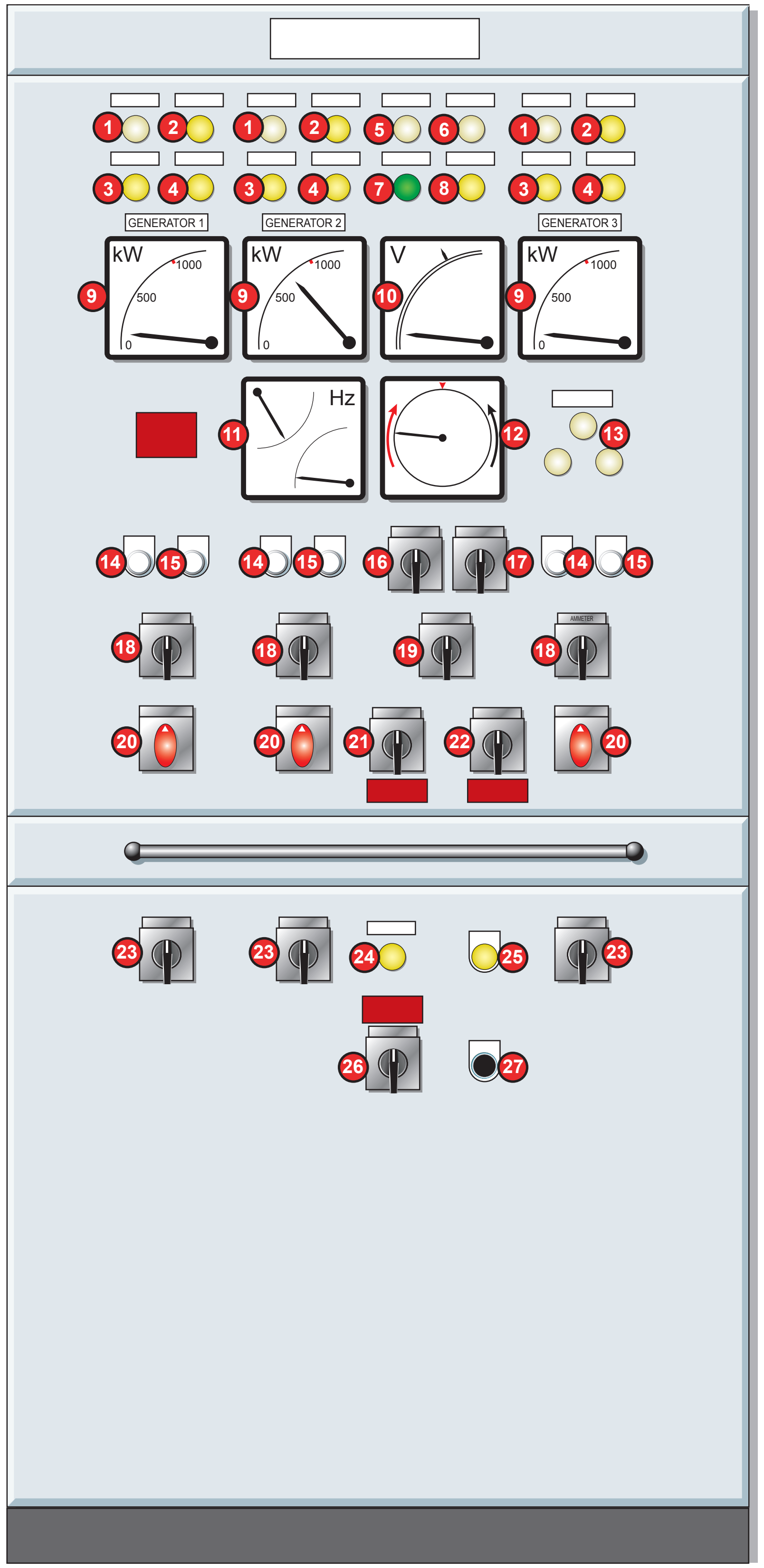
It is assumed that automatic control is available as described in procedure No.1 (FC11). When an HPP start request is received, a check is made to confirm if the surplus power available (PS) is sufficient to allow starting. The settings are as follows:

- PS > 255kW (GEN 2 or GEN 3 running) or 125kW (GEN 1 running)
- PS > 905kW (GEN 1 and GEN 2 running) or 905kW (GEN 1 and GEN 3 running)
- PS > 1,035kW (GEN 2 and GEN 3 running)
- PS > 1,685kW (GEN1, GEN 2 and GEN 3 running)

a) If the surplus power available (PS) is insufficient to allow starting, the 1st standby diesel generator will receive a start command and will start.

b) If the engine fails to start within 15 seconds a START FAIL alarm will be activated at the relevant main switchboard

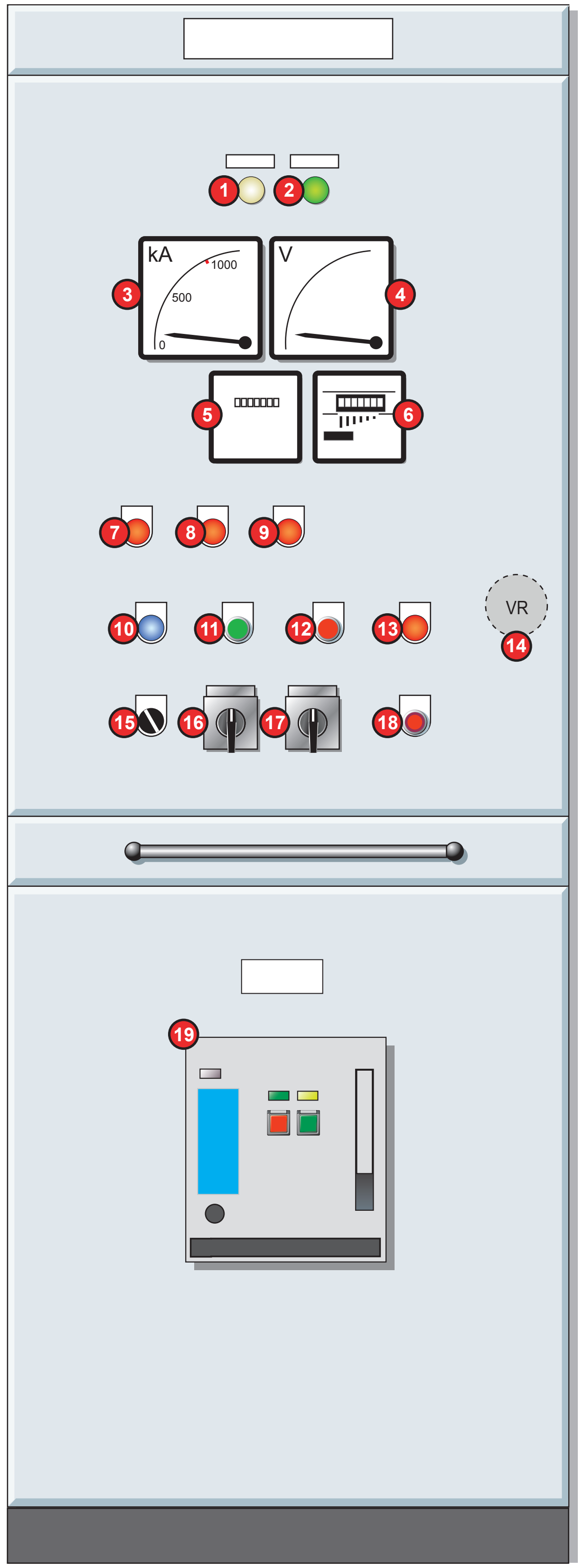
Illustration 2.13.2a Generator and Synchronising Panels



Synchronising Panel

Synchronising Panel Key

1. Generator ‘Ready To Start’ Indicator Lamp
2. Generator ‘Master’ Indicator Lamp
   (The above indicator lamp positions may be reversed on some vessels)
3. Generator 1st Standby Indicator Lamp
4. Generator 2nd Standby Indicator Lamp
5. 24V DC Source Indicator Lamp
6. Preference and Emergency Stop Source Lamp
7. Emergency Generator ACB On Indicator Lamp
8. Emergency Generator Standby Indicator Lamp
9. Generator Wattmeter
10. Generator and Bus Voltmeter
11. Generator and Bus Frequency Meter
12. Synchroscope
13. Synchronising Lamps
14. Auto Synchro Start Illuminated Pushbutton (ASS)
15. Load Shift Start Illuminated Pushbutton (LSS)
16. Frequency/Voltmeter Switch (FVS1)
17. Frequency/Voltmeter Selector Switch (FVS2)
18. Generator Mode Selector Switch (MSS)
19. Synchroscope Selector Switch SYS
20. Generator ACB Control Switch (BCS)
21. Generator Standby Selector Switch (COS-A)
22. Synchro and Power Control Switch COS-P
23. Generator Governor Control Switch (GCS)
24. Auto Stop Blocking Indicator Lamp
25. Short Circuit Trouble Indicator Lamp (STR)
26. Auto Stop Blocking Switch COS-B
27. Lamp Test Pushbutton



Generator Panel

Generator Panel Key

1. Power Available Indicator Lamp
2. Generator ACB Closed Indicator lamp
3. Generator Ammeter
4. Generator Voltmeter
5. Running Hour Meter
6. Running Watt Hour Meter
7. Turning Gear Engaged Indicator Lamp (TGE)
8. Start Fail Indicator Lamp (SF)
9. Common Shutdown Indicator Lamp (CS)
10. Space Heater IndicatorLamp
11. Engine Start Pushbutton (PB1)
12. Engine Stop Pushbutton (PB2)
13. Reverse Power Indication Lamp
14. Voltage Regulator (Inside Panel)
15. Space Heater (Off - On) Switch
16. Ammeter Phase Selection Switch
17. Voltmeter Phase Selection Switch
18. Generator ACB Abnormal Reset
19. Generator ACB

generator panel and at the engine control console operator station, and a start command will be given to the 2nd standby diesel generator.

c) Once voltage is established (≥ 95% of the rated voltage) an automatic synchronising command will be issued and the diesel generator will synchronise with the bus bar.

d) Upon synchronising, the diesel generator ACB will receive a close command and will then close.

e) If voltage is not established within 20 seconds of the engine starting or if the 1st standby generator ACB fails to close within 60 seconds of voltage being established, an ACB NON CLOSE alarm will be activated at the engine control console operator station, and a start command will be given to the 2nd standby diesel generator. Upon synchronising, the 2nd standby diesel generator ACB will receive a close command and will then close.

f) Upon closing of the ACB, an automatic load-sharing command will then be issued and automatic load-sharing will be carried out.

15. Bus Abnormality

The normal voltage and frequency levels at the main switchboard bus are:

- Voltage: 450V
- Frequency: 60Hz

Under certain fault conditions, the voltage and frequency may rise or lower according to the fault. These fluctuating levels are undesirable for the operation of the ship's plant.

There are bus abnormality limits for the main bus voltage and frequency deviation and the limits for these are set as follows:

- Low voltage limit: 427.5V (-5%) for 5 seconds
- High voltage limit: 472.5V (+5%) for 5 seconds
- Low frequency limit: 57Hz (-5%) for 5 seconds
- High frequency limit: 63Hz (+5%) for 5 seconds

If any of the above limits are reached, an alarm is raised.

Main Generator ACB Specifications and Protection Settings

Manufacturer:	Terasaki
Type:	AR212S (GEN1), AR216S (GEN 2 and GEN 3)
Number of poles:	3
Voltage:	450V AC
Frequency:	60Hz
Ampere frame:	1,250A (GEN 1), 1,600A (GEN 2 and GEN 3)
Base current I_N:	1,042A (GEN 1), 1,251A (GEN 2 and GEN 3)
Overcurrent trip type:	AGR-21S-PSU

Generator Protection Equipment

The generator is protected from the abnormal conditions described below by means of the reverse power trip, short-circuit trip, undervoltage trip and overcurrent trips.

1. Abnormality Due to Undervoltage

If the voltage of a generator decreases to less than 382.5V (85% of the rated value), the undervoltage tripping device, contained in the air circuit-breaker, will operate to trip the breaker. If a short-circuit fault occurs, the generator voltage will lower and may cause the undervoltage tripping device (UVT) to operate. With this in mind, a time delay device (of about 0.5 seconds) has been fitted to the undervoltage device to prevent the ACB from tripping immediately, allowing the defective system circuit-breaker to operate first.

2. Abnormality Due to Overcurrent (Preference Tripping)

The generator ACB base current is set at 1,251A (GEN 2 and GEN3) and 1,042A (GEN 1). The pick-up current for the 1st stage preferential trip is set at 1,187A (GEN 2 and GEN3) and 990A (GEN 1) (95% of the generator ACB base current). If the current on a running generator exceeds 1,424A (GEN 2 and GEN3) or 1,188A (GEN 1) (120% of the pick-up current) for a period of 10 seconds, the PMS will initiate the release of the first stage preferential trips. If the current still exceeds this level after a further 10 seconds, the second stage preferential trips are released thereby providing protection against the overcurrent which would otherwise trip the ACB. The preferential trips are described in Section 2.13.8.

3. Abnormality Due to Overcurrent (Long Time Delay Trip)

The generator ACB base current is set at 1,251A (GEN 2 and GEN3) and 1,042A (GEN 1). The pick-up current for the long time delay trip is set at 1,376A (GEN 2 and GEN3) and 1,147A (GEN 1) (110% of the generator ACB base current). If the current on a running generator exceeds 1,651A (GEN 2 and GEN3) or 1,425A (GEN 1) (120% of the pick-up current) for a period of 10 seconds, the overcurrent relay will operate to trip the ACB.

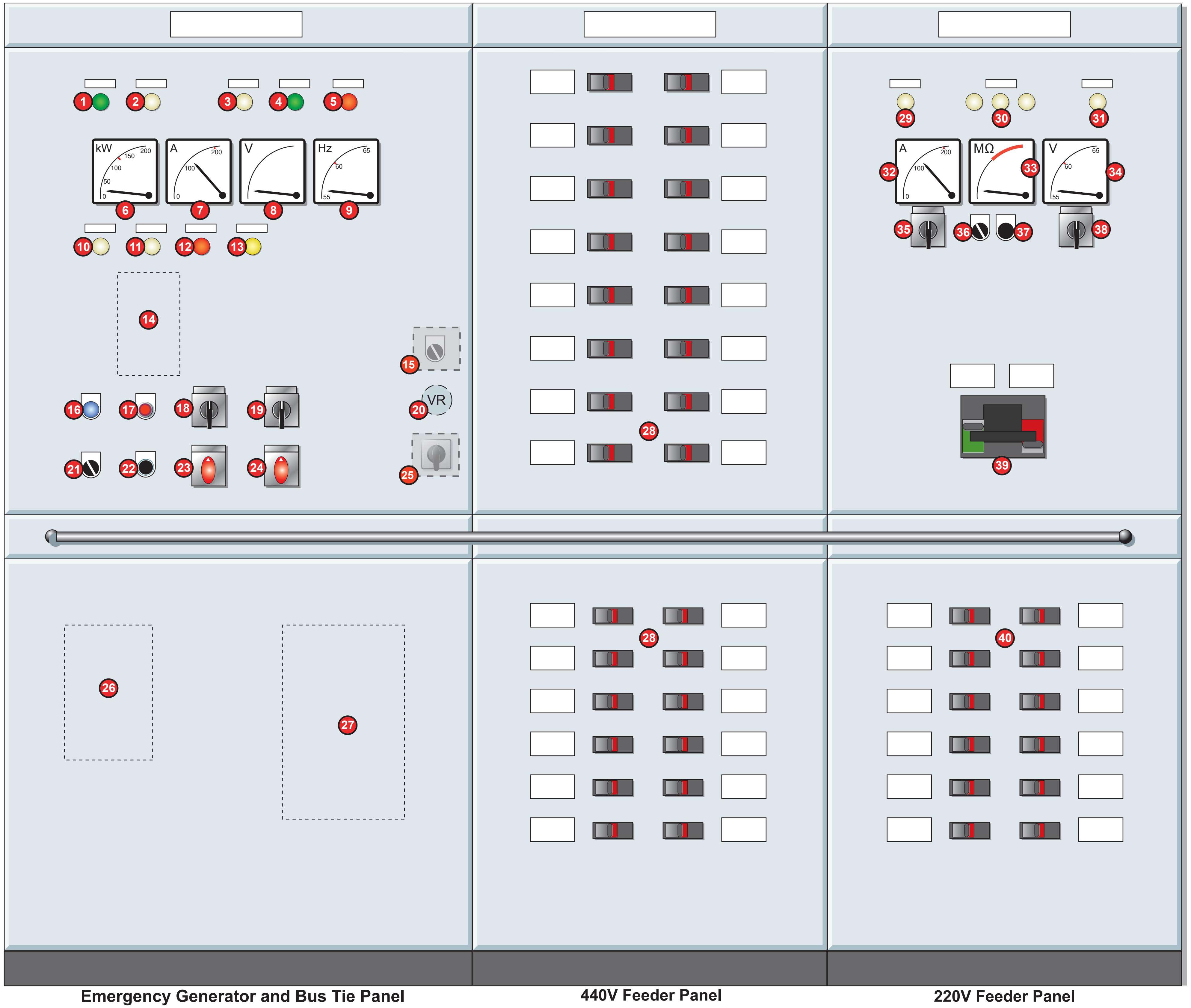
4. Abnormality Due to Overcurrent (Short Time Delay Trip)

If the generator current exceeds 3,127A (GEN 2 and GEN3) or 2,605A (GEN 1) (250% of the generator ACB base current), the ACB will be tripped almost instantaneously (about 400msec) by the short time delay trip fitted to the ACB. If the current exceeds 12,500A (GEN 2 and GEN3) or 10,400A (GEN 1) 1,000% of generator ACB base current (19,250A), the ACB will trip instantaneously (zero time delay).

5. Abnormality Due to Reverse Power

If there are abnormalities in the output of an engine during parallel operation, it may cause the generator to function as a motor, due to the power it receives from the other generator(s) through the common bus bar. The effective reverse power will then flow through the connected circuit. If this reverse power reaches a level of 78kW (GEN 2 and GEN3) or 65kW (GEN 1) (10% of the rated power) for ten seconds, the reverse power relay will operate to trip the generator's ACB.

Illustration 2.13.3a Emergency Switchboard



Key

1. Emergency Generator ACB On Lamp
2. Emergency Generator Power Available Lamp
3. Main Switchboard Power Available Lamp
4. Bus Tie Closed Lamp
5. Bus Tie Open Lamp
6. Emergency Generator Wattmeter
7. Emergency Generator Ammeter
8. Emergency Generator Voltmeter
9. Emergency Generator Frequency Meter
10. 24V DC Source Lamp
11. Emergency Stop Source Lamp
12. Disconnecting Switch Open Lamp
13. Emergency Generator Standby Lamp
14. Disconnecting Switch (Inside Back of Panel)
15. EP15 Bypass Switch (Inside Panel)
16. Space Heater Lamp
17. Emergency Generator Trouble Reset Pushbutton
18. Ammeter Phase Selection Switch
19. Voltmeter Phase Selection Switch
20. Voltage Regulator (Inside Panel)
21. Space Heater (Off - On) Switch
22. Lamp Test Pushbutton
23. Emergency Generator ACB Control Switch (BCS)
24. Bus Tie ACB Control Switch (BCS-B)
25. Emergency Generator Test Switch (COS-T) (Inside Panel)
26. Emergency Generator ACB
27. Bus Tie ACB
28. 440V Feeder Panel Distribution Circuit-Breakers
29. Transformer No.1 Source Available Lamp
30. 220V AC Section Earth Lamps
31. Transformer No.2 Source Available Lamp
32. 220V AC Section Ammeter
33. 220V AC Section Insulation Resistance Ohmeter
34. 220V AC Section Voltmeter
35. Ammeter Phase Selection Switch
36. Lighting On/Off Switch
37. Earth Test Pushbutton
38. Voltmeter Phase Selection Switch
39. Transformer Incoming Supply Circuit-Breakers
40. 220V Feeder Panel Distribution Circuit-Breakers

2.13.3 EMERGENCY SWITCHBOARD AND GENERATOR OPERATION

The vessel is equipped with one diesel-driven emergency generator. Under normal conditions the emergency switchboard is supplied from the main switchboard No.1 440V feeder panel (circuit 1P2). In the event of failure of the normal supply, the emergency generator will start automatically and connect to the emergency switchboard. Interlocks are provided which prevent the emergency generator running in parallel with any of the main diesel-driven generators. The emergency generator engine may be manually started from the local control panel at the engine side, but cannot be manually started from the emergency switchboard.

Note: For further details of the flow charts referred to in the following descriptions, please see drawing No. J-7560~3/E - Emergency Switchboard.

1. Emergency Diesel Generator Engine Manual Control from the Engine Local Control Panel (Flow Chart FC1E)

a) The engine start conditions are normal.

b) The mode selection switch on the engine local control panel is set to the LOCAL position.

Local control from the engine local control panel at the engine is now available.

2. Emergency Diesel Generator Engine Automatic Control (Flow Chart FC1E)

It is assumed that the emergency generator test switch is in the NORMAL position, the bus tie MCCB is closed and the emergency generator disconnecting switch is closed.

a) The engine start conditions are normal.

b) The mode selection switch on the engine local control panel is set to the EMERGENCY position. The STANDBY indicator on the emergency switchboard generator panel is illuminated.

Automatic control of the emergency diesel generator engine is now available.

3. Manual Emergency Generator Engine Start and Connection onto the Dead Bus (Flow Chart FC2E)

It is assumed that manual control of the diesel generator engine is available as described in procedure No.1 (FC1E).

a) At the generator engine local control panel, the operator presses the START pushbutton. The emergency generator engine starts via its electric starter.

b) When voltage is established, the operator turns the EG ACB CONTROL switch (BCS) at the generator panel of the emergency switchboard to the CLOSE position. The generator ACB receives a close command and closes. The ACB ON lamp at the emergency switchboard, emergency generator panel is illuminated.

The emergency generator now feeds the emergency switchboard.

4. Manual ACB Disconnection (Flow Chart FC2E)

a) At the generator panel of the emergency switchboard, the operator turns the EG ACB CONTROL switch (BCS) at the generator panel of the emergency switchboard to the OPEN position. The generator ACB receives an open command and opens. The ACB ON lamp at the emergency switchboard, emergency generator panel is extinguished.

b) After a predetermined cooldown period, the generator engine may be stopped at the generator engine local control panel.

5. Emergency Generator Automatic Start and Connection onto the Dead Bus (Flow Chart FC11EA)

It is assumed that the engine is in automatic control as described in procedure No.2 (Flow Chart FC1E):

a) The emergency switchboard bus tie breaker opens due to a zero volt situation (blackout).

b) The emergency switchboard bus voltage drops to zero. After a delay of 5 seconds, the emergency generator engine receives a start command and starts.

c) A check is made to confirm that the emergency switchboard bus is still dead. If this is the case, the emergency generator ACB receives a close command and closes.

Note: Closing of the emergency generator circuit-breaker is delayed for 5 seconds to allow the standby main diesel-driven generator the possibility of restoring the normal power supply.

The emergency generator now feeds the emergency switchboard.

6. Automatic Changeover to Normal Power Due to Main Switchboard Power Restoration (Flow Chart FC11EA)

It is assumed that automatic control is available as described in procedure No.2 (Flow Chart FC1E), the emergency generator test switch is in the NORMAL position and that the emergency generator is supplying the emergency switchboard.

a) At the generator panel of the emergency switchboard, the operator turns the EG ACB CONTROL switch (BCS) at the generator panel of the emergency switchboard to the OPEN position. The generator ACB receives an open command and opens.

b) The emergency switchboard bus tie MCCB (circuit TCB) receives an automatic close command and closes.

c) When the bus tie breaker is closed and power is available from the main switchboard, a stop command is sent to the generator engine control panel and the generator engine will be stopped.

The emergency switchboard is now being supplied from the main switchboard.

7. Emergency Generator Test Start and ACB Closure Without Interruption of Supply (Flow Chart FC22EA)

In this test the emergency generator will start automatically and the generator ACB will close, but will not feed the emergency switchboard. It is assumed that the engine is ready to start and that the mode selection switch on the engine local control panel is set to the EMERGENCY position

a) Open the emergency generator disconnection switch located inside the emergency switchboard, emergency generator panel.

b) Turn the emergency generator test switch (COS-T) (located inside the emergency generator panel and marked EM'CY GEN TEST) to the TEST position.

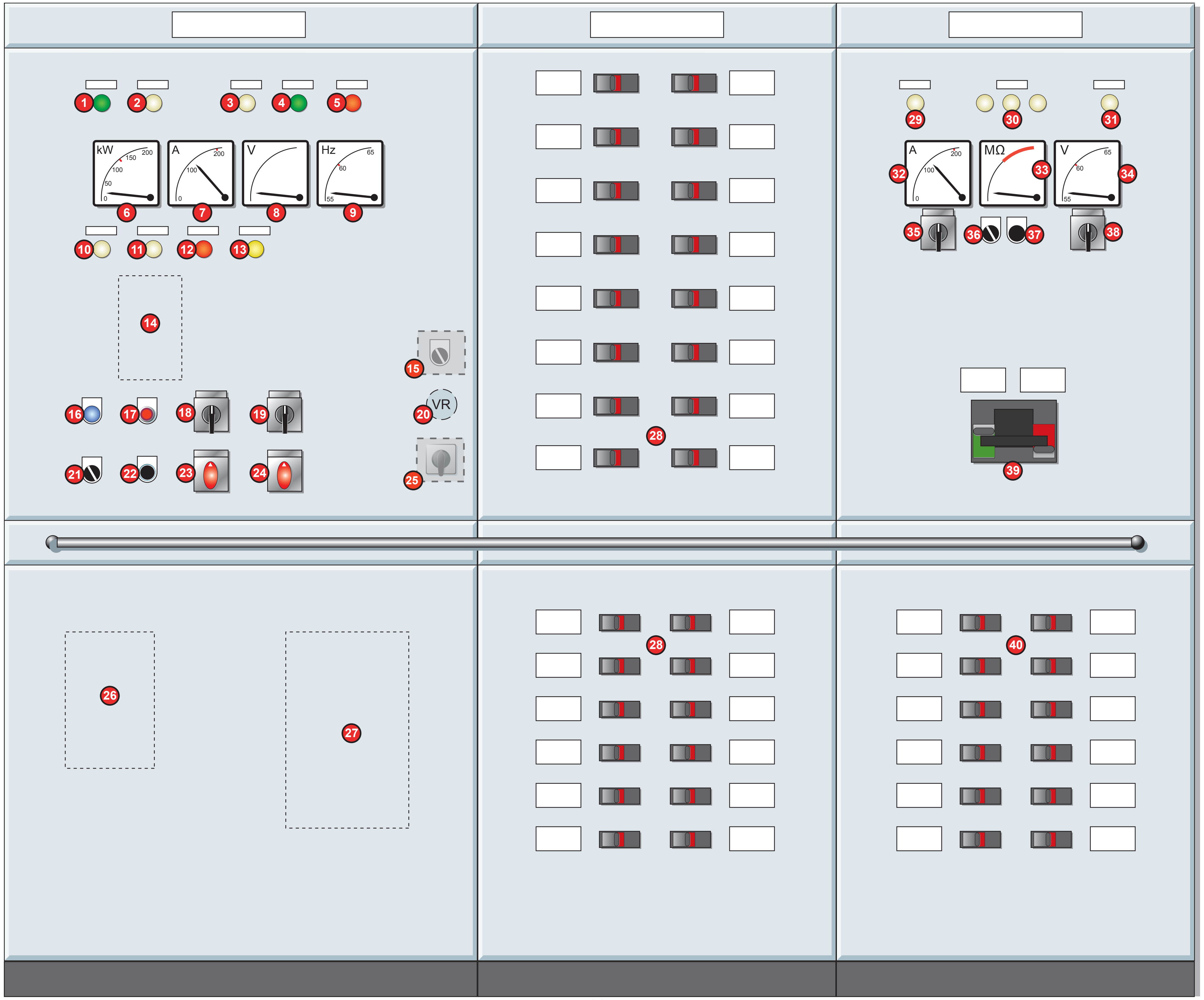
c) The emergency generator engine receives a start command and starts.

d) When voltage has been established (≥95% of the normal rating) the emergency generator ACB receives a close command and closes. The emergency generator now feeds the emergency switchboard.

e) Upon completion of the test, turn the emergency generator test switch (COS-T) to the NORMAL position.

f) At the generator panel of the emergency switchboard, the operator turns the EG ACB CONTROL switch (BCS) at the generator panel of the emergency switchboard to the OPEN position. The generator ACB receives an open command and opens.

Illustration 2.13.3a Emergency Switchboard



Key

1. Emergency Generator ACB On Lamp
2. Emergency Generator Power Available Lamp
3. Main Switchboard Power Available Lamp
4. Bus Tie Closed Lamp
5. Bus Tie Open Lamp
6. Emergency Generator Wattmeter
7. Emergency Generator Ammeter
8. Emergency Generator Voltmeter
9. Emergency Generator Frequency Meter
10. 24V DC Source Lamp
11. Emergency Stop Source Lamp
12. Disconnecting Switch Open Lamp
13. Emergency Generator Standby Lamp
14. Disconnecting Switch (Inside Back of Panel)
15. EP15 Bypass Switch (Inside Panel)
16. Space Heater Lamp
17. Emergency Generator Trouble Reset Pushbutton
18. Ammeter Phase Selection Switch
19. Voltmeter Phase Selection Switch
20. Voltage Regulator (Inside Panel)
21. Space Heater (Off - On) Switch
22. Lamp Test Pushbutton
23. Emergency Generator ACB Control Switch (BCS)
24. Bus Tie ACB Control Switch (BCS-B)
25. Emergency Generator Test Switch (COS-T) (Inside Panel)
26. Emergency Generator ACB
27. Bus Tie ACB
28. 440V Feeder Panel Distribution Circuit-Breakers
29. Transformer No.1 Source Available Lamp
30. 220V AC Section Earth Lamps
31. Transformer No.2 Source Available Lamp
32. 220V AC Section Ammeter
33. 220V AC Section Insulation Resistance Ohmeter
34. 220V AC Section Voltmeter
35. Ammeter Phase Selection Switch
36. Lighting On/Off Switch
37. Earth Test Pushbutton
38. Voltmeter Phase Selection Switch
39. Transformer Incoming Supply Circuit-Breakers
40. 220V Feeder Panel Distribution Circuit-Breakers

g) After a predetermined cooldown period, the generator engine may be stopped at the generator engine local control panel.

h) Close the emergency generator disconnection switch located inside the emergency switchboard, emergency generator panel.

CAUTION
The disconnecting switch for the emergency generator must not be operated unless the emergency generator has completely stopped.

8. Emergency Generator Test Start Without ACB Closing (Flow Chart FC22EA)

In this test, the emergency generator will start automatically but the generator ACB will not close. It is assumed that the mode selection switch on the engine local control panel is set to the EMERGENCY position.

a) Turn the emergency generator test switch (COS-T) (located inside the emergency generator panel and marked EM'CY GEN TEST) to the TEST position.

b) The emergency generator engine receives a start command and starts.

c) Check the voltage and frequency of the emergency generator.

d) Turn the emergency generator test switch (COS-T) to the NORMAL position and the emergency generator will stop automatically.

9. Emergency Generator Test Start and ACB Closure Via Blackout

In this test, the emergency generator will start automatically and the generator ACB will close to feed the emergency switchboard. It is assumed that the engine is ready to start and that the mode selection switch on the engine local control panel is set to the STBY position.

a) Turn the emergency generator test switch (COS-T) (located inside the emergency generator panel and marked EM'CY GEN TEST) to the TEST (BLACKOUT) position. The bus tie MCCB will trip resulting in a loss of supply to the emergency switchboard.

b) The emergency generator engine receives a start command and starts.

c) The emergency generator ACB receives a close command and closes.

d) Check the voltage and frequency of the emergency generator.

e) Upon completion of the test, turn the emergency generator test switch (COS-T) to the NORMAL position.

f) At the generator panel of the emergency switchboard, the operator turns the EG ACB CONTROL switch (BCS) at the generator panel of the emergency switchboard to the OPEN position. The generator ACB receives an open command and opens.

g) The emergency switchboard bus tie MCCB (circuit TCB) receives an automatic close command and closes.

h) After a predetermined cooldown period, the generator engine stops automatically.

Emergency Generator Protection Equipment

The ship's emergency generator is protected from the abnormal conditions described below by means of their undervoltage trip and overcurrent trips.

1. Abnormality Due to Undervoltage

The emergency generator air circuit-breaker (ACB) is equipped with an undervoltage trip (UVT). In the event of loss of supply to the ACB, the UVT will cause the breaker to trip.

2. Abnormality Due to Overcurrent (Long Time Delay Trip)

The generator ACB base current I_o is 200A. The pick-up current for the long time delay trip is set at 211.7A (110% of the generator base current I_o). If the current on the emergency generator exceeds 254A (120% of the pick-up current) for a period of 20 seconds, the overcurrent relay will operate to trip the ACB.

3. Abnormality Due to Overcurrent (Short Time Delay)

If the generator current exceeds 500A (250% of the generator ACB base current I_o), the ACB will be tripped almost instantaneously (about 120msec).

2.13.4 ELECTRICAL DISTRIBUTION

Illustration 2.13.4a Main 440V and 220V Distribution

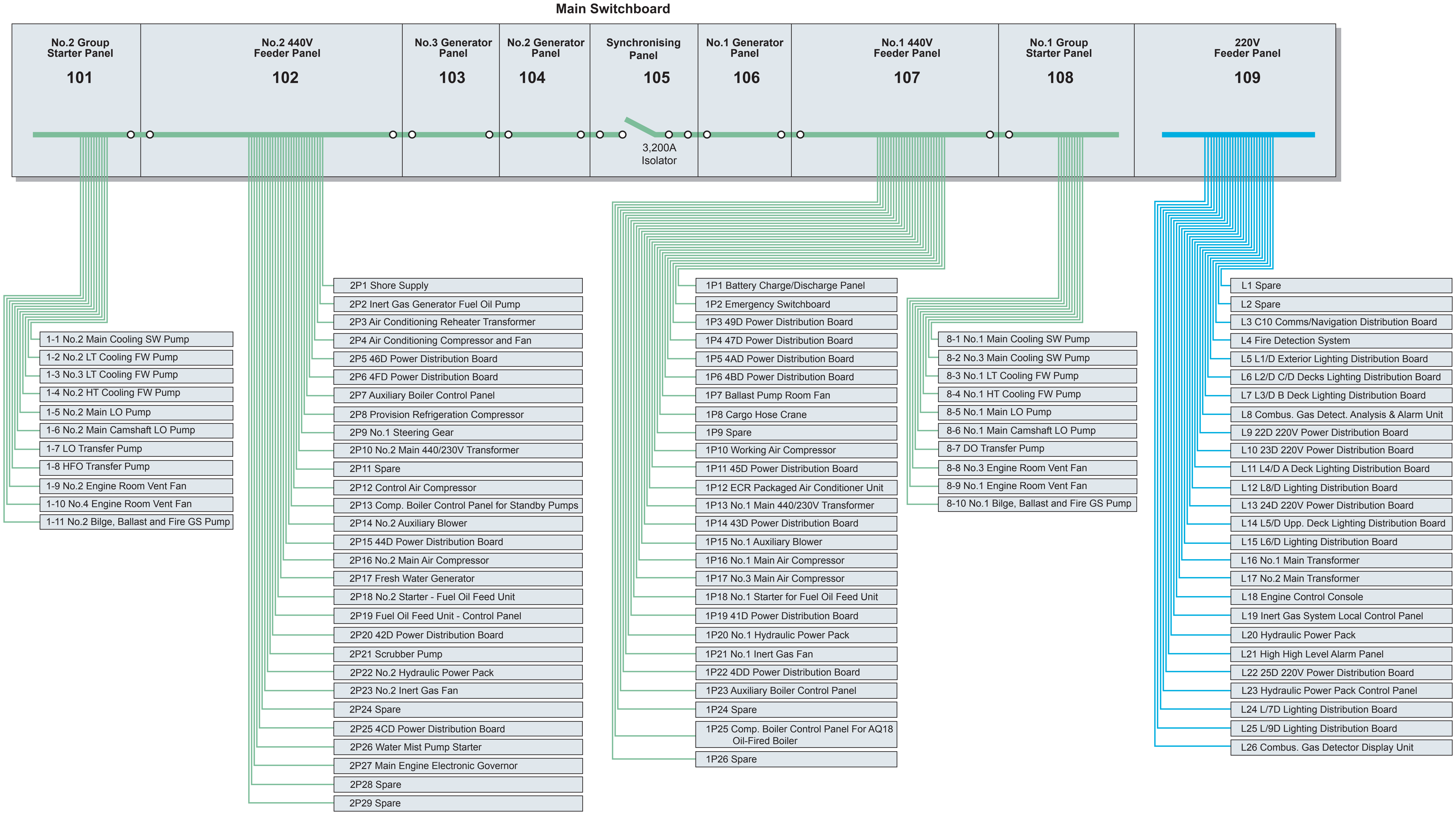


Illustration 2.13.4b Emergency 440V and 220V Distribution

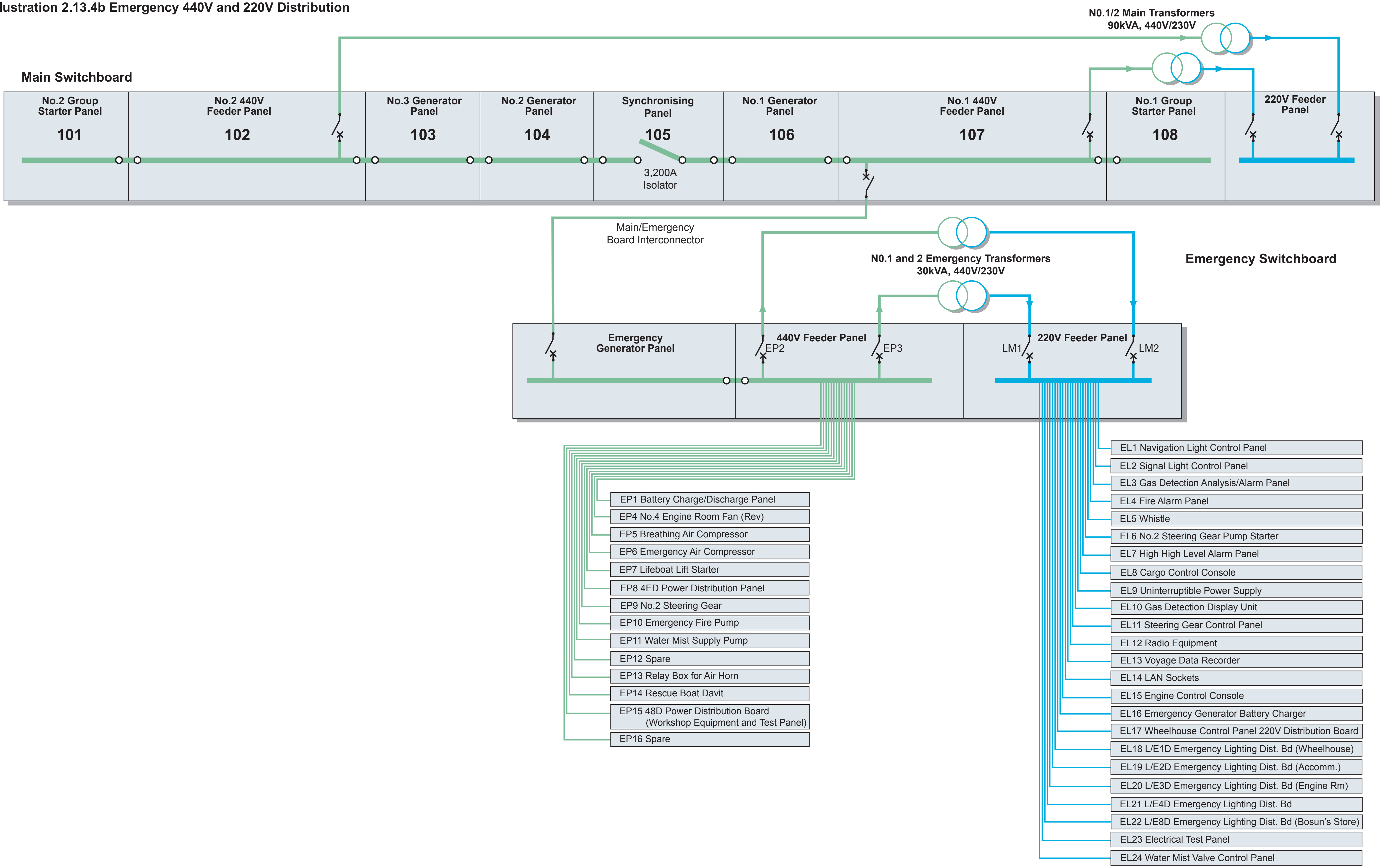
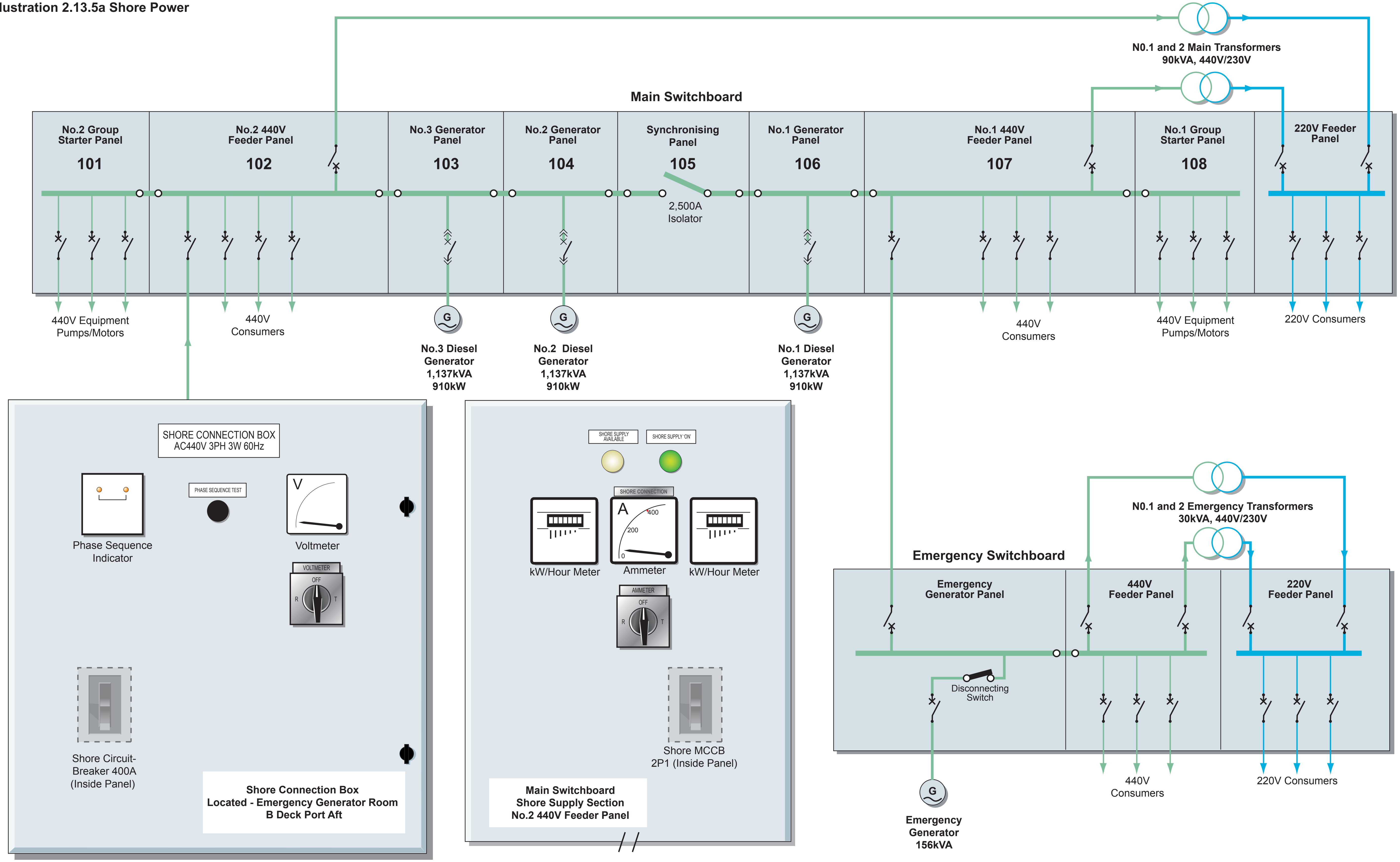


Illustration 2.13.5a Shore Power



2.13.5 SHORE POWER

Shore power supply: 440V AC, 3-phase, 60Hz
Maximum current: 400A

Introduction

A shore connection box is provided in the emergency generator room on B deck port aft to accept power cables during refit.

The shore connection box connects, via a moulded case circuit-breaker, to the main switchboard, No.2 440V feeder panel. The emergency switchboard may then be supplied as normal through the bus tie breaker on the panel.

A SHORE SUPPLY AVAILABLE lamp, SHORE SUPPLY ON lamp, an ammeter and kilowatt hour meter for the shore supply are located on the main switchboard No.2 AC 440V feeder panel. The kilowatt hour meter is provided to measure and record the power consumed by the vessel when on shore supply.

A phase sequence indicator unit is provided on the shore power panel. The sequence should be checked before connecting shore power to the main switchboard. If the sequence is found to be incorrect, the shore supply must be isolated and two phases changed over. The rotation should then be reinstated and the phase sequence checked again.

Interlocking is provided between the ship's main generator ACBs and the shore supply breaker. The shore supply breaker cannot be closed if any generator ACB is closed. Conversely, none of the ship's generator's ACBs can be closed if the shore supply breaker is closed. This arrangement prevents the shore supply being paralleled with any other supply.

Procedure for the Operation of Shore Power Reception

a) If required, the emergency generator may be run-up and connected to the emergency switchboard. This will provide essential services and emergency lighting during the changeover. If not required, set the emergency generator to LOCAL operation to ensure it does not start on blackout.

b) Supervise the connection of the shore cables at the shore connection box.

c) When it is intended to receive power from the shore, confirm that the shore supply voltage is correct.

d) Confirm that the shore supply phase sequence is correct.

e) Isolate all non-essential services, reducing the load at the main switchboard to a minimum. Ensure only one diesel generator is connected.

f) Turn the main switchboard SYNCHRO & POWER CONTROL switch to the MANUAL position. This will prevent the standby generator starting on blackout and the sequential restart sequence from starting when power returns.

g) Close the MCCB for shore power at the connection box.

h) At the main switchboard, ensure that the SHORE SUPPLY AVAILABLE lamp is illuminated, if so, open the generator ACB.

i) Close the shore power MCCB on the No.2 440V feeder panel of the main switchboard. This breaker is interlocked and cannot be closed if the feeder panel is live. Conversely, if the shore power is supplying the feeder panel, no generator ACB can be closed.

j) At the main switchboard, the SHORE SUPPLY ON lamp is illuminated.

k) Close the emergency switchboard bus tie breaker on the main switchboard.

l) Return the emergency switchboard to normal. If the generator is running, open the emergency generator ACB. Close the bus tie-breaker on the emergency switchboard. The shore power is now supplying the main and emergency switchboards.

m) Proceed to supply essential services such as fire detection, lighting etc.

n) If no maintenance is scheduled for the emergency generator, it may be left on automatic standby. The emergency generator will then feed emergency lighting, etc, in the case of failure of the shore supply.

o) The shore supply should be closely monitored to ensure the 400A current limit is not exceeded.

Procedure for Transfer from Shore Supply to Main Diesel Generator

a) Isolate the emergency generator to ensure that it does not start.

b) Isolate all non-essential services. Reduce the load at the main switchboard to the absolute minimum.

c) Turn the main switchboard SYNCHRO & POWER CONTROL switch to the MANUAL position. This is to ensure that no main generators start when the vessel blacks out.

d) Run-up the selected main generator.

e) At the main switchboard synchronisation and bus tie panel, turn the FREQUENCY/VOLTMETER selection switch (FVS-2) to the incoming generator's position (GEN1, GEN2 or GEN3).

f) Adjust the frequency to 60Hz by means of the relevant GOVERNOR MOTOR control switch (GCS) on the synchronising panel.

g) Open the shore power MCCB on the No.2 440V feeder panel of the main switchboard. The main switchboard blacks out.

h) Turn the STANDBY SELECT switch (COS-A) at the main switchboard synchronising panel to the MANU position. Turn the relevant generator ACB CONTROL switch (BCS) to the CLOSE position. The ACB closes and the generator supplies the main switchboard. The ACB CLOSED LAMP is illuminated on the generator panel.

i) Check the voltage and adjust the frequency to 60Hz. Supply main lighting, fire detection, etc.

j) Close the emergency switchboard bus tie breaker on the main switchboard.

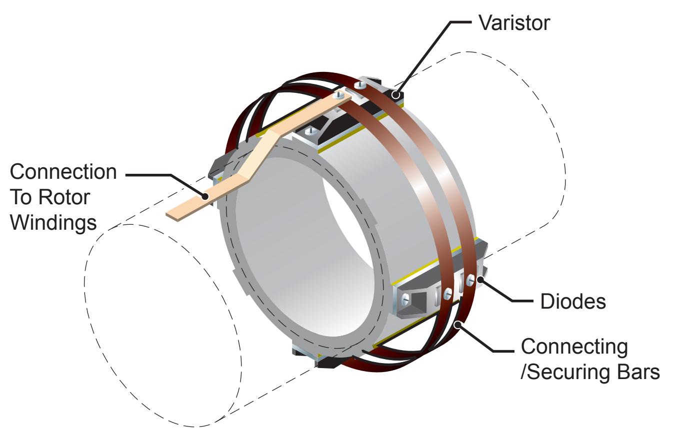
k) Close the bus tie breaker on the emergency switchboard. The emergency switchboard is now supplied from the main switchboard.

l) Supply emergency consumers as required.

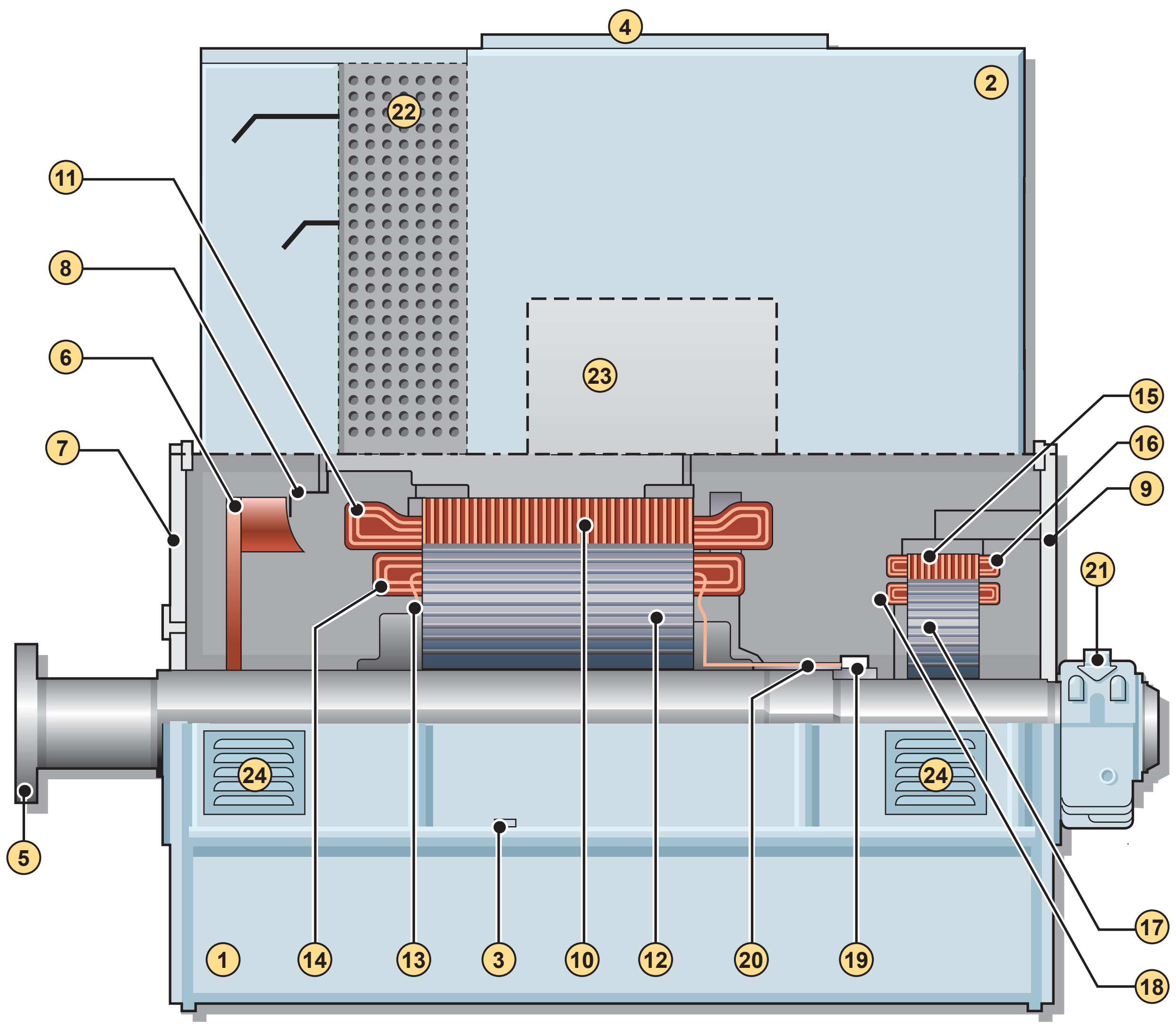
m) Ensure the emergency generator is returned to normal automatic start.

n) Isolate the shore supply from ashore and remove cables.

Illustration 2.13.6a Main Alternator



Rotating Rectifier Assembly



Hyundai HFJ6 Alternator
Simplified Sectional View

Alternator Key

1. Frame
2. External Equipment Housing
3. Earthing Terminal
4. Housing Cover
5. Shaft: Prime Mover
6. Fan
7. DE End Shield
8. Air Guide
9. NDE End Shield
10. Stator Core
11. Stator Winding
12. Rotor Core
13. Damper Winding
14. Rotor Winding
15. Exciter Stator Core
16. Exciter Stator Winding
17. Exciter Rotor Core
18. Exciter Rotor Winding
19. Rotating Rectifier
20. Rectifier Lead to Rotor Winding
21. NDE Sleeve Bearing
22. Air/Water Cooler
23. Exciter Equipment Assembly
24. Emergency Cooling Louvres

2.13.6 MAIN ALTERNATORS

No.1 Generator

Manufacturer:	Hyundai Heavy Industries
Type:	HFJ6 508-14K-EB
Voltage:	450V AC, 3-phase, 60Hz,
Capacity/rating:	650kW, 1,042.4A, 812.5kVA, 0.8pf, 10-pole
Speed:	720 rpm
IP rating:	IP44
Heating:	230V, 315W
Bearing type:	Sleeve bearing

No.2 and No.3 Generators

Manufacturer:	Hyundai Heavy Industries
Type:	HFJ6 508-14K-EB
Voltage:	450V AC, 3-phase, 60Hz,
Capacity/rating:	780kW, 1,250.9A, 975kVA, 0.8pf, 10-pole
Speed:	720 rpm
IP rating:	IP44
Heating:	230V, 315W
Bearing type:	Sleeve bearing

General Description

Three main alternators are provided. No.1 alternator is rated at 812.5kVA at 450V AC, 3ph, 60 Hz, and No.2 and No.3 alternators are rated at 975kVA at 450V AC, 3ph, 60 Hz. They are of the totally enclosed, self-excited, brushless type.

Each generator is fitted with a shaft-mounted exciter located at the non-drive end. The excitation current required for the exciter is provided by the main machine via an excitation control unit and automatic voltage regulator (AVR). The AVR is accessible via a removable cover on the side of the generator.

The on-load voltage is kept constant by the AVR which regulates the excitation current to the exciter. Output power from the alternator stator is fed into a current/voltage compound transformer, and the output of this is regulated and fed through the exciter stator windings. The magnetic field in the exciter stator induces AC into the exciter rotor, which is rectified by the rotating diode rectifier set and passed to the main rotor DC windings. In this way the excitation levels are boosted for heavy loads and reduced for light loads. This provides a constant output voltage independent of load levels. Initial voltage build-up is via residual magnetism in the rotor.

An external manual voltage regulator, VR, is fitted inside the generator panels at the main switchboard.

Alternator cooling is provided by passing air over the integral fresh water cooler, using a closed-circuit air supply. The cooling air temperature is monitored via the alarm and monitoring system. The cooler is fitted with double-walled tubes to reduce the chances of leakage. The space between the tubes drains to chambers where leak detectors will activate an alarm if a water level is detected.

If necessary, the alternator may be run with the air cooler out of service and isolated, although it will be necessary to open the emergency side air vents and remove the baffle plates as directed by the manufacturer's instructions. Although the alternator's power rating under this emergency cooling is not affected, ensure that the ventilation in the generator space(s) is maintained at maximum efficiency and monitor the generator closely to prevent overheating.

A 230V space heater is fitted, which is energised when the generator circuit-breaker is open. This protects against internal condensation during shutdown periods.

The alternator windings are fitted with six embedded PT100 temperature sensors that monitor the stator temperature in each phase. Three sensors are in use with three spares.

A further temperature sensor is located in the cooling air flow.

The alternator has only one bearing. This is a sleeve bearing fitted at the non-drive end. This bearing also has a PT100 temperature sensor fitted.

Alarm Settings

Winding Temperature:	Alarm: 140ºC
Cooling Air Temperature:	Alarm: 100ºC

Alternator Circuit-Breakers

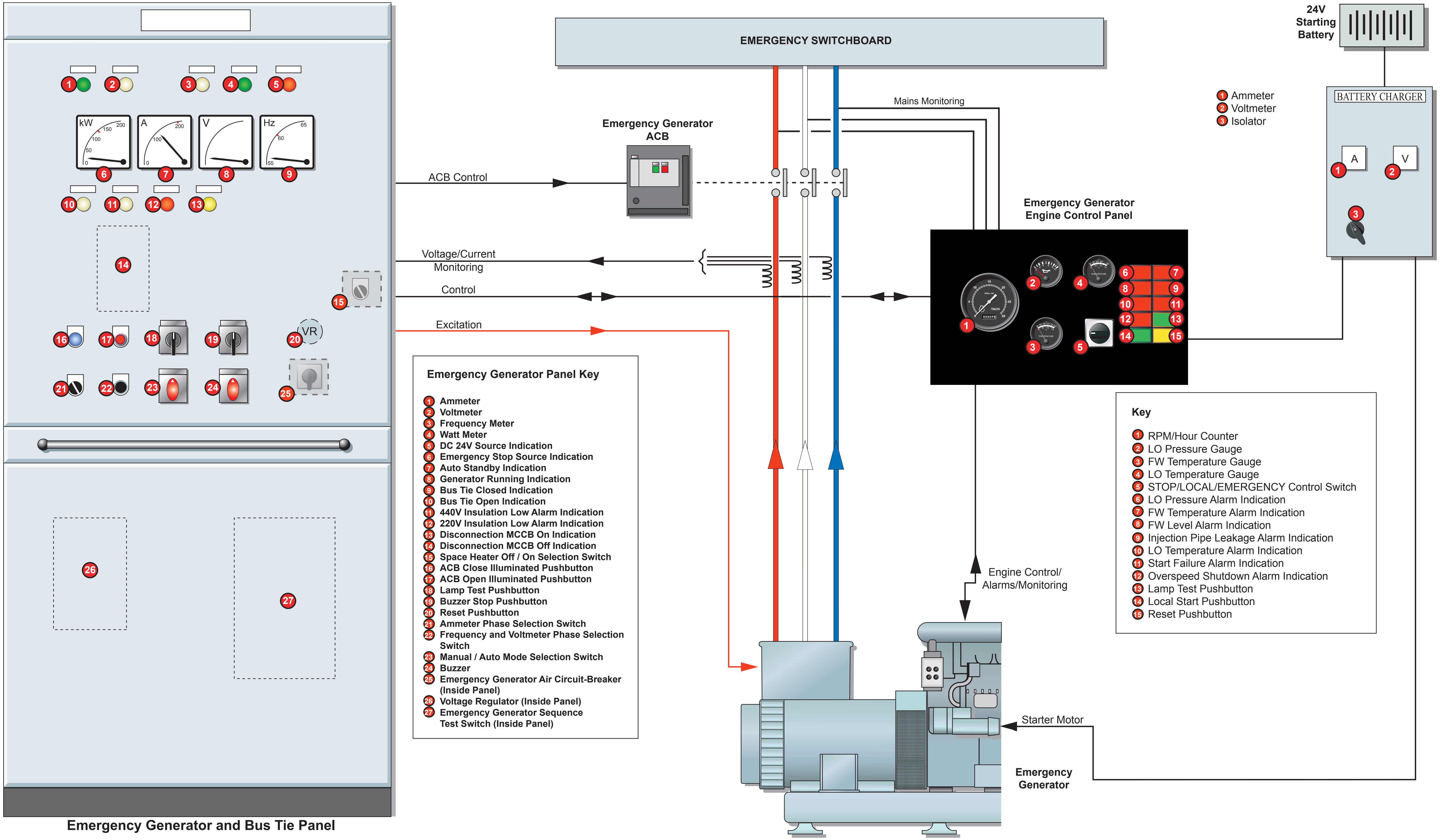
Manufacturer:	Terasaki
Model:	AR212S (No.1), AR216S (No.2 and No.3)
Type:	Air circuit-breaker
Overcurrent unit:	AGR-21S-PRU

The diesel-driven alternators supply the main switchboard via 3-phase withdrawable air circuit-breakers (ACB) mounted in the lower section of the main switchboard generator cubicles. The ACB has closing springs that are normally charged by an internal electric motor. In the case of motor failure, the springs may be manually charged by a charging handle inserted into the front face of the ACB. The ACB is fitted with an undervoltage trip (UVT) device. Controlled tripping is carried out from the overcurrent protective device. The trip levels may be adjusted at this unit.

The ACB is of the withdrawable type; it may be partially removed to the TEST position for testing or completely withdrawn to the ISOLATED position for maintenance purposes. In the TEST position, the auxiliary control contacts are connected, but the main contacts are isolated so the ACB can be operated without any electrical problems. In the ISOLATED position, the auxiliary control contacts and the main contacts are isolated. The ACB may be locked in the OPEN position and the locking key withdrawn for safety.

The ACBs are normally operated remotely and automatically via the operating controls on the main switchboard synchronising panel. The ACBs can also be operated locally at the actual ACB using the front panel buttons in an emergency.

Illustration 2.13.7a Emergency Alternator



2.13.7 EMERGENCY ALTERNATOR

Manufacturer:	Newage International Stamford
Type:	UC.M27 4F2
Voltage:	450V AC, 3-phase, 60Hz,
Capacity/rating:	120kW, 192.5A, 150kVA, 0.8pf, 4-pole
Speed:	1,800 rpm
IP rating:	IP 23
Excitation:	36V DC, 1.8A
Heating:	220V, 130W

General Description

A self-contained emergency alternator, rated at 120kW, is fitted in the emergency generator room on the portside of the funnel casing on B deck for use in an emergency. The alternator is the self-excited brushless type and can be set for manual or automatic operation. Automatic will be normally selected, with the manual setting being used for testing the generator.

The emergency switchboard is normally supplied from the main switchboard. When automatic operation is selected, the emergency generator is started automatically by detecting zero-voltage on the emergency switchboard bus bar. The emergency alternator air circuit-breaker will connect automatically to the emergency switchboard after confirming the continuation of no-voltage.

The emergency generator is designed to restore power to the emergency switchboard within 45 seconds. The bus tie breaker on the emergency switchboard, which feeds from the main switchboard, is opened automatically when zero-voltage is detected on the main switchboard.

The alternator is fitted with a 220V space heater to prevent condensation when the alternator is stationary or idling. The heater is interlocked with the operation of the air circuit-breaker.

The alternator is capable of starting the plant from dead ship condition.

The alternator consists of a conventional rotor and stator mounted in the same frame as the exciter stator and rotor. The shaft also drives an externally mounted permanent magnet generator (PMG). The PMG is mounted at the non-drive end of the alternator. The exciter consists of an exciter stator frame and a rotating armature at the non-drive end of the alternator rotor. The exciter rotor feeds the rotating rectifier assembly which feeds the DC excitation current to the alternator rotor.

The alternator is fitted with a low-maintenance ball bearing at the non-drive end.

Automatic Voltage Regulator

Manufacturer:	Newage
Model:	MX-341

The alternator's automatic voltage regulator is fitted within the alternator terminal cover. There is a potentiometer inside the lower emergency switchboard generator cubicle 'A' to enable the voltage to be manually adjusted.

The AVR utilises a permanent magnet generator (PMG) to provide a power source and reference signal for the AVR. The AVR then regulates the input to the exciter stator to provide voltage regulation of the alternator output.

Emergency Alternator Circuit-Breaker

Manufacturer:	Terasaki
Type:	Air circuit-breaker
Model:	AME-3B
Number of poles:	3
Voltage:	450V AC
Frequency:	60Hz
Ampere frame:	250A
Base current I_N:	200A
Overcurrent trip type:	AOS
Overcurrent trip setting:	220A in 20 seconds
	500A in 120 milliseconds

The emergency alternator supplies the main switchboard via a 3-phase Air Circuit Breaker (ACB). The ACB is fitted with a motor-driven closing device, if this unit fails, the breaker may be operated manually. The ACB is fitted with an undervoltage trip (UVT) device. Controlled tripping is carried out from the overcurrent protective device; the trip levels may be adjusted at this unit.

The ACB is not withdrawable. It is normally operated remotely via the emergency switchboard breaker control switches or automatically from the emergency switchboard control system.

The feeder line from the alternator ACB to the emergency switchboard bus is fitted with a manually operated disconnector switch. This switch is located and accessed from the rear of the emergency switchboard and can be opened to test the generator starting and ACB connection facilities. These tests are described in Section 2.13.3, Emergency Switchboard and Generator Operation.

CAUTION
It is essential that the emergency generator has stopped before operating the disconnector switch.

The generator has sufficient capacity to enable the starting of the required machinery to power-up the vessel from a dead condition.

2.13.8 PREFERENTIAL TRIPPING AND SEQUENTIAL RESTARTING

Main Switchboard Preferential Tripping

When a generator(s) on-line is overloaded, the vessel's non-essential consumers are tripped by the preferential trip system, reducing the load on the generator and thereby providing protection against the overcurrent which would otherwise trip the generator ACB.

The vessel's preferential tripping system has two tripping functions:

Generator Overload

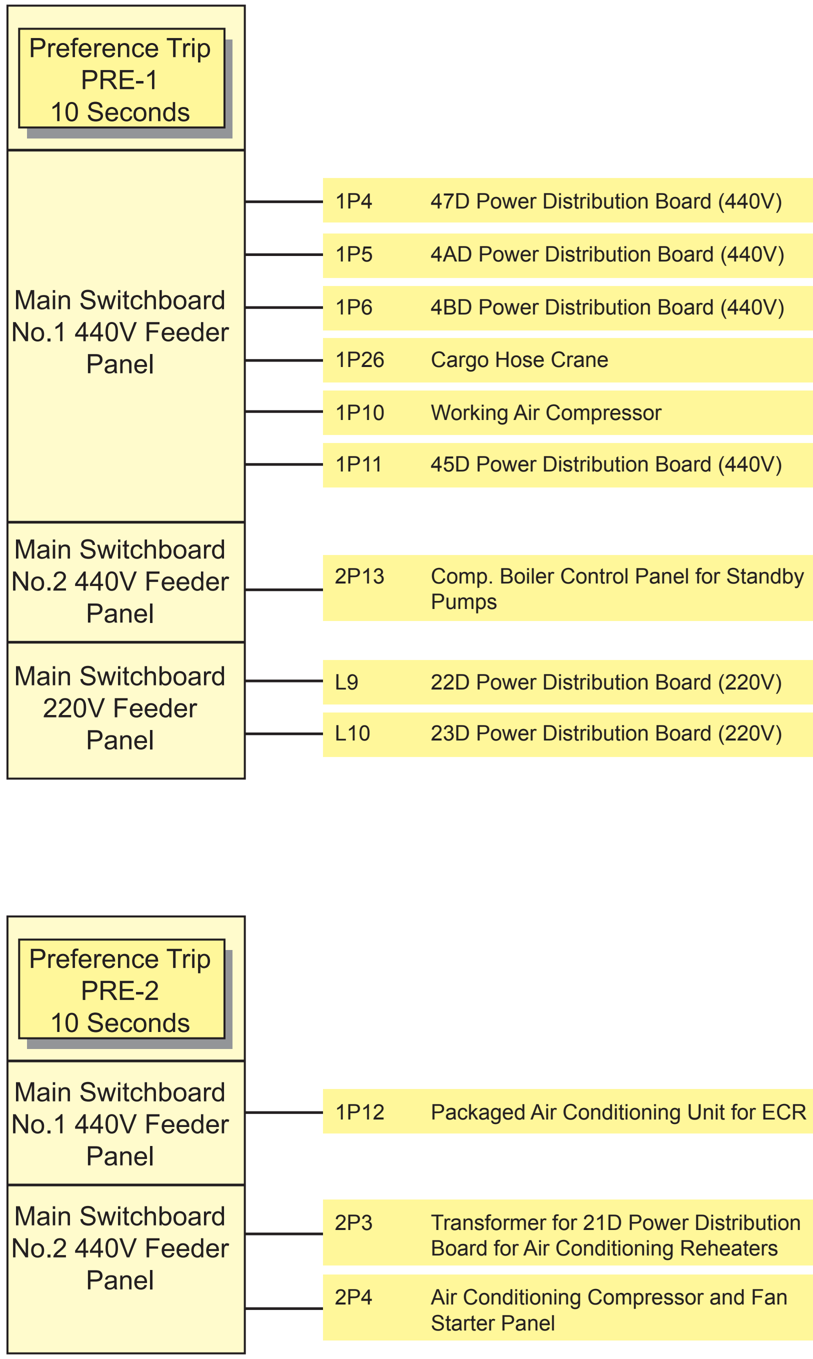
The generator ACB base current is set at 1,251A (GEN 2 and GEN3) and 1,042A (GEN 1). The pick-up current for the 1st stage preferential trip is set at 1,187A (GEN 2 and GEN3) and 990A (GEN 1) (95% of the generator ACB base current). If the current on a running generator exceeds 1,424A (GEN 2 and GEN3) or 1,188A (GEN 1) (120% of the pick-up current) for a period of 10 seconds, the PMS will initiate the release of the first stage preferential trips. If the current still exceeds this level after a further 10 seconds, the second stage preferential trips are released, thereby providing protection against the overcurrent which would otherwise trip the ACB.

ACB Abnormal Trip (Parallel Operation)

If, during parallel operation, a generator ACB suffers an abnormal trip, the PMS will initiate the release of the preferential tripping function, thereby providing protection against the overcurrent which would otherwise trip the ACB. An ACB abnormal trip may result from one of the following:

- Diesel generator engine emergency trip / manual stop
- Overcurrent
- Undervoltage
- Reverse power
- ACB mechanical trouble

Illustration 2.13.8a Preferential Tripping



Sequential Restart

The vessel's automatic control system will automatically restart the required machinery to restore power to the vessel. To fulfil this requirement, at least one diesel generator must be left in the automatic standby mode.

The essential machinery is started automatically according to the sequence shown on the right. The sequence is started when power is restored to the 440V main switchboard.

Motors that were selected for duty before the blackout will be automatically returned to duty when power is restored. Similarly, motors selected for standby will automatically return to standby. If the machinery designated for duty does not restore normal system conditions, such as pressure, within a preset time, the standby motor will cut-in automatically.

Illustration 2.13.8b Sequential Restart

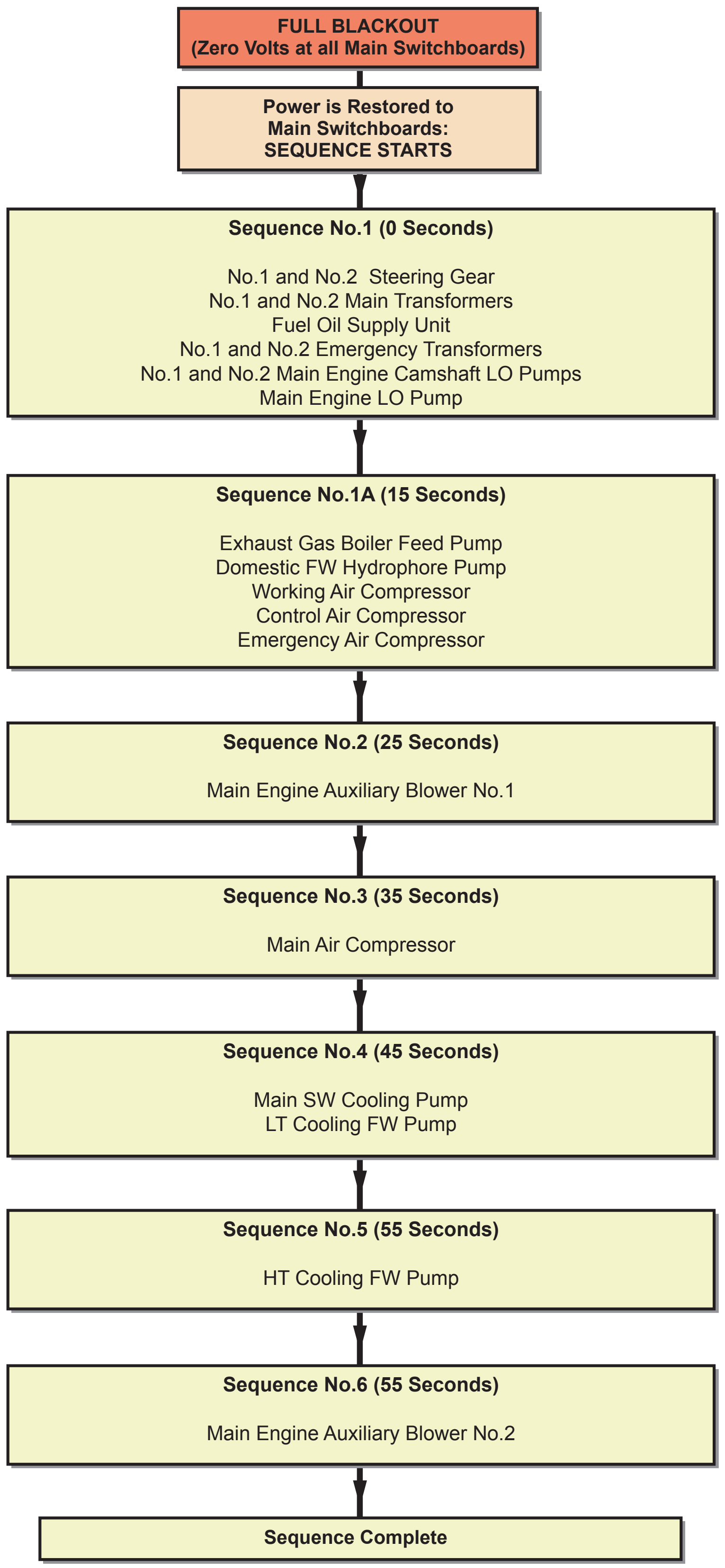
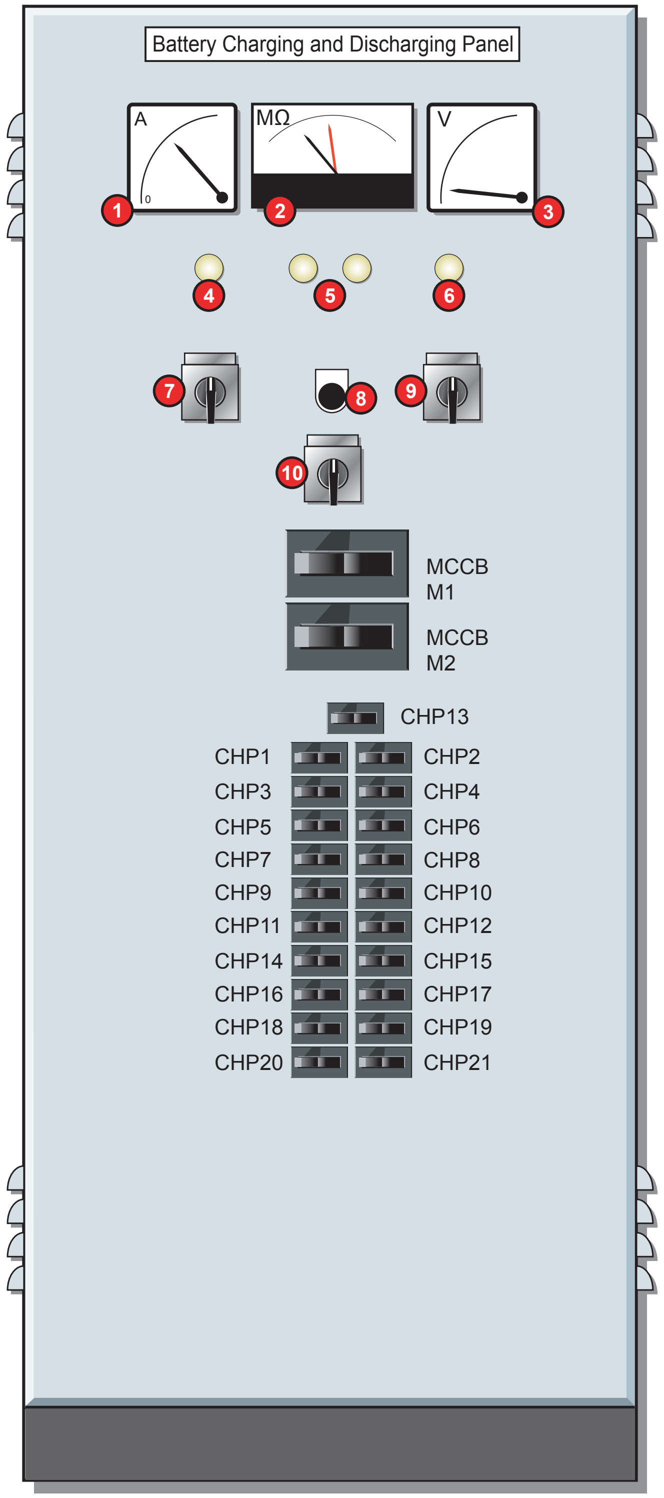
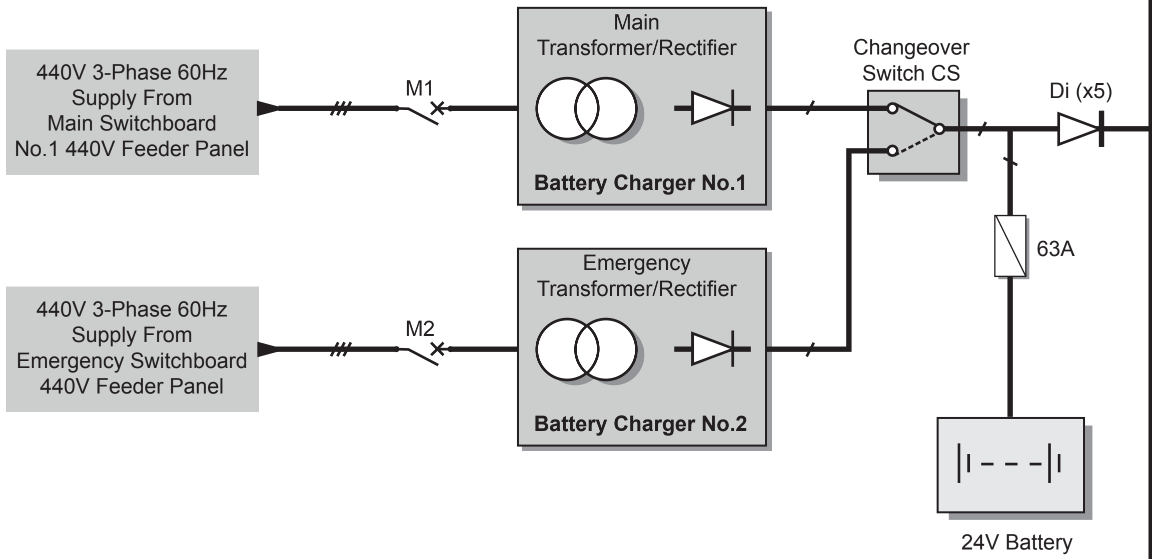


Illustration 2.13.9a Battery Charger and Discharge Board



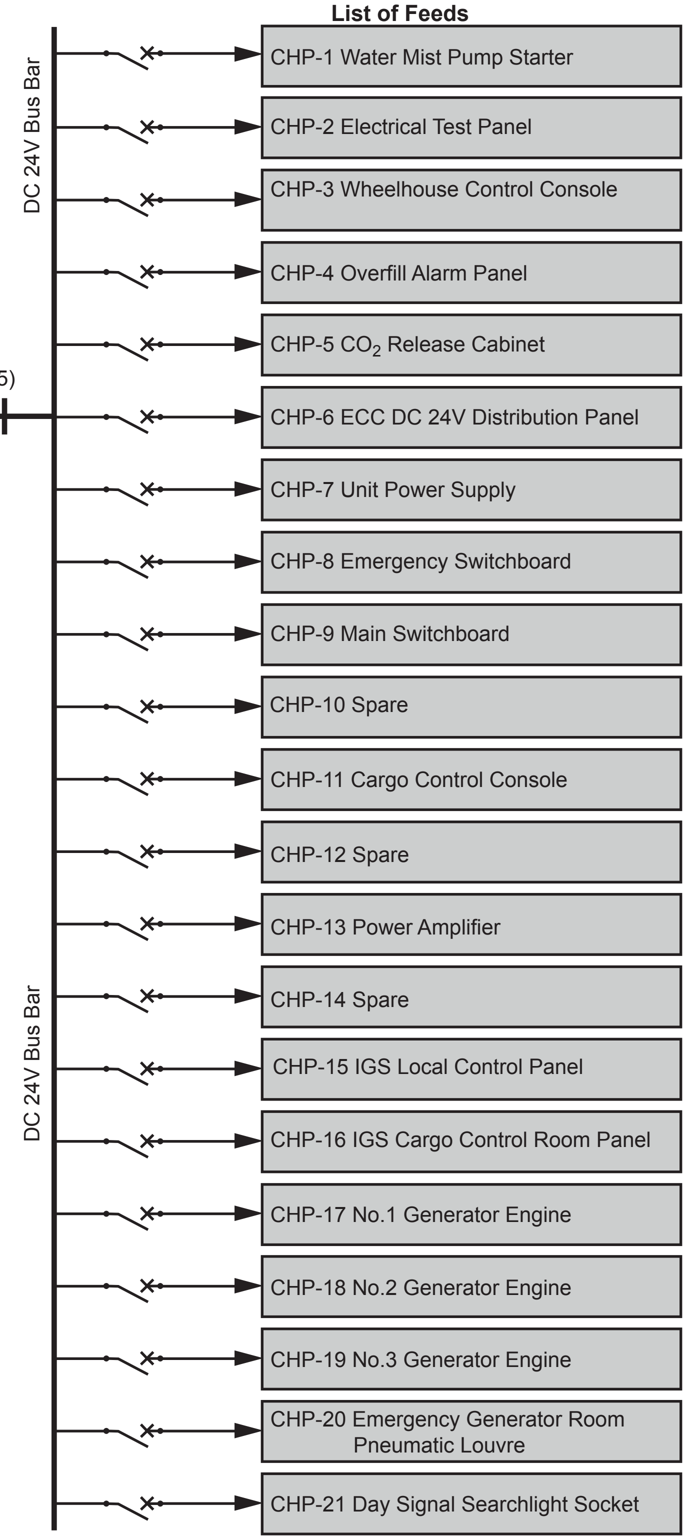
Key

1. Ammeter
2. Insulation Resistance Monitor
3. Voltmeter
4. MSB AC Source Available Lamp
5. Earth Lamps
6. ESB AC Source Available Lamp
7. Ammeter Selection Switch (Battery/Off/Load)
8. Earth Lamp Test Pushbutton
9. Voltmeter Selection Switch (R-S/S-T/T-R)
10. Charge Selection Switch (Charger No.1/ Charger No1 & No.2/Charger No.2)



Battery Charging and Discharge Board Simplified Schematic Diagram

Battery Charging and Discharge Board List of Feeds



2.13.9 UPS AND BATTERY SYSTEMS

The ship's emergency power requirements are supplied by the emergency switchboard network, see illustration 2.13.4b for a list of consumers.

Essential items of safety, navigation and communication equipment are supplied from battery-backed power supply systems such as UPS units and battery charge and discharge boards. These units are designed to provide a continuous supply to the consumers. In the event of mains or emergency supply failure, the batteries take over the supply to the consumers. When the main supplies are reinstated, the batteries will receive a boost charge. This charge will automatically be reduced to a floating (trickle) charge when the batteries regain their full charge.

WARNING
The company's safety procedures must be strictly adhered to when carrying out any maintenance on batteries.

The following battery and charger systems are fitted on board:

24V Charge/Discharge Board

Manufacturer:	Terasaki
Voltage (supply):	440V AC, 60Hz
Output:	24V DC

Batteries

Manufacturer:	Xuxiao
Set:	1
Type:	Gell 6-GFM-150
Capacity:	24V, 300Ah
Model:	6-GFM-150
Total no. of cells:	4 x 12V cells

The 24V charge and discharge board is located in the converter room on E Deck, aft of the bridge. This unit supplies essential communication equipment and the bridge, cargo and ECR control consoles.

The unit is fitted with two chargers, one supplied from the main switchboard and one supplied from the emergency switchboard. In the case of a failure, the appropriate charger can be utilised by the selection switch on the front panel.

The board is backed up by a 300Ah back-up battery that consists of four 150Ah 12V sealed batteries located in the battery room on the port side of E deck.

The charger is fitted with a battery voltage monitoring facility which will raise an alarm if the battery voltage falls below a preset level. The unit is also fitted with a charger failure alarm.

The board should be regularly inspected for earths on the outgoing circuits by operation of the earth lamps. When an earth is present on an outgoing circuit, one of the lamps will glow brighter than the other. Careful isolation of the outgoing circuits will locate the faulty circuit with the lamps returning to their normal equal brilliance once the faulty circuit is isolated.

Operation

The battery charger board is a fully automatic charging device which serves for the automatic charging of the storage battery. The chargers should be changed over once per month.

Floating Charge

While the storage battery is fully charged, it is normally subjected to a floating charge. In this condition, the charger supplies the 24V system with power. During periods of high demand and failure of the power source the battery will take over.

A constant voltage is applied to the battery and the charging current will vary according to charged state of the battery, thus always maintaining the battery in the fully charged state. In this arrangement, a constant voltage is normally applied to the battery by the automatic voltage regulator (AVR) regardless of load variation, power variation, ambient temperature change, etc.

If the battery has been subjected to a period of duty due to power failure, on restoration of the power supply, the battery charger is automatically transferred to equalising charge and rapidly charges the battery. As soon as the battery becomes fully charged, it reverts to floating charge.

Radio (GMDSS) Batteries

Manufacturer:	Xuxiao
Set:	2
Type:	Gell
Capacity:	24V, 200Ah
Model:	6-GFM-200
Total no. of cells:	2 x 2 x 12V cells

All essential communication and navigation equipment is fed from the radio switch box distribution board located in the converter room. This board supplies items of equipment such as the GMDSS equipment, GPS receivers, etc. This board is normally fed from the emergency switchboard 220V feeder panel, but will change over automatically to a battery supply if the emergency supply fails. This board is split and has two Sailor PCH4652 battery chargers charging two back-up battery sets, each consisting of two 24V 200Ah sealed batteries located in the battery room on the port side of D deck.

Emergency Generator Battery Charger

Manufacturer::	Uni Trafo Technic ApS
Type:	UTT 1774
Voltage (supply):	230V AC, 60Hz
Output:	24V DC, 10A

Batteries

Manufacturer:	Optima
Type:	Lead-acid sealed
Capacity:	24V, 50Ah
Model:	N 7312
Total no. of cells:	2 x 12V cells

The charger is fitted in the emergency generator room and is fed from the emergency switchboard 220V section, circuit EL16. The charger is fitted with an ammeter and voltmeter to monitor the charging supply. The batteries are located in the emergency generator room, underneath the charger. A battery isolator switch is fitted on the inboard side of the generator engine to enable the batteries to be isolated if required.

Engine Control Room 24V DC UPS Supply Panel

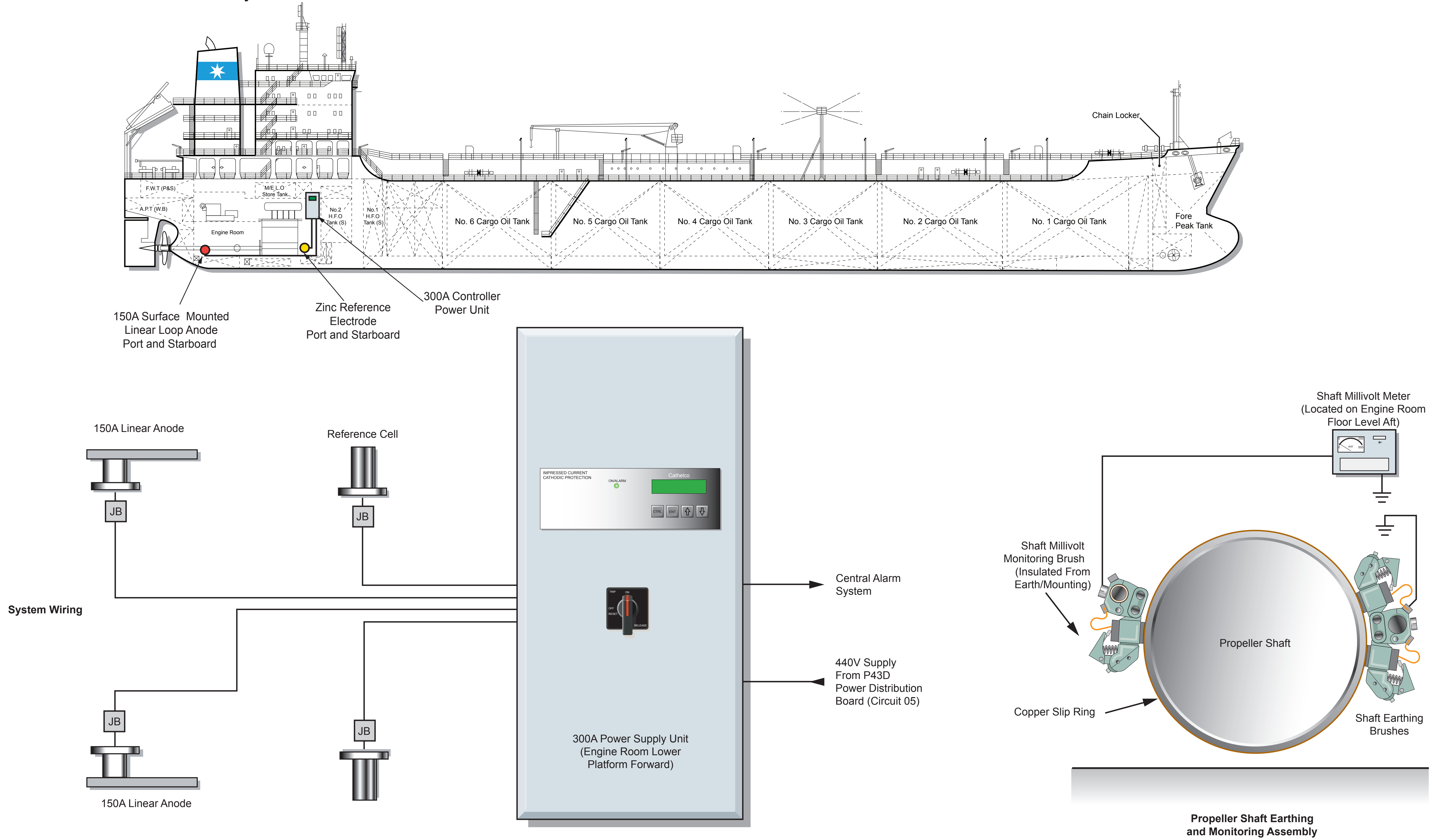
Manufacturer:	e.t.a, Barzeghino, Italy
Voltage (supply):	250V
Output:	24V 20A

This panel is fitted in the port aft corner of the ECR and is used to provide a stable power supply for essential equipment such as the main engine EGS2000 governor, DMS2100 system, UMS alarm panels, control consoles, etc.

The panel is supplied with 220V AC from the emergency switchboard and 24V DC from the battery charge/discharge board. In the event of either supply failing, the panel will automatically change over to the remaining supply.

A further earth monitoring power supply box monitors the control power supplies to the three generator control systems and the main engine DPS and DMS systems.

Illustration 2.13.10a Cathodic Protection System



2.13.10 CATHODIC PROTECTION SYSTEM

Manufacturer:	Cathelco Ltd., Chesterfield, UK
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. If the two battery electrodes are connected electrically, one of the battery plates in the electrolyte will waste away through the action of the flow of electrical current. 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.

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. The computer controller is programmed to identify this situation by analysis of the voltage reading, the current reading and the reference cell inputs. In fresh water, the current falls to zero and the voltage will go to maximum to compensate. This situation will be recognised during the system self-test and the unit will immediately go into standby mode. The self-test is performed every eight hours. When the vessel moves back into salt water, the system will return to normal operation when the next self-test is performed.

Principle 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 paintwork. If the potential of the hull is made too negative with respect to the anode, then damage to the paint film may occur electrolytically or through the evolution of hydrogen gas between hull steel and paint.

The system on the 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 approximately 200mV.

Operation

Once the power supply 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 of the power supply unit will show the following readings:

- Anode current and voltage
- Reference cell millivolt reading

Electrical Installation

The electrical system consists of a power supply unit located on the forward bulkhead of the engine room lower platform level. The power supply unit is wired to the port and starboard reference electrodes and the port and starboard anodes, and is also equipped with facilities to raise an external alarm to give warning of any system abnormalities.

The system is fed from 440V power distribution board P43D, via breaker number 03.

Propeller and Rudder Stock Earthing

To avoid electrolytic corrosion of the propeller shaft, 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 located on the engine room floor level The shaft potential should be maintained below 150mV.

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

Daily:

- Confirm that the LCD of the power supply unit is illuminated and the ON/ALARM LED is lit.
- Record the output current and all voltage.
- Record the reference electrode voltages.

Weekly:

- Check and clean the propeller shaft slip ring and brushes. Confirm that the brushes move freely in their holders and are held firmly on to the slipring by the brush holder spring.
- Inspect the rudder stock earth strap for signs of fraying.

Monthly:

- Return completed log sheets to the manufacturer for scrutiny every month.

3 Monthly

- Inspect and clean the power supply unit cooling fans and grilles every three months. Check units for loose connections.

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.

Further detailed instructions are available in the manufacturer's manual.

Marine Growth Prevention System (MGPS)

Manufacturer: Cathelco Ltd., Chesterfield, UK

The vessel employs a marine growth prevention system to control marine growth infestation and corrosion in the vessel's sea water systems. This is achieved by the use of anodes located inside the vessel's two sea water strainers. Two anodes are located in each strainer; one copper (MG) anode and one aluminium (TC) anode.

The copper anodes release ions during electrolysis which combine with those released by the sea water to form an environment which discourages the growth of organisms in the vessel's sea water pipework.

The aluminium anodes react with the sea water to form aluminium hydroxide. This disperses down the vessel's sea water pipework forming an anti-corrosive barrier.

The system virtually eliminates marine growth infestation while corrosion is reduced to a fraction of that normally expected.

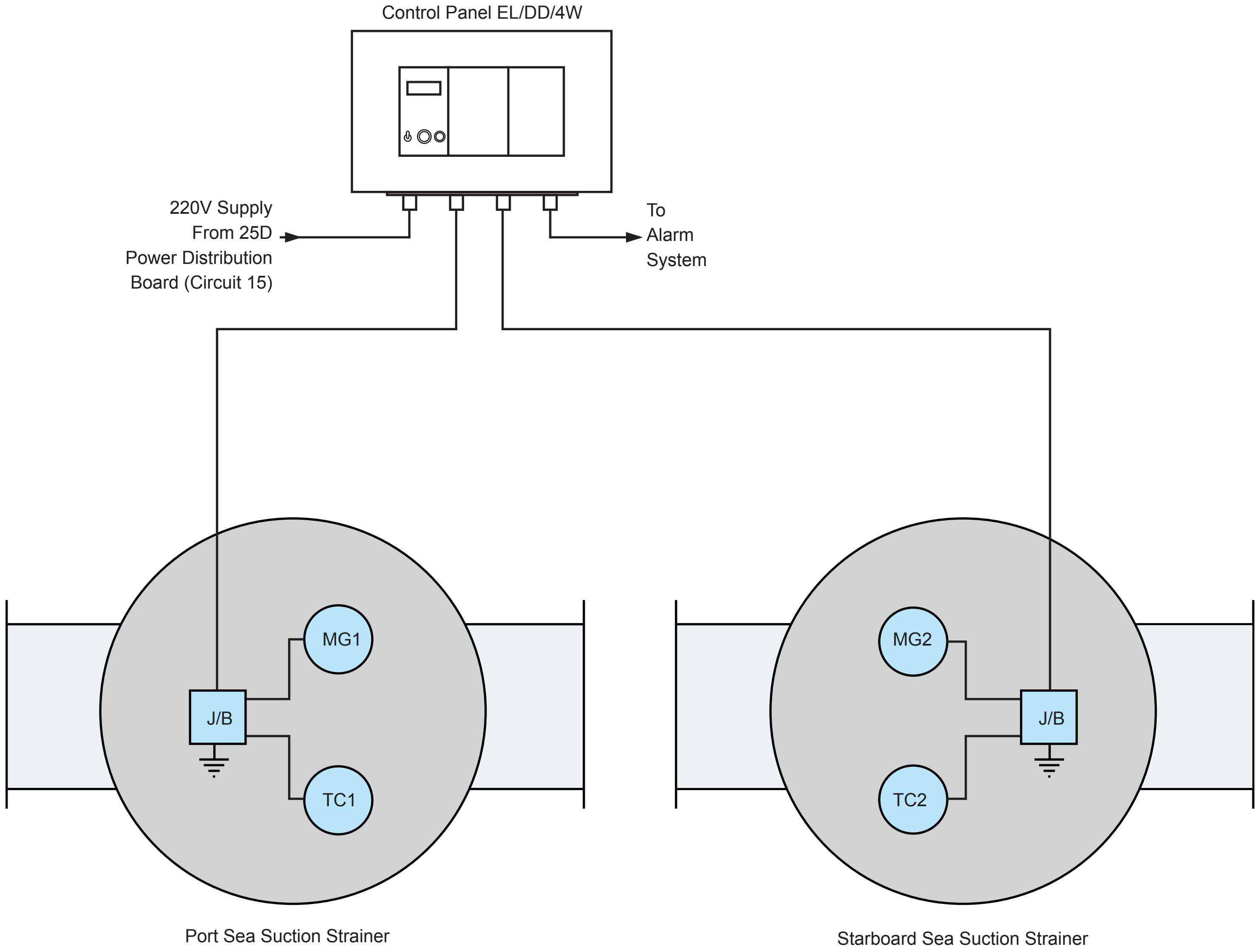
A control panel is located on forward bulkhead of the port side of the lower floor level, above the port sea suction chest. The control panel consists of a power module and two anode modules. Each anode module controls one pair of anodes. The current level for each anode is shown in individual digital displays. An alarm indicator is located adjacent to each digital display which will illuminate if there is a module failure resulting in zero current or overcurrent output.

The control panel is fully automatic and therefore does not require any adjustments in service. It is recommended by the manufacturer that the control panel is inspected on a weekly basis. During the inspection the digital displays should be checked to confirm that all the anodes are fully operational.

The effectiveness of the system can only be determined by inspection. It is recommended by the manufacturer that, if after some 6 months of operation, the opportunity to examine a strainer, length of pipe or heat exchanger presents itself, this should be done. If there are signs of infestation, the current to each anode should be increased by a maximum of 0.4 amps. If no fouling is present the current to each anode should be reduced by a maximum of 0.2 amps. This procedure should be repeated until the optimum current settings are set.

Note: Increased current settings will reduce anode life.

Illustration 2.13.10b Marine Growth Prevention System (MGPS)

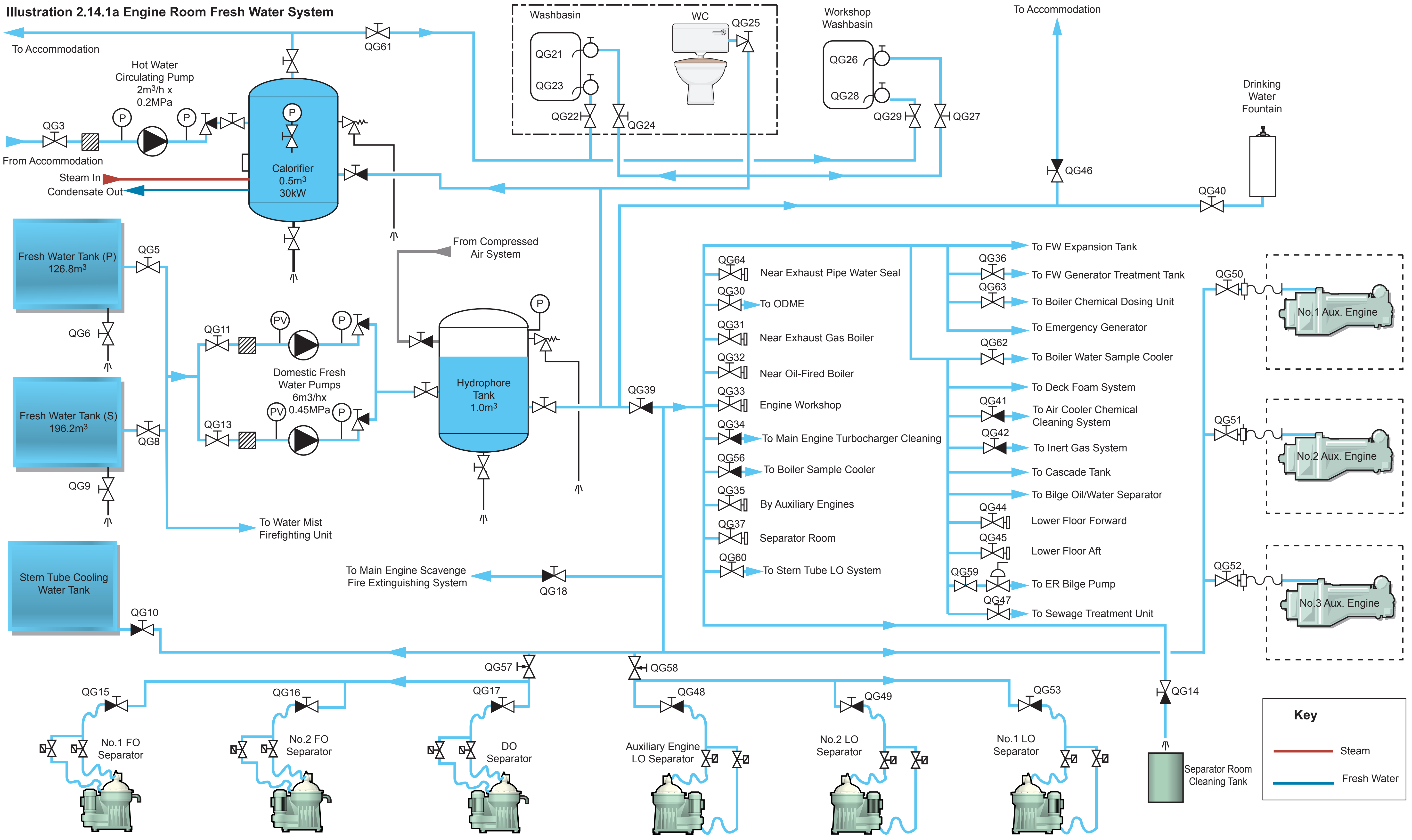


Key

MG1	Copper Anode 1
MG2	Copper Anode 2
TC1	Aluminium Anode 1
TC2	Aluminium Anode 2
J/B	Junction Box

2.14 Accommodation Systems

Illustration 2.14.1a Engine Room Fresh Water System



2.14 ACCOMMODATION SYSTEMS

2.14.1 DOMESTIC FRESH WATER SYSTEM

Domestic Fresh Water Pumps

Manufacturer:	Shinko Industries Ltd.
Model:	HJ40-2M
No. of sets:	2
Capacity:	6.0m^3/h at 0.45MPa

Fresh Water Hydrophore Tank

Manufacturer:	Nantong CSEMC Machinery Man. Co. Ltd.
Model:	C-1.0-00
Capacity:	1.0m^3
Working pressure:	0.50MPa

Hot Water Circulating Pump

Manufacturer:	Shinko Industries Ltd.
Model:	HJ40-2M
No. of sets:	1
Capacity:	2.0m^3/h at 0.20MPa

Calorifier

Manufacturer:	Nantong CSEMC Machinery Man. Co. Ltd.
Capacity:	0.5m^3
Steam heating:	2.6m^2
Electric heating:	30kW

Description

Fresh water for domestic and engine room use is stored in two fresh water storage tanks. Both tanks are normally filled with water from either the fresh water generator or a shore supply when in port. The distilled water produced by the fresh water generator is discharged to the storage tanks through a rehardening filter and a silver-ion steriliser.

Water is supplied to the domestic and service fresh water systems from the storage tanks by two duty/standby pumps, which discharge to the hydrophore tank. The duty pump operates automatically, starting and stopping according to the pressure in the hydrophore tank.

Water for the calorifier is supplied from the hydrophore system and is heated for the domestic hot water system. The calorifier is a thermostatically controlled 0.5m^3 vertical storage and heating vessel. Heating is provided by either a bank of 41 steam heating tubes, 16mm diameter with a total heating area of 2.7m^2 coil, or a 30kW set of electric immersion heater elements. The electric heater is used when the steam heating is not available. The fresh water is heated to 70°C and circulated around the hot water system by the hot water circulating pump. The steam heating is controlled by an adjustable self-actuating control valve in the steam supply connected to the sensing bulb by a sealed capillary. The electric heating elements are switched on/off by the contactor in the control panel, the control signal being initiated by the shell-mounted thermostat.

To reduce heat losses the calorifier shell is insulated with rockwool encased in galvanised steel cladding.

A separate fresh water pump supplies water from the fresh water storage tanks to the water mist fire extinguishing system. This pump is not part of the domestic water system.

The fresh water system supplies the following systems and services:

- Sanitary water system
- Sewage treatment system
- Drinking water system
- Accommodation hot water services
- Main engine turbocharger cleaning
- Separator operating water systems
- Fresh water cooling system
- Chemical dosing units
- Bilge oil/water separator system
- Generator engine turbocharger cleaning
- Fresh water generator solution tank
- Main engine chemical cleaning tank
- Main engine air cooler cleaning
- Oil discharge monitoring equipment
- Engine room services
- Auxiliary and composite boiler sample coolers
- Inert gas system
- Hotwell/cascade tank
- Deck services

Procedure for Operation of the Domestic Fresh Water System

a) Position the valves as shown in following table:

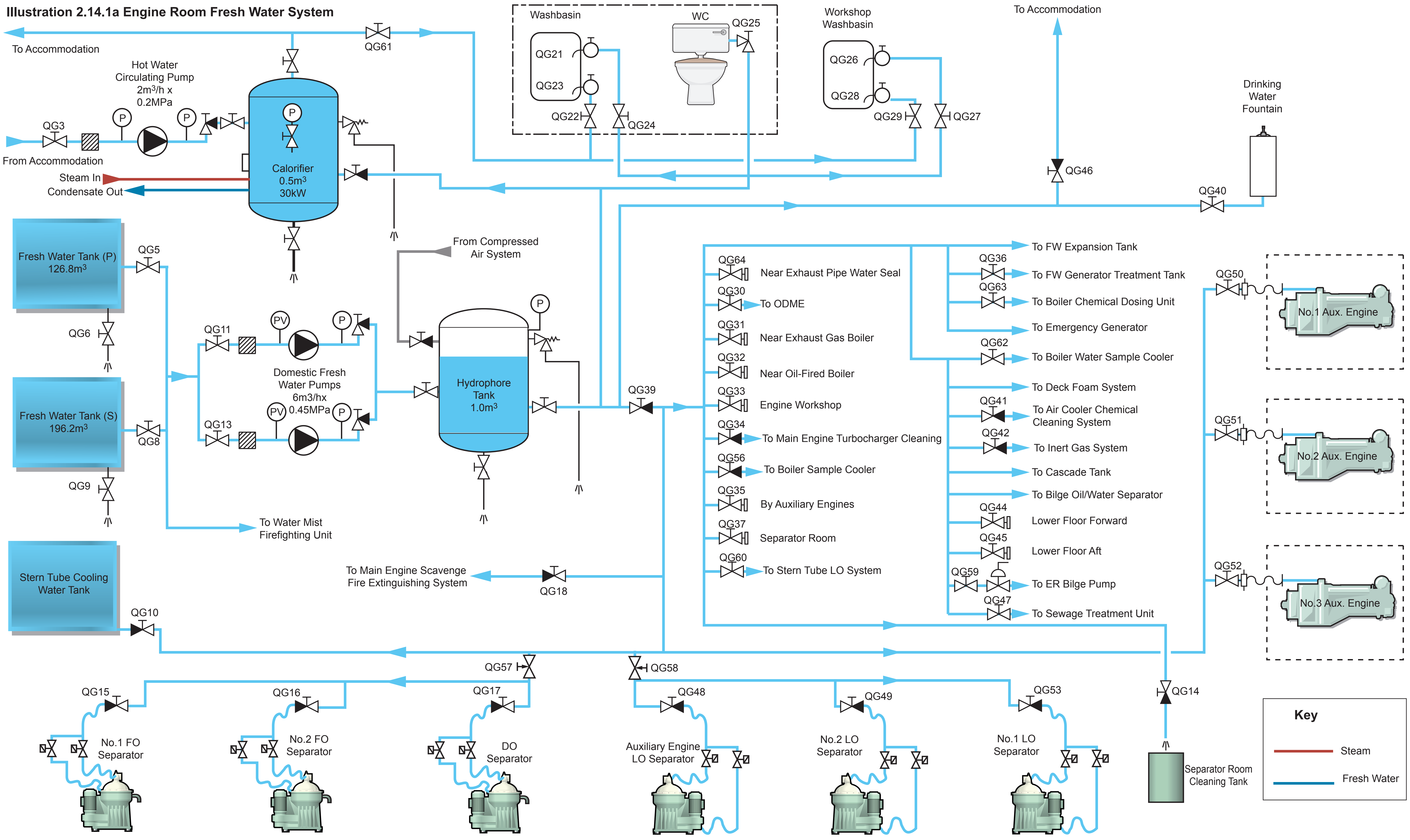
Position	Description	Valve
Open	Fresh water tank outlet valve (port or starboard duty tank)	QG5 or QG8
Open	No.1 fresh water tank unit pump suction valve	QG11
Open	No.2 fresh water tank unit pump suction valve	QG13
Open	No.1 fresh water tank unit pump discharge valve	
Open	No.2 fresh water tank unit pump discharge valve	
Open	Fresh water tank unit tank inlet valve	
Closed	Fresh water tank unit tank discharge to FW system	
Open	Engine room water fountain isolating valve	QG40
Open	Engine room washbasin cold water isolating valve	QG27
Open	Engine room water closet isolating valve	QG25
Open	Engine room WC washbasin cold water isolating valve	QG22
Open	Calorifier cold water inlet valve	
Open	Accommodation cold water isolating valve	QG46
Open	Engine room services and systems cold water isolating valve	QG39
Open	Calorifier hot water outlet valve	
Open	Hot water circulating pump inlet valve	QG3
Open	Hot water circulating pump discharge valve	
Open	Calorifier hot water recirculating inlet valve	
Open	Engine room services and systems cold water isolating valve	QG61

b) Start one fresh water tank unit pump and fill the fresh water tank unit to about 75% capacity, then stop the fresh water tank unit pump.

c) Open the air inlet valve to the fresh water tank unit until the operating pressure is reached and close the air supply.

d) Switch one fresh water tank unit pump to AUTOMATIC operation.

Illustration 2.14.1a Engine Room Fresh Water System



e) Open the fresh water tank unit outlet valve slowly until the system pressurises. Check that the duty fresh water pump starts and stops to maintain the system pressure within the operating pressure range.

f) Start the hot water circulating pump.

g) Start the calorifier electric heater.

h) Check that the hot water system warms-up and the electric heater reaches and maintains the correct water temperature.

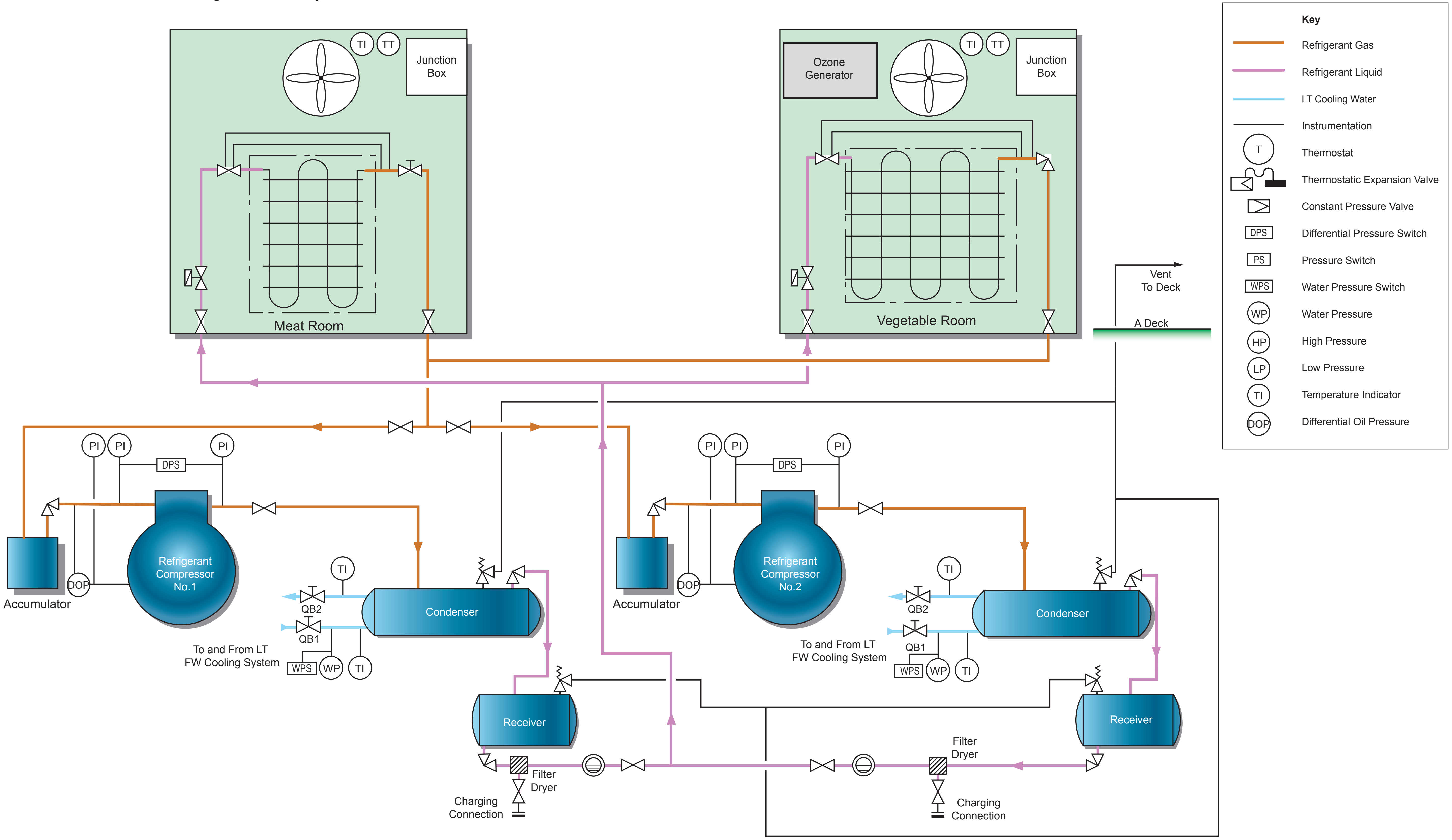
i) Supply steam to the calorifier when steam is available.

j) Shut down the electric heater.

k) Check level in hydrophore tank and add compressed air as required.

Note: After refilling, the system should be vented and all air removed to prevent water hammer.

Illustration 2.14.2a Domestic Refrigeration Plant System



2.14.2 DOMESTIC REFRIGERATION SYSTEM

Refrigeration Plant

Package supplier:	York Refrigeration Marine

Compressor

Package supplier:	Sabroe Refrigeration A/S
Manufacturer:	Bock Kaltemaschinen GmbH, Germany
Type:	Semi-hermetic, 4 cylinder reciprocating.
Model:	HGX34P/315-4
No. of units:	2
Speed:	1750 rev/min
Refrigerant:	R407C
Evaporation temp:	-28.5°C
Condensing temp:	43°C
Cooling capacity:	3.85kW

Condenser

Manufacturer:	Bitzer
Type:	Horizontal shell & tube
Model:	COKZ 110805
No. of units:	2
Water inlet temp:	36.0°°C
Water outlet temp:	39.7°C
Water flow:	1.7m^3/h

Receiver

Manufacturer:	Bitzer
Model:	R202 20 L
No. of units:	2

Evaporator

Manufacturer:	Helpman BV
Type (meat/fish room):	MLZX08-7E
Cooling temp:	-20.0°C
Type (vegetable room):	MLZX08-7X
Cooling temp:	+2.0°C

PLC

Manufacturer:	Mitsubishi
Type:	FX2N-32MR-ES/UL
HMI control panel:	E200

Ozone Generator

Manufacturer:	Murco Ltd., Dublin
Model:	MAS 90
Power:	230V, 4.0W

Description

Cooling for the meat/fish room and the vegetable room is provided by a direct expansion refrigeration system. The plant operates automatically and comprises two compressors, two condenser/receivers, one evaporator in the meat room, one evaporator in the vegetable room, and associated pipework and PLC based controls.

Air in the cold rooms is circulated through the evaporator coils by electrically-driven fans.

The vegetable room is fitted with an ozone generator. Ozone (O_3) as tri-atomic allotrope of oxygen, is a highly reactive oxidising agent and readily breaks down the bacteria that causes fruit and vegetables to decay, thus extending the time they will remain fresh. It is generated by passing air over an electrical field and is then circulated in the air in the vegetable room in a concentration typically between 0.5 and 10ppm.

As ozone depletes naturally after about 20 minutes to ordinary oxygen (O_2), the generator must remain on for prolonged periods to remain effective. Ozone will react with airborne molecules and reduce the natural odours inside the vegetable room, which gives an indication of the generator's effectiveness. During depletion it leaves no residual by-products.

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 programme built into the PLC unit.

In normal operation, one compressor/condenser/receiver unit is used, with the second compressor available for use but with all valves shut until required.

The plant is not designed to operate with both compressors running at the same time because of the risk of transfer of lubricating oil from one machine to the other.

The compressor draws R407C refrigerant as a vapour from the cold room evaporator cooling coils and pumps it under pressure to the fresh water cooled condenser where the vapour is condensed. The condensed liquid then passes to the receiver before being returned, through a filter/dryer unit, to the cold room evaporators.

The compressors are protected by high pressure, low pressure and low lubricating oil pressure cut-out switches. Each unit is also fitted with a crankcase heater which is automatically switched on when the compressor stops. The heater reduces the amount of gas entrained in the lubricating oil, minimising foaming on start-up. The compressor motors are cooled by the returning refrigerant gas.

Thermostats in each room enable the PLC control system to operate the solenoid valves independently, so as to reduce the number of starts and running time of the compressor.

The evaporators convert the refrigerant as it expands into a super-cooled vapour, under the control of the expansion valves. This vapour extracts heat from the air blowing over the finned evaporator tubes and is then returned to the compressor through the non-return suction valves. When all the solenoid valves to the evaporators are closed by the room thermostats, the low suction pressure activates the low pressure cut-out and the compressor stops.

A back-pressure controlled constant pressure valve is included in the vegetable room circuit to prevent excessive expansion of the refrigerant and the temperature dropping too far below the normal set point, which would damage the provisions, should the inlet solenoid valve fail to close properly.

Any leakage of refrigerant from the system will result in the system becoming undercharged, this is indicated by under performance and low suction and discharge pressures.

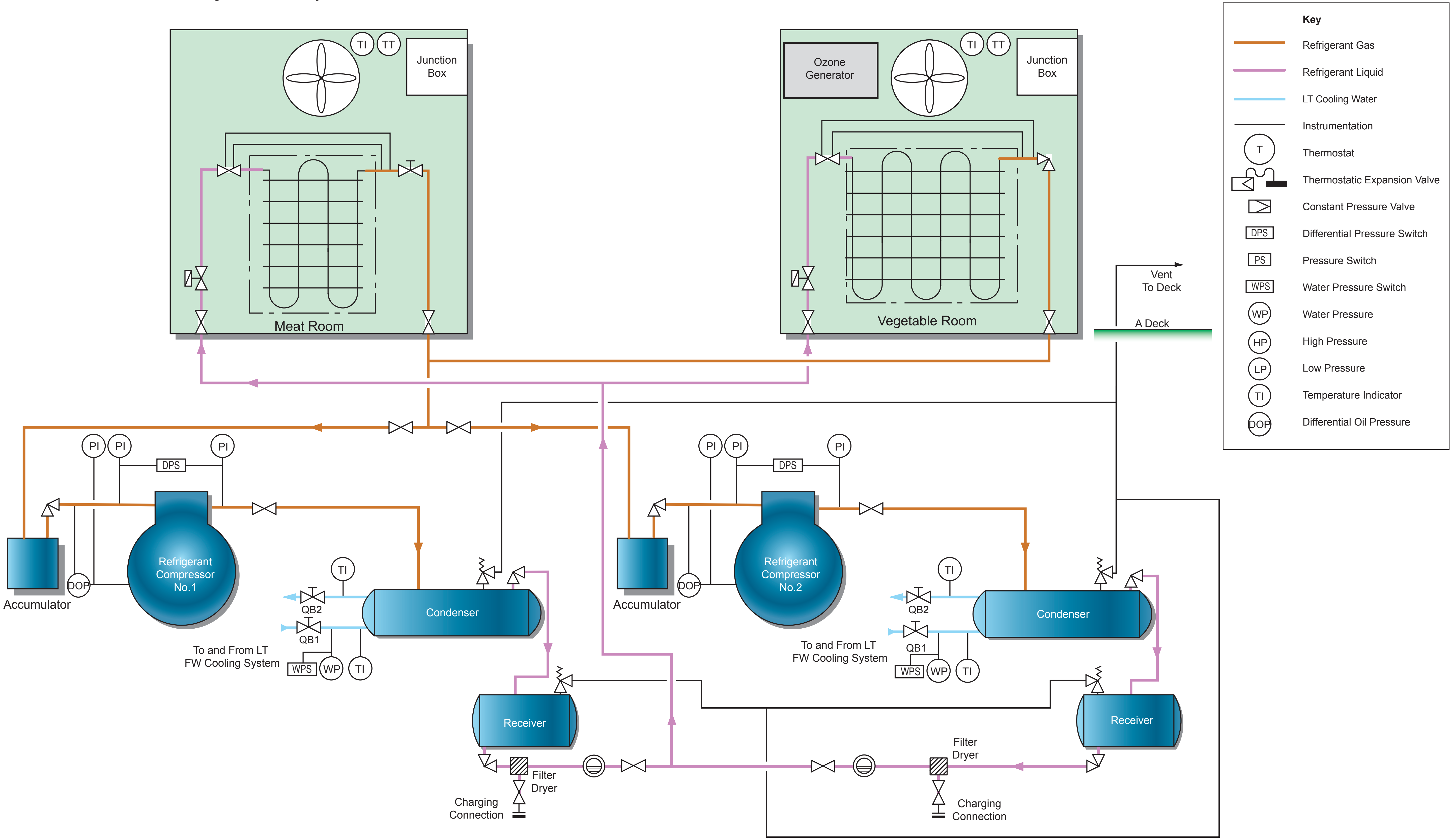
A side effect of low refrigerant gas charge is an apparent low lubricating oil level in the sump. A low charge level will result in excess oil being entrapped in the circulating refrigerant, causing the level in the sump to drop.

When the system is recharged to full capacity the lost oil will separate out and be returned to the compressor sump.

During operation the liquid level visible in the receiver sight glass will drop, increasing again when the compressor stops. If the system does become undercharged the level remains low and the whole refrigerant system should be checked for leakage.

When required, additional refrigerant may be added through the liquid charging line, after first venting the connection between the refrigerant cylinder and the charging connection. The refrigerant is dried before entering the system as any trace of moisture in the system will lead to problems with the thermostatic expansion valve becoming iced-up and unable to operate.

Illustration 2.14.2a Domestic Refrigeration Plant System



Control System

The refrigeration plant is controlled by a FX2N PLC with an MAC E410 operator panel. All inputs and outputs on the PLC are transmitted as both digital and analogue. The status of the PLC is indicated by four LEDs on the front of the PLC indicate its status, these are:

- POWER - illuminated when control voltage is connected
- RUN - illuminated when the programme is running
- BATT-V - illuminated when battery is missing or low voltage
- ERROR - flashes when there is an error in the software or hardware.

From the operator panel the operator may start/stop the evaporator fan units, the ozone generator and the compressors. All measuring values showing the status of the plant may be read on the touch screen display. The desired set point and limit values are also entered or adjusted by use of this screen.

The unit is menu-driven from the keys on the screen display. Function, numeric and control keys are incorporated in the screen. The basic displays are:

- Main menu
- Plant Status
- Compressors
- Rooms
- Alarms

When the screen is touched the operator will see the root display, from this screen the compressor, rooms or plant status displayed are accessed. Touching the appropriate label on the screen brings up the desired display graphic, from which any changes are made.

Plant Screen Display

When the PLANT option is selected, the display will show the status of the compressors (running/stopped/shutdown) and the refrigerated chambers (temperature/cooling/defrosting).

Compressor Screen Display

When the COMPR. Option is selected, details of compressor No.1 are displayed, they include an information line indicating whether the machine is running, stopped, ready, in a low suction pressure stopping phase, or if there is an alarm condition, and the running hours of the machine. Data for compressor No.2 is viewed touching the arrow sign for next screen.

Rooms Screen Display

When the ROOMS option is selected, the operation data for the meat room is displayed.

Alarms

The control unit will monitor the system and raise a general alarm in the Lyngsø alarm and monitoring system if any of the system operational parameters are exceeded.

Operating Procedures

To Start the Refrigeration Plant

a) At the refrigeration control panel set the power supply breaker to the ON position.

b) Check that the sump oil level is correct.

c) All stop valves (except the compressor suction) in the refrigerant line should be opened and fully back-seated to prevent the pressure on the valve reaching the valve gland.

d) Ensure that the LT fresh water cooling system is operating and that cooling FW is circulating correctly.

e) Open the valves for the condenser cooling water. Check there is sufficient flow.

f) Open the compressor suction valve one turn.

g) On the E200 panel set the room temperatures required. When the compressor is set to start, the controller will start the duty compressor and bring the temperature in the rooms down.

h) When the compressor runs-up, continue opening the suction valve slowly, taking care to prevent the possibility of liquid returning to the compressor. Also take care to keep the suction pressure above the low pressure cut-out point.

i) When the room temperatures are pulled down to the required value the compressor will now operate automatically according to the cooling demand from the rooms.

When Running

j) Check the inlet and outlet pressure gauges.

k) Check the oil level and oil pressure.

l) Check for leakages.

Defrosting

The room cooler in the meat room is fitted with electrical defrosting, the evaporator and drip trays being provided with electric heating elements. The frequency of defrosting is chosen by means of a defrosting command line in the E410 screen display. Additionally, there is a maximum defrost time period which is set on the panel. The defrosting sequence is as follows:

a) The compressor stops and all solenoid valves in the system close.

b) The fans in the meat room stop working, but the fan in the vegetable room continues the circulation of the warm air over the cooler. In this way the cooling surfaces are kept free from ice.

c) The electric heating elements in the meat room switch on.

d) As long as the cooler is covered with ice, the melting takes nearly all of the heat supplied by the heating element and the temperature of the cooler and the refrigerant is constantly kept near zero. When the ice has melted, the refrigerant temperature rises as the temperature reaches the set point of the defrosting thermostat, (approximately +10°C) the heating element switches off.

e) The compressor starts.

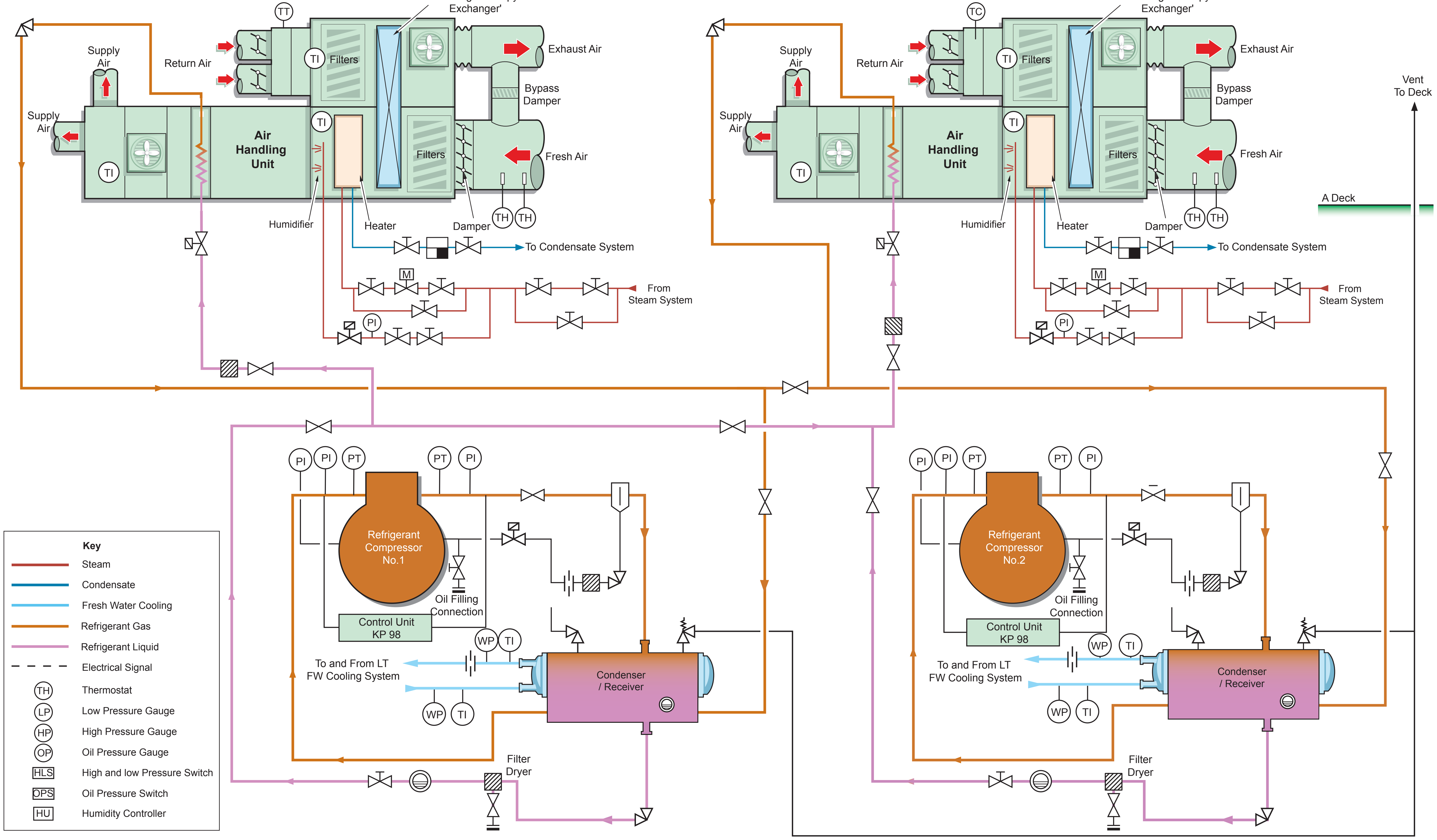
f) When the coil surface temperature has gone below the freezing point, the fan in the meat room starts.

Note: The recommended defrost cycle is 20 to 30 minutes every 8 hours. If the defrost cycle is insufficient, check that the frequency of visits by catering staff is not excessive and check that the door seals are in good condition.

System Running Checks

- Check the lubricating oil levels in the crankcase.
- Check the lubricating oil pressure.
- Check the moisture indicators.
- Check the suction and discharge pressure and temperature and any unusual variations must be investigated.
- Check all room temperatures and evaporation coils for any sign of frosting.

Illustration 2.14.3a Accommodation Air Conditioning Plant



2.14.3 ACCOMMODATION AIR CONDITIONING SYSTEM

Package supplier: York Refrigeration

Compressor

Manufacturer:	Sabroe
Model:	SMC108S
No. of sets:	2
Speed:	1474 rev/min
Refrigerant:	R134A
Evaporation temp:	5.0°C
Condensing temp:	48.8°C
Cooling capacity:	201kW
Power consumption:	58.6kW
Capacity steps:	25, 50, 75, 100%

Condenser/Receiver

Manufacturer:	Sabroe
Model:	CRKC411910
Number of condensers:	2
Water inlet temp:	36.0°C
Water outlet temp:	41.7°C
Water flow:	39.3m^3/h
Pressure drop:	4.0mwg

Air Handling Unit

Manufacturer:	Novenco, Denmark
Model:	CLIMASTER ZCR 18/8R
Number of condensers:	2
Capacity:	201kW

Description

Conditioned air is supplied to the accommodation by two air handling units located in the air conditioning room situated on the upper deck. The units comprise an electrically-driven fan drawing air through:

- Filters
- Mixing chamber for fresh and recirculated air
- Preheating coil
- Humidifier nozzles
- Evaporator coils
- Rotary heat exchanger (enthalpy wheel)

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.

All cabin ventilation units have been adjusted to supply the maximum air quantity assigned to the individual cabins and rooms served by the plant. Regulation of the air quantity to any individual cabin is made by means of a control lever on the cabin unit.

A rotary heat exchanger unit reduces the cooling or heating load on the air conditioning system. When cooling is required, the incoming air is hotter than the outgoing air and so the incoming air is cooled by the exhaust air being vented. When heating is required, the incoming air is colder than the outgoing air and so the incoming air is heated by the exhaust air being vented.

With heating or cooling coils in use, the unit is designed to operate with 70% fresh air supply. The ratio of circulation air may be varied manually using the dampers in the air inlet trunking.

The inlet filters are of the washable mat type and heating is provided by coils using steam as the heating medium.

Cooling is provided by a direct expansion R-134A refrigeration system. The plant is automatic and consists of two compressor/condenser units supplying the evaporators located in the accommodation air handling units.

Each refrigeration unit is capable of supplying 100% of the total capacity requirement, and in normal operation one refrigeration unit will be in use.

The compressor compresses the vapour returning from the evaporator coils and delivers the hot refrigerant gas to the condenser where the LT cooling water condenses the gas. From the condenser the liquid refrigerant passes through a filter dryer to the thermostatic expansion valves where it is expanded and changes state to a vapour. The expansion continues through the majority of the evaporator coil and in doing so absorbs heat from the air passing over the coil.

The compressor is fitted with an internal oil pressure activated unloading mechanism for automatic starting and variable capacity control. It is protected by a high and low pressure cut-out switch and low lubricating oil pressure trip, and is fitted with a crankcase oil heater.

Control System

The refrigeration plant is controlled by a FX2N PLC with an MAC E410 operator panel. All inputs and outputs on the PLC are transmitted as both digital and analogue. The status of the PLC is indicated by four LEDs on the front of the PLC indicating its status, these are:

- POWER - illuminated when control voltage is connected
- RUN - illuminated when the programme is running
- BATT-V - illuminated when battery is missing or low voltage
- ERROR - flashes when there is an error in the software or hardware

From the operator panel the operator may adjust temperature and humidity settings, start/stop the air handling units and the compressors. All measuring values showing the status of the plant may be read on the touch screen display. The desired set point and limit values are also entered or adjusted by use of this screen.

The unit is menu-driven from the keys on the screen display. Function, numeric and control keys are incorporated in the screen. The basic displays are:

- Main Menu
- Plant Status
- Compressors
- Air Handling Units
- Alarms

When the screen is touched the operator will see the root display, from this screen the compressor, rooms or plant status displayed are accessed. Touching the appropriate label on the screen brings up the desired display graphic, from which any changes are made.

Plant Screen Display

When the PLANT option is selected, the display will show the status of the compressors (running/stopped/shutdown) and the air handling units (temperature/cooling/heating).

Compressor Screen Display

When the COMPR. Option is selected, details of compressor No.1 are displayed, they include an information line indicating whether the machine is running, stopped, ready, in a low suction pressure stopping phase, or if there is an alarm condition, and the running hours of the machine. Data for compressor No.2 is viewed by touching the arrow sign for next screen.

Air Handling Unit (AHU) Screen Display

When the AHU option is selected, the operation data for the No.1 AHU is displayed. Data for No.2 AHU is viewed by touching the arrow sign.

In addition, this screen will display:

- Control setting that is in operation
- Compensation on/off and type

- Temperature values for supply air
- Supply set point (actual regulation value with outdoor compensation)
- Reheat
- Reheat set point (actual regulation value with outdoor compensation)
- Heating start value
- Cooling start value
- Fan operating hours
- Number of starts of the compressor

Alarms

The control unit will monitor the system and raise a general alarm in the alarm and monitoring system if any of the system operational parameters are exceeded. The operator will then use the alarm function screen to acknowledge and view the alarm. The alarm code will be displayed in the information line. A complete alarm list is shown in the manufacturer's manual.

Operating Procedures

To Start 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.

WARNING
It is essential that no water should be lying in the air conditioning system as it may encourage the growth of legionella bacteria, which may cause serious illness or death in affected personnel. Drains should be kept clear and areas where water may lie should be sterilised at frequent intervals.

To Start the Air Conditioning Compressor

a) The compressor crankcase heater should be switched on 6 hours before starting.

b) Check that the sump oil level is correct.

c) All stop valves 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.

d) Ensure that the central fresh water cooling system is available.

e) Open the valves for the condenser cooling water. Check that there is sufficient flow.

f) Open the compressor suction valve, one turn only.

g) Set the required air temperature and other operational control parameters on the E200 control panel.

h) Start the compressor.

i) Open the suction valve slowly, ensuring that no liquid refrigerant is allowed to enter the compressor.

j) Ensure that the suction pressure is above the cut-out point.

When Running

a) Check the inlet and outlet pressure gauges.

b) Check the oil level and oil pressure.

Compressor - Running Checks

- Check the lubricating oil pressure daily.
- Check the crankcase oil level daily.
- Check the suction and discharge pressure daily.
- Check the oil temperature, refrigerant gas suction and discharge temperatures, and motor bearing temperature daily.
- A periodic check should be kept on any undue leakage at the shaft seal.

To Stop the Compressor for Short Periods

a) Close the condenser liquid outlet valve and the outlet from the filter.

b) Allow the compressor to pump out the system so that the low level pressure cut-out operates.

c) Isolate the compressor motor at the control panel.

d) Close the compressor suction valve.

e) Close the compressor discharge valve.

f) Close the inlet and outlet valves on the cooling water to the air conditioning refrigeration unit.

g) Switch on the crankcase heater.

To Shut Down the Compressor for an Extended Period

If the cooling system is to be shut down for a prolonged period, it is advisable to pump down the system to the condenser and isolate the refrigerant gas charge. Leaving the system with full refrigerant pressure increases the risk of leakage through the compressor shaft seals.

a) Shut the liquid outlet valve on the condenser and the outlet from the filter.

b) Run the compressor until the low pressure cut-out operates.

c) 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.

d) Shut the compressor suction and discharge valves.

e) Close the inlet and outlet valves on the cooling water to the condenser.

f) The compressor discharge valve should be labelled as closed and the compressor motor isolated to prevent possible damage from inadvertent starting.

2.14.4 MISCELLANEOUS AIR CONDITIONING UNITS

Package air conditioning units are provided to supply the following spaces:

- Engine control room
- Engine room workshop
- Galley

The units are all self-contained, comprising a fan, compressor, refrigerant circuit, filters and controls, and are supplied with cooling water from the low temperature central fresh water cooling system.

Engine Control Room Unit

Manufacturer:	York Refrigeration
Model:	SCU - E20
Refrigerant:	R134a
Cooling capacity:	16,100kcal/h (18.8kW)
Heating capacity:	12,900kcal/h (15kW Electric)
Compressor:	MTZ 1254M
No. of sets:	1

Engine Room Workshop Unit

Manufacturer:	York Refrigeration
Model:	SCU - E6
Refrigerant:	R134a
Cooling capacity:	4,800kcal/h (5.6kW)
Heating capacity:	3,800kcal/h (4.5kW Electric)
Compressor:	MTZ 324M
No. of sets:	1

Procedure for the Operation of the Package Air Conditioning Units

Starting

a) Turn the main power switch to the ON position. This automatically switches on the compressor crankcase heater, and the heater should be turned on at least 12 hours before the unit is operated.

b) Ensure that the LT fresh water cooling system is operating and open the inlet and outlet valves to the package air conditioning unit.

c) Open the condenser refrigerant inlet and outlet valves.

d) Check for any signs of leakage of refrigerant and lubricating oil.

e) Ensure that the air filter is clean.

f) Turn the unit's control switch to FAN and check that the fan operates correctly.

g) Turn the control switch to COOL if cooling is required or to HEAT if heating is required.

h) The temperature may be regulated by turning the thermostat dial to a selected position in the COOLER or WARMER scales.

The package air conditioning unit is now operating and temperature may be adjusted as in item h) above.

Shutting Down

a) Turn the selector switch to the OFF position.

The package air conditioning unit will shut down, but with the main power switch still in the ON position the compressor crankcase heater will remain on.

b) Close the condenser cooling water inlet and outlet valves.

Under normal circumstances the package air conditioning unit is turned off using the above procedure. If the compressor unit needs to be isolated for maintenance, the maintenance manual must be consulted in order to ensure that no refrigerant gas is released.

Routine maintenance of the package air conditioning unit involves cleaning of the filter elements on a monthly basis.

Galley Air Conditioning Unit

Manufacturer:	York Refrigeration
Model:	HIP-5WDE
Refrigerant:	R134a
Cooling capacity:	14,600kcal/h (17kW)
Heating capacity:	12,900kcal/h (15kW Electric)
Compressor:	MTZ 80
No. of sets:	1

A package type air conditioning unit for the galley is located in the air conditioning room on the upper deck. The unit consists of a single-stage hermetically sealed type compressor which feeds into a water-cooled condenser. The cooling water is supplied from the engine room LT cooling system via a booster pump.

From the condenser the liquid is supplied to a direct expansion evaporator which is controlled by a temperature controller which is fitted onto the front of the unit. A 0.75kW double-suction multi-blade centrifugal fan located in the unit which is rated at 1,000m^3/h circulates the cooled (or warmed) air into the galley.

The package unit is also fitted with an electric heater for use in cold climates.

The galley uptake from the centre of the room is fitted with a fixed CO_2 fire extinguishing unit, in the event that the front cover is opened to allow access to the CO_2 cylinder, the galley package air conditioning unit will stopped automatically.

Procedure for the Operation of the Galley Package Air Conditioning Unit

a) At the cooling water booster pump on the starboard aft side of the engine room upper platform, open the cooling water inlet and outlet valves.

b) Open the cooling water inlet and outlet valves for the condenser in the air handling unit room. Start the cooling water pump, ensure the correct pressure is obtained at the condenser.

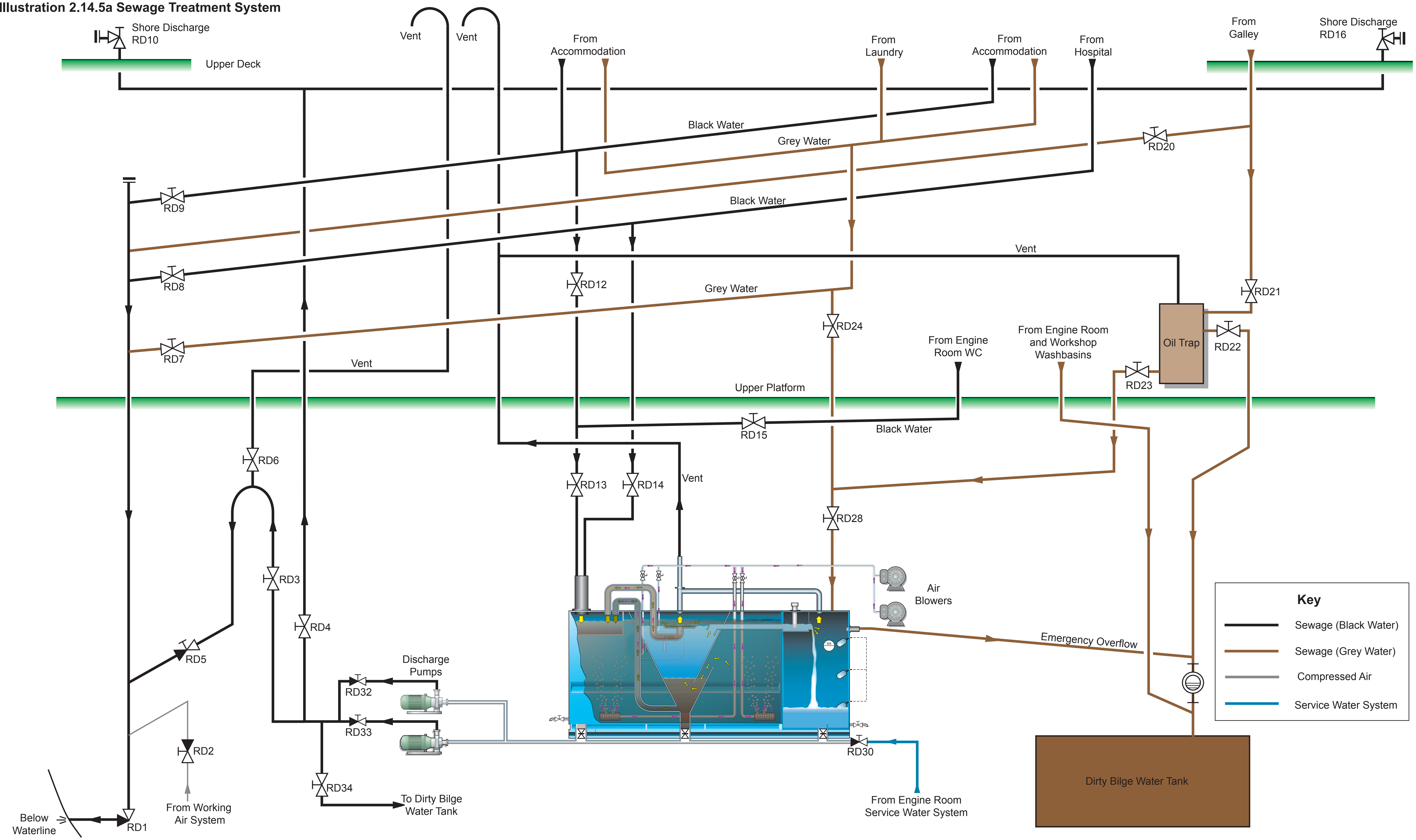
c) Ensure the power is available for the unit, then on the temperature controller set the temperature required in the galley.

When the current temperature is displayed on the LCD press the SET key once, the display will change to a blinking read-out. Press the UP or DOWN keys to set the required temperature, holding in the required key for longer than 4 seconds will advance the temperature range more rapidly.

When the required setting has been reached release the UP or DOWN button then press the SET button for at least 5 seconds, this will then store the required value.

d) Press the START button, the unit will now control the galley temperature, starting and stopping under automatic control.

Illustration 2.14.5a Sewage Treatment System



2.14.5 SEWAGE TREATMENT SYSTEM

Sewage Treatment Plant

Manufacturer:	Jowa AB, Gothenburg, Sweden
Model:	STP3
Type:	Bioreactor
No. of sets:	1
Organic load:	1.8kg BOD5/day
Bioreactor volume:	0.95m^3
Bioreactor - peak retention time:	3.3 hours
Settling chamber volume:	0.31m^3
Settling chamber - peak retention time:	1.1 hours
Total complement:	35 P.E. (for black water gravity system)
Power consumption:	7.3kW
Capacity:	2.45m^3/day

Discharge Pump

Manufacturer:	Herborber Unipump
Model:	4/HK50
No. of sets:	2
Capacity:	10m^3/hour at 0.066MPa

Macerating Pump

Manufacturer:	Zenit
Model:	GRS100/2G40HT
No. of sets:	1
Capacity:	14.4m^3/h at 0.066MPa

Air Blower

Manufacturer:	Becker
Model:	DT 4.25/K
No. of sets:	2
Capacity:	30m^3/h at 0.10MPa

Chemical Dosing Metering Pump

Manufacturer:	Iwakie
Model:	SB 10VC
No. of sets:	1
Capacity:	30 litres/min at 1.0MPa

Description

The biological sewage treatment plant treats all black and grey water in compliance with the requirements of the MARPOL 73/78 ANNEX IV standard, and conforms with IMO MEPC 2(VI), which specifies the following effluent values:

- Suspended solids <50mg/litre
- Coliform bacteria <250 per 100ml
- BOD5 < 50mg/litre

The principle of operation is that naturally occurring bacteria feed on the organic components in the waste water in the presence of oxygen and covert the waste to carbon dioxide and water. This water is then disinfected before being discharged overboard. Discharge is controlled by the +system, which operates automatically.

Sewage Treatment Plant

The sewage treatment plant is an aerated, submerged, fixed-film bioreactor type unit contained within a four compartment tank.

Raw sewage (influent) is led to the first compartment, a pre-treatment chamber, where a submerged macerating pump operates continuously to macerate the raw sewage before it enters the bioreactor in the second chamber. When there is no influent, the pump circulates water and sludge from the bottom of the bioreactor, which prevents the bioreactor matrix from clogging.

The bioreactor has no moving parts but contains a polypropylene, cross-fluted matrix media, on which the bacterial biomass adheres and rapidly grows. The matrix is designed so that constant mixing of the waste water occurs in each vertical column of the media, ensuring maximum contact between the waste water and the surfaces on which the biomass is fixed. The waste water is driven upwards by aerators over alternate columns of the matrix and it flows downwards in adjacent columns. This ensures that the fluid moves in a serpentine fashion through the whole of the bioreactor, ensuring maximum contact time and optimum biological treatment.

The self-cleaning aeration system fed by the air blower provides:

- Dissolved oxygen for the biomass to feed on and degrade the waste.
- The motive force for the passage of the waste water through the aeration chamber.
- The removal of solids from the bioreactor without the need for back-washing or de-sludging.

The aeration system also ensures that the bioreactor produces no offensive odours.

Solids are produced by the development of the bacterial biomass by their absorption of organic materials, nitrogen and phosphorus nutrients, micronutrients and oxygen. During this process, which removes the organic contamination from the water, the biomass film thickens on the matrix. After a period the slime layer becomes too deep for nutrients and oxygen to penetrate right through it. At this stage it dies and stops producing sticky polysaccharides and loses its adhesion to the plastic matrix. It is sloughed off from the matrix by the sheering force of the air and water, and passes into the effluent water stream. These fully digested, odourless, biological solids settle in the settling chamber from where they are recycled back to the inlet and degraded with the influent from the sanitary system.

The bioreactor needs no nutrient addition or pH correction and no chemicals are required. Primary settlement of sewage is not needed as the bioreactor can take the complete influent, via a perforated inlet pipe and the action of the macerating pump. This removes any requirement for handling septic solids and their disposal. The intensive bacterial activity that takes place in the bioreactor ensures that pathogenic bacteria, present in the sewage influent, are rendered ineffective.

The bioreactor has a quick biological start-up period and is not sensitive to long shutdown periods due to is continuous sludge return. As the bioreactor is a submerged, fixed-film unit, the biomass is inherently stable and able to tolerate both hydraulic and organic shock loadings. Low flows and loadings can also be accepted for extended periods.

Note: The use of disinfecting chemicals for cleaning WCs, or the disposal of such chemicals in WCs, will kill the bacteria in the sewage treatment plant and should not be used.

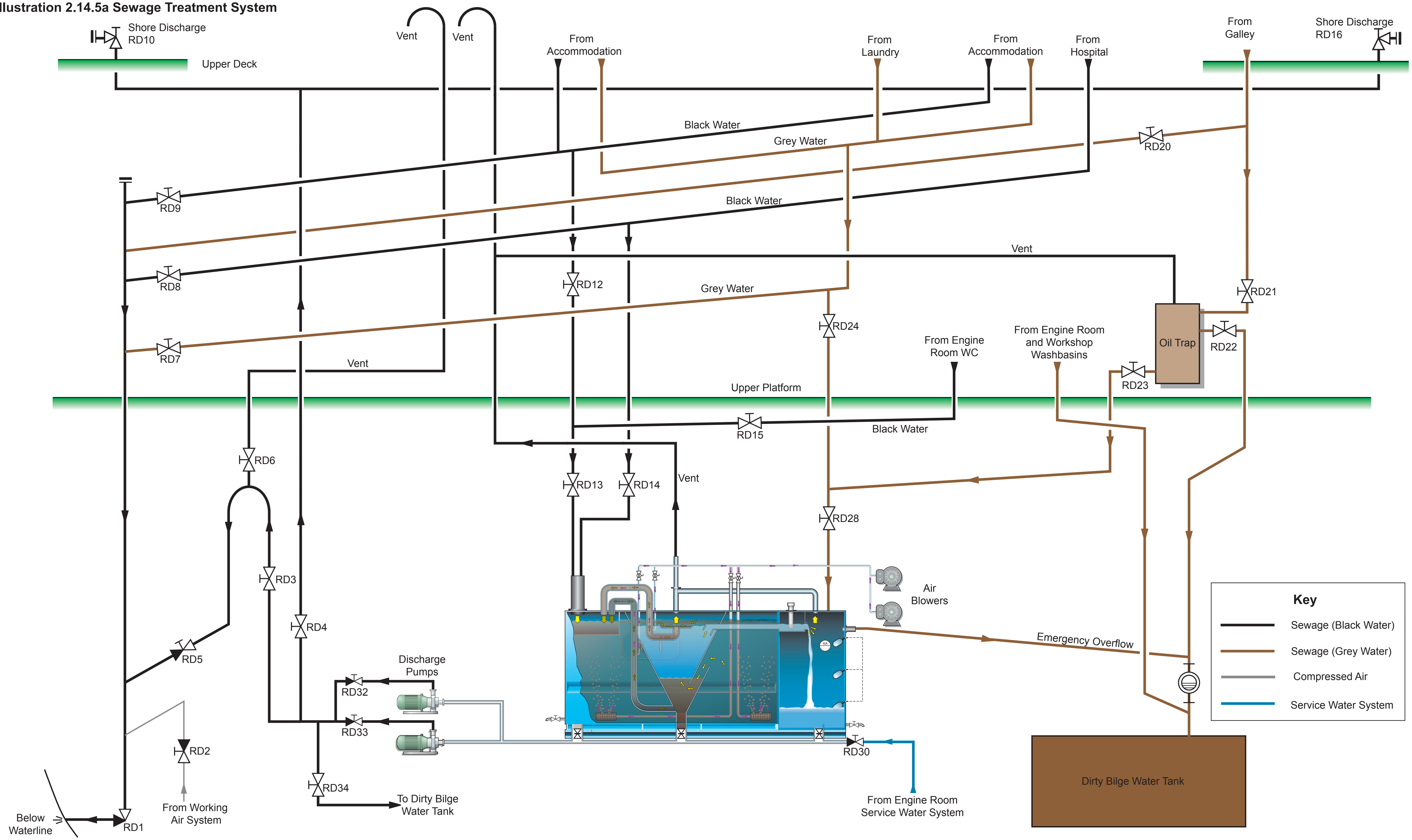
From the bioreactor chamber the effluent water weirs over into the third chamber where it is disinfected by contact with chlorine delivered by a metering pump in proportion to the flow being discharged. The contact tank is provided with an emergency overflow, which is led to the dirty water bilge tank.

In normal operation the effluent is discharged overboard via the pair of duty/standby discharge pumps. The pumps can also discharge the contents of the sewage treatment plant ashore via deck connection on the port and starboard sides of the main deck.

The design of the pipework enables raw sewage from all the WCs to be directed to the sewage treatment plant or, in exceptional circumstances, where legislation allows it, overboard. Galley waste water is directed through an oil/grease trap to the chlorine contact chamber. Drains from the washbasins in the engine room WC and workshop are led directly to the dirty water bilge tank.

When legislation prohibits the discharge of sewage effluent to the sea it is possible to discharge to the dirty water bilge tank, which provides a short term storage reserve that should be pumped out via the oily water separator as soon as practicable.

Illustration 2.14.5a Sewage Treatment System



Procedure for Operating the Sewage Treatment Plant

a) Position the system valves as shown in the table:

Position	Description	Valve
Closed	Accommodation sewage overboard discharge valve	RD9
Closed	Galley waste water overboard discharge valve	RD20
Closed	Hospital sewage overboard discharge valve	RD8
Closed	Laundry waste water overboard discharge valve	RD7
Closed	Galley waste oil/grease trap outlet valve to dirty bilge water tank	RD22
Closed	Discharge pump discharge valve to deck connection	RD4
Closed	Port sewage deck discharge valve	RD10
Closed	Starboard sewage deck discharge valve	RD16
Closed	Discharge pump discharge valve to dirty bilge water tank	RD34
Open	Accommodation sewage treatment plant (STP) system valve	RD12
Open	Accommodation sewage STP inlet valve	RD13
Open	Engine room WC STP inlet valve	RD15
Open	Hospital sewage STP inlet valve	RD14
Open	Galley waste water oil trap inlet valve	RD21
Open	Oil trap outlet valve to STP	RD23
Open	Laundry outlet valve to STP	RD24
Open	Oil trap/laundry inlet valve to STP	RD28
Open	Chlorination contact compartment outlet valve	V03
Closed	Bioreactor compartment outlet valve	V02
Closed	Macerator compartment outlet valve	V01
Open	No.1 Discharge pump discharge valve	RD32
Open	No.2 Discharge pump discharge valve	RD33
Open	Overboard discharge line valve	RD3
Open	Overboard discharge line vent valve	RD6
Open	Overboard discharge line valve	RD5
Open	Overboard discharge valve	RD1
Closed	Overboard discharge clearing service air supply valve	RD2
Closed	STP service water supply valve	RD30

b) Ensure that the bioreactor test cock is closed.

c) Open valve V03 (Tank IV, clean water chamber).

d) Open valve RD30 and fill up the unit with water from the service water system. Close the valve when full.

e) At the control panel turn the main switch to ON and the MANUAL/AUTO selector switch to manual.

f) Select the duty discharge pump and start it.

g) Turn the MANUAL/AUTO selector switch to auto.

The macerating pump and duty air blower will run continuously. The discharge pump will run under level control initiated by float switches in the disinfection chamber.

A solenoid valve (V-30) will open once every hour for 2 minutes (set at delivery), which will start the solids airlift from the settling chamber back to the macerator chamber. The solids airlift may be adjusted on the PLC, located inside the control cabinet. The frequency and duration of the airlift should be adjusted to return most of the sludge in the settling chamber to the pre-treatment chamber, to avoid high concentration of suspended solids in the discharge water.

2.14.6 GARBAGE DISPOSAL AND INCINERATOR

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 utilising shore facilities where available. A summary of the garbage disposal regulations is given below.

The special areas are as follows:

- The Mediterranean Sea
- The Baltic Sea
- The Black Sea
- The Red Sea
- The Persian Gulf
- The North West European Waters
- The Gulf of Aden
- The Antarctic
- The Wider Caribbean Area

Garbage 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 of 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 MARPOL 73/78 is complied with, waste is treated under the following cases:

- Food waste
- Combustible dry waste, plastic and others
- Non-combustible dry waste
- Other waste, including oily rags and cans and chemical cans

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 and transported by hand to the garbage room, located on A deck at the starboard side of the engine casing.

Dry Waste

Dry waste production for approximately 50 people is given as approximately 30kg per day or 1,000 to 1,500 litres per day, without compacting.

The volume can be reduced by a factor of 5 by shredding or compacting the waste.

Dry waste from the accommodation is collected in the waste management room and compacted.

Dry waste from the engine room is taken directly to the garbage room.

Other Waste

Cans that have contained oils or chemicals must be stored in the garbage room before discharge ashore.

The Maersk company Garbage Management Plan procedures must be complied with at all times. This plan designated individuals who are responsible for:

Garbage management procedures

Disposal of garbage

The collection of garbage

The processing of garbage

The storing of garbage

There are procedures for the collection, disposal, processing and storage of garbage and these must be complied with.

Collection Facilities

The garbage room, located on A deck at the starboard side of the engine casing acts as the central collection area for all garbage from the accommodation areas of the ship. Each cabin is provided with two garbage containers, one for plastic waste and one for other waste. Garbage is collected from cabins on a frequent basis and taken to the garbage room for storage and packaging into larger containers for subsequent disposal.

Larger items of garbage for disposal which cannot conveniently be stored in the garbage room are stored in other suitable locations where safe storage is available.

When disposing of garbage ashore, harbour regulations must be complied with at all times and only approved collection agents and disposal facilities must be used. A record must be kept of all garbage disposals.

Illustration 2.14.6a Garbage Regulations

REGULATIONS FOR GARBAGE DISPOSAL AT SEA (ANNEX V OF MARPOL 73/78

GARBAGE TYPE	OUTSIDE SPECIAL AREAS	** IN SPECIAL AREAS	*** OFFSHORE PLATFORMS & ASSOCIATED VESSELS
PLASTICS - INCLUDES SYNTHETIC ROPES, FISHING NETS AND PLASTIC BAGS	DISPOSAL IS PROHIBITED	DISPOSAL IS PROHIBITED	DISPOSAL IS PROHIBITED
FLOATING DUNNAGE, LINING AND PACKING MATERIALS	> 25 MILES OFFSHORE	DISPOSAL IS PROHIBITED	DISPOSAL IS PROHIBITED
PAPER, RAGS, GLASS, METAL, BOTTLES, CROCKERY AND SIMILAR REFUSE	> 12 MILES	DISPOSAL IS PROHIBITED	DISPOSAL IS PROHIBITED
* ALL OTHER GARBAGE INCLUDING PAPER, RAGS, GLASS, etc. COMMINUTED OR GROUND	> 3 MILES	DISPOSAL IS PROHIBITED	DISPOSAL IS PROHIBITED
FOOD WASTE NOT COMMINUTED OR GROUND	> 12 MILES	> 12 MILES	DISPOSAL IS PROHIBITED
* FOOD WASTE COMMINUTED OR GROUND	> 3 MILES	> 12 MILES	> 12 MILES
MIXED REFUSE TYPES	* * * *	* * * *	* * * *

* COMMINUTED 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.

*** OFFSHORE PLATFORMS AND ASSOCIATED SHIPS INCLUDE ALL FIXED OR FLOATING PLATFORMS ENGAGED IN EXPLORATION OR EXPLOITATION OF SEABED MINERAL RESOURCES, AND ALL SHIPS ALONGSIDE OR WITHIN 500M OF SUCH PLATFORMS.

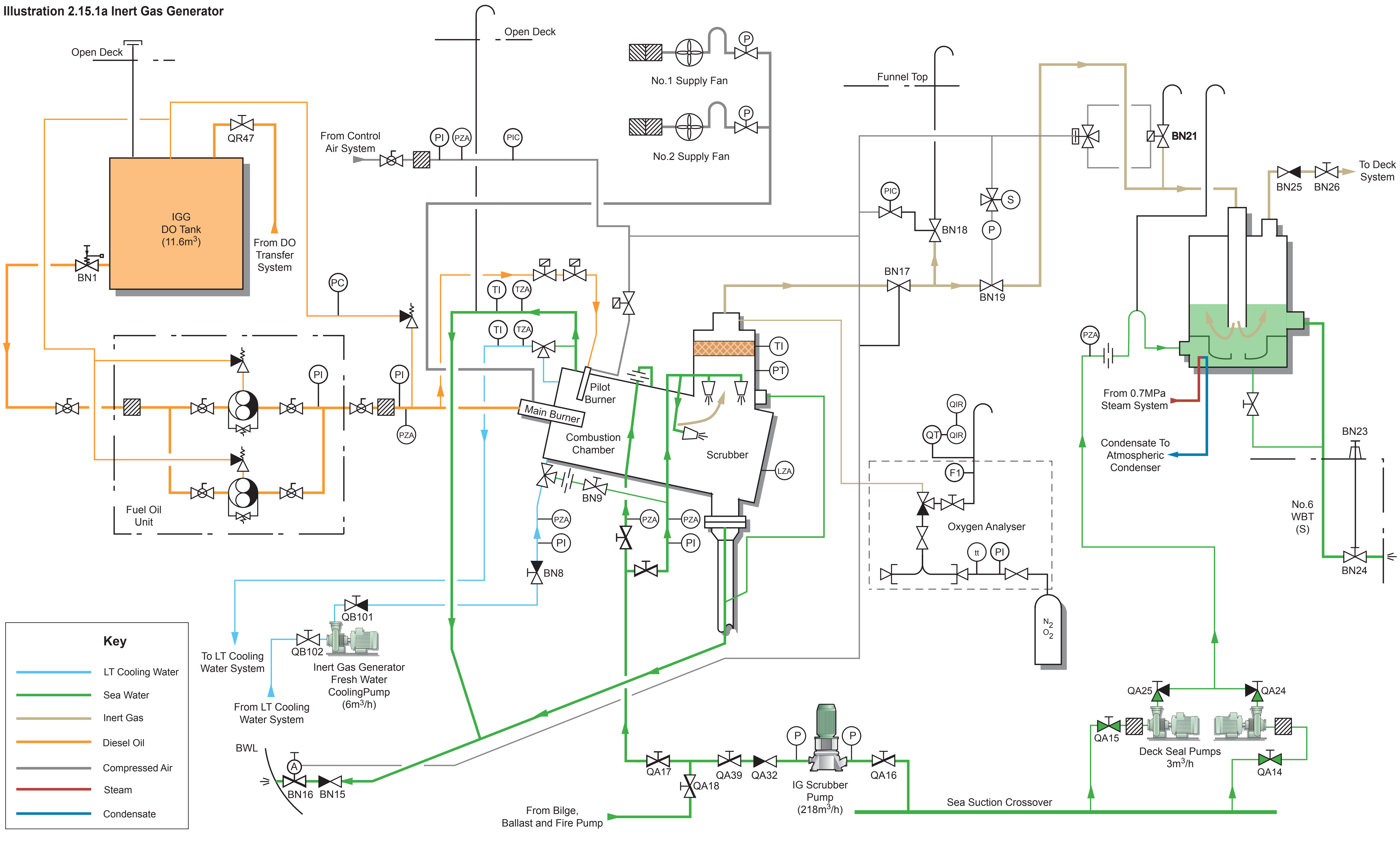
**** WHEN GARBAGE IS MIXED WITH OTHER HARMFUL SUBSTANCES HAVING DIFFERENT DISPOSAL OR DISCHARGE REQUIREMENTS, THE MORE STRINGENT DISPOSAL REQUIREMENTS SHALL APPLY.

2.15 Inert Gas System

2.15.1 Inert Gas Generator

2.15.2 Operation

Illustration 2.15.1a Inert Gas Generator



2.15 INERT GAS SYSTEM

2.15.1 INERT GAS GENERATOR

Manufacturer:	Aalborg Inert Gas Systems BV (Smit Gas Systems BV)
Model:	Gin 3000 - 0.15 FU
Capacity:	3,000m^3/h at 0.15MPa

The inert gas plant, which is installed in a dedicated space adjacent to the engine room, produces inert gas that is used to provide protection from explosion in the cargo oil and slop tanks. This is achieved by reducing the oxygen content in the tanks below that required to allow combustion. A slight over-pressure in the tanks should be maintained at all times to prevent dilution of the inert atmosphere with air.

During the discharging of the cargo, liquid pumped out of the tanks is replaced by inert gas. At all times, pressure of the inert gas in the tanks is maintained slightly above atmospheric.

The operating principle is based on the combustion of a low sulphur content fuel and the cleaning and drying of the exhaust gases.

The inert gas plant comprises of the inert gas generator, including the scrubbing tower unit, two air supply fans, an effluent water seal, a fuel supply unit, deck seal and the instrumentation/control system.

The plant burns marine diesel oil (MDO) at 220kg/h providing 3,000m^3/h of inert gas when running at full capacity. This is sufficient to maintain the inert atmosphere in the cargo tanks during discharge.

When gas freeing or inerting empty tanks the system capacity is such that a maximum of two tanks may be purged efficiently at any one time. This will provide sufficient gas flow into the tank to thoroughly mix the gaseous contents and minimise pockets of vapour.

The quality of the inert gas produced is as follows:

Inert gas delivery rate (m^3/h)	750 ~ 3,000
Inert gas composition (% vol) O_2	2 to 4%
Inert gas composition CO_2	14% maximum
Inert gas composition CO (max)	500ppm
Inert gas composition SO_2 (max)	50ppm
Nitrogen balance to 100%	Balance
Inert gas composition 'soot'	Bacharach 0

The inert gas plant is stopped and started from the inert gas space adjacent to the engine room. This space also contains the oxygen analyser for monitoring the quality of the inert gas produced.

Associated Equipment

Scrubber Pump

Manufacturer:	Shinko
Model:	SVS200-M
Capacity:	218m^3/h at 0.40MPa

Deck Seal Pumps

Manufacturer:	Shinko
Model:	HJ40M-2M
No. of sets	2
Capacity:	3m^3/h at 0.35MPa

IGG Fresh Water Cooling Pump

Manufacturer:	Shinko
Model:	VJ40-2M
Capacity:	6m^3/h at 0.25MPa

Fuel Oil Pumps

Manufacturer:	Danfoss
Model:	KSN-450-R
No. of sets	2
Capacity:	0.9m^3/h at 0.40MPa

Centrifugal Supply Fans

Manufacturer:	Rotodyne Ventilatoren BV, The Netherlands
Model:	CV-250/1025-P70S
No. of sets	2
Capacity	3,400m^3/h at 0.168MPa

Working Principle

Inert gas is produced by the combustion of diesel oil supplied by the fuel oil pump and air provided by blowers, taking place in the combustion chamber of the inert gas generator.

Good combustion is essential for the production of a good quality soot-free low oxygen inert gas.

The products of the combustion are mainly carbon dioxide, water and small quantities of oxygen, carbon monoxide, oxides of sulphur and hydrogen. The nitrogen content is generally unchanged during the combustion process and the inert gas produced consists mainly of 85% nitrogen and 14% carbon dioxide.

Initially, the hot combustion gases produced are cooled indirectly in the combustion chamber by the surrounding water jacket. Thereafter, cooling of the gases mainly occurs in the scrubber section of the generator, where the sulphur oxides and any soot particles are washed out. The sea water for the inert gas generator is supplied by the inert gas scrubber pump or, if this is unavailable, from one of the bilge, ballast and fire pumps.

The combustion gas leaves the IG generator through a demister, where any moisture and water droplets are separated out before delivery to the deck main via the deck water seal.

The inert gas system can also be used to supply fresh air for gas-freeing of the tanks with the same volumetric capacity.

Burner Description

The combustion air is supplied to the main burner by one of two blowers, each supplying 100% of the total capacity of the generator.

Fuel (MDO) is supplied at a constant pressure by the fuel pump. This pump has a built-in pressure relief valve.

Before ignition or start-up of the unit, and with the fuel pump running, all the fuel flows back to the IGG diesel oil tank via the fuel oil pressure control valve. This valve also serves to regulate the delivery pressure of the pump.

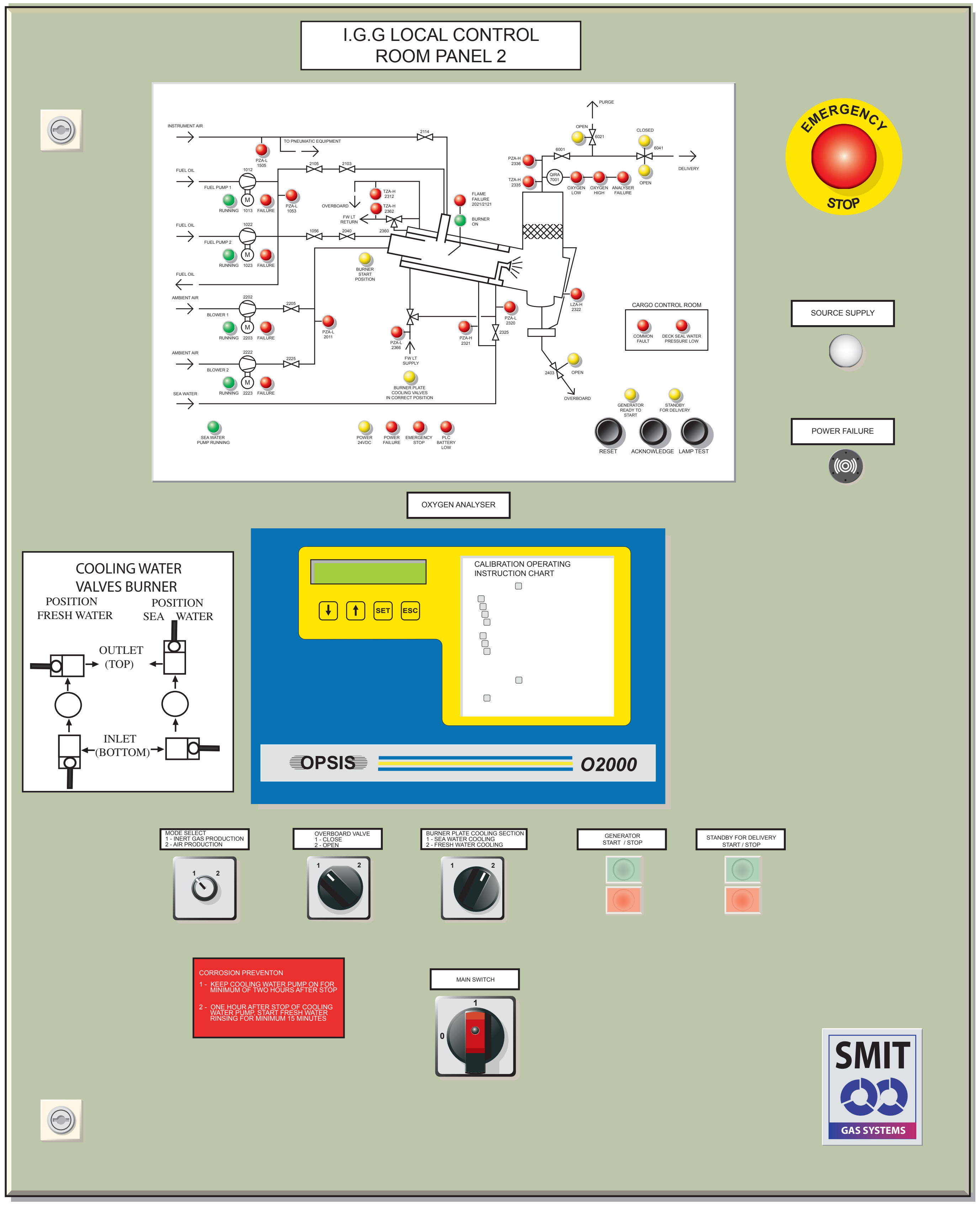
The fuel oil is pumped to the nozzle of the main burner via two solenoid valves and two fuel oil regulating valves.

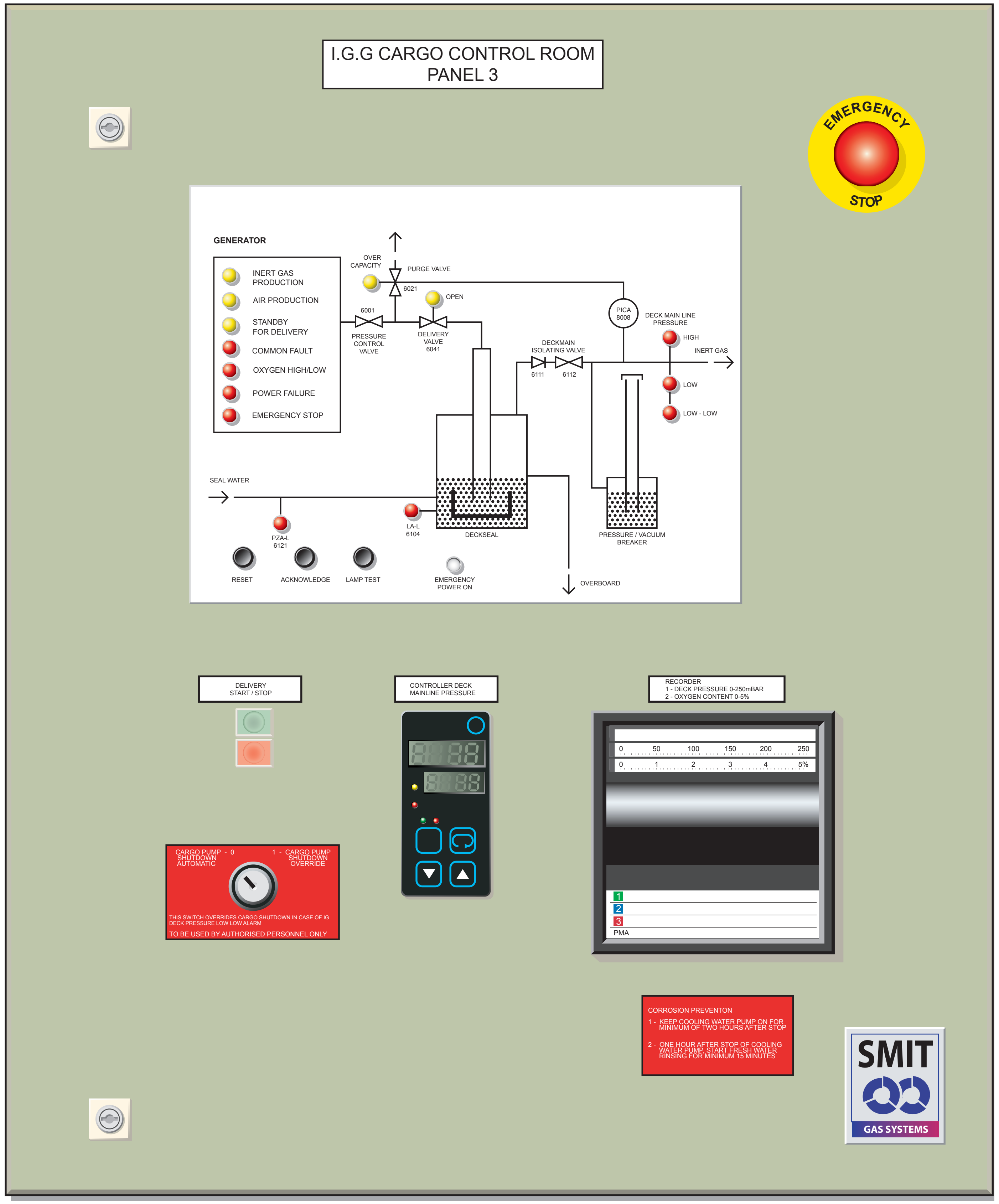
A program switch in the local control panel regulates a series of solenoid valves which operate the pilot burner and initial firing operation.

The main burner is ignited by a pilot burner. The main fuel oil burner is of the high-pressure atomising type. The fuel is directed to the burner orifice through tangential slots which ensure that the fuel leaves the burner as a thin rotating membrane which is atomised just after leaving the nozzle as it mixes with the contra-rotating combustion air.

The capacity control of the unit is arranged so that the burner unit is able to move in and out of the casing, as this capacity control movement is taking place the combustion air slots increase and decrease accordingly, as does the fuel supply, and therefore maintaining the correct air to fuel ratio.

Illustration 2.15.2a Inert Gas Generator Control Panels No.2 and 3





2.15.2 OPERATION

The operation of starting and stopping of the inert gas generator plant is undertaken by the engineering department.

a) Open all valves for the associated utilities, ie, sea water, fuel, fresh water cooling, instrument air, overboard discharge valves etc. Ensure the deck seal is in operation. In normal operations a deck seal pump is in constant operation supplying the deck seal, with the second pump arranged as duty standby. Ensure the IGG space exhaust fan is in operation.

b) Supply electrical power to the inert gas generator panel. Normally the main power switch is left in the ON position in order to maintain outputs to the remote panels etc.

c) Carry out a calibration test on the oxygen analyser.

d) Determine if the burner head assembly is to be fresh or sea water cooled; in normal operations fresh water cooling is the preferred method. Ensure the manual three-way valves at the burner head are correctly set for fresh water circulation, then set the selection switch on the local control panel to FRESH WATER COOLING.

Note: It is important to avoid contamination of the LT cooling system with sea water, therefore always visually check that the three-way valves are both set correctly.

e) Ensure that the scrubber pump is set to remote operation.

f) If fresh water cooling of the burner head is to be used ensure pump is ready for service and start the pump from the stop/start pushbutton panel in the IGG room.

g) Set the mode selection switch to IG PRODUCTION.

h) If all of the initiation parameters are satisfactory, the GENERATOR READY TO START indicator light will be illuminated. The generator is started by operating the green START button. The complete starting process is fully programmed and safety interlocked.

i) The purge line to atmosphere is opened when the generator is started and will remain open until the oxygen content drops to within the required limits. At this point the supply to deck valve (BN19) will open and the purge valve (BN18) will close when the selection switch in the SCC has been changed over to START DELIVERY.

The starting program runs as follows: (Page 23 of the manufacturer's operating instruction sets out the automatic start-up sequence time period for the plant.)

a) The supply fan purges the system with air for 60 seconds before the pilot burner is ignited by the spark plug.

b) The pilot burner is ignited. As soon as the flame is detected the main burner is started (85 seconds after start-up).

c) After flame detection of the main burner and flame stabilise, the pilot burner is shut down (90 seconds after start-up).

d) After approximately five minutes of operation the O_2 content should be within limits, at this point the STAND BY selection switch can be set to ON ('1').

e) On the SCC control panel the GENERATOR STANDBY FOR DELIVERY indication light will light up, control is now taken by the deck officer in the SCC by turning the START DELIVERY switch to the START position.

Shutting the IGG Plant Down

When cargo operations have finished the deck officer will turn the START DELIVERY selection switch to the off position, '0'. This will now shut the delivery valve to deck and open the purge valve to atmosphere.

The engine room should now be informed that the IGG plant may now be shut down.

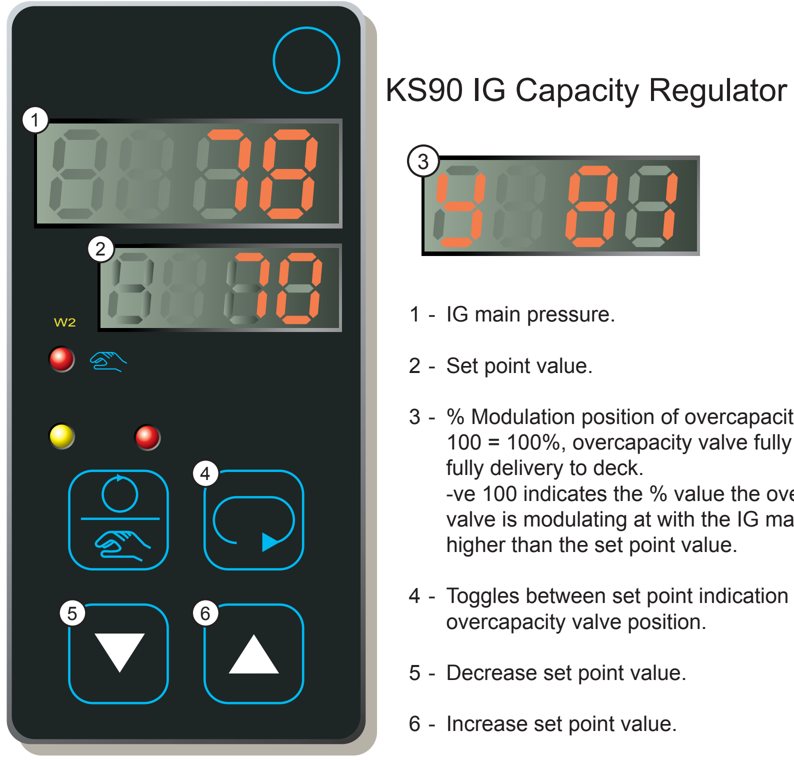
Pressing the STOP button on the local control panel once will shut down the burner unit, but leave the supply fan running in order to purge the furnace and uptake. If the stop button is pressed twice in rapid succession then an emergency stopping of the plant will take place with the burner and fan stopping immediately.

Leave the SW scrubber pump and FW cooling pump running for a minimum of 30 minutes in order that the jacket and burner end plate are fully cooled down before stopping the pumps.

The cooling water outlet and scrubber outlet line combine together by the working air compressor on the starboard side of the upper platform. The combined overboard line then descends to the tank top and discharges overboard close to the starboard aft end of the main engine.

If the inert gas generator is not to be used for some time it is recommended that the sea water cooling system is flushed through with fresh water.

Illustration 2.15.2b Inert Gas Capacity Control Panel



1 - IG main pressure.

2 - Set point value.

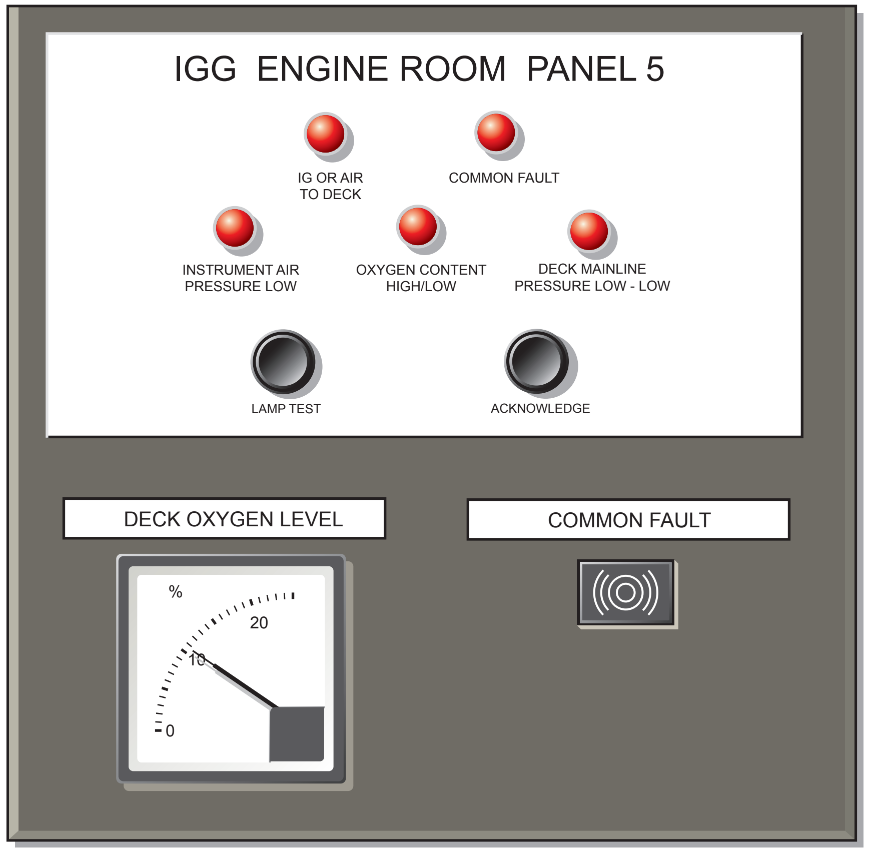
3 - % Modulation position of overcapacity valve; 100 = 100%, overcapacity valve fully closed i.e., fully delivery to deck. -ve 100 indicates the % value the overcapacity valve is modulating at with the IG main pressure higher than the set point value.

4 - Toggles between set point indication and overcapacity valve position.

5 - Decrease set point value.

6 - Increase set point value.

Illustration 2.15.2c Engine Control Room Inert Gas Panel



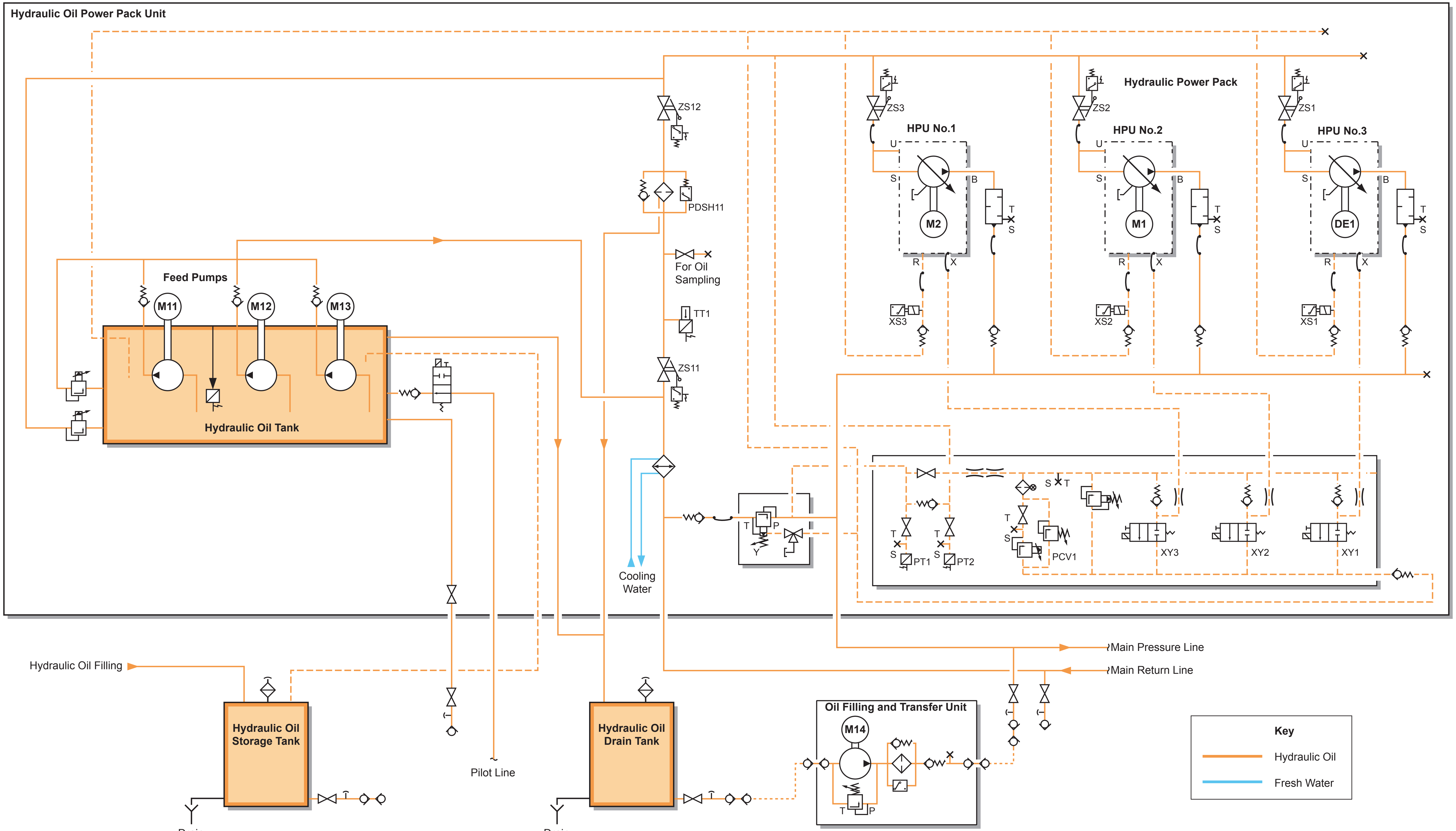
2.16 Hydraulic Oil System

2.16.1 Hydraulic Power Pack System

2.16.2 Hydraulic Power Pack Diesel Engine

2.16.3 Hydraulic Valve Remote Control System

Illustration 2.16.1a Hydraulic Oil Power Pack Unit



2.16 HYDRAULIC OIL SYSTEM

2.16.1 HYDRAULIC POWER PACK SYSTEM

Electrical Power Pack

Manufacturer: Frank Mohn (Framo)
Model: A4VSO500DP/30R-PPH25N00-S1068
Capacity: 799 litres/min at 26.2MPa
Rating: 405kW
Pump speed: 1,780 rpm
No. of sets: 2

Diesel Driven Power Pack

Manufacturer: Frank Mohn (Framo)
Model: A4VSO500DP/30R-PPH25N00-S1068
Capacity: 819 litres/min at 26.2MPa
Pump speed: 1,350/1,770 rpm
Diesel engine: Cummins
Model: KTA 19D (M1)
Rating: 485kW (650 bhp) at 1,800 rpm
Specific fuel cons: 216g/kWh at full load
No. of sets: 1

Feed Pumps

Manufacturer: Frank Mohn (Framo)
Model: KRAL CKCR 118V/ABB 132SC
Capacity: 273 litres/min at 0.80MPa
Rating: 11kW
Pump speed: 3,436 rpm
No. of sets: 3

Hydraulic Oil Cooler

Manufacturer: Sperre Industrie AS
Model: DPK 406/1800-VS-7
Heat transfer rate: 399kW
Minimum/maximum
cooling flow required: 65/100m^3/h
Surface area: 29.1m^2
No. of sets: 1

Hydraulic Oil Bypass Filter

Manufacturer: C.C.Jensen AS, Denmark
Model: HDU 27/108 MZ-E1Z
No. of sets: 1

Hydraulic Oil Transfer Unit

Manufacturer: ING. PER GJERDRUM AS, Norway
Pump model: CK15.2006H
No. of sets: 1
Pressure: 1.40MPa
Capacity: 1.79m^3/h

Oil Consumption For Each Consumer

Unit	Capacity (m^3/h)	Head (MPa)	Requirement (litres/min)
12 x Cargo pump model SD150	385	1.20	373 at 24.3MPa
3 x Cargo pump model SD125	180	1.20	189 at 22.8MPa
1 x Cargo pump model SD100	70	1.20	113 at 20.3MPa
2 x Ballast pump model SB300	800	0.25	245 at 19.9MPa
2 x Tank cleaning pump model MA200/150	125	1.20	242 at 19.8MPa
1 x Portable cargo pump model TK150	250	0.60	212 at 22.0MPa
1 x Bow thruster unit	760kW	1,480 rpm	2,337 at 22.4MPa
2 x Winch/windlass			
6 x Winch (5 x twin drum and 1 x single drum)			

Introduction

Hydraulic power is used to power the following items of deck machinery:

- Cargo pumps
- Water ballast pumps
- Slop and residual tank pumps
- Cargo tank cleaning pumps
- Portable cargo oil pump
- Bow thruster unit
- Anchor handling windlasses
- Mooring winches

Power Packs

Hydraulic power is provided by the power pack unit which consists of one 440kW diesel-hydraulic unit and two 405kW electro-hydraulic units. The hydraulic feed pumps maintain the hydraulic system under pressure at all times. The requirements of the system operation, whether full cargo discharge or hydraulic power for operating deck machinery, dictate how many power pack pumps units will be in operation according to the maximum demand of each cargo pump/thruster/winch.

The duty officer will select the most appropriate units that are available. The engine room staff should inform the duty officer if any hydraulic power pack units are not available for duty. The hydraulic power pack system is located in a dedicated space in the engine room at the forward end of the upper platform. The hydraulic pumps are located in a sound-deadening boxes with the drive shafts from the prime movers passing through the bulkhead of these enclosures.

Oil Filling and Transfer Unit

CAUTION

The cleanliness of the oil entering the system is of the utmost importance. It must only be pumped into the hydraulic oil storage tank via a suitable filtration unit and into the system via the transfer unit filter. Hoses must be dedicated clean hydraulic hoses. Quick disconnect couplings must be cleaned prior to use and the dust caps replaced immediately after disconnection.

The hydraulic power system is provided with an oil filling and transfer unit which is used to transfer oil from the hydraulic oil storage tank via the main return line to the auxiliary oil tank and the hydraulic oil pipes, delivery and return, of the main system. This maintains the hydraulic oil tank at the required level and provides for the refilling of the system after maintenance.

Hydraulic Feed Pump Unit

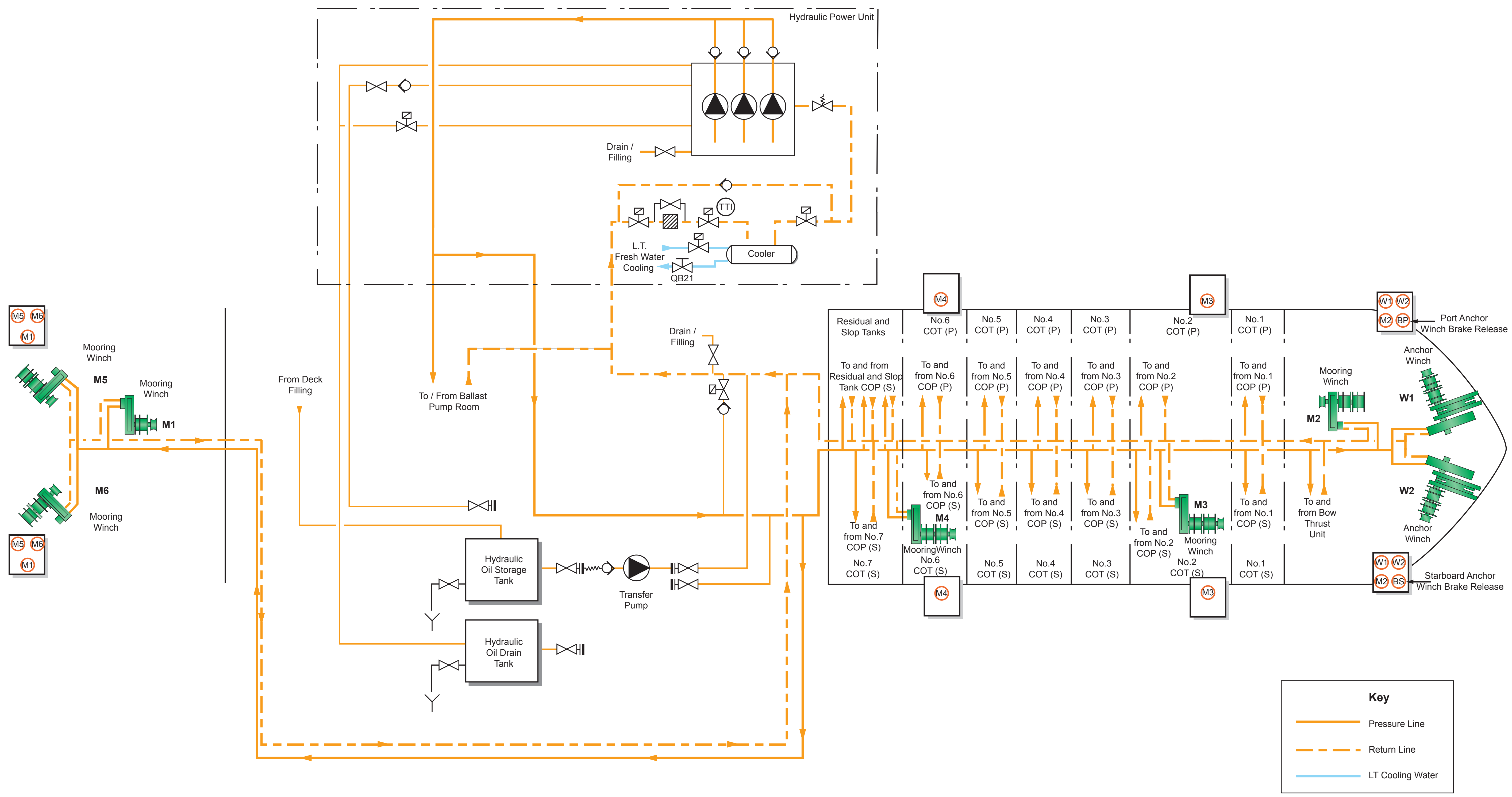
The auxiliary hydraulic unit has three electric motor-driven feed pumps. In order to prevent cargo leaking into the hydraulic oil system the feed pumps maintain the system pressure at approximately 0.40MPa when the cargo pump and deck machinery systems are not in use. The feed pumps take their suction from the float tank, one pump is constantly running with the other two pumps on standby.

When the command is given to start a main hydraulic pump, a second feed pump will start automatically before the main pump(s) to ensure that there is positive pressure on the suction side of the main pumps. After the main power pack pumps are stopped, one of the running feed pumps will be stopped automatically after a period of 10 minutes.

CAUTION

Any leakage of cargo into the hydraulic system could cause serious damage to the hydraulic plant, therefore it is essential to maintain system pressure by running a feed pump unit when the main system is shut down.

Illustration 2.16.1b Deck Machinery Hydraulic System



Feed pump No.3 has a power feed from both the main and the emergency switchboards, a selector switch for this is located on the feed pump starter panel in the hydraulic power pack room.

Main Hydraulic Circuit

The main hydraulic circuit is a closed loop with oil returning from the hydraulic motor units to the pump suction manifold. The return pipe also has a connection to the hydraulic oil tank to allow for thermal expansion. The connection from the feed pump unit also provides make-up oil. Oil returning to the power pack passes through a cooler, the cooler being circulated with fresh water as part of the low temperature fresh water cooling system. The pressure and return hydraulic oil pipes run the length of the ship serving the winches, cargo and ballast pumps and the bow thruster. A deaerating/venting valve block is located at the forward end of the ship with a connection to the pressure and return hydraulic lines. This unit allows air to be removed from the system as required.

The main hydraulic pumps are of the axial piston type with a tilting swash plate which provides for variable oil delivery. The control system adjusts the angle of the swash plate in order to regulate the pump delivery to match the use of oil by the cargo pumps, winches and bow thruster; the pressure in the main hydraulic system is maintained at a constant level whilst the system is operational. At start-up the variable pump is set at maximum delivery and pressure rapidly builds up in the delivery line. This pressure is internally bled-off through the pressure regulator and a solenoid valve which is energised at start-up. This results in the angle of the swash plate being reduced to a minimum by the control system.

After approximately 10 seconds for the electrically-driven pumps, or 3 minutes in the case of the diesel engine-driven pumps, the solenoid valve is de-energised and pilot oil from the pump pushes the swash plate to an increased angle resulting in the delivery of oil into the main pressure line. If no pressure oil is needed then the pressure in the main line builds up and when it reaches the set value of the proportional valve, the valve will open and oil will flow to the pressure regulator which will adjust the swash plate angle to suit the required oil delivery.

If hydraulic oil consumption by the cargo pumps increases, the system pressure falls and the oil flow through the proportional valve will reduce. Pilot oil from the pump is then able to push the swash plate to an angle at which delivery of hydraulic oil from the pump is increased. If there are a number of power pack units operating they function independently, but the system oil pressure is maintained at the desired value by the combined effect of the operating pumps.

Pumps are provided with hydraulic controls which enable them to be operated remotely from the cargo control section of the Ship's Control Centre (SCC). Hydraulic oil for activating the pump control valves is taken from the pressure hydraulic main with a return line connection to the main hydraulic return pipe. A system of electro-hydraulic control valves activates the pumps via small bore pilot hydraulic pipes, two pipes to each pump. The precise delivery rate for each pump is controlled either from the Framo Cargo Pumping System control panel or through the IPH- Hydraulic System display in the SCC.

The winches, three aft (poop deck), two on the cargo deck, one forward and one aft, as well as one winch and the two windlass/winch units on the focsle deck are provided with pressure oil and return lines, with control for each unit via local control stands.

The ship is equipped with the following hydraulic pumps:

- No.1 cargo oil pump (port and starboard)
- No.2 cargo oil pump (port and starboard)
- No.3 cargo oil pump (port and starboard)
- No.4 cargo oil pump (port and starboard)
- No.5 cargo oil pump (port and starboard)
- No.6 cargo oil pump (port and starboard)
- No.7 cargo oil pump (starboard)
- Slop tank pump (No.1 and No.2 port)
- Residual tank pump (port)
- Water ballast pump (port and starboard)
- Tank cleaning pump (port and starboard)
- Portable cargo oil pump

The cargo oil, slop tank and ballast pumps are of the submerged type, but the tank cleaning and slop holding tank pumps are deck-mounted. The tank cleaning pump is located in the starboard deck stores. There are six sets of coupling connecting points on the hydraulic main (pressure and return lines) for the attachment of portable hydraulic equipment.

Procedure for Operating the Hydraulic Power Pack System

The procedure description assumes that the power pack hydraulic system has previously been correctly filled and commissioned.

a) Ensure that there is sufficient oil in the hydraulic oil tank, replenish from the hydraulic oil storage tank if necessary.

b) Check the hydraulic system for signs of leakage and rectify as required.

Note: Whenever the hydraulic system is operating a check should be made for signs of leakage which can be rectified when the system is shut down.

c) Supply fresh water cooling from the low temperature central cooling system to the hydraulic oil cooler by opening the cooler outlet valve QB35 and the cooler inlet valve QB21. A motorised valve QB79, after the inlet valve, controls the cooling water flow in response to temperature fluctuations.

d) Check the power pack diesel engine (hydraulic pump No.3) and ensure that it is ready for operation (see Section 2.16.3). For normal operation from the SCC the selector switch is set to REMOTE. Ensure that any alarms have been cleared.

e) Check the electric motor-driven power pack unit (pumps No.1 and No.2) and ensure that they are ready for operation.

f) For normal operations the three feed pumps are set to REMOTE, in order that they can be started and stopped by the Framo control system. When the main pumps are shut down only one pump will be running.

g) The main switchboard's power management system will monitor the power demand and block a start request by an electrically-driven pump unit until there is sufficient generator capacity to cope with the starting load demand.

h) Select the main hydraulic pump unit(s) for operation and start the system. The number of power pack pump units required will depend upon the hydraulic power requirement. The operating pressure should be approximately 1.5-2.0MPa above the highest hydraulic motor feed pressure when the oil is at a temperature above 20°C. Check that the cooler is operating to maintain a suction temperature of 55°C.

i) Check that there is electrical power at the pump control panel and that the electro-hydraulic valve controllers are functioning.

j) Operate the winches or pumps as required.

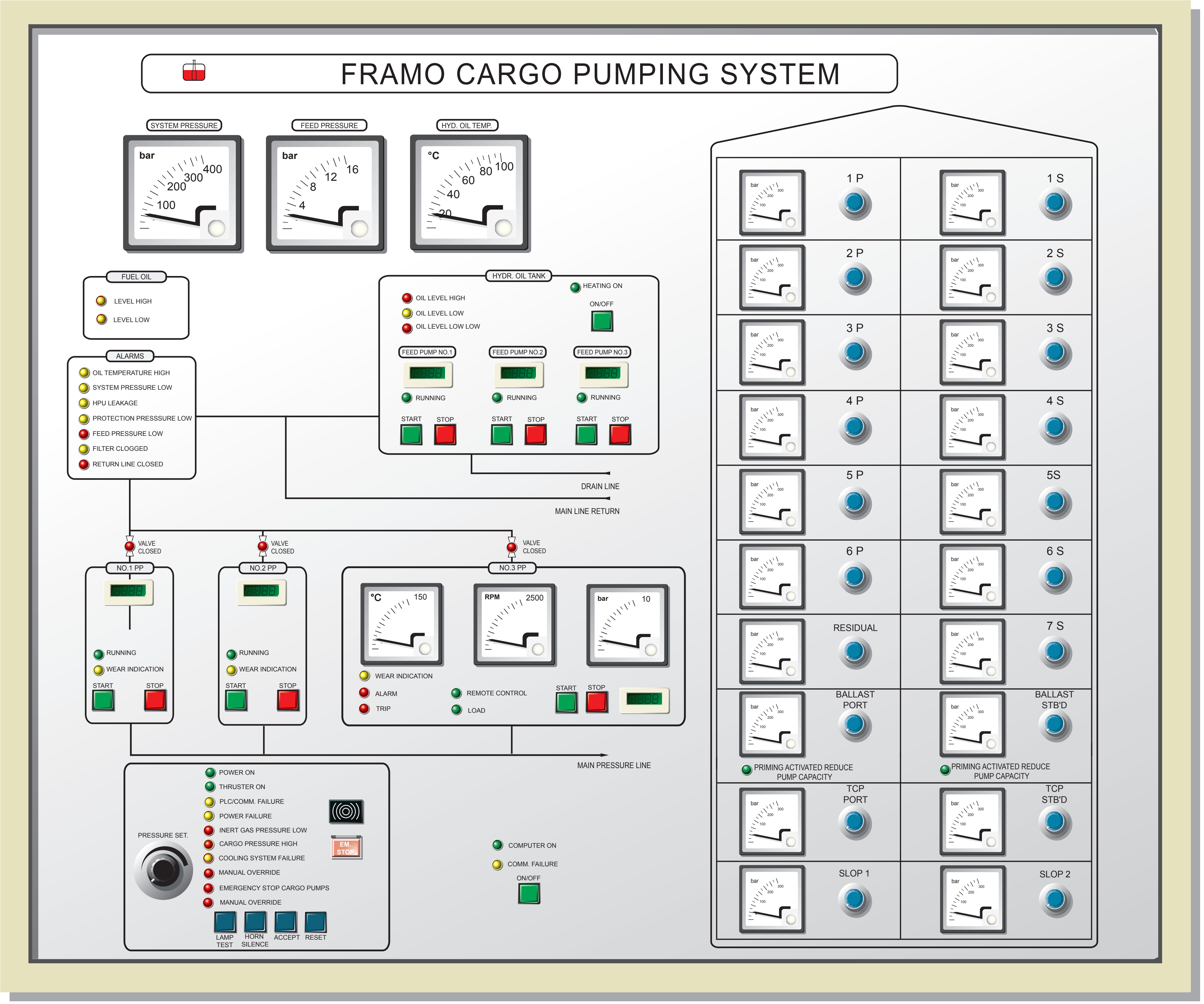
Note: Samples of oil from the hydraulic system must be taken at the intervals recommended by the oil supplier and must be sent for analysis as soon as possible after the samples have been taken.

Note: Diesel hydraulic power packs must not run unloaded for more than 15 minutes in order to avoid under-cooling. Which leads to incomplete combustion, reduced lubrication and increased maintenance.

Note: An electrically-driven pump unit must not be started more than 4 times in any 60 minute period. Two successive starts can be carried out, thereafter an interval of at least 15 minutes must be allowed between further starts.

Note: The hydraulic oil must be maintained in the temperature range of 20°C - 60°C.

Illustration 2.16.1c Main Cargo Pumps - SCC Control Console



Shutting Down

When there are no further requirements on the hydraulic power pack system either for cargo, ballast, manoeuvring or mooring operations, shut down the power packs as follows:

a) The system hydraulic pressure should be reduced to a minimum. The power packs can then be stopped. The cooling system is left in an operational state; the inlet valve is motor-driven and will thermostatically adjust itself.

b) The electrical generating capacity can be reduced as necessary.

c) One of the running feed pumps can now be stopped. If this action is not carried out by the operator, then the system will automatically stop one pump ten minutes after the power packs are stopped.

Note: The hydraulic system must always be maintained at a pressure above that which is acting on any pump unit. The maximum pressure will be the static pressure due to oil in the cargo tank and so the hydraulic system should be maintained at a pressure of about 0.4MPa.

Hydraulic Oil Samples

The sampling procedure must be followed precisely to ensure external contamination. Never take a sample by breaking a line or draining a hose.

The sample will be analysed for the following:

Solid Particulates

The presence of solids indicate system component failure and will itself cause further wear and component failure.

Viscosity

Viscosity changes generally indicate mixing with other fluids of oxidation of the oil.

Water

Presence of water can indicate a cooler defect or condensation where there is rapid cooling of the oil in the receivers. Water will also be indicated by foaming. Water will increase wear, cause corrosion, affect the oil's additive package and also clog filters.

Zinc and Phosphorus

These minerals are usually present in the oil's additive package. A decrease in the levels indicates that they are chemically reacting and the cause should be investigated.

Specific Gravity

Specific gravity is tested, as a significant change indicates a mixing with other fluids.

Flashpoint

The flashpoint is tested as a significant change indicates a mixing with other fluids.

Total Acid Number (TAN)

An increase in the TAN indicates oxidation of the oil.

Procedure for Sampling Hydraulic Oil Samples

a) Operate the system for at least 30 minutes.

b) Remove the plug from the sampling valve and drain.

c) With the sample valve still open, open the sample bottle (keeping the cap in hand to prevent contamination) and fill the sample bottle.

d) Close the sampling valve and cap the bottle immediately.

e) Complete a sample label and attach the label to the sample container.

Emergency Stop

It is important that the emergency stop is only used during an emergency and not for normal stopping of the system. There are six emergency stop positions, two at the after end of the focsle deck (port and starboard), two at the after end of the cargo manifold (port and starboard),the CCR control console and outside the port entrance to the hydraulic power pack space. The emergency stop buttons should only be activated:

- When there is damage which results in a serious leak
- When there is damage to cargo lines
- When there is critical hunting in the system
- When there is critical vibration at the power packs
- When there is the damage or the risk of damage to the bowthrust unit

System Shutdown

The following conditions result in a system shutdown by the control system:

- Low oil level in the tank
- A closed valve on the return line
- Low feed supply pressure
- Feed pump failure when running two pumps

Note: After a system shutdown the cause of the problem must be rectified and the oil system refilled if necessary with venting prior to start-up.

Manual Override

In the event of failure of the electrical control system a manual override panel is located inside the control cabinet.

Note: This panel must only be used in critical situations as serious damage can result due to incorrect operation.

Modes of Operation

There are two modes of manual operation:

Mode 1

This is engaged by means of the pushbutton and is used when malfunction of a sensor or a loose terminal causes an automatic shutdown of the hydraulic system. It overrides individual automatic shutdown functions.

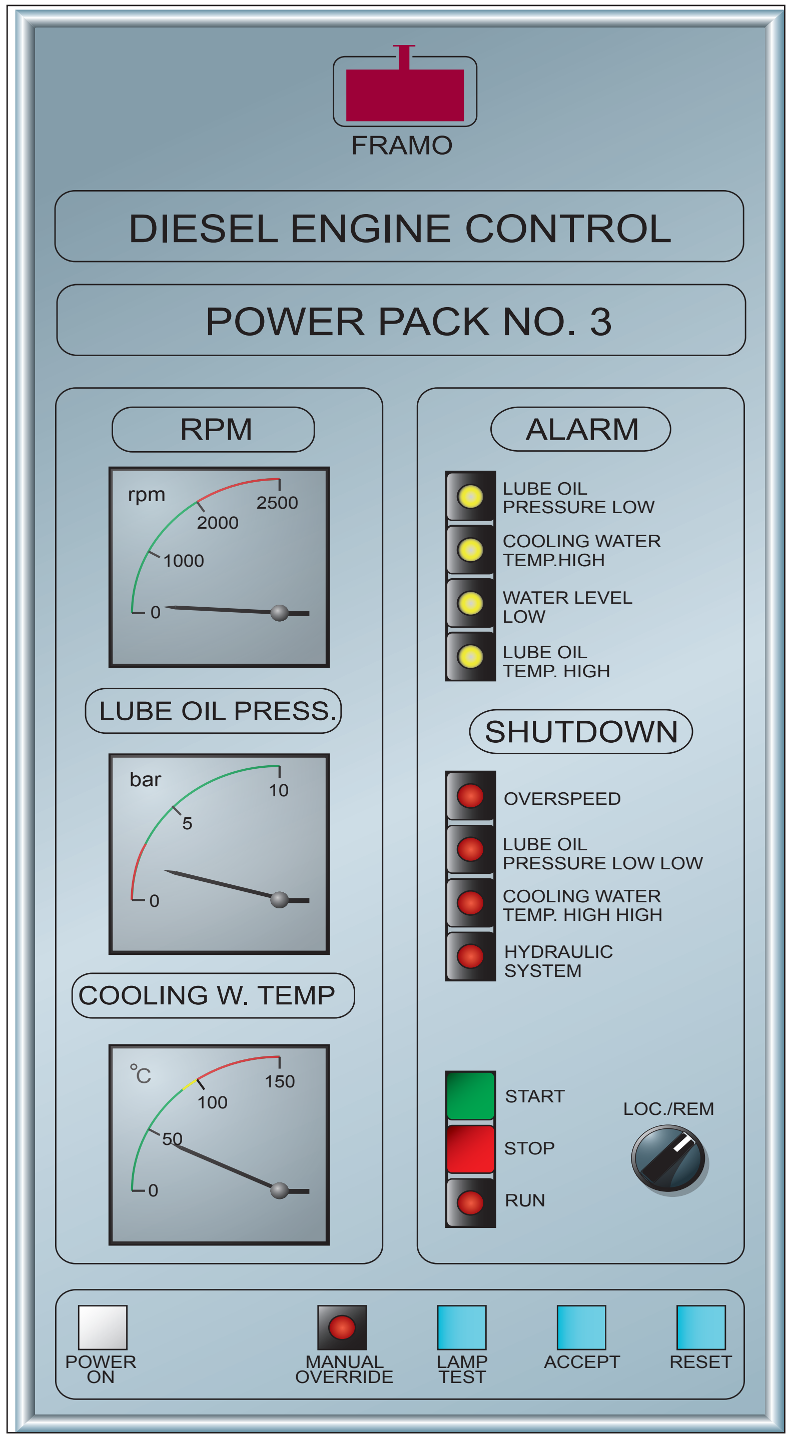
Mode 2

This is accessed by means of a key switch and may be used in the event of failure of the programmable logic controller. It overrides all shutdown functions except the manual emergency stop function.

Emergency Override Panel

This overrides the entire control system and the manual emergency stop function. It must only be used for emergency operation of pumps if mode 2 has been tried unsuccessfully. The panel is located locally at the starter panels.

Illustration 2.16.2a Diesel Engine Control Panel



2.16.2 HYDRAULIC POWER PACK DIESEL ENGINE

Manufacturer:	Frank Mohn A/S (Framo)
Model:	A4VSO500DP/30R-PPH25N00-S1068
Capacity:	819 litre/minute at 26.2MPa
Pump speed:	1,350/1,770 rpm
Diesel engine:	Cummins
Model:	KTA 19D (M1)
Rating:	485kW (650 BHP) at 1,800 rpm
Specific fuel cons:	216g/kWh at full load
No. of sets:	1

Introduction

The power pack diesel engine operates on the four-stroke cycle and is fitted with a single turbocharger with after-cooler. The engine operates on marine gas oil at all times. The engine is equipped for local or remote start using an air-driven starter motor.

The engine has its own integral lubricating system with a sump which is replenished manually as required. Oil is circulated around the engine system, including bearings (main, top and bottom end), cam boxes and turbocharger, by the crankshaft-driven lubricating oil pump. The system pressure is controlled by a pressure regulator fitted at the pump outlet. From the regulator the oil flows through the cooler elements which are circulated with water from the fresh water cooling system. After the cooler the oil flows to the filter head which is fitted with two replaceable filter elements. From the various engine parts oil drains back to the sump and the pump suction pipe.

The engine is cooled by means of an enclosed fresh water circulating system. A crankshaft-driven pump takes suction from the cooler unit and passes the water to the oil cooler, charge air after-cooler, cylinder block and cylinder covers. Return from the engine cooling system is to the coolant manifold which directs the cooling water to the thermostat block; there is a separate cooling water return from the after-cooler to the thermostat block. The thermostats direct water to the fresh water cooler or directly to the pump suction depending upon the cooling water temperature. Fresh water in the cooling system is treated to inhibit corrosion and the system may be replenished via the expansion tank which is fitted on top of the cooler. The expansion tank is fitted with a level glass and level alarms.

Fresh water from the low temperature fresh water circulating system is used to cool the fresh water circulating in the enclosed engine system, see Section 2.5.2.

Exhaust gas from the cylinders is directed to the turbocharger and then to the uptake pipe. Each cylinder cover has two exhaust valves and two air inlet valves. Air from the turbocharger passes through the charge air cooler and then to the engine air inlet manifold.

Marine gas oil is used to power the engines and this is supplied from the marine gas oil tank by gravity via quick-closing tank valve QR92 to a service tank which is kept topped-up via a float operated valve inside the service tank. The engine fuel supply system is described in Section 2.6.4.

Fuel supplied to the engine from the service tank passes through a duplex filter on its way to the fuel pump inlet. The engine-driven fuel pump supplies fuel under pressure to the fuel pressure line and this supplies individual cylinder injectors. The injector fuel drain return flows to an outlet pipe and then back to the service tank. The engine is started by means of an air-driven starter motor supplied from the general service air system.

The engine is provided with a programmable logic controller (plc) and an electric fuel control governor. These operate in conjunction with the power pack control system and provide control of the starting, running and stopping of the diesel engine.

The diesel engine has a control panel which links the diesel engine with the hydraulic system control panel. The diesel control panel provides monitoring facilities for the engine in addition to the start and stop switches and the location selector. The local control panel has the following alarms:

- Low LO pressure
- Cooling water high temperature
- Low water level
- LO temperature high

Additionally, the panel has the following shutdowns:

- Engine overspeed
- LO pressure low low
- Cooling water temperature high high
- Hydraulic system failure

At the local panel for the engine there is a mode selection switch for either LOCAL or REMOTE starting. Local starting is by means of the START pushbutton on the control panel. Remote operation is by means of the power pack control system located in the CCR. For normal operations the diesel engine is set for remote operation, provided that the engine and pump unit are available for operation.

Procedure for Starting a Hydraulic Power Pack Engine

a) Check that the lubrication systems has the correct level of oil in the sump, top-up as required with the correct grade of oil.

b) Open the cooling water inlet and outlet valves for the hydraulic power pack engine.

c) Ensure that the diesel oil isolating valve for the engine is open.

d) Ensure that the outlet valve from the service tank to the engine is open and that the run-down topping-up line from the marine gas oil tank is open, quick-closing valve QR92.

Before the engine can be started locally, two of the hydraulic feed pumps must be running. In normal operation the feed pumps are set for remote operation, therefore it will be necessary to switch one of the feed pumps to local control. Manually starting the additional feed pump will remove the control system blocking signal which will then allow a diesel engine to be started locally.

e) Press the START pushbutton at the local panel. The engine will be turned over by the starter motor and fire on fuel. The engine will accelerate to the preset low speed of 1,350 rpm and remain there for about 150 seconds, during this period the green RUN lamp will flash. After that stabilising period the engine speed will increase to the normal operating speed of 1,770 rpm, at this point the green RUN lamp will illuminate steadily. The engine may then be loaded via the power pack system which puts stroke on the variable delivery hydraulic pump.

If the diesel engine is to be started from the Framo operating panel in the CCR, the local panel mode selection switch must be set to the REM position, additionally, the feed pumps should also be set for remote operation. The engine run-up sequence is identical to manual operation. When the power unit is ready for operation the REMOTE CON and LOAD indication lamps will be illuminated on the CCR control panel.

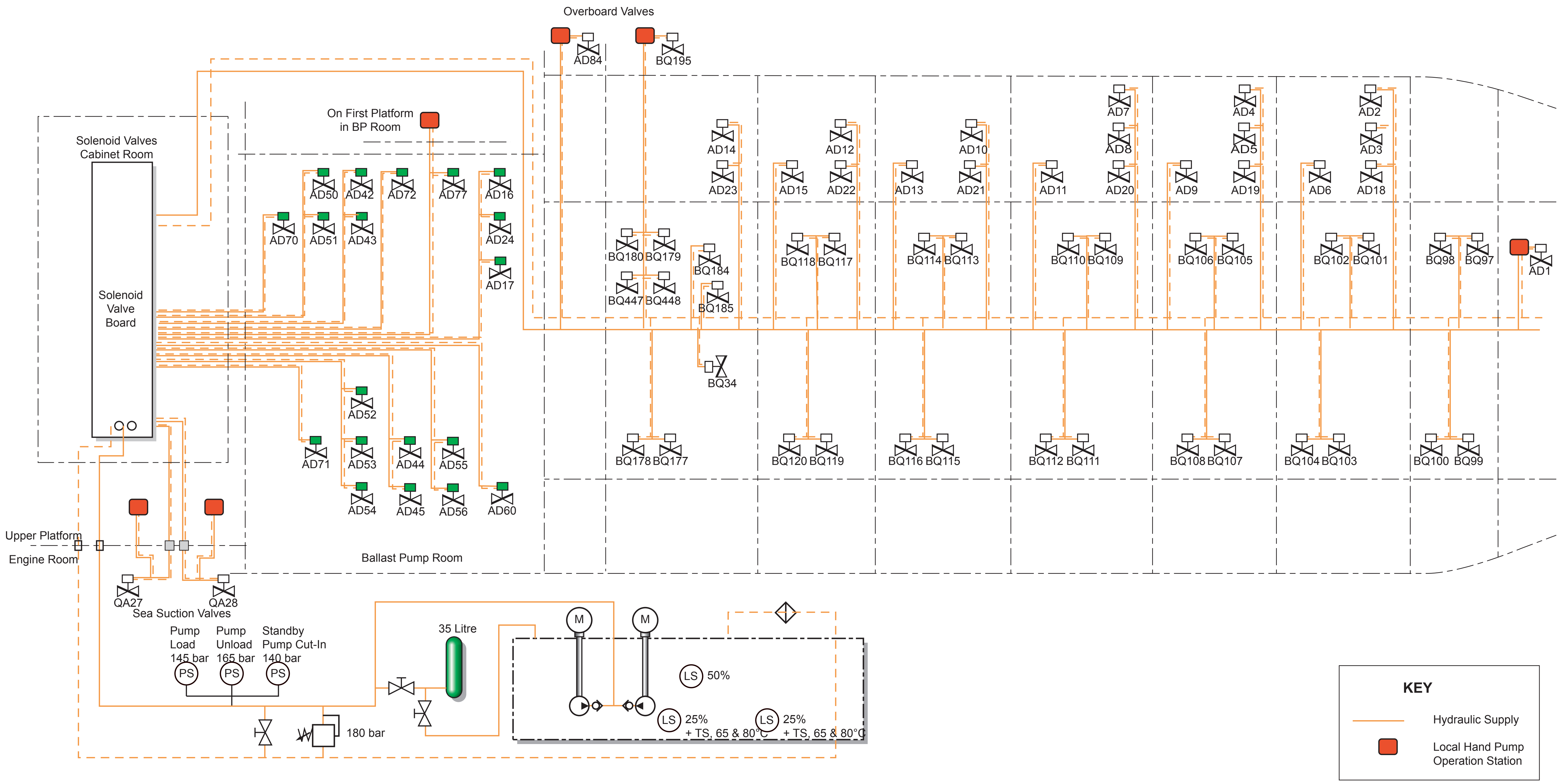
Procedure for Stopping the Hydraulic Power Pack Engine

a) Press the STOP pushbutton at the remote control panel.

The engine speed will decrease to the preset low speed of 1,350 rpm and remain there for about 180 seconds whilst the engine system stabilises. The hydraulic pump is disengaged 10 seconds after the STOP pushbutton is pressed. After the 180 second delay the engine is stopped. If the STOP pushbutton is pressed at the local control panel, the diesel engine is stopped immediately.

b) Check the lubrication oil level and top-up as necessary

Illustration 2.16.3a Hydraulic Valve Remote Control System



2.16.3 HYDRAULIC VALVE REMOTE CONTROL SYSTEM

Manufacturer:	Danfoss Marine Systems A/S
Model:	SPU 100 FAP
Pump:	2 x Bosch P3 gear pump 5 litres/min
Oil tank capacity:	100 litres
Accumulator capacity:	35 litres
Operating pressure:	13.5MPa constant pressure system, (pump operating pressure 14.5MPa to 16.5MPa, standby pump cut-in 14.0MPa)
Low pressure alarm:	13.0MPa
Low level alarm:	50% capacity, low low 25% (trip)
High temperature alarm:	65°C, very high 85°C

Introduction

The main cargo oil and ballast valves are operated from the IPH screen display, CARGO CONTROL or BALLAST CONTROL on the cargo control console in the SCC. Selecting the valve icon on the appropriate screen will bring up an operating faceplate which allows the operator to open or close a valve, proportional type valves have a slider bar and incremental buttons. A figure can be typed in the % bar if the keyboard is used, although the keyboard is normally located below the worktop and not very accessible for normal operations. The valves when operated from the faceplate control the solenoid valves contained in the solenoid valve board situated in the solenoid valve room. The solenoid valves direct hydraulic pressure, generated by the hydraulic power pack, to open or close the hydraulic valves.

Indication of the degree of opening of the intermediate opening valves is given on the screen display as a % figure.

Other remote valves are of the full open and full closed type. An indication of the valves closed status is when the valve icon is indicated in blue and at a right angle to the line flow. During the transition stage the valve colour will change to yellow. When the valve reaches its fully open position the colour will change to green.

Valve actuators are of the hydraulic cylindrical double-acting type and are mounted directly on the valve.

One solenoid valve board is situated in the solenoid valve room. It supplies the pump room valves and the valves situated in the cargo tanks and bottom void for the ballast tanks.

The engine room ship side sea suction valves QA27 and QA28 are also operated from the cargo and ballast valve system hydraulic power pack.

Hydraulic Power Pack

The valve operating hydraulic power pack is situated in the engine room in the same compartment as the cargo, ballast pump hydraulic system pumps. It consists of two sets of electric-driven hydraulic pumps and a single 20 litre accumulator supplying a constant pressure system.

Each hydraulic pump is capable of actuating two of the largest valves simultaneously from fully open to fully closed or vice versa within 1 minute.

In the event of power pack failure the accumulators will allow closing of two of the largest valves within 1 minute.

Starting and stopping of the hydraulic pumps can be done at the power pack side or from the IPH HYDRAULIC SYSTEM screen display when the pumps are set to REMOTE operation. The pressure is controlled by means of a pressure switch which controls a solenoid valve, this valve returns oil to the tank when the maximum operating pressure is reached. The hydraulic pumps supply hydraulic oil to the solenoid valve board.

Two sets of portable hydraulic handpump units are provided for use in an emergency. These can be connected into the supply lines to the valve actuators in the solenoid valve cabinets.

Hydraulic pipes are led directly to each valve from the solenoid valve board.

Procedure for the Operation of the Cargo Valve Hydraulic Power Pack

a) Ensure that the hydraulic tank is filled with the correct grade of oil and at the correct level.

b) Ensure that the pump suction filters are clean.

c) Ensure the line filters to the solenoid valve filters are clean.

d) Check that the accumulator is charged with nitrogen gas. If necessary, recharge the accumulator using the accompanying nitrogen gas bottle and reducing valve.

e) Open the accumulator isolating valve.

f) Switch one pump to LOCAL control, then operate the RUN switch to start the pump.

g) Check that the pressure control is satisfactory, when the pump stops change it over to REMOTE and STANDBY operation.

h) Put the other pump on REMOTE and STANDBY.

i) Open the outlet valve from the power pack.

j) Open the pressure and return outlet valves on all the solenoid valve boxes.

Emergency Handpumps

Two portable handpumps are supplied, and when not in use are stowed in the cargo gear locker on the starboard side, forward of the cargo manifold. The hydraulic oil reservoirs of these pumps should be kept topped-up to ensure that they are ready for use when required.

Operation

a) Open the solenoid valve box, which controls the valve to be operated.

b) Shut the pressure valve for the solenoid valve box.

c) Shut the return valve for the solenoid valve box.

WARNING

Failure to close the above valves could result in oil flowing into the handpump reservoir. This could result in possible injury to the operator.

d) Remove the plugs from the quick-connect couplings.

e) Open the handpump vent to avoid over-pressurising the reservoir.

f) Connect the hydraulic hoses from the handpump, noting the pressure and return markings on the couplings.

g) Open the isolating valves on the connections.

h) Shut the vent on the handpump reservoir.

i) Select open or close and operate the pump.

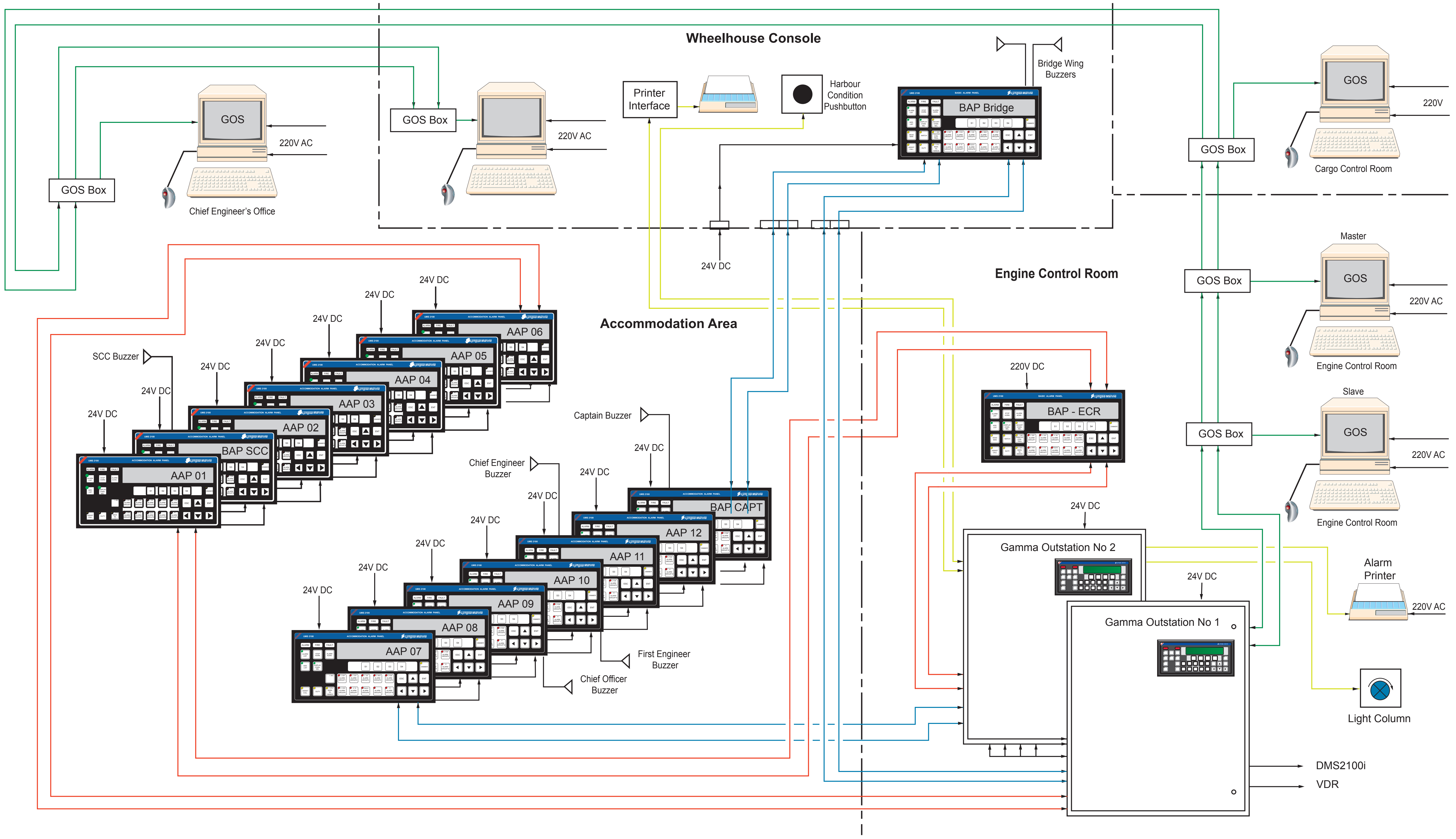
Note: The solenoid valves can be operated manually by pushing the buttons protruding through the solenoid coils.

WARNING

Use protective clothing and goggles when operating the portable hydraulic handpumps.

SECTION 3: MAIN MACHINERY MONITORING SYSTEM

Illustration 3.1.1a Integrated Management System Layout



3.1 MAIN MACHINERY CONTROL AND MONITORING SYSTEM

3.1.1 MACHINERY CONTROL AND ALARM SYSTEM

Manufacturer: Lyngsø Marine A/S

Main System Components

UCS 2100	Universal Alarm and Control System
UMS 2100	Alarm, Monitoring and Control System
DPS 2100	Main Engine Remote Safety System
DMS 2100i	Bridge Manoeuvring System

The main engine remote control and safety system and the bridge manoeuvring system are described in Section 2.1 which deals with main engine control and manoeuvring. The engine safety system operates in conjunction with the universal alarm and control system. Control of the electrical generators and power distribution system is described in Section 2.13.

The layout of the UCS system hardware is shown above in illustration 3.1.1a.

The UCS 2100 Alarm and Control System

The ship's main technical equipment, systems and machinery are continuously and automatically supervised by the UCS2100 alarm, monitoring and control system. The system provides various levels of alarm, control and monitoring facilities for the systems and equipment supervised by the UCS2100 system.

The system consists of a network of outstations and Graphic Operator Stations (GOS), enabling the operators to monitor and supervise the majority of the ship's machinery from a single operator station. The GOS incorporates the extended alarm display (EAD).

The GOS consist of a personal computer (PC), with a monitor, keyboard and trackball unit. The computer uses the 'Stella Windows' graphic environment to handle the man-machinery interface (MMI). Control operations within the UCS2100 are handled by Gamma computers, these handle signal acquisition, alarm and automatic control functions.

Information from the UCS2100 is displayed on graphics diagrams at the GOS. The GOS display is divided into three parts: a menu bar, a header, and a selectable diagram or mimic, eg, a control and overview system picture or an alarm list. The menu bar and the header with status information are always visible.

The header constantly displays the most essential information from the alarms system such as:

- The oldest unacknowledged alarm
- The number of present and unacknowledged alarms
- The number of present cut-outs
- The actual watch station, duty officer and back-up officer
- The time and date

The lower part of the GOS screen displays a graphic mimic diagram which deals with the control and monitoring information.

Picture Hierarchy on the Graphic Operator Station

The alarm groups of the UCS2100 are placed in a picture hierarchy. The group overview picture (F3) presents labels to all group alarms. Any of the alarm groups can be selected by pointing at the square located to the left of the picture text string and pressing the activation pushbutton. The square flashes in the case of an unacknowledged alarm on the control picture, giving the operator a fast and safe overview of the actual situation.

The alarm group overview picture may be selected by pressing the function key (F3) on the keyboard or from the short-cuts pull-down menu on the command bar in the upper edge of the screen.

All base functions are available from the task-bar to the right of the screen which displays square box headers for each function and its respective function key short-cut displayed on the square, or from the short-cuts pull-down menu on the command bar in the upper edge of the screen.

Integrated Alarm System

In the alarm list on the GOS it is possible to obtain a common overview of all present machinery alarms, manual, or automatic cut-outs and system failures in the control system. Alarm acknowledgement is carried out directly from the ACKNOWLEDGE function key (F12) on the GOS keyboard at the alarm watch station. Before acknowledgement the alarm horn must be silenced. This is done from the STOP HORN function key (F11) on the GOS keyboard.

Alarm Handling from the Graphic Operator Station

Alarm acknowledgements may be carried out from the location of the alarm watch station.

The alarm horn is silenced by pressing the STOP HORN function key (F11) on the GOS keyboard. The oldest unacknowledged alarm is always displayed in the header. Acknowledgement of this unacknowledged alarm can be made by pressing the ACKNOWLEDGE function key (F12) on the GOS keyboard.

Acknowledgement of any alarm may also be made from the corresponding control picture where the alarm indication is displayed. The cursor arrow is moved to the flashing red symbol and the trackball's activate pushbutton is pressed. A pop-up menu displays the alarm identifier and the ACKNOWLEDGE command which is activated by pressing the trackball pushbutton.

From the alarm list, an acknowledgement is performed by pointing the cursor at the unacknowledged alarm(s) marked with red text with the trackball and clicking.

Data Collection and Data Logging

Analogue and binary parameters may be logged on the GOS hard disk for later data analysis. All condition changes of parameters and values, selected to be logged, are stored for a period covering the previous 24 hours (maximum 96 hours). Compressed one-minute mean-values (optional minimum, maximum, total, actual value or number of events) are stored for a period of 30 days.

The GOS offers the following facilities for data analysis; trend display, data export, and time-related reports can be generated.

Reports Facilities

The facilities of the GOS include the following standard reports:

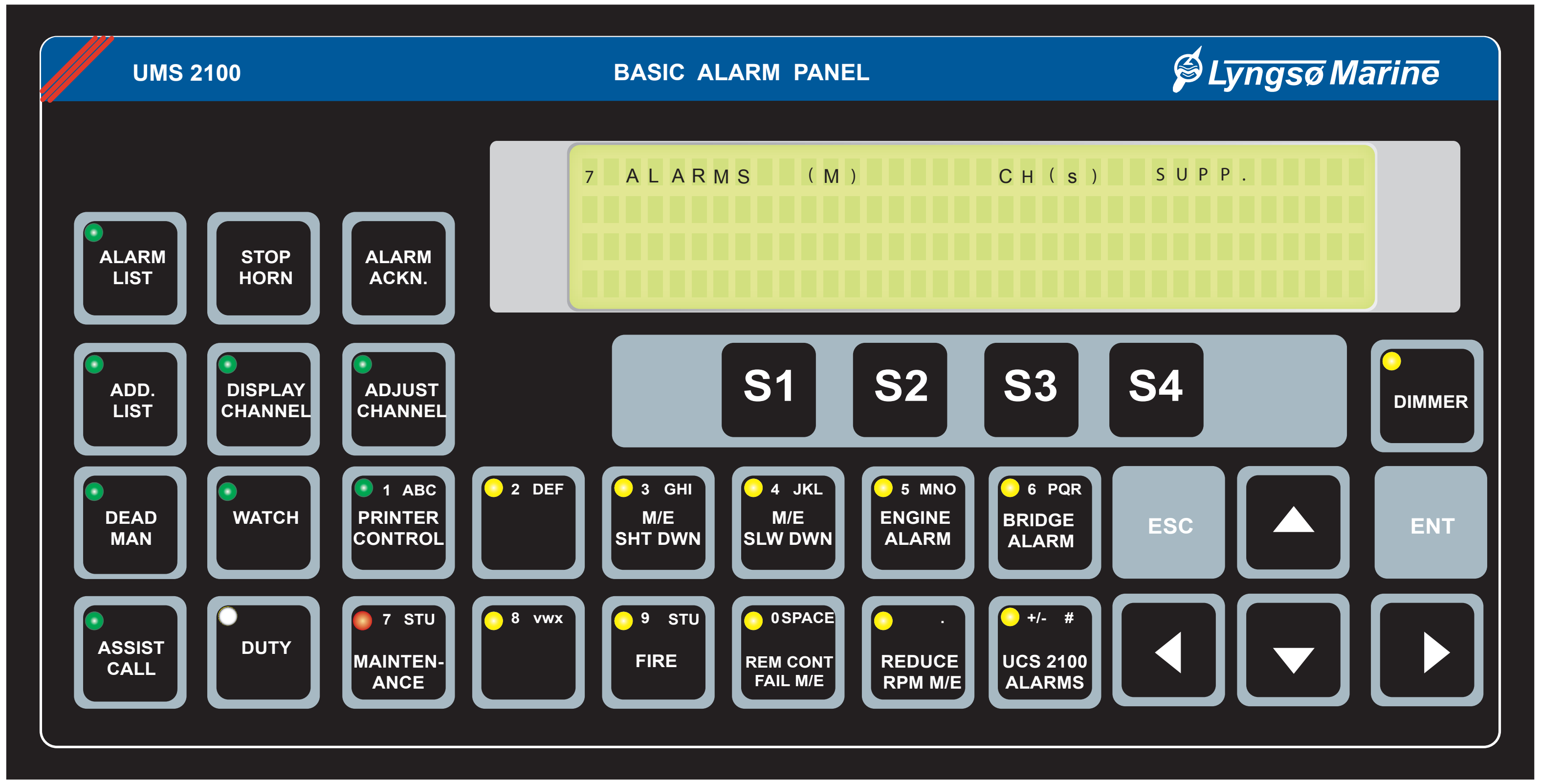
- Daily reports
- Monthly reports
- Yearly reports

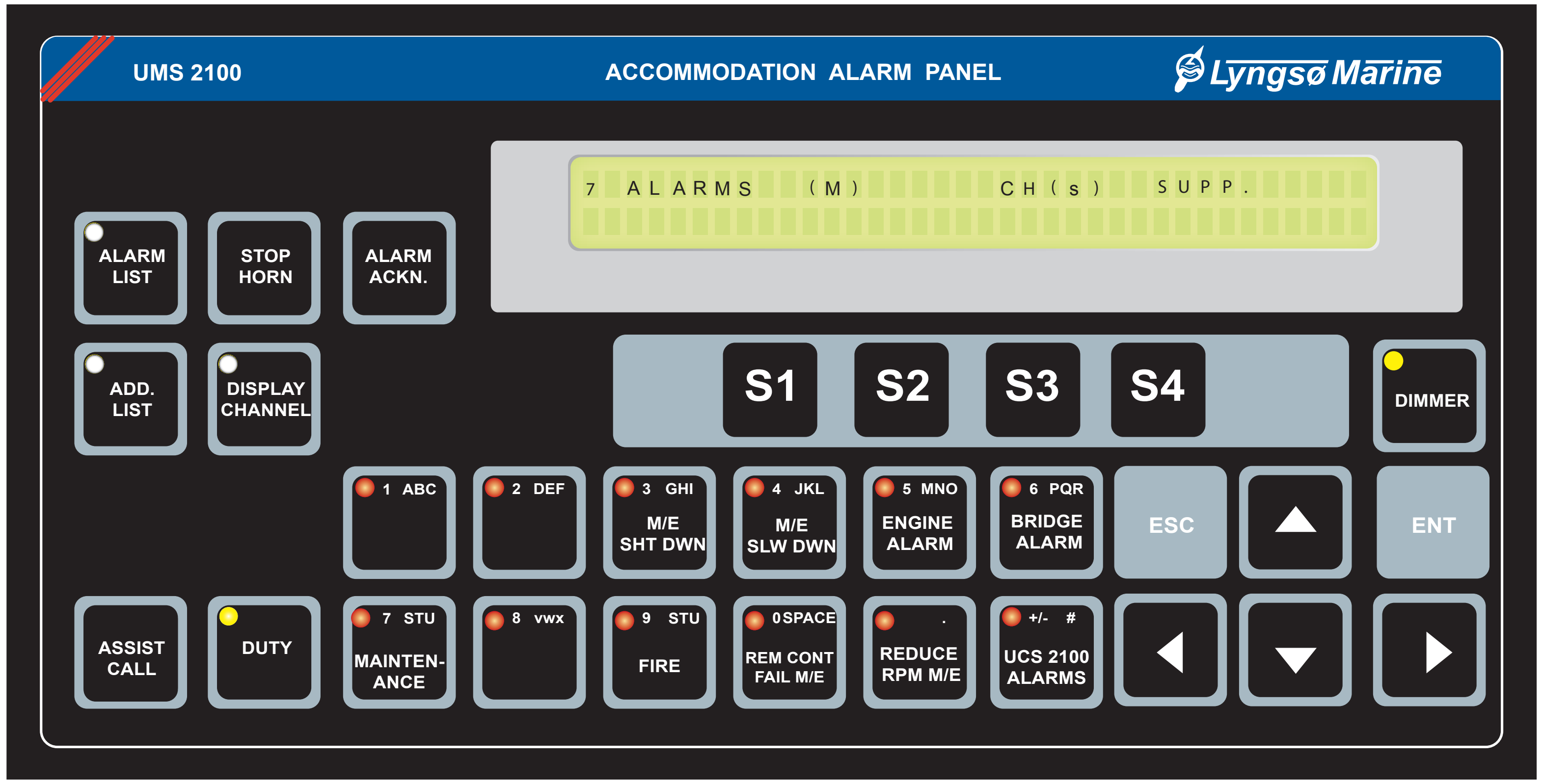
The reports are based on the compressed data from the log. To generate a daily report, the compressed one-minute data is compressed further to obtain values for each hour.

Reports are made as either detailed reports or as overview (compressed) reports. Detailed reports show both the 60 values for each hour and the totals for each day. The overview report shows the total values for the day only. The hour values from the daily reports are then used for generation of the monthly report, and the values from the monthly report are used for the yearly report. Reports may be printed out automatically at a specified time or upon request from the operator.

Other reports may be user configured. Data may also be exported in DIF file format, compatible with a number of standard PC applications for further analysis or reporting.

Illustration 3.1.1b Basic and Accommodation Alarm Control Panels





Trend Display

One to six graphs for supervised parameters may be displayed in the same trend display with individual colour and measuring scale. The individual colour is used to separate the ID number, the measuring scale, the trend curve and the digit value for each measurement. A zoom function is available by selecting the new area by means of the trackball.

Trend displays that are used frequently may be accessed directly from the Trend Log button (or F7) or again from the short-cut menu. Trend curves showing values for the previous 24 hours (maximum 4 days) or part of that period, are based upon the continuously logged data. A Trend display for a period exceeding the last 24 hours (maximum 4 days) is based upon the compressed values.

Parameters, which are not predefined for logging, may be displayed during on-line data collection, initiated on the request of the operator.

Trending is described in detail in Section 3.1.4, Trending.

Event Log

Main events such as running feedback signals from motors and engines can be automatically logged on the alarm and event log printer, giving a complete machinery log.

All events, such as commands and feedback changes, may also be logged on the GOS hard disk. The log is accessible on the GOS and may be printed on a printer, either on request as a report or continuously.

The commands are only included in the log on the specific GOS from which the command is actually activated.

Printers and Screen Dumps

There are two system printers, one located in the ECR, the other on the bridge.

UMS2100 Main Components

The UMS2100 system consists of a number of networked components as follows:

- PLC Outstations
- Basic Alarm Panels (BAP)
- Accommodation Alarm Panels (AAP)
- Extended Alarm Displays (EAD)
- Alarm/Log printer

The outstations handle the functions of alarm detection and control of the alarm panels (basic alarm panels and accommodation alarm panels).

The Basic Alarm Panels (BAP) are installed on the bridge, in the Captain's cabin, the ship's control centre (SCC) and in the engine control room (ECR). The BAP provides the operator with all necessary facilities for use of the alarm system including alarm acknowledge, duty deck and engineer officer selection, control of printer etc.

The Accommodation Alarm Panels (AAP) are installed in the cabins of the deck and engineer officers and in public rooms such as the saloon, gymnasium and duty mess. The AAP is used for alarm signalling and to call officers in the accommodation areas.

The Extended Alarm Display (EAD) is used together with the BAP to extend the amount of information to be displayed simultaneously. The EAD is an integrated part of the Graphics Operator Station (GOS).

The STELLA network interconnects the outstations and is mainly used for the interchange of information between the outstations and the GOS.

The RTN 2100 panel network connects the outstations and the alarm panels.

Unattended Machinery Spaces Alarm System

This system provides monitoring of sensors and alarms at a central panel in the ECR and at alarm panels throughout the ship that allow remote alarm indication at the bridge, cabins, public rooms, etc. A printer that logs all the alarms and events is also connected to the system.

When the system is selected for unmanned machinery space operation, an alarm will cause an audible alarm in the cabin of the engineer who has been selected on duty, as well as in the public rooms. To acknowledge the alarm, the duty engineer must go to the engine control room.

The extended alarm display (EAD) allows for the presentation of more information, giving the operator an improved overview of the system from a GOS.

UMS2100 System Introduction

The purpose of the alarm and monitoring system is to collect the information concerning the operational safety of machinery and equipment on board the ship and monitor alarm situations. After an alarm is raised, the system must announce this to the duty personnel. The system must carry out the following tasks:

- Acquisition of supervision data, ie, sensor values
- Detection of alarm states, ie, illegal values or states
- Announcement of detected alarms
- Supervision of engineer response
- Logging of alarms and events

The alarm system gathers data by the use of its input channels which are connected to the various sensors. The collected data is passed on to the monitoring channels which interpret the data and convert it into information.

When the UMS2100 detects an alarm it is announced both by a visual signal and an audible signal and on the various types of text displays.

In response to the alarm announcement, the duty engineer is required to silence the buzzer/horn and acknowledge the alarm to confirm that they are aware of the occurrence.

If the engineer does not respond to the alarm announcement within an preset time (usually 5 minutes, but adjustable), the UMS2100 system will announce the alarm in all possible locations to make sure that the alarm is noticed and attended to.

An alarm has four states:

- Normal
- Present but not acknowledged
- Normal and not acknowledged
- Present and acknowledged

The alarm announcement refers to the announcement of a new alarm, ie, an alarm which has changed from being not present to being present but not acknowledged. An alarm announcement includes the use of the buzzer and the alarm LED on the alarm panels and additional external horns and lamps are used.

The alarms are always announced in at least one location (the watch station), and must always be acknowledged from there within a preset time, otherwise an alarm will be raised to call other engineers.

The watch station is the centre of the alarm system and from here the alarms must be acknowledged. Except for the use of the manual cut-outs, the alarm announcement cannot be suppressed on the watch station regardless of the UMS2100 operation mode.

Other locations at which an alarm is announced depends on whether or not the watch station is attended or if a duty engineer has been selected.

Alarm Groups

An alarm will be presented to the watchkeeping engineer only as a general alarm. An alarm group LED which will enable the engineer to determine the nature of the alarm quickly, eg, if it comes from the main engine, pumps, power plant, fire, etc.

The UMS2100 system is able to handle up to 100 alarm groups and each individual alarm may be assigned a maximum of four of these groups at a time.

While the alarm LED is active at those panels where alarms are directed, the alarm group LEDs are never suspended. These will always display the status of the group to which they are assigned.

The alarm groups feature the following states:

- No alarms and no unacknowledged alarms in the group.
- Alarm in the group: Includes ‘signal validity failure’ (sensor failure)
- Machinery alarm in the group: Excludes ‘signal validity failure’
- Unacknowledged alarms in the group

The basic alarm panels (BAP) and the accommodation alarm panels (AAP) contain 10 LEDs for indication of up to 10 of the 100 alarm groups independently and individually assigned for the display of the following information:

- No alarm in the group: LED off
- Alarm in the group, all alarms acknowledged: LED on
- Unacknowledged alarm in group: LED flashing

The alarm groups may also be shown on the Extended Alarm Display(s).

The Bridge and Accommodation Alarm System

In addition to the individual alarm announcements and the group alarms, the UMS2100 will advise duty engineers of the occurrence of new alarms, making it possible to operate the vessel with unmanned machinery spaces. This takes place via the AAPs located in the cabins and public rooms as well as at the BAPs located at the wheelhouse, Master’s cabin, ECR and SCC.

Duty Engineer Watch System

At the raising of a new alarm, the UMS2100 makes a selective, automatic call (duty call) in the accommodation area. Selective means that it is possible to select one engineer as the duty engineer who will be able to move around the ship’s accommodation.

When a duty engineer is selected, the AAPs of the public rooms also give an alert, as the alarms occur. In response to a duty call, the duty engineer must perform the same actions as for a normal alarm announcement; firstly silence the horn/buzzer and then acknowledge the alarm at the watch station.

The duty selection itself must also be acknowledged, this is carried out either from the cabin of the duty engineer or in the engine control room (ECR) when making the initial selection. If the duty call is acknowledged from the cabin, the horn/buzzers in the accommodation area and on the bridge are silenced, but the horn in the engine room and the alarms remain active until accepted at the watch station in the ECR.

The horn/buzzer may be stopped locally in the public rooms, this will not be interpreted as an acknowledgement of the duty call, and the cabin alarm remains active until accepted locally or from the watch station.

In the event that an alarm has not been acknowledged within a predetermined time (typically 5 minutes), an ALL ENGINEERS CALL will be announced on all of the panels. If the buzzers and horns are activated due to an ALL ENGINEERS CALL these can only be silenced by the acknowledgement of all alarms at the watch station in the ECR.

Any of the AAPs located in the cabins of the duty officers may function in a similar manner to the panels in the public rooms. This means that a cabin panel which is not selected on duty, may still indicate visually any alarm as it occurs.

Selection of Duty Engineer/Back-Up Engineer

One engineer can be selected as duty engineer at a time. When selected on duty he is called in his cabin immediately when an alarm occurs in the alarm system.

The selection of a duty engineer and/or a back-up engineer is done from a predefined basic alarm panel (often the watch station). When selecting a duty engineer the accommodation alarm panel in the engineer’s cabin will give a steady sound which must be silenced/acknowledged on the panel. Alternatively, the UMS2100 system is able to be configured in such a manner that the duty engineer selection may be acknowledged from the panel from where the selection was initiated.

DPS2100 Main Engine Remote Safety System

Manufacturer: Lyngsø Marine A/S
Model: DPS2100

The engine safety system (DPS2100) is installed in parallel with the bridge manoeuvring system (DMS2100i), but is designed to monitor and protect the propulsion plant independently of the DMS. The DPS2100 protects the plant against inadmissible operating states and an alarm is not created until one of the limit values is exceeded. All limits are set to values which are below those at which the engine might be endangered. The alarms are visually indicated on the assigned operating panel and audibly by means of a buzzer. The DPS2100 operating panel is in the ECR and is connected to the DMS system within the PCS cabinet.

Limit values and delay times, are stored as parameters, the values of which are set to suit the requirements of the engine. These settings are recorded in the internal parameter list of the program and are stored in the DMZ module.

Note: Parameter changes must only be made by authorised personnel.

This system is described in more detail in Section 2.1.3, Main Machinery Safety System.

3.1.2 OPERATOR STATIONS

UCS system general operator stations (GOS) are fitted at the following locations:

- Chief Engineer's office
- Bridge
- Ship's control centre
- Engine control room (x2)

At each station is a visual display unit (VDU), an operator/keyboard unit and a trackball unit. The GOS is also the interface for alarm handling in the UCS2100 system.

The GOS display is based on a Windows environment, allowing the screen to be divided into several areas (windows), the composition of the visible windows is selected by the operator as required.

In addition to the main windows, the system makes use of dialogue-boxes which are used for both presenting information to the user as well as enabling the user to control the system.

Operator Station Components

The GOS consists of a personal computer (PC) either built into the console or a desktop unit. The screen operates in graphic mode at all times and graphic and text information may be presented simultaneously.

The keyboard is a standard PC keyboard. In addition to the letter and number keys, the keyboard is also equipped with 12 function keys, several of which are used for dedicated purposes in connection with the GOS operation.

Display Layout

The display is divided into two main parts; a header window and a working area window. The header window is always present and displays the header diagram for the actual operator station.

The working area window displays selected graphic system diagrams or lists which are used to supervise the machinery components, eg, alarm lists or mimic diagrams. On starting, the working area window will display the main menu diagram from which is used to gain access to the other diagrams and lists in the system.

In addition to the two main windows there is a caption bar at the top of the screen displaying the date and time, and a menu bar from where various functions of the GOS can be controlled.

Caption:	In the caption, the date and time is displayed, date and time may be displayed as UTC time or as local time. Additionally, it is possible to indicate the type of time, UTC, LT (local time) or actual time zone.
Menu Bar:	In the menu bar various drop-down menus can be activated. These menus are used to operate some of the functions of the GOS.
Header Window:	The header window contains the header diagram.

The header diagram displays important information from the alarm system related to the GOS, such as number of alarms, number of unacknowledged alarms, watch location and duty officer and most important the oldest unacknowledged alarm.

The header diagram also includes short-cuts (selection buttons) to some often used functions, eg, the Main Menu Diagram, the Alarm List, Stop Horn and Acknowledge.

Working Area:	The working area can contain many different lists or diagrams, the most important are listed below:
Lists:	Alarm list Alarm group Failure lists (sensor fail, device fail) Suppression lists (cut-out, simulated)
Diagrams:	Function block diagram Graph diagram Bar graph diagram

Operation

A diagram on the screen consists of a static background drawing with some dynamic objects to indicate alarms and measurements. Some of these dynamic objects are also active areas from which an action may be carried out, this action could be to open another diagram or to acknowledge an alarm, for example.

On the screen is a pointing device, shown as an arrow, this pointing arrow is called the cursor. The cursor is moved around the screen with the trackball. The cursor is used for pointing out active areas in the screen diagrams. The cursor must be placed inside the active area in order to open a new diagram. The active area is indicated by a frame when the cursor is inside the area.

The trackball is used to move the cursor around the screen and an area is selected by pressing one of the trackball buttons. If the active area is an 'open a new diagram' area, the relevant diagram will be opened by a left click.

If the active area is indicating an alarm, a right click will open alarm menu, and if it is unacknowledged, a left click on the 'ACKNOWLEDGE' text will acknowledge the alarm, or a left click on the text 'DISPLAY CHANNEL' will open a dialogue with detailed information of this alarm.

Description of Lists and Diagrams

Header Diagram

The header diagram contains important information for the alarm system/ systems to which this GOS has access. The UCS2100 system can have from 1 to 4 alarm systems, such as one system for machinery alarms and another for cargo system alarms. Each GOS may have access to one or more of these separate alarm systems.

Besides alarm system information, the header also includes short-cuts to some of the most used diagrams. The short-cuts are shown as Windows buttons, a left click on the button will open the relevant diagram.

The header also includes a button for 'STOP HORN', a red symbol indicates that the horn is active, a left click on the button will silence the horn.

The header also includes a button for 'ACKNOWLEDGE', a red symbol indicates that an unacknowledged alarm exists. A left click on the button will acknowledge the oldest unacknowledged alarm, the alarm text for this alarm is also shown in the bottom line of the header. It is only possible to acknowledge alarms which are visible on the screen in view.

The horn and acknowledge buttons will only function and indicate an active state if the GOS is the actual 'on watch' station for the alarm system of the new alarm.

Group Overview Diagram

The group overview is the overview diagram at the top of the diagram hierarchy, from this diagram there is a route to all other mimic diagrams in the system. It is possible to open mimic diagrams and alarm groups directly from the main menu diagram or to open other overview diagrams for smaller parts of the system.

Each alarm group, mimic diagram and sub-overview diagram is indicated by an active area in the group overview diagram. To open the matching diagram, a left click is made on the square or on the text of the active area. If there is an unacknowledged alarm in the matching diagram, the square will flash red. If there is acknowledged alarms and no unacknowledged alarms in the matching diagram, the square will turn to steady red.

Alarm List

The alarm list is the list of all standing alarms, both acknowledged and unacknowledged, in the alarm system. One alarm occupies one line in the alarm list. The alarms are sorted by starting time, so the oldest alarm is at the top and the newest alarm is at the bottom of the list. If the alarm is more than 24 hours old, the starting time is exchanged for the starting date.

The alarm list is able to display all alarms defined in the system. Normally up to 20 alarm lines may be shown on the screen, if the actual number of alarms is greater than this it is indicated in the bottom of the list. The rest of the alarms are seen by scrolling in the alarm list using the PAGE UP and PAGE DOWN keys or by making a left click on one of the scroll buttons.

The colour of the text in the alarm list is normally white on a blue background, except for the 'STATE' text. The colour of the state text is controlled by the priority of the alarm, for priority 1 the colour is red, for priority 2 the colour is magenta and for priority 3 the colour is yellow. The state text flashes for as long as the alarm remains unacknowledged.

A right click on an alarm line will bring up a small menu with two texts, 'DISPLAY CHANNEL' and 'ACKNOWLEDGE'.

The 'ACKNOWLEDGE' text is disabled (not possible to select - shown in grey) if the alarm is acknowledged, if the horn is not silenced or if this GOS does not have the right to acknowledge the alarm. If the 'ACKNOWLEDGE text is enabled (possible to use - shown in black) the alarm can be acknowledged by making a left click on the 'ACKNOWLEDGE' text.

A left click on the 'DISPLAY CHANNEL' text will open the display channel diagram for this alarm channel. The display channel diagram shows detailed information for the alarm channel set-up, such as alarm delay, alarm limits, connection terminals, cut-out and simulation status; some aspects of the set-up may also be changed from the display channel diagram, eg, delays and limits.

Different States of an Alarm

1. **New Unacknowledged Alarm**

   A new unacknowledged alarm is indicated with the time the alarm started. The alarm may be acknowledged by left clicking on the button showing three exclamation marks; this also acknowledges all other unacknowledged alarms visible in the current page of the alarm list. It is not possible to acknowledge a alarms whilst the horn is still sounding and this must be silenced first.

2. **New Unacknowledged Alarm - Selected**

   A new unacknowledged alarm which has been selected by a left click somewhere on the alarm identification line is indicated by a blue background colour. A selected alarm is acknowledged by left clicking on the button showing one exclamation mark; this will only accept the selected alarm. Alarms may not be acknowledged whilst the horn is sounding.

3. **Unacknowledged Alarm - Returned to Normal**

   An unacknowledged alarm that has turned 'normal' again is indicated by removal of the start time and the state text is changed to 'NORM' but still flashes. The alarm is acknowledged by left clicking on either of the exclamation mark buttons. Alarms may not be acknowledged whilst the horn is sounding.

4. **Standing Alarm**

   The alarm line marked 'D' is a standing acknowledged alarm, the state text is steady red and the starting time of the alarm is indicated.

5. **Standing Alarm, Older Than 24 Hours**

   A standing acknowledged alarm (state text is steady red) and the starting time is indicated as a date. If required, the time will be found in the Event Log.

6. **Alarm - Returned to Normal**

   An acknowledged alarm that has returned to its 'normal' state again is indicated by grey text, the state text 'NORM' and no starting time indication. This line is not removed automatically as this could cause confusion when the other lines are moving while it is being looked it. The line will be removed when left clicking at the bottom, if another page is selected or if the alarm is closed.

Within the PROPERTIES of any alarm channel, (right click on the alarm channel and select PROPERTIES), the following sub-menus are found:

Alarm Groups

Each alarm channel may be included in up to 4 separate alarm groups. The alarm groups in which this alarm is included are indicated in the Alarm Group field.

If a left button click is made in the box to the left of the name of the alarm group, the matching alarm group diagram is opened.

Channel Parameters

Limit:

Binary alarm channels have only one limit. Analogue alarm channels have 1, 2, or 3 limits. If more than one limit is active at the same time, the message text for the highest number is displayed in the alarm list.

Type:

Binary / low limit / high limit.

Message:

Displays the message text that is defined for this limit, defined during commissioning.

Priority:

Priority of the alarm channel, 1 - 3 for alarms and 4 for event. Priority is used to select the colour of the state text and indication in mimic diagrams, priority 1 is red, priority 2 is magenta, priority 3 is yellow and priority 4 white. The priority is also used to select which alarm to include in the alarm list if 'Only priority 1 alarms' or 'Only priority 1 + 2 alarms' are selected in the additional list dialogue. Alarms with priority 4 are not shown in the alarm list, but may be included in an alarm group and shown on a mimic diagram.

Value:

Limit value for analogue channels, not used for binary channels. The adjust dialogue is opened by a left button click at the end of the line.

Delay On/Off:

Delay on is the time from which the limit is exceeded (analogue) or the input is activated (binary) until the alarm is announced by horn and displayed in the alarm list.

Delay off is the time from which the limit is no longer exceeded (analogue) or the input is suppressed (binary) until the alarm removed from the alarm list.

The adjust dialogue is opened by a left button click at the end of the line.

M.cut:

Manual cut-out indicates an ON if the alarm is suppressed by a manual cut-out. This feature may be used if there is a sensor fail or the machinery system is under repair to avoid false alarms.

Manual cut-out may be switched on and off from the adjust dialogue, this is opened by a left button click at the end of the line.

Normally cut-out for all limits of the alarm channel is done from limit 1, and the on/off text is only displayed for limit 1. But in some cases there may be separate cut-outs for each limit which is indicated by an on/off text in each limit.

Channel Calculation

The signals which are used to calculate the state of the alarm channel are displayed in the channel calculation field.

For analogue channels, 1 to 3 input signals may be used; a main signal, one signal that is added to the main signal and one signal that is subtracted from the main signal.

For binary channels, 1 or 2 signals may be used, the calculated signal is a logical operation between the two signals, AND, OR, XOR and XNOR may be used.

Each signal is specified in one line with the following information:

Signal:

Indicates how this signal shall be used in the calculation, Main, Add, Subtract analogue channels, and Main, NOT, AND, OR, XOR or XNOR for binary channels.

Type:

Indicates the type of signal, the following types are available, sensor input, another monitoring channel, constant, serial input, SLS point and an alarm group.

ID/Name:

The ID and name for the signal.

Mod. ID:

ID for input module of the Gamma PLC only for sensor inputs.

Terminal:

Connection terminals on the input module of the Gamma PLC, only for sensor inputs.

Range:

Sensor range.

Channel Time

Channel time is the time for latest change of state for this alarm channel. The following state changes will set the time: alarm occurs, alarm turns normal, cut-out activated and channel set in simulation.

Simulation

All channels may be set in simulation mode, in this mode there is no connection to input signals for the channel, but the input value is set manually. A left button click will open the simulation dialogue.

Data Log

The UCS2100 system is able to print a log of the actual values for selected channels, this function is called the Data Log. The selection of each channel may be changed in the Data Log selection dialogue, which is opened by a left button click.

There is one data log for each alarm system.

The printing of the data log may only be started from the basic alarm panel (BAP) by pressing the PRINTER CONTROL key, the MORE soft key and the DATALOG soft key.

Procedures for Using the Graphic Operator Station

Open Alarm List

The alarm list is opened in any of the following ways:

- Click with the left trackball button with the cursor on the screen 'ALARM LIST' button in the header.
- Press the F2 function key at the keyboard.
- Click with the left trackball button with the cursor pointer on SHORTCUTS in the menu bar; this will open a drop-down list of diagrams, select 'ALARM LIST' with the cursor and click with the left key.

Open Lists for Cut-Out, Simulation, Sensor Fail or Device Fail

These lists are opened using the dialogue box 'Additional Lists', additional lists may be opened in any of the following ways:

- Click with the left trackball button with the pointer cursor on the 'ADDITIONAL LIST' button.
- Press the F5 function key at the keyboard.
- Click with the left trackball button with the cursor pointer on the SHORTCUTS drop-down in the menu bar, this will open a drop-down list of diagrams, select 'ADDITIONAL LIST' with the cursor and click with the left key.

Open Alarm Group Diagram

Most important alarm groups are listed in the group overview diagram and these are opened by a click of the left trackball button in the matching active area. Both the text and the square of the alarm group are active.

If the required alarm group is not shown in the group overview, a list of all alarm groups in the system may be opened in one of two ways:

- Click with the left trackball button on SHORTCUTS in the menu bar, this will open a drop-down list of diagrams; select ALARM GROUP with the cursor and click with the left trackball button.
- Press the F4 function key at the keyboard. Select the required alarm group with a left click on the text and make a left click on the 'OK' button.
- Left click on the GROUP DISPLAY key.
- At the menu bar, click on GROUP and select GROUP from the drop-down menu.

In all cases, this will bring up an additional group list which may then be scrolled down until the desired group is selected by clicking on it, then pressing OK.

Stop Horn

When the horn is sounding, it is cancelled in one of the following ways:

- Press the Fl1 function key at the keyboard.
- Click with the left trackball button with the pointer cursor on the 'STOP HORN' button in the header.
- The horn may also be silenced with a press on the STOP HORN key on the basic alarm panel (BAP).

Acknowledge the Oldest Unacknowledged Alarm

The oldest unacknowledged alarm is always displayed in the header (lowest line if it is a multiple alarm system header). It may be acknowledged in one of the following ways:

- Press the F12 function key at the keyboard.
- Click with the left trackball button with the pointer cursor on the 'ACKNOWLEDGE' button in the header.

Acknowledge Alarms

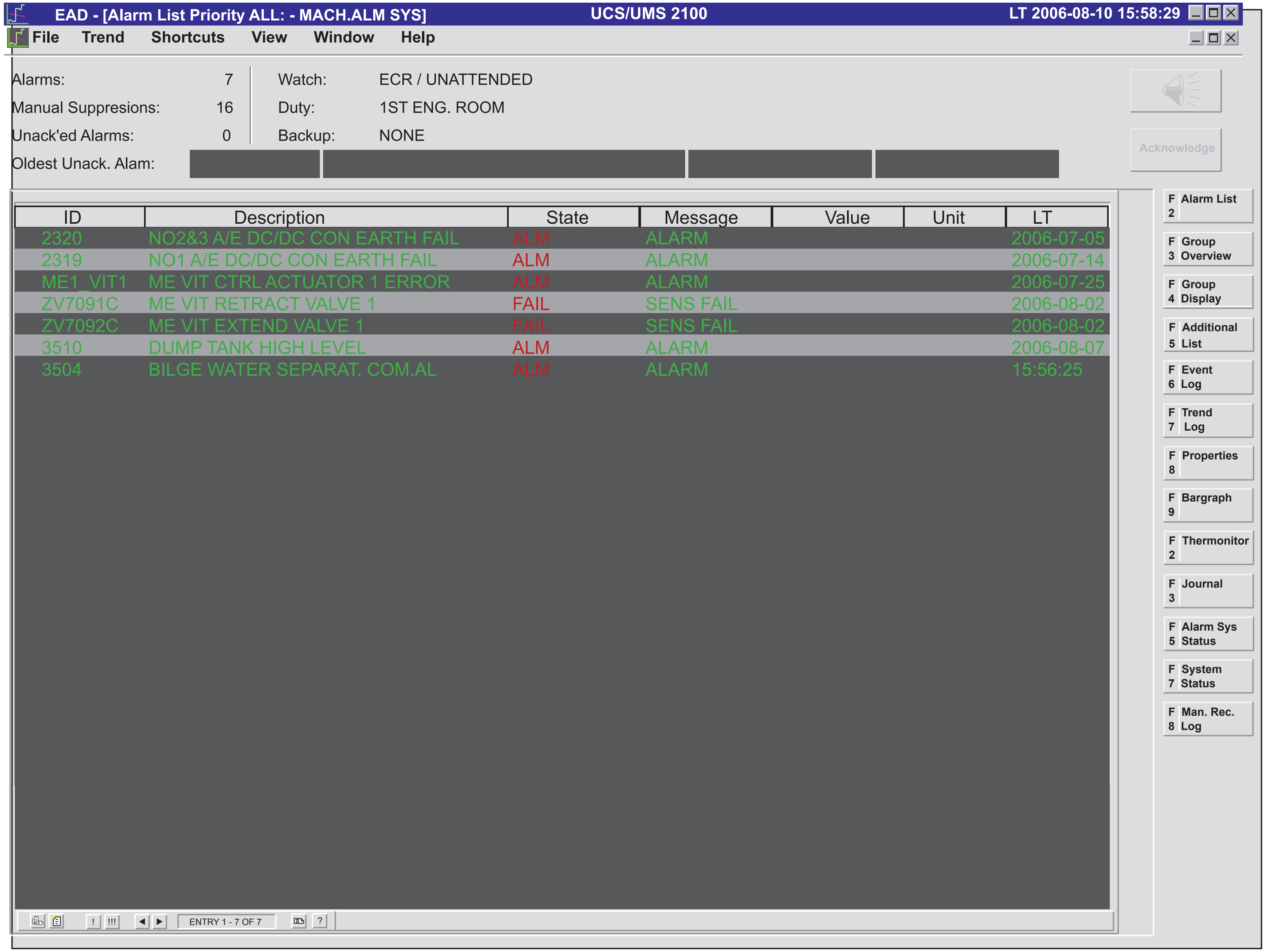
Unacknowledged alarms in lists are indicated by flashing 'State' text. These alarms may be acknowledged in one of the following ways:

- Make a right click somewhere in the alarm line, this will open a small pop-up menu. From this menu, the alarm is acknowledged by a left click on the ACKNOWLEDGE text.
- Select the alarm line by a left trackball button click, the background will change to blue. When the alarm is selected it is acknowledged by a left click on the button.

Note: Alarms are only able to be acknowledged when the horn is silenced and the GOS is watch station for the actual alarm system.

Unacknowledged alarms in display channel diagrams are indicated by flashing 'State' text. These alarms are acknowledged by a left trackball button click on the single exclamation mark button.

Illustration 3.1.3a Screen Displays



3.1.3 SCREEN DISPLAYS

The screen displays at the Graphic Operator Stations (GOS) operate in a standard Windows environment. The GOS screens are divided into two parts, a header window and a selectable working area window, which will be a control overview or an alarm list. The menu bar and header with status information are always present. For enhanced safety, the header constantly displays the most essential information from the alarm system, independent of the actual control assignment, such as:

- Oldest unacknowledged alarm
- Number of present and unacknowledged alarms
- Number of present cut-outs (inhibited alarm channels)
- Actual watch station, duty officer and back-up officer
- Date and time

Alarm information is clearly indicated by means of a graphic alarm symbol placed close to the symbol for the machinery component.

Picture Hierarchy on the Graphic Operator Stations

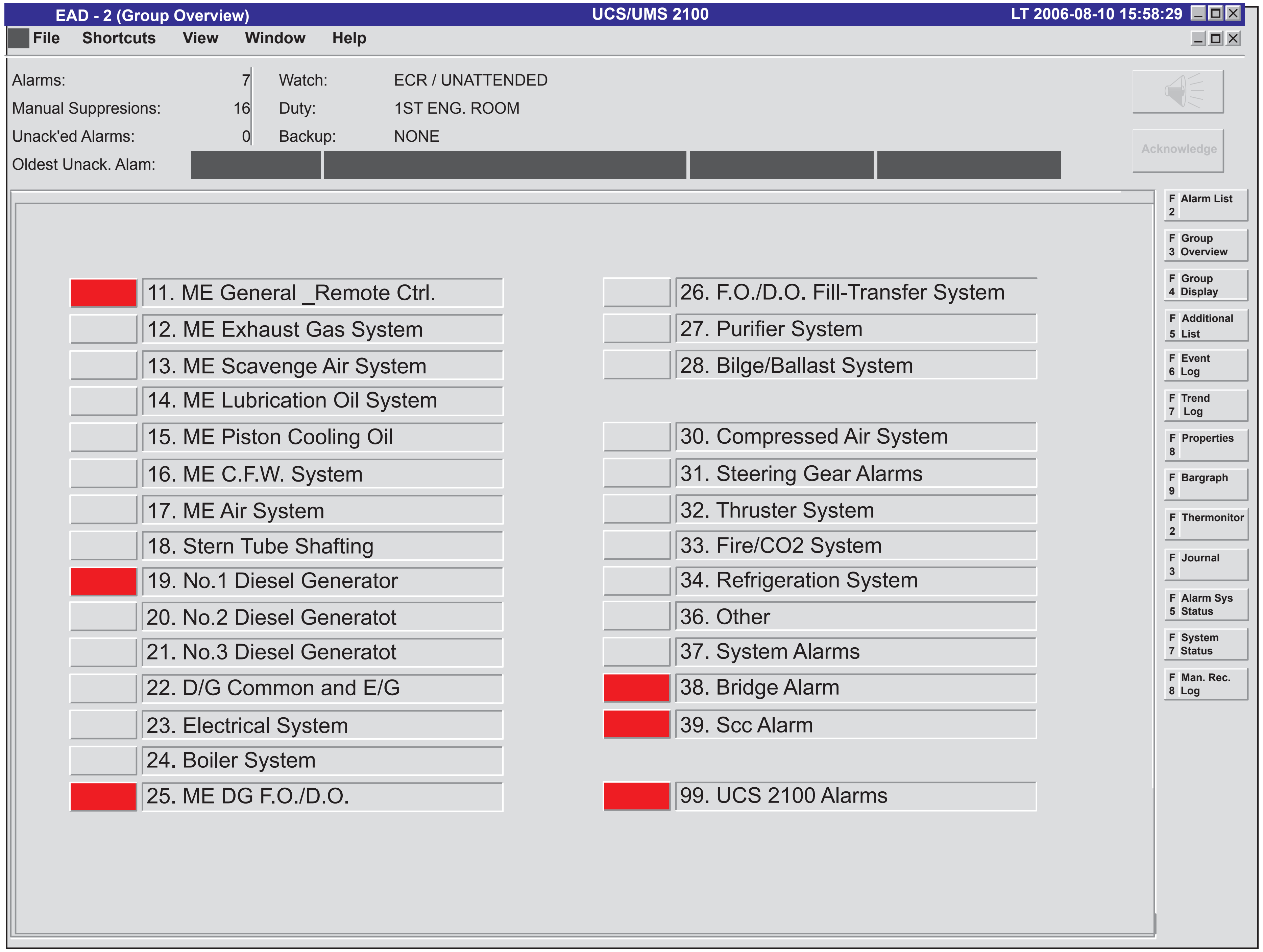
The alarm and control pictures of the UCS2100 control system are placed in a picture hierarchy. The alarm and control overview picture presents labels to all of the control pictures. Any of the pictures may be selected by using the trackball to move the cursor pointer, pointing at the box to the left of the picture label and then left clicking the trackball.

A square located to the left of the picture label flashes in the case of an unacknowledged alarm on the system depicted by the picture. This feature gives the operator a fast and safe overview of the actual situation. Steady red light shows an acknowledged alarm.

The alarm and control overview picture can be selected by pressing a function key on the keyboard or from the short-cuts pull-down menu on the command bar in the upper edge of the screen.

All of the alarm and control pictures are available from the picture label on the alarm and control overview picture or from the area/diagram pull down menu on the command bar in the upper edge of the screen.

Illustration 3.1.3b Screen Hierarchy



3.1.4 TRENDING

The UCS2100 system is able to display one to six graphs for parameters under analysis in the same trend display with individual colours and measuring scales. The individual colour is used to separate the element ID number, the measuring scale, the trend curve and the value for each measurement.

Trend displays that are used often may be accessed directly from the Trend Log button (or F7) or again from the short-cut menu. Trend curves showing values for the previous 24 hours (maximum 4 days) or part of that period, are based upon the continuously logged data. A Trend display for a period exceeding the last 24 hours (maximum 4 days) is based upon the compressed values.

Parameters, which are not predefined for logging, may be displayed during on-line data collection, initiated on the request of the operator. There is also a zoom function available, selected by pointing out the area required using the trackball.

Trend curves may be saved as a file on the PC hard drive. The data used for the trend displays are accessible on the Graphic Operator Stations (GOS) and can be printed in tabulated form on the printer.

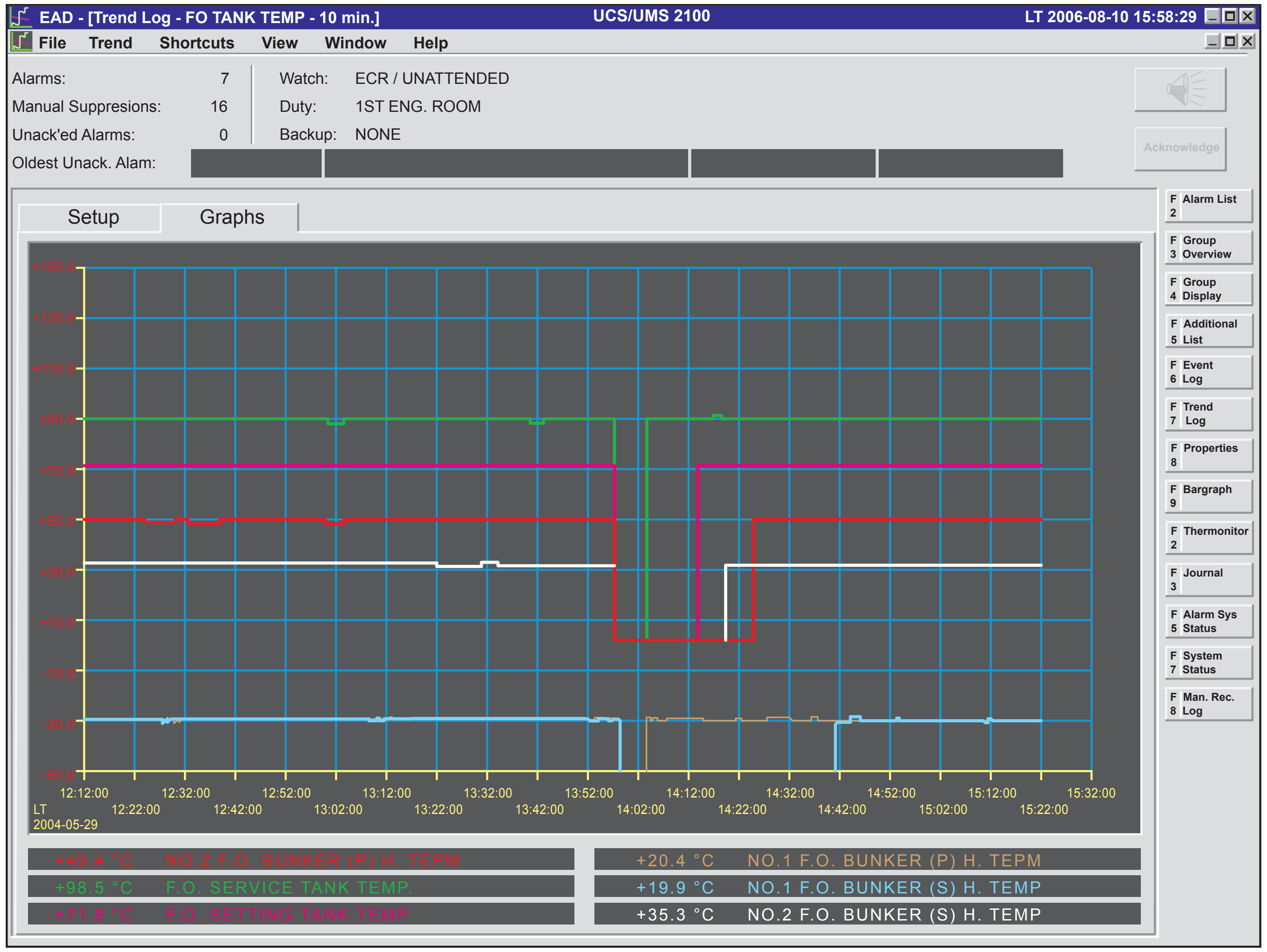
The TREND SETUP function is used for setting up a graph-diagram. The graph pictures are particularly helpful in identifying and analysing the operating disruptions. Additionally, it is helpful in providing a visual evaluation of changes of the process values, just as the graphs are an important tool in connection with the documentation of the vessel's operation. In the individual configuration, a number of graph windows may be configured, each one displaying graphs of up to six variables of predetermined element values.

On the TREND SETUP page, left click on one of the user defined graph labels to bring up the SELECT MONITORING CHANNELS window. This window has two boxes on the left and right. The left-hand box lists all available channels where the right-hand box lists selected channels. Initially this will list the channels currently selected for the user defined graph which was initially selected. Between the two boxes are ADD and REMOVE buttons which are used to transfer up to six desired channels to the SELECTED window. If the intention is to save this graph, it may then be renamed and saved as a further user defined graph.

If the operator selects one or more elements, the graph diagram will automatically include these. More than one element may be selected by keeping the SHIFT key pressed when selecting the elements. Regardless of how it is opened, a graph window has a fixed position and size on the screen.

The fixed definition graph may be selected from the menu Graphs (by clicking on the box to the left of the required graph name). The Graphs menu is able to contain up to 19 graph displays.

Illustration 3.1.4a Trending



Start Time and Window Period for Graphs

After opening a graph window, the operator may change the period over which the graph is active. This is achieved by right clicking on the graph display which will bring up a selection window with LIVE and TIME DIVISION options. All graphs are set to LIVE as default, so selecting TIME DIVISION allows the operator to adjust the scale of time on the graph, increasing the divisions on the scale up to periods of 24 hours.

This allows the graph to cover periods of up to around twenty days on one graph to analyse long term trends.

Changing the Presentation of a Graph Display

Whilst displaying the graph, if the operator clicks on an element name tag at the bottom of the screen, the channel properties page for that element will be displayed. Included in that page is a bar graph of that element against its measured range.

During monitoring, should the operator wish to add further elements or subtract elements from the graph, the SELECT MONITORING CHANNELS window should be called up and the required channels subtracted or added up to the maximum of six. Being able to deactivate one or more graph displays may, for example, be helpful in situations where two graphs completely or partially cover one another, or in situations where one of several graphs is required to be examined more closely.

Regardless of the selection of the graph form, the zoom and pan functions are the same.

3.1.5 ALARMS HANDLING

The alarm list is a display of all standing alarms, both acknowledged and unacknowledged. The system can include from 1 to 4 systems (bridge alarms, machinery alarms, etc). Each alarm system has its own alarm list.

Each alarm occupies one line in the alarm list and up to 20 alarms can be displayed on the screen. If there are over 20 alarms, the actual number is shown in the bottom right of the display. Use of the PAGE UP and PAGE DOWN keys allows for scrolling through the alarm list.

The colour of the alarm text is normally green with the alarm 'state' text in red (if priority 1 alarm) or magenta (if priority 2), yellow (if priority 3), white (if priority 4) or blue (if Manual cut-out). A right click on the alarm brings up a small menu with two texts: 'DISPLAY CHANNEL' and 'ACKNOWLEDGE'. Left clicking on 'ACKNOWLEDGE' allows the alarm to be acknowledged or if this is not possible, the text is shown in grey (already acknowledged or horn not silenced, etc). Left clicking on 'DISPLAY CHANNEL' opens the display for the particular system the alarm originates from. Detailed alarm information such as delays and limits, etc, is also shown.

Trend Displays

One to six graphs for supervised parameters can be displayed in the same trend display with individual colour and measuring scale. The individual colour is used to separate the ID number, the measuring scale, the trend curve, and the digit valve for each measurement. See Section 3.1.4 for further information.

Alarm Groups

An alarm group list is a list of all alarms included in this group, independent of the alarm state. The layout of the list and the alarm lines are the same as for the alarm list, but the list is sorted alphabetically after the ID.

Alarms in an alarm group can have more states than in the alarm list, because some of the states of the alarm channel are moved to separate lists, eg, cut-out list or lists of simulated channels.

The possible states (state texts) for an alarm channel in a Alarm Group are listed below:

State	Appearance	Description
NORM	Steady green	The alarm channel in normal state, ie, no alarms and no failures.
ALM	Flashing red	Unacknowledged alarm, priority 1.
ALM	Steady red	Acknowledged standing alarm, priority 1.
ALM	Flashing magenta	Unacknowledged alarm, priority 2.
ALM	Steady magenta	Acknowledged standing alarm, priority 2.
ALM	Flashing yellow	Unacknowledged alarm, priority 3.
ALM	Steady yellow	Acknowledged standing alarm, priority 3.
FAIL	Flashing red	Unacknowledged alarm for sensor fail.
FAIL	Steady red	Acknowledged sensor fail, outside normal range.
NORM/CA	Steady blue	Alarm channel with standing alarm where the alarm is suppressed by a Cut-Out.

All state texts can be extended with an 'S' in the beginning, eg, 'S NORM' or 'S ALM'. This 'S' indicates that the alarm channel is in simulation mode. In simulation mode, the displayed value is manually keyed in and has no connection to the input from the sensor.

Additional Lists

Additional lists is a set of lists for alarm channels in a certain state, there is one set of additional lists for each alarm system.

Additional lists include the following lists:

Suppression Lists

Simulated Channels	List of all channels that are in simulation mode.
Automatic Suppressed	List of all channels that are suppressed by automatic cut-out.
Manual Suppressed	List of all channels that are manually suppressed (manual cut-out).

Failure Lists

Device Fail List	List of all channels with device fail (hardware fail in the Gamma PLC or power fail to the Gamma PLC).
Sensor Fail List	List of all channels with sensor fail (input from sensor is outside the defined range).

Alarm List, Only High Priority Alarms

Alarm List Priority I:	Alarm list only including alarms with priority 1.
Alarm List Priority 1+2:	Alarm list only including alarms with priority 1 or 2.

Additional lists have the same layout as the alarm list and alarm group lists and the operation of the list is the same, ie, it is possible to acknowledge alarms and open the Display Channel diagram.

Display Channel Diagram

The Display Channel diagram shows detailed information of an alarm channel, and it is also possible to adjust some parameters for the alarm channel, these adjustments are protected by password level 1. The display channel diagrams are divided in smaller areas matching the various functions that are available. The Display Channel diagram top line is the same line as displayed in the alarm group/alarm list for this alarm. This line includes the ID for the alarm channel, description, alarm state, message text, value (only for analogue channels) and start time for the alarm (if active).

Alarm Channel Information

Type:	Analogue / binary
Alarm System:	Alarm channel alarm system name
Outstation:	The outstation ID of the Gamma PLC
Address:	The address (unit number) of the PLC

The channel parameters are also shown here and include the alarm message text, priority, limit value, delay time if applicable and any manual cut-outs, etc.

3.1.6 UNMANNED SERVICE (UMS) / MANNED HAND-OVER

The following procedures are carried out when changing over to and from manned operation:

Due to Alarm Initiation

a) The alarm is activated on the Accommodation Alarm Panel (AAP) in the cabin of the duty engineer and on the panels in the public rooms.

b) The duty engineer accepts the alarm and proceeds to the engine control room (ECR).

c) The duty engineer accepts and silences the alarm at the watch station on the control room console.

d) If the vessel is at sea, the duty engineer informs the bridge of the manned engine room condition and the nature of the alarm.

e) In the ECR the duty engineer selects watch keeping control as manned.

f) The alarm condition is rectified. If necessary the duty engineer calls for assistance.

g) On completion, the duty engineer informs the bridge and selects appropriate cabin as duty engineer.

h) The duty engineer proceeds to his cabin and accepts the duty selection on the AAP.

i) The machinery spaces are in UMS condition.

WARNING
Whenever personnel enter the machinery spaces on their own the bridge should be informed and the Dead Man Alarm system must be in use.

Normal Hand-Over

a) The duty engineer proceeds to the ECR and informs the bridge of the changeover to the manned condition.

b) At the watch station on the control room console select the manned condition.

c) Examine the log printouts generated during the UMS period.

d) Undertake the watch routine, taking actions as necessary to maintain the engine room machinery in a safe and efficient working condition. Ensure that all ship safety systems are functioning, and if any monitored system is not functioning the back-up system must be operated.

e) Hand-over to the oncoming duty engineer, discussing any irregularities. Ideally all hand-over information should be presented in written as well as verbal form. This may include notes on the computer system or written on the notice board in the control room. The oncoming duty engineer must have sufficient information to enable him to fully understand the present operating status of all machinery, the circumstances under which that machinery is operating, and any likely events which might occur during the next period of duty (such as fuel pumping or bunker transfer).

f) Inform the first engineer of any plant defects. He will then decide if they should be included in the present day's work list.

g) The first engineer delegates the work list and discusses relevant safety practices.

h) The duty engineer should be aware of all the maintenance being carried out and should be informed of any changes to the day's schedule.

i) The duty engineer may then proceed with his normal tour of inspection of the machinery spaces.

3.2 ENGINE CONTROL ROOM, CONSOLE AND PANELS

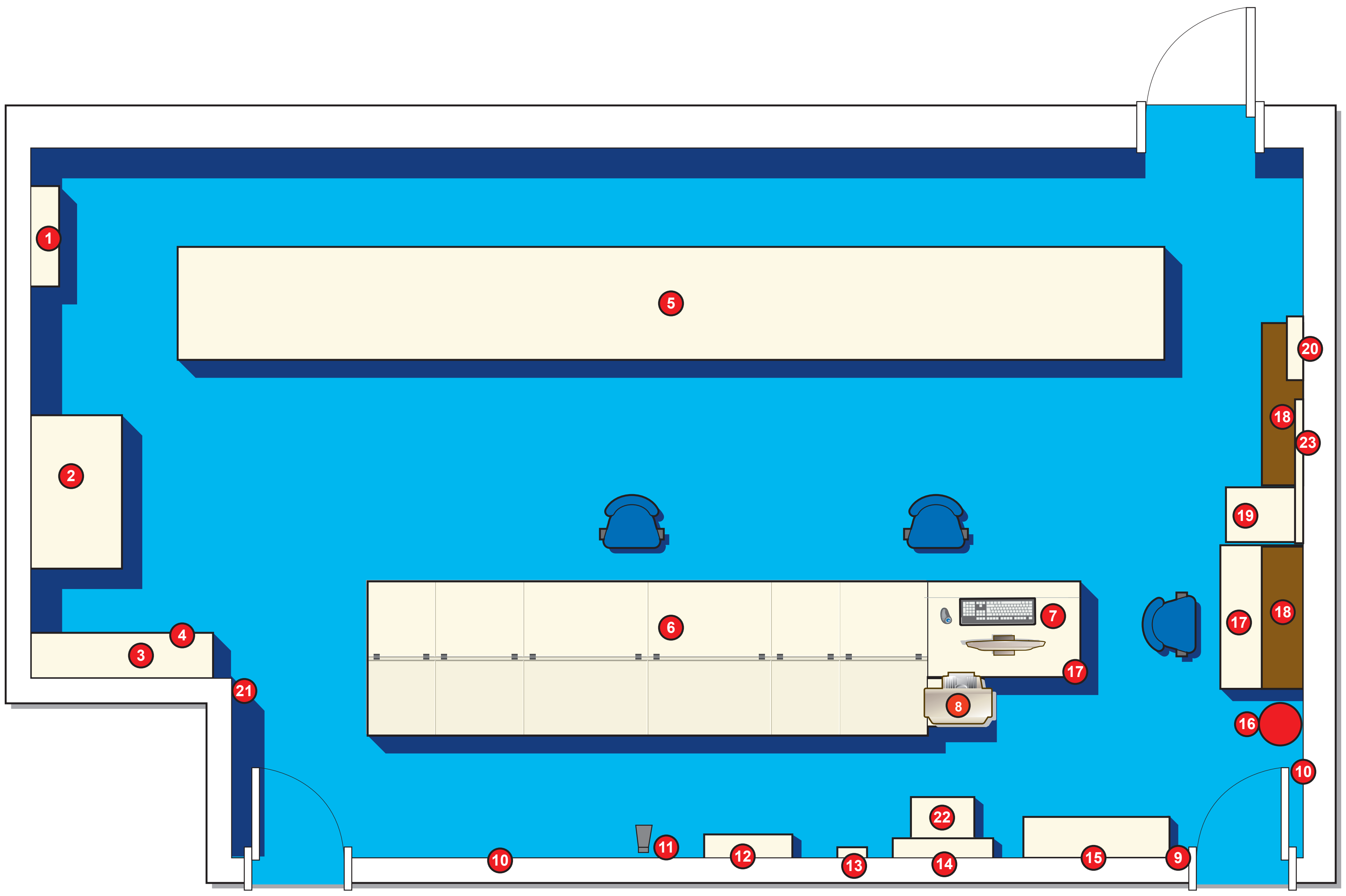
3.2.1 ENGINE CONTROL ROOM

The engine control room is situated on the port side of the upper platform (2nd deck) of the engine room, where all the necessary equipment and controls are located to permit the centralised supervision of machinery operations. Automatic and remote control systems are provided to allow the machinery spaces to run unattended at sea and in port during cargo operations.

It contains the following:

- Main engine control and operating console
- Main switchboard
- Computer workstation
- UMS2100 monitoring system cabinets
- Main engine oil mist detector alarm panel
- ECR console UPS supply unit
- EGS2000 power unit
- Main engine crankcase oil mist detector panel
- Inert gas generator alarm repeater panel
- Instruction books cabinet and shelves
- Package air conditioning unit
- Safety plans and notice boards
- One EEBD unit
- Two life jackets
- Two immersion suits
- CO_2 fire extinguisher
- Refrigerator

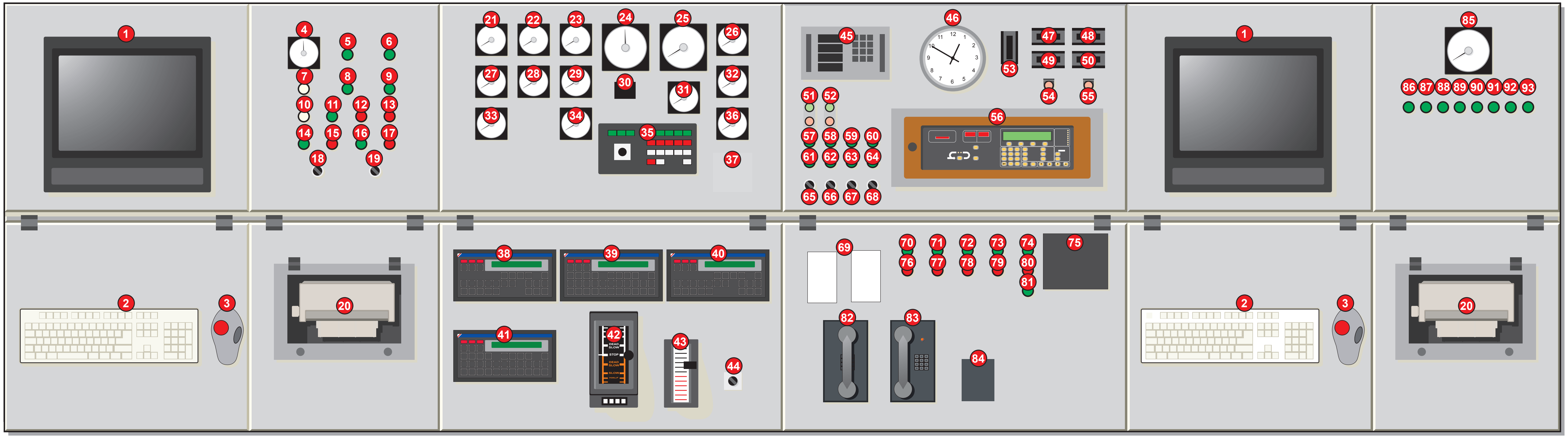
Illustration 3.2.1a Engine Control Room



Key

1. Uninterrupted Power Supply Panel
2. Package Air Conditioning Unit
3. UMS2100 Outstation
4. UCS 2100 Local Operator Panel
5. Main Switchboard
6. Control Console
7. Computer and Monitor
8. Printer
9. Fire Alarm Point
10. Whiteboard
11. Alarm Light Column and Horn
12. Main Engine Governor Panel
13. Inert Gas Generator Panel
14. Main Engine Crankcase Oil Mist Detector
15. UMS2100 Main Panel
16. CO_2 Fire Extinguisher
17. Desk
18. Bookshelves
19. Filing Cabinet
20. Alarm Column Connection Box
21. EEBD
22. Refrigerator
23. Safety Plans

Illustration 3.2.2a Engine Control Console



Key

1. Generall Operator Station - Monitor
2. General Operator Station - Keyboard
3. General Operator Station - Trackball
4. Rudder Angle Indicator
5. No.1 Steering Gear Running Lamp
6. No.2 Steering Gear Running Lamp
7. MSB 220V AC Available Lamp
8. MSB 220V AC Power Supply Lamp
9. 24V DC Power On Lamp
10. ESB 220V AC Available Lamp
11. ESB 220V AC Power Supply Lamp
12. Main Engine Remote Control Failure Lamp
13. Manual RPM Reduce Lamp
14. Sea Chest Valve (Port) Open Lamp
15. Sea Chest Valve (Port) Closed Lamp
16. Sea Chest Valve (Starboard) Open Lamp
17. Sea Chest Valve (Starboard) Closed Lamp
18. Port Sea Valve Selector Switch
19. Starboard sea Valve Selector Switch
20. Alarm/Log Printer
21. Main Engine Lubricating Oil Inlet Pressure
22. Main Engine Lubricating Oil Inlet Temperature
23. Main Engine Jacket Cooling Water Inlet Pressure
24. Main Engine RPM Indicator
25. Main Engine Turbocharger RPM Indicator
26. Main Engine Starting Air Inlet Pressure
27. Main Engine Fuel Oil Inlet Pressure
28. Main Engine Jacket Cooling Water Inlet Temperature
29. Main Engine Scavenge Air Cooler Cooling Water Pressure
30. Main Engine Revolution Counter
31. Fuel Oil Pump Index
32. Main Engine Control Air Inlet Pressure
33. Main Engine Lubricating Oil Camshaft Pressure
34. Main Engine Piston Cooling Oil Inlet Pressure
35. Main Engine Indication Panel
36. Main Engine Scavenge Air Inlet Pressure
37. RPM / Speed Table
38. Bridge Manoeuvring Panel - DMS2100i
39. Main Engine Safety System Panel - DPS2100
40. Electronic Governor System Panel - EGS2000
41. Basic Alarm Panel - UMS2100
42. Telegraph Receiver Unit
43. Main Engine Manoeuvring Handle
44. Bridge / ECR Contro Changeover Switch
45. Main Engine Shaft Power Meter
46. Clock
47. Auxiliary Boiler Water Level Indicator
48. Composite Boiler Water Level Indicator
49. Auxiliary Boiler Pressure Indicator
50. Composite Boiler Steam Pressure Indicator
51. Fuel Oil Pump Start / Stop Buttons
52. Diesel Oil Pump Start / Stop Buttons
53. Booster Unit Viscometer Unit
54. Auxiliary Boiler Emergency Stop Button
55. Composite Boiler Emergency Stop Button
56. Fire Detector Repeater Panel
57. Feed Pump DO1 for No.1 Booster Unit Running Lamp
58. Booster Pump DO3 for No.1 Booster Unit Running Lamp
59. Feed Pump DO2 for No.2 Booster Unit Running Lamp
60. Booster Pump DO4 for No.2 Booster Unit Running Lamp
61. Feed Pump DO1 for No.1 Booster Unit Remote Lamp
62. Booster Pump DO3 for No.1 Booster Unit Remote Lamp
63. Feed Pump DO2 for No.2 Booster Unit Remote Lamp
64. Booster Pump DO4 for No.2 Booster Unit Remote Lamp
65. Feed Pump DO1 for No.1 Booster Unit Switch
66. Booster Pump DO3 for No.1 Booster Unit Switch
67. Feed Pump DO2 for No.2 Booster Unit Switch
68. Booster Pump DO4 for No.2 Booster Unit Switch
69. Telephone Directories
70. No.1 Main Air Compressor Running Lamp
71. No.2 Main Air Compressor Running Lamp
72. No.3 Main Air Compressor Running Lamp
73. Working Air Compressor Running Lamp
74. Control Air Compressor Running Lamp
75. Microphone for Talk-Back System
76. No.1 Main Air Compressor Emergency Stop
77. No.2 Main Air Compressor Emergency Stop
78. No.3 Main Air Compressor Emergency Stop
79. Working Air Compressor Emergency Stop
80. Control Air Compressor Emergency Stop
81. Lamp Test
82. Automatic Telephone
83. Sound Powered Telephone
84. Ashtray
85. Speed Log Indicator
86. Water Mist Discharge - Aux. Boiler
87. Water Mist Discharge - Main Engine
88. Water Mist Discharge - Aux. Engine No. 1 and No. 2
89. Water Mist Discharge - Aux. Engine No. 3
90. Water Mist Discharge - Comp. Boiler
91. Water Mist Discharge - FO Booster Unit
92. Water Mist Discharge - FO Separators
93. Water Mist Discharge - Inert Gas Generator

3.2.2 ENGINE CONTROL CONSOLE

The main engine control and operating console contains:

- Two alarm / monitoring system display screens with keyboards and trackballs (General Operator Station (GOS))
- Power supply available / operational indicator lamps
- Steering gear running indicator lamps
- Local operator stations for:
    - UMS2100
    - DMS2100i
    - DPS2100
    - EGS2000
- Main engine telegraph unit (bridge control)
- Main engine local control unit
- Main engine emergency stop pushbutton
- Main engine/turbocharger RPM indicators
- Turning gear engaged/disengaged indicator lamps
- Main engine auxiliary blower pre-select/running indicator lamps
- Automatic telephone, sound powered telephone and talk-back telephones with number/station lists
- Rudder angle indicator
- Fire detector repeater panel
- Temperature and pressure gauges for the main engine air, lubricating oil and fuel oil systems
- Main engine rpm/hours counters
- Main engine horse power indicator unit
- Stop horn/klaxon pushbuttons
- Remote control failure alarm
- Manual engine RPM reduction alarm
- Lamp test pushbutton
- Start air compressor lead/lag selector switch
- MDO/HFO in use indicator lights
- FO unit remote control panel
- Engine room clock and adjustment
- Auxiliary boiler and composite boiler steam pressure and water level indicators
- Auxiliary boiler emergency stop pushbutton
- Composite boiler emergency stop pushbutton
- Ship speed log repeater panel
- Alarm / Log printers

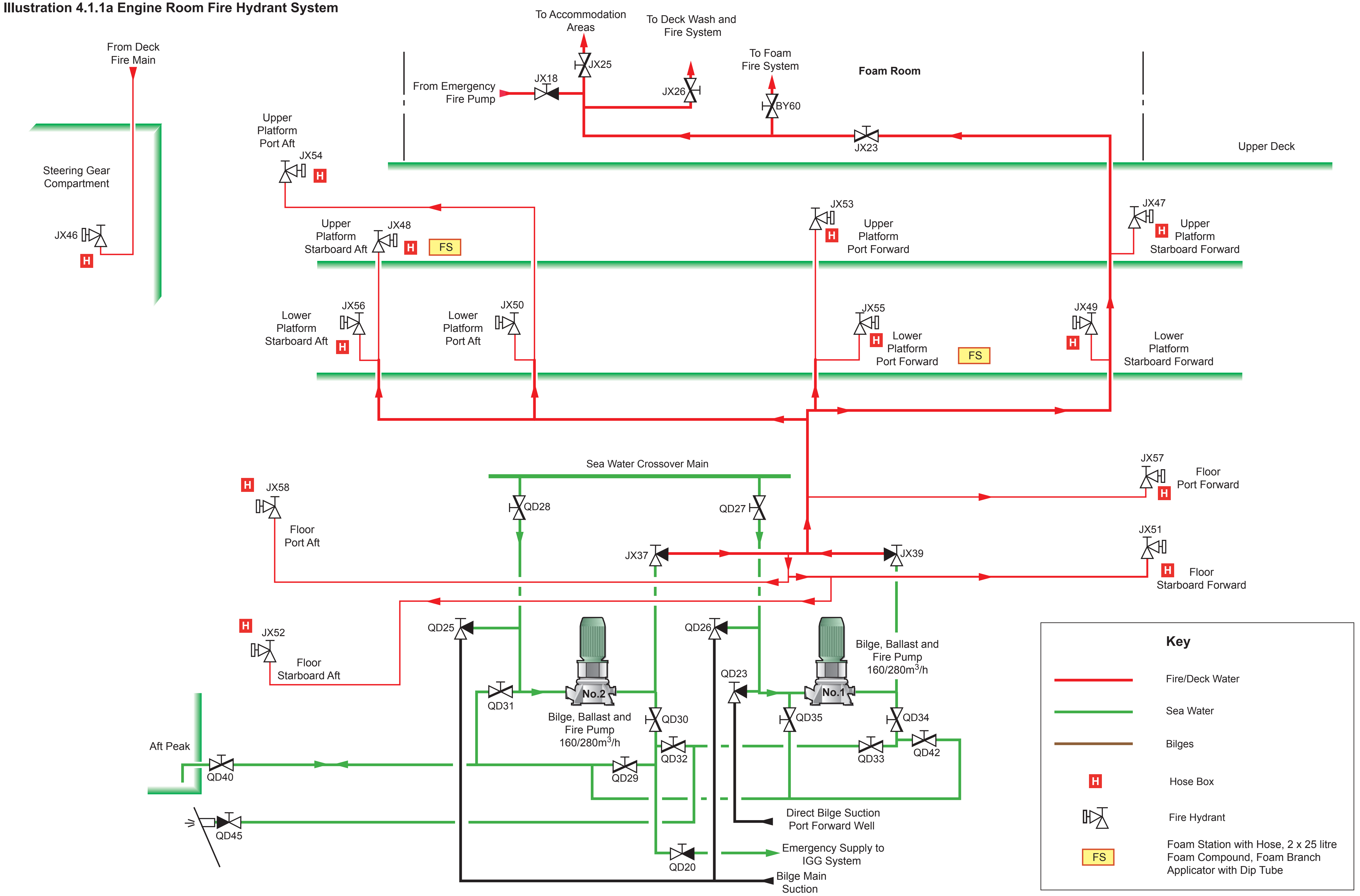
The power for the console is supplied from the emergency switchboard and has a UPS back-up in case of emergency.

The main switchboard contains:

- Three generator sections
- The synchronising section
- Two 440V feeder sections
- Two group starter sections
- One 230V feeder section

SECTION 4: EMERGENCY SYSTEMS

Illustration 4.1.1a Engine Room Fire Hydrant System



4.1 FIRE HYDRANT SYSTEM

The following pumps are able to supply the fire and wash deck system:

Bilge, Ballast and Fire Pumps

No. of sets: 2
Capacity: 220/280m³/h at 1.10/0.45MPa

Emergency Fire Pump

Capacity 72m³/h at 0.90MPa

The above pumps may supply sea water to the following services:

- The fire hydrants in the engine room
- The fire hydrants on deck
- The fire hydrants serving the accommodation block
- The fire hydrants in the ballast pump room
- Main foam system
- Ballast pump room bilge eductor drive
- Bow thrust space bilge eductor drive
- Hawse pipe cable washers
- Forward bilge eductors
- Emergency supply to inert gas generator scrubber
- Water to the tank cleaning system
- Filling the residual tank
- Aft peak tank

The bilge, ballast and fire pumps are normally set up for the fire main and foam room service with the discharge and suction valves locked open.

The pumps in the engine room take suction from the main sea water crossover line in the engine room, the suction for the emergency fire pump is from its own sea chest in the emergency fire pump space. The emergency fire pump sea chest is fitted with a connection for weed clearance by air or steam blowing.

The emergency fire pump supplies the fire main only. It is an electrically-driven self-priming vertical centrifugal pump which is situated in the emergency fire pump space and is accessed through the steering flat either from the poop deck or through the engine room. The electrical power for this pump is supplied through the emergency switchboard.

The fire pumps may be started and stopped from the following locations:

- Locally, adjacent to the pump.
- The fire control station adjacent to the ship's control centre.
- Wheelhouse, below the main fire detection control panel.
- Foam room, except the emergency fire pump.
- ECR main switchboard at the 440V group starter panel for each pump, except the emergency fire pump.

The fire and deck wash main runs the full length of the vessel and is branched off to the individual fire hydrants, which are located so that two separate hoses are able to direct a water spray/jet at any position on the vessel.

Isolating valves are positioned between each set of hydrants on the fire main line. This enables pressure to be maintained aft of the valve in the event of a breach or open hydrant.

Preparation for the Operation of the Fire Hydrant System

a) Set the suction and discharge valves of the bilge, ballast and fire pumps for supplying sea water to the fire main. The description assumes that the sea water main is already connected to the sea via the low suction.

Ensure that the bilge suction valves for both of these pumps are positively shut to ensure that no bilge water is discharged into the fire main.

Ensure that the emergency fire pump suction and discharge valves are open.

b) All of the intermediate isolating valves along the fire main on the upper deck are to be open.

c) All fire hydrant outlet valves are closed.

d) All drain valves are closed, including those in the ballast pump room and the bow thruster space.

e) Set up the valves as shown in the following table:

Focsle

Position	Description	Valve
Closed	Port hawse pipe cable washer supply valve	JX48
Closed	Starboard hawse pipe cable washer supply valve	JX49
Closed	Supply valve to chain locker eductor	JX57
Closed	Supply valve to focsle bilge eductor	JX58
Closed	Supply valve to bow thruster space bilge eductor	JX59

Ballast Pump Room

Position	Description	Valve
Closed	Supply valve to bilge eductor	JX70

Foam Room

Position	Description	Valve
Open	Supply valve from emergency fire pump	JX18
Open	Supply valve to main deck fire main	JX23
Open	Supply valve to the accommodation areas	JX25
Open	Isolating supply valve to deck	JX26

Engine Room

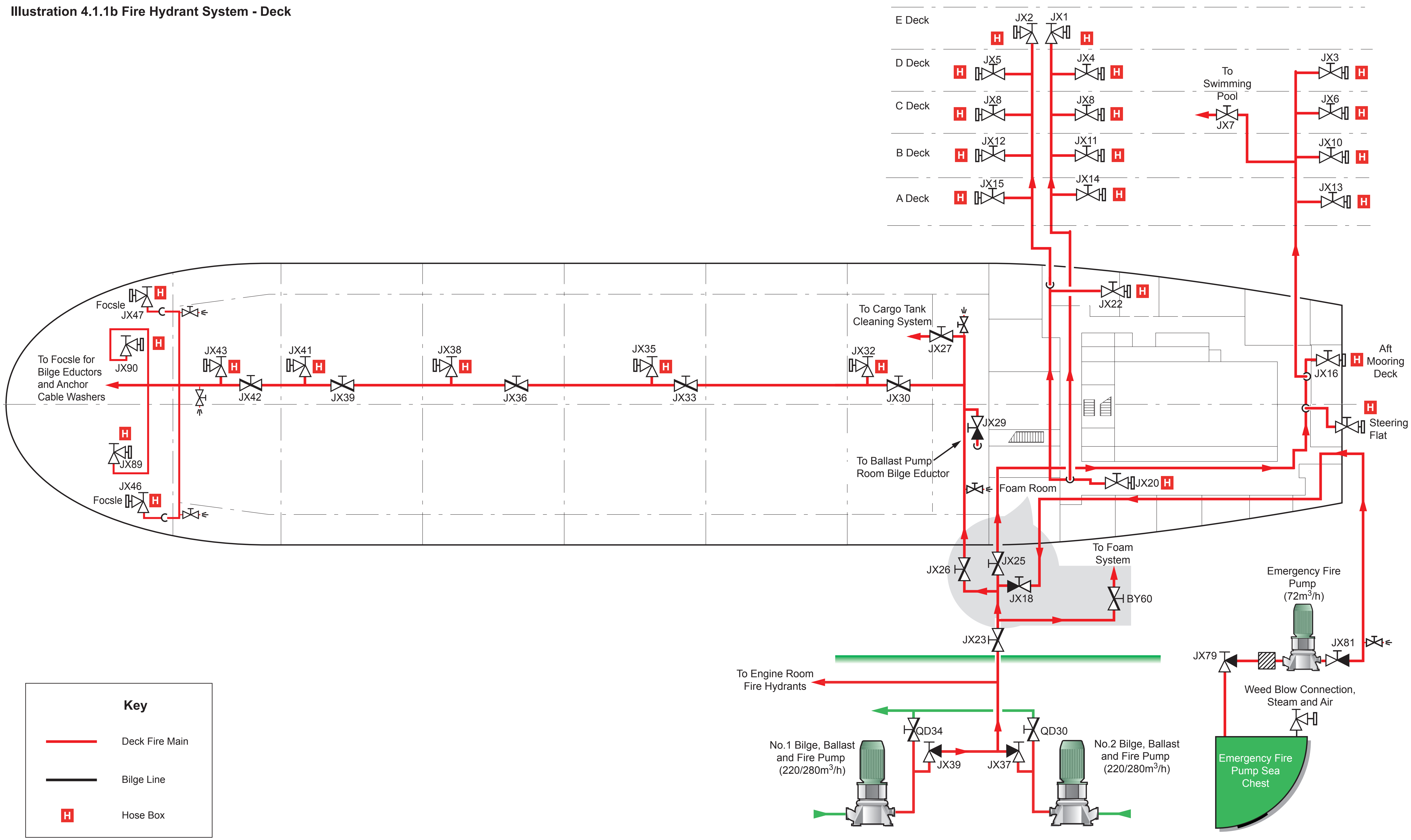
Position	Description	Valve
Locked Open	No.1 bilge, ballast and fire pump sea water suction valve	QD27
Locked Open	No.1 bilge, ballast and fire pump discharge valve	JX39
Locked Open	No.2 bilge, ballast and fire pump sea water suction valve	QD28
Locked Open	No.2 bilge, ballast and fire pump discharge valve	JX37
Locked Closed	No.1 bilge, ballast and fire pump bilge main suction valve	QD26
Locked Closed	No.1 bilge, ballast and fire pump direct bilge suction valve	QD23
Locked Closed	No.2 bilge, ballast and fire pump bilge main suction valve	QD25
Locked Closed	No.1 bilge, ballast and fire pump discharge valve to overboard, ballast and IG systems	QD34
Locked Closed	No.2 bilge, ballast and fire pump discharge valve to overboard, ballast and IG systems	QD30
Locked Closed	No.1 bilge, ballast and fire pump bilge suction valve from ballast system	QD35
Locked Closed	No.2 bilge, ballast and fire pump bilge suction valve from ballast system	QD31

Emergency Fire Pump Space

Position	Description	Valve
Locked Open	Emergency fire pump suction valve	JX79
Locked Open	Emergency fire pump discharge valve	JX81

All of the above pumps are ready to be started remotely from the locations as previously indicated.

Illustration 4.1.1b Fire Hydrant System - Deck



Note: Whenever a bilge, ballast and fire pump, or the emergency fire pump is operating, at least one fire hydrant valve should be open to ensure a flow of water through the pump to prevent overheating, this would usually be an anchor cable washer.

After use, any hose and nozzle unit used must be properly stowed in the hose box ready for future use. Any defects in the hose, nozzle, valve or system must be reported immediately and rectified as soon as possible. Hose boxes must never be left with components which are defective.

Emergency Fire Pump

When the emergency fire pump is to be used it may be started remotely. Both the pump suction valve and the discharge valve to the fire main from this pump are always kept open, so that the pump may be started and will supply water to the fire main immediately. The valves should, however, be operated and lubricated periodically to ensure that they are operational and free to be closed should the need arise.

The Fire Main

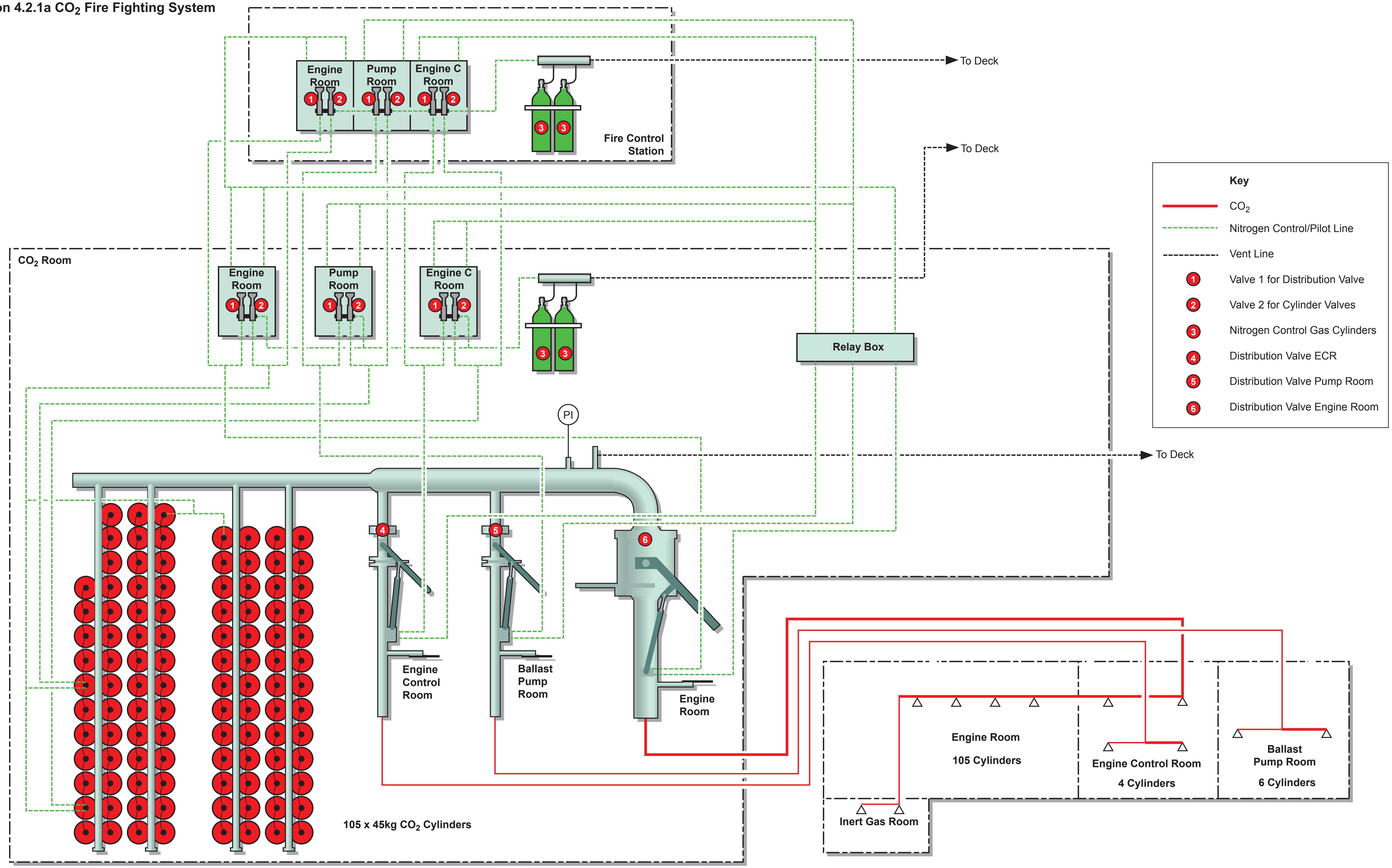
The fire main has outlets in the engine room, around the accommodation block and on the deck forward and aft. At each hydrant outlet is a hose box containing a coupling spanner, fire hose and a spray/jet fire nozzle. The hydrant valves should be operated and lubricated at frequent intervals to ensure that they will open satisfactorily in the event of an emergency.

Intermediate valves in the fire main along the deck should be kept open at all times to ensure that water will be available at all deck hydrants whenever required.

International Ship-Shore Connection

There are two international ship-shore connections located in storage boxes on the port and starboard sides of the upper deck adjacent to the entrance doors into the accommodation. These must be kept readily available for use in port where it may be necessary to utilise water supplied by the shore-based fire authorities to assist in the fighting of a fire.

Illustration 4.2.1a CO_2 Fire Fighting System



4.2 CO_2 FIRE FIGHTING SYSTEM

Introduction

Dependent upon the application, CO_2 is normally employed at levels of between 35% and 50% by volume to produce an oxygen deficiency incapable of sustaining combustion and thus extinguishing any 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. CO_2 is not generally regarded as having a high intrinsic toxicity and is not normally considered to produce combustion products in a fire situation. Liquid or recently evaporated CO_2 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.

The CO_2 cylinders should be located in areas where the ambient temperature will not exceed 46°C; cylinders must not be stored in direct sunlight. All main cylinders are located in the CO_2 room on the port side of the funnel casing on 'A' deck aft. The cylinders are fitted with individual safety devices to relieve excess pressure caused by high temperatures.

WARNING

DANGER OF ASPHYXIATION

Re-entry to a CO_2 flooded area should not be made until the area has been thoroughly ventilated.

The CO_2 fire fighting system for the engine room/inert gas generator room, the engine control room and the ballast pump room consists of 105 high pressure cylinders each containing 45kg of CO_2.

In the event of a fire in the ballast pump room, six cylinders would be released, and for the engine control room, only four cylinders would be released. All 105 cylinders will be released in the event of an engine room//inert gas generator room fire. The illustration above gives an indication of which cylinders are used for each protected space.

The system can be operated from both the ship's fire station and locally in the CO_2 room on 'A'-Deck of the funnel casing.

Engine Room CO_2 Flooding System

Manufacturer:	Semco Maritime
Type:	High pressure
Capacity:	105 cylinders each containing 45kg
Discharge time:	2 minutes

WARNING

Release of CO_2 into any space must only be considered when all other options have failed, and then only on the direct instructions of the Chief Engineer, who will have consulted the Master.

In the Event of Fire in the Engine Room

a) Obtain the key from one of the master keyholders.

b) Go to the master control cabinet located in the CO_2 room or fire control station.

c) Ensure all personnel have evacuated the engine room and have been accounted for.

d) Close and check that all doors, hatches and fire flaps are shut.

e) Stop the main engine, generating engines and auxiliary boiler.

f) Operate the HFO, MDO and LO tank quick-closing valves, stop the engine room fans and pumps via the emergency stops as required. A list of the ESS emergency stops and grouping is given below.

ESS-1

No.1, No.2, No.3 and No.4 engine room fans
No.1 and No.2 main engine auxiliary blowers
ECR air conditioning unit
45D power distribution board

ESS-2 (Also located outside the galley)

(Accommodation fans and galley equipment)
Air conditioning fans
47D and 4AD 440V power distribution panels
22D and 23D 220V power distribution panels

ESS-3

Ballast pump room fan

ESS-4

HFO, MDO and LO purifiers
Auxiliary boiler control panel
4ED, 41D and 42D power distribution boards
FO supply units Nos.1 and 2
FO supply units control panel
Hydraulic power pack control panel
Main engine LO pumps
Main engine camshaft oil pumps
Heavy oil transfer pump
Diesel oil transfer pump
Lubricating oil transfer pump

ESS-5

No.1, No.2 and No.3 generator engines

ESS-6 (Cargo and Inert Gas System)

No.1 and No.2 inert gas fans
IGG FO pump
Ballast pump room fan
No.1, No.2 and No.3 hydraulic power packs

Emergency Stop Pushbuttons Are Also Provided On The Wheelhouse Aft Electrical Panel For:

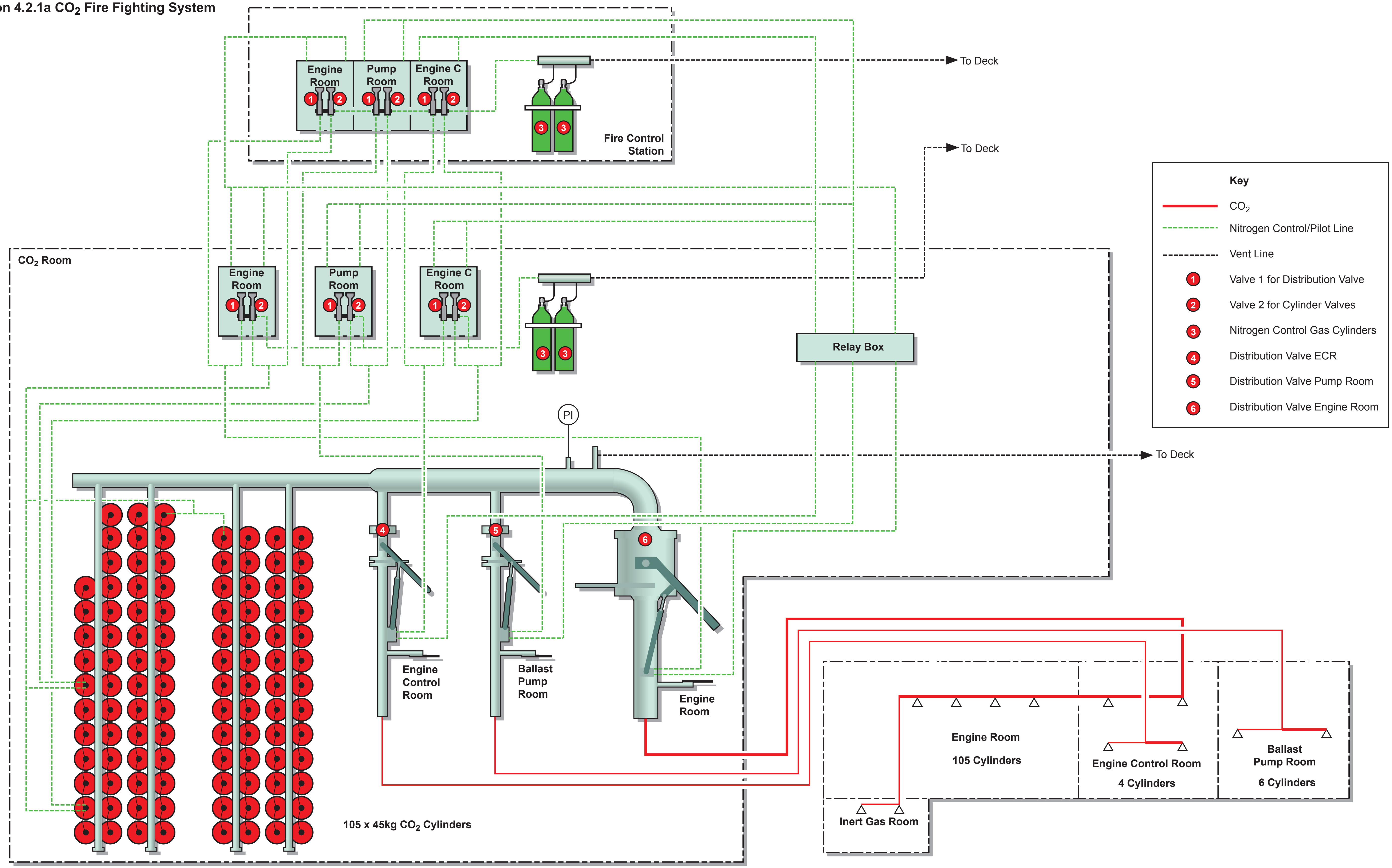
- **ESS-1**
- **ESS-2**
- **ESS-3**

g) Unlock the control cylinder cabinet (only in the FCS, the control cylinders in the CO_2 room are free-standing) and open the door.

h) Open the engine room release box, the alarm horns and flashing lights will operate in the engine room.

i) Open one control cylinder valve fully, then from the release box open No.1 and No.2 control valves. Control nitrogen gas will pass via No.1 valve to the pilot cylinder for the main gang

Illustration 4.2.1a CO_2 Fire Fighting System



of cylinders which will then open all 105 cylinders ready for release into the engine room.

Control nitrogen gas passing through No.2 control valve will be directed to operate the distribution valve cylinder for the engine room.

j) If the nitrogen operated system fails to operate, the main distribution valve can be opened manually in the CO_2 room and the individual cylinders released by hand.

k) Do not re-enter the engine room for at least 24 hours and ensure that all practical precautions have been taken. These include: maintaining cooling and inspections of the boundaries; noting cooling down rates and/or any hot spots which may have been found.

l) After this period, an assessment party, wearing breathing apparatus may quickly enter the space through a door which is then closed behind them.

m) Check that the fire has been extinguished and that all surfaces have cooled sufficiently prior to ventilating the engine room. Premature opening may cause re-ignition when the oxygen in the atmosphere comes into contact with hot combustible material.

n) Do not enter the engine room or inert gas generator room without breathing apparatus until the spaces have been thoroughly ventilated and the atmosphere proved safe.

Ballast Pump Room and Engine Control Room CO_2 Fire Fighting Systems

Manufacturer:	Semco Maritime
Type:	High pressure
Requirements:	6 x 45kg cylinders for ballast pump room
	4 x 45kg cylinders for ECR

In the Event of Fire in the Pump Room or Engine Control Room

a) Obtain the key from one of the master keyholders.

b) Go to the master control cabinet located in the CO_2 room or fire control station for either the pump room or engine control room.

c) Ensure all personnel have evacuated the space/area that will be injected with CO_2.

d) Close and check that all doors, hatches and fire flaps are shut for the spaces/areas that are to be injected with CO_2 .

e) Unlock the control cylinder cabinet (only in the FCS, the control cylinders in the CO_2 room are free-standing) and open the door.

f) Stop the appropriate fans, FO and hydraulic pumps, generator engines etc, consistent with the space being injected with CO_2. Close all doors, hatches and fire flaps. A list of the ESS emergency stops are indicated on the previous page.

g) Open the release box for the space/area to be injected with CO_2, the alarm horns and flashing lights will operate in that space/area.

h) Open one control cylinder valve fully, then from the release box open No.1 and No.2 control valves. Control nitrogen gas will pass via No.1 valve to release the designated pilot cylinder for the area being injected, which when operated will activate the remaining cylinders required for release into the engine control room or the ballast pump room, as appropriate.

Control nitrogen gas passing through No.2 control valve will be directed to operate the appropriate distribution valve cylinder for the ECR or the ballast pump room.

i) If the Nitrogen operated system fails to operate, the distribution valve can be opened manually in the CO_2 room and the individual cylinders released by hand.

Allow time for the CO_2 to extinguish the fire and the space to cool down.

j) Do not re-open the space until all reasonable precautions have been taken to ascertain that the fire is out. Premature opening could cause re-ignition if the oxygen in the atmosphere comes into contact with hot combustible material.

k) When the fire is out, ventilate the space thoroughly.

l) Do not enter the pump room or engine control room without breathing apparatus until the room has been thoroughly ventilated and the atmosphere proved safe.

Alarms for Engine Room and Ballast Pump Room System

Should any cylinder discharge accidentally, it will pressurise the main line-up to the stop valve. This line is monitored by a pressure switch and will activate the CO_2 leakage alarm in the Lyngsø alarm and monitoring system.

Over-pressure of the main line is prevented by a relief valve, which will vent the gas to atmosphere.

Should the electrical power supply to the system fail, the CO_2 Power Failure alarm will operate in the Lyngsø alarm and monitoring system.

Paint Locker CO_2 System

The paint locker is covered by a fixed CO_2 system containing two 45kg CO_2 cylinders with manual release only.

Ensure that there are no personnel in the room and that the ventilation fan for the space is stopped and the vent damper is closed on the focsle deck starboard side before releasing the CO_2 into the space.

Cargo Sample Locker CO_2 System

The sample locker on the port side of the main deck is covered by a fixed CO_2 system containing a single 45kg CO_2 cylinder with manual release only.

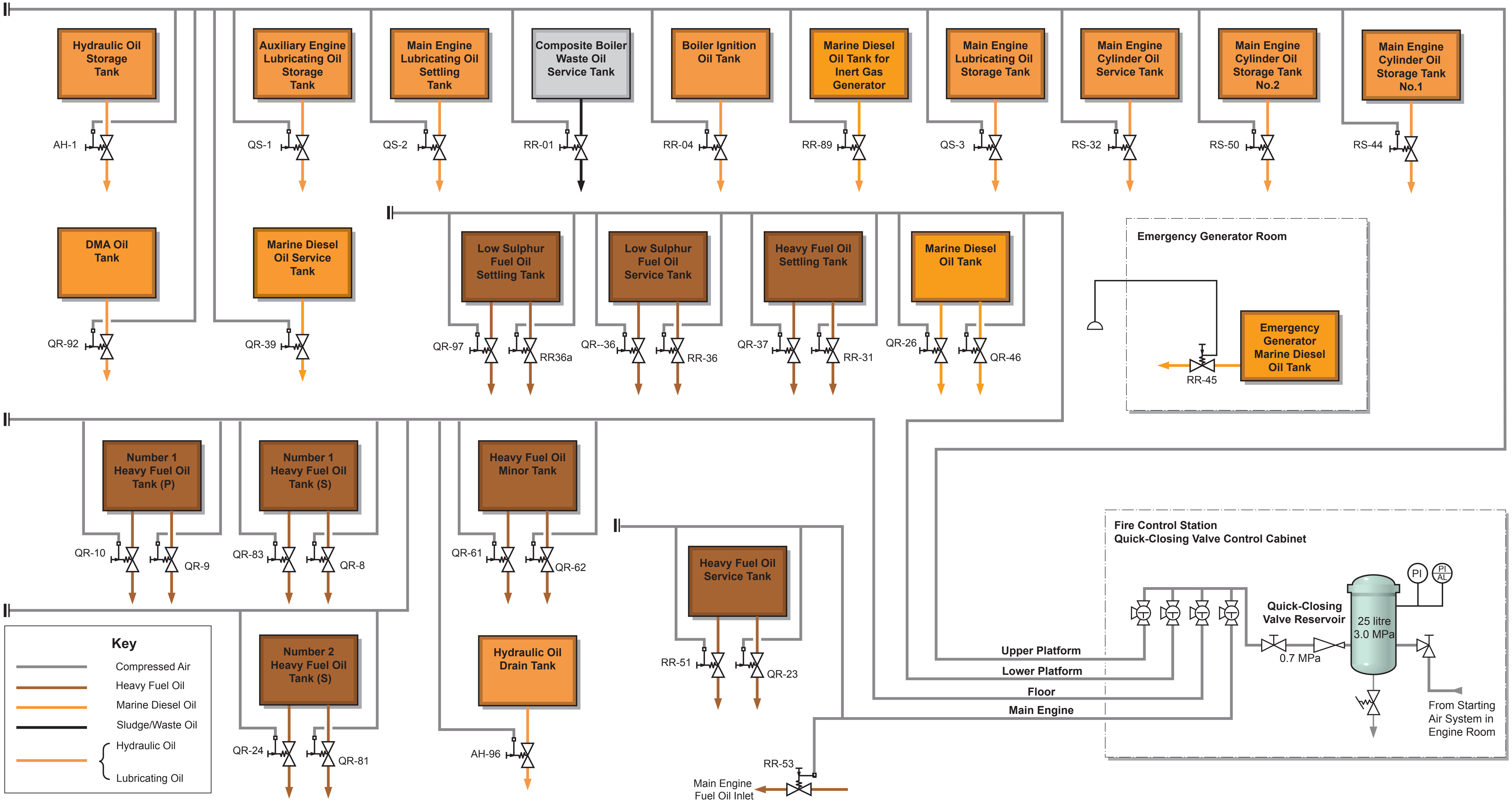
Ensure that there are no personnel in the room and that both the door and the vent damper are closed before releasing the CO_2 into the space.

Galley CO_2 System

The galley exhaust ventilation trunk has a local CO_2 system containing a single 5.4kg CO_2 cylinder which is manually operated from inside the galley, and provides extinguishing capability in the event of a fire in the exhaust fan trunking.

In the case of fire in the exhaust trunk, switch off the galley fans and close the fire dampers with the switches provided both inside and outside the galley entrance from the accommodation cross alleyway, then release the CO_2. When the release protection door is open the galley fans will be automatically stopped if this has not already been carried out.

Illustration 4.3.1a Quick-Closing Valve System



4.3 QUICK-CLOSING VALVES AND FIRE DAMPERS

4.3.1 QUICK-CLOSING VALVE 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 activated from the fire control station. Compressed air for the tripping signal is supplied from an air reservoir situated inside the valve control box located in the fire control station. The reservoir is supplied, at a pressure of 3.0MPa, from the engine room starting air system via an inlet valve which is normally locked open. The air is then reduced to 0.70MPa for use in the valve system.

The quick-closing valve air reservoir is fitted with a low pressure alarm transmitter. The tank valvess are grouped into four groups, three groups cover the separate levels in the engine room and the fourth group covers the fuel supply to the main engine. Each group has a dedicated three-way air supply and vent cock. In normal operation the supply line is vented to atmosphere, but when the cock is turned, air is supplied to the pistons of the valve collapse mechanisms, these collapse the bridge of each valve, allowing the valve spring to close the valve.

If the cabinet door is locked, a key is located in a break glass box adjacent to the CO_2 release cabinets. If the door is jammed, access to the operating cocks for the quick-closing valves is by breaking the glass in the cabinet door.

The quick-closing valves are reset after closing by venting the air supply and operating the valve handwheel in a closed direction; this resets the bridge mechanism. The quick-closing valve may then be opened in the normal manner.

The emergency generator fuel tank outlet valve is also fitted with a quick-closing valve. This valve operates in a similar manner, however, the collapse of the valve bridge is initiated by means of a flexible wire cable with a handle situated outside the emergency generator room. When this handle is pulled the valve will trip and close, shutting off the fuel supply to the engine.

Oil Tank Quick-Closing Valves

WARNING

Some tanks, such as small 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.

Tank	Description	Valve
Group 1: Upper Platform		
Hydraulic oil storage tank	Outlet Valve	AH1
Auxiliary engine lubricating oil storage tank	Outlet Valve	QS1
Main engine lubricating oil settling tank	Outlet Valve	QS2
Composite boiler waste oil tank	Outlet Valve	RR1
Boiler ignition oil tank	Outlet Valve	RR4
Inert gas generator diesel oil tank	Outlet Valve	RR89
Main engine lubricating oil storage tank	Outlet Valve	QS3
Main engine cylinder oil service tank	Outlet Valve	RS32
Main engine cylinder oil storage tank No.1	Outlet Valve	RS44
Main engine cylinder oil storage tank No.2	Outlet Valve	RS50
DMA oil tank	Outlet Valve	QR92
Diesel oil service tank	Outlet Valve	QR39
Group 2: Lower Platform		
Low sulphur fuel oil settling tank	Outlet Valve	QR97
Low sulphur fuel oil settling tank	Outlet Valve	RR36
Low sulphur fuel oil service tank	Outlet Valve	QR36
Low sulphur fuel oil service tank	Outlet Valve	RR36a
Heavy fuel oil settling tank	Outlet Valve	QR37
Heavy fuel oil settling tank	Outlet Valve	RR31
Diesel oil storage tank	Outlet Valve	QR26
Diesel oil storage tank	Outlet Valve	QR46
Group 3: Floor		
No.1 heavy fuel oil tank - port	Suction Valve	QR9
No.1 heavy fuel oil tank - port	Suction Valve	QR10
No.1 heavy fuel oil tank - starboard	Suction Valve	QR8
No.1 heavy fuel oil tank - starboard	Suction Valve	QR83
No.2 heavy fuel oil tank - starboard	Suction Valve	QR24
No.2 heavy fuel oil tank - starboard	Suction Valve	QR81
Heavy fuel oil - minor tank	Suction Valve	QR61
Heavy fuel oil - minor tank	Suction Valve	QR62
Hydraulic oil drain tank	Outlet Valve	AH96
Group 4: Main Engine		
Heavy fuel oil - service tank	Outlet Valve	QR23
Heavy fuel oil - service tank	Outlet Valve	RR51
Main engine	Inlet Valve	RR53
Group 5: Emergency Generator		
Emergency generator diesel oil tank	Outlet Valve	RR45

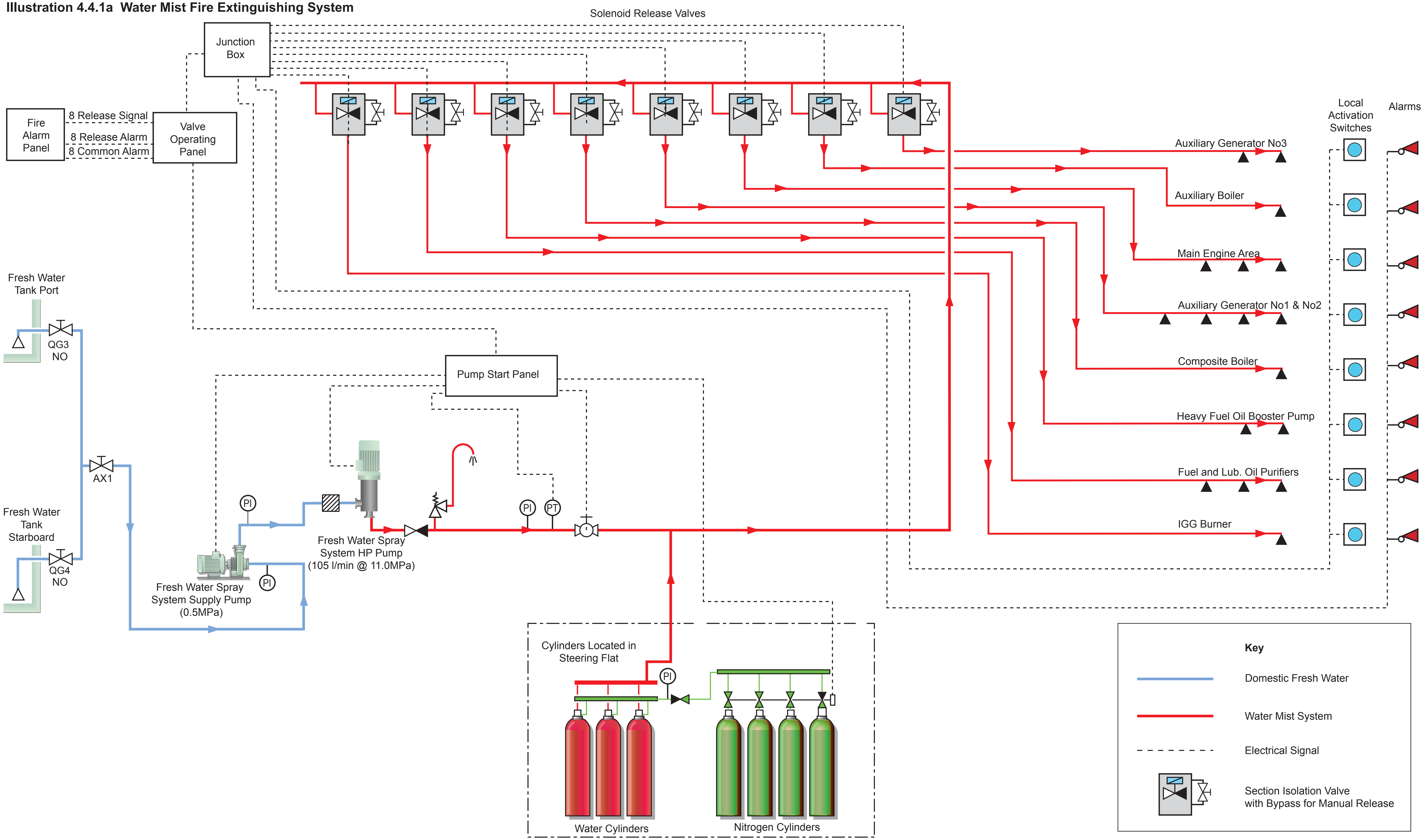
4.3.2 FIRE DAMPERS

The following engine room fans/vents are fitted with fire dampers and these are operated locally:

- Funnel louvres - aft side at F deck level
- No.1 engine room fan - port side C deck
- No.2 engine room fan - starboard side C deck
- No.3 engine room fan - port side C deck
- No.4 engine room fan - starboard side C deck
- Purifier room exhaust vent fan damper - forward side of funnel, A/Upper deck
- Funnel top access trapdoor - handle pull cable at base of funnel on port side by entrance door to funnel.

Some machinery space vent /fan mushroom covers are fitted with screw-down valves which are normally in the open position. These are closed by turning the handwheel so that the valve in the housing closes. Some local vents have mechanically operated dampers which are closed by means of a lever, the levers of such systems are moved to the open or closed positions as required. Other ventilation is provided by means of flaps or doors which should be closed and secured with the butterfly nut/bolts fitted.

Illustration 4.4.1a Water Mist Fire Extinguishing System



4.4 WATER MIST EXTINGUISHING SYSTEM

System manufacturer:	Semco Callenberg, Denmark
High pressure pump:	Danfoss PAH63
	105 litres/min x 11.0MPa
Low pressure pump:	Grundfoss CRN 5-3
	0.5MPa
Nozzles:	14 x DLI:7-01-56-5-12-00
	3 x DLI:7-01-56-5-19-00
Back-up cylinders:	
Water:	3 cylinders each of 80 litre
Nitrogen:	4 cylinders each of 80 litre

Description

The water mist system is supplied by a high pressure pump which in turn is supplied by a low pressure feed pump drawing directly from the vessel's domestic fresh water storage tanks.

Eight zones are protected by the water mist system and each zone has its own solenoid valve which is opened when a fire is detected in that zone and the release system is activated. When the release system is activated for a zone the fresh water mist system HP pump is started and the solenoid valve for the zone is opened. Water is directed to the distribution line for the protected space and the high pressure water issues from the nozzles in that protected zone in the form of very fine water mist. Water mist cools the zone and excludes oxygen, so it is ideal for protecting spaces where oil fires can occur.

The system is designed to use 62 litres/min when all nozzles for the largest system (main engine area) are open, the water mist system supply pump is designed to supply in excess of this amount to ensure that the system will remain operating with a ready supply of fresh water in the storage tanks.

In addition to the HP pump unit, the water mist system has a back-up arrangement consisting of three water cylinders and four nitrogen cylinders. Should the pump unit be unable to operate, the nitrogen in the cylinders will discharge the water cylinders to the protected space when the back-up system is activated. The back-up system provides 5 minutes of water flow to the largest system (main engine area), the system is activated automatically by the controller should the HP pump fail or be shut down due to a low low level in the domestic fresh water tank; this pump shutdown ensures that the pump does not operate without water.

The local control panel is incorporated in the pump unit which is located at the upper platform level on the starboard side aft, near the FW hydrophore tank. This allows the high pressure pump to be started or stopped if required.

The solenoid valves are located on the aft bulkhead adjacent to the pump unit. Additionally, each solenoid valve also has a lever for manually opening the individual valve and releasing the water mist as necessary.

The back-up fresh water and nitrogen cylinders are located in the steering gear room and are activated automatically in the event of pump failure. Local operation may be carried out by manually opening the valves on the nitrogen cylinders.

Each protected space has a local activation pushbutton for that space. There are activation pushbuttons for all spaces in the ship's fire control station. Activation of the system for a protected space is by pressing the activation pushbutton for that zone. At the valve operating panel in the ship's fire control centre, indicator lamps are provided for:

- System ready (lamp)
- System failure (lamp)
- Pump running (lamp)

There are pushbuttons for:

- Reset system failure
- Reset buzzer
- Lamp test

The system may be operated manually for any section by pressing the pushbutton for that section, but generally it will be activated automatically by the ship's fire monitoring and detection system. The water mist is released into a designated space when there are at least two fire detectors in a protected space in alarm at the same time.

Zone isolation valves are provided for the following items of machinery:

- Auxiliary Boiler (1 nozzle)
- Main Engine (3 nozzles)
- Diesel Generator No.1 and No.2 (2 nozzles each engine)
- Diesel Generator No.3 (2 nozzles)
- Composite Boiler (1 nozzles)
- FO Booster Unit (2 nozzles)
- Separator Room (6 nozzles)
- Inert Gas Generator (1 nozzle)

The nozzles are situated a maximum of 4 metres apart and between 1.5 and 10.6 metres above the object to be protected. This is to allow for the complete atomisation of the water droplets into a fine smothering mist covering the full protected area.

The water mist system activates the following alarms in the general alarm system:

- System failure
- Pump motor thermal failure
- Emergency stop activated
- System OFF
- Main bus/emergency bus supply failure
- Main valve closed (indicator switch)
- Low water level in storage tank
- Low nitrogen cylinder pressure

Operation

Should a fire occur in any of the above spaces, the system may be operated:

- Automatically upon activation of two fire detectors in a protected space.
- Remotely from the ship's fire station control panel for the water mist system. The water mist release pushbutton for a protected space is pressed; indicator lamps show that the system has been activated.
- Locally by pressing the water mist release pushbutton located outside the protected space.

The HP pump will start and deliver high pressure fresh water to the nozzles in the protected space when the pushbutton for a protected space is manually operated, or when an automatic release is initiated. The feed pump is automatically started in order to supply water under pressure to the HP pump suction. When the fire has been extinguished, stop the pump manually and reset all the valves to their standby positions.

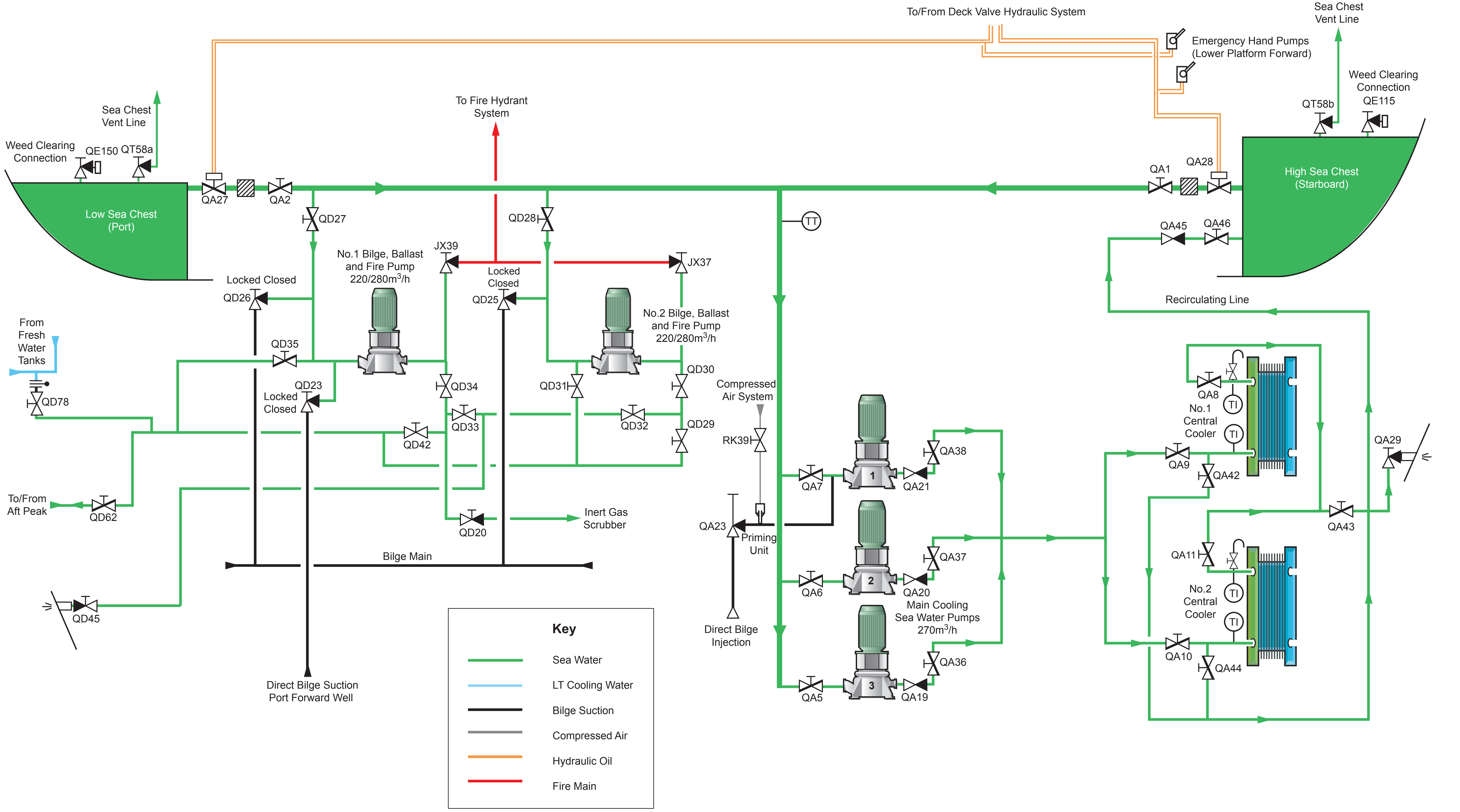
If the main HP water spray pump is not operational, the emergency back-up system comprising the water and nitrogen cylinders may be operated to protect any compartment. This emergency system has a limited water capacity for 5 minutes of operation. After release of the back-up system the water and nitrogen cylinders must be replenished as soon as possible.

Emergency Operation

In the event of failure of the control system the water mist system may be operated in emergency mode. The HP pump unit is started locally and the water is supplied to the protected space by manually opening the solenoid valve for the protected space, by use of the override lever on the side of the valve body. If necessary, the pump protection devices (low water level in the storage tank and motor thermal overload) may be bypassed by use of the switch Q1.2 inside the local starter panel.

SECTION 5: EMERGENCY PROCEDURES

Illustration 5.1.1a Emergency Bilge Suction



5.1 FLOODING IN THE ENGINE ROOM - EMERGENCY BILGE SUCTION

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 (at weekly intervals whenever possible), so that they can be operated easily when required. Valves such as fire pump suction valves, which are normally open, should be closed and re-opened regularly to prevent a build-up of marine growth.

Before opening sea water filters for cleaning, make sure all the isolating valves are tight by opening the vent in the cover. Always break the cover joint before removing all the cover bolts. This also 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 system, as a valve indicated as being shut, may be partially or even fully open.

All personnel should be familiar with the position of the various bilge suctions and valves as well as the pumps that may be utilised for bilge pumping duties. They should also be familiar with the position of the main sea suction and overboard valves and aware of which sea suction is currently in use.

The emergency bilge suction valve should be operated and lubricated on a regular basis, such as weekly.

Double bottom sounding pipe cocks should be kept closed when not in use and all caps secured. Self-closing devices must also be in use as appropriate.

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; strainers may be difficult to clean if flooding does occur.

Ship-side Valves

The main sea suction valves, high and low suction, are hydraulically operated, with remote operation from the engine control room and the ship's control centre. They may also be operated with the emergency handpumps located at forward end of the lower engine room platform adjacent to the spare cylinder liner.

Pumps Available for Bilge Pumping Duties

Engine Room Bilge Pump

5m^3/h x 0.30MPa

The engine room bilge pump can take suction from the engine room bilge main. The engine room bilge pump does not discharge water directly overboard only to:

- Dirty bilge tank
- Sludge pump discharge line to deck (port and starboard)

No.1 Bilge, Ballast and Fire Pump

220/280m^3/h x 1.0/0.45MPa

No.1 bilge, ballast and fire pump takes suction from the engine room bilge main and from a direct engine room bilge suction, which is located in the bilge well at the forward end of the engine room on the port side of the centre line. The bilge, ballast and fire pump discharges directly overboard.

No.2 Bilge, Ballast and Fire Pump

220/280m^3/h x 1.0/0.45MPa

No.2 bilge, ballast and fire pump takes suction from the engine room bilge main and discharges directly overboard.

Oil/Water Separator Feed Pump

5.0m^3/h x 0.23MPa

Takes suction from the engine room bilge main and both the clean and dirty bilge tanks, the pump then discharges overboard through the oil/water separator.

No.1 Central Cooling Sea Water Pump

270m^3/h x 0.25MPa

This pump may draw through a dedicated emergency bilge suction QA23 at the starboard side of the tank top, the valve for this is operated by an extended spindle from above the floor plate level aft of the scrubber pump.

During this operation main sea water pumps No.2 and No.3 are stopped and pump No.1 operated manually, the pump sea suction valve QA7 is throttled-in or shut as required. The pump discharges to the central coolers as normal and from them to overboard. Back-pressure may be reduced by opening the backflush/bypass valves QA42 and QA44.

5.1.1b Flooding in the Engine Room

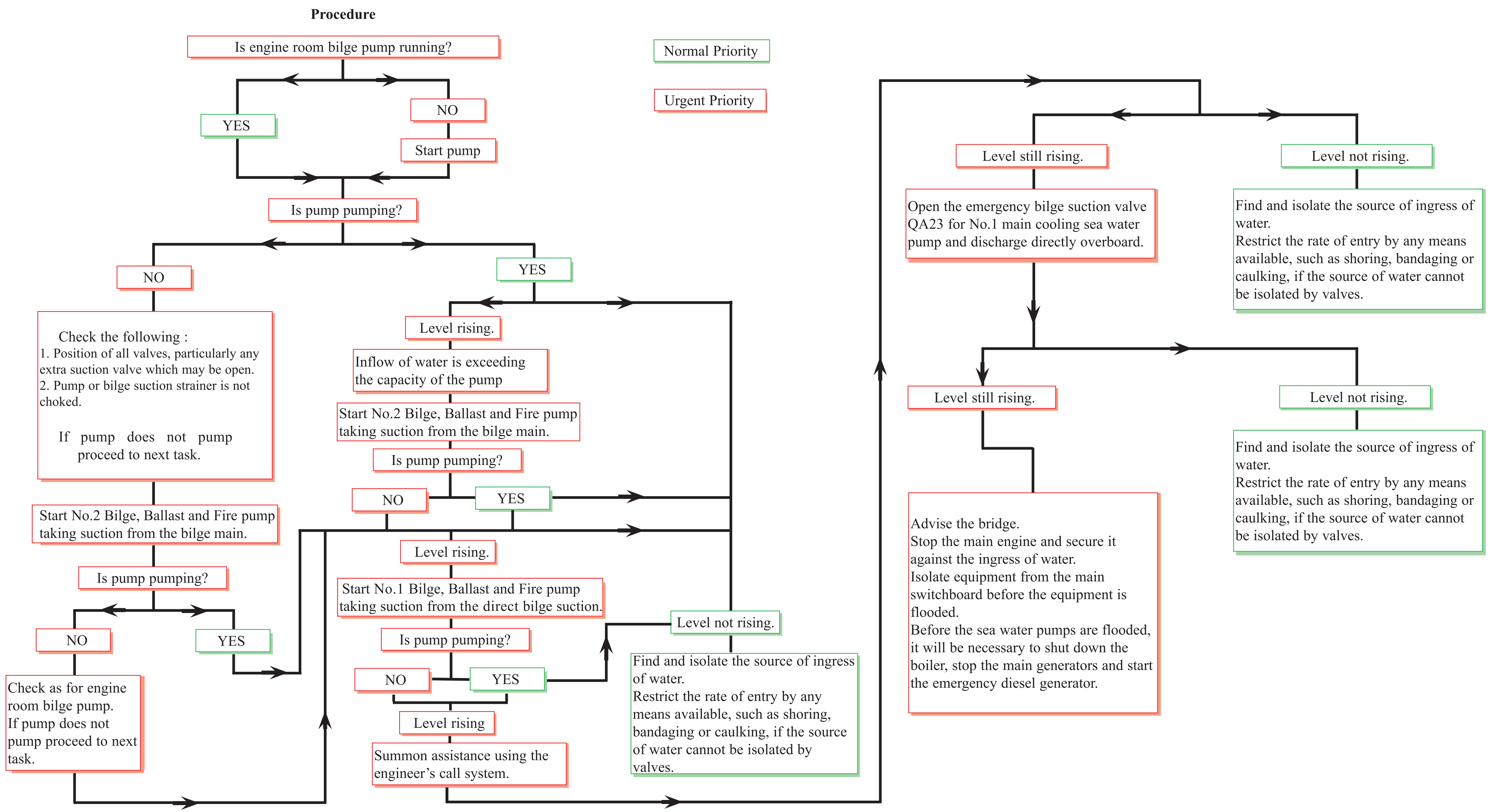
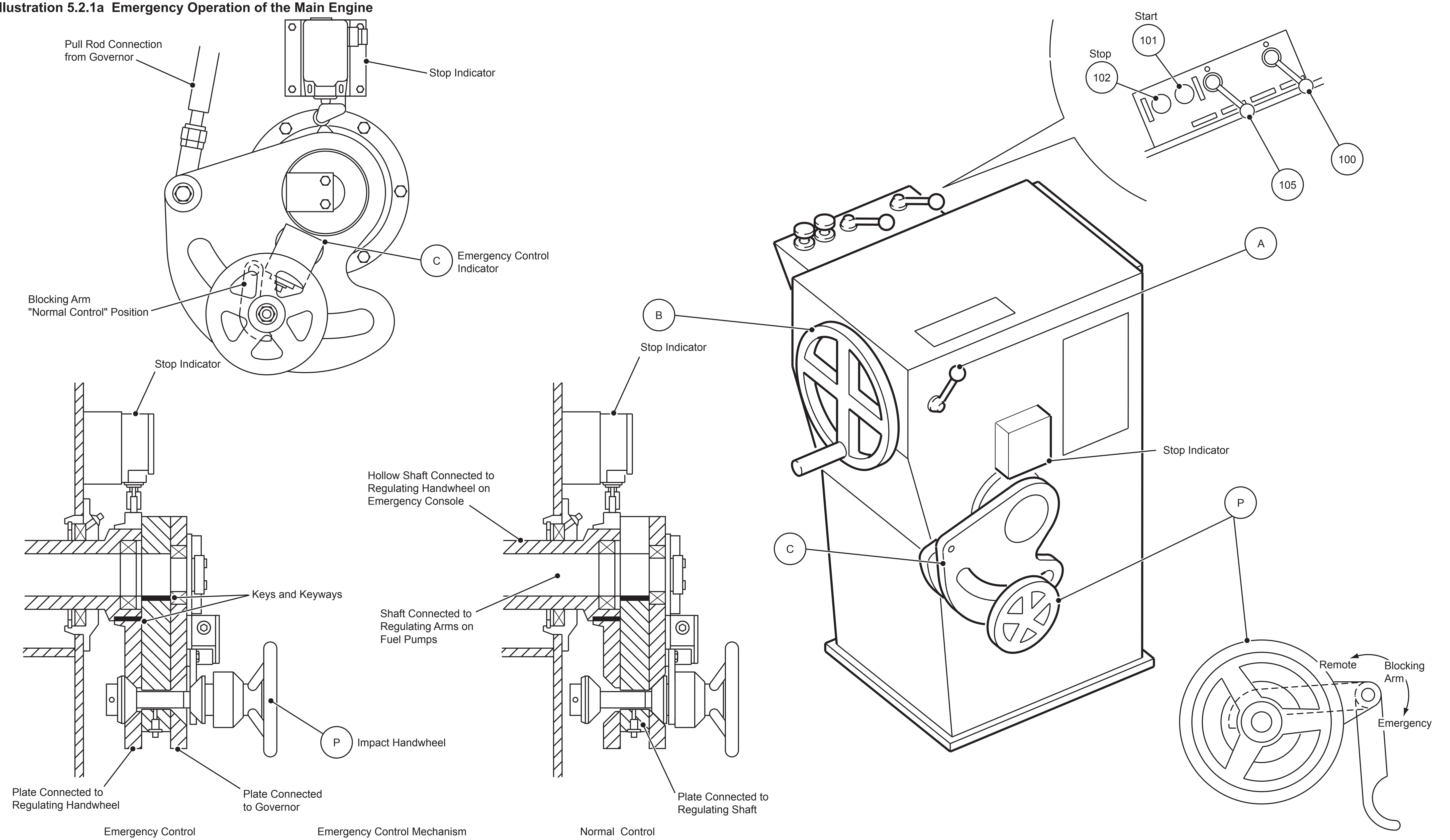


Illustration 5.2.1a Emergency Operation of the Main Engine



5.2 EMERGENCY OPERATION OF THE MAIN ENGINE

Emergency Control from the Engine Side

Note: The numbering of parts and valves is according to the MAN B&W engine operating manual.

The engine can be operated from the emergency control stand at the engine side (middle platform, port, aft) in the following circumstances:

1. As a result of breakdown of the normal pneumatic manoeuvring system.
2. As a result of a breakdown of the governor or its electronics.
3. If direct fuel pump index-control is required.

Note: The engine side control stand has priority over all other control locations. Control may be taken by the engine side control stand at any time by turning the valve 100 to the LOCAL position.

Changeover with a stopped engine:

a) Check that the valve 105, which is in the telegraph handle of the local control system is in the required position, ahead or astern, in which the engine is required to start.

Note: Reversing to a new direction is only possible when STOP valve 102 is activated (the pushbutton is depressed).

b) At the local control stand release the regulating handwheel by means of the small lever (lever A) located at the side of the stand. Turn this lever in the anti-clockwise direction to free the regulating handwheel.

c) Put the linkage blocking arm on the impact handwheel in the local (emergency) position.

d) Turn the regulating handwheel (B) to move the innermost lever of the changeover mechanism (C) to a position where the impact handwheel (P) is able to enter the tapered slots in both of the levers. Quickly turn the impact handwheel anti-clockwise. This will cause the governor to disconnect from the fuel pump control linkage and allow the local control stand regulating handwheel to be connected instead. Regulation of the engine speed can now be made locally by turning the regulating handwheel.

e) Change the position of the remote/local lever valve 100, from the REMOTE to the LOCAL position. The air supply is now directed to the valves of the manoeuvring system for emergency control from the local control stand.

f) The engine is now ready for starting from the local position at the engine side.

Note: Always keep the threads of the changeover mechanism well lubricated.

Procedure for Changeover to Engine Side Control with the Engine Running

a) Reduce the engine load to a maximum 80% of MCR.

b) Check that the position of ahead/astern lever, valve 105, corresponds to the present engine running direction.

c) Release the regulating handwheel (B) by turning the small lever (lever A) at the side of the control stand and then move the regulating handwheel to bring the tapered slots of the changeover mechanism plates into position opposite each other.

d) Put the blocking arm mechanism into the local (emergency) control position.

e) Quickly, move the impact handwheel (P) to the opposite position. This disconnects the fuel pumps from the governor and connects them to the regulating handle on the engine side control stand.

f) Move the REMOTE/LOCAL lever, valve 100, to the LOCAL position. This leads control air to the valves in the local control stand.

g) If the STOP pushbutton valve 102 is not deactivated the engine will now receive a STOP order.

h) Press the START pushbutton valve 101 briefly to provide an air impulse to deactivate the STOP valve 102.

i) The engine is now running under control from the local (emergency) control stand. Regulation of the engine speed can now be made locally by turning the regulating handwheel.

Note: When the governor is disengaged, the engine is still protected against overspeed by the electric overspeed trip, ie, the engine is stopped automatically if the revolutions increase to the overspeed setting. The overspeed shutdown can only be reset by moving the regulating handwheel to the STOP position. Manoeuvring must therefore be carried out very carefully, especially when doing so in rough weather. It should also be noted that when operating the engine from the local control stand, all of the engine monitoring systems are still functioning.

The auxiliary blowers must be operating, and these are started from the starter unit at the local control station. The telegraph and indicator box at the local control station provides information on the engine condition, such as speed, turning gear engaged and fuel cam position.

Procedure for Controlling the Engine from the Emergency Control Stand

a) To stop the engine depress the STOP pushbutton valve 102 at the local control stand.

b) To reverse the direction of the engine rotation, the ahead/astern lever, valve 105, must be moved to the new position. Reversing the engine is only possible when the STOP valve has been activated.

c) When the starting air distributor has been moved to the correct position for the rotational direction required and its position visually confirmed, the fuel control regulating handwheel can be moved to a suitable position to give fuel injection and a running speed of about SLOW.

d) To start the engine, the START valve 101 must be depressed.

e) When the start level rotational speed has been reached the START valve is deactivated by releasing the START pushbutton valve. The engine should now be running on fuel.

f) The engine speed can be manually controlled by operating the regulating handwheel which directly regulates the fuel injection pumps by moving the fuel pump control linkage.

5.3 EMERGENCY STEERING

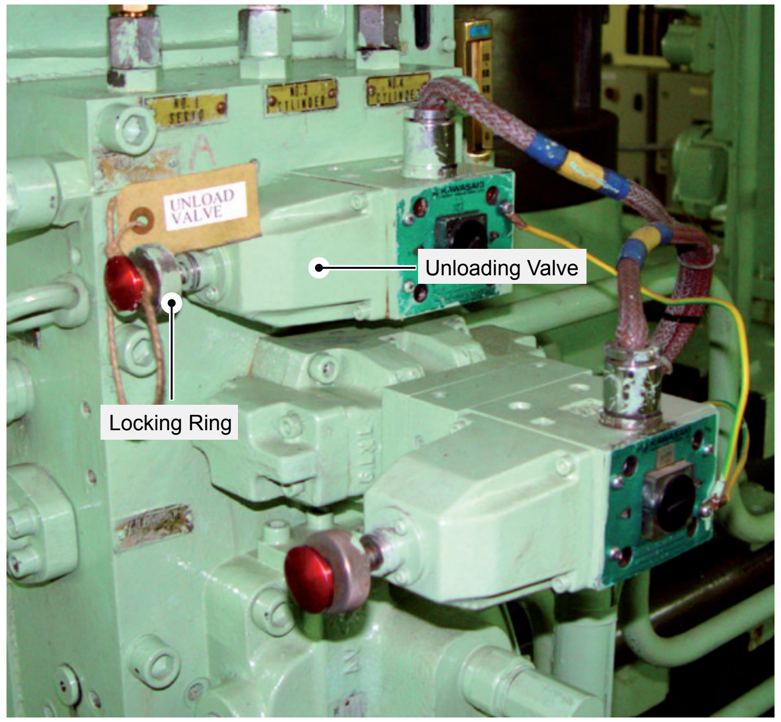
If failure occurs in the remote operating system from the wheelhouse, the steering can be operated from the steering gear room.

Description

The steering gear consists of a tiller, turned by a four cylinder hydraulic system, that in turn is driven by two 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.



Steering Gear Unloading Valve Block

Procedure for Operation of 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 with emergency steering only, one steering gear pump unit must be running.

b) Turn the LOCAL/REMOTE control switch to LOCAL control.

This switch is on the NFU (No Follow Up) panel on the starboard side of the steering gear room.

c) Operate the pushbuttons PORT or STARBOARD to turn the steering gear in the direction request by the bridge. The pushbutton is depressed for the period it takes to turn the rudder to the desired position, and then it is released in order to stop further rudder rotation.

If this system should fail, manual operation of the steering gear can be carried out as follows with one pump unit operating:

a) Switch off electrical power to the torque motor and select LOCAL for the pump unit.

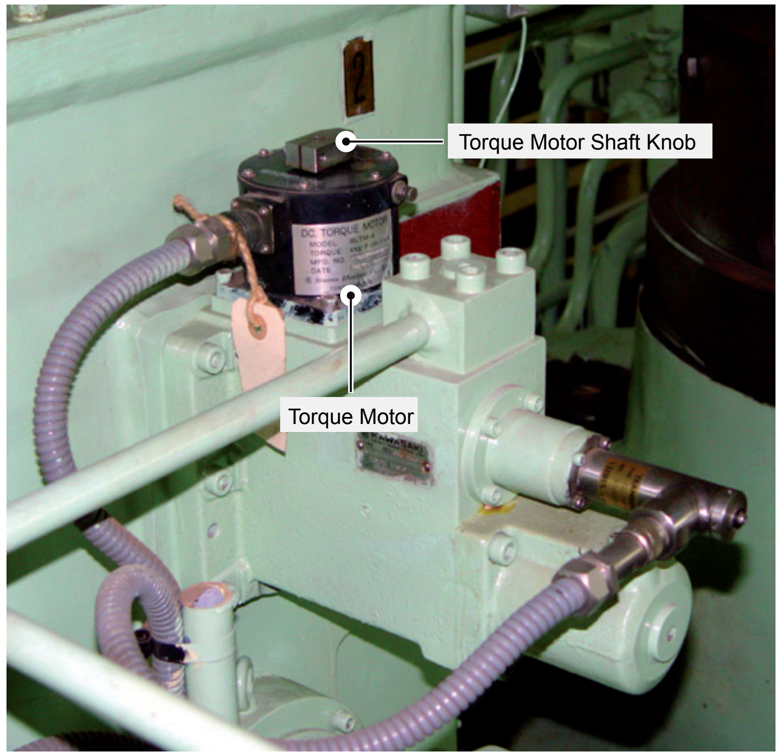
b) Push in the red pushbutton on the unloading valve of the operating pump unit and lock it in place by turning the screw locking device; check that the pushbutton remains locked in the depressed position.

c) The tiller can be moved in accordance with the steering command from the bridge by turning the pump control knob which is located at the top of the torque motor. This puts a stroke on the pump to produce the desired angle of rudder movement. The tiller will stop at the position set by the torque motor knob.

Emergency Steering Drill

Emergency steering drill should be carried out at least once every three months when traffic and navigational restrictions permit.

It is to consist of the direct operation of the main steering gear by using the manual control within the steering flat. This operation is to be directed from the navigation bridge. After each drill, details and the date it was carried out are to be entered in the Official Log Book and Particulars and Records Book.



Steering Gear Torque Motor

5.4 EMERGENCY FIRE PUMP

Manufacturer:	Shinko Industries
No. of sets:	1
Model:	RVP 130MS
Capacity:	72m^3/h at 0.90MPa

The emergency fire pump is located in a space below the steering gear compartment. Access to the emergency fire pump is through the steering flat which has entrances from the poop area of the upper deck and from the engine room. The pump is a vertical centrifugal pump type and is primed by a vacuum pump driven from the pump drive shaft.

The pump is electrically-driven with power supplied from the emergency switchboard 440V feeder panel.

The pump supplies 72m^3/h of water to the fire main at 0.90MPa, total pressure.

Starting and stopping of the pump can take place from the following locations:

- Locally at the pump
- At the top of the emergency fire pump compartment
- In the fire control station area in the ship's control centre
- The wheelhouse

The emergency fire pump draws water from a dedicated sea chest. The pump suction valve JX79 and the discharge valve JX81 are always locked in an open position. The pump discharges into the aft section of the fire main.

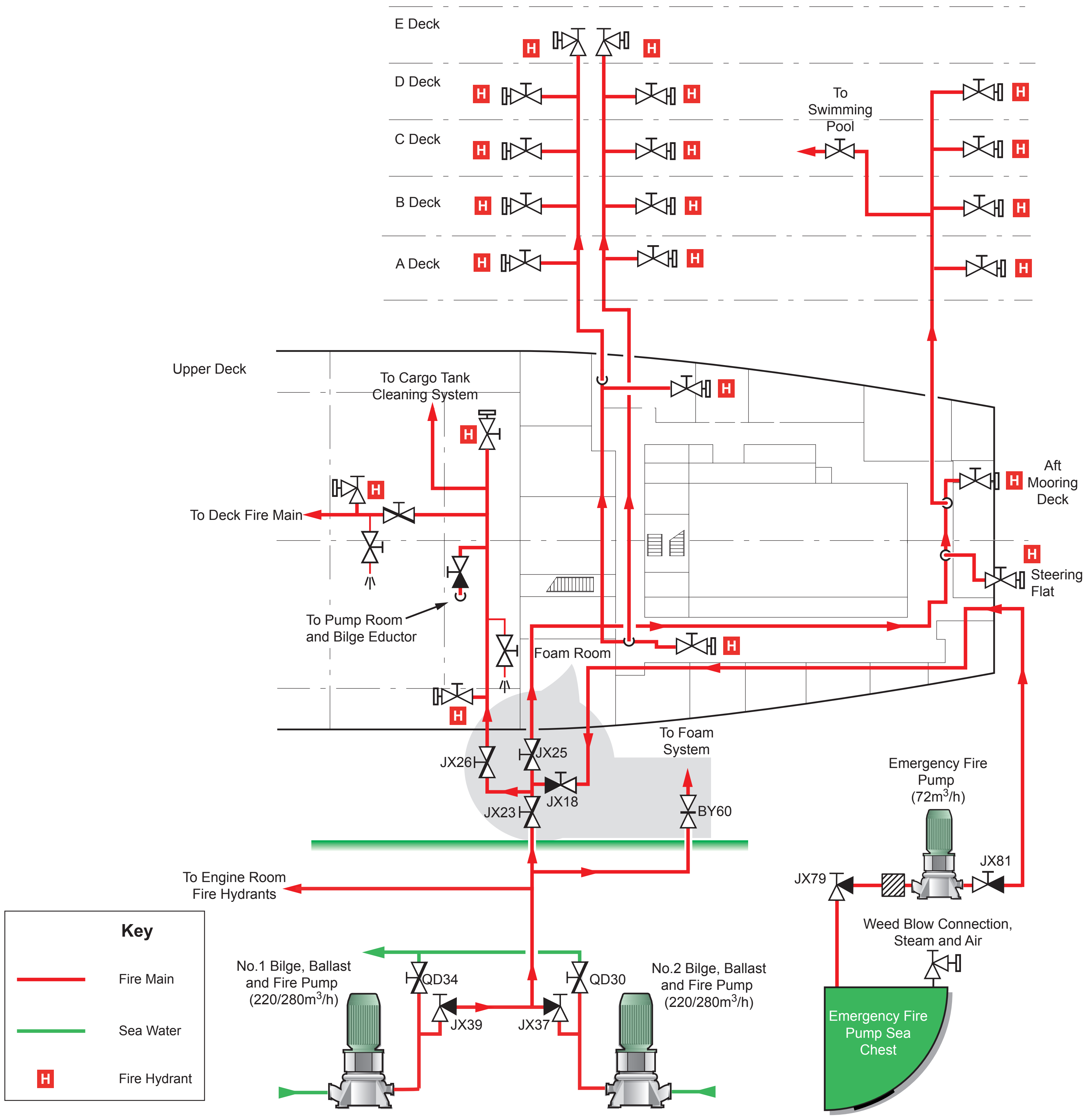
Operation of Fire Pump

When the pump is stopped, no pressure is detected at the pump discharge. The auto-cylinder pushes the vacuum pump friction drive coupling against the pump shaft friction drive coupling.

When the pump is started, the pump coupling drives the vacuum pump which is sealed by circulating water from the water tank. The vacuum pump draws air from the pump suction, which in turn primes the pump. The pump picks up suction and the pressure at the pump outlet disconnects the priming pump.

The emergency fire pump discharge line connects directly into the fire main through valve JX18 in the foam room. The foam room is located in the accommodation block on upper deck at the port side forward of the cross alleyway.

Illustration 5.4.1a Emergency Fire Pump Connection



5.5 FIRE IN THE ENGINE ROOM

Engine Room Fire Prevention

The best way of dealing with an engine room fire is to prevent one. Oil spills must be cleaned up as soon as they occur and oily waste or rags must not be left lying around. Any leakage from oil pipes must be rectified as soon as possible.

Rags, oily waste and similar combustible material must not be stored in the engine room and plastic containers must not be used for storing such material or used as drip trays.

Lagging must be correctly fitted to exhaust manifolds and the dripping of oil onto hot manifolds, even when lagged, must be prevented.

Fire detection equipment must be checked frequently and fire extinguishing appliances must be in an operable state at all times.

Should a Fire Occur in the Engine Room

WARNING

Under no circumstances should anybody attempt to tackle an engine room fire alone. It is essential that the fire alarm be raised as soon as an outbreak of fire is detected.

General

a) Immediately sound the fire alarm and muster the crew.

b) If personnel are missing, consider the possibility of searching in the fire area.

c) Determine the location of the fire, what is burning, the direction of spread and the possibility of controlling the fire.

d) If there is the least doubt whether the fire can be controlled by ship's crew, warn of the situation on the distress frequencies.

e) If the fire fighting capacity is limited, give priority to fire limitation until the situation is clarified.

f) If substances which are on fire, or close to a fire, may emit poisonous gases or explode, direct the crew to a safe position before actions are organised.

g) Establish the vessel's position and update the communication centre.

h) If any person is seriously injured, request assistance from the nearest rescue centre.

In Port

WARNING

Fire plans are housed in red cylindrical containers at the port and starboard accommodation entrances on the upper deck. These are positioned to assist outside parties to deal with a fire on board and should under no circumstances be removed.

i) Activate the emergency shutdown system in agreement with the terminal duty personnel.

j) Conduct a crew check.

k) Organise the crew for fire fighting duties.

l) Inform the terminal authorities and the local fire brigade even if the fire appears to be under control.

m) If personnel are missing, consider the possibility of searching in the fire area.

n) Close all accessible openings and hatches to prevent the fire spreading.

o) Prepare to disconnect the cargo and bunkering hoses and release the bunkering barge if applicable.

p) Prepare to vacate the berth, if required, and inform the authorities immediately if there might be problems in vacating the berth.

q) If there is a danger of the release of poisonous gases or of explosion, consider part or total ship abandonment. Ship drawings, cargo plans etc, should be taken ashore. A crew check is to be carried out again.

r) Consider using the fixed fire extinguishing systems, depending on the extent of the fire. The local pressurised water mist system applies to the specific areas of main engine, generators, boilers, and separator room whilst the CO_2 system covers all engine room spaces.

s) On the arrival of the fire brigade, inform the Chief Fire Officer of:

- Any personnel missing
- Assumed location of fire
- What is assumed to be burning
- Any conditions that may constitute a hazard

t) Assist the Chief Fire Officer with information and orientation, by means of drawings and plans.

If the fixed fire extinguishing system is to be used, take the following action:

Battening Down of the Engine Room

a) Stop the main and auxiliary engines and shut down the boiler.

b) Sound the evacuation alarm.

c) Stop all the ventilation fans.

d) Start the emergency generator and put on load.

e) Trip the quick-closing valves and the engine room auxiliary machinery from the fire control centre.

f) Count all personnel and ensure that none are in the engine room.

g) Close all fire flaps and funnel doors.

h) Close all doors to the engine room.

i) Start the emergency fire pump and pressurise the fire main.

j) Operate the pressurised water mist system or the CO_2 system depending upon the location and extent of the fire.

Operation of Water Mist Fire Extinguishing System

The fixed water mist system may be used to control or extinguish a fire in selected protected areas. The system will activate automatically and the fire alarm sounded if two or more fire detector heads in any one area register combustion.

The system for a particular protected space or area may also be activated from three independent positions. By means of the individual alarm/activation pushbutton located outside but adjacent to the protected space, at the valve block next to the water mist pump unit on the upper platform, starboard side aft. The water mist may also be manually activated remotely from the main control panel in the fire control station.

The use of the water mist system together with local firefighting and boundary cooling may be sufficient to extinguish a fire without resorting to use of the CO_2 system.

When operating the water mist system in a protected space the standard procedures for containing a fire should be followed, machinery shut down, ventilation stopped, all doors closed and appropriate quick-closing valves tripped.

Operation of Fixed Fire Extinguishing Systems

If the fixed CO_2 system fire extinguishing system is to be used, take the following action:

a) Stop the main engine and shut down the boiler.

b) Sound the evacuation alarm.

c) Stop all the ventilation fans.

d) Start the emergency generator and put it on load.

e) Trip the quick-closing valves and engine room auxiliary machinery from the fire control centre.

f) Count all personnel and ensure that none are in the engine room.

g) Close all fire dampers and flaps and funnel doors. Close all doors to the inert gas plant and engine room.

h) Start the emergency fire pump and pressurise the fire main.

i) Operate the CO_2 system.

Emergency Stops

The emergency stop panels are located in the fire control station next to the ship's control centre on A deck.

ESS-1

(Engine room fans)
No.1, No.2, No.3 and No.4 engine room supply fans
No.1 and No.2 main engine auxiliary blowers
ECR air conditioning unit
45D power distribution board

ESS-2

(Accommodation fans and galley equipment)
Air conditioning fans
CO_2 room fan
47D and 4AD power distribution panels
22D and 23D 220V power distribution panels.

ESS-3

Ballast pump room exhaust fan

ESS-4

(Engine room oil pumps)
HFO and MDO purifiers
HFO and MDO transfer pumps
Main engine No.1 and No.2 lubricating oil pumps
Main engine No.1 and No.2 camshaft oil pumps
Auxiliary boiler control panel
FO supply units No.1 and 2
FO supply units control panel
Incinerator
Hydraulic power pack control panel
41D power distribution board
42D power distribution board
4ED power distribution board

ESS-5

No.1, No.2 and No.3 generator engines

ESS-6

(Cargo and inert gas system)
No.1 and No.2 inert gas fans
IGG FO pump
No.1 and No.2 hydraulic power packs

Emergency stop pushbuttons are also provided in the wheelhouse for:

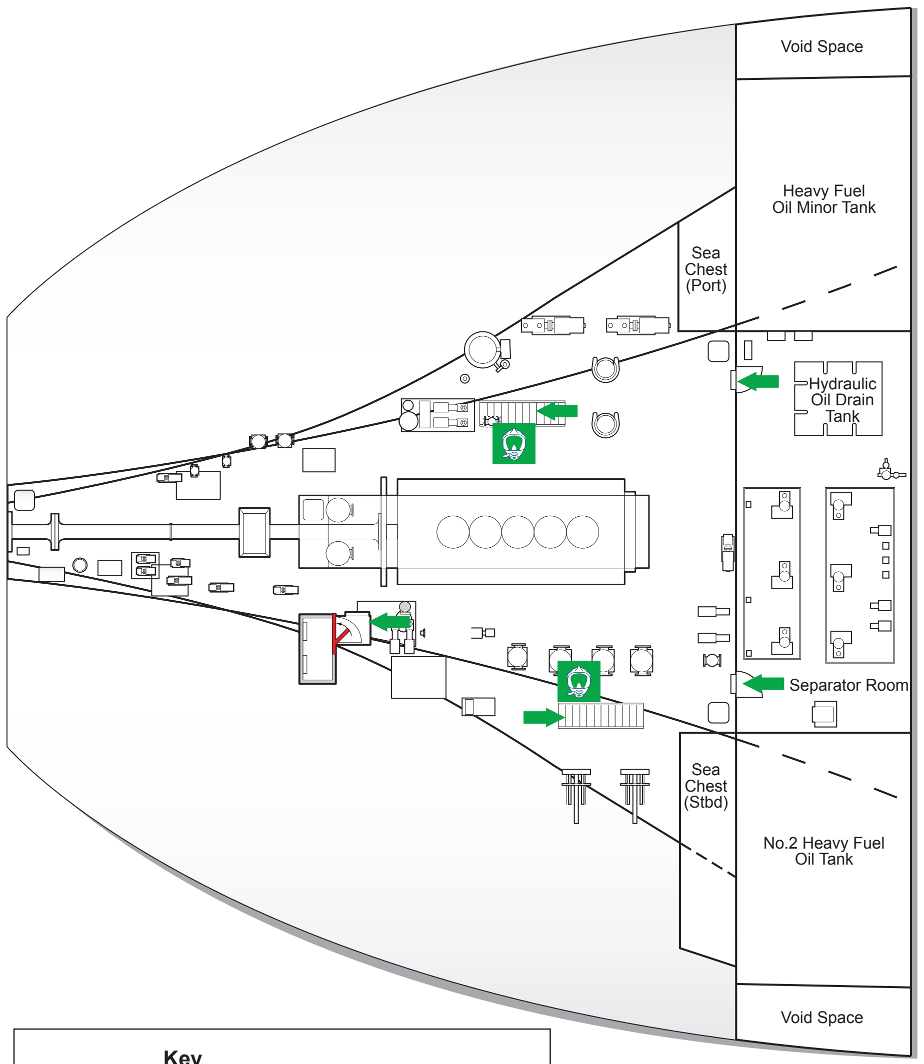
- **ESS-1** - Engine room fans and auxiliary blowers
- **ESS-2** - Accommodation fans and galley equipment
- **ESS-3** - Ballast pump room fan

Emergency stop pushbuttons for the HFO and MDO transfer pumps are also provided at the port and starboard bunker stations.

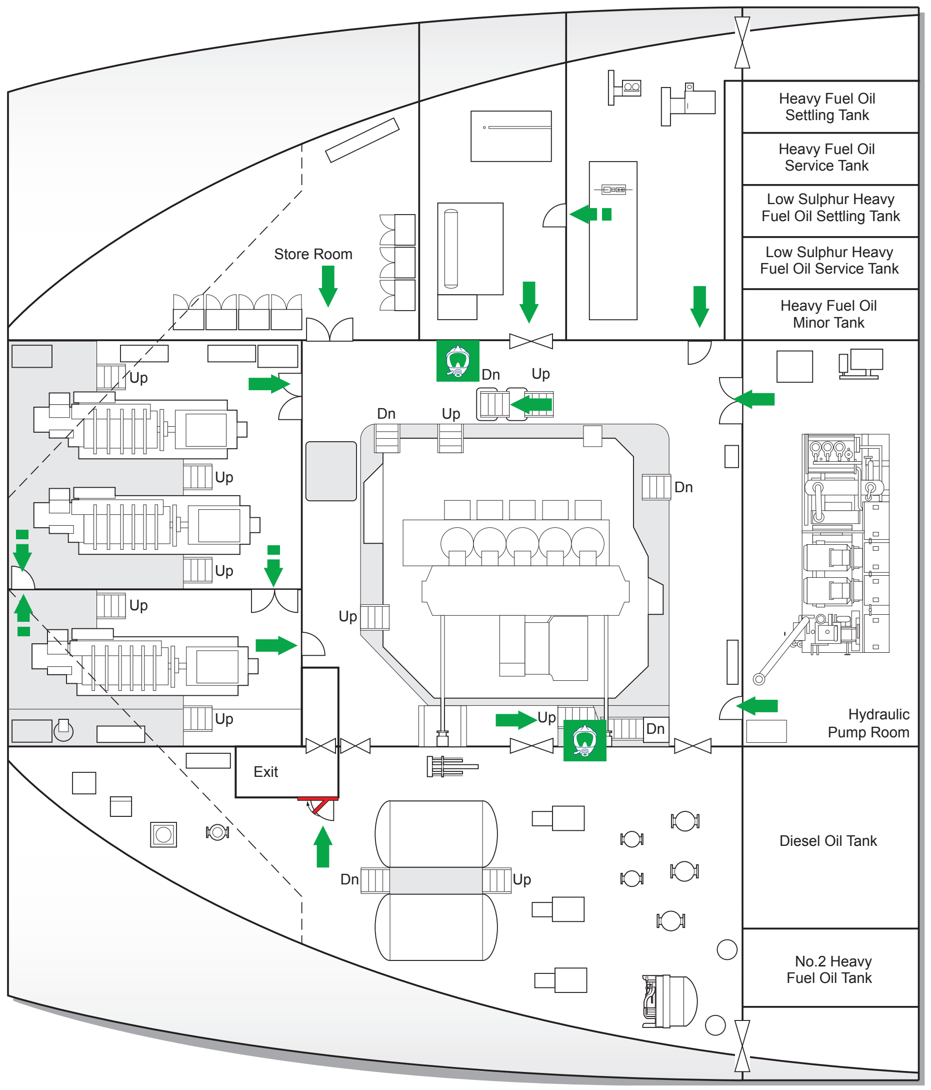
5.6 ESCAPE SYSTEM AND FIRE DOORS

Illustration 5.6a Lifesaving Equipment, Escape Routes and Fire Doors in Engine Room

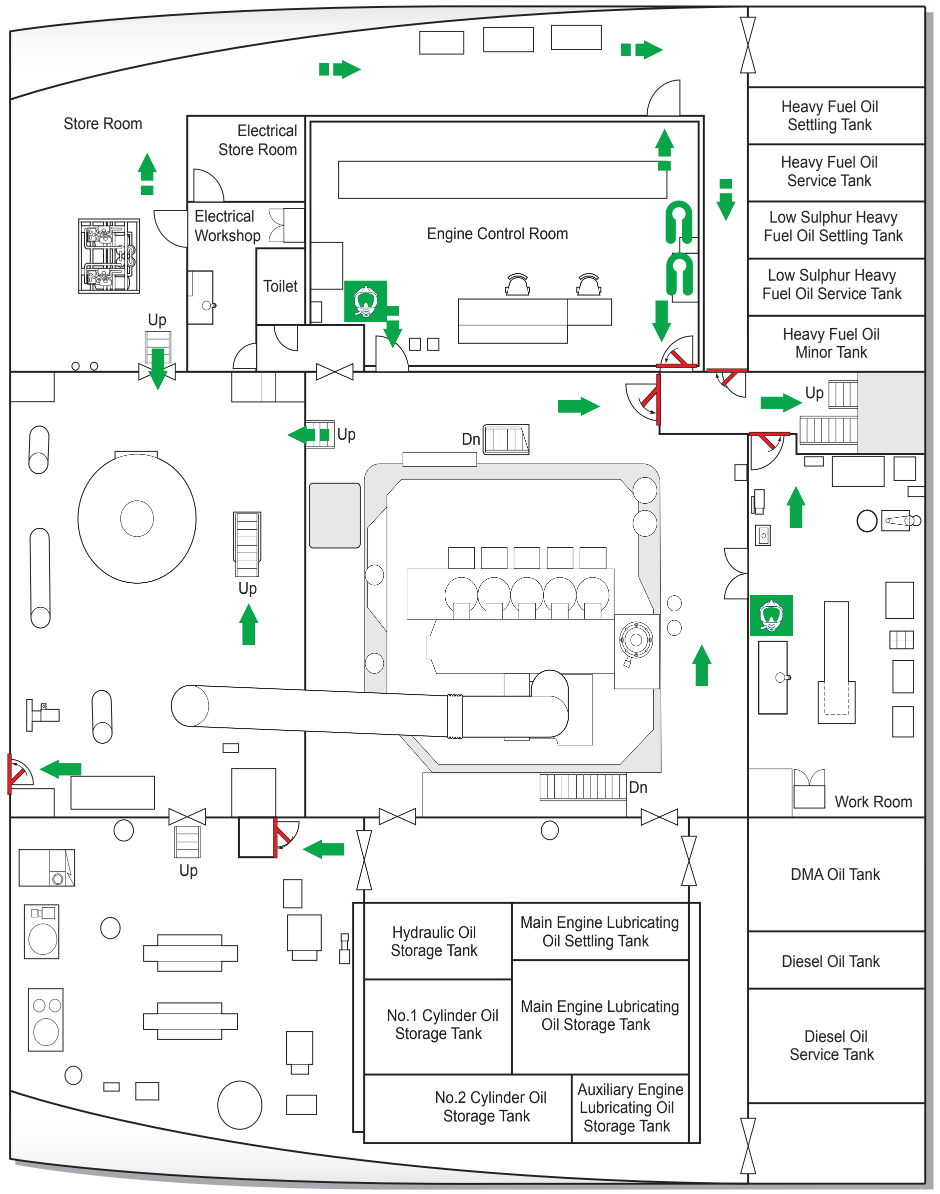
Engine Room Floor



Engine Room Lower Platform



Engine Room Upper Platform



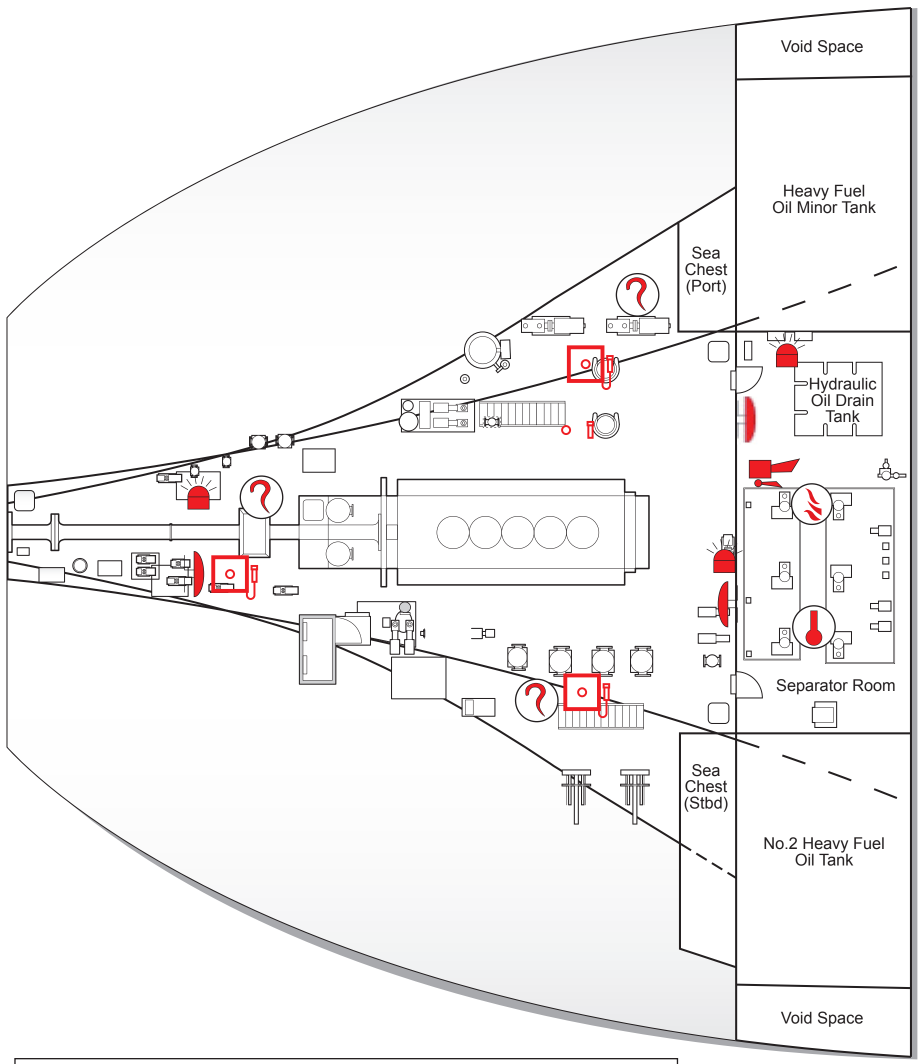
Key

- Fire Door Class A Self-Closing
- Secondary Escape
- Primary Escape
- Life Jacket
- Emergency Escape Breathing Device

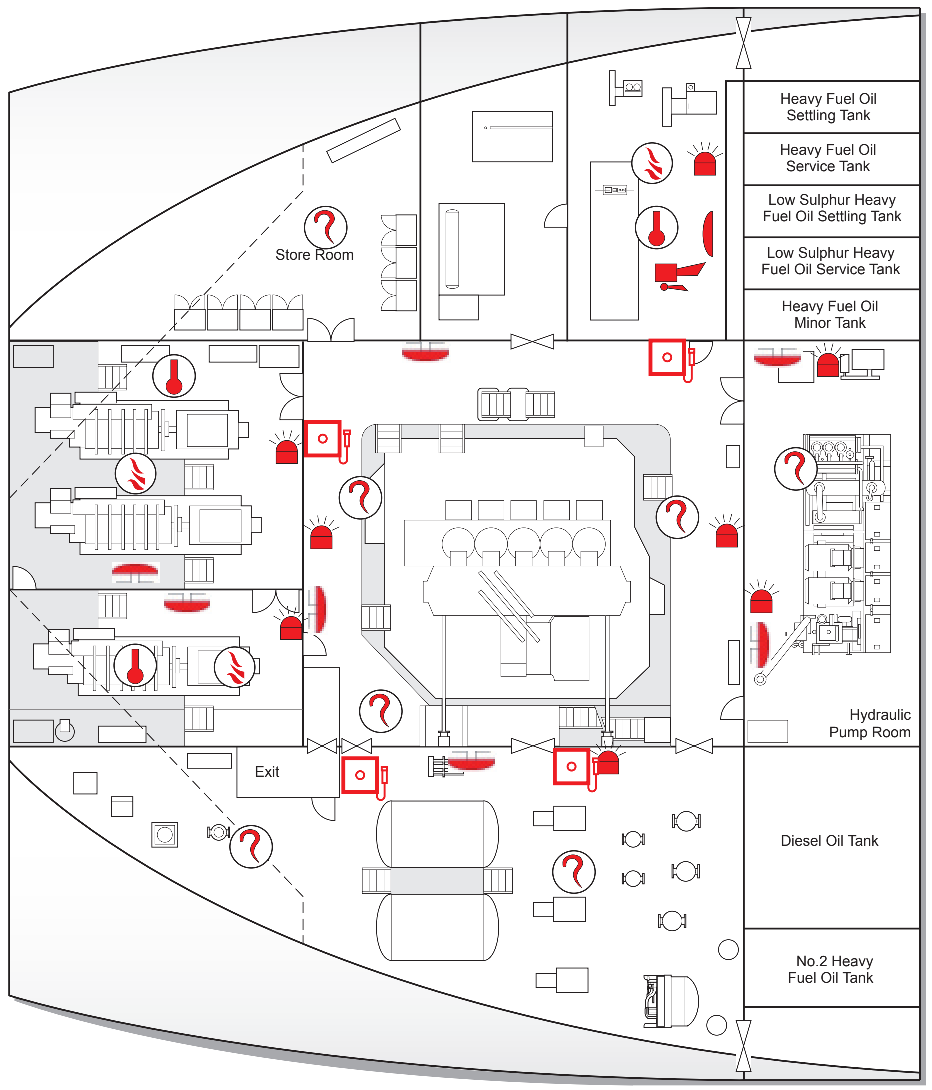
5.7 FIRE ALARMS

Illustration 5.7.1a Fire Alarm and Detection System in Engine Room

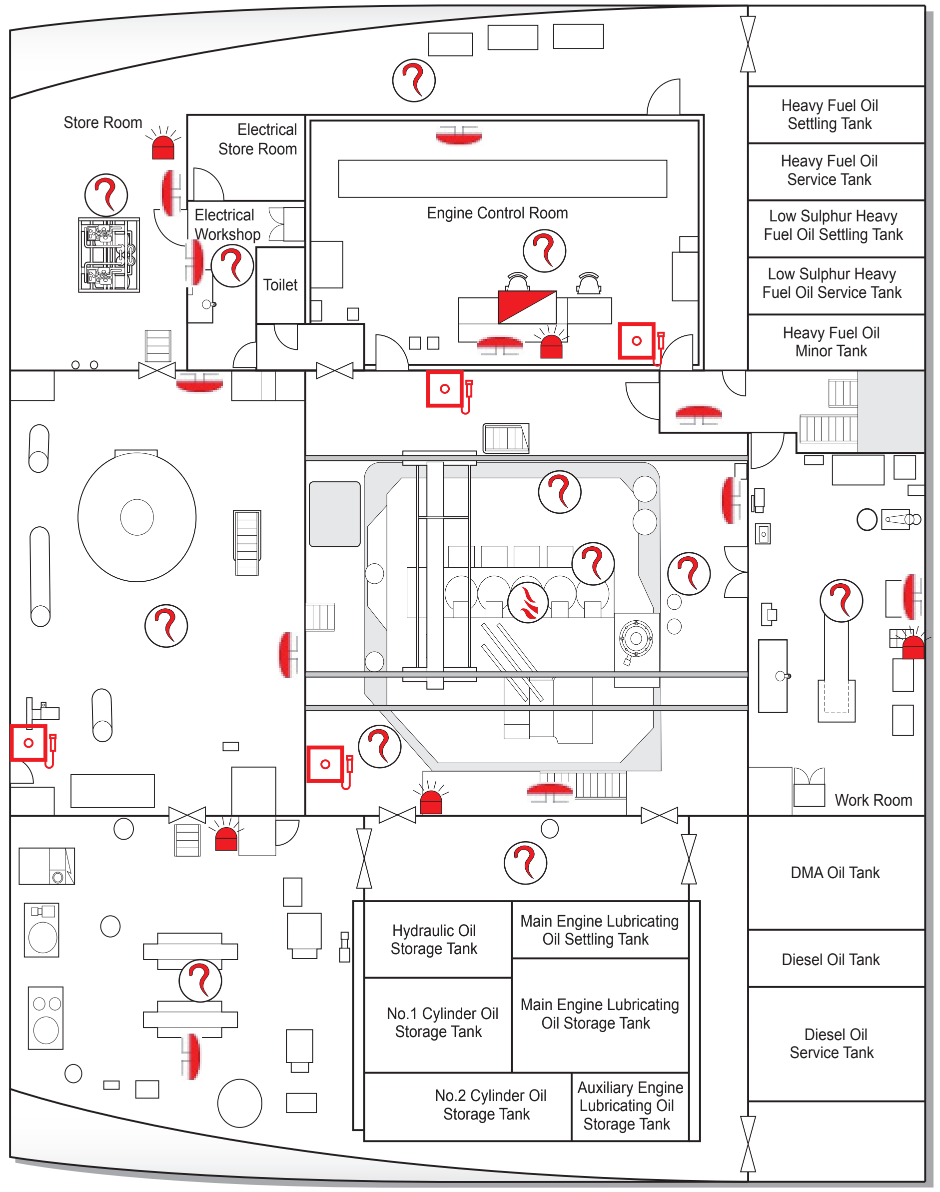
Engine Room Floor

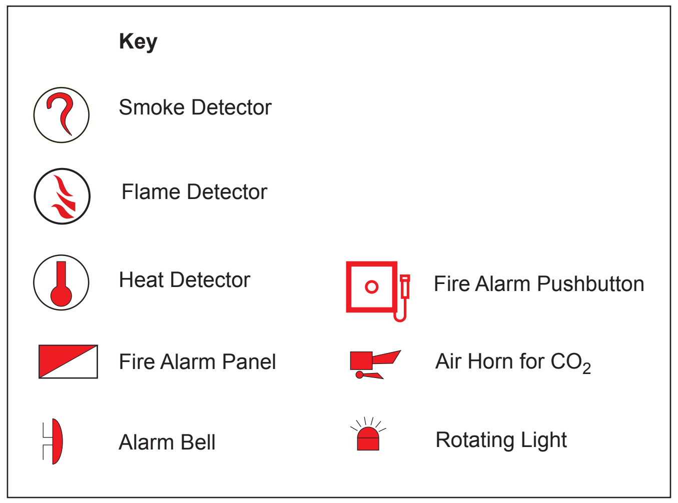


Engine Room Lower Platform



Engine Room Upper Platform

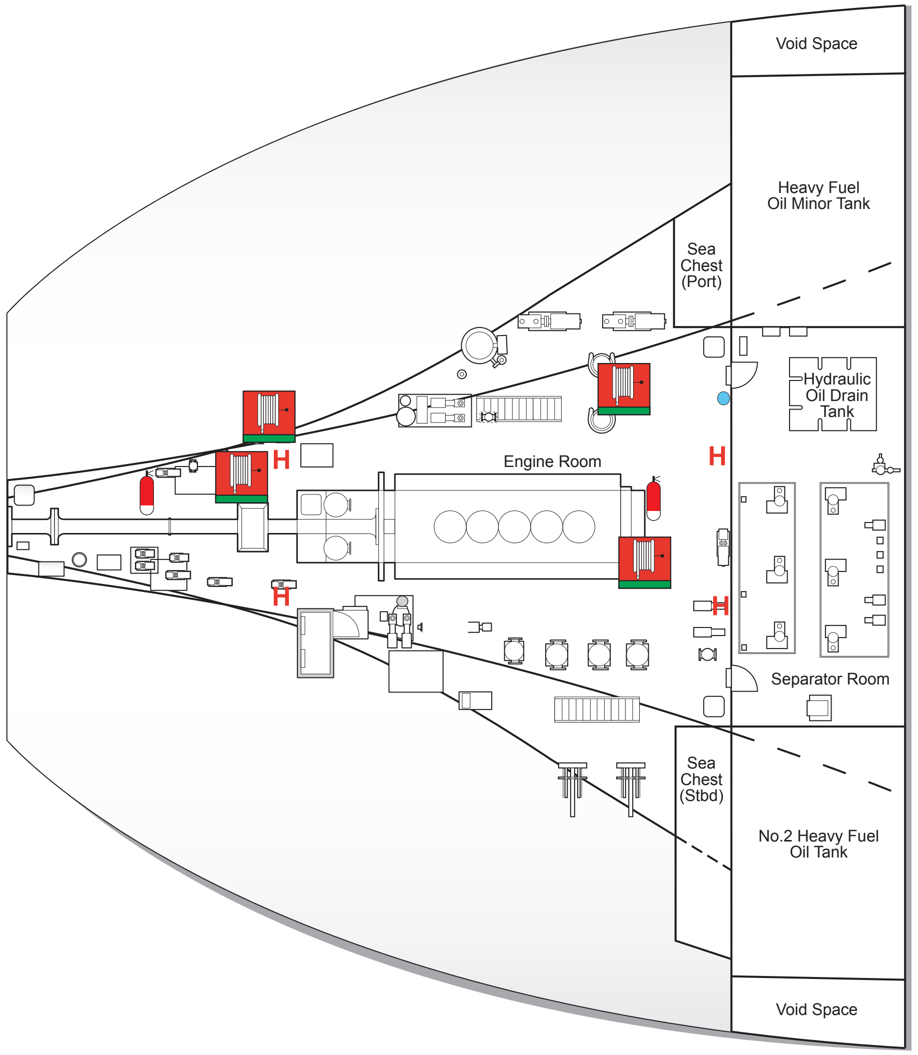




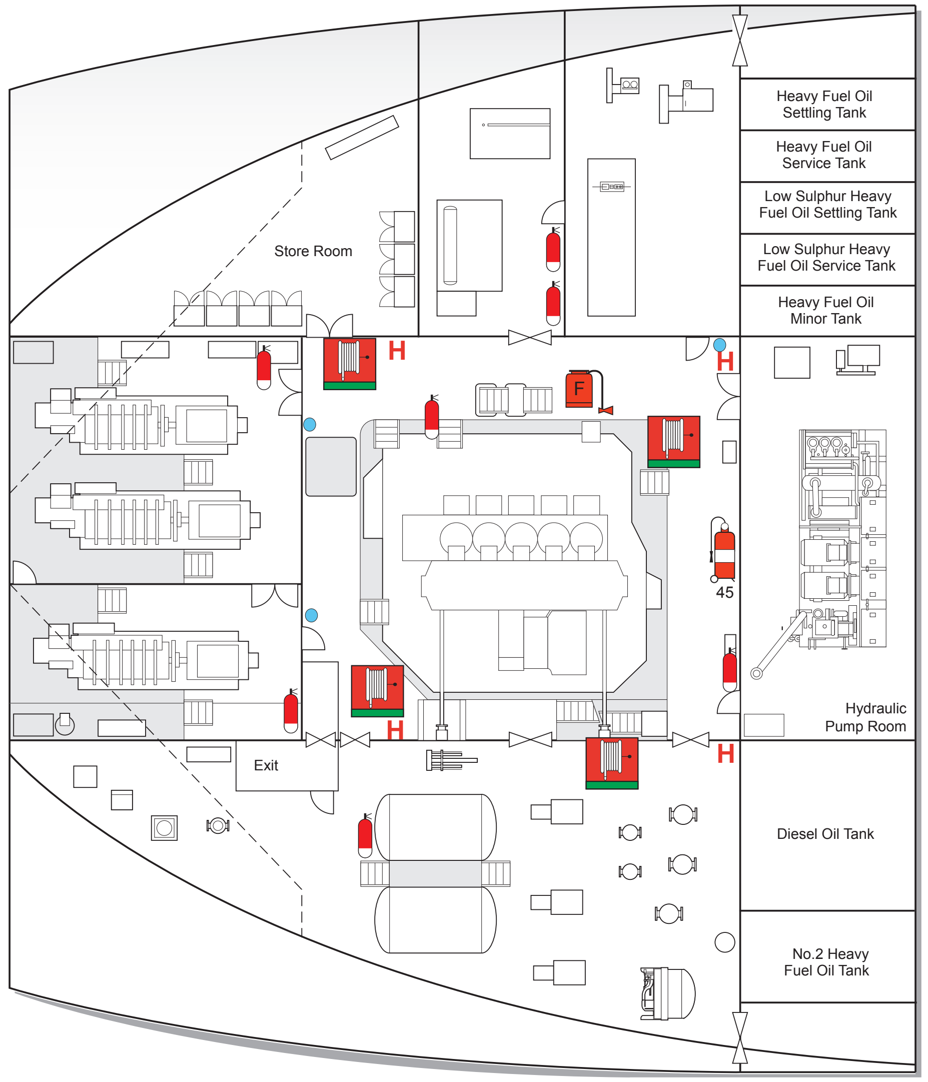
5.8 FIRE FIGHTING EQUIPMENT IN THE ENGINE ROOM

Illustration 5.8.1a Fire Fighting Equipment in the Engine Room

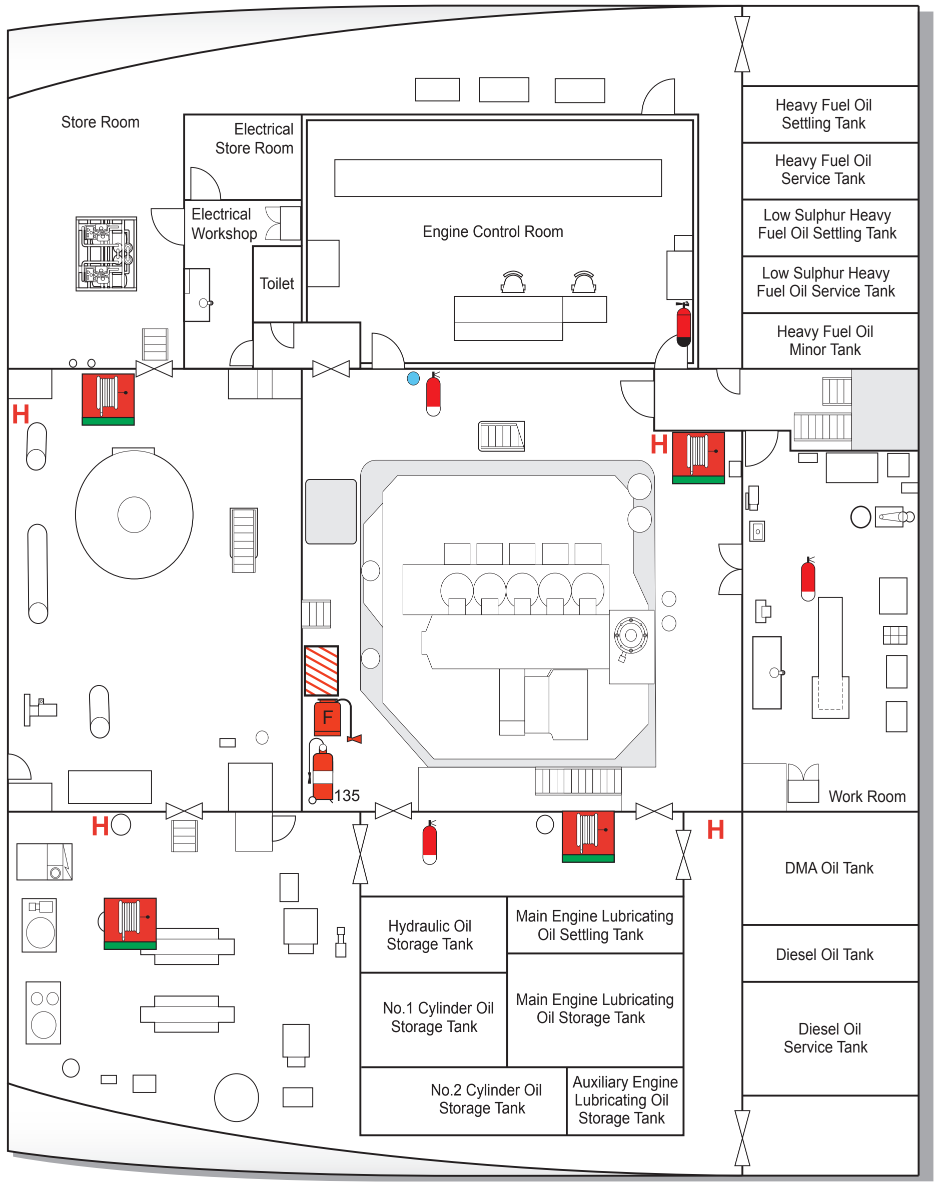
Engine Room Floor



Engine Room Lower Platform



Engine Room Upper Platform



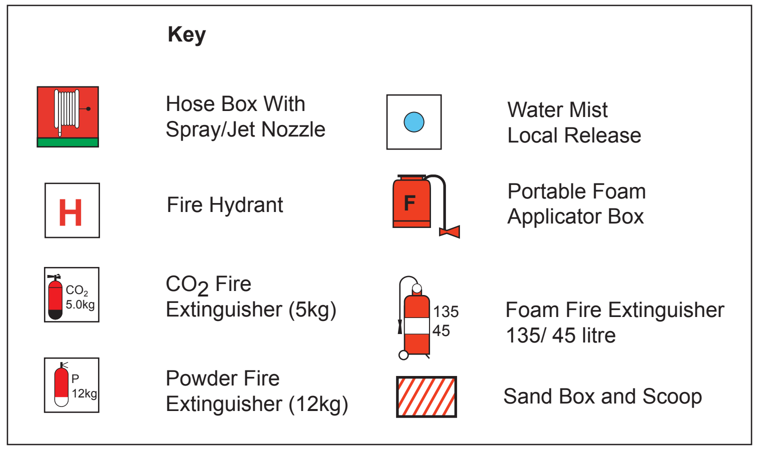
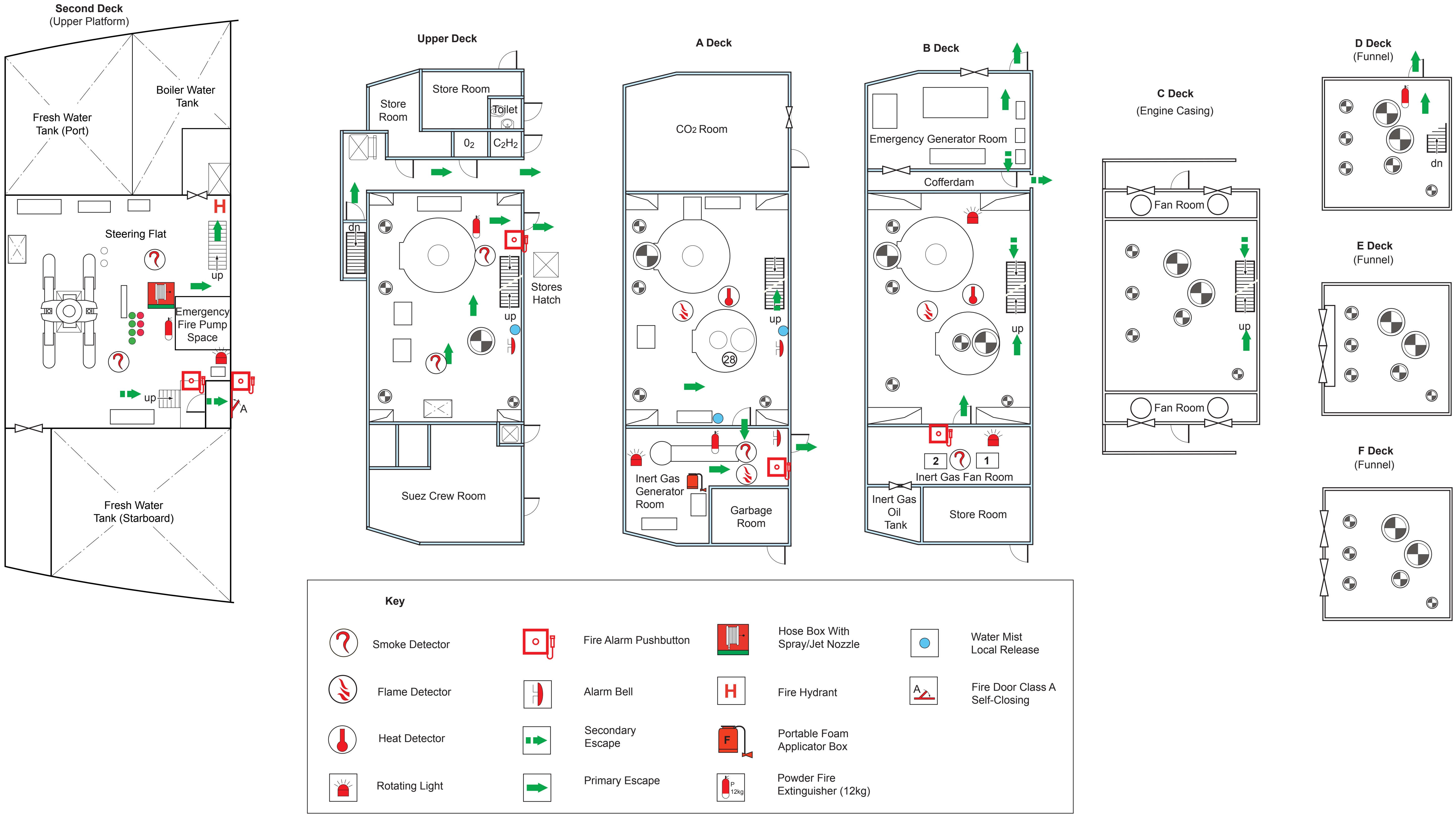


Illustration 5.9a LSA, Fire Alarms and FFE in Steering Flat and Engine Casing



SECTION 6: COMMUNICATIONS

6.1 Communication Systems

6.1.1 UMS 2100 System

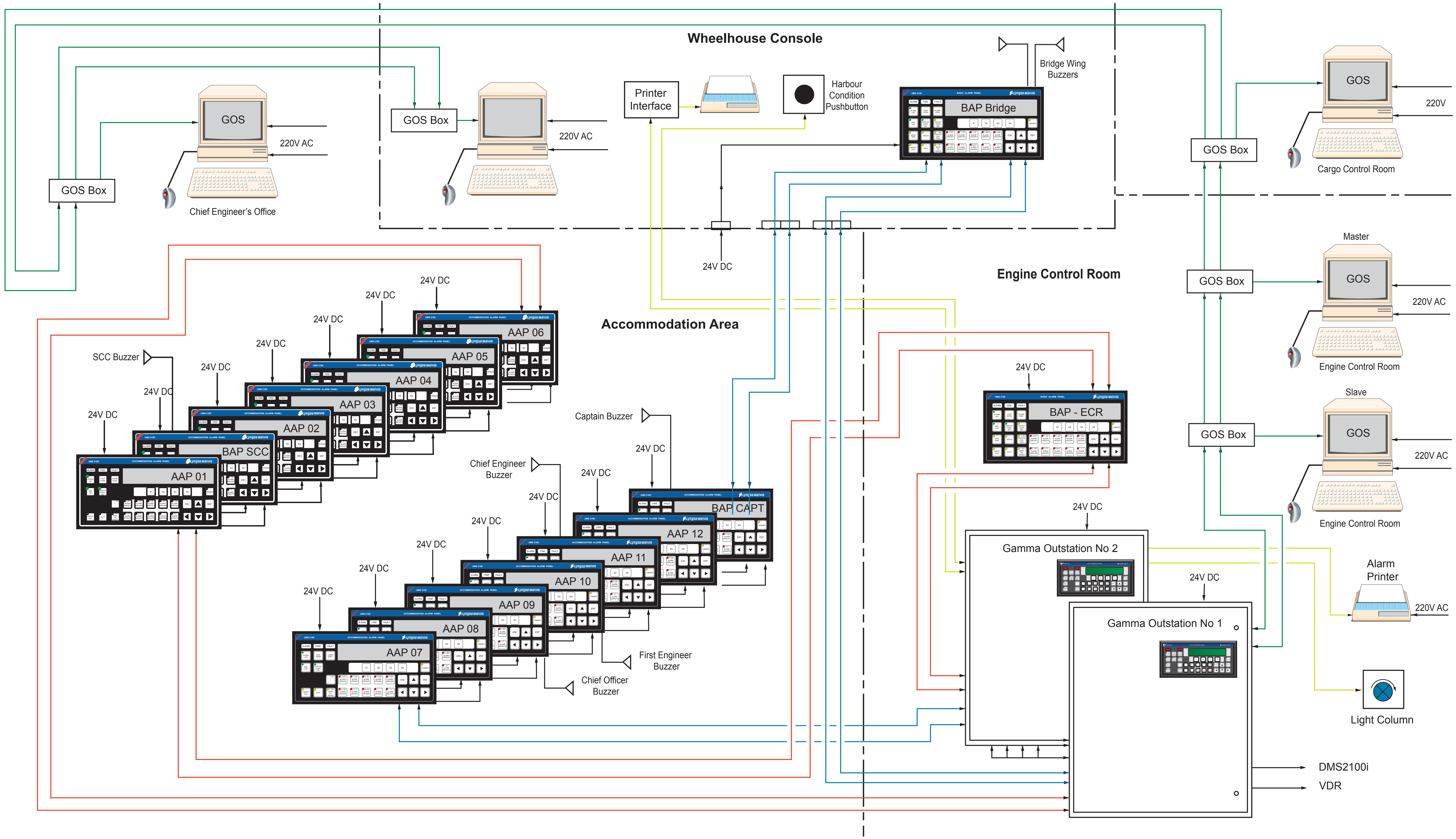
6.1.2 Intrinsically Safe Sound Powered Telephone System

6.1.3 Automatic Telephone System

6.1.4 Public Address System

6.1.5 Shipboard Safety Management System

Illustration 6.1.1a UMS 2100 System



6.1 COMMUNICATIONS SYSTEMS

6.1.1 UMS 2100 SYSTEM

Manufacturer: Lyngsø Marine
Type: UMS 2100

Introduction

The purpose of an alarm and monitoring system is to collect the information concerning safety on board the ship and to monitor the alarm situation.

The system carries out the following tasks:

- Acquisition of supervision data, ie, sensor values
- Detection of alarm states, ie, illegal values or states
- Announcement of detected alarms
- Supervision of engineer response
- Logging of alarms and events

After discovering an alarm situation, the system will announce this to the duty engineer and the bridge, thereby making it possible to safely operate the ship with ‘unmanned machinery spaces’.

The alarm is not only presented as an alarm in general but also as an alarm group. The engineer can determine the nature of the alarm quickly, for example. from either the main engine, pumps, power plant, fire and so on.

When the system detects an alarm, it announces it both by a light, a sound, and on various types of text displays. In response to the alarm announcement, the engineer must stop the buzzer/horn and acknowledge the alarm, in order to confirm that he is aware of what has happened. Failure to do this, within a reasonable period of time which is typically 5 minutes, will result in the system announcing the alarm in all possible locations.

An alarm has four states:

- Normal
- Normal and not acknowledged
- Present but not acknowledged
- Present and acknowledged

The ECR station is the centre of the system, and it is from here that the alarms must be acknowledged, even though the alarm may be muted at other location panels.

Note: Silencing the buzzer/horn has no significance to the alarm state. The alarm must be acknowledged in order to avoid the ‘ALL ENGINEERS CALL’.

Alarms Cut-out

In some cases alarms may need to be disabled (suppressed), for example, if the sensor is faulty, if work is being carried out that may cause undesired alarms or when the main engine is stopped resulting in a low fuel oil pressure alarm.

Suppression of alarms can be activated at the ECR station or the local operating panel after inserting a valid password.

WARNING
Alarm suppressions should only be carried out by authorised personnel.

Description

Bridge and Accommodation Alarm System

The advising of an alarm to the duty engineers takes place through the Accommodation Alarm Panels (AAPs) which are located in the cabins of the duty engineers and the public rooms, and on the Basic Alarm Panels (BAPS) on the bridge and in the SCC.

When an alarm occurs, the buzzer on the bridge will sound, and the navigator can only silence it locally by pressing STOP HORN at the bridge panel or the duty officer can silence it by pressing the STOP HORN pushbutton at the SCC panel when in port. This will not affect the status of the alarm anywhere else.

To select/deselect ‘unmanned machinery spaces’ a request is raised from the ECR panel to the bridge panel. This may be accepted or rejected by the bridge, or withdrawn by the ECR.

Any of the AAPs located in the cabins can be brought to function as the panels in the public rooms. Therefore, a cabin panel not selected on duty, can be selected to give alert as the alarm occurs. This allows a duty engineer to visit another cabin other than their own.

Duty Engineer Watch System

When a UMS alarm sounds, the duty engineer can acknowledge the alarm either in his cabin or a public room, depending where the engineer is when it occurs.

The action is to first silence the buzzer/horn locally and then proceed to the ECR panel to silence and acknowledge the alarm at source.

Failure to acknowledge the alarm at the ECR panel within predetermined time (typically 5 minutes) will result in an ‘ALL ENGINEERS CALL’ announcement on all panels.

A back-up engineer can also be selected if necessary, in case the duty engineer does not respond to an alarm.

UMS 2100 Printer

The printer is controlled from the ECR panel and the bridge panel, however, only the printing of reports are possible from the bridge.

The following information can be printed:

- Alarm/Event log
- Data log
- Alarm list
- Cut-out list

Alarm/Event log

This log contains events concerning:

- Alarms changing from normal to alarm and vice versa
- Change of state of event channel
- Channels entering and leaving cut-out states
- System and configuration error messages
- Entering and leaving of privileged modes
- Change of duty engineers and ‘Unmanned Watch Station’ status
- Change of system date and time

Data Log

This is a report on channels showing their current value or status.

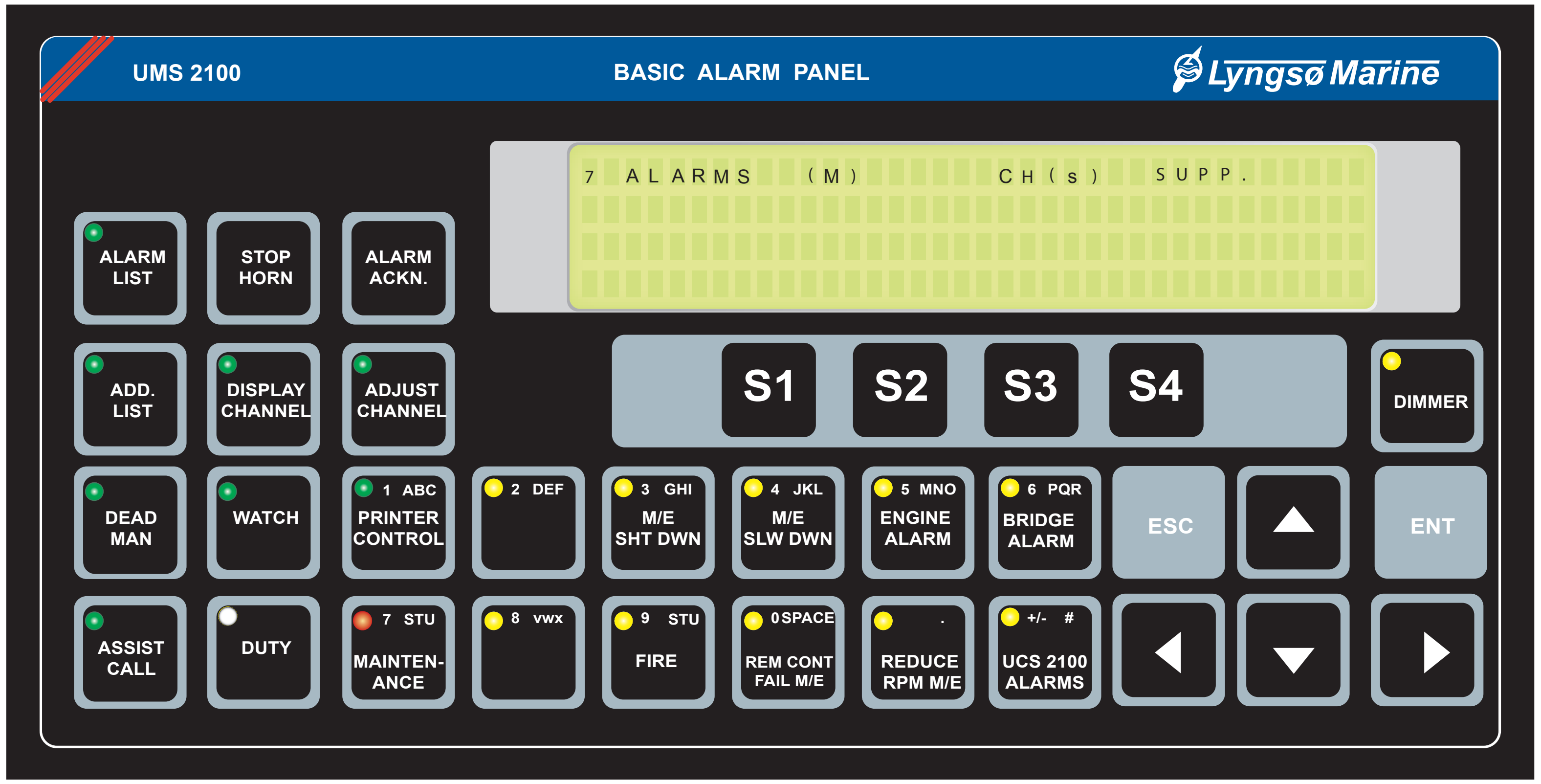
Alarm List Report

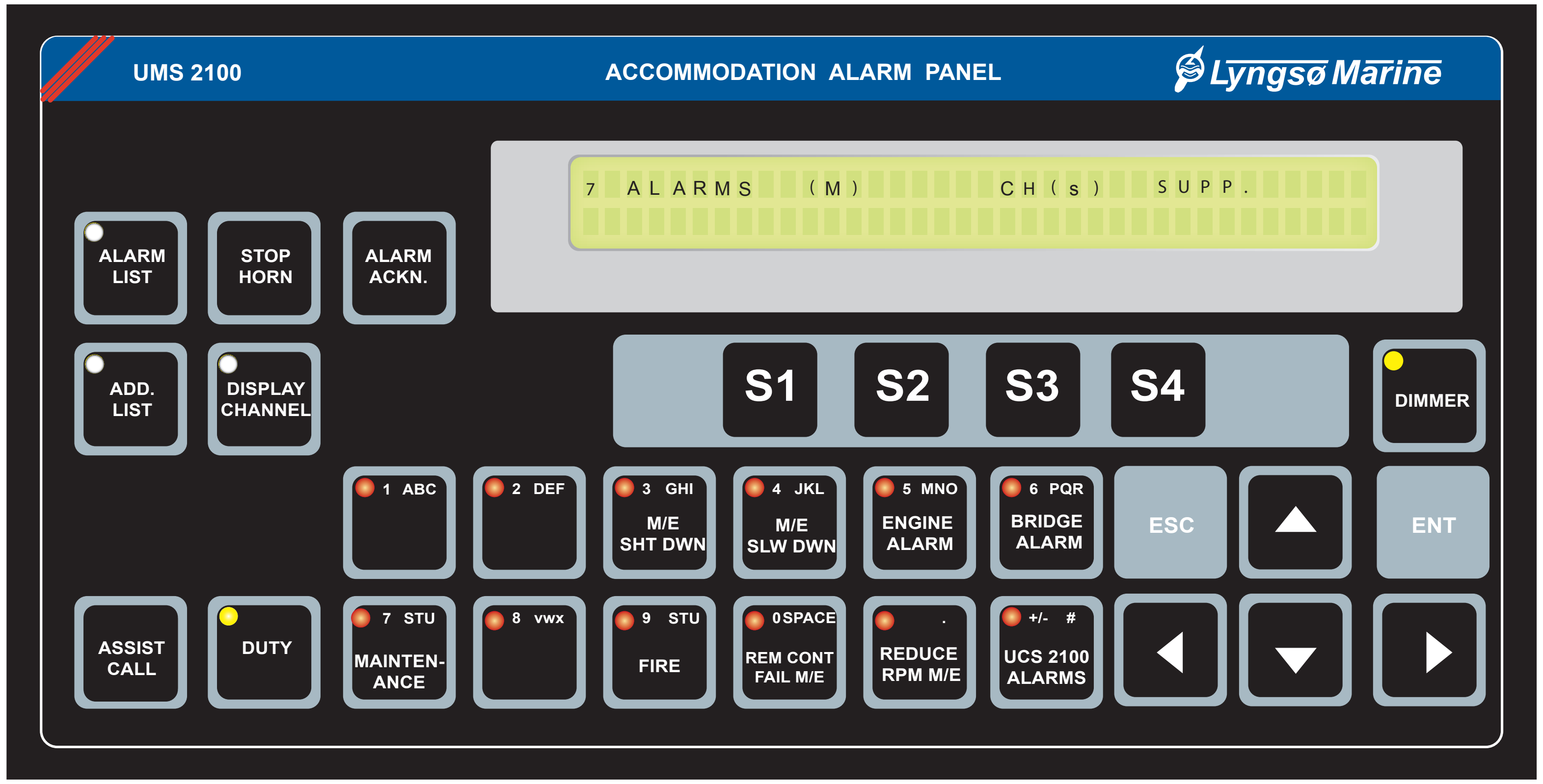
This is a print of the content of the alarm list and it contains all the standing and acknowledged alarms in the system at the moment the report was ordered. It runs continually but can be interrupted for reports of other types, such as Noon Log reports each day.

Cut-out List Report

This contains all the channels which are in the automatic or manual cut-out list state.

Illustration 6.1.1b UMS 2100 Operator Panels





Operator Panels

See illustration 6.1.1b above.

There are 3 types of panels available:

- Local Operator Panels (LOP)
- Basic Alarm Panels (BAP)
- Accommodation Alarm Panels (AAP)

The main difference between the LOP and the other 2 panel types, is that the LOP gives the operator access to the channels connected to the LOP only, not the entire UMS 2100 system. LOP panels are fitted at system outstations.

The BAPs and AAPs are normally used at the following locations:

- On the bridge (BAP only)
- In the ECR. The panel is used as a watch station (BAP only)
- In the public rooms (AAPs only)
- In the engineer's cabins (AAPs only)

During the periods when the engine room is manned, the alarms are announced and acknowledged from the ECR BAP or the related LOP.

When the engine room is unmanned the AAPs enable the system to distribute the alarm announcement to the duty engineer's cabin, the public rooms and the bridge.

Local Operator Panels (LOP)

The panel consists of the following features:

- A four-line LCD display with backlight
- A buzzer
- An alarm LED
- A keyboard

Basic Alarm Panels (BAP)

The panel consists of the following features:

- A four-line LCD display with backlight
- A buzzer
- An alarm LED
- A keyboard
- Alarm group LEDs

Accommodation Alarm Panels (AAP)

The panel consists of the following features:

- A two-line LCD display with backlight
- A buzzer
- An alarm LED
- A keyboard
- Alarm group LEDs

Basic Description of Features

- LCD display: Displays the numerical data
- Buzzer: Draws the engineer's attention to any new situation in the UMS2100
- Alarm LED: Used for the indication of unacknowledged alarms
- Keyboard:
  - Soft keys: The functions of these keys are shown on the display
  - Cursor and select keys: Used for scrolling in lists and pointing at elements
  - Function keys: Each key enables the operator to access a unique function or mode in the UMS 2100
  - When one of the keys is pressed an LED on the key will be illuminated
- Alarm Group LEDs: These are able to display the status of ten different alarm groups via the group alarm LEDs

Duty LED Function

This is used for the following purposes:

- Indication that a duty engineer has been selected
- Indication that a duty call is unacknowledged
- Indication that a duty selection is in progress

Automatic Duty Call Announcement at the Alarm Panels

When a duty engineer has been selected, a duty call is given when a new alarm appears.

The call is announced on the panels at the following locations:

- In the duty engineer's cabin
- The public rooms
- On the bridge or SCC, if 'Unattended Engine Room' is selected

The panels react in the following way:

- The buzzer flashes
- The alarm LED flashes
- The duty LED flashes

The duty call is acknowledged in the following ways:

- By pressing the 'STOP HORN' in the duty engineer's cabin
- By pressing the 'STOP HORN' on the BAP
- Acknowledging the alarm at the LOP

When the duty call has been acknowledged the following occurs:

- All buzzers which have been started due to the duty call are stopped
- The duty LED stops flashing

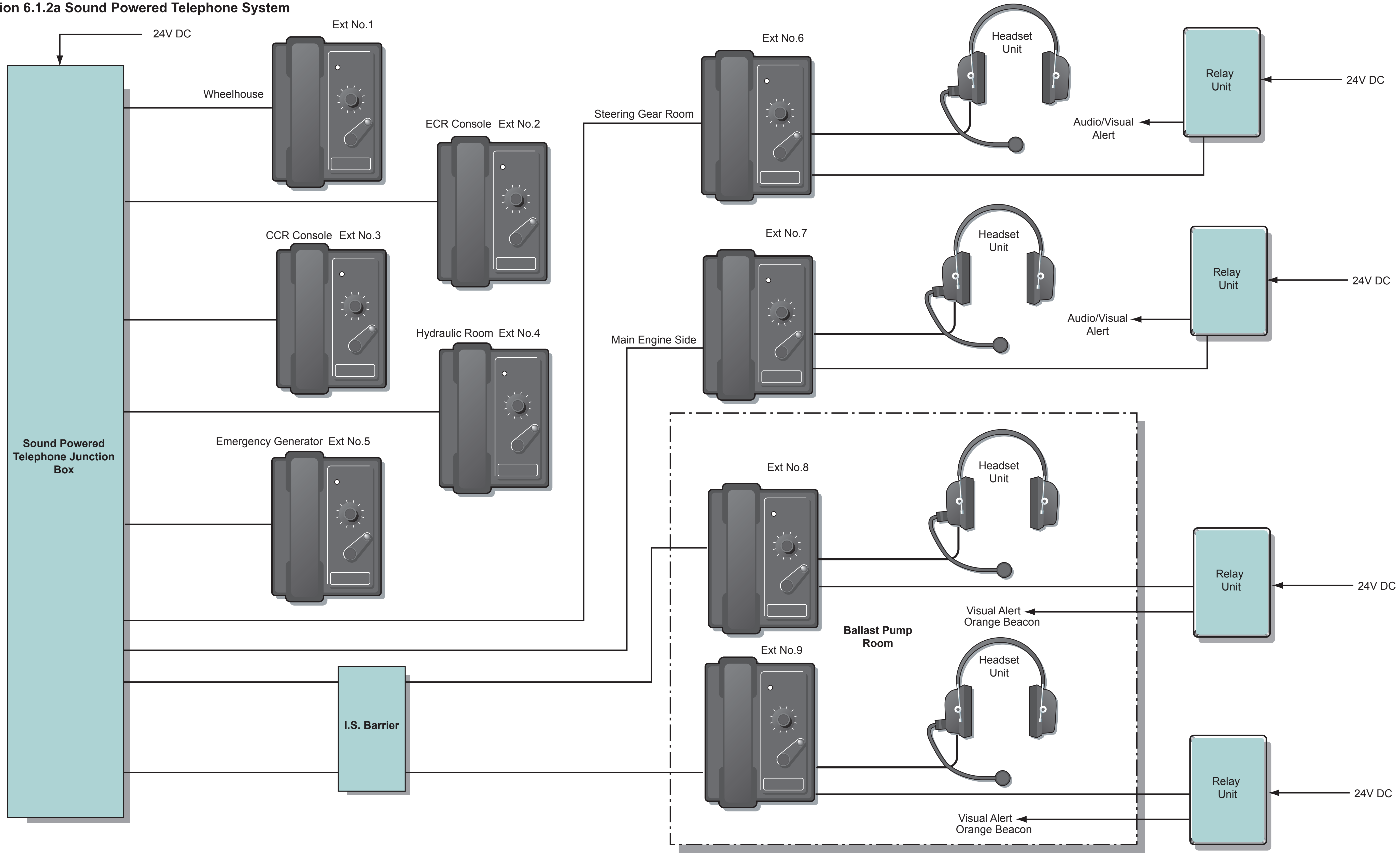
All Engineers Call

The call is announced on all the panels at the following locations:

- The public rooms
- On the bridge and in the SCC
- In all cabins
- In the ECR

Note: When an 'all engineers call' is initiated, the buzzers cannot be stopped locally. All of the buzzers sound until all the alarms have been acknowledged from the ECR watch station - BAP.

Illustration 6.1.2a Sound Powered Telephone System



6.1.2 INTRINSICALLY SAFE SOUND POWERED TELEPHONE SYSTEM

Manufacturer:	Gitiesse
Type	IMCOS 9111-W (Intrinsically Safe)
	IMCOS 9111-W
	IMCOS 9010-W
	IMCOS 9010-C

Introduction

The intrinsically safe sound powered telephone system is installed on board to fulfil the demands of emergency communication between vital positions on the vessel during times of power failure or failure of the primary telecommunication system.

The system has units at the following positions:

- Wheelhouse
- ECR
- SCC
- Hydraulic room
- Emergency generator room

Headsets with a noise-cancelling microphone can be connected to the phones at the following locations:

- Ballast pump room (IS)
- Main engine, local (emergency) control position
- Steering gear room

Operating Procedure

Calling

a) Use the selection switch to select the required extension and lift the handset.

b) Rotate the hand generator handle approximately 10 turns, the calling signal is transmitted to the called party.

c) When the called party lifts their handset proceed with communications.

> **Note:** If the signal reduces during communication, rotate the generator another 10 turns.

d) On completion of communications, replace the handset in the cradle and turn the selection switch to off.

Receiving a Call

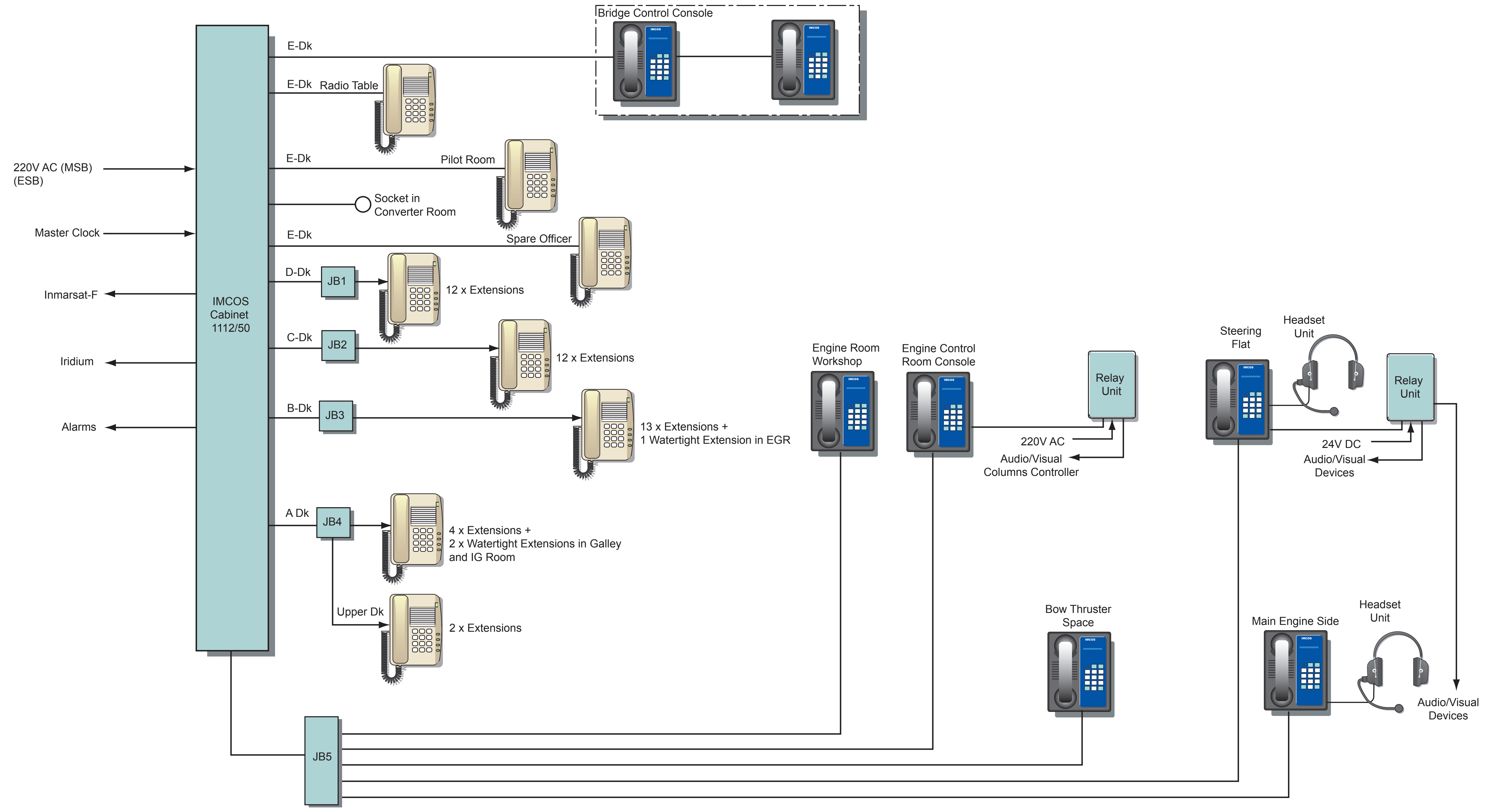
a) When the telephone bell rings and the lamp lights lift the telephone handset. Proceed with communications.

b) On completion of communications replace the handset.

> **Note:** Do not rotate the generator in a hazardous area if the telephone indicator light is on.

When using the headset the handset must be removed from the cradle for communication to be carried out.

Illustration 6.1.3a Automatic Telephone System



6.1.3 AUTOMATIC TELEPHONE SYSTEM

Manufacturer: Gitiesse
Type: IMCOS

Introduction

The Dial Telephone System is an automatic dial type system with a capacity of 64 lines. The programmable electronic type telephone exchange is capable of handling all telephones and shore telephone lines.

Programmable features are:

- Priority access
- Public address access
- Group pick-up (conference)
- Call forwarding

Power for the system is supplied from the wheelhouse navigation power distribution board. The main PBX cabinet is located aft in the converter room, in the IMCOS cabinet No.2.

Telephones in machinery rooms are connected to a light signal column in addition to normal acoustic signal. Machinery room telephones are on individual lines and configured for group pick-up. Telephones in noisy areas, including the machinery rooms, steering gear rooms, and emergency generator room, are fitted with headsets.

Four trunk lines are available for external connections such as shore connections or Inmarsat.

The automatic dial telephone system is connected to the public address system and selected telephones can be used to make announcements through the PA using access code 46. The dial telephone access to the public address system is secondary to the access from the control panel in the wheelhouse, and can be overridden from the control panel.

The dial telephone system is connected to the Inmarsat-F equipment, and is configured such that selected dial telephones are able to make Inmarsat calls.

Operation

Normal Calls

a) Lift the telephone handset.

b) Dial the required extension number.

c) Replace the handset after completion of communication.

PA Access

a) Lift the handset.

b) Dial the PA access number 46.

c) Replace the handset after making the announcement.

External Calls

Note: This facility is restricted to authorised telephones only.

a) Lift the handset.

b) Dial the external line prefix:

- 801 - selects the first free trunk line
- 8801 to 8804 - selects trunk lines 1 to 4

c) Dial the extension.

d) Replace the handset after making the call.

Intrusion

If a called line is busy, an intrusion can be made by pressing R or FLASH depending on the type of extension.

Re-route Calls

a) Lift the handset.

b) Dial the call forward code 541.

c) Dial the number required to receive the calls.

d) Replace the handset.

To deactivate the re-route dial 59 and replace the handset.

Alarm Call

a) Lift the handset.

b) Dial the code 693 41.

c) Dial the hours and minutes (in 24 hour format) of the time required for the ‘wake up’ call.

d) Dial R or FLASH to confirm.

e) Replace the handset.

To cancel an alarm call:

a) Lift the handset.

b) Dial the cancel code 693 42.

c) Dial R or FLASH to confirm.

d) Replace the handset.

Conference Call

a) Lift the handset.

b) Dial the first extension and wait for an answer.

c) Press and release FLASH an intercom dial tone is received and the existing call is placed on exclusive hold. The recall timer is activated.

d) Dial the second number and announce ‘conference’.

e) Press and release FLASH to connect to the first extension.

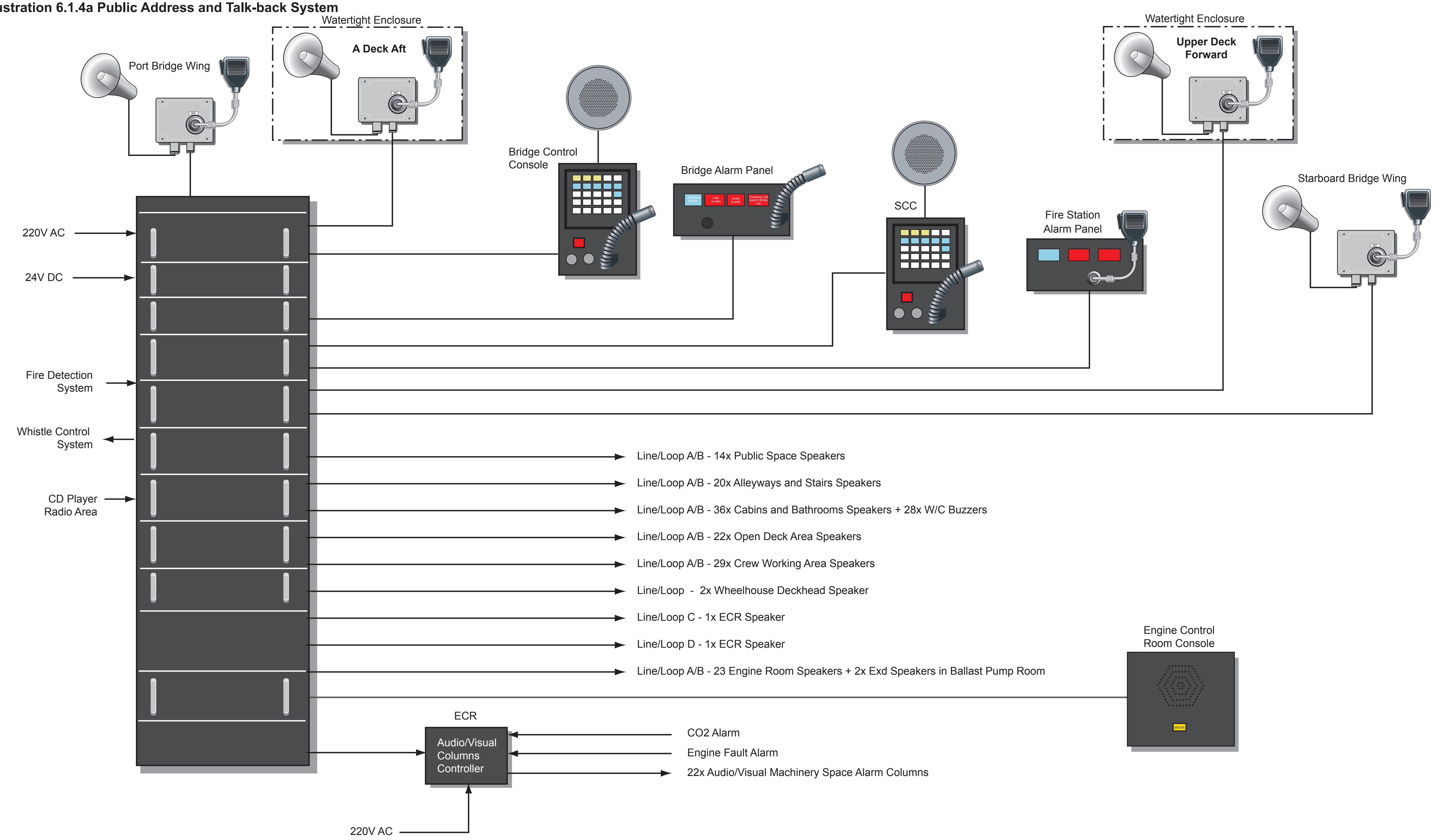
f) Press and release FLASH within 2 seconds to establish the conference.

g) Replace the handset.

Programming

This facility is available to authorised service personnel for programming of the exchange PLC. A programming telephone inside the cabinet is available for this service.

Illustration 6.1.4a Public Address and Talk-back System



6.1.4 PUBLIC ADDRESS SYSTEM

Manufacturer: Gitiesse
Type: 1112/D50

Introduction

The Public Address (PA) system has been produced for the marine industry. The main amplifier rack and a radio/CD unit is situated in two cabinets in the wheelhouse aft. The system allows for the broadcast of emergency as well as general announcements, and has inputs from the fire alarm repeater panel and automatic telephone exchange, and an output to the ship's whistle system. The system is supplied with 220V AC and in the event of a power failure will be powered by 24V DC from a dedicated battery supply.

A monitor panel is positioned on the front of the cabinet with red and green LEDs to indicate the status of the equipment.

Main System

The main amplifier rack comprises the following:

- 5 x power amplifiers
- Amplifier monitor panel
- PA Controller
- Talk-back
- Alarm generator module
- PABX interface

A radio/CD entertainment rack is situated in the radio area.

In addition to the above there are two remote control panels, one in the wheelhouse control console and one in the ship's control room. Two general emergency pushbuttons are situated in the following locations:

- Wheelhouse control console
- Fire control station

Power Amplifier

Five of these units are situated in the main rack (No.1) and provide amplification for different groups of speakers. Each unit has its own individual power switch.

Radio/Cassette and Radio/CD Units

These units allow the operator to play pre-recorded CDs or live radio over the PA system for entertainment purposes.

Microphone Panel

Three control panels are available, one on the bridge console, one in the SCC, and a duplicate on the front of the PA rack. The panels contain an LED test button for confirming LED operation.

The unit has a gooseneck microphone with an integrated switch. Pushbuttons are used for zone selection including an ALL AREAS pushbutton. After selecting an area to make a broadcast to, the operator uses the microphone to make an announcement.

Emergency Alarm Panel

The alarm panel situated in the wheelhouse and fire station allows the operator to make a priority emergency broadcast. The panel contains 3 or 4 pushbuttons depending on the type, (general alarm, fire alarm, manual alarm and an emergency call button, the fire station has no manual alarm button). A gooseneck microphone or a hand-held microphone with a press-to-talk switch is plugged into the front of the panel, depending on the location. A dimmer control is also fitted on the wheelhouse panel.

The general alarm signal is in accordance with IMO-SOLAS rules, 7 short and 1 long blast can be interfaced with the ship's whistle in order to have duplicate timing.

The PA priority level is as follows:

1 Emergency announcements
2 General alarm
3 Fire alarm
4 Fire alarm crew only (Passenger vessels)
5 General PA announcements and routine messages
6 Automatic pre-recorded messages/announcements
7 Background music

Monitor Speaker Unit

Two in-built speakers are fitted in the panel, one for monitoring the PA output and another adjacent to the radio/disk player for monitoring entertainment output.

This panel allows the operator to monitor an output signal, such as music, from the entertainment equipment rack. A monitor volume control knob is situated next to the speaker.

Paging

Announcements can be made from designated automatic phones around the ship.

Speakers

Different speakers are used around the ship dependent on location. The majority of the cabin speakers have a volume control facility. The speakers are connected as two independent and redundant loops, each one from a different amplifier as a safety feature.

In hazardous areas, explosion-proof speakers are fitted. These areas include the ballast pump room.

Many speakers are ceiling mounted. Some of these are bi-directional and some flush-mounted. Outdoor speakers are of a watertight design.

Operation

Before making an announcement check that the system is not already in use.

a) Press the speaker selection pushbuttons on one control panel to select the broadcast areas.

b) Press the switch on the microphone and proceed with the announcement.

c) When the announcement is complete, release the microphone switch and de-select the speaker selection pushbuttons.

6.1.5 SHIPBOARD SAFETY MANAGEMENT SYSTEM

The shipboard safety management system exists to ensure that the vessel is managed safely and efficiently.

Meetings should be held at regular intervals to ensure all personnel are aware of the objectives of the system.

Weekly management meetings should be held to discuss the vessel's forthcoming operations schedule, as well as mechanical or fabric maintenance due to be completed.

A safety meeting is held each month, with a minimum of one meeting every 3 months.

The object is to discuss safety at sea, prevention of human injury or loss of life and avoidance of damage to the marine environment and property.