elf aquitaine norge a/s

Copy No 009

FRIGG FIELD

TCP2 GAS COMPRESSION TRAINING MANUAL

VOLUME 1

mark one

1 PURPOSE

1.1 The purpose of the TCP2 Gas Compression Training Manual and its associated course is to familiarise Elf Aquitaine Norge process operators and other engineers with the theory and practice of the operation of the gas compression and power generation equipment (and associated utilities) installed on the Frigg TCP2 platform.

2 STANDARD TO BE ACHIEVED

2.1 The standard of proficiency to be achieved on completion of the course is as follows:

(a) General understanding of the principles of gas compression.

(b) General understanding of the TCP2 gas compression facilities (TCP2–C) and their functional role in the overall Frigg field process flow.

(c) General knowledge of the layout of all plant, the principles of operation and functional role of each item of major equipment.

(d) General knowledge of the instrumentation and controls associated with the gas compression facilities and their associated utilities.

(e) General knowledge of start-up and shutdown requirements and procedures for the gas compression facilities and their associated utilities.

(f) Good knowledge of key emergency procedures and safety considerations.

(g) For process operators; sufficient knowledge of all gas compression and ancillary equipment (and associated utilities) to enable safe and efficient operation, simple trouble-shooting and maintenance.

3 FORMAT OF THE MANUAL

3.1 Although this is a Training Manual, all TCP2–C system information (Parts C to F inclusive) has been presented in such a manner that it can be converted to an Operations Manual, with little change of format.

4 VALIDITY

4.1 This edition (Issue 1. October 1980) of the manual has been produced from available Piping and Instrument Diagrams (PID), Process Flow (PF) diagrams, Kvaerner-Technip design information, and vendors' information, before the completion of offshore installation.

4.2 The content of the Training Manual has not been fully validated technically and will be subject to update as a result of design changes, as-built drawings, revised control and operating methods and parameters, and alterations arising from start-up experience.

5 CONTENT OF THE MANUAL

5.1 The Training Manual consists of four parts, each comprising one or more chapters, and bound in two separate volumes. The content of the parts is generally as follows:

Part C 'Gas Compression Scheme' consists of 18 chapters covering the Overall Frigg Process, Gas Compression – Description, Power Generation and all utilities. (C1 to 8 in Vol 1; C9 to 18 in Vol 2).

Part D 'Gas Compression – Operation' contains one chapter only and should be read in conjunction with Chapter C2 'Gas Compression – Description'.

Part E 'Safety' contains seven chapters covering Fire and Gas Detection Systems, fire extinguishing systems (Halon and Firewater), Personnel Safety and Chemical Hazards.

Part F 'Emergency Shutdown System' contains one chapter only, covering the safety logic of manual and automatic shutdowns.

5.2 The chapters are arranged in volumes as follows:

Vol 1 (Compression)	– Chapters C1 to C8 inclusive, and D1 and F1.
Vol 2 (Utilities & Safety)	– Chapters C9 to C18 inclusive, and E1 to E7 inclusive.

5.3 All chapters within each part are listed on Part Contents lists.

6 SYMBOLS AND ABBREVIATIONS

6.1 A 'Glossary of Symbols' (extracted from PID 5424W 00 0040 01 'PID Symbols and Abbreviations') appears at the beginning of both volumes of the Manual. This contains those symbols and abbreviations which have been used in producing the simplified illustrations in the Manual. In this process of simplification, much detail on the source PID and PF has been omitted in order to present only the minimum information necessary to an understanding of the purpose and operational principles of a system, sub-system or equipment. Reference material (PID and PF) has been listed at the beginning of each chapter and these drawings must be consulted for full appreciation of systems etc.

6.2 There are six different valve panel control arrangements specific to ESD and hand valves which are shown on the Glossary of Symbols. For simplicity the pertinent arrangement ('A1' or 'A2' etc) is not reproduced in detail on illustrations.

6.3 A departure from PID/PF presentation should be noted; this is the placing of 'H', 'HH', 'L' and 'LL' **outside** alarm and switch symbols on most system drawings (particularly where tag numbers are not shown). This notation has been used in order to align with the normal presentation in operations manuals and also to reduce the area taken up by these symbols.

6.4 Tag numbers of valves (other than ESDVs and associated hand valves), instruments and controllers have generally been omitted from illustrations, unless they are of particular importance in relation to Gas Compression. In addition, where lines or control arrangements are duplicated, only one (typical) has often been shown, eg a series of vessels or pumps with identical flow and control configurations.

7 USE OF COLOUR

7.1 Colours have been added to system pipelines in order to assist in understanding each individual illustration. These colours are generally not related to the colour codings used on mimic diagrams or installed pipework, although wherever possible the same colours are used for particular fluids within each system or sub-system (eg Chapter). Red has been used throughout to denote ESD valve controllers.

7.2 The colour coding is generally as follows:

ESDV SYMBOLS.
FIREWATER LINES.

PROCESS GAS.
FUEL GAS.
VENTED GAS (HP & LP).
REFERENCE/BALANCE GAS (COMPRESSOR).

LUBE OIL.
HYDRAULIC OIL.
SERVICE AIR.

DIESEL OIL.
LUBE OIL SCAVENGE (GAS TURBINE).

SEA WATER.
CONDENSATE.
HP PROCESS OILY WATER.
SEAL OIL (COMPRESSOR).

LP OILY WATER.

FRESH WATER.
FRESH WATER/TEG MIXTURE.
INSTRUMENT AIR.

TEG.
METHANOL.
REFRIGERANT (AIR CONDITIONING).

FRESH WATER/TEG MIXTURE.
(WHERE DIFFERENTIATION IS NECESSARY).

VENTILATION/AIR CONDITIONING AIR.

A few departures from the above colour coding occur on some illustrations; these are identified on the colour keys which appear on all illustrations.

8 AUTHORITY VESTED IN THE TRAINING MANUAL

8.1 This is a Training Manual and as such is not intended to form a single-point reference for all platform operations; none of the procedures and associated illustrations excludes the use of revised 'as-fitted'/'as-built' drawings, operating/procedures manuals or reference material, and they are in no way intended to replace, in whole or in part, instructions which may be issued from time to time by Elf Aquitaine Norge.

Issue No	Dated	Amended by (Signature)	Date

TCP2 GAS COMPRESSION

TRAINING MANUAL

CONTENTS

GLOSSARY OF SYMBOLS (1)

ISSUE 1 OCT 1980

PIPING SYMBOLS

- ADJUSTABLE CHOKE VALVE
- HAND CONTROL VALVE
- GATE VALVE
- REDUCED BORE BALL VALVE
- FULL BORE BALL VALVE
- GLOBE VALVE
- NEEDLE VALVE
- THREE-WAY VALVE
- THREE-WAY BALL VALVE
- ANGLE VALVE
- DIAPHRAGM VALVE
- MANUAL ADJUSTABLE CHOKE VALVE
- BUTTERFLY VALVE
- INJECTOR
- CHECK VALVE
- STRAINER
- AIR RELEASE VALVE
- AIR INLET VALVE
- FUNNEL
- RAPID COUPLING
- HALF SYMMETRICAL COUPLING
- SPECTACLE BLIND
- VENT
- CAP
- BLIND FLANGE
- PLUG
- CSO CAR SEALED OPEN
- CSC CAR SEALED CLOSED
- TRAP OR DRAINER
- AIR FILTER
- FIRE HOSE REEL
- FIREWATER MONITOR
- GAS DETECTOR
- SPRINKLER HEAD (OPEN)

DIAGRAM ABBREVIATIONS

AEG	GAS DETECTOR (ANALYSER ELEMENT GAS)
AEF	FIRE DETECTOR HEAT (ANALYSER ELEMENT FIRE)
AES	SMOKE DETECTOR (ANALYSER ELEMENT SMOKE)
AUV	ULTRA VIOLET DETECTOR
CO	CUT OFF
CWD	COOLING WATER DRAIN
DG	DIESEL GENERATOR
FC	FAIL CLOSED
FO	FAIL OPEN
HF	HYDRAULIC FLUID
IA	INSTRUMENT AIR
IG	INERT GAS
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
OD	OPEN DRAIN
PB	PUSHBUTTON
SA	SERVICE AIR
TEG	TRIETHYLENE GLYCOL

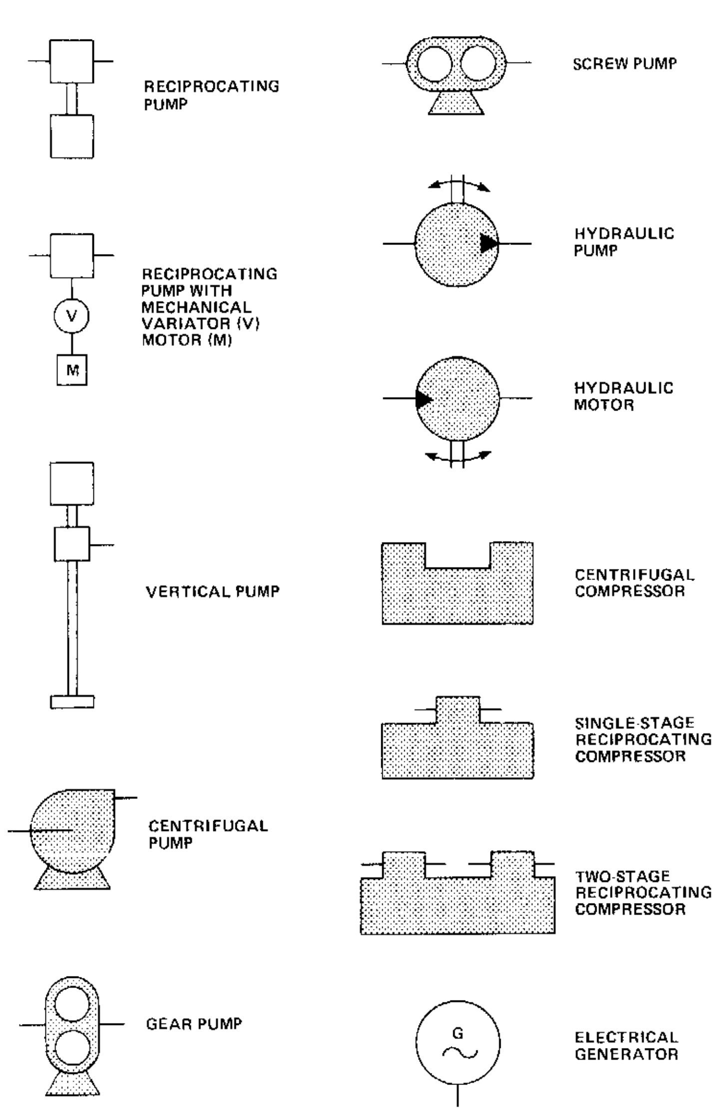
GL(1)

NOTE:

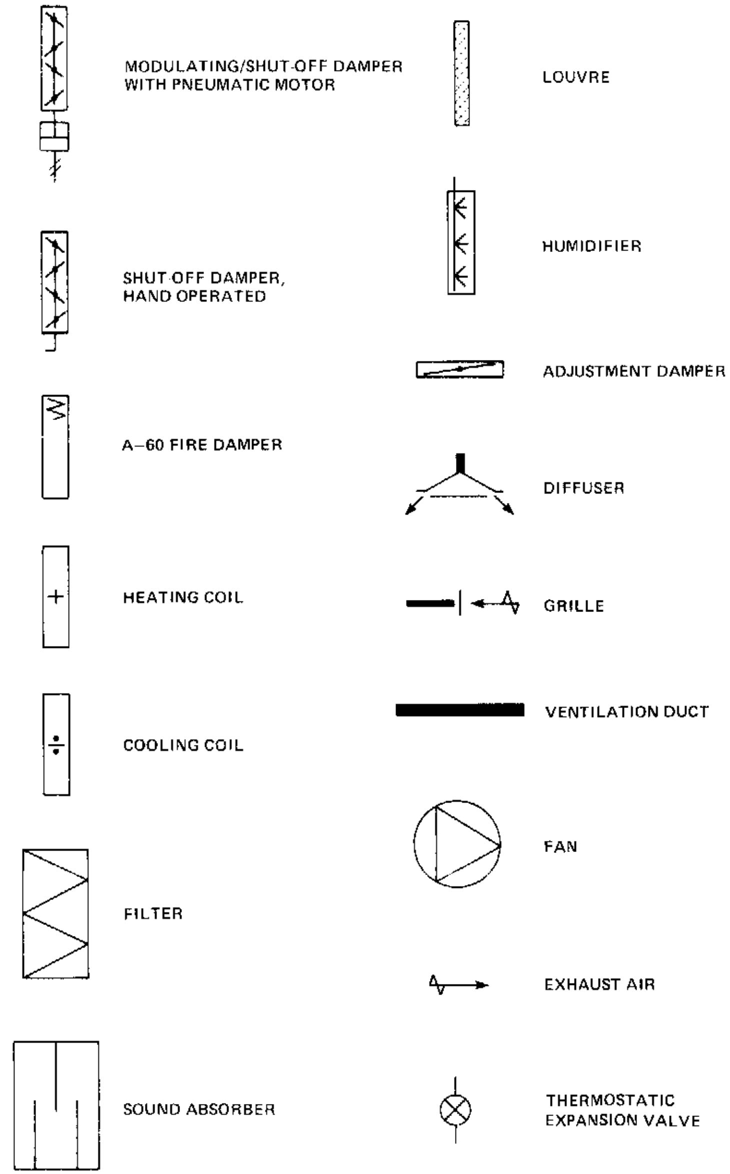
THIS GLOSSARY OF SYMBOLS CONTAINS THOSE SYMBOLS AND ABBREVIATIONS WHICH HAVE BEEN USED IN PRODUCING THE SIMPLIFIED ILLUSTRATIONS IN THIS TRAINING MANUAL.

FOR COMPLETE DETAILS, REFERENCE SHOULD BE MADE TO PID 5424W 00 0040 01; 'PID SYMBOLS AND ABBREVIATIONS'.

MACHINE SYMBOLS



HEATING AND VENTILATION SYMBOLS



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GLOSSARY OF SYMBOLS (3)

INSTRUMENTATION SYMBOLS

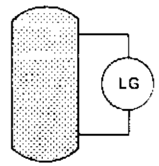
- HYDRAULIC LINE
- INSTRUMENT LINE
- PNEUMATIC LINE
- ELECTRIC LINE
- CAPILLARY LINE
- RUPTURE DISC
- FLOW ELEMENT (TURBINE METER)
- ROTAMETER
- FLOW GAUGE
- DIAPHRAGM OPERATED VALVE
- PRESSURE REGULATOR (OR)
- DIAPHRAGM VALVE WITH HANDWHEEL
- ON/OFF PILOT VALVES
- PILOT VALVES: EV – SOLENOID; PV – PNEUMATIC
- PISTON-OPERATED VALVE
- THREE-WAY DIAPHRAGM VALVE
- ANGLE DIAPHRAGM VALVE
- AUTOMATIC ADJUSTABLE CHOKE VALVE
- RELIEF VALVE (PSV) (= PRESSURE SAFETY VALVE)
- FLAME ARRESTER (AF)
- FLOW STRAIGHTENING VANE (FX)
- FLOW ELEMENT, ORIFICE FLANGE OR RESTRICTION ORIFICE

INSTRUMENT LOCATION SYMBOLS

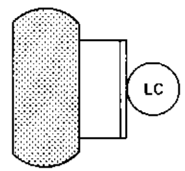
- LOCALLY MOUNTED INSTRUMENT
- INSTRUMENT MOUNTED IN FRONT OF CONTROL PANEL ON QP
- INSTRUMENT MOUNTED INSIDE CONTROL PANEL ON QP
- INSTRUMENT MOUNTED IN FRONT OF CONTROL PANEL ON TCP2-C
- INSTRUMENT MOUNTED INSIDE CONTROL PANEL ON TCP2-C
- INSTRUMENT MOUNTED IN FRONT OF LOCAL PANEL ON TCP2-C (NOTE: NOT CONTROL PANEL)
- INSTRUMENT MOUNTED INSIDE LOCAL PANEL ON TCP2-C (NOTE: NOT CONTROL PANEL)
- LOCALLY MOUNTED LIGHT
- PANEL-MOUNTED LIGHT ON QP
- PANEL MOUNTED LIGHT ON TCP2-C
- PANEL-MOUNTED LIGHT ON LOCAL PANEL ON TCP2-C
- HAND SWITCH { L = LOCAL; C = CONTROL ROOM } (C, HS, L, FROM C OR L)

NOTE: IN SPECIAL CASES MANUAL CONTROL MAY BE FROM LOCAL PANELS, BUT THIS MUST BE AUTHORISED IN EACH CASE.

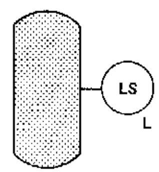
- HS OR (symbol) HAND SWITCH



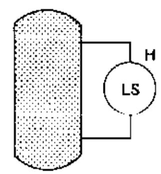
LEVEL GLASS



LEVEL CONTROLLER, EXTERNAL CHAMBER



LEVEL SWITCH, INTERNAL MOUNTING



LEVEL SWITCH, EXTERNAL CHAMBER

GL(3)

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IDENTIFICATION LETTERS FOR INSTRUMENTS

	VARIABLE INDICATION	PRIMARY ELEMENT	TRANSMITTER	INDICATOR	RECORDER	CONTROLLER	INDICATOR CONTROLLER	RECORDER CONTROLLER	CONTROL/ON OFF VALVE	ALARMS (5) HIGH	ALARMS (5) HIGH HIGH	ALARMS (5) LOW	ALARMS (5) LOW LOW	SIGNALISATION HIGH(4)	SIGNALISATION LOW(4)	SWITCH (3) & (4)	TOTALIZER/INTEGRATOR	FUNCTION RELAY/ CONVERTER	SAFETY VALVE	PNEUMATIC VALVE	THERMOWELL	PILOT VALVE	GAUGE
		E	T	I	R	C	IC	RC	CV	AH	AHH	AL	ALL	LH	LL	S	Q	Y	SV	PV	W	XV	G
FLOW	F	FE	FT	FI(2)	FR	FC	FIC	FRC	FCV	FAH	FAHH	FAL	FALL	FLH	FLL	FS	FQ	FY		FPV		FXV	FG
LEVEL	L	LE	LT	LI	LR	LC	LIC	LRC	LCV	LAH	LAHH	LAL	LALL	LLH	LLL	LS		LY		LPV		LXV	LG
PRESSURE	P	PE	PT	PI	PR	PC	PIC	PRC	PCV	PAH	PAHH	PAL (7)	PALL	PLH	PLL	PS(7)		PY	PSV	PPV		PXV	PG(2)
TEMPERATURE	T	TE	TT	TI	TR	TC	TIC	TRC	TCV	TAH	TAHH	TAL	TALL	TLH	TLL	TS		TY	TSV		TW		TG(2)
DIFFERENTIAL FLOW	Fd	FdE	FdT	FdI	FdR	FdC	FdIC	FdRC	FdCV	FdAH	FdAHH	FdAL	FdALL	FdLH	FdLL	FdS		FdY					
DIFFERENTIAL LEVEL	Ld	LdE	LdT	LdI	LdR	LdC	LdIC	LdRC	LdCV	LdAH	LdAHH	LdAL	LdALL	LdLH	LdLL	LdS		LdY					
DIFFERENTIAL PRESSURE	Pd	PdE	PdT	PdI	PdR	PdC	PdIC	PdRC	PdCV	PdAH	PdAHH	PdAL	PdALL	PdLH	PdLL	PdS		PdY					
DIFFERENTIAL TEMPERATURE	Td	TdE	TdT	TdI	TdR	TdC	TdIC	TdRC	TdCV	TdAH	TdAHH	TdAL	TdALL	TdLH	TdLL	TdS		TdY					
SPEED	S	SE	ST	SI	SR	SC	SIC	SRC	SCV	SAH	SAHH	SAL	SALL	SLH	SLL	SS		SY					
ANALYSER	A	AE	AT	AI	AR	AC	AIC	ARC	ACV	AAH	AAHH	AAL	AALL	ALH	ALL	AS		AY					
POSITION	Z(1)		ZT	ZI	ZR	ZC	ZIC	ZRC	ZCV	ZAH	ZAHH	ZAL	ZALL	ZLH	ZLL	ZS							
MANUAL (HAND OPERATED)	H					HC	HIC		HCV/ HV							HS						HXV	
MOISTURE (HUMIDITY)	M		MT			MC										MS							
EMERGENCY SHUTDOWN	ESD/E								ESDV (7)											EPV		EXV	
ELECTRIC CURRENT	I				IR																		
OTHERS	X	XE	XT	XI	XR	XC	XIC	XRC	XCV	XAH	XAHH	XAL	XALL	XLH (6)	XLL (6)	XS	XQ	XY		XPV		XXV	

NOTES:

1. PREFIX 'E' IS USED FOR ESD INSTRUMENTS eg 'EZ'.
2. ALSO USED TO REPRESENT A LOCAL MEASUREMENT.
3. SPECIFY HIGH OR LOW.
4. FOR VALVE POSITION SWITCHES 'H' = 'OPEN' AND 'L' = 'CLOSED'.
5. 'XA' NOT SPECIFIED ALARM(S).
6. 'XL' NOT SPECIFIED SIGNALISATION.
7. (DETAIL A1 & A2)

Detail A1	Detail A2	
11PSL001	11PSL001	11PAL001
11PSL15–1A 11PSL25–1A 11PSL35–1A	11PSL11–1A 11PSL21–1A 11PSL31–1A	11PAL11–1 11PAL21–1 11PAL31–1

NOTE:

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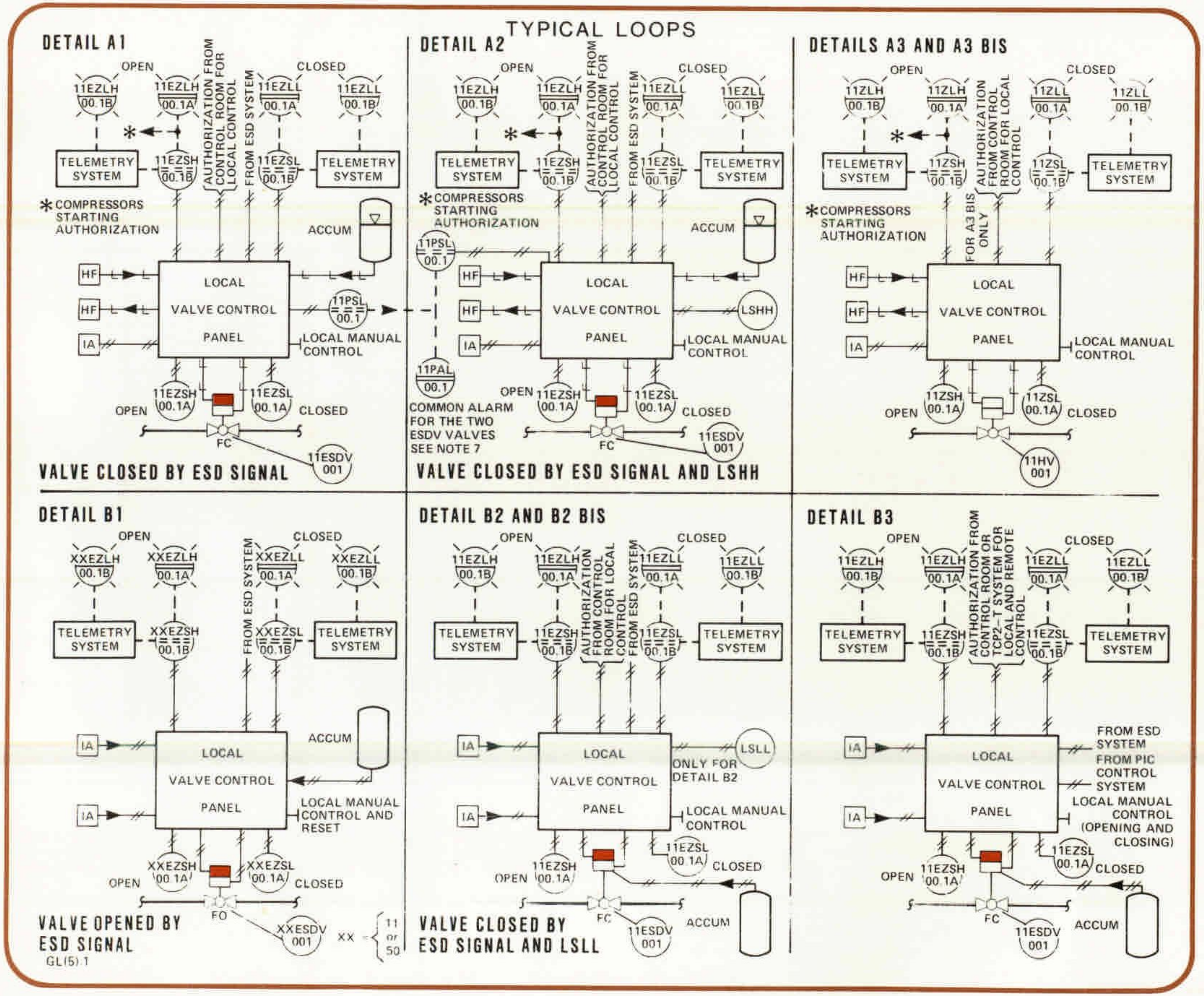

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A1

11ESDV15.1
11ESDV25.1
11ESDV35.1

A2

11ESDV11.1
11ESDV21.1
11ESDV31.1

A3

11HV11.1
11HV15.1
11HV31.1
11HV35.1

A3 BIS

11HV21.1
11HV21.2
11HV25.1
11HV25.2

B1

11ESDV15.2 *
11ESDV17.1

11ESDV35.2 *
11ESDV37.1

11ESDV21.2
11ESDV25.2 *
11ESDV25.3

50ESDV11.1
50ESDV11.3

* WITH PSLL

B2

11ESDV12.2
11ESDV16.2
11ESDV22.2
11ESDV32.2
11ESDV36.2

B2 BIS

50ESDV11.5
50ESDV11.7

50ESDV11.6
50ESDV11.8

50ESDV50.5
50ESDV52.5
50ESDV54.5

B3

50ESDV16.1
50ESDV16.2
50ESDV16.3
50ESDV16.4

PART C

GAS COMPRESSION SCHEME

CONTENTS

CHAPTER C1

OVERALL FRIGG PROCESS

CONTENTS

ILLUSTRATIONS

SECTION 1 – FRIGG FIELD

1 SUMMARY

1.1 The Frigg field comprises a gas-rich reservoir with a strong natural drive; ie pressure within the reservoir is at present sufficient for recovery of the gaseous hydrocarbon deposits without recourse to any secondary recovery method such as water injection ('water flooding').

1.2 Production from the field and its control is being achieved by the following complex of platforms:

(a) CDP1 and DP2 – Drilling platforms.

(b) TP1 and TCP2 – Treatment platforms.

(c) QP – The accommodation platform, which also contains the central control facilities for Frigg field platforms.

(d) FP – The common flare facility for all production and treatment platforms.

1.3 Platforms QP, TP1 and TCP2 are physically interconnected by bridges which, as well as providing for personnel traffic, carry interconnecting process and utility lines, electrical power cables, and signal and control cables.

1.4 Processed ('sales') gas is piped to the UK (St. Fergus, Scotland) from both TP1 and TCP2 through 32in dia sea lines in two stages:

(a) Some 186km to intermediate platform MCP01 (operated by Total Oil Marine) which, at present, acts only as a manifold. There is provision in MCP01 for the future installation of compression facilities if boosting of pipeline pressure should become necessary.

(b) A further 176km (approximately) from MCP01 to the shore terminal at St. Fergus (also operated by Total Oil Marine) where final treatment is carried out before 'hand-over' to the British Gas Corporation (BGC), the prime sales outlet for Frigg gas at present.

NOTE
St. Fergus also receives processed gas from the Brent field (Shell/Esso).

SECTION 2 – GAS COMPRESSION

1 REASON FOR GAS COMPRESSION

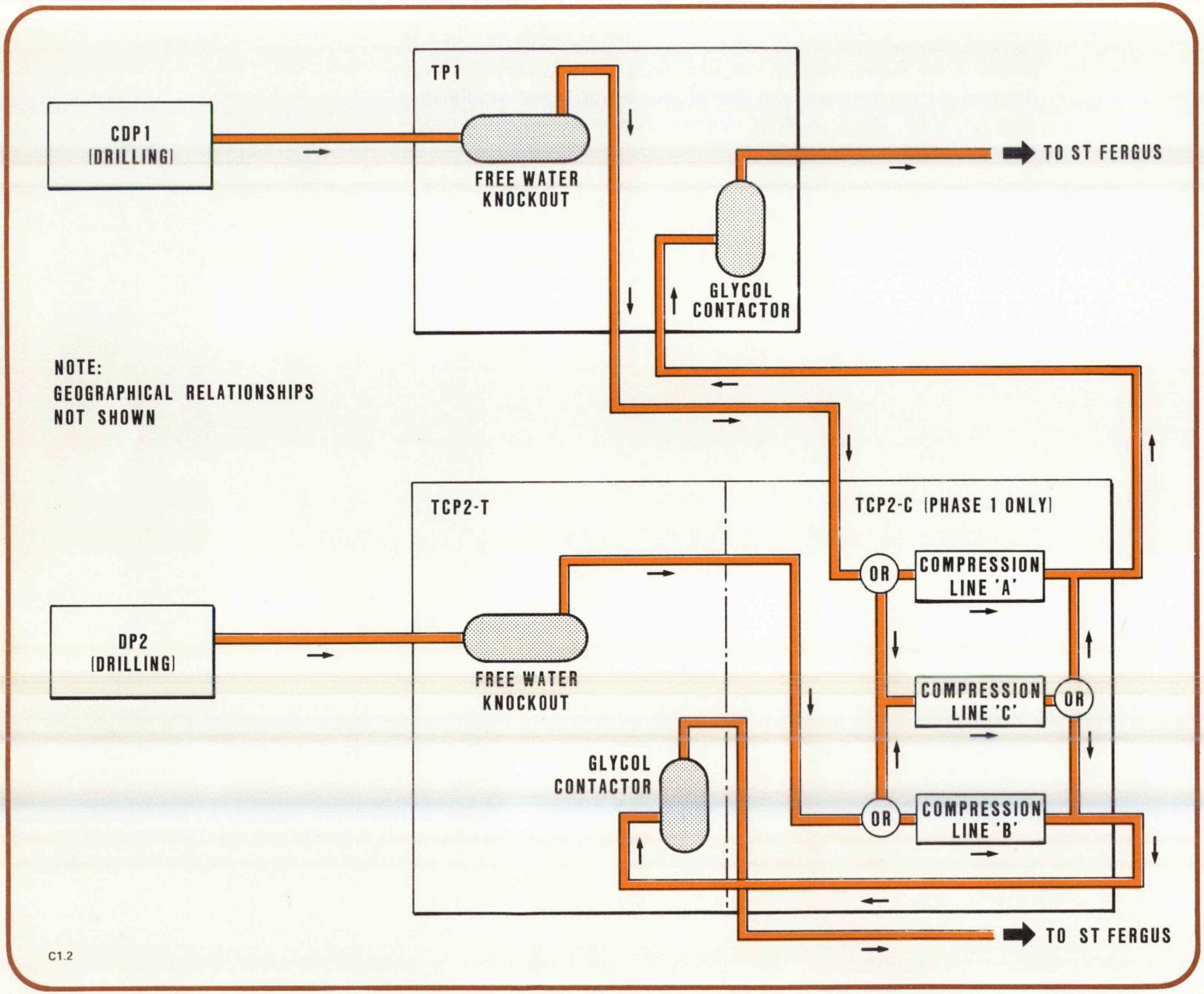
See illustration C1.1

1.1 The initial ('downhole') pressure and temperature in the Frigg field reservoir is approximately 198 bar and 60°C. The gas sales requirement (BGC) is for some 64 million standard m^3/day at a minimum delivery pressure of 44 bar. Since the pressure drop during treatment at St. Fergus is some 5 bar, the gas must therefore arrive onshore at a pressure of about 49 bar. In addition, a pipeline velocity in excess of 4m/s is necessary in order to avoid condensate accumulation at low spots in the pipeline. The Frigg process must therefore ensure:

(a) Gas arrival at St. Fergus at a minimum pressure of 49 bar.

(b) Gas sea line velocity greater than 4m/s.

1.2 As gas is extracted from Frigg field, the reservoir pressure drops. Therefore, to maintain the required delivery pressure and flow rate, compression before delivery will be required when flowing wellhead pressure falls below 140 bar. Illustration C1.1 shows the projected demand for gas sales and the loss of production which would arise as a result of fall-off in Frigg reservoir pressure if no compression stage were to be introduced.


TP1
CDP1 (DRILLING)
FREE WATER KNOCKOUT
TO ST FERGUS
GLYCOL CONTACTOR
NOTE:
GEOGRAPHICAL RELATIONSHIPS NOT SHOWN
TCP2-T
TCP2-C (PHASE 1 ONLY)
OR
COMPRESSION LINE 'A'
DP2 (DRILLING)
FREE WATER KNOCKOUT
COMPRESSION LINE 'C'
OR
GLYCOL CONTACTOR
OR
COMPRESSION LINE 'B'
TO ST FERGUS

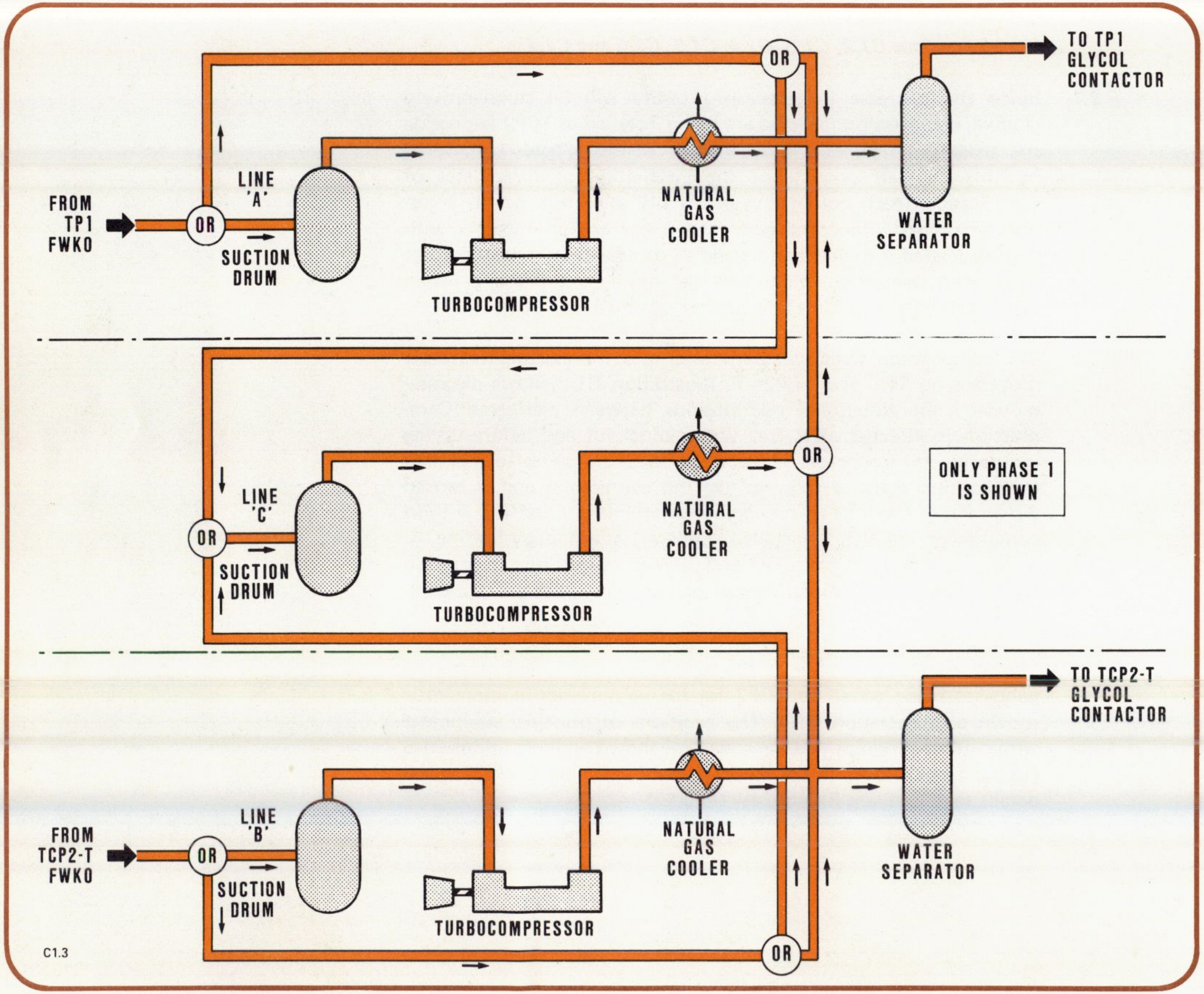
2 GAS COMPRESSION FACILITIES

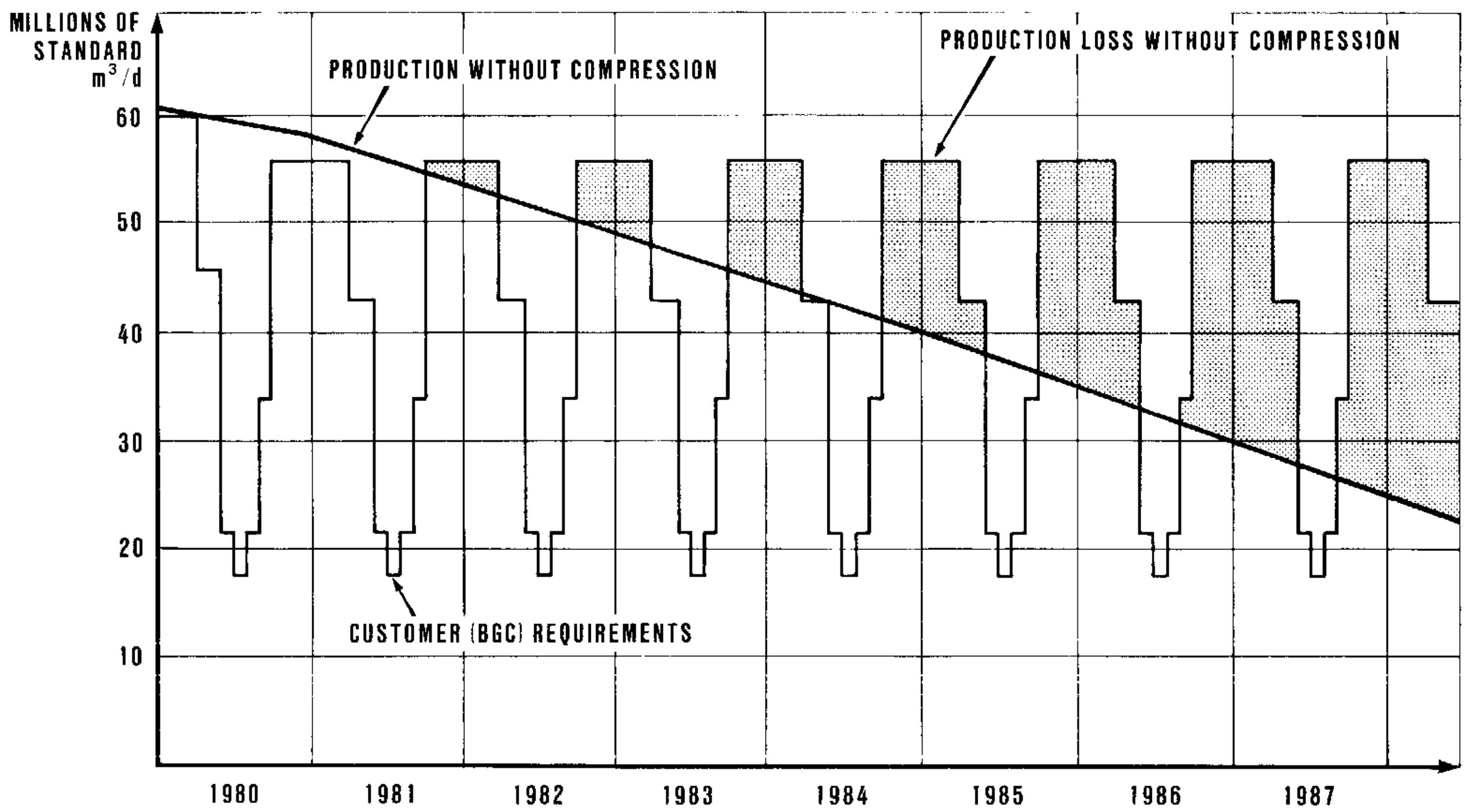
See illustrations C1.2, C1.3, C1.4, C1.5, C1.6 and C1.7

2.1 Since the decrease in reservoir pressure will be comparatively gradual, compression facilities are being installed in TCP2 (alongside the existing Treatment area) in two phases. Phase 1 (covered by this manual) consists of the installation of three lines of compression (each comprising essentially a suction drum, a gas-turbine driven turbocompressor and a gas cooler) together with two associated water separators and all necessary utilities. A further three turbocompressor lines will be installed at Phase 2, when flowing wellhead pressure falls further (planned for 1985).

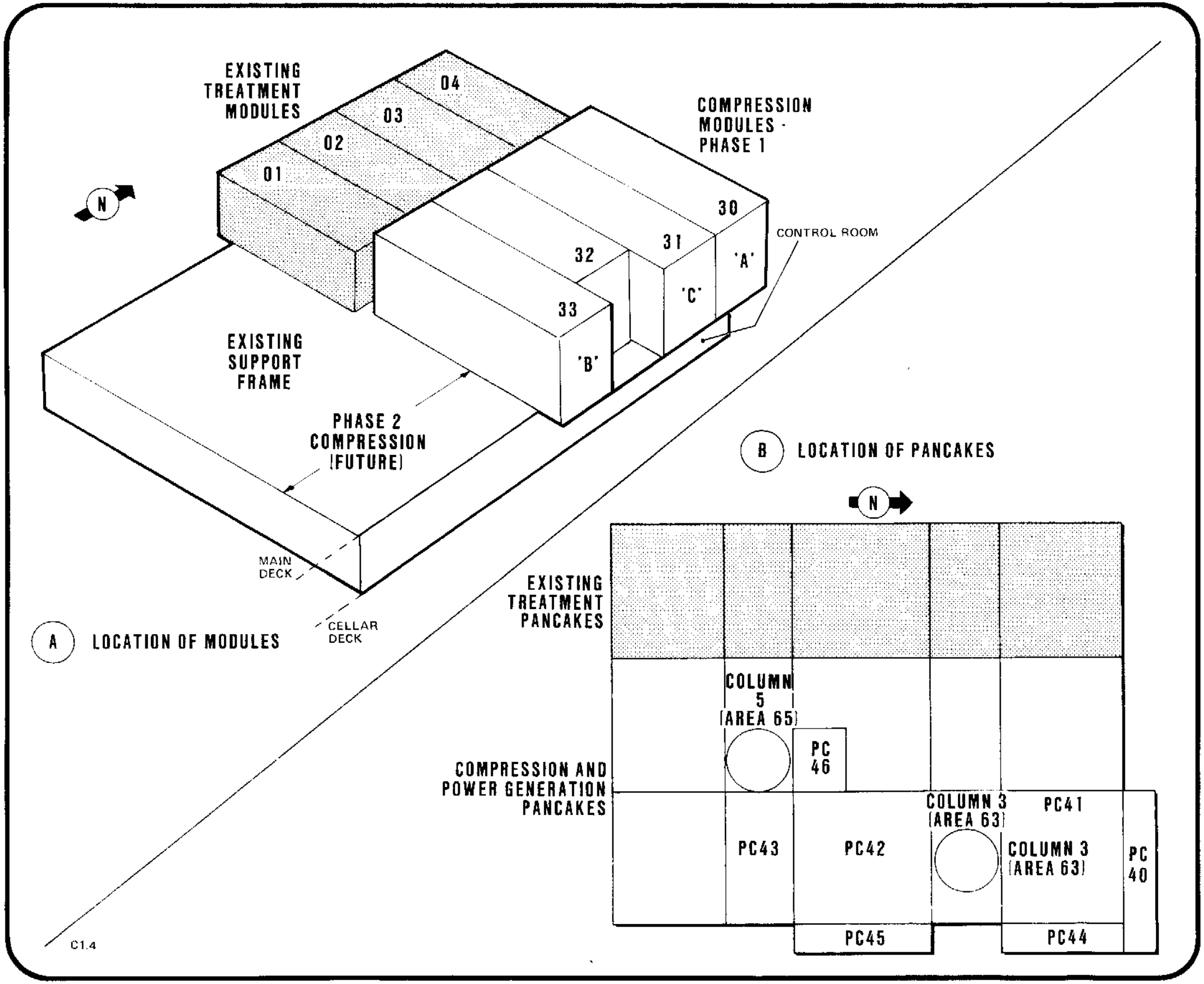
2.2 The compression stage will be phased into the existing treatment processes on TP1 and TCP2—T. Illustration C1.2 shows diagrammatically the functional relationships between platforms. Compression is effected after free water knockout and before drying in the glycol contactors in each platform (in order to maintain the working pressure required by the contactors) and is carried out in Phase 1 in one of two compression lines ('A' or 'B'). A third compression line ('C') is installed in Phase 1 as a standby for line 'A' or 'B', accepting gas from TP1 or TCP2—T respectively. Illustration C1.3 shows the simplified overall process flow within TCP2 compression area.

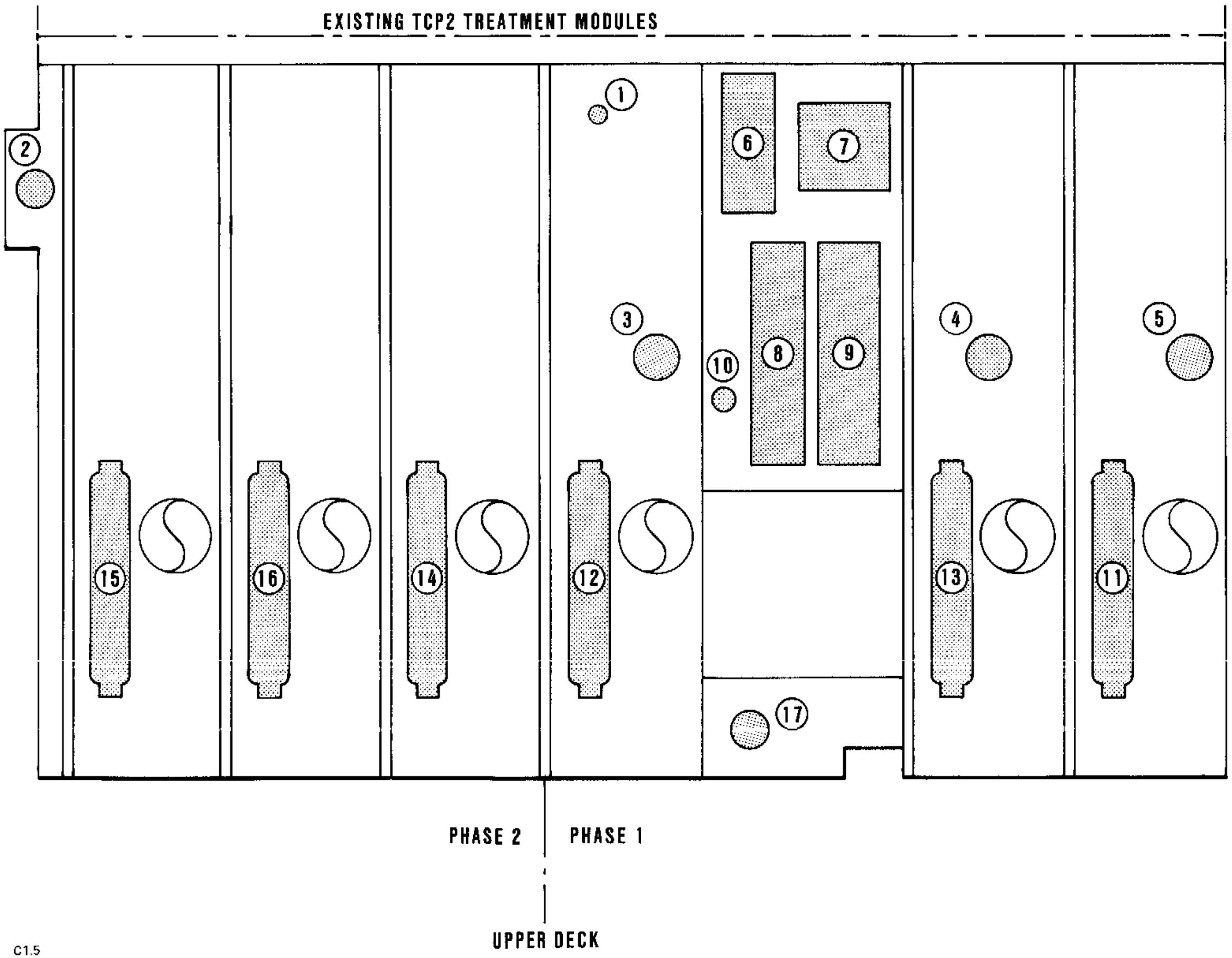
2.3 The physical arrangement of the four new modules and seven new pancakes being added to TCP2 for gas compression equipment is shown on illustration C1.4. The positions of principal equipment within these modules and pancakes are shown on illustrations C1.5 (Upper Deck), C1.6 (Main Deck) and C1.7 (Cellar Deck); for full details see Plot Plans PID 5424W 00 0060 74.


TO TP1
GLYCOL
CONTACTOR
OR
LINE
'A'
FROM
TP1
FWKO
OR
SUCTION
DRUM
NATURAL
GAS
COOLER
WATER
SEPARATOR
TURBOCOMPRESSOR
OR
ONLY PHASE 1
IS SHOWN
LINE
'C'
OR
SUCTION
DRUM
NATURAL
GAS
COOLER
TURBOCOMPRESSOR
TO TCP2-T
GLYCOL
CONTACTOR
LINE
'B'
FROM
TCP2-T
FWKO
OR
SUCTION
DRUM
NATURAL
GAS
COOLER
WATER
SEPARATOR
TURBOCOMPRESSOR
OR
C1.3



MILLIONS OF STANDARD m³/d
60
50
40
30
20
10
PRODUCTION WITHOUT COMPRESSION
PRODUCTION LOSS WITHOUT COMPRESSION
CUSTOMER (BGC) REQUIREMENTS
1980
1981
1982
1983
1984
1985
1986
1987

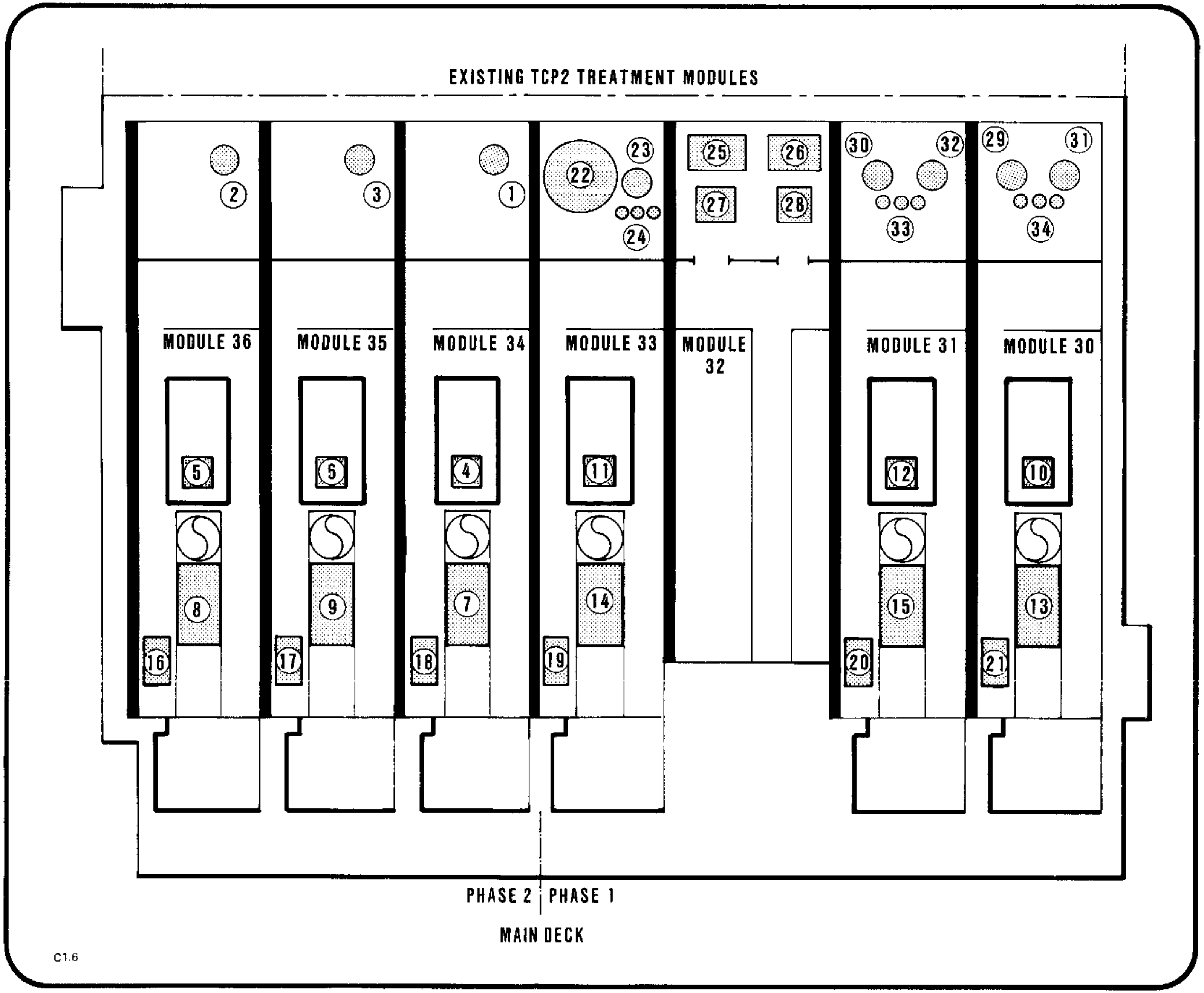

EXISTING TREATMENT MODULES
01
02
03
04
COMPRESSION MODULES - PHASE 1
30
31
32
33
'A'
'B'
'C'
CONTROL ROOM
EXISTING SUPPORT FRAME
PHASE 2 COMPRESSION (FUTURE)
MAIN DECK
CELLAR DECK
N
A LOCATION OF MODULES
B LOCATION OF PANCAKES
N
EXISTING TREATMENT PANCAKES
COLUMN 5 (AREA 65)
PC 46
COMPRESSION AND POWER GENERATION PANCAKES
COLUMN 3 (AREA 63)
PC41
PC43
PC42
COLUMN 3 (AREA 63)
PC 40
PC45
PC44
C1.4


EXISTING TCP2 TREATMENT MODULES
1
2
6
7
3
10
8
9
4
5
15
16
14
12
13
11
17
PHASE 2
PHASE 1
UPPER DECK

C1.5

2.3.1 **Equipment List – Upper Deck (C1.5)**

Illustration Identity	Tag No	Equipment
1	67X02	LP Vent Stack
2	60X05	Crane (Future)
3	)	Ventilation Extraction Ducts
4	)	
5	)	
6	56X01	Hydraulic Package
7	50X07A/B	Fuel Gas Heaters
8	50X01A)	Fuel Gas Packages
9	50X01B)	
10	58T01	Expansion Tank
11	11E01A)	Natural Gas Coolers
12	11E01B)	
13	11E01C)	
14	12E01A)	Future Natural Gas Coolers (Phase 2)
15	12E01B)	
16	12E01C)	
17	60X01	Crane

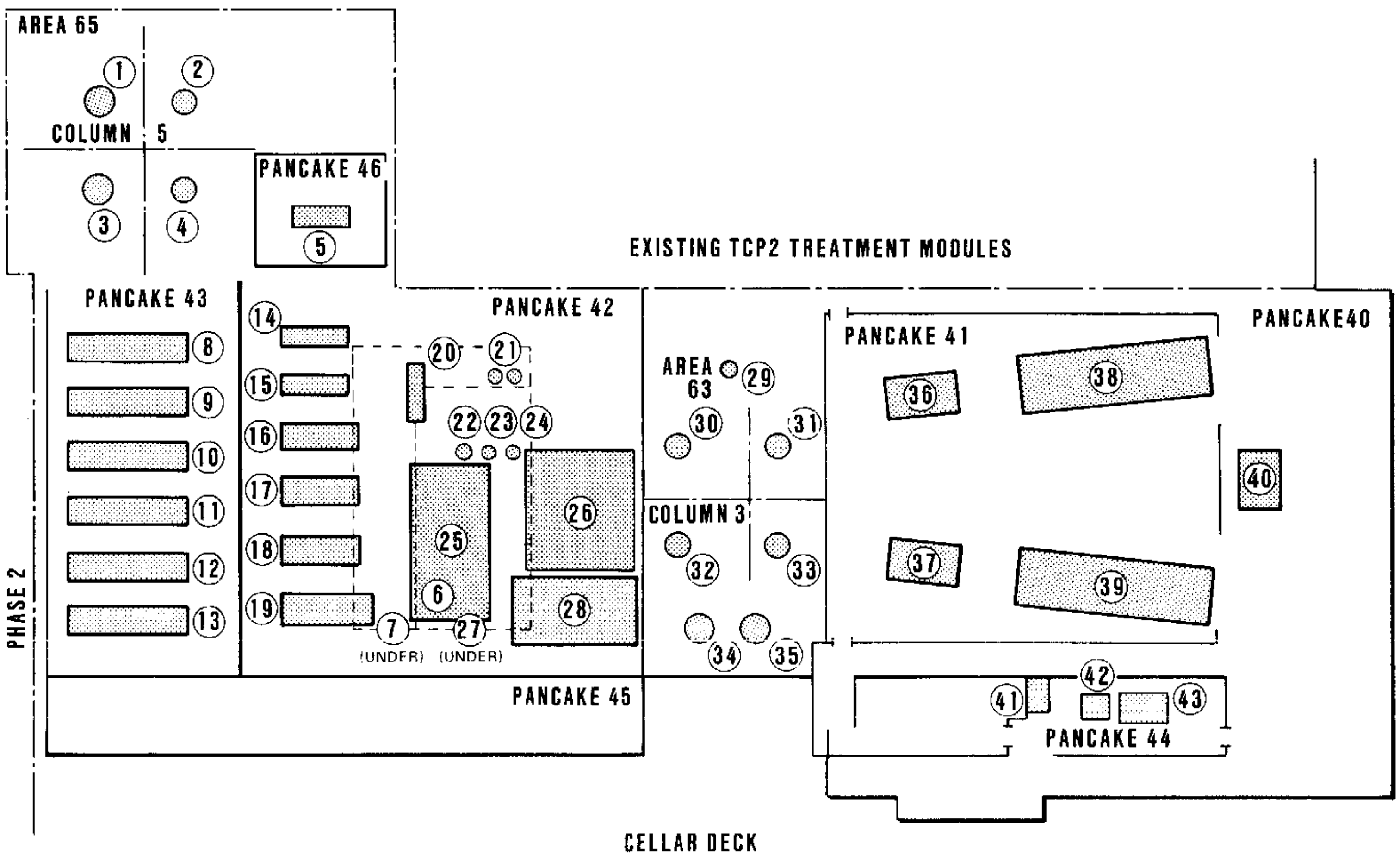


EXISTING TCP2 TREATMENT MODULES
2
3
1
22
23
24
25
26
27
28
30
32
29
31
33
34
MODULE 36
MODULE 35
MODULE 34
MODULE 33
MODULE 32
MODULE 31
MODULE 30
5
6
4
11
12
10
8
9
7
14
15
13
16
17
18
19
20
21
PHASE 2
PHASE 1
MAIN DECK
C1.6

2.3.2 **Equipment List – Main Deck (C1.6)**

Illustration Identity	Tag No	Equipment	Module
1	12B01A)	Future Suction Drums (Phase 2)	
2	12B01B)		
3	12B01C)		
4	12K01A)	Future Gas Compressors (Phase 2)	34
5	12K01B)		36
6	12K01C)		35
7	12KG01A)	Future Gas Turbines for Compressors (Phase 2)	34
8	12KG01B)		36
9	12KG01C)		35
10	11K01A)	Gas Compressors	30
11	11K01B)		33
12	11K01C)		31
13	11KG01A)	Gas Turbines for Compressors	30
14	11KG01B)		33
15	11KG01C)		31
16	)	Future Lube Oil Skids (Phase 2)	36
17	)		35
18	)		34
19	)	Lube Oil Skids	33
20	)		31
21	)		30

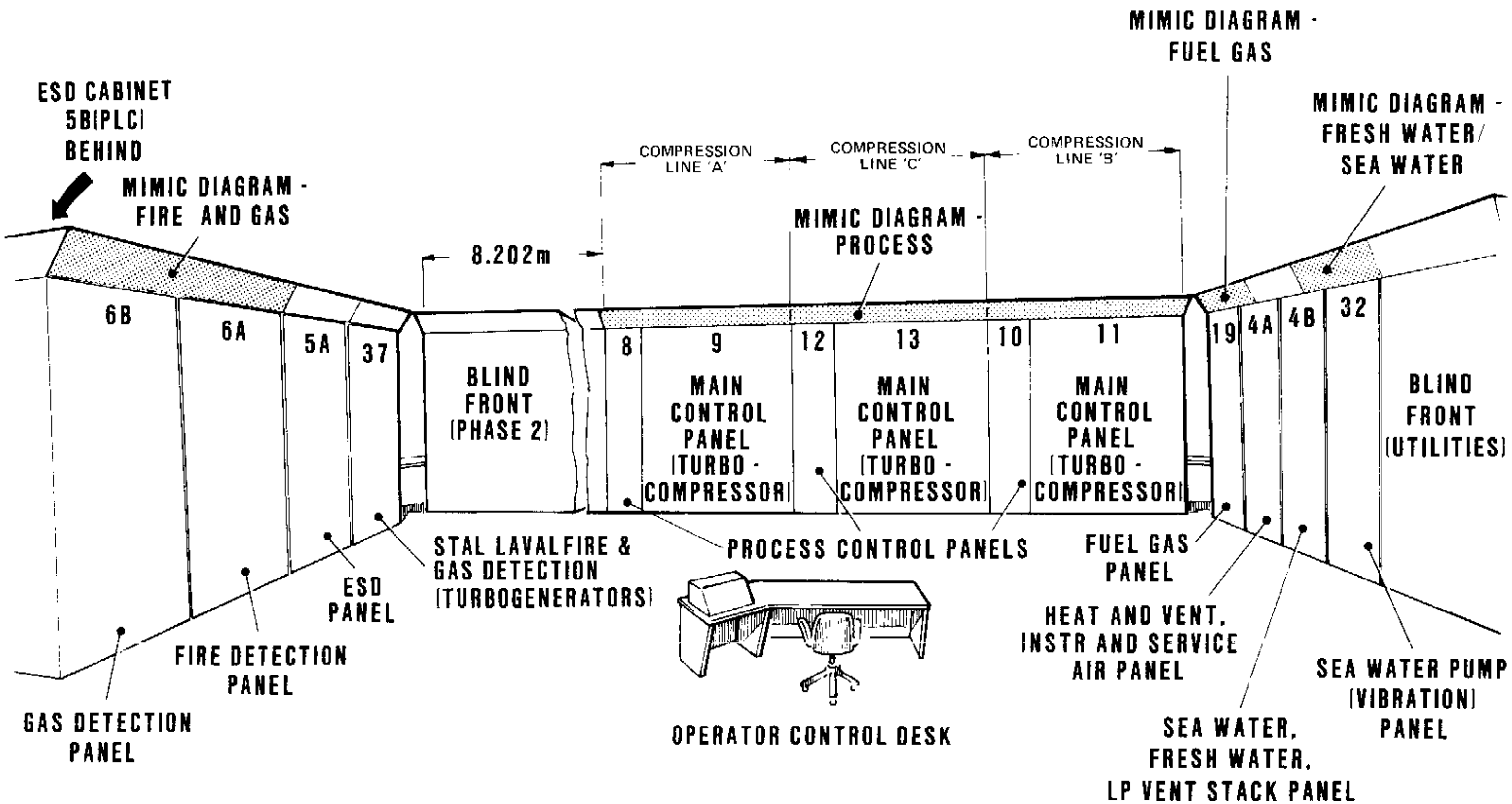
Illustration Identity	Tag No	Equipment	Module
22	67B01	LP Vent Scrubber	
23	11B01B	Suction Drum	
24		Fuel Gas Knockout Pot & Filters	
25	T52.32.1.7)	Transformers	
26	T52.32.1.6)		
27		) Fuel Gas Heater	
28		) Transformers	
29	11B02A)	Water Separators	
30	11B02B)		
31	11B01A)	Suction Drums	
32	11B01C)		
33		) Fuel Gas Knockout	
34		) Pot & Filters	


AREA 65
1
2
COLUMN 5
PANCAKE 46
3
4
5
EXISTING TCP2 TREATMENT MODULES
PANCAKE 43
PANCAKE 42
PANCAKE 41
PANCAKE40
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
6
28
7 (UNDER)
27 (UNDER)
AREA 63
29
30
31
COLUMN 3
32
33
34
35
36
37
38
39
40
41
42
43
PANCAKE 44
PANCAKE 45
PHASE 2
CELLAR DECK

2.3.3 Equipment List – Cellar Deck (C1.7)

Illustration Identity	Tag No	Equipment	Area/ Pancake
1	58C02	Sea Water Rejection Shaft	Area 65
2	58P01E	Future Sea Water Cooling Pump (Phase 2)	Area 65
3	58C01	Sea Water Rejection Shaft	Area 65
4	58P01F	Future Sea Water Cooling Pump (Phase 2)	Area 65
5	68P01B & 68PD01B	Fire Pump and Diesel Engine	46
6	57X01.T01	Air Receiver	46
7	58T02	Fresh Water/TEG Drain Tank	42
8	58E01.A6	Future Sea Water/Fresh Water Heat Exchangers (Phase 2)	43
9	58E01.A5	Future Sea Water/Fresh Water Heat Exchangers (Phase 2)	43
10	58E01.A4	Sea Water/Fresh Water Heat Exchangers	43
11	58E01.A3	Sea Water/Fresh Water Heat Exchangers	43
12	58E01.A2	Sea Water/Fresh Water Heat Exchangers	43
13	58E01.A1	Sea Water/Fresh Water Heat Exchangers	43
14	58P04A	Fresh Water Utility Pumps	42
15	58P04B	Fresh Water Utility Pumps	42
16	58P02A	Fresh Water Process Pumps	42
17	58P02B	Fresh Water Process Pumps	42
18	58P02C	Future Fresh Water Process Pumps (Phase 2)	42
19	58P03	Future Fresh Water Process Pumps (Phase 2)	42

Illustration Identity	Tag No	Equipment	Area/ Pancake
20	55X02	Anti-corrosion Dosing Set	42
21	58P05A/B	Fresh Water/TEG Drain Tank Pumps	42
22	55P03	Turbine Washing Pump	42
23	55P01A	Fresh Water Make-up Pumps	42
24	55P01B	Fresh Water Make-up Pumps	42
25	57X01	Air Compressor Package	42
26	68P01A & 68PD01A	Fire Pump and Diesel Engine	42
27	55T01	Fresh Water Storage Tank	42
28	55X01A/B	Watermakers	42
29	50P02	Washdown Pump	
30	58P01A	Sea Water Cooling Pumps	Area 63
31	58P01B	Sea Water Cooling Pumps	Area 63
32	58P01C	Sea Water Cooling Pumps	Area 63
33	58P01D	Sea Water Cooling Pumps	Area 63
34	58S01A	Sea Water Strainers	Area 63
35	58S01B	Sea Water Strainers	Area 63
36	52G01A	Main Alternators	41
37	52G01B	Main Alternators	41
38	52GG01A	Gas Turbines for Power Generation	41
39	52GG01B	Gas Turbines for Power Generation	41
40		Fuel Gas Knockout Pot	40
41	53T01	Diesel Day Tank, Emerg DG	44
42	53GD01	Emergency Diesel Generator, Diesel Engine	44
43	53G01	Emergency Diesel Generator, Alternator	44



ESD CABINET 5B(PLC) BEHIND
MIMIC DIAGRAM - FIRE AND GAS
8.202m
COMPRESSION LINE 'A'
COMPRESSION LINE 'C'
COMPRESSION LINE 'B'
MIMIC DIAGRAM - PROCESS
MIMIC DIAGRAM - FUEL GAS
MIMIC DIAGRAM - FRESH WATER/ SEA WATER
6B
6A
5A
37
BLIND FRONT (PHASE 2)
8
9
12
13
10
11
MAIN CONTROL PANEL (TURBO - COMPRESSOR)
MAIN CONTROL PANEL (TURBO - COMPRESSOR)
MAIN CONTROL PANEL (TURBO - COMPRESSOR)
19
4A
4B
32
BLIND FRONT (UTILITIES)
STAL LAVALFIRE & GAS DETECTION (TURBOGENERATORS)
PROCESS CONTROL PANELS
FUEL GAS PANEL
ESD PANEL
FIRE DETECTION PANEL
GAS DETECTION PANEL
OPERATOR CONTROL DESK
HEAT AND VENT. INSTR AND SERVICE AIR PANEL
SEA WATER PUMP (VIBRATION) PANEL
SEA WATER, FRESH WATER, LP VENT STACK PANEL

SECTION 3 – POWER GENERATION

1 SUMMARY

See illustration C1.7

1.1 In order to provide for the additional electrical power requirements of gas compression, two large gas-turbine generators are being installed in two of the pancakes (40 and 41) of the new TCP2 compression area. These two new generators will become the primary source of power for the whole 5.5kV Frigg electrical network.

1.2 The location of the power generation equipment is shown on illustration C1.7 (Cellar Deck).

SECTION 4 – CONTROL

1 SUMMARY

1.1 Centralised control of all Frigg processes will still be exercised from platform QP Control Room, which receives some indications of process parameters, fire & gas detection and ESD information, and valve positions by transmission lines (across the bridges from TP1 and TCP2) and some by telemetry.

1.2 The new Control Room to be installed in TCP2 compression area allows for localised control of all utilities and of the compression equipment. Levels 1 and 2 shutdowns cannot be exercised from TCP2–C Control Room.

2 TCP2–C CONTROL ROOM LAYOUT

See illustration C1.8

2.1 The Main and Process control panels for Phase 1 (Lines 'A', 'B' and 'C' – Panels 8 & 9, 10 & 11 and 12 & 13 respectively) face the operator control desk, with the Compression Process mimic diagram above them. The area to left front of the operator control desk will be used for the Phase 2 Main and Process control panels.

2.2 To the right of the operator control desk are the control panels for Fuel Gas (19); Heating & Ventilation, and Instrument & Service Air (4A); Sea Water, Fresh Water, and LP Vent Stack (4B); and Sea Water Pump Vibration (32). Mimic diagrams for Fuel Gas, and Fresh Water/Sea Water are sited above their respective control panels.

2.3 To the left of the operator control desk are the control panels for Gas Monitor, Stal Laval Fire & Gas Detection (37); ESD (5A); Fire Detection (6A); and Gas Detection (6B). A mimic diagram for Fire & Gas is sited above these control panels. ESD Cabinet 5B (Programmable Logic Controllers) is situated behind the left-hand control panels.

CHAPTER C2

GAS COMPRESSION – DESCRIPTION

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS (Continued)

SECTION 1 – INTRODUCTION

Reference: PID 5424W 11 0030 01 Sheets 1 to 3
PF 5424W 10 1200 02.20
PF 5424W 10 1200 02.112
PF 5424W 10 1200 02.265

1 As the field becomes depleted the pressure drops. If the outlet pressure is too low it becomes impossible to export the requested amount of gas to St. Fergus. Therefore, depending upon the flow required, the Frigg outlet pressure has to be raised to be equal at least to the pressure at St. Fergus plus the pressure drop in the line. A compression unit is installed for this purpose and progressively compensates for the decline in reservoir pressure by maintaining the export pressure constant.

2 The whole compression unit is installed in two phases on TCP2. In each phase the installation consists of two compression lines and three turbocompressor packages. One package is dedicated to each line and the third may be used as a standby for either line. Each compressor package is virtually identical. Line and compressor identities for the two phases are as follows:

(a) Phase 1:

Line 'A' – 11KG01A
Line 'B' – 11KG01B
Line 'C' – 11KG01C (Standby)

(b) Phase 2 (Future)

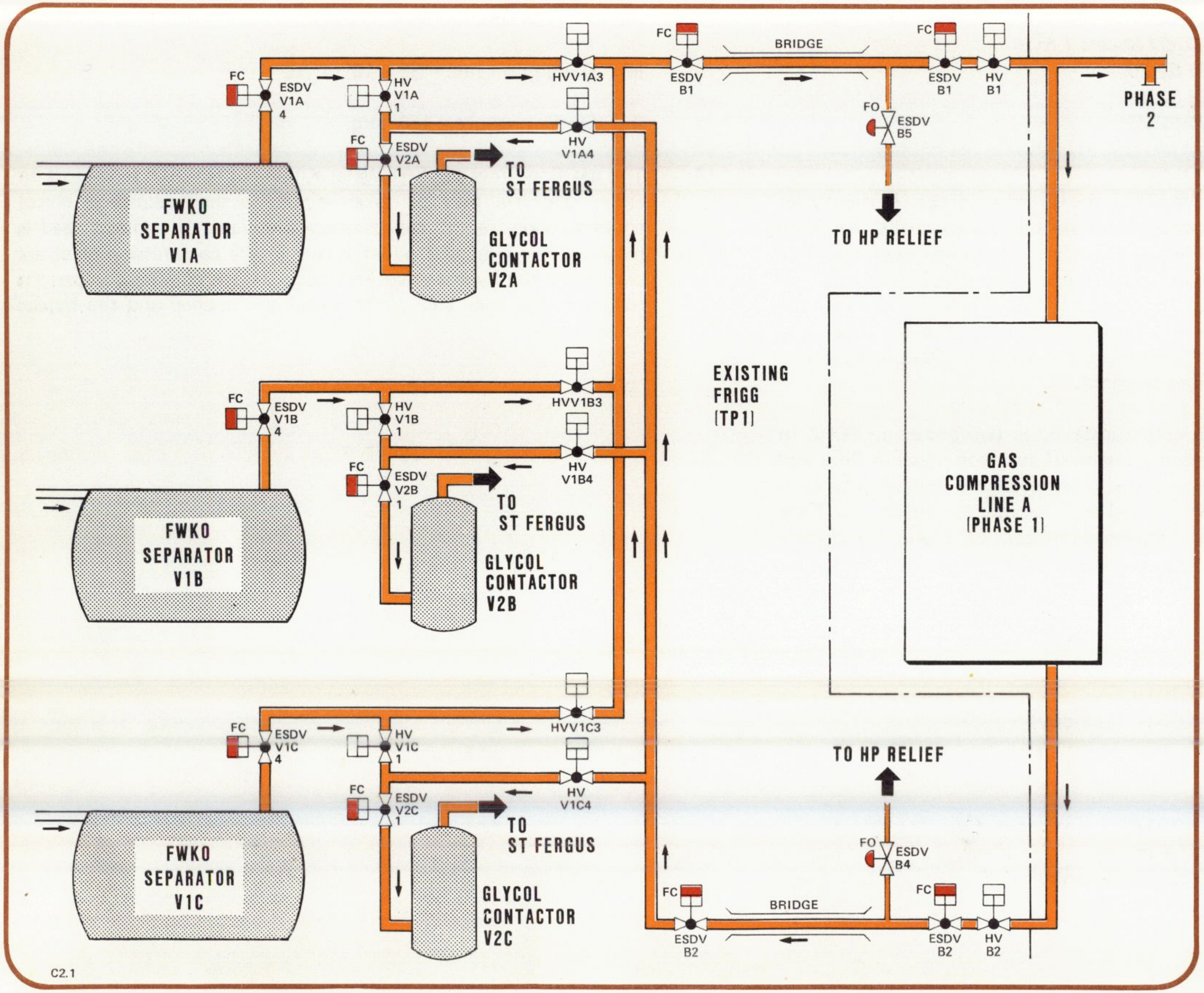
Line 'A' – 12KG01A
Line 'B' – 12KG01B
Line 'C' – 12KG01C (Standby)

3 Each of the two parallel compression lines has been designed for the following conditions:

(a) Design flow rate = $32 \times 10^6 m^3/d$.

(b) Outlet pressure = 153 barg.

4 The gas flow from the Free Water Knockout (FWKO) separators on either platform may be taken direct to their respective glycol contactors or via the gas compression plant. If a direct feed is required, the inlet and outlet valves to the compression plant are closed and the bypass valves are opened. If the compression plant is required, the inlet and outlet valves are opened and the bypass valves closed.


FC
ESDV
V1A
4
HV
V1A
1
HVV1A3
FC
ESDV
B1
BRIDGE
FC
ESDV
B1
HV
B1
PHASE
2
FO
ESDV
B5
HV
V1A4
FC
ESDV
V2A
1
TO
ST FERGUS
TO HP RELIEF
FWKO
SEPARATOR
V1A
GLYCOL
CONTACTOR
V2A
EXISTING
FRIGG
(TP1)
FC
ESDV
V1B
4
HV
V1B
1
HVV1B3
HV
V1B4
FC
ESDV
V2B
1
TO
ST FERGUS
GAS
COMPRESSION
LINE A
(PHASE 1)
FWKO
SEPARATOR
V1B
GLYCOL
CONTACTOR
V2B
FC
ESDV
V1C
4
HV
V1C
1
HVV1C3
HV
V1C4
FC
ESDV
V2C
1
TO
ST FERGUS
TO HP RELIEF
FO
ESDV
B4
FWKO
SEPARATOR
V1C
GLYCOL
CONTACTOR
V2C
FC
ESDV
B2
BRIDGE
FC
ESDV
B2
HV
B2
C2.1

SECTION 2 – INTERFACES WITH TP1 and TCP2

1 INLET AND OUTLET GAS INTERFACES – LINE 'A'

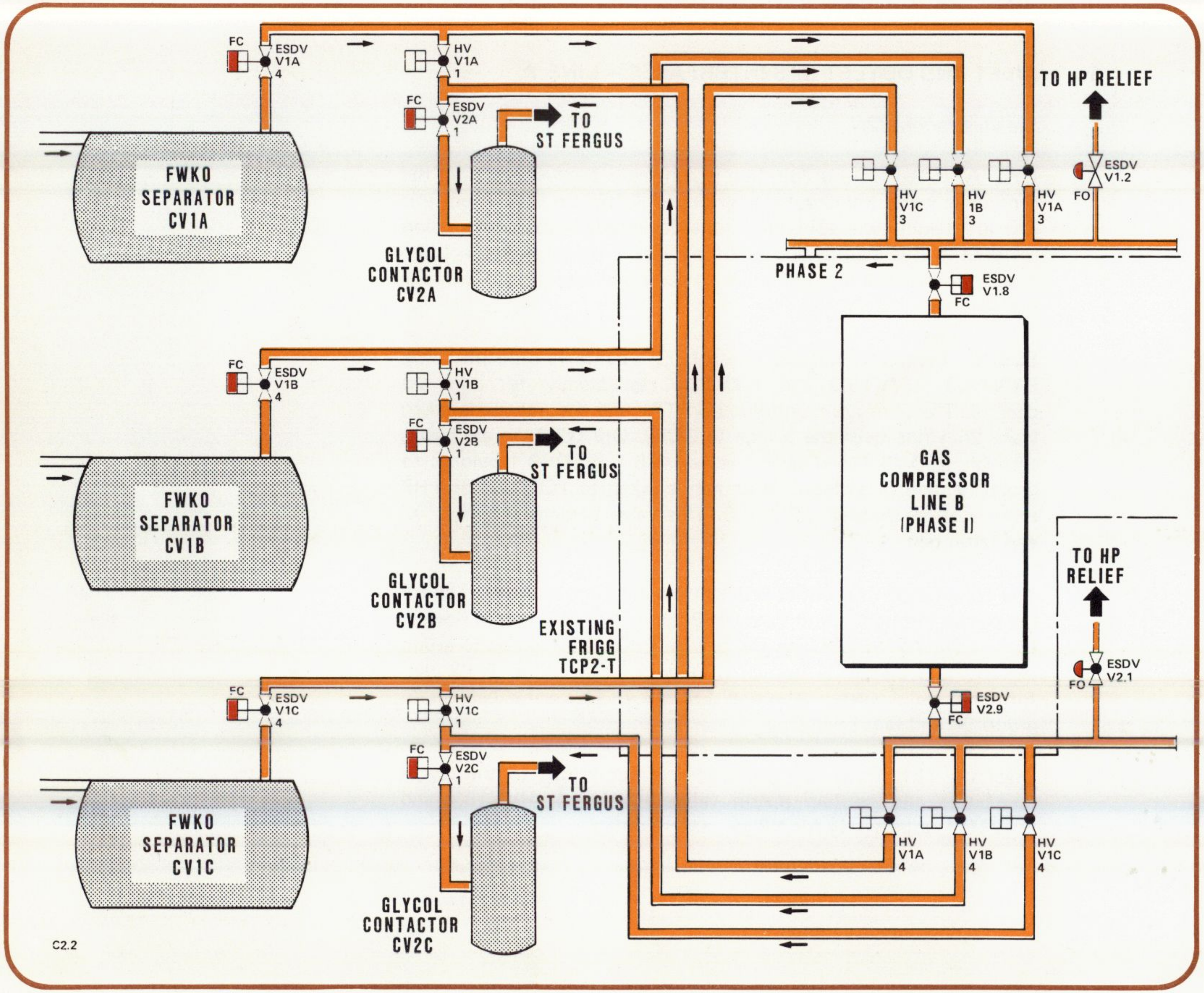
See illustration C2.1

1.1 Line 'A' is fed from a 26in line which takes the wet gas from the three free water knockout separators V1A/B/C on TP1. From this line are taken two 26in lines, one for Phase 1 gas compression featured in this manual and one for Phase 2 (Future). Phase 1 line inputs to 11B01A suction drum as described later. Phase 2 line is blanked off.

1.2 Each of the three wet gas lines on TP1 contains a piston valve, HVV1A.3, HVV1B.3 and HVV1C.3 respectively, for inlet gas control. The lines are manifolded on TP1 and the wet gas is taken via a 26in line over the bridge to TCP2. On TCP2 the gas passes through ESDVB.1 and piston valve HVB.1. ESDVB.1 belongs to group 'V' and fails closed. A branch is taken to TCP2 platform HP relief system through ESDVB.5. This valve belongs to group 'X' and fails open.

1.3 The compressor unit outlet is taken to a 24in line on TCP2. The HP gas passes through piston valve HVB2 and ESDVB.2 before flowing to TP1 via a 24in line over the bridge. ESDVB.2 belongs to group 'V' and fails closed. A branch is taken off this line to TCP2 platform HP relief system through ESDVB.4. This valve belongs to group 'X' and fails open.

1.4 Once on TP1, three HP gas lines are manifolded to the glycol contactors and contain piston valves HVV1A.4, HVV1B.4 and HVV1C.4 respectively for HP gas outlet control.


FWKO SEPARATOR CV1A
FWKO SEPARATOR CV1B
FWKO SEPARATOR CV1C
GLYCOL CONTACTOR CV2A
GLYCOL CONTACTOR CV2B
GLYCOL CONTACTOR CV2C
TO ST FERGUS
TO ST FERGUS
TO ST FERGUS
FC ESDV V1A 4
HV V1A 1
FC ESDV V2A 1
FC ESDV V1B 4
HV V1B 1
FC ESDV V2B 1
FC ESDV V1C 4
HV V1C 1
FC ESDV V2C 1
EXISTING FRIGG TCP2-T
TO HP RELIEF
HV V1C 3
HV 1B 3
HV V1A 3
ESDV V1.2 FO
PHASE 2
ESDV V1.8 FC
GAS COMPRESSOR LINE B (PHASE I)
TO HP RELIEF
ESDV V2.1 FO
ESDV V2.9 FC
HV V1A 4
HV V1B 4
HV V1C 4
C2.2

2 INLET AND OUTLET GAS INTERFACES – LINE 'B'

See illustration C2.2

2.1 Line 'B' is fed from a 26in line which manifolds wet gas lines from the three free water knockout separators CV1A/B/C on TCP2. From this line are taken two 26in lines, one for Phase 1 gas compression featured in this manual and one for Phase 2 (Future). Phase 1 line inputs through ESDVV1.8 to 11B01B suction drum as described later. Phase 2 line is blanked off.

2.2 Each of the three wet gas lines contains a piston valve, HVV1A.3, HVV1B.3 and HVV1C.3 respectively, for inlet gas control. A branch is taken off their manifolding line to the platform HP relief system through ESDVV1.2. This valve belongs to group 'W' and fails open.

2.3 The compressor unit outlet is taken through ESDVV2.9 to a 24in line to which is manifolded three 18in lines to glycol contactors CV2A/B/C. A branch is taken off this manifold to the platform HP relief system through ESDVV2.1. This valve belongs to group 'W' and fails open.

2.4 The lines to the glycol contactors contain piston valves HVV1A.4, HVV1B.4 and HVV1C.4 respectively for HP gas outlet control.

3 UTILITY INTERFACES

3.1 Interfaces are provided between the gas compression system and the following utilities:

(a) Instrument and Service Air System.

(b) HP Relief System.

(c) LP Vent System.

(d) Main Fresh Water Cooling System.

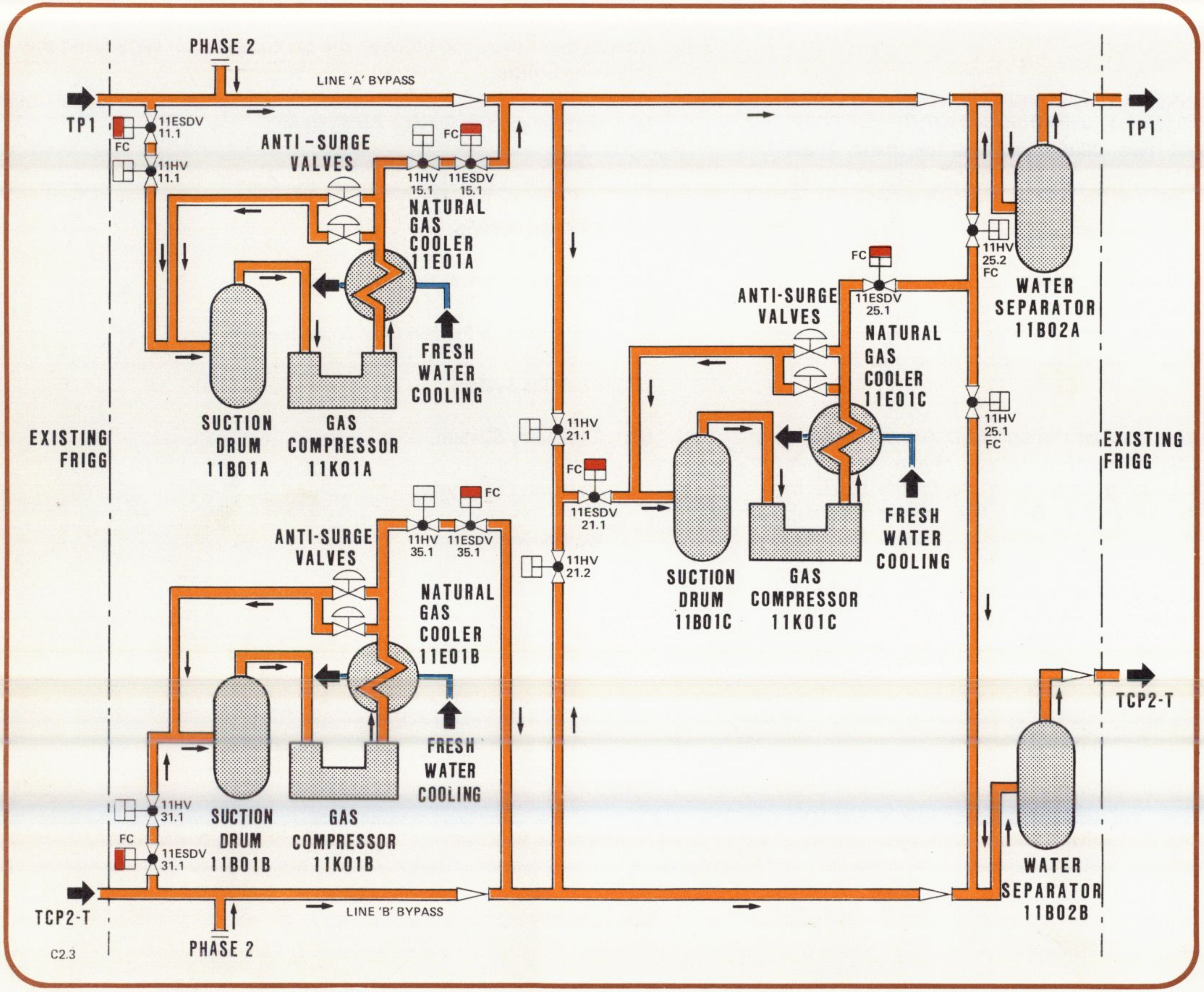
(e) High Pressure Process Oily Water System.

(f) Fuel Gas System.

(g) Telemetry System.

(h) Platform ESD System.

(j) Washdown System.


PHASE 2
LINE 'A' BYPASS
TP1
11ESDV 11.1
FC
11HV 11.1
ANTI-SURGE VALVES
11HV 15.1
11ESDV 15.1
FC
NATURAL GAS COOLER 11E01A
FRESH WATER COOLING
SUCTION DRUM 11B01A
GAS COMPRESSOR 11K01A
EXISTING FRIGG
11HV 21.1
FC
11ESDV 21.1
11HV 21.2
FC
11ESDV 25.1
ANTI-SURGE VALVES
NATURAL GAS COOLER 11E01C
FRESH WATER COOLING
SUCTION DRUM 11B01C
GAS COMPRESSOR 11K01C
11HV 25.2 FC
11HV 25.1 FC
WATER SEPARATOR 11B02A
TP1
EXISTING FRIGG
ANTI-SURGE VALVES
11HV 35.1
11ESDV 35.1
FC
NATURAL GAS COOLER 11E01B
FRESH WATER COOLING
SUCTION DRUM 11B01B
GAS COMPRESSOR 11K01B
11HV 31.1
FC
11ESDV 31.1
TCP2-T
LINE 'B' BYPASS
PHASE 2
TCP2-T
WATER SEPARATOR 11B02B
C2.3

SECTION 3 – COMPRESSION PLANT

1 INTRODUCTION – LINES 'A', 'B' and 'C'

See illustration C2.3

1.1 Gas coming from TP1 and TCP2 FWKO enters each line and passes through suction drum 11B01 where it is freed from oily water. It is then drawn by the compressor 11K01 at a temperature of 50°C and a pressure dependent upon reservoir conditions.

1.2 Gas at compressor outlet (153 bar max and 105°C max) is cooled to 50°C in 11E01 by fresh water/TEG. It is then freed from oily water in separator drum 11B02 from where it passes to the treatment units. Line 'C' uses the separator of either line 'A' or 'B'.

1.3 In order to protect each compressor, anti-surge valves are connected between discharge and suction lines.

1.4 At the outlet of line 'A' separator drum, some of the gas can be used as fuel gas to supply gas turbines through the fuel gas treatment unit.

1.5 Each line 'A' and 'B' is provided with a bypass line connected upstream to inlet block valves and downstream to outlet block valves, allowing the use of line 'C' as a spare for lines 'A' or 'B'.

1.6 The compressors and their drivers are respectively located in Modules 30, 31 and 33 on the Main Deck level.

2 COMPRESSOR LINE 'C'

See illustrations C2.3, C2.4(1), (2) and (3)

2.1 Introduction

2.1.1 The compression process in line 'C' is identical to that in lines 'A' and 'B' except that line 'C' is not furnished with a water separator downstream of its natural gas cooler. The cooler outlet is diverted to either line 'A' or line 'B' water separator.

2.1.2 A bypass line is taken from the suction drum inlets in lines 'A' and 'B'. These rejoin their lines (through a check valve in each case) at a point upstream of the water separators. It is from this point in each line that an input is taken to line 'C'.

2.1.3 Line 'C' is for use as a standby to either line 'A' or line 'B'. A system of logic switching and use of automatically operated control valves ensures smooth transition from normal operation of lines 'A' and 'B' to the substitution of one of these lines by line 'C'. The converse is also true. The line substituted by line 'C' is fully isolated and checked automatically to avoid any entry of process gas. The logic of operation is described in paragraph 3.

2.2 Inlet Piping Configuration

2.2.1 Suction drum 11B01C takes its input process gas either from line 'A' bypass or line 'B' bypass through one of two logic-interlocked control valves, 11HV21.1 or 11HV21.2 respectively. These two valves are identical and are operated hydraulically from a local valve control panel. Either one or the other (but never both) may be opened provided that an authorisation signal has been received from TCP2 Control Room. They cannot be opened remotely. Lamps indicate whether they are open or closed on the mimic and on QP via telemetry.

2.2.2 In the 26in common inlet line to the suction drum is 11ESDV21.1. This valve is the primary inlet emergency shutdown device. It will close in the event of an ESD, a high-high level in the suction drum, a high-high pressure on the discharge side of the compressor or a high-high pressure in the sales gas header.

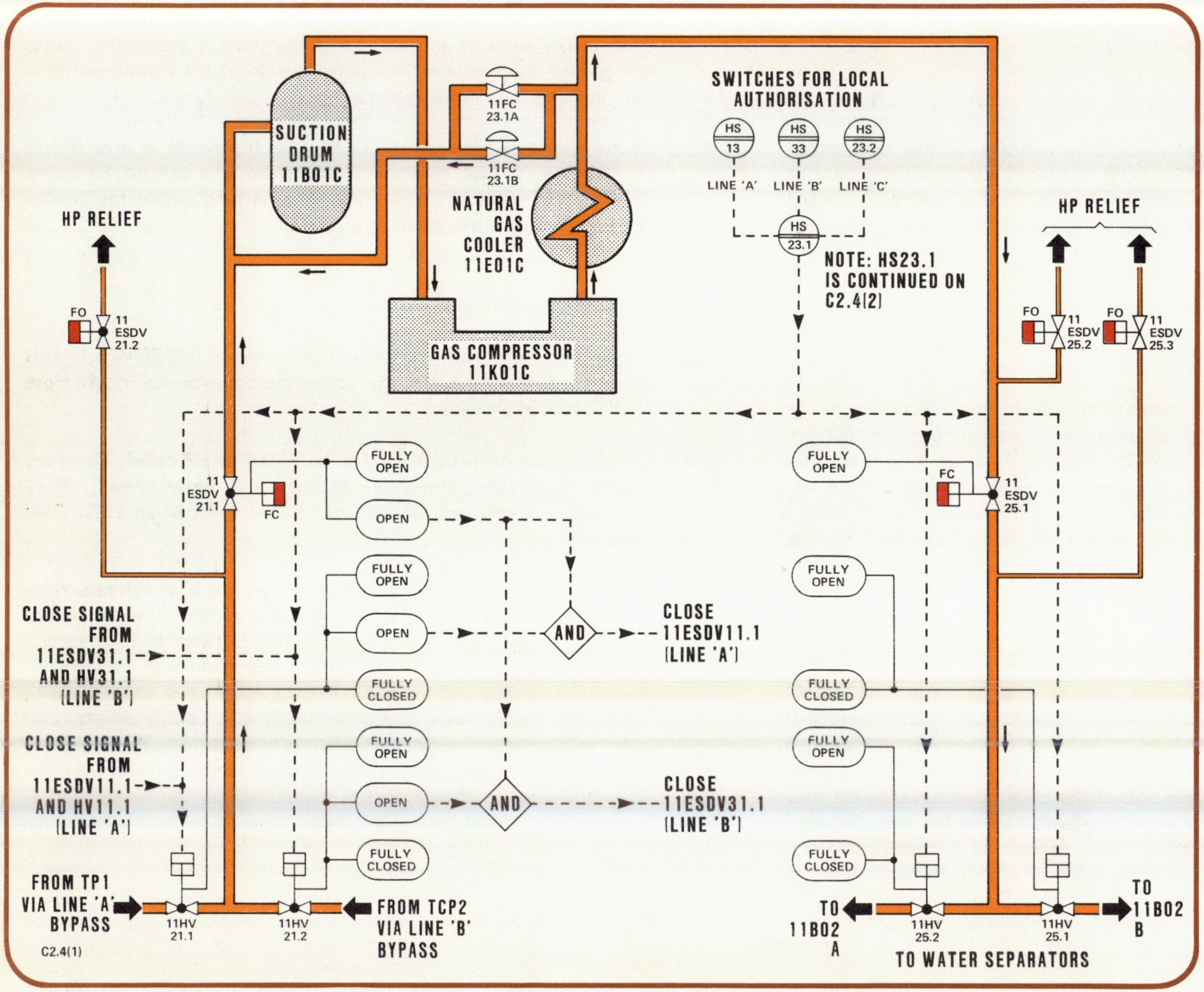
2.2.3 In the pipework between the inlet valves from lines 'A' and 'B' and the shutdown valve to the suction drum is a line to HP relief through 11ESDV21.2. This valve is a venting device for depressurising the line in the event of an ESD.

2.3 Outlet Piping Configuration

2.3.1 In the 24in line from the natural gas cooler is 11ESDV25.1. This valve is the primary outlet emergency shutdown device. It will close in the event of an ESD.

2.3.2 On either side of 11ESDV25.1 is an ESDV to HP relief. These are 11ESDV25.2 (upstream) and 11ESDV25.3 (downstream). They both open to depressurise the lines in the event of an ESD. They both fail open.

2.3.3 The 24in line now splits into two 24in lines one of which returns to line 'A' water separator inlet and the other to line 'B' water separator inlet. In each line is a block valve, HV25.2 and HV25.1 respectively, and they are logic-interlocked. These two valves are identical and are operated hydraulically from a local valve control panel. Either one or the other (but never both) may be opened provided than an authorisation signal has been received from TCP2 Control Room. They cannot be opened remotely. Lamps indicate whether they are open or closed on the mimic and on QP via telemetry.


SUCTION DRUM 11B01C
11FC 23.1A
11FC 23.1B
NATURAL GAS COOLER 11E01C
GAS COMPRESSOR 11K01C
SWITCHES FOR LOCAL AUTHORISATION
HS 13
HS 33
HS 23.2
LINE 'A'
LINE 'B'
LINE 'C'
HS 23.1
NOTE: HS23.1 IS CONTINUED ON C2.4(2)
HP RELIEF
FO
11 ESDV 21.2
HP RELIEF
FO
11 ESDV 25.2
FO
11 ESDV 25.3
11 ESDV 21.1
FC
FC
11 ESDV 25.1
FULLY OPEN
OPEN
FULLY OPEN
OPEN
FULLY CLOSED
FULLY OPEN
OPEN
FULLY CLOSED
AND
AND
CLOSE 11ESDV11.1 (LINE 'A')
CLOSE 11ESDV31.1 (LINE 'B')
CLOSE SIGNAL FROM 11ESDV31.1 AND HV31.1 (LINE 'B')
CLOSE SIGNAL FROM 11ESDV11.1 AND HV11.1 (LINE 'A')
FULLY OPEN
FULLY OPEN
FULLY CLOSED
FULLY OPEN
FULLY CLOSED
FROM TP1 VIA LINE 'A' BYPASS
11HV 21.1
11HV 21.2
FROM TCP2 VIA LINE 'B' BYPASS
TO 11B02 A
11HV 25.2
11HV 25.1
TO 11B02 B
TO WATER SEPARATORS
C2.4(1)

3 LOGIC CONTROL OF LINES 'A', 'B' and 'C'

3.1 Introduction

3.1.1 A system of interlocking logic ensures safe separation between the three lines while providing for substitution of either line 'A' or line 'B' by line 'C'.

3.1.2 Line 'C' is provided with a three-position selector switch HS23.1 on TCP2 control panel. This selector allows turbine 11KG01C start-up on line 'A', for example, only if the valves to and from line 'A' are open and the valves to and from line 'B' are closed.

3.2 Valve Control and Interlocking

See illustrations C2.3 and C2.4(1)

3.2.1 The important valves are as follows:

(a) Line 'A' inlet 11ESDV11.1, 11HV11.1
outlet 11ESDV15.1, 11HV15.1

(b) Line 'B' inlet 11ESDV31.1, 11HV31.1
outlet 11ESDV35.1, 11HV35.1

(c) Line 'C' inlet 11ESDV21.1
11HV21.1 (from 'A' bypass)
11HV21.2 (from 'B' bypass)
outlet 11ESDV25.1
11HV25.2 (to 'A' separator)
11HV25.1 (to 'B' separator)

3.2.2 The following logic applies:

(a) If 11ESDV21.1 and 11HV21.1 are OPEN, 11ESDV11.1 CLOSES (ie line 'A' bypassed and line 'C' operational).

(b) If 11ESDV21.1 and 11HV21.2 are OPEN, 11ESDV31.1 CLOSES (ie line 'B' bypassed and line 'C' operational).

(c) If 11ESDV11.1 and 11HV11.1 are OPEN, 11HV21.1 CLOSES (ie line 'C' isolated when line 'A' operational).

(d) If 11ESDV31.1 and 11HV31.1 are OPEN, HV21.2 CLOSES (ie line 'C' isolated when line 'B' operational).

3.2.3 Switch HS23.1 has three positions and provides the pneumatic authorising signals at the local control panels.

(a) 'LINE C TO LINE A'.

(i) Allows opening of 11ESDV21.1 and 11HV21.1 (with consequent closing of 11ESDV11.1 and interlocking closed of 11HV21.2).

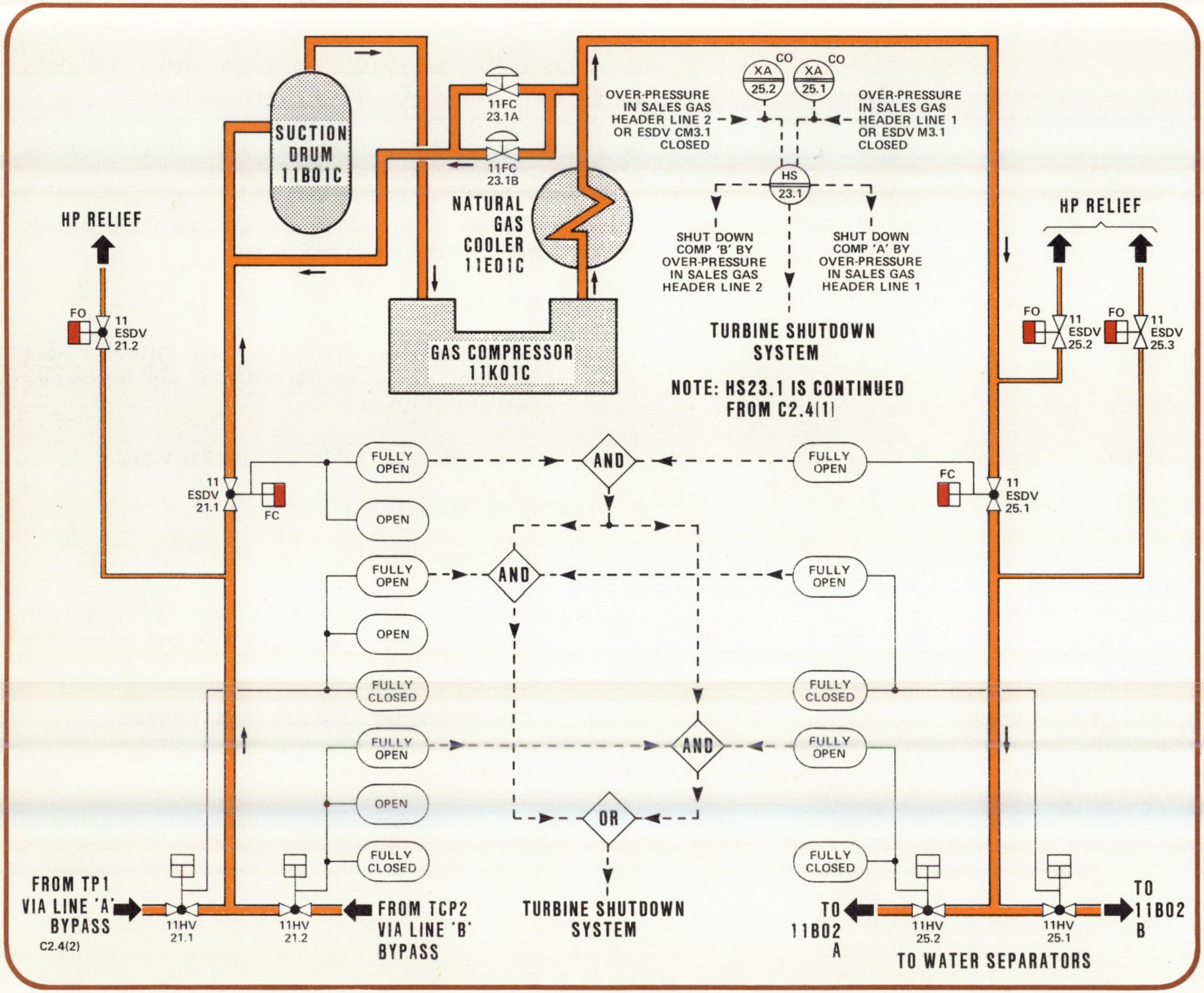
(ii) Allows opening of 11ESDV25.1 and 11HV25.2.

(b) 'LINE C OUT OF SERVICE'.

(c) 'LINE C TO LINE B'.

(i) Allows opening of 11ESDV21.1 and 11HV21.2 (with consequent closing of 11ESDV31.1 and interlocking closed of 11HV21.1).

(ii) Allows opening of 11ESDV25.1 and 11HV25.1.



SUCTION DRUM 11B01C
11FC 23.1A
11FC 23.1B
NATURAL GAS COOLER 11E01C
GAS COMPRESSOR 11K01C
XA 25.2 CO
XA 25.1 CO
OVER-PRESSURE IN SALES GAS HEADER LINE 2 OR ESDV CM3.1 CLOSED
OVER-PRESSURE IN SALES GAS HEADER LINE 1 OR ESDV M3.1 CLOSED
HS 23.1
SHUT DOWN COMP 'B' BY OVER-PRESSURE IN SALES GAS HEADER LINE 2
SHUT DOWN COMP 'A' BY OVER-PRESSURE IN SALES GAS HEADER LINE 1
TURBINE SHUTDOWN SYSTEM
NOTE: HS23.1 IS CONTINUED FROM C2.4(1)
HP RELIEF
FO 11 ESDV 21.2
HP RELIEF
FO 11 ESDV 25.2
FO 11 ESDV 25.3
11 ESDV 21.1 FC
FC 11 ESDV 25.1
FULLY OPEN
OPEN
AND
FULLY OPEN
FULLY OPEN
OPEN
AND
FULLY OPEN
FULLY CLOSED
FULLY CLOSED
FULLY OPEN
AND
FULLY OPEN
OPEN
OR
FULLY CLOSED
FULLY CLOSED
TURBINE SHUTDOWN SYSTEM
FROM TP1 VIA LINE 'A' BYPASS
C2.4(2)
11HV 21.1
11HV 21.2
FROM TCP2 VIA LINE 'B' BYPASS
TO 11B02 A
11HV 25.2
11HV 25.1
TO 11B02 B
TO WATER SEPARATORS

3.3 Turbine Shutdown System Interlocking

See illustration C2.4(2)

3.3.1 An added function of the three-position switch HS23.1 is that it routes an overpressure signal from the sales gas header to cause a shutdown of compressor 'C' if the compressor is delivering gas to that particular header. At the same time, the turbine is shut down and an overpressure alarm is annunciated.

3.3.2 Logic signalling from the positions of the compressor inlet and outlet ESDVs, and the inlet and outlet HVs, provides a shutdown signal in the event of the wrong combination of valves being fully open.

3.4 Valve Indications

See illustrations C2.4(3) and (4)

3.4.1 A lamp is lit indicating bypass line 'B' is open to compressor 11K01C when the following conditions are fulfilled:

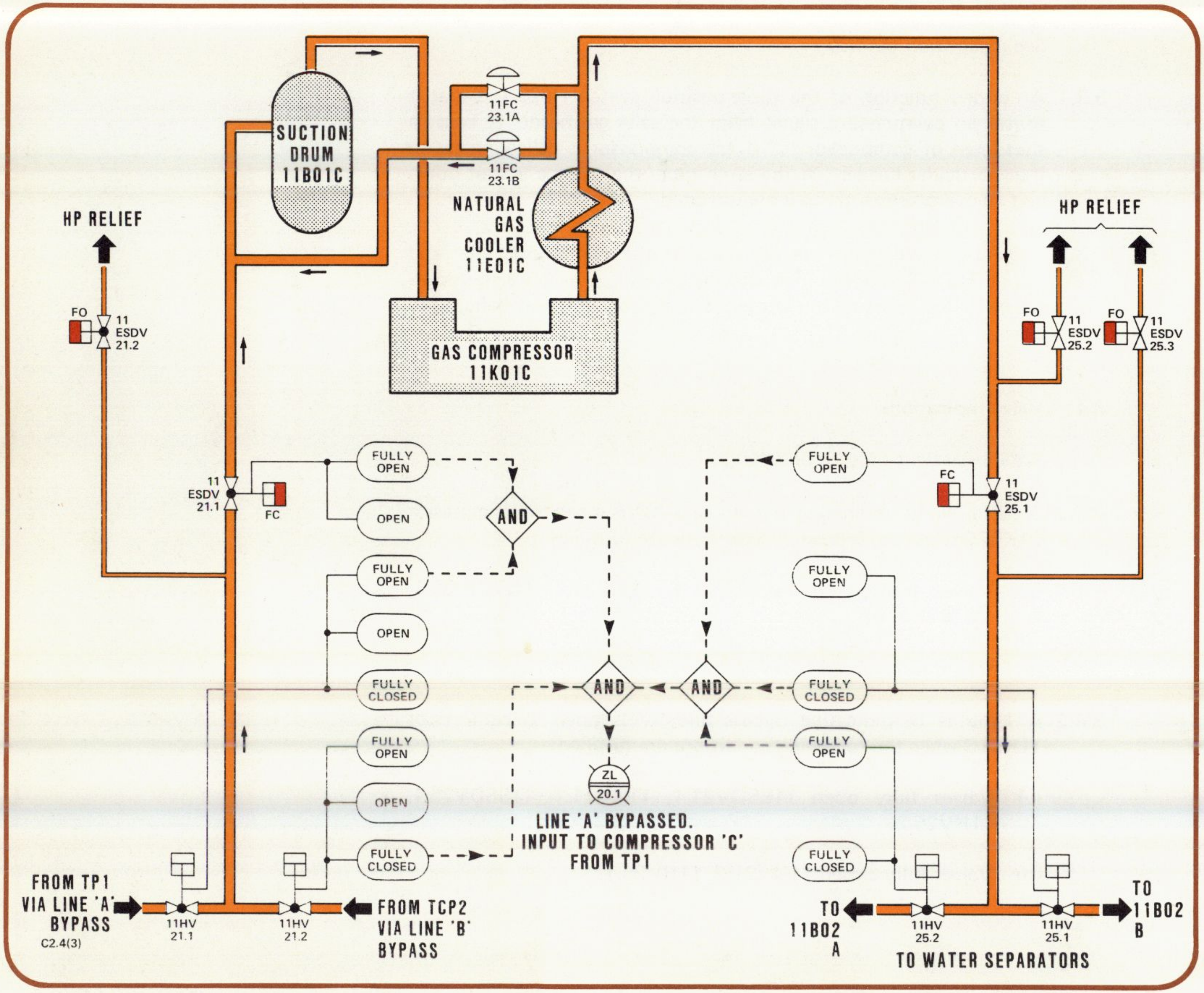
(a) Valves fully open 11ESDV21.1, 11HV21.2, 11ESDV25.1, 11HV25.1.

(b) Valves fully closed 11HV21.1, 11HV25.2.

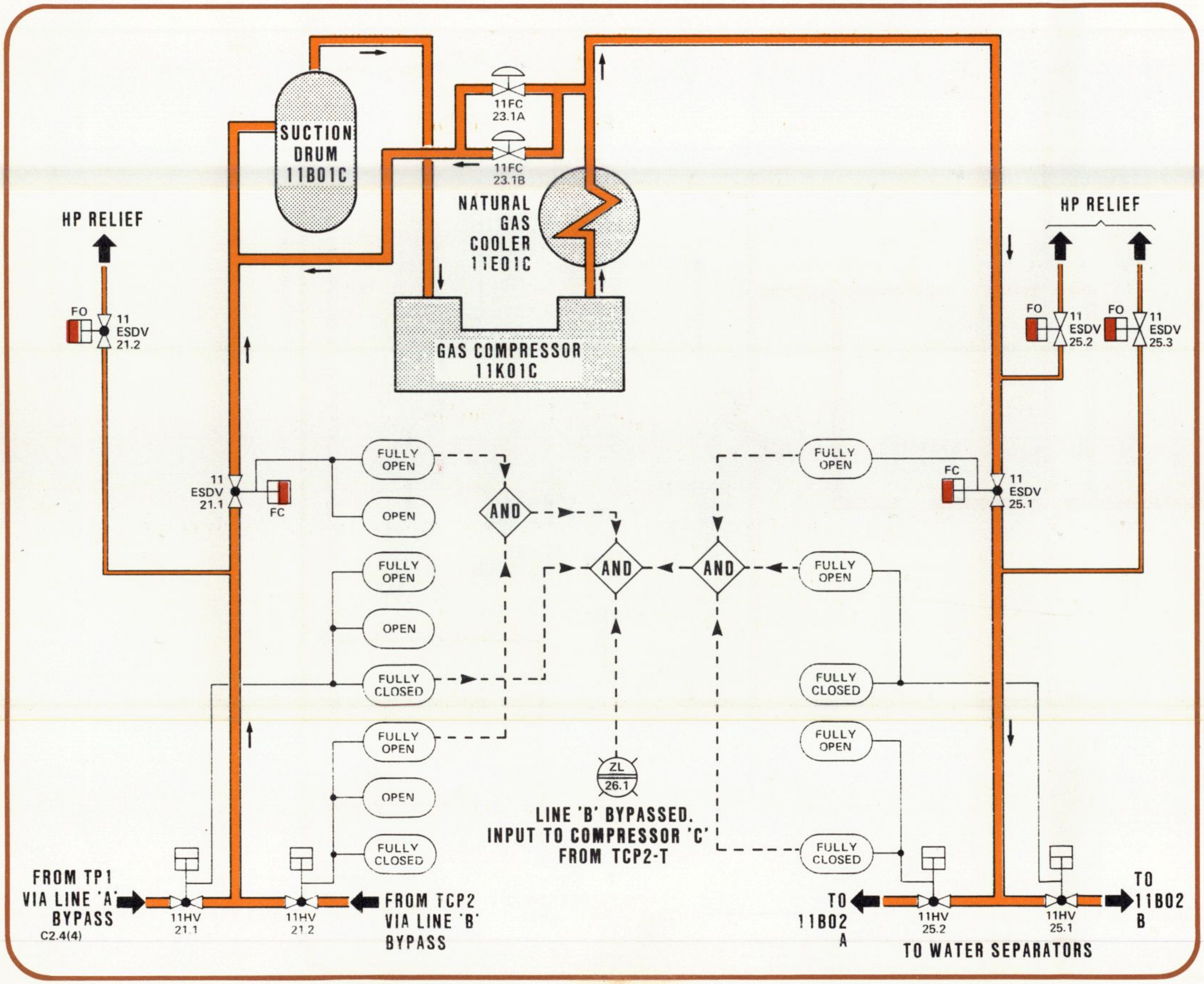
3.4.2 A lamp is lit indicating bypass line 'A' is open to compressor 11K01C when the following conditions are fulfilled:

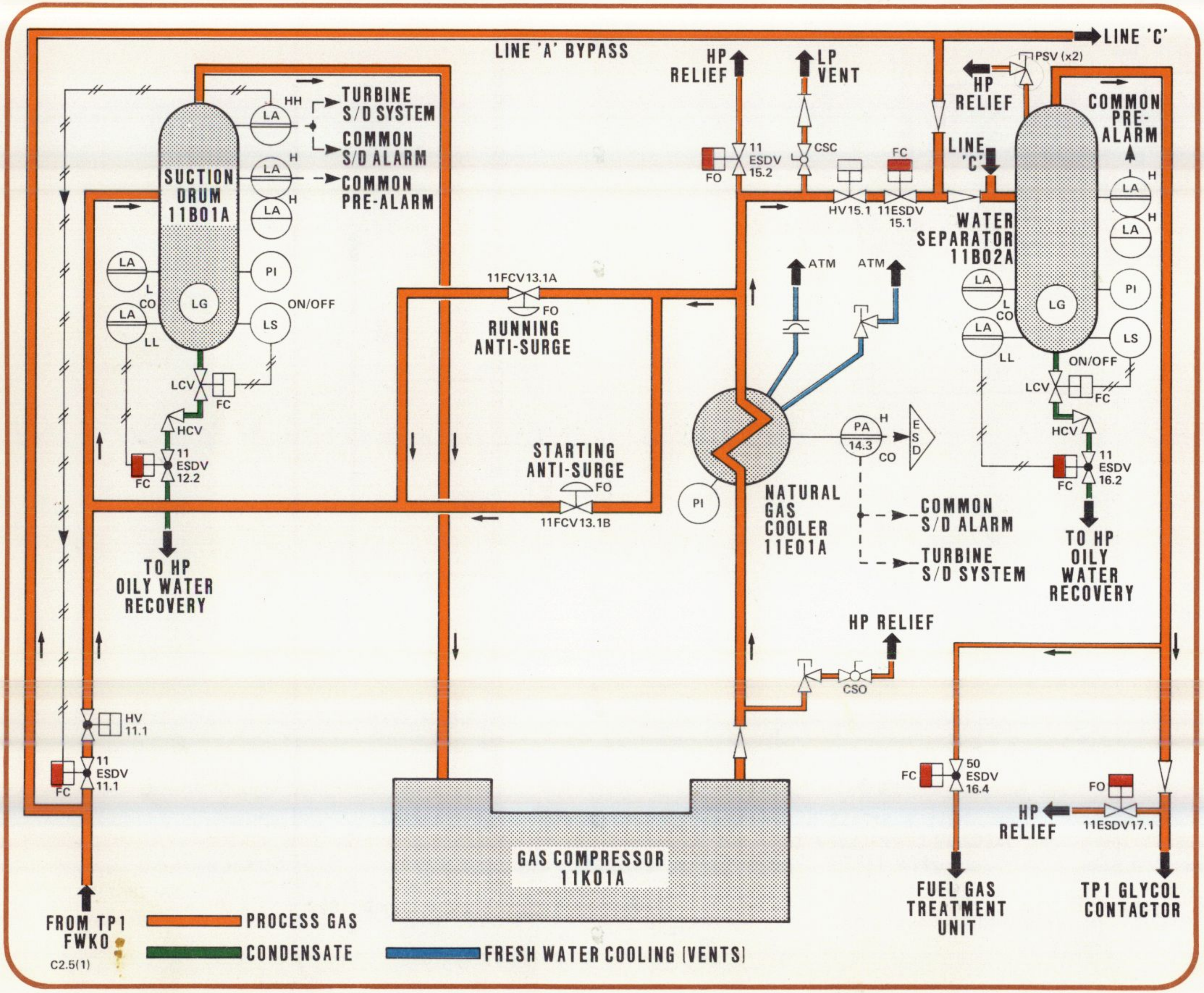
(a) Valves fully open 11ESDV21.1, 11HV21.1, 11ESDV25.1, 11HV25.2.

(b) Valves fully closed 11HV21.2, 11HV25.1.



SUCTION DRUM 11B01C
11FC 23.1A
11FC 23.1B
NATURAL GAS COOLER 11E01C
GAS COMPRESSOR 11K01C
HP RELIEF
FO
11 ESDV 21.2
HP RELIEF
FO
11 ESDV 25.2
FO
11 ESDV 25.3
11 ESDV 21.1
FC
FC
11 ESDV 25.1
FULLY OPEN
OPEN
FULLY OPEN
OPEN
FULLY CLOSED
FULLY OPEN
OPEN
FULLY CLOSED
AND
AND
AND
FULLY OPEN
FULLY OPEN
FULLY CLOSED
FULLY OPEN
FULLY CLOSED
ZL 20.1
LINE 'A' BYPASSED. INPUT TO COMPRESSOR 'C' FROM TP1
FROM TP1 VIA LINE 'A' BYPASS
C2.4(3)
11HV 21.1
11HV 21.2
FROM TCP2 VIA LINE 'B' BYPASS
TO 11B02 A
11HV 25.2
11HV 25.1
TO 11B02 B
TO WATER SEPARATORS


SUCTION DRUM 11B01C
11FC 23.1A
11FC 23.1B
NATURAL GAS COOLER 11E01C
GAS COMPRESSOR 11K01C
HP RELIEF
FO
11 ESDV 21.2
11 ESDV 21.1
FC
HP RELIEF
FO
11 ESDV 25.2
FO
11 ESDV 25.3
FC
11 ESDV 25.1
FULLY OPEN
OPEN
FULLY OPEN
OPEN
FULLY CLOSED
FULLY OPEN
OPEN
FULLY CLOSED
AND
AND
AND
FULLY OPEN
FULLY OPEN
FULLY CLOSED
FULLY OPEN
FULLY CLOSED
ZL 26.1
LINE 'B' BYPASSED. INPUT TO COMPRESSOR 'C' FROM TCP2-T
FROM TP1 VIA LINE 'A' BYPASS
C2.4(4)
11HV 21.1
11HV 21.2
FROM TCP2 VIA LINE 'B' BYPASS
TO 11B02 A
11HV 25.2
11HV 25.1
TO 11B02 B
TO WATER SEPARATORS


LINE 'A' BYPASS
LINE 'C'
HP RELIEF
LP VENT
PSV (x2)
TURBINE S/D SYSTEM
COMMON S/D ALARM
COMMON PRE-ALARM
HH
H
LA
SUCTION DRUM 11B01A
PI
LG
LS
ON/OFF
L
CO
LL
LCV
FC
HCV
11 ESDV 12.2
TO HP OILY WATER RECOVERY
11 ESDV 15.2
FO
CSC
HV15.1
11ESDV 15.1
LINE 'C'
WATER SEPARATOR 11B02A
11FCV13.1A
RUNNING ANTI-SURGE
STARTING ANTI-SURGE
11FCV13.1B
ATM
PA 14.3
ESD
NATURAL GAS COOLER 11E01A
11 ESDV 16.2
CSO
HV 11.1
11 ESDV 11.1
GAS COMPRESSOR 11K01A
50 ESDV 16.4
11ESDV17.1
FUEL GAS TREATMENT UNIT
TP1 GLYCOL CONTACTOR
FROM TP1 FWKO
PROCESS GAS
CONDENSATE
FRESH WATER COOLING (VENTS)
C2.5(1)

4 COMPRESSOR LINES 'A', 'B' and 'C' PROCESS VESSELS AND INSTRUMENTATION

See illustration C2.5(1)

4.1 Suction Drum 11B01A/B/C

4.1.1 The suction drums in each line are identical and carry the same fittings and instrumentation. This description covers 11B01A only.

4.1.2 The drum is vertically mounted with a height of 4.51m and an external diameter of 1.888m. It is designed for a flowrate of 32 x $10^6 m^3$/d at a pressure of 101 bar and temperature of 50°C. Calculated pressure drop from inlet to outlet is 0.35 bar.

4.1.3 The drum is designed to free the inlet gas from oily water and has three piping connections; inlet from TP1, outlet to the compressor and sump outlet to the high pressure process oily water system.

4.1.4 The following instrumentation is fitted apart from local gauges:

(a) LALL. Alarms on low-low level. At the same time 11ESDV12.2 is closed.

(b) LAL. Alarms on low level.

(c) LAH. Alarms on high level with common pre-alarm. The alarm is repeated in QP.

(d) LAHH. Alarms on high-high level with common shutdown alarm and a turbine shutdown signal. At the same time 11ESDV11.1 is closed to prevent liquid carry-over from the suction drum to the compressor.

(e) LS. Operates ON/OFF over the working range of liquid level and opens or closes the oily water outlet LCV to maintain this range.

4.2 Natural Gas Cooler 11E01A/B/C

4.2.1 The gas coolers in each line are identical and carry the same fittings and instrumentation. This description covers 11E01A only.

4.2.2 The vessel is a horizontally mounted single-pass countercurrent flow shell and tube heat exchanger. It is designed for a gas flowrate of 32 x $10^6 m^3$/d at 153 bar and a water flowrate of 1152m^3/h. Designed gas inlet temperature is 95°C and outlet 50°C. The duty is 32.57 x 10^6 kcal/h. Calculated pressure drop on the gas side is 0.4 bar and on the water side 1.15 bar.

4.2.3 The shell side (cooling water) is protected from overpressure by a PSV set at 7.5 bar and a rupture disc RD at 8 bar. The tube side (process gas) is protected from overpressure by a PSV on the inlet line, set at 171 bar.

4.2.4 The shell side pressure is also monitored. PAH alarms on high pressure with common shutdown alarm and a turbine shutdown signal. An ESD signal is also initiated.

4.2.5 The emphasis given to protection against overpressure on the shell side is due to the need to protect the shell from possible tube rupture.

4.3 Water Separator 11B02A/B

4.3.1 The water separators are identical and carry the same fittings and instrumentation. This description covers 11B02A only.

4.3.2 The vessel is vertically mounted with a height of 3.593m and an external diameter of 1.188m. It is designed for a flowrate of 32 million m^3/d at a pressure of 152 bar at a temperature of 50°C. Calculated pressure drop from inet to outlet is 0.385 bar.

4.3.3 The vessel is designed to free the compressed gas from oily water and has three piping connections; inlet from the natural gas cooler, outlet to TP1 treatment unit and sump outlet to the high pressure process oily water system. It is protected from overpressure by one of two PSVs both set at 171 bar. The one not in use is kept isolated on each side by car-sealed closed valves.

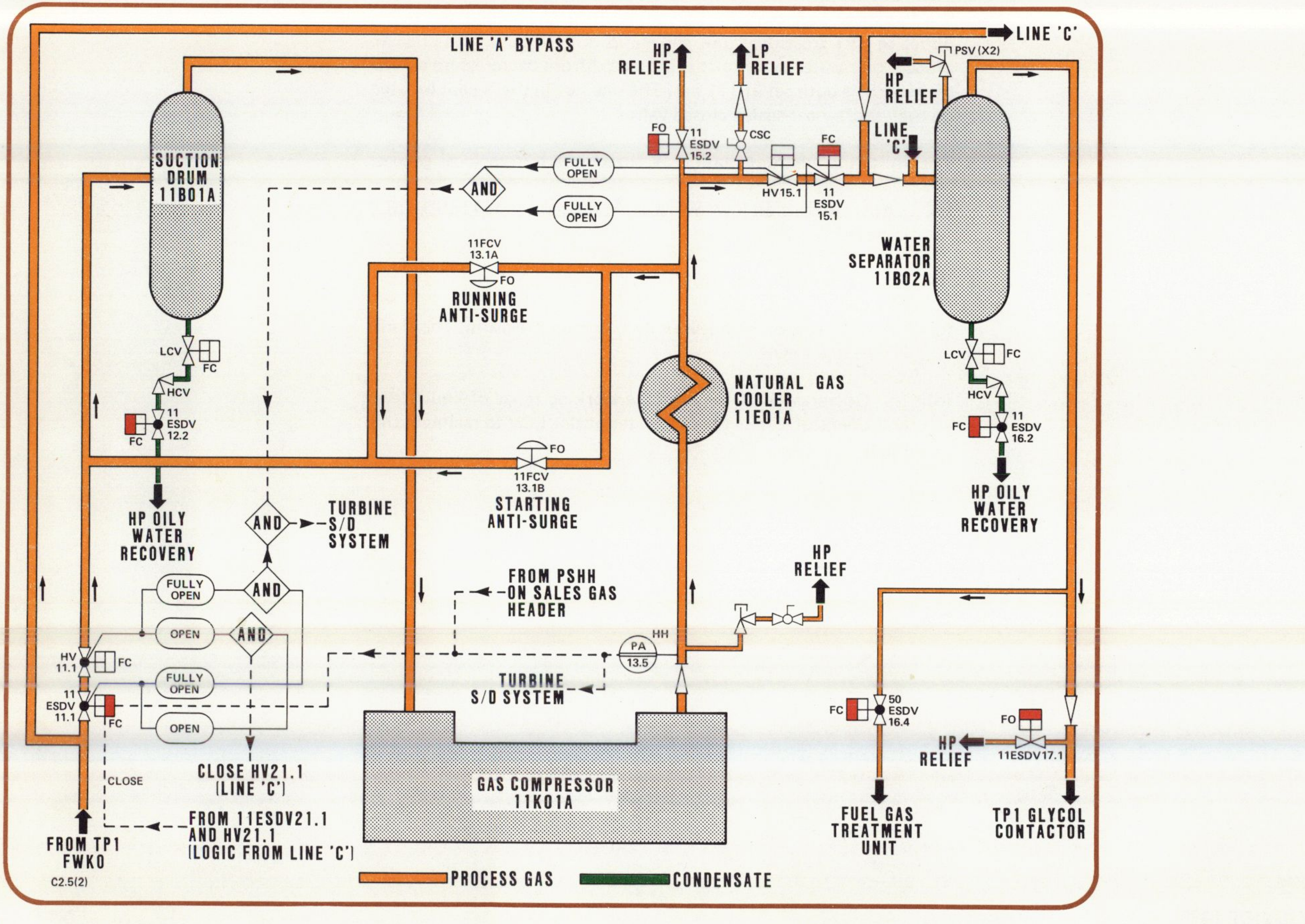
4.3.4 The following instrumentation is fitted apart from local gauges:

(a) LALL. Alarms on low-low level. At the same time 11ESDV16.2 is closed.

(b) LAL. Alarms on low level.

(c) LAH. Alarms on high level with common pre-alarm. The alarm is repeated in QP.

(d) LS. Operates ON/OFF over the working range of liquid level and opens or closes the oily water outlet LCV to maintain this range.


LINE 'A' BYPASS
LINE 'C'
HP RELIEF
LP RELIEF
PSV (X2)
HP RELIEF
LINE 'C'
SUCTION DRUM 11B01A
FO
11 ESDV 15.2
CSC
FC
FULLY OPEN
AND
FULLY OPEN
HV15.1
11 ESDV 15.1
WATER SEPARATOR 11B02A
11FCV 13.1A
FO
RUNNING ANTI-SURGE
LCV
FC
HCV
11 ESDV 12.2
NATURAL GAS COOLER 11E01A
LCV
FC
HCV
11 ESDV 16.2
FO
11FCV 13.1B
STARTING ANTI-SURGE
HP OILY WATER RECOVERY
HP OILY WATER RECOVERY
AND
TURBINE S/D SYSTEM
HP RELIEF
FULLY OPEN
AND
FROM PSHH ON SALES GAS HEADER
OPEN
AND
HH
PA 13.5
HV 11.1
FULLY OPEN
TURBINE S/D SYSTEM
11 ESDV 11.1
OPEN
50 ESDV 16.4
FO
HP RELIEF
11ESDV17.1
CLOSE HV21.1 (LINE 'C')
CLOSE
GAS COMPRESSOR 11K01A
FROM 11ESDV21.1 AND HV21.1 (LOGIC FROM LINE 'C')
FROM TP1 FWKO
FUEL GAS TREATMENT UNIT
TP1 GLYCOL CONTACTOR
PROCESS GAS
CONDENSATE
C2.5(2)

5 COMPRESSOR LINES 'A' and 'B' VALVE INTERLOCKING

See illustration C2.5(2)

5.1 The main inlet and outlet valves of lines 'A' and 'B' are mutually interlocked to the turbine shutdown system. The inlet valves are additionally interlocked with the inlet valves to line 'C'.

5.2 The inlet valves are as follows:

(a) 11ESDV11.1. This valve is the primary inlet emergency shutdown device. It will close in the event of an ESD, a high-high level in the suction drum, a high-high pressure on the discharge side of the compressor or a high-high pressure in the sales gas header. It will also close in the event of the opening of both 11ESDV21.1 and HV21.1 in the inlet to line 'C' suction drum.

(b) HV11.1. This valve is opened locally provided that an authorisation signal has been received from TCP2 Control Room.

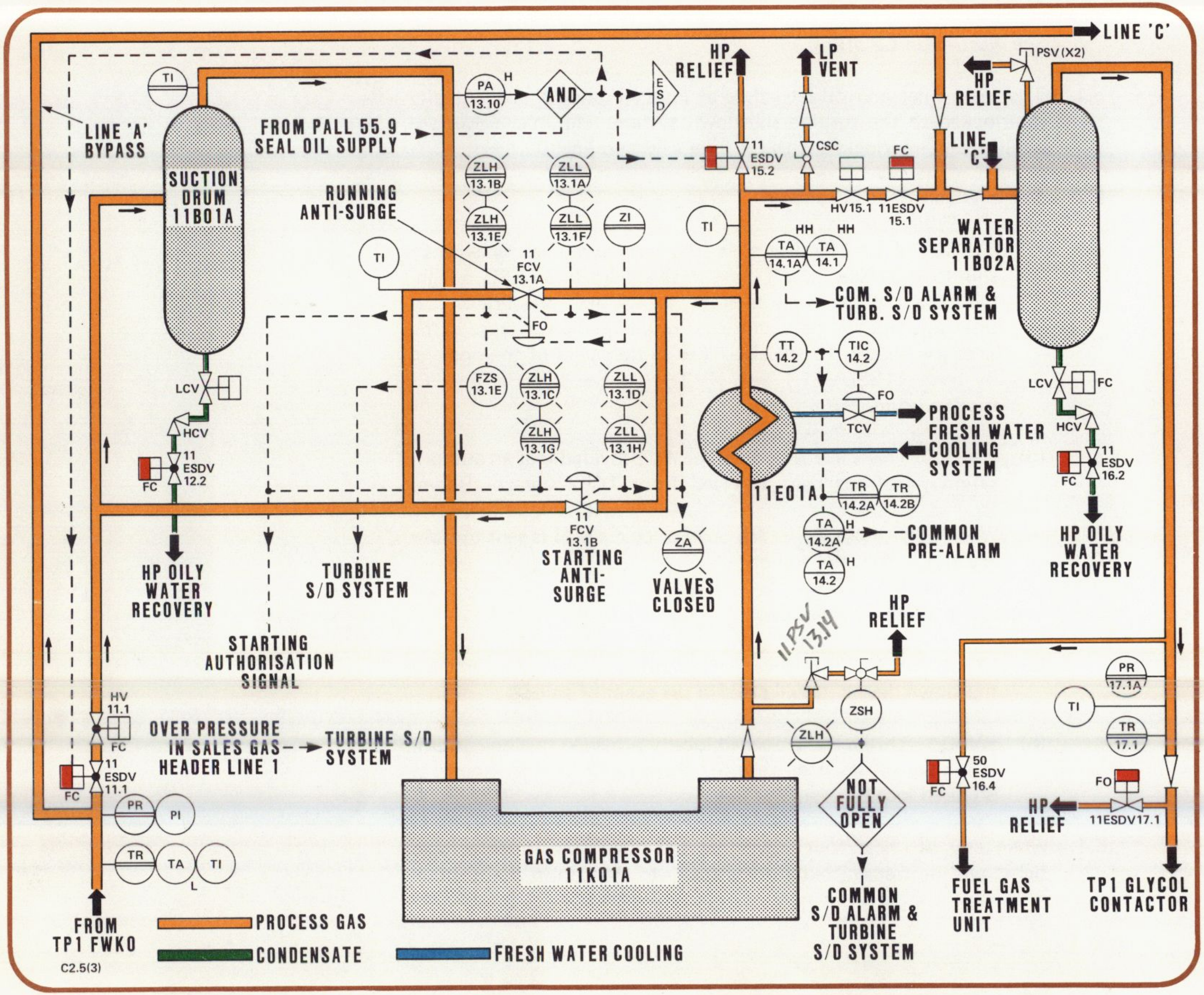
(c) When both these valves are open a logic signal is sent to close HV21.1 in the inlet to line 'C'.

5.3 The outlet valves are as follows:

(a) 11ESDV15.1. This valve is the primary outlet emergency shutdown device. It will close in the event of an ESD.

(b) HV15.1. This valve is opened locally provided that an authorisation signal has been received from TCP2 Control Room. It is closed locally.

5.4 When any of these four valves are less than fully open a logic signal will be transmitted automatically to shut down the turbine.


LINE 'C'
HP RELIEF
LP VENT
PSV (X2)
HP RELIEF
LINE 'A' BYPASS
FROM PALL 55.9 SEAL OIL SUPPLY
SUCTION DRUM 11B01A
AND
ESD
11 ESDV 15.2
CSC
LINE 'C'
FC
HV15.1
11ESDV 15.1
WATER SEPARATOR 11B02A
RUNNING ANTI-SURGE
11 FCV 13.1A
FO
COM. S/D ALARM & TURB. S/D SYSTEM
TT 14.2
TIC 14.2
TCV
PROCESS FRESH WATER COOLING SYSTEM
LCV
HCV
11 ESDV 12.2
FC
11 ESDV 16.2
HP OILY WATER RECOVERY
11E01A
TR 14.2A
TR 14.2B
TA 14.2A
COMMON PRE-ALARM
TA 14.2
11 FCV 13.1B
STARTING ANTI-SURGE
ZA
VALVES CLOSED
TURBINE S/D SYSTEM
STARTING AUTHORISATION SIGNAL
HP RELIEF
11.PSV 13.14
HV 11.1
OVER PRESSURE IN SALES GAS HEADER LINE 1
TURBINE S/D SYSTEM
11 ESDV 11.1
ZSH
ZLH
NOT FULLY OPEN
50 ESDV 16.4
PR 17.1A
TR 17.1
11ESDV17.1
HP RELIEF
GAS COMPRESSOR 11K01A
COMMON S/D ALARM & TURBINE S/D SYSTEM
FUEL GAS TREATMENT UNIT
TP1 GLYCOL CONTACTOR
FROM TP1 FWKO
PROCESS GAS
CONDENSATE
FRESH WATER COOLING
C2.5(3)

6 COMPRESSOR LINES 'A', 'B' and 'C' PROCESS PIPING AND INSTRUMENTATION

See illustration C2.5(3)

6.1 Introduction

6.1.1 This section describes line 'A' in detail, considering the process flow from inlet to outlet as shown in the illustration.

6.1.2 The process flow in lines 'A', 'B' and 'C' is identical from their suction drum inlets to their natural gas cooler outlets. Line 'C' cooler outlet is directed either to line 'A' water separator or line 'B' water separator. Line 'A' is then identical to line 'B' through their water separators except for an additional line which serves as a fuel gas offtake from the line 'A' water separator.

6.1.3 The following description is applicable to both lines 'A' and 'B'. The tag and equipment numbers apply to line 'A' only.

6.2 Suction Drum Piping and Instrumentation

6.2.1 A 26in line serves the inlet of 11B01A. The gas is monitored by the following instruments:

(a) TR. Provides a temperature record. TAL alarms on low temperature.

(b) PR. Provides a pressure record.

6.2.2 The sump drain line from the suction drum contains a level control valve LCV which is held open when level switch LS operates at the upper end of the normal liquid level range. When the liquid reaches the lower level, the valve closes. Most of the pressure drop to the high pressure process oily water system is achieved by choke valve HCV. The LCV fails closed.

6.2.3 The suction drum liquid level is prevented from falling any further on low-low level or ESD, by the automatic closing of 11ESDV12.2. This has to be reset both behind the instrument panel in TCP2 Control Room and by local manual reset.

6.2.4 The suction drum outlet 26in line temperature is indicated by TI on TCP2 control panel

6.3 Compressor Cooler Piping and Instrumentation

6.3.1 Compressor suction is fed by the direct 26in line from the suction drum. Its discharge is taken by 24in line to the tube side of the natural gas cooler and thence to the water separator. There are two important offtakes from the line connecting the cooler to the water separator that are intimately concerned with compressor performance.

(a) 20in line through 11FCV13.1A. This is the running anti-surge line for recirculating cooled compressed gas back through the suction drum to the compressor inlet. Operation of the surge valve (FCV) is detailed in Paragraph 7.1. Indication is given in TCP2 Control Room when the FCV is fully open by ZLH, or fully closed by ZLL. When fully open a Starting Authorisation Signal is initiated provided that 11FCV13.1B is also fully open. When both valves are fully closed, alarm indication is given in TCP2 Control Room. Continuous indication is also given in the Control Room by ZI of the position of 11FCV13.1A. A failure in the control air system to this valve will be detected by FZS13.1E and cause the turbine to shut down.

(b) 10in line through 11FCV13.1B. This is the starting anti-surge line. Operation of the FCV is detailed in Paragraph 7.7. Indications are similar to those for 11FCV13.1A except that there is no continuous indication of position.

Neither of these valves is fitted with isolating or bypass valves.

6.3.2 A blanked-off methanol connection is made on the high pressure side of each anti-surge control valve, but not shown in the illustration. They provide for the possible injection of methanol if the cooling of the gas as it expands through the control valve causes hydrate formation.

6.3.3 Connected into the cooler gas outlet line is an HP relief line containing 11ESDV15.2. This valve is operated pneumatically from a local valve control panel and fails open. It is opened automatically to vent the line in the event of an ESD or a combination of high pressure in the compressor suction line and low-low pressure in the compressor seal oil supply. Such a combination if unchecked would endanger the plant by allowing gas leakage to occur from the compressor through its shaft sealing glands. An ESD is therefore initiated with appropriate alarms. A purging connection is teed into the relief line on the high pressure side of the ESDV but not shown in the illustration.

6.3.4 Also connected into the cooler gas outlet line is an LP vent line. This is used for final depressurisation under manual control after a shutdown for maintenance.

6.3.5 The line is next taken through a check valve to the water separator. The check valve prevents any backflow of high pressure gas from line 'C'.

6.3.6 At the gas inlet side of the cooler is a PSV with its outlet to HP relief. Its block valve is car-sealed open. Should there be any closure of this valve, lamp indication will be given on the control panel and the turbocompressor will be shut down. This is accompanied by a common shutdown alarm.

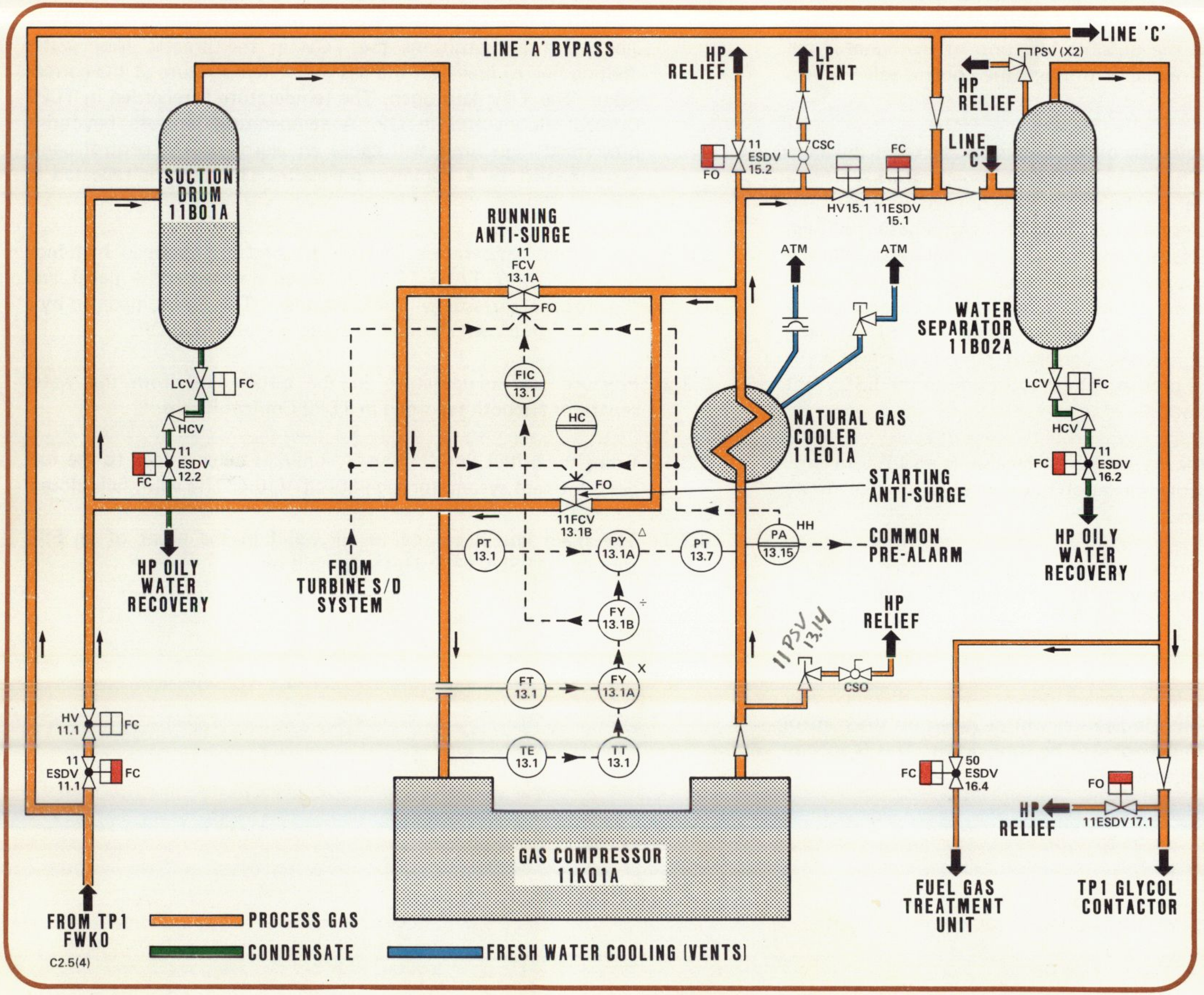
6.3.7 At the gas outlet side of the cooler is a temperature transmitter TT14.2 which feeds temperature indicator controller TIC14.2. The controller positions the TCV in the process fresh water cooling line to maintain the gas outlet temperature at the correct value. The TCV fails open. The temperature is recorded in TCP2 Control Room and in QP. A temperature increase beyond a prescribed high limit will cause an alarm on the control panel accompanied by a common pre-alarm. The alarm is repeated in QP.

6.3.8 An outlet temperature increase beyond a prescribed high-high limit will cause TAHH14.1A to alarm on the control panel, and the turbocompressor will be shut down. This is accompanied by a common shutdown alarm. The alarm is repeated in QP.

6.3.9 Pressure and temperature in the outlet line from the water separator are both recorded in TCP2 Control Room.

6.3.10 From the outlet line (in line 'A' only) is taken a feed to the fuel gas treatment system through 50ESDV16.4. This valve fails closed.

6.3.11 The main line is vented to HP relief in the event of an ESD through 11ESDV17.1. This valve fails open.


LINE 'A' BYPASS
LINE 'C'
HP RELIEF
LP VENT
PSV (X2)
SUCTION DRUM 11B01A
11 ESDV 15.2
FO
CSC
FC
HV15.1
11ESDV 15.1
LINE 'C'
RUNNING ANTI-SURGE
11 FCV 13.1A
FO
ATM
ATM
WATER SEPARATOR 11B02A
LCV
FC
HCV
11 ESDV 12.2
FIC 13.1
HC
NATURAL GAS COOLER 11E01A
11 ESDV 16.2
STARTING ANTI-SURGE
11FCV 13.1B
PT 13.1
PY 13.1A
PT 13.7
PA 13.15
HH
COMMON PRE-ALARM
HP OILY WATER RECOVERY
FROM TURBINE S/D SYSTEM
FY 13.1B
11 PSV 13.14
CSO
FT 13.1
FY 13.1A
HV 11.1
11 ESDV 11.1
TE 13.1
TT 13.1
50 ESDV 16.4
11ESDV17.1
GAS COMPRESSOR 11K01A
FUEL GAS TREATMENT UNIT
TP1 GLYCOL CONTACTOR
FROM TP1 FWKO
PROCESS GAS
CONDENSATE
FRESH WATER COOLING (VENTS)
C2.5(4)

7 COMPRESSOR SURGE CONTROL INSTRUMENTATION

See illustration C2.5(4)

7.1 Anti-surge control when the compressor is running is exercised by 11FCV13.1A. This is positioned continuously by a combination of signals and prevents the compressor operating at any time under conditions which could bring about the unstable process of surging. The signals are derived from elements measuring flow, temperature, suction pressure and discharge pressure and the valve is positioned through an electric/pneumatic converter by controller FIC13.1. The controller takes as its measured variable a signal which is mathematically equal to

$$\frac{\text{flow x temperature}}{\text{discharge pressure—suction pressure}}$$

7.2 The means for providing such a complex signal is quite simple, and uses certain specialised computing devices. The controller, which is represented on the mimic and installed in TCP2 Control Room, takes its input from an electronic divider, FY13.1B. This carries out the division process in the equation above. It receives two inputs, one from an electronic pressure differential amplifier PY13.1A and from a flow measurement loop.

7.3 The pressure differential amplifier PY13.1A takes its inputs from inlet and discharge pressure sensors PT13.1 and PT13.7 respectively and produces the lower half of the fraction in the equation above.

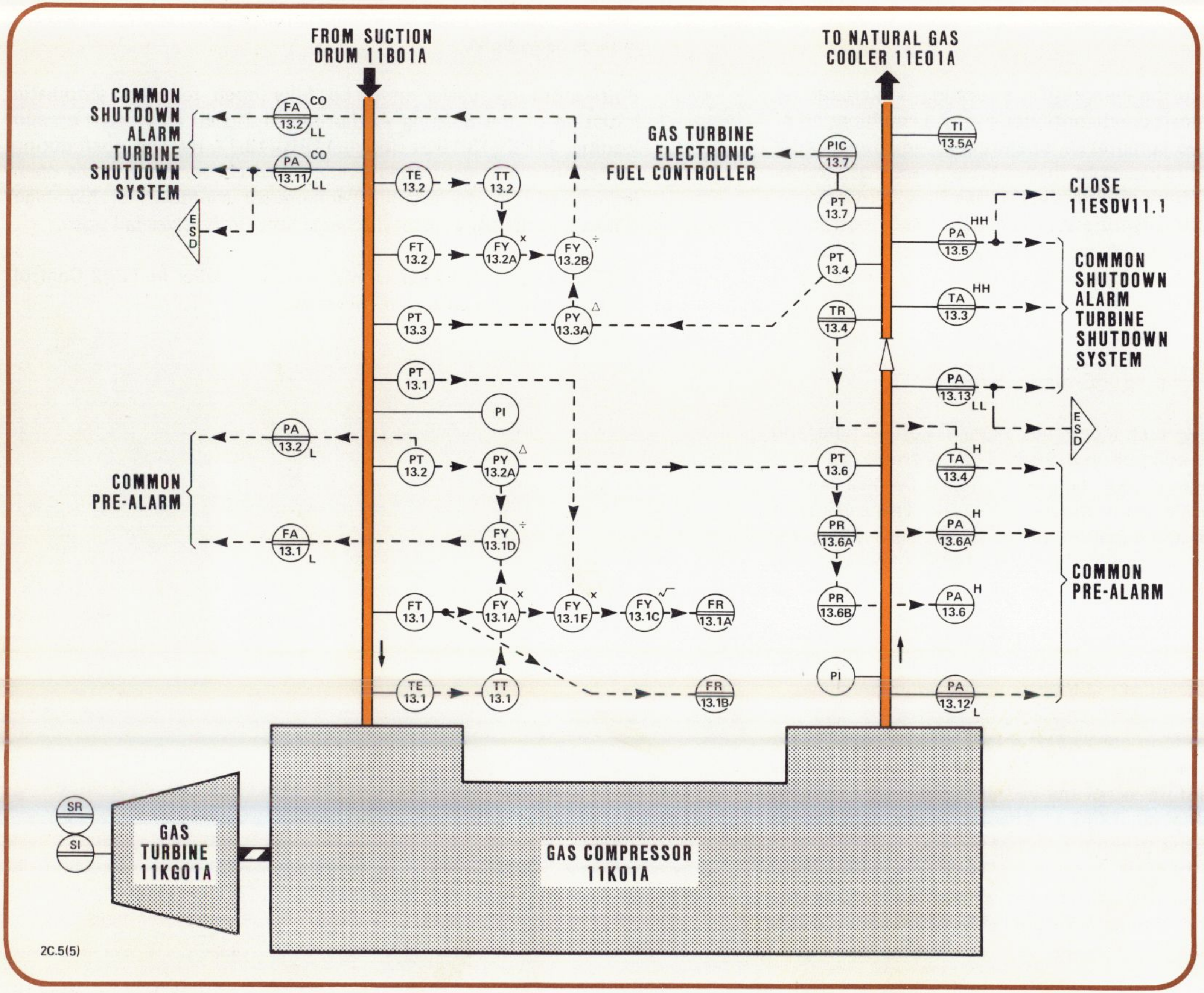
7.4 The flow measurement loop consists of a flow transmitter FT13.1 feeding an electronic multiplier FY13.1A. The other input to the multiplier is a temperature signal derived at temperature element TE13.1 and transmitted by TT13.1. The multiplier provides an output which is equivalent to the top half of the equation.

7.5 With a continuous input that represents the required fraction, the controller positions the running anti-surge valve to maintain stable operation.

7.6 Some of the signals generated in this anti-surge control loop are used for indicating and recording instrumentation and are described in later paragraphs.

7.7 Both anti-surge valves must be fully open to allow automatic initiation of the Starting Authorisation Signal. After start-up and loading, 11FCV13.1B is closed. 11FCV13.1A remains open during operation and is controlled as described above. Both valves open immediately in the event of compressor shutdown or high-high pressure in the compressor discharge line. Both valves fail open.

7.8 11FCV13.1B is provided with a hand controller in TCP2 Control Room for manual control if necessary.


FROM SUCTION DRUM 11B01A
TO NATURAL GAS COOLER 11E01A
COMMON SHUTDOWN ALARM TURBINE SHUTDOWN SYSTEM
GAS TURBINE ELECTRONIC FUEL CONTROLLER
CLOSE 11ESDV11.1
COMMON SHUTDOWN ALARM TURBINE SHUTDOWN SYSTEM
ESD
COMMON PRE-ALARM
COMMON PRE-ALARM
ESD
FA 13.2 CO LL
PA 13.11 CO LL
TE 13.2
TT 13.2
FT 13.2
FY 13.2A
FY 13.2B
PT 13.3
PY 13.3A
PT 13.1
PI
PA 13.2 L
PT 13.2
PY 13.2A
FY 13.1D
FA 13.1 L
FT 13.1
FY 13.1A
FY 13.1F
FY 13.1C
FR 13.1A
TE 13.1
TT 13.1
FR 13.1B
TI 13.5A
PIC 13.7
PT 13.7
PA 13.5 HH
PT 13.4
TA 13.3 HH
TR 13.4
PA 13.13 LL
TA 13.4 H
PT 13.6
PR 13.6A
PA 13.6A H
PR 13.6B
PA 13.6 H
PI
PA 13.12 L
SR
SI
GAS TURBINE 11KG01A
GAS COMPRESSOR 11K01A

2C.5(5)

8 COMPRESSOR PERFORMANCE INSTRUMENTATION

See illustration C2.5(5)

8.1 A flow recorder FR13.1A is mounted in TCP2 Control Room and partly uses signals derived in the anti-surge control loop. The flow is to be recorded as though at standard temperature and pressure and must therefore be corrected continuously and automatically for temperature and pressure. The flow is temperature corrected by TT13.1 and is transmitted by FY13.1A. This signal is then corrected for pressure in electronic multiplier FY13.1F whose pressure input signal is derived from PT13.1. However, this corrected flow signal now requires to be made linear for easier recording since its value at present is equivalent to the SQUARE of the flow. It is therefore routed through an electronic square root extractor FY13.1C before being recorded on FR13.1A.

8.2 It can be seen from the illustration that an uncorrected flow signal from FT13.1 is displayed on flow recorder FR13.1B, also in TCP2 Control Room. This acts as a checking device for the more complex loop. Using straight observations of suction pressure and temperature the corrected figure can be calculated.

8.3 It is important that any condition of low flow should be alarmed. Consequently the alarm, FAL13.1 mounted on TCP2 control panel, is annunciated by detection of low flow as sensed by the first of two independent circuits. Its input is taken from low select relay FY13.1D which is fed with two signals. One is the temperature corrected flow signal from FT13.1A (already described), the other is a pressure difference signal derived by electronic pressure differential amplifier PY13.2A from signals transmitted by PT13.2 and PT13.6. These represent compressor inlet and discharge pressures and the difference between them is equivalent to flow. The first flow signal to fall to an unacceptably low level has the effect of triggering off the alarm. This is accompanied by a common pre-alarm.

8.4 FALL13.2 is a low-low flow alarm annunciator mounted on TCP2 control panel and backs up FAL13.1. It is initiated by FY13.2B which has two inputs. One is a temperature corrected flow signal from FY13.2A. The other is a pressure difference signal from PY13.3A which measures the difference between inlet and discharge pressures as sensed by PT13.3 and PT13.4. A low-low flow alarm produced in this way is accompanied by a common shutdown alarm and a compressor shutdown.

8.5 Pressure is monitored on the inlet side of the compressor. A pressure decrease beyond a prescribed low limit will cause PAL13.2 to alarm on the control panel accompanied by a common pre-alarm. If the pressure further decreases, PALL13.11 will alarm and the turbocompressor will be shut down together with an ESD. This is accompanied by a common shutdown alarm.

8.6 Pressure is monitored on the discharge side of the compressor. A pressure decrease beyond a prescribed low limit will cause PAL13.12 to alarm on the control panel accompanied by a common pre-alarm. If the pressure further decreases, PALL13.13 will alarm and the turbocompressor will be shut down together with an ESD. This is accompanied by a common shutdown alarm.

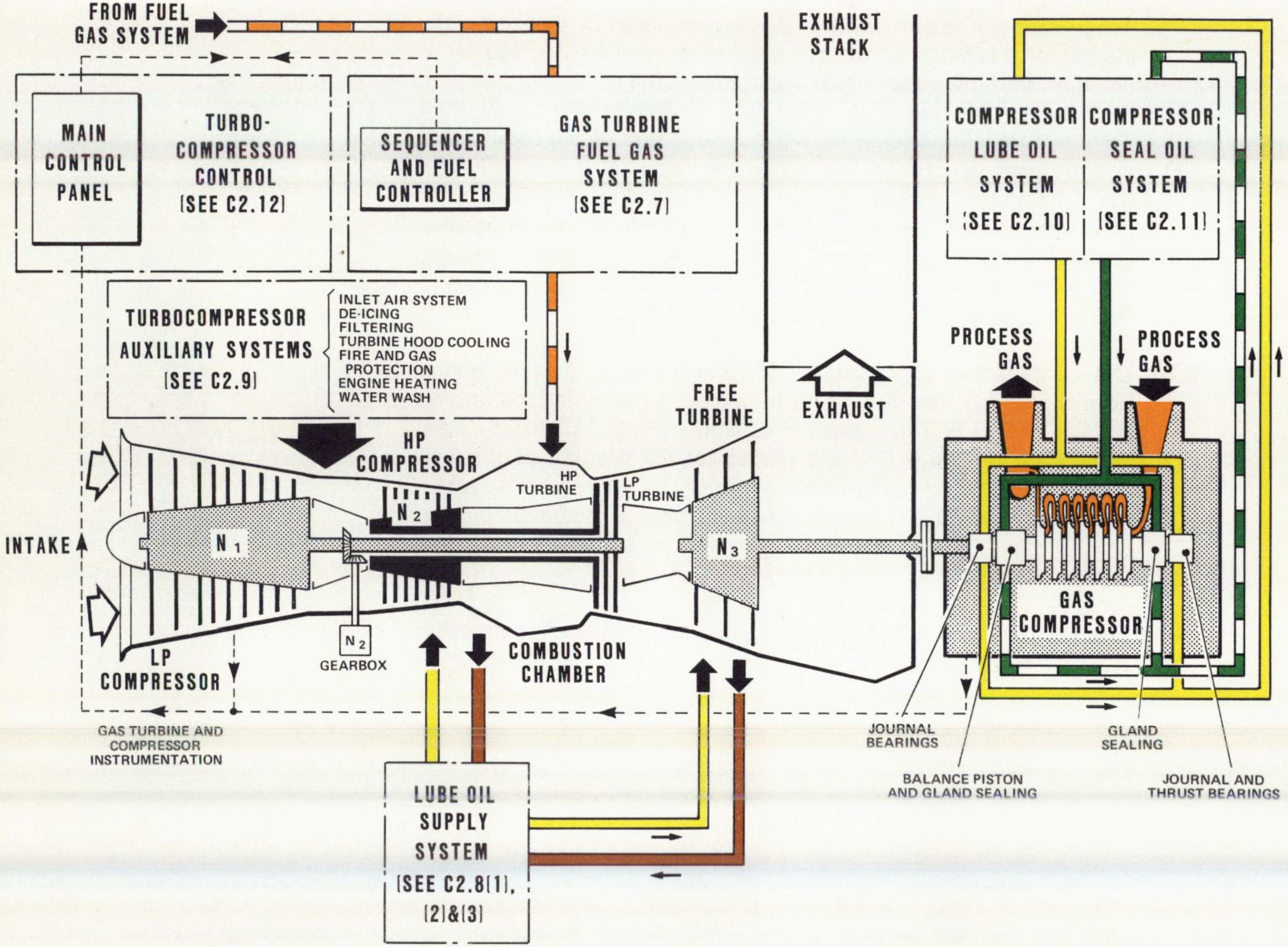
8.7 Discharge pressure transmitted by PT13.6 is recorded in TCP2 Control Room by PR13.6A and in QP by PR13.6B. A discharge pressure increase beyond a prescribed high limit will cause PAH13.6A to alarm on the control panel accompanied by a common pre-alarm. The alarm is repeated in QP on PAH13.6.

8.8 A discharge pressure increase beyond a prescribed high-high limit will cause PAHH13.5 to alarm on the control panel and the turbo-compressor will be shut down. This is accompanied by the automatic closing of 11ESDV11.1 in the suction drum inlet line and by a common shutdown alarm. (See illustration 2.5(1)).

8.9 Temperature is monitored on the discharge side of the compressor and recorded by TR13.4 in the Control Room. It is also indicated by TI13.5A. A temperature increase beyond a prescribed high limit will cause TAH13.4 to alarm on the control panel accompanied by a common pre-alarm. If the temperature further increases, TAHH13.3 will alarm and the turbocompressor will be shut down. This is accompanied by a common shutdown alarm.

8.10 Gas turbine fuel control takes its primary control signal under normal loaded conditions from pressure indicator controller PIC13.7. This takes its measured variable from PT13.7 fitted in the compressor discharge line and modulates the position of the fuel control valve in the turbine control unit. The set point is adjusted to give the required loading. The controller is mounted on the control panel in TCP2 Control Room and its position is illustrated on the mimic.

8.11 Free turbine speed is instantaneously indicated and continually recorded in the Control Room.



PROCESS GAS
FUEL GAS
LUBE OIL SUPPLY
LUBE OIL SCAVENGE
SEAL OIL
POLLUTED SEAL OIL

SECTION 4 – GAS TURBINE AND COMPRESSOR INSTALLATION

1 GAS TURBINE AND COMPRESSOR – SUMMARY

See illustration C2.6

1.1 The gas turbine unit driving the compressor in each line consists of a United Technologies Corporation FT4C–3F/GF modular industrial gas turbine complete with control system and auxiliary equipment. The turbine unit consists of a Pratt and Whitney Aircraft GG4C gas generator to produce the hot gases and a Turbo Power and Marine Systems FT4C–3 free (or power) turbine which converts the hot gases into mechanical energy.

1.2 The free turbine inlet case is bolted to the exhaust case of the gas generator. The free turbine rotor is aerodynamically coupled to the gas generator and is mechanically independent. The turbine is shaft-coupled direct to the compressor.

1.3 The gas turbine is designed to operate on clean natural gas conforming to the TPM Fuel Specifications. The output varies inversely with ambient temperature.

1.4 The gas turbine can be started and automatically brought to a free turbine speed of 2000 rev/min. The compressor can then be manually or automatically loaded to the desired load point.

1.5 On a normal shutdown the compressor is first automatically unloaded to enable automatic cooldown of the power unit. The engine cooldown begins at a reduced speed until finally the fuel is shut off and both engine and compressor slow to a stop.

1.6 The gas turbine is fitted with a Hamilton Standard Division (HSD) SPC2H electrical fuel control which governs the speed of the high power compressor of the gas generator by opening or closing a fuel modulating valve. The fuel control senses the low power compressor rotor speed (N_1), high power compressor rotor speed (N_2), free turbine speed (N_3), gas generator exhaust gas temperature (Tt_7), and inlet air temperature (Tt_2).

1.7 The load schedule for the machine defines the maximum power available at any given ambient temperature. The load schedule is subject to a fuel control power limiting device called 'Tt_7 topper' which prevents the engine from exceeding preset exhaust gas temperature (Tt_7) limits. The fuel control also limits the N_1 rotor speed.

1.8 Free turbine overspeed is sensed simultaneously by an overspeed relay in the sequencer cabinet and the fuel control. Either of these devices will trip the fuel shutoff valves in the event of free turbine speeds exceeding the overspeed limit.

1.9 Each engine is equipped with a pneumatic starter that uses natural gas tapped from the fuel line to drive the starter. The line pressure is reduced to approximately 2.4 bar (35 psig) at the starter inlet by a pressure regulating valve. A solenoid shutoff valve cuts gas flow to the starter when an N_2 speed of approximately 3400 rev/min is attained. The gas is vented to the TCP2–C LP vent system.

1.10 Three identical compressors are installed, each driven by a gas turbine. They are respectively located in Modules 30, 31 and 33 on the Main Deck level and are numbered as follows:

(a) Phase 1

Line 'A' – 11K01A
Line 'B' – 11K01B
Line 'C' – 11K01C (standby)

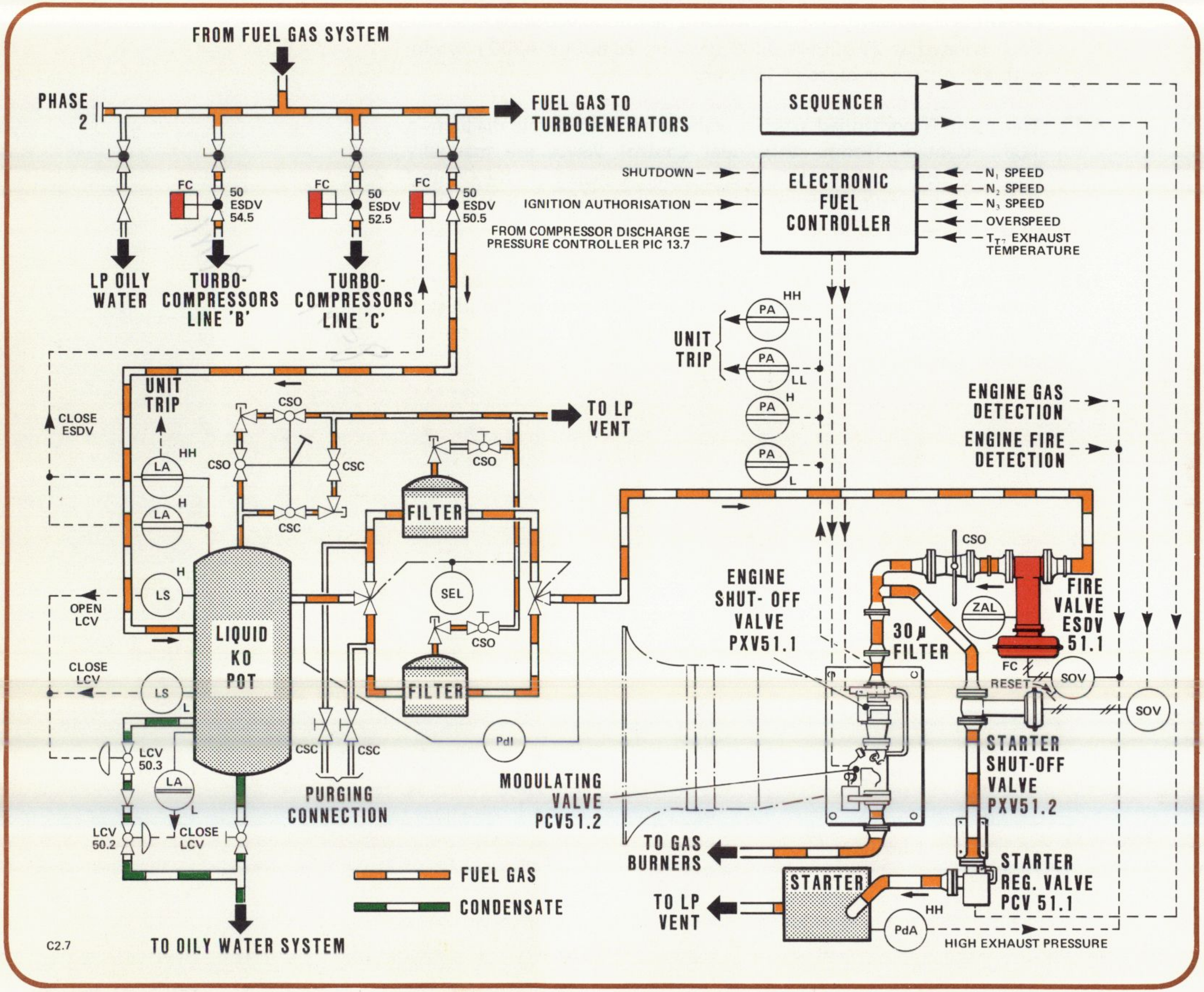
(b) Phase 2 (Future)

Line 'A' – 12K01A
Line 'B' – 12K01B
Line 'C' – 12K01C

1.11 Each unit is an Altsthom Atlantique BCL–607A centrifugal pipeline compressor, direct driven 2000—4200 rev/min seven-stage machine. Each is rated at 21 300kW 3600 rev/min, 28 600kW 4200 rev/min, with a discharge pressure of 153 barg.

1.12 The plant is controlled from a main panel with mimic diagram in TCP2 Control Room. Individual control valves are manually operated from local panels with authorising signals from the Control Room. Some indications and alarms are transmitted via telemetry to QP for overall control.

1.13 The gas turbine and the compressor are both supplied with individual services or utilities. These are indicated on the illustration and each is then described and illustrated in detail on the following pages.


FROM FUEL GAS SYSTEM
PHASE 2
FUEL GAS TO TURBOGENERATORS
FC
50 ESDV 54.5
50 ESDV 52.5
50 ESDV 50.5
LP OILY WATER
TURBO-COMPRESSORS LINE 'B'
TURBO-COMPRESSORS LINE 'C'
SEQUENCER
SHUTDOWN
IGNITION AUTHORISATION
FROM COMPRESSOR DISCHARGE PRESSURE CONTROLLER PIC 13.7
ELECTRONIC FUEL CONTROLLER
N1 SPEED
N2 SPEED
N3 SPEED
OVERSPEED
T_T7 EXHAUST TEMPERATURE
UNIT TRIP
PA
HH
LL
H
L
CLOSE ESDV
LA
LS
CSO
CSC
TO LP VENT
FILTER
SEL
OPEN LCV
CLOSE LCV
LIQUID KO POT
ENGINE GAS DETECTION
ENGINE FIRE DETECTION
ENGINE SHUT- OFF VALVE PXV51.1
30 μ FILTER
ZAL
FIRE VALVE ESDV 51.1
FC
RESET
SOV
LCV 50.3
LCV 50.2
PdI
PURGING CONNECTION
MODULATING VALVE PCV51.2
STARTER SHUT-OFF VALVE PXV51.2
TO GAS BURNERS
STARTER
STARTER REG. VALVE PCV 51.1
TO LP VENT
PdA
HIGH EXHAUST PRESSURE
FUEL GAS
CONDENSATE
TO OILY WATER SYSTEM

2 GAS TURBINE FUEL SYSTEM

See illustration C2.7

2.1 Fuel gas from the main Fuel Gas System is supplied to the gas generator through a liquid knockout pot, a gas filter arrangement and a series of control valves. Line 'A' only is considered. Lines 'B' and 'C' are identical.

2.2 Gas enters the liquid knockout pot through 50ESDV50.5 at a pressure of 17 bar and maximum flowrate of 11 300m^3/h. Liquids knocked out of the gas are disposed of in the HP process oily water recovery system. The ESDV closes in the event of high-high level in the pot (22.7 litres). This also initiates a unit trip and is alarmed on the compressor control panel. In the event of a high level alarm the ESDV closes but without a unit trip.

2.3 Liquid level in the pot is maintained between two fixed levels set by two level switches. These switches respectively close and open LCV50.3 in the liquid outflow line. Also in this line is a check valve to prevent backflow, and an automatic block valve LCV50.2. This valve is normally open but closes in the event of low level in the pot. This event is alarmed.

2.4 The knockout pot is equipped with two PSVs set to 24 bar and venting to the platform LP vent system. The block valves around these PSVs are mechanically linked so that only one PSV is in service at a time.

2.5 The gas passes from the knockout pot to the filter arrangement, where either one or the other is in service, depending upon the position of a manual selector. This pneumatically positions the three-way inlet and outlet valves. Each filter is equipped with a PSV set to 24 bar and venting to the platform LP vent system. A differential pressure indicator is connected between inlet and outlet for gauging the state of the filter. Purging connections are also provided.

2.6 The gas outlet from the filter then passes through 50ESDV51.1. This closes in the event of an ESD, turbine gas detection, turbine fire detection or high-high differential pressure at the gas generator starter duct. Downstream of the ESDV is a manual block valve which is car-sealed open.

2.7 Gas to the starter is taken through two valves. The first is PXV51.2 which is solenoid-operated from the sequence start system. The second is a pressure control valve PCV51.1. This valve takes its operating pressure from the gas line itself and gas is only admitted to it when solenoid valve PXV51.1 is energised from the sequence start system. If pressure in the starter duct exceeds 0.69 bar differential, 50ESDV51.1 closes and an alarm is indicated on the main control panel. The starter exhausts to the platform LP vent system through a check valve.

2.8 Gas to the burner can is taken through a 30 micron filter and three fuel control valves. The first is PXV51.1 and is solenoid-operated from the electronic fuel control unit. This is the main shutoff valve. The second and third valves are of integral construction and tagged PCV51.2. The second is solenoid-operated from the electronic fuel control unit, the third is motor-operated. The latter is the modulating valve which is positioned according to fuel requirements governed by the gas compressor discharge pressure. All three valves are vented to the platform atmospheric vents. Among other inputs to the electronic fuel control unit are shutdowns, ignition authorisation and the compressor discharge pressure signal from 11PIC13.7.

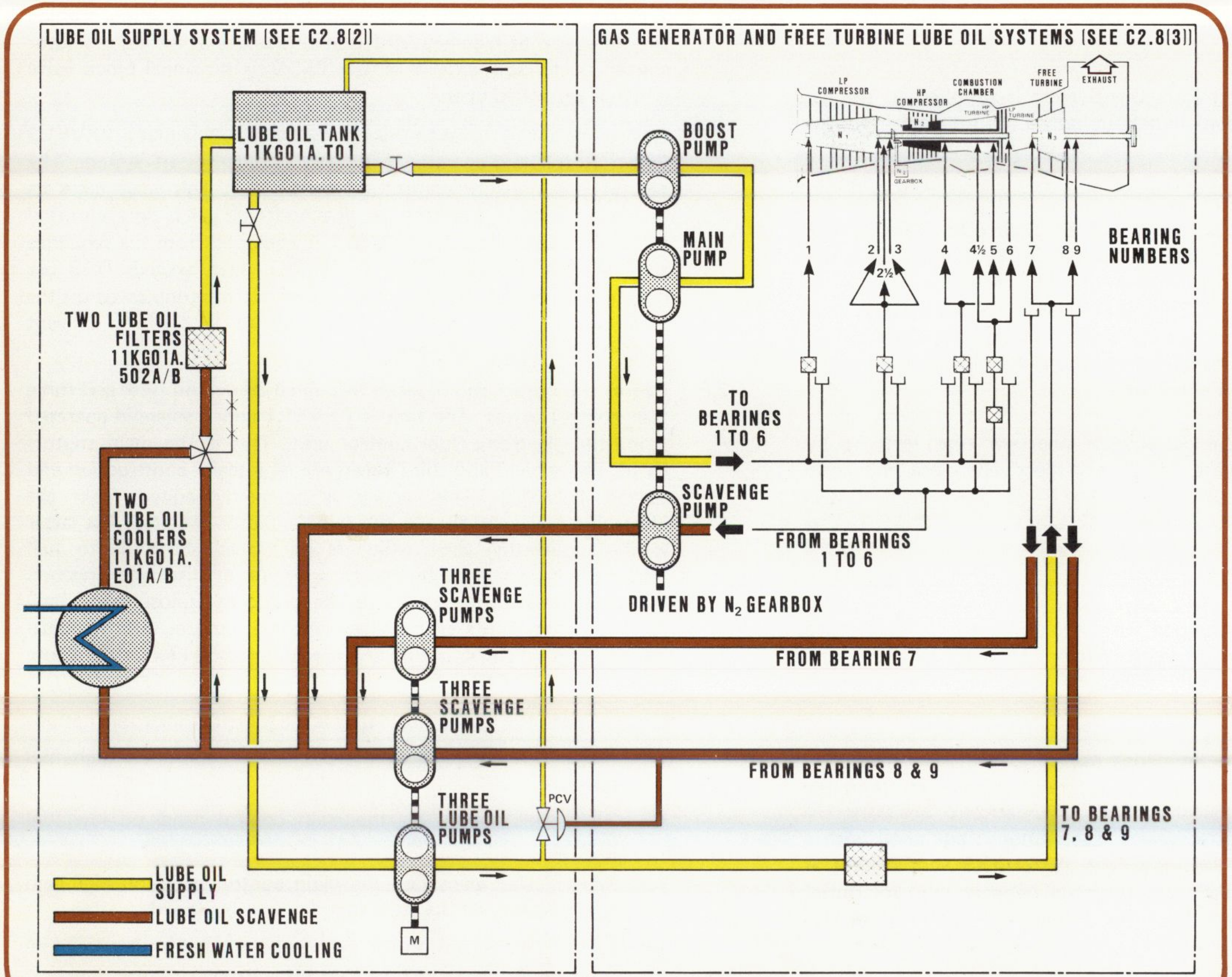
2.9 On the line to the fuel control valves is the following instrumentation:

(a) PAH. This alarms on the main control panel on high fuel pressure.

(b) PAL. This alarms on the main control panel on low fuel pressure.

(c) PAHH. This alarms on the main control panel on high-high fuel pressure. At the same time the unit is tripped.

(d) PALL. This alarms on the main control panel on low-low fuel pressure. At the same time the unit is tripped.


LUBE OIL SUPPLY SYSTEM (SEE C2.8(2))
GAS GENERATOR AND FREE TURBINE LUBE OIL SYSTEMS (SEE C2.8(3))
LUBE OIL TANK
11KG01A.T01
BOOST
PUMP
MAIN
PUMP
TWO LUBE OIL
FILTERS
11KG01A.
502A/B
TO
BEARINGS
1 TO 6
SCAVENGE
PUMP
FROM BEARINGS
1 TO 6
DRIVEN BY N2 GEARBOX
TWO
LUBE OIL
COOLERS
11KG01A.
E01A/B
THREE
SCAVENGE
PUMPS
FROM BEARING 7
THREE
SCAVENGE
PUMPS
FROM BEARINGS 8 & 9
THREE
LUBE OIL
PUMPS
PCV
TO BEARINGS
7, 8 & 9
M
LP
COMPRESSOR
HP
COMPRESSOR
COMBUSTION
CHAMBER
FREE
TURBINE
EXHAUST
HP
TURBINE
LP
TURBINE
GEARBOX
1
2
2½
3
4
4½
5
6
7
8
9
BEARING
NUMBERS
LUBE OIL
SUPPLY
LUBE OIL SCAVENGE
FRESH WATER COOLING

C2.8(1)

3 GAS TURBINE LUBE OIL SYSTEMS

3.1 Introduction

See illustration C2.8(1)

3.1.1 The gas generator and the free turbine share a common lube oil system although each retains its particular lubricating fittings and piping. Each has lube oil supply pumps and scavenge pumps with a common supply and 10 micron (nominal) filtering system. The lube oil is stored in a locally positioned tank, 11KG01A–T01.

3.2 Gas Generator Supply

See illustrations C2.8(2) and (3)

3.2.1 The lube oil tank is fitted with the following instrumentation:

(a) LAH, LAL and LALL. These alarm respectively on high, low and low-low level. In the event of low-low, a unit trip signal is initiated.

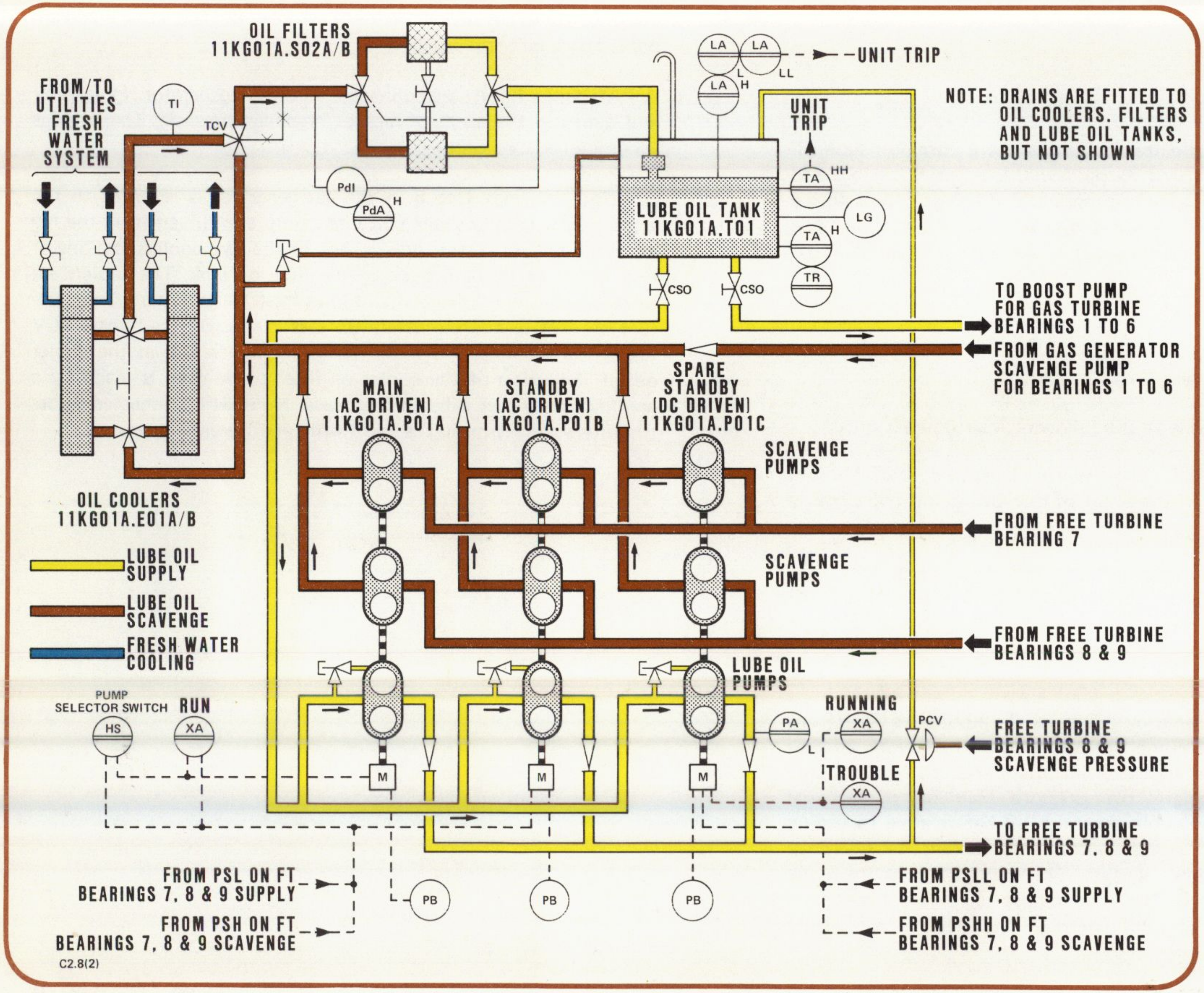
(b) TAH and TAHH. These alarm respectively on high and high-high temperature. In the event of high-high, a unit trip signal is initiated.

3.2.2 Suction is taken from the tank for the gas generator bearings (Nos 1 to 6) by a boost pump feeding a main pump. Both pumps are mounted on the N_2 gearbox driven by the auxiliaries drive from the gas generator. Boost pump pressure is controlled by a recirculation PCV taking its reference from the boost pump discharge pressure. A PSV recirculates over-pressure. Main pump discharge pressure is controlled at approximately 3.2 bar relative to engine breather pressure by a recirculation PCV taking its reference pressure from the breather system. This vents oil mist from the gearbox to an air/oil separator. The supply oil to the bearings is passed through a filter with a bypass PSV. The check valve prevents oil drain-back at shutdown.

3.2.3 A PAL and a PALL are connected to the bearing supply line and alarm in the event of low or low-low pressure. The latter is accompanied by a unit trip signal.

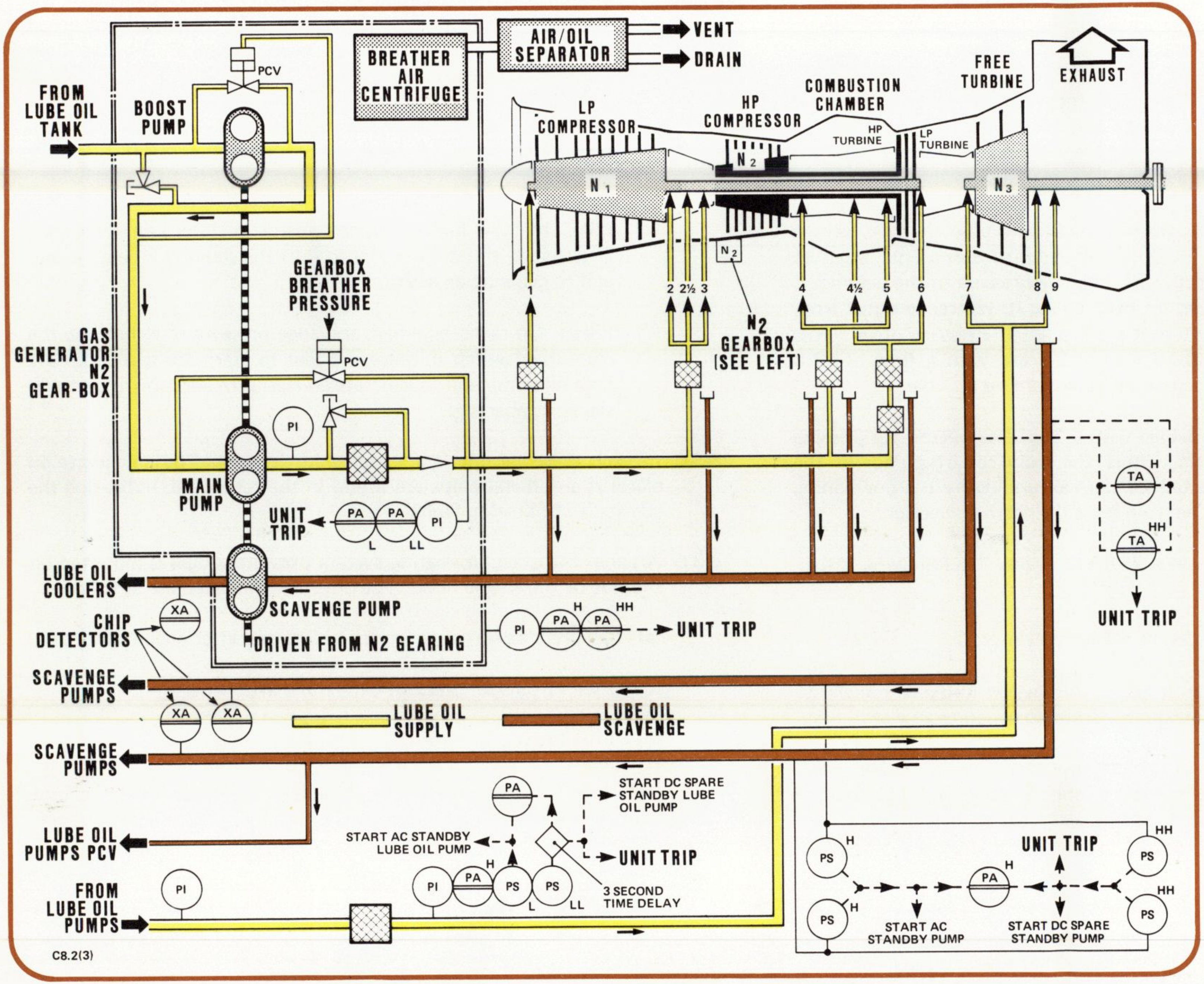
3.2.4 A PAH and a PAHH are connected to the gas generator N_2 gearbox and alarm in the event of high or high-high pressure. The latter is accompanied by a unit trip signal.

3.2.5 Oil from bearings 1 to 6 in the gas generator is returned to the supply system by a single scavenge pump also driven from the N_2 gearbox. The oil passes through one of the two coolers and one of two filters on its path back to the lube oil tank. The coolers are supplied with water from the utilities fresh water system. Temperature control to approximately 82°C is exercised by a bypass TCV taking its reference from the lube oil temperature at the cooler outlet. Selection of the cooler or filter to be used is made by a manual changeover valve in each case. A PdAH is connected across the filters and alarms in the event of high differential pressure.



OIL FILTERS
11KG01A.S02A/B
LA
LA
L
LL
H
UNIT TRIP
FROM/TO UTILITIES FRESH WATER SYSTEM
TI
TCV
UNIT TRIP
NOTE: DRAINS ARE FITTED TO OIL COOLERS, FILTERS AND LUBE OIL TANKS, BUT NOT SHOWN
PdI
PdA
TA
HH
LUBE OIL TANK
11KG01A.T01
LG
TA
TR
CSO
CSO
TO BOOST PUMP FOR GAS TURBINE BEARINGS 1 TO 6
FROM GAS GENERATOR SCAVENGE PUMP FOR BEARINGS 1 TO 6
SPARE STANDBY (DC DRIVEN) 11KG01A.P01C
MAIN (AC DRIVEN) 11KG01A.P01A
STANDBY (AC DRIVEN) 11KG01A.P01B
SCAVENGE PUMPS
OIL COOLERS
11KG01A.E01A/B
FROM FREE TURBINE BEARING 7
LUBE OIL SUPPLY
LUBE OIL SCAVENGE
FRESH WATER COOLING
SCAVENGE PUMPS
FROM FREE TURBINE BEARINGS 8 & 9
LUBE OIL PUMPS
PUMP SELECTOR SWITCH
HS
RUN
XA
RUNNING
XA
PA
PCV
FREE TURBINE BEARINGS 8 & 9 SCAVENGE PRESSURE
M
M
M
TROUBLE
XA
TO FREE TURBINE BEARINGS 7, 8 & 9
FROM PSL ON FT BEARINGS 7, 8 & 9 SUPPLY
PB
PB
PB
FROM PSLL ON FT BEARINGS 7, 8 & 9 SUPPLY
FROM PSH ON FT BEARINGS 7, 8 & 9 SCAVENGE
FROM PSHH ON FT BEARINGS 7, 8 & 9 SCAVENGE

C2.8(2)



AIR/OIL SEPARATOR
VENT
DRAIN
BREATHER AIR CENTRIFUGE
PCV
FROM LUBE OIL TANK
BOOST PUMP
FREE TURBINE
EXHAUST
COMBUSTION CHAMBER
LP COMPRESSOR
HP COMPRESSOR
HP TURBINE
LP TURBINE
N1
N2
N3
GEARBOX BREATHER PRESSURE
1
2 2½ 3
4 4½ 5 6
7 8 9
N2 GEARBOX (SEE LEFT)
GAS GENERATOR N2 GEAR-BOX
PCV
PI
MAIN PUMP
UNIT TRIP
PA PA PI
L LL
TA H
TA HH
UNIT TRIP
LUBE OIL COOLERS
XA
SCAVENGE PUMP
CHIP DETECTORS
DRIVEN FROM N2 GEARING
PI PA PA
H HH
UNIT TRIP
SCAVENGE PUMPS
XA XA
LUBE OIL SUPPLY
LUBE OIL SCAVENGE
SCAVENGE PUMPS
PA
START DC SPARE STANDBY LUBE OIL PUMP
START AC STANDBY LUBE OIL PUMP
UNIT TRIP
LUBE OIL PUMPS PCV
PI PA PS PS
H L LL
3 SECOND TIME DELAY
FROM LUBE OIL PUMPS
PI
PS H
PS H
PA H
PS HH
PS HH
UNIT TRIP
START AC STANDBY PUMP
START DC SPARE STANDBY PUMP

C8.2(3)

3.3 Free Turbine Supply

See illustrations C2.8(2) and (3)

3.3.1 There are three sets of scavenge and lube oil pumps. Each set consists of two scavenge pumps and one lube oil pump driven by one motor. One set is designated 'Main' and is driven by an AC motor. The second is designated 'Standby' and is also driven by an AC motor. The third is designated 'Spare Standby' and is driven by a DC motor. The pumps are connected to supply the free turbine bearings (Nos 7, 8 and 9). Only one pump runs at a time, together with its related scavenge pumps. Lube oil pressure to the bearings is controlled by a recirculation PCV taking its reference signal from the scavenge pressure at bearings 8 and 9. Pressure drop across these bearings is thus maintained at 3.5 bar with a flow of 37.8 litres per minute. PSVs across the pumps are set at 7 bar.

3.3.2 Each pump motor is provided with a 'Jog' pushbutton for priming and checking the system. Either the main set of pumps or the standby set can be selected for normal running by the positioning of the selector switch. The main set is the normal selection.

3.3.3 The supply line to bearings 7, 8 and 9 has the following instrumentation:

(a) PAH. Alarms in the event of high pressure.

(b) PSL. On falling low pressure this switch initiates a signal to start the standby lube oil pump and to generate an alarm, PAL.

(c) PSLL. On falling low-low pressure and after a 3-second delay this switch initiates a signal to start the spare standby lube oil pump and cause a unit trip. An alarm is also generated.

3.3.4 Oil from bearing 7 is returned to the supply system by one of the two running scavenge pumps. Oil from bearings 8 and 9 is returned by the other of the two running scavenge pumps. The two lines have the following instrumentation:

(a) TAH and TAHH. These alarm respectively on high and high-high temperature. In the event of high-high a unit trip signal is initiated.

(b) PSH. On rising high scavenge pressure in either line the respective switch initiates a signal to start the standby lube oil pump and to generate an alarm.

(c) PSHH. On rising high-high scavenge pressure in either line the respective switch initiates a signal to start the spare standby lube oil pump and to generate an alarm. In addition, a unit trip signal is generated.

3.3.5 In each scavenge line is a metal chip detector. These generate an alarm if any metal chips are found in the return oil, indicating the possibility of bearing faults.

3.3.6 A panel with five lubricating system pressure gauges is mounted on the side of the engine hood. The pressures indicated are as follows:

(a) Oil pressure on gas generator before and after engine strainer.

(b) Free turbine oil pressure before and after filter.

(c) Breather pressure for the gas generator.

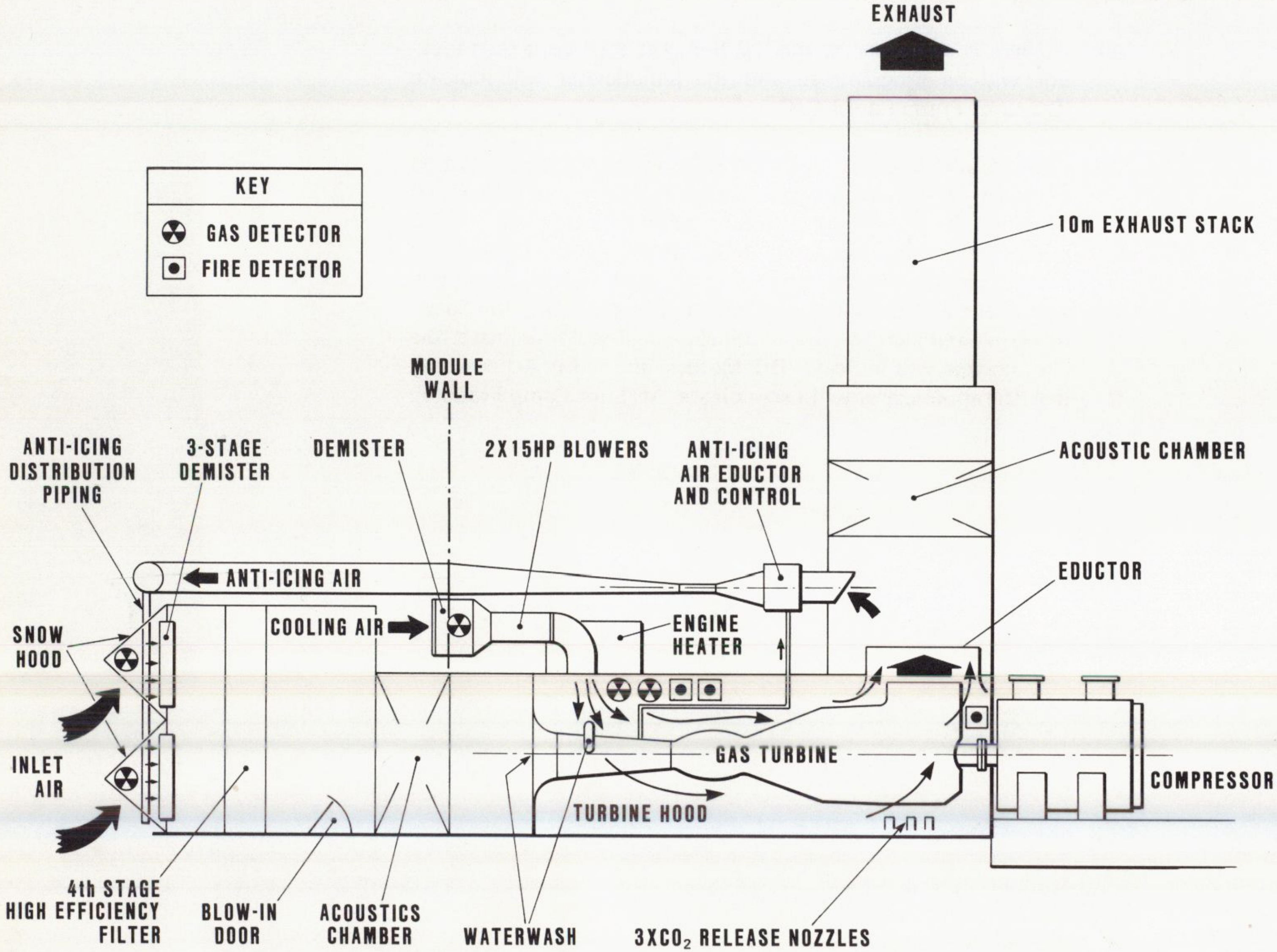
Main lube oil filter differential pressure is indicated on the turbine lube oil console.

3.3.7 The lube oil used must be a Type II synthetic gas turbine oil conforming to the latest revision of P & WA Oil Specifications No 521.

3.3.8 Operation of the pump sets is as follows:

(a) If there is no power to the DC pump at start-up, a start lockout will be programmed and the annunciator will indicate 'DC Lube Pump Power Off'.

(b) With parallel selected, both the AC and DC pumps are turned on when the start switch is actuated. The DC pump is switched off when the AC pump attains approximately 3 bar and the DC pump attains approximately 1 bar. If the AC pump does not reach 3 bar after two seconds or if AC power is lost, a unit trip will occur and the DC pump will supply oil during the coastdown. A red light on the auxiliary panel will illuminate, the annunciator will indicate 'DC Motors On' and if AC power is lost, the annunciator will also indicate 'AC Lube Pump Trouble'.


EXHAUST
10m EXHAUST STACK
KEY
GAS DETECTOR
FIRE DETECTOR
MODULE WALL
ANTI-ICING DISTRIBUTION PIPING
3-STAGE DEMISTER
DEMISTER
2X15HP BLOWERS
ANTI-ICING AIR EDUCTOR AND CONTROL
ACOUSTIC CHAMBER
EDUCTOR
ANTI-ICING AIR
SNOW HOOD
COOLING AIR
ENGINE HEATER
INLET AIR
GAS TURBINE
COMPRESSOR
TURBINE HOOD
4th STAGE HIGH EFFICIENCY FILTER
BLOW-IN DOOR
ACOUSTICS CHAMBER
WATERWASH
3XCO$_2$ RELEASE NOZZLES

4 GAS TURBINE AUXILIARY SYSTEMS

See illustration C2.9

4.1 Primary Air Inlet

4.1.1 The turbine compressor draws air through louvres fitted with snow hoods and anti-icing headers, and through a four-stage air inlet moisture separation system. The first three stages form a demister.

4.1.2 The first stage of the demister is a vane type separator for removal of most of the droplets of water that are larger than 15 microns in diameter. The second stage is a dual purpose filtering medium which removes solid particles from the inlet air stream and acts as an agglomerator to enlarge the extremely small mist droplets that pass through the first-stage vanes. The third stage removes the droplets that were enlarged by the second stage agglomerator. The fourth stage consists of high efficiency fixed media cartridges mounted in an easily accessible framework.

4.1.3 The filter enclosure is equipped with an access door, a differential pressure switch for measuring differential pressure across the high efficiency filter, and two bypass air doors. The gravity-operated bypass doors begin to open when the pressure differential reaches a preset limit. The doors are trace-heated and the heat will automatically turn on at 5°C (41°F). A limit switch provides the signal for an annunciator alarm when the doors are opened.

4.2 Inlet Air Anti-icing

4.2.1 The inlet air anti-icing system uses a portion of the exhaust gas stream drawn from the exhaust ducting by an eductor. The eductor is powered by air bled from the gas generator compressor.

4.2.2 The mixture of exhaust gases and bled air is led through a 36cm diameter duct to a distribution header located upstream of the inlet air demister. An arrangement of piping from this header distributes the warm gases over the face of the incoming air stream.

4.2.3 When the ambient air temperature drops to 6.7°C (44°F) an ICING CONDITION alarm is annunciated in the Control Room. After personnel have verified that a potential icing condition exists, the system is manually activated. A temperature control system, which controls a butterfly valve in the 36cm duct and a valve in the compressor air line, is used to keep the gas turbine inlet air temperature at approximately 3°C (37°F).

4.2.4 When the outdoor ambient air temperature rises to 7.8°C (46°F) an ICING CONDITION OVER alarm is sounded and the system is then manually shut off.

4.3 Turbine Cooling and Heating System

4.3.1 Each engine is provided with its own blower system and heater. This is used for cooling its external surfaces when running or providing warm air during shutdown periods to eliminate moisture and condensation. Two 15 hp blowers are fitted and draw air through vane separators for removal of the larger water droplets. The air is passed through the heater which is turned ON automatically at shutdown and OFF at start-up or when water wash is selected.

4.3.2 After passing through the heater elements which will be switched off when the turbine is running, the air is led through a check valve into the enclosure formed by the turbine hood. The check valve is to prevent any possibility of turbine exhaust finding its way into the blower duct. In the event of check valve failure the engine is tripped.

4.3.3 The following additional protection is provided:

(a) The heater trips if the air temperature exceeds approximately 470°C or if there is no air flow.

(b) The gas turbine trips on high blower duct pressure.

4.3.4 The air flows past the external surfaces of the engine and through a ring eductor into the turbine exhaust stack. The flow is considerably enhanced by the effect of the eductor when the engine is running.

4.4 Gas Turbine Water Wash System

4.4.1 The system supplies water to the spray nozzles at the engine inlet and to the turbine area (through fuel manifold and nozzles) to remove corrosive deposits from the engine. The water wash programme may be varied from one to five cycles. Each wash is followed by a three-minute drain period and the last wash of any programme selected is followed by a 15-minute drain period to clear the engine of all remaining water. After the final drain period, the engine is dried by starting and running up to a preset N_3 rev/min. A five-cycle wash programme takes approximately 35 minutes.

4.4.2 The programme may be selected at any time but will not start until 90 minutes after engine shutdown. If the Water Wash Stop button is pressed during a wash programme, the wash cycle then in progress will be completed and the 15-minute drain phase will be programmed.

4.4.3 Water used for washing should be of clean, clear quality suitable for drinking. The rate of flow should be 6.3 l/s (83.2 gal/min) at 3.8 bar (55 psi).

CAUTION
THE WATER WASHING PROGRAMME SHOULD NOT BE INITIATED WHEN THE AMBIENT TEMPERATURE FALLS BELOW 4.4°C (40°F) DUE TO THE POSSIBILITY OF ICE FORMATION LOCKING THE N_1 AND N_2 ROTORS. IF A PROLONGED PERIOD OF TEMPERATURES BELOW 4.4°C IS ANTICIPATED, THE WATER WASH SYSTEM SHOULD BE DRAINED.

4.5 Gas Turbine Fire Detection and Extinguishing System

4.5.1 The turbine enclosure is provided with an extended discharge CO_2 fire extinguishing system consisting of:

(a) CO_2 cylinders.

(b) Primary and secondary discharge heads located on the cylinders.

(c) Primary and secondary nozzle system inside the enclosure.

4.5.2 The system is actuated by any one of three temperature detectors within the enclosure. These are set at 232°C (450°F), which is approximately 140°C higher than the highest expected temperature at the detector locations (forward and rearward of the turbine exhaust elbow, and above the fuel systems). Two gas detectors, set to trip at 60 per cent LEL within the enclosure, and any two of six at the primary air inlet under the snow hoods, set to trip at 15 per cent LEL, will also activate the fire extinguishing system.

4.5.3 The discharge of CO_2 for the enclosure is actuated by any of the following:

(a) Any of the Fenwall fire detectors or enclosure detectors within the enclosure.

(b) The manual release fire station (pushbutton) located on the exterior wall near the enclosure door.

(c) The corresponding manual release control switch located on the Unit Control Panel.

(d) Manual release on CO_2 bottles.

4.5.4 Upon initiation of a fire signal either by one of the temperature detectors or by one of the override controls, the main fire relay immediately energises, initiating the following:

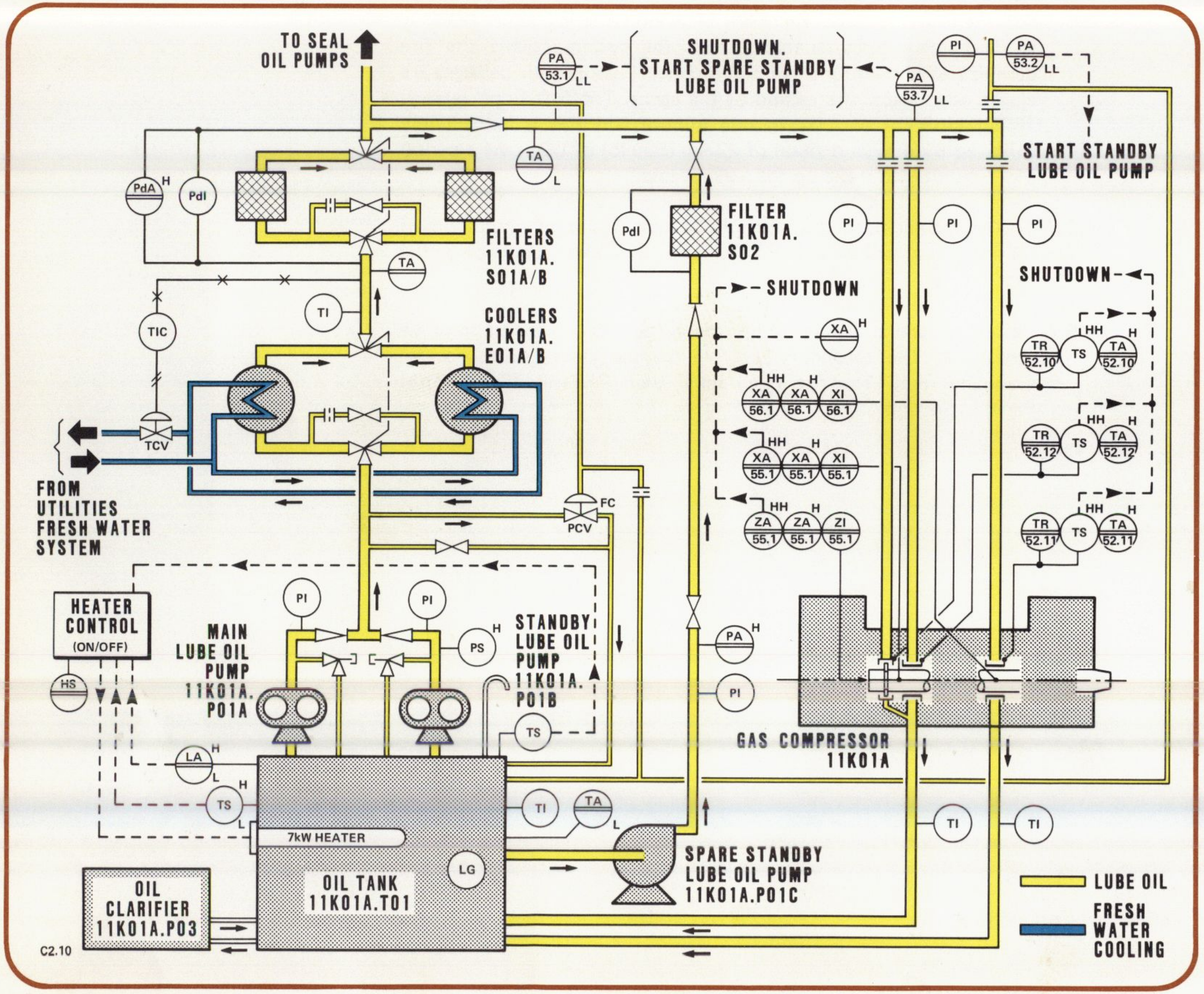
(a) The lockout relay will be automatically tripped. This will initiate an emergency shutdown of the unit.

(b) The auxiliary fire relay closes the fuel fire valve, shuts off the enclosure cooling fans and provides the 'fire' signal to the annunciator panel.

4.5.5 When activated manually the system discharges immediately. When automatically activated there is a 17-second interval before the CO_2 is discharged. Simultaneously with the system release the fire dampers at the entrance of the secondary cooling air passages are closed to prevent the escape of the agent. The first flood releases 160kg (353 lb) of CO_2 in one minute and this is immediately followed by a second flood of 227kg (500 lb) of CO_2 over a period of 12 minutes to make up the leakage loss.

4.5.6 The engine enclosure doors should be kept closed for a minimum of 90 minutes after discharge of the agent to prevent reignition of the fire.

4.5.7 Before restarting the unit the discharged CO_2 cylinders must be recharged. The secondary air fire damper doors must also be manually reset. The fire relay must then be reset. (See Control Panel in Section 5.)


TO SEAL OIL PUMPS
SHUTDOWN. START SPARE STANDBY LUBE OIL PUMP
START STANDBY LUBE OIL PUMP
PA 53.1 LL
PA 53.7 LL
PA 53.2 LL
PI
TA L
PdA H
PdI
FILTERS 11K01A. S01A/B
FILTER 11K01A. S02
TA
TI
TIC
COOLERS 11K01A. E01A/B
TCV
FROM UTILITIES FRESH WATER SYSTEM
SHUTDOWN
XA H
XA 56.1 HH
XA 56.1 H
XI 56.1
XA 55.1 HH
XA 55.1 H
XI 55.1
ZA 55.1 HH
ZA 55.1 H
ZI 55.1
TR 52.10
TS
TA 52.10 HH H
TR 52.12
TA 52.12
TR 52.11
TA 52.11
FC
PCV
HEATER CONTROL (ON/OFF)
HS
MAIN LUBE OIL PUMP 11K01A. P01A
STANDBY LUBE OIL PUMP 11K01A. P01B
PS H
PA H
GAS COMPRESSOR 11K01A
LA H L
TS H L
7kW HEATER
OIL TANK 11K01A.T01
LG
TI
TA L
SPARE STANDBY LUBE OIL PUMP 11K01A.P01C
OIL CLARIFIER 11K01A.P03
LUBE OIL
FRESH WATER COOLING
C2.10

5 COMPRESSOR LUBE OIL SYSTEM

See illustration C2.10

5.1 Oil for lubrication and shaft sealing is pumped from and circulated back to oil tank 11K01A.T01 which has a capacity of $3.6m^3$. The tank is fitted with a 7kW electric heater and the following instrumentation apart from local gauges:

(a) LAH/L. Alarms on high or low level. On low level the electric heater is switched off. If level is satisfactory, a permissive signal is transmitted to the heater control system.

(b) TS. Controls the switching of the electric heater, on at 30°C and off at 45°C in AUTO control. The heater control system may be switched to AUTO, MANUAL or OFF from the local control panel.

(c) TAL. Alarms when temperature falls to 25°C.

5.2 The oil tank is connected to an oil clarifier 11K01A–P03 which serves to maintain a low impurity and water content in the lube oil. The clarifier can be brought into operation as required, following the results of oil sampling.

5.3 Mounted on the tank are two motor-driven lube oil pumps 11K01A.P01A/B. Each pump has a capacity of $35m^3/h$ at 4 bar head. Each has a discharge relief valve set at 8 bar. They serve a common discharge line through check valves and operate as one duty and the other standby.

5.4 In the common discharge line are two 3in recirculation connections, one through a manual valve that is normally kept closed, the other through pressure control valve PCV. This takes its regulating signal from the low pressure side of the two filters mentioned below.

5.5 The common discharge line is taken to two coolers 11K01A.E01A/B served by the utilities fresh water system. One cooler is selected as duty, the other as standby, by a pair of ganged changeover valves. The temperature of the cooled oil is regulated by a temperature controller TIC which acts upon control valve TCV in the cooling water return. TAH alarms on the local control panel on high temperature.

5.6 The common discharge line is now taken to two filters 11K01A. S01A/B. One filter is selected as duty, the other as standby, by a pair of ganged changeover valves. PdAH, connected across the filter, alarms on the local control panel if the differential pressure exceeds its limit.

5.7 After the filters the line divides to serve the seal oil system and to feed the two main bearings of the compressor. Into this line is connected the discharge line from the spare standby lube oil pump 11K01A.P01C. This pump takes its suction from the oil tank and discharges through filter 11K01A.S02. Pump discharge pressure is monitored and PAH alarms on the local control panel on high pressure. Backflow from this pump to the main supply line is prevented by a check valve. The pump is automatically controlled to allow a safe rundown on shutdown.

5.8 The lube oil line to the compressor is served by the following instrumentation apart from local gauges:

(a) TAL. Alarms on low temperature.

(b) PALL53.2. Alarms on low-low pressure. At the same time the standby lube oil pump is automatically started. To prevent false operation on short-lived pressure drops the instrumentation is connected to a point downstream of a gauge line orifice.

(c) PALL53.1 and PALL53.7. Alarm independently on a further drop in pressure. At the same time the spare standby lube oil pump is automatically started and a shutdown is initiated.

(d) PI. Provides pressure indication on the local control panel. This takes its connection from the same line as PALL53.2 and for the same reason.

5.9 The compressor bearings are served by the following:

(a) TAH52.10/11/12. Alarm individually on high temperature.

(b) 11TR52.10/11/12. Record individual temperatures on the local control panel.

(c) TSHH. Operate individually if temperature rises to 85°C to initiate shutdown and alarm on the main control panel.

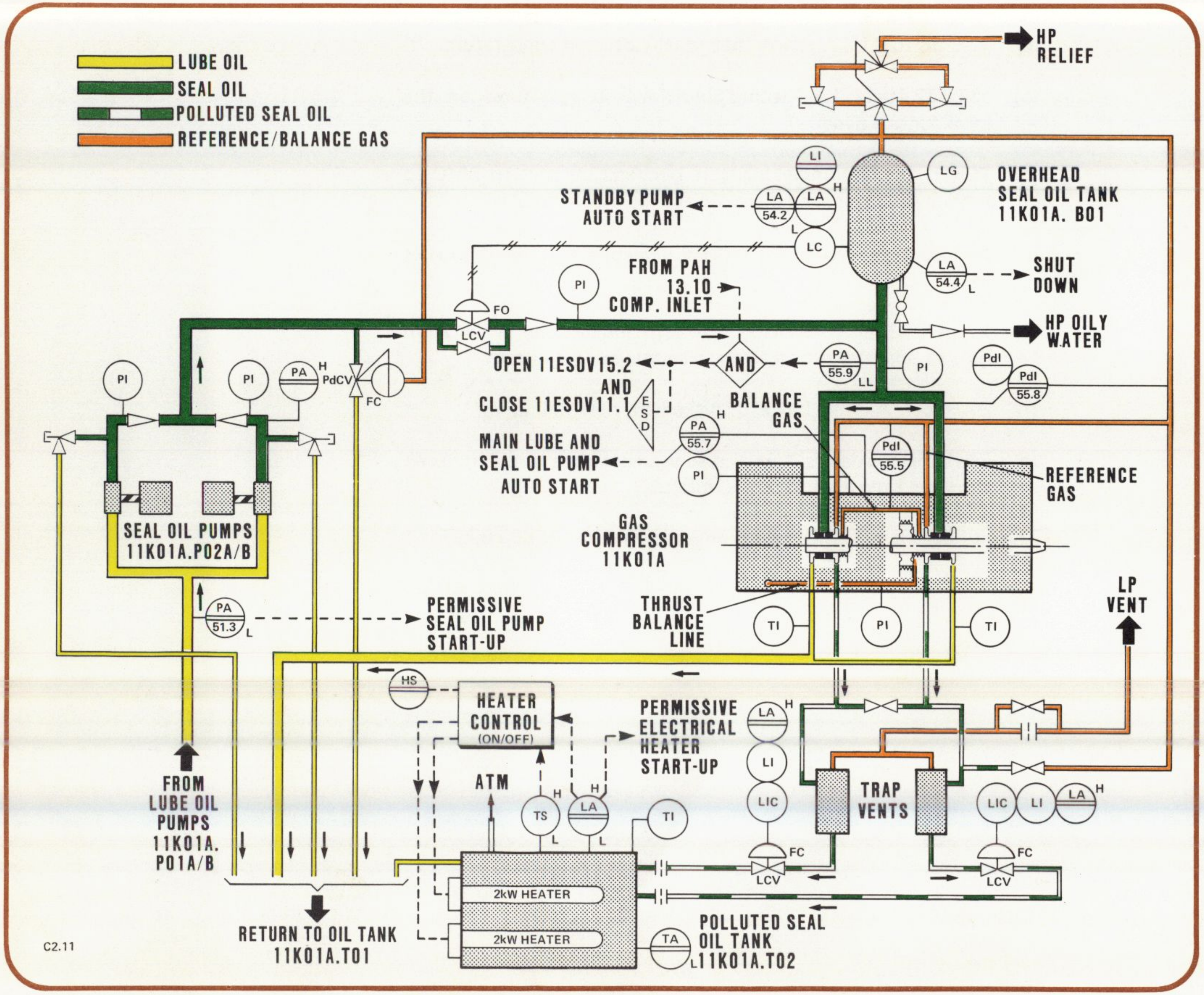
(d) XAH55.1 and XAH56.1. Alarm individually if vibration rises to 25μ.

(e) XAHH55.1 and XAHH56.1. Alarm individually if vibration rises to 50μ. At the same time a shutdown is initiated.

(f) ZAH55.1. Alarms if axial displacement rises to 0.2mm.

(g) ZAHH55.1. Alarms if axial displacement rises to 0.34mm. At the same time a shutdown is initiated.

5.10 The oil flow from the bearings is now returned to the oil tank.



LUBE OIL
SEAL OIL
POLLUTED SEAL OIL
REFERENCE/BALANCE GAS
HP RELIEF
OVERHEAD SEAL OIL TANK 11K01A. B01
LI
LG
LA 54.2
LA
LC
STANDBY PUMP AUTO START
LA 54.4
SHUT DOWN
HP OILY WATER
FROM PAH 13.10 COMP. INLET
PI
FO
LCV
PdCV
FC
OPEN 11ESDV15.2 AND CLOSE 11ESDV11.1
ESD
AND
PA 55.9
PI
PdI
PdI 55.8
BALANCE GAS
PA 55.7
MAIN LUBE AND SEAL OIL PUMP AUTO START
PI
PdI 55.5
REFERENCE GAS
GAS COMPRESSOR 11K01A
THRUST BALANCE LINE
TI
PI
TI
LP VENT
SEAL OIL PUMPS 11K01A.P02A/B
PA 51.3
PERMISSIVE SEAL OIL PUMP START-UP
HS
HEATER CONTROL (ON/OFF)
PERMISSIVE ELECTRICAL HEATER START-UP
LA
LI
LIC
TRAP VENTS
LIC
LI
LA
ATM
TS
LA
TI
FROM LUBE OIL PUMPS 11K01A. P01A/B
2kW HEATER
2kW HEATER
RETURN TO OIL TANK 11K01A.T01
TA
POLLUTED SEAL OIL TANK 11K01A.T02

6 COMPRESSOR SEAL OIL SYSTEM

See illustration C2.11

6.1 On both shaft ends of the compressor seals are installed to prevent gas from flowing out of compressor casing. At each end sealing is ensured by combining a set of labyrinth seals and an oil seal. The oil seal consists of two steel rings. The rings float in their housing, free to follow the radial movements of the shaft while remaining concentric, and are locked to prevent rotation on the shaft. The two rings are placed face to face and separated by a set of springs. Oil, under greater pressure than that of the gas in the chamber just upstream of the inner ring, is forced through the annular space between the two rings. The oil film between the inner ring and the shaft prevents the gas from escaping along the shaft.

6.2 Oil leakage from the outer ring ('low pressure ring') encounters an atmospheric pressure system and returns to the main tank. Oil leakage from the inner ring ('higher pressure ring') prevents gas from exiting and is collected in the automatic traps then recovered in the polluted seal oil tank under level control.

6.3 The heat produced in the sealing rings is reduced by the same oil which exits from the outer ring; this is because the rate of flow of this oil is much higher than the rate of flow of the oil exiting from the inner ring. This fact is due to the different clearance of the rings and to the different pressure levels encountered by the oil when exiting; atmospheric pressure for the oil exiting from the outer ring, and a pressure which is slightly lower than the inlet pressure for the oil exiting from the inner ring.

6.4 The pressure of the oil at the inlet of the seals is kept constantly higher than that of the gas by means of an automatic feed and regulation system.

6.5 The balance drum mounted on the compressor shaft provides an opposite balance to the axial thrust developed within the compressor. For this purpose the chamber formed by the balance drum and the seal is connected by a 'balance' pipe to the compressor suction line. The size of the drum is such that the axial thrust, though not entirely balanced, is considerably reduced, the remaining thrust being absorbed by the thrust bearing. This ensures that the rotor cannot move in an axial direction.

6.6 Downstream of the common discharge line filters, seal oil is taken and boosted to a pressure of 160 bar by seal oil pumps 11K01A. P02A/B. Each pump has a capacity of 7.8m^3/h. Each has a discharge relief valve set at 160 bar. They serve a common seal oil line through check valves and operate with one duty and the other standby. On their common suction line is 11PS51.3 which operates if the pressure from the lube oil pumps falls below 0.8 bar; when this happens it removes the permissive for seal oil pump start-up.

6.7 In the common seal oil pressure line is a 1in recirculation connection through pressure control valve PdCV. This is regulated direct from the pressure developed in the overhead seal oil tank 11K01A. B01. As the pressure in the tank increases, the recirculation valve is opened to relieve the excess seal oil to the oil tank. The purpose of the tank is explained later.

6.8 The seal oil is piped to the compressor through level control valve LCV and a check valve. The level control valve requires air to close and is controlled by LC on the overhead seal oil tank. If the level in the tank rises, the control valve is progressively closed. The level should remain constant during normal running operation when the oil flow through the shaft seals is equalled by the supply through the control valve.

6.9 The overhead seal oil tank provides a steady head of seal oil pressurised by gas from the compressor reference gas connection. This maintains a constant balance between seal oil pressure at the shaft seals and the gas contained within the compressor. Furthermore, during blowdown following a trip, the pressure of oil in the seals will diminish at the same rate as that of the gas, and the tank will provide sufficient flow during compressor coastdown. It is sized to provide a two-minute flow at normal seal oil rates and includes additional capacity for a two-minute flow from low level alarm to trip plus 30 minutes which is sufficient for coastdown and block-in. This assumes that the pressure remains constant inside the compressor for the first five minutes and that depressurisation occurs over the remaining 25. Vapour-volume above the tank high level alarm setting is equivalent to one minute normal flow.

6.10 The seal oil tank is equipped with the following fittings and instrumentation apart from local gauges:

(a) PSV. These relieve tank pressure to platform HP relief at a setting of 160 bar.

(b) Two ¾in vent lines to atmosphere through block valves. (Not shown on illustration.)

(c) LAL54.4. Alarms when seal oil level falls to lowest limit, 2670mm from lower flange to initiate shutdown. At the same time a shutdown is initiated.

(d) LAL54.2. Alarms when seal oil level falls to first lower limit. At the same time the standby seal oil pump is automatically started.

(e) LAH. Alarms on high level.

(f) Connections to PdCV and compressor reference gas line. The connection to the compressor reference gas line is extended to the polluted seal oil line to one of the trap vents. This line is valved and may be used for blowing down the reference gas line should there be any ingress of oil.

6.11 In the line from the overhead seal oil tank to the compressor is PALL55.9. This alarms on low-low seal oil pressure. At the same time if there is high pressure in the compressor inlet an ESD is initiated, 11ESDV11.1 (suction drum inlet) is automatically closed and 11ESDV15.2 is opened to vent the high pressure gas line. This is done to prevent gas leakage past the compressor seals.

6.12 Associated with the compressor shaft sealing arrangements is the following instrumentation:

(a) PdI55.5. Indicates pressure difference between balance gas line and reference gas line. This allows regular checks to be made on the effectiveness of the shaft sealing labyrinths.

(b) PdI55.8. Indicates pressure difference between reference gas line and seal oil supply line. This allows regular checks to ensure that the gas pressure at the seals is always greater than the oil pressure by a specified amount.

(c) PAH55.7. Alarms when compressor balance gas rises to 0.4 bar. At the same time the main lube and seal oil pumps are automatically started. This is to prevent gas escapes through the seals in the event of inadvertent entry of gas into the compressor when stationary.

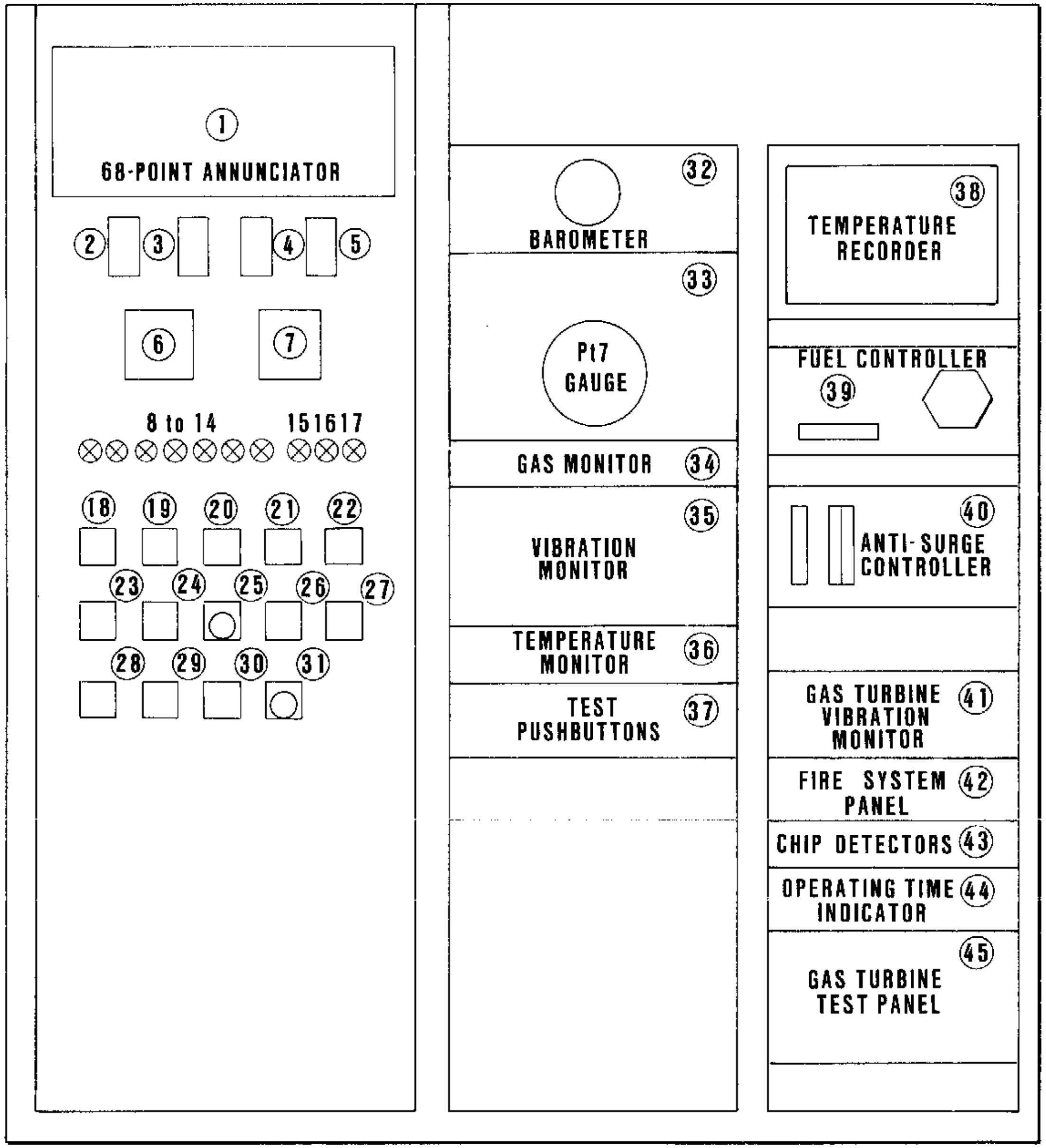
6.13 Seal oil that is unpolluted by gas recirculates back to the main oil tank. Polluted oil is passed through trap vents and through the two level control valves LCV to the polluted seal oil tank 11K01A.T02. The trap vents vent off the gas to the platform LP vent system. The oil level, acting as a seal within each, is sensed by an LIC. These act upon the level control valves previously mentioned. Both valves fail closed. Each trap vent has an LAH which alarms in the event of high level.

6.14 The polluted seal oil tank is fitted with two 2kW electric heaters and is equipped with the following instrumentation apart from local gauges:

(a) LAH/L. Alarms on high or low level. On low level the electric heaters are switched off. If level is satisfactory, a permissive signal is transmitted to the heater control system.

(b) TS. Controls the switching of the electric heater, on at 80°C and off at 90°C, in AUTO control. The heater control system may be switched to AUTO, MANUAL or OFF from the local control panel.

(c) TAL. Alarms when temperature falls to 70°C.



C2.12

KEY

1. ANNUNCIATOR
2. COMP LUBE OIL PRESS
3. COMP SEAL OIL/REF GAS ΔP
4. COMP BALANCE GAS/REF GAS ΔP
5. SEAL OIL TANK LEVEL
6. N_1 TACHOMETER
7. N. TACHOMETER

LAMPS:

8. 'READY-TO-START'
9. 'SEQUENCE RUNNING'
10. 'ENGINE CRANKING'
11. 'ENGINE IGNITION'
12. 'ENGINE RUNNING'
13. 'LOAD LIMIT'
14. 'PROCESS VALVES IN PROPER POSITION'
15. 'WATER WASH READY'
16. 'WASH IN PROGRESS'
17. 'DRY IN PROGRESS'

SWITCHES:

18. ENGINE LOCKOUT
19. MODE SELECTOR (LOCAL/REMOTE)
20. ENGINE MODES SELECTOR (MANUAL/AUTO)
21. STOP/START
22. GOVERNOR CONTROL (N_3 SPEED)
23. ANTI-ICE (ON/OFF)
24. WATER WASH (ARM/DISARM)
25. EMERGENCY STOP
26. LOCKOUT RELAY 86G–1 RESET
27. OIL PUMPS (OFF/AUTO/ON)
28. COMP SEAL & LUBE OIL HEAT
29. COMP POLLUTED OIL HEAT
30. SECONDARY FANS (No 1/No 2)
31. ENGINE HEAT RESET
32. BAROMETER
33. Pt_7 GAUGE
34. GAS MONITOR
35. VIBRATION MONITOR
36. TEMPERATURE MONITOR
37. TEST PUSHBUTTONS
38. TEMPERATURE RECORDER
39. FUEL CONTROLLER
40. ANTI-SURGE CONTROLLER
41. GAS TURBINE VIBRATION MONITOR
42. FIRE SYSTEM PANEL
43. CHIP DETECTOR
44. OPERATING TIME INDICATOR
45. GAS TURBINE TEST PANEL

SECTION 5 – GAS TURBINE AND COMPRESSOR CONTROL

See illustration C2.12

1 UNIT CONTROL PANEL

1.1 Control for the gas turbine and compressor is exercised from the main unit control panels in Module 32 Control Room. There is one unit control panel for each turbocompressor set.

1.2 The following controls and indicators are provided; they are numbered to facilitate their identification on the illustration:

(1) (a) Annunciator Panel – Comprises 68 points arranged in 34 double windows, a horn, an Acknowledge button, a Reset button and a Test button. In the event of a fault or malfunction, the appropriate window will illuminate and a warning alarm will sound.

(b) Acknowledge Button – Turns off the audible and flashing alarm, but the Annunciator window(s) remain illuminated. The 'first in' alarm remains slowly flashing.

(c) Reset Button – Resets the annunciator panel after the fault or malfunction has been corrected or no longer exists.

(d) Test Button – Lights up the entire annunciator panel for an integrity check.

(2) Compressor Lube Pressure Indicator – Indicates pressure of compressor lube oil.

(3) Seal Oil to Reference Gas Pressure Differential Indicator – Indicates seal oil to reference gas pressure differential.

(4) Balance Gas to Reference Gas Pressure Differential Indicator – Indicates balance gas to reference gas pressure differential.

(5) Seal Oil Tank Level Indicator – Indicates level of compressor seal oil tank.

(6) N_3 Tachometer – Free turbine/compressor speed.

(7) N_2 Tachometer – Gas generator high pressure compressor speed.

(8) READY-TO-START Light – On when all conditions for starting are satisfied.

NOTE
Annunciator will not be cleared.

(9) SEQUENCE RUNNING Light – On from actuation of the starting sequence to initiation of a Stop signal.

(10) ENGINE CRANKING Light – On when minimum cranking speed (N_2 1500 rev/min) has been reached. This is the lowest speed at which ignition is permitted. Off at starter cut-off speed (N_2 3400 rev/min).

(11) ENGINE IGNITION Light – On when the ignition is turned on by the sequencer. Off at approximately N_2 5200 rev/min.

(12) ENGINE RUNNING Light – On at N_2 3400 rev/min.

(13) LOAD LIMIT Light – On when turbine has reached the fuel control load limit schedule.

(14) PROCESS VALVES IN PROPER POSITION Light – Indicates process valves in proper position and compressor is ready to start.

(15) WATER WASH READY Light – On when the engine coast-down period has elapsed. Off when the wash cycle begins.

(16) WASH IN PROGRESS Light – On when the automatic wash programme has begun. Off when the wash cycles programmed are completed or cancelled.

(17) DRY IN PROGRESS Light – On at the start of the drain period. Off when the engine reaches a preset N_3 rev/min during the drying operation.

(18) Engine Lockout Switch (43–7) – Normally kept in RUN position. Used during test programmes or maintenance period to lock out engine.

(19) Mode Selector Switch (43–1) – Selects either Local or Remote operation. (Remote-placed unit on process controller.)

(20) Engine Modes Selector Switch (43–2) – Selects Manual or Automatic. Reselection during operation is permissible.

(21) Stop/Start Switch (1–1) – Starts or shuts down the unit during normal operation. Switch is spring-loaded to return to normal position when released.

(22) Governor Control Switch (18–1) – Raises or lowers N_3 speed after reaching 2000 rev/min.

(23) Anti-ice Control Switch (43–27) – Selects anti-icing of primary inlet air On or Off.

(24) Water Wash Control Switch (43–11) – Selects Arm to start or Disarm to stop a water wash programme.

(25) Emergency Stop Button (43–E) – Press this switch to actuate an immediate shutdown; the cooldown period is bypassed.

(26) Lockout Relay (86G–1) Reset Switch – Resets the 86G–1 protective devices after a trouble is corrected and engine coast-down period is completed.

(27) Oil Pumps Control Switch (43–28)

In AUTO position, compressor seal oil pumps, compressor lube oil pumps and free turbine lube oil pumps are On at engine start and Off at end of coastdown.

In ON position, compressor seal oil pumps will run during engine shutdown.

NOTE
Compressor lube and seal oil pumps should always be running whenever gas is in the loop.

(28) Compressor Seal and Lube Oil Heat (43–31) – Turns on heaters in compressor polluted oil tank.

(29) Compressor Polluted Oil Tank Heat (43–32) – Turns on heaters in compressor polluted oil tank.

(30) Secondary Fans No 1 and No 2 (43–29) – Selects either No 1 or No 2 secondary air fans for standby unit. Does not affect operating units.

(31) Engine Heat Reset (43–30) – Resets engine heat at engine shutdown.

(32) Barometer (Unit A only).

(33) Pt_7 Gauge and Shutoff Valve – Indicates gas generator exhaust pressure (Pt_7) in/mm (gauge).

(34) Natural Gas Monitor – Eight gas detectors are fitted; four in the primary air inlet, two in the secondary air inlet and two in the engine enclosure. Each is electrically linked to a single natural gas monitor.

Each monitor contains:

(a) A meter indicating per cent of LEL (Lower Explosive Limit).

(b) Four lights indicating HIGH ALARM, LOW ALARM, NORMAL and MALFUNCTION.

(c) A toggle switch with latching position (alarms lock in) or non-latching (alarms automatically reset).

(d) Two adjustment screws, one for calibrating the monitor and the other for setting the scale zero point.

An annunciated alarm will occur if any one detector in the primary air inlet reaches the 15 per cent LEL and an alarm/trip will occur if any two of these detectors reach the 15 per cent LEL.

An annunciated alarm and start lockout will occur if either detector in the secondary air inlet or engine enclosure reaches the 20 per cent LEL and an alarm/trip will occur if both secondary air inlet detectors or both enclosure detectors reach 60 per cent LEL.

If both enclosure detectors read 60 per cent LEL, the fire protection system will also be activated.

(35) Bentley Nevada Vibration Monitor – Receives vibration signals from each main bearing of the axial compressor. If the normal limit is reached, an annunciated alarm is actuated. If the maximum limit is reached, it will shut down the unit.

(36) Temperature Monitor – Receives temperature signals from the compressor bearing thermocouples for readout on the temperature indicator.

(37) Test Pushbuttons – Press to test various devices such as compressor lube oil pressure switch etc for functional operation. Label indicates device to be checked.

(38) Temperature Recorder (Leeds and Northrup, Speedomax) – 18°C to 800°C temperature range, twelve-point recorder. The recorder is turned on at engine start and off at the end of generator coastdown by the sequencer. The following temperatures are recorded:

(a) Gas Generator T_{t7} temperature from six individual thermocouples (non-averaging circuit) which are monitored in sequence. An open circuit in an individual thermocouple circuit will result in the recorder driving up the scale and effecting an alarm.

(b) Gas Generator and Lube Oil Temperature. The recorder will initiate an annunciated alarm if lube oil temperature alarm limit is reached. The engine is automatically shut down at the lube oil temperature trip limit by a separate device.

(39) Fuel Control for Gas Turbine Engine – The fuel control face panel provides the following switches and indication points:

(a) On/Off Switch – Provides 24V dc and 115V ac power to the fuel control.

(b) POWER Light – On when power is being received by the control and the fuel control inverter is producing the required ac power.

(c) FADE-IN Lamp – On when N_2 signal reaches a preset frequency equivalent to approximately 5200 rev/min.

(d) N_7 CONTROL INDICATION Lamp – On when the engine is on N_3 control.

(e) N_G MAX Lamp – On when the N_2 reference is at max position.

(f) N_F MAX Lamp – On when the N_3 reference is at max position.

(g) N_G MIN Lamp – On when the N_2 reference is at min position.

(h) N_F MIN Lamp – On when the N_3 reference is at min position.

(j) UNDERVOLTAGE Lamp – On when the inverter dc power input is inadequate for fuel control requirements.

(k) FADE-OUT Lamp – On when N_2 speed drops below minimal requirement to sustain operation (shutdown 86G–1).

(l) N_F OVERSPEED Lamp – On when N_3 speed reaches the preset limit (shutdown 86G–1).

(m) VALVE ERROR Lamp – On when fuel modulating valve angle exceeds that required by the fuel control schedule (shutdown 86G–1).

(n) VALVE LOSS Lamp – On when fuel control lacks a modulating valve feedback signal (shutdown 86G–1).

(p) NO N_1 Lamp – On when fuel control lacks an N_1 signal (shutdown 86G–1).

(q) VALVE LEVEL Lamp – On when on-line valve is not reasonably closed 5 seconds after start until ignition (shutdown 86G–1).

(r) EGT TRIP Lamp – On when the Tt_7 temperature exceeds the preset limit.

(s) Lamp Test Button – Push-to-set button illuminates all lamps when pressed and the control is powered.

(t) Meter Select Switch – Selects one of five supply voltages or five signal voltages for monitoring with the percent meter or with a voltmeter via the meter readout terminals.

(u) Percent Meter – Indicates by percentage the strength of the selected voltage sensed by the control.

(40) Anti-surge Controller – Controls the compressor to prevent surging. Operates and controls the anti-surge valve in response to pressure and flow signals from the unit process.

(41) Vibration Monitor for Gas Turbine Engine – Vibration amplitude, indicated by a meter, is selected for use or test on each of the three channels (one GG and two FT).

Coloured lamps indicate an OPEN PICKUP alarm (white), LIMIT 1 VIBRATION alarm (amber) and a LIMIT 2 VIBRATION shutdown (red) for each channel. Another lamp (amber) indicates system malfunction, engine or turbine trouble, or a non-use selection.

A Reset button must be depressed to rearm visual alarms after test or alarm indication.

Vibration alarms and shutdown are simultaneously indicated on a single control panel annunciator window.

A velocity output jack is provided for wave analysis.

(42) Fire System Panel – Includes SYSTEM ARMED (neon) indication lamp, a System Test button, a Fire System Release switch and a Reset button which is used to rearm the system. The System Test button has a 17-second time delay.

(43) Chip Detector – Monitors the gas turbine lube oil systems for metallic chips. The chip detector light (red) is illuminated when the chip sensor located in the base of the chip detector housing senses metallic chips from sensor head. Separate alarm signals are indicated for the gas generator and the free turbine.

(44) Operating Time Indicator – Provides engine operating time.

(45) Gas Turbine Test Panel – Provides readout connections to measure gas generator speed (N_1 and N_2), free turbine speed (N_3), engine inlet temperature (Ts_1), gas generator and free turbine oil-in-discharge (Pt_7), total pressure at low pressure turbine discharge (Pt_7), and total temperature at low pressure turbine discharge (Tt_7) for individual alumel and chromel thermocouples.

2 OPERATING RANGES AND LIMITS

Item	Limits – Metric Units
DISCHARGE TEMPS (AVG Tt_7):	
Max Temperature (AVG Tt_7)	
Below Fade-in	566°C – Trip
Above Fade-in	766°C – Trip
Max Difference Between T/C Sets (1, 3, 5 & 2, 4, 6)	
Below Fade-in	222°C – Trip
Above Fade-in	111°C – Trip
Maximum Difference Between High and Low Individual Thermocouples (Δ Tt_7)	83°C – Operation above idle
MAXIMUM SPEEDS:	
Low Pressure Compressor, N_1	7060 rev/min (Topper)
High Pressure Compressor, N_2	
Free Turbine, N_3	4400 ± 25 rev/min – Trip (See Note 1)

Item	Limits – Metric Units
GAS GENERATOR AND FREE TURBINE OIL SYSTEMS:	
Main Oil Pressure	
GG Operating (Min)	2.07 bar – Trip
FT (Oper after N_2 1500 rev/min)	
(Minimum)	0.69 bar – Trip
(Maximum)	6.7 bar – Alarm
GG Oil Breather Pressure	
GG Operating (Maximum)	0.345 bar – Alarm 0.69 bar – Trip
Oil-in Temperature (Maximum) (GG and FT)	107°C – Alarm 121°C – Trip
Min Oil Level (Measured) from Bottom of Tank	250mm – Alarm 206mm – Trip
Max Gearbox Mounted Oil Filter Differential Pressure	2.07 bar (0.55 to 0.69 bar)
Max External Oil Filter Differential Pressure	1.17 bar – Alarm

Item	Limits — Metric Units
VIBRATION (Double Amplitude):	See Note 2
Gas Generator (One Pickup)	5 mils — Alarm 10 mils — Trip
Free Turbine	
Inlet	4 mils — Alarm 5 mils — Trip
Exhaust	3 mils — Alarm 4 mils — Trip

NOTES

1. Whenever an N_3 speed over 4600 rev/min is attained, the free turbine must be inspected and the results reviewed before further operation.

2. An annunciated alarm will occur with an open circuit for any vibration pickup. All vibration levels are double amplitude. The alarm level signals must be sustained for a minimum of 2 seconds to initiate an alarm.

3 PROTECTIVE AND AUXILIARY DEVICES

3.1 General

3.1.1 The protective and auxiliary devices for the gas generator, the free turbine, the compressor and the other equipment are fully automatic and do not require the services of an operator.

3.1.2 The automatic devices are divided into three groups, depending upon the type of action each initiates. These groups are called 'Emergency Shutdown', 'Start Lockout', and 'Alarm', and are described below.

3.2 Emergency Shutdown

3.2.1 The devices detect any condition which makes it imperative to shut down the gas turbine or the compressor as quickly as possible. Each of the items listed below has a position on the annunciator panel in the Control Room and will also energise the Emergency Shutdown trip relay circuit. When this relay is tripped, it will initiate an emergency shutdown of the unit. The cause will be identified by a window illuminating on the annunciator panel.

3.2.2 An Emergency Stop pushbutton is provided on the control panel and on the engine enclosure. They should be used only when an emergency condition exists; that is when there is indication that the emergency shutdown trip relay has malfunctioned or has been bypassed.

3.2.3 If the unit is shut down, the cause should be determined before operating again.

3.2.4 **Emergency Shutdown Functions**

(a) **Gas Turbine Lube**

1. GG Lube Pressure Low.
2. GG Breather Pressure High.
3. FT Lube Pressure Low.
4. FT Scavenge Pressure High.
5. FT Scavenge Temperature High
6. FT DC Lube Pump Running.
7. Lube Level Low.
8. Lube Temperature High

(b) **Gas Turbine Fuel**

1. Mod Valve Failure.
2. Fuel Pressure Low/High.
3. Knockout Pot Level High.

(c) **Compressor**

1. Incomplete Sequence.
2. Lube Pressure Low.
3. Bearing Temperature High.
4. Lube Level Low.
5. Vibration.

(d) **Miscellaneous**

1. Starter Duct Pressure High.
2. Enclosure Fan Failure.
3. Overspeed/Loss N_3.
4. Incomplete Start.
5. GG Heat Valve Open.
6. Vibration.
7. Fuel Control Shutdown.
8. Emergency Shutdown.
9. Unit Trip.
10. Speed Monitor Not Reset.
11. Manual Trip.
12. Fire.
13. Combustible Gas – Inlet.
14. Combustible Gas – Enclosure.
15. DC Voltage Low or High.

3.3 Start Lockout

3.3.1 The following devices detect conditions that would prevent a safe or successful start. All operate the Start Lockout circuitry and keep the READY-TO-START light de-energised. The first group is also annunciated as individual alarms on the annunciator or as a status light on the control panel.

(a) **Annunciated**

1. Fire Valve Closed.
2. Fuel Pressure Low.
3. FT DC Lube Pump Trouble.
4. Speed Monitor Not Reset.
5. Engine Lube Level High.
6. Compressor (Not) Ready.
7. Unit Trip.

NOTE
Item 5 indicates that coolant may be leaking into the lube oil.
Item 6 is a Status light on the control panel.

(b) **Not Annunciated**

1. Annunciator not functioning (horn only activated).
2. Fuel Control Speed N_2/N_3 Speed References not at minimum (applicable control panel indicator lights show de-energised).
3. Engine coastdown not complete.
4. Water wash drain period not timed out.

3.4 Alarms

3.4.1 These devices alert maintenance personnel when there are conditions requiring preventive maintenance, repairs, or adjustments to avoid an emergency shutdown. All are annunciated on the control panel, but will not shut down the engine.

3.4.2 Should an alarm occur, the engine should be shut down at the first opportunity and the cause determined before operating again.

(a) **Gas Turbine Lube**

1. Pump Backup Timer.
2. GG Pressure Low.
3. Level Low/High.
4. FT Pressure High.
5. Temperature High.
6. AC Pump Trouble.
7. Filter Differential.
8. FT DC Pump Trouble.
9. Chip Detector.
10. Breather Pressure High.
11. FT Scavenge Pressure High.

(b) **Gas Turbine Fuel**

1. Pressure Low/High.
2. Knockout Pot Level Low.
3. Knockout Pot Level High.

(c) **Fire Protection**

1. Gas Detector Malfunction.
2. Engine Enclosure Temp High.
3. Combustible Gas — Inlet.
4. Combustible Gas — Enclosure or Secondary Air Inlet.

(d) **Compressor Lube**

1. Pressure Low.
2. Temperature High.
3. Temperature Low.
4. Tank Temperature Low.
5. Filter Differential.
6. Standby Pump Running.
7. Spare Standby Pump Running.
8. Pump Trouble.

(e) **Compressor Seal Oil**

1. Low Suction Pressure.
2. Standby Pump Running.
3. Tank Level High.
4. Tank Level Low.
5. Polluted Oil Traps High.
6. Polluted Tank Level Low.
7. Polluted Tank Temp Low.

(f) **Miscellaneous**

1. Engine Vibration.
2. Temp Recorder Open Thermocouple.
3. Inlet Blow-in Doors Open.
4. Icing Temperature.
5. Anti-ice Valve Open.
6. AC Voltage Low/High.
7. Comp Bearing Temp High.
8. Balance Gas Pressure High.
9. Compressor Vibration.
10. Surge Valve Open.

3.5 Trips

Compressor Line 'A'	Compressor Line 'B'	Compressor Line 'C'	Function
11FZSL.13.1A	11FZSL.33.1A	11FZSL.23.1A	Running anti-surge valve closed.
11FZSH.13.1B	11FZSH.33.1B	11FZSH.23.1B	Running anti-surge valve open.
11FZSH.13.1C	11FZSH.33.1C	11FZSH.23.1C	Start-up (bypass) anti-surge valve open.
11FZSL.13.1D	11FZSL.33.1D	11FZSL.23.1D	Start-up (bypass) anti-surge valve closed.
11PS53.1 11PS53.7	11PS73.1 11PS73.7	11PS63.1 11PS63.7	Lube oil pressure low-low. (Shuts down gas turbine and starts spare standby lube oil pump.)
11LS54.4A 11LS54.4B	11LS74.4A 11LS74.4B	11LS64.4A 11LS64.4B	Overhead tank level low-low.
11XS56.1	11XS76.1	11XS66.1	No 1 bearing shaft vibration (X/Y) high-high.
11XS55.1	11XS75.1	11XS65.1	No 2 bearing shaft vibration (X/Y) high-high.
11ZS55.1	11ZS75.1	11ZS65.1	Both directions rotor axial displacement high-high.
11TE55.2 11TE55.4 11TE56.2	11TE75.2 11TE75.4 11TE76.2	11TE65.2 11TE65.4 11TE66.2	Metal bearings temperature high-high.

Operation of any one of the final eight devices listed above will shut down the gas turbine. An authorisation to start signal is given to the gas turbine if both anti-surge valves are open.

3.6 **On/Off Controls**

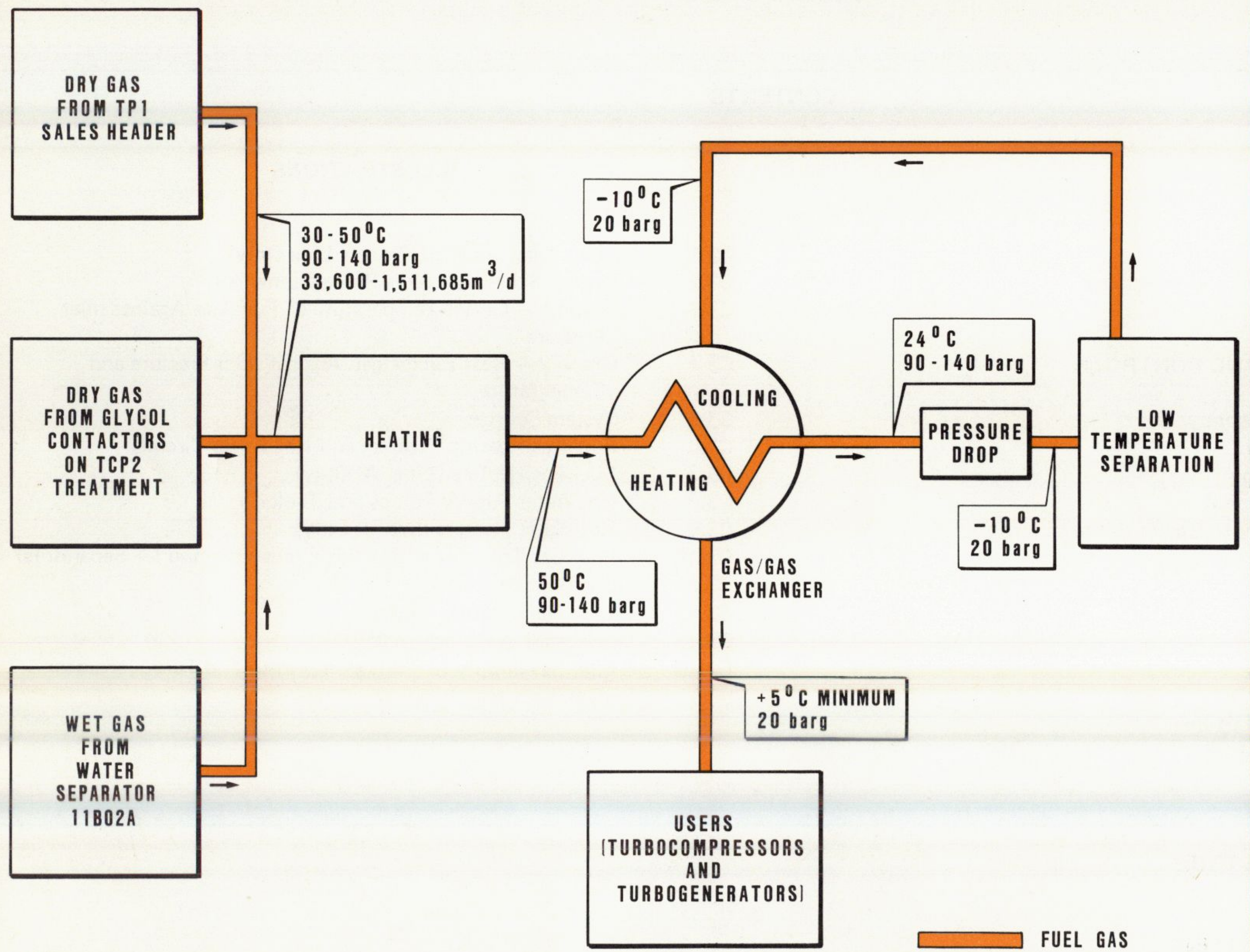
Compressor Line 'A'	Compressor Line 'B'	Compressor Line 'C'	Function
11TS50.1	11TS70.1	11TS60.1	Reservoir temperature low (2nd). (7kW heater ON/OFF.)
11TS58.2	11TS78.2	11TS68.2	Polluted seal oil reservoir temperature low (2nd). (2kW heaters ON/OFF.)

CHAPTER C3

FUEL GAS SYSTEM

CONTENTS

ILLUSTRATIONS


DRY GAS FROM TP1 SALES HEADER
DRY GAS FROM GLYCOL CONTACTORS ON TCP2 TREATMENT
WET GAS FROM WATER SEPARATOR 11B02A
30-50°C
90-140 barg
33,600-1,511,685m³/d
HEATING
50°C
90-140 barg
COOLING
HEATING
GAS/GAS EXCHANGER
-10°C
20 barg
24°C
90-140 barg
PRESSURE DROP
-10°C
20 barg
LOW TEMPERATURE SEPARATION
+5°C MINIMUM
20 barg
USERS (TURBOCOMPRESSORS AND TURBOGENERATORS)
FUEL GAS

SECTION 1 – DESCRIPTION

Reference: PID 5424W 50 0040 01
PF 5424W 50 0800 01.1 and 01.101

1 SUMMARY

See illustrations C3.1 and C3.2

1.1 The Gas Compression area Fuel Gas System is installed to provide treated fuel gas of the required specification (see Equipment Details, para 2.1) for the efficient operation of the gas turbines driving the gas compressors and power generators. The system also provides untreated gas for purging the LP vent. In the event of system failure, the gas turbine drivers can be supplied with cold fuel gas from the TCP2 Treatment area Fuel Gas System. This supply line is blanked and would only be used in exceptional circumstances.

1.2 The system comprises two identical lines (Line A and Line B) which operate with one line duty and the other at standby. Each line is fitted with the following equipment:

(a) Fuel Gas Heating Package.

(b) Gas/Gas Heat Exchanger.

(c) Fuel Gas Scrubber (Low Temperature Separator).

1.3 Gas supply to the Fuel Gas System can originate from the following sources (dependent on operational conditions):

(a) Dry gas from the TP1 sales gas header.

(b) Dry gas from the TCP2 Treatment area glycol contactors.

(c) Wet gas from Water Separator 11B02A.

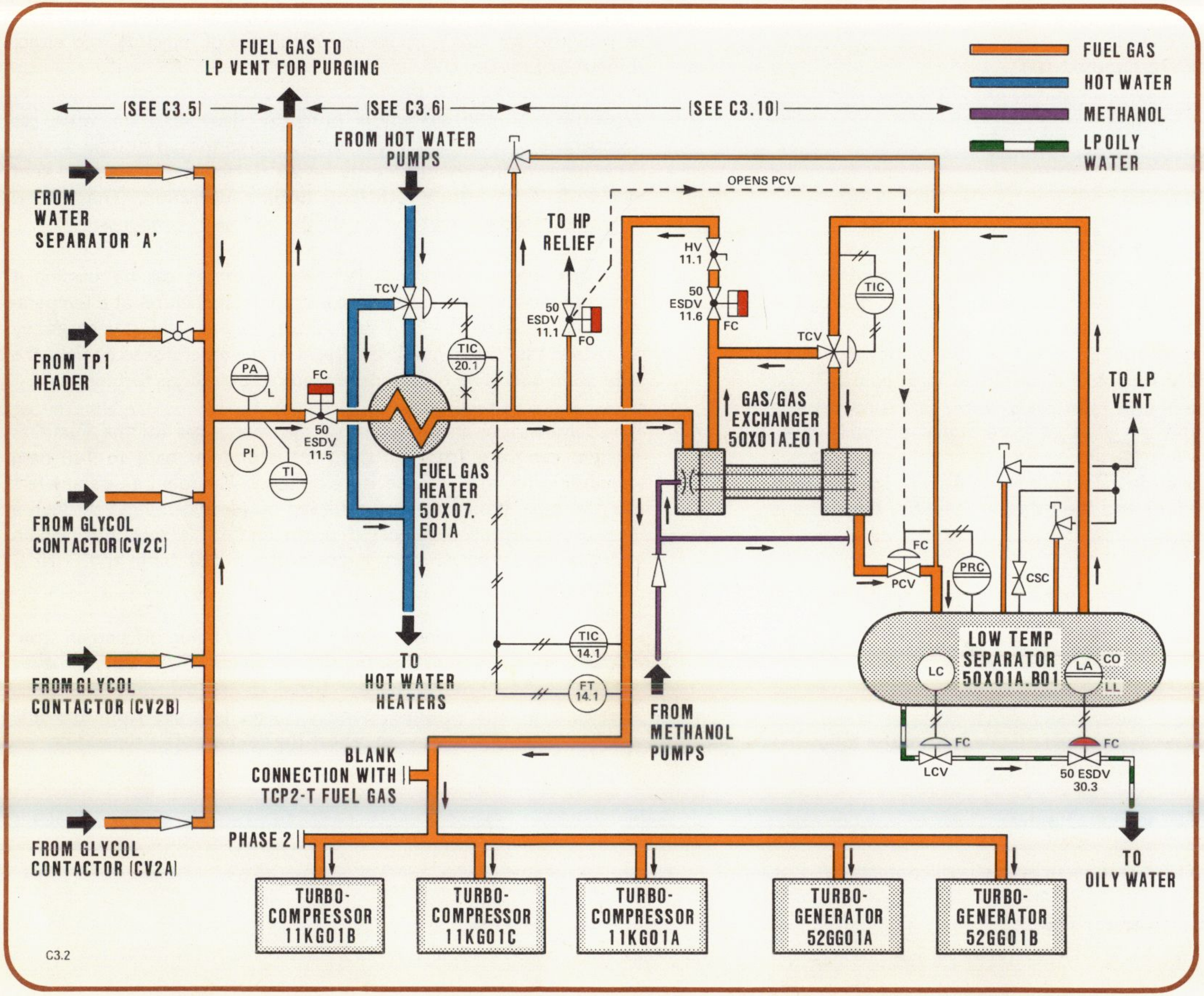
1.4 If wet gas is being used, it is necessary to inject methanol into the system to prevent hydrate formation. A Methanol Injection System is provided for this purpose and is capable of injecting into either Line A or Line B.

1.5 Operation of the system is primarily dependent on what gas temperature is achieved in the supply line to the gas turbine drivers. This temperature should ideally be 20°C. However, it must be kept above 5°C to ensure efficient turbine operation. The second important factor is that the gas should be free of condensate.

1.6 Hydrocarbon condensate is removed from the gas by passing it through the low temperature separator which operates at a temperature and pressure of –10°C and 20 barg respectively. It is necessary to reheat the 'dried' gas downstream of the separator to achieve the minimum operating temperature required by the gas turbines.

1.7 The temperature and pressure of the source gas for the Fuel Gas System can vary from 30°C to 50°C and 90 barg to 140 barg depending on what source is being used. The required parameters for the separation stage are achieved by passing the gas through a pressure control valve located upstream of the separator, which reduces the pressure and temperature to 20 barg and –10°C respectively.

1.8 As previously mentioned (para 1.6) the gas being discharged from the separator requires reheating to a minimum 5°C. This is achieved in the gas/gas heat exchanger fitted in the separator inlet line upstream of the pressure control valve. Hot gas from the line prior to separation is used to reheat the cold gas after separation.


FUEL GAS TO LP VENT FOR PURGING
(SEE C3.5)
(SEE C3.6)
(SEE C3.10)
FUEL GAS
HOT WATER
METHANOL
LP OILY WATER
FROM WATER SEPARATOR 'A'
FROM TP1 HEADER
FROM GLYCOL CONTACTOR (CV2C)
FROM GLYCOL CONTACTOR (CV2B)
FROM GLYCOL CONTACTOR (CV2A)
FROM HOT WATER PUMPS
TO HOT WATER HEATERS
TO HP RELIEF
OPENS PCV
TCV
PA
PI
TI
FC
50 ESDV 11.5
TIC 20.1
FUEL GAS HEATER 50X07. E01A
50 ESDV 11.1
FO
HV 11.1
50 ESDV 11.6
TIC
GAS/GAS EXCHANGER 50X01A.E01
TO LP VENT
PCV
PRC
CSC
LOW TEMP SEPARATOR 50X01A.B01
LC
LA
CO
LL
LCV
50 ESDV 30.3
TO OILY WATER
TIC 14.1
FT 14.1
FROM METHANOL PUMPS
BLANK CONNECTION WITH TCP2-T FUEL GAS
PHASE 2
TURBO-COMPRESSOR 11KG01B
TURBO-COMPRESSOR 11KG01C
TURBO-COMPRESSOR 11KG01A
TURBO-GENERATOR 52GG01A
TURBO-GENERATOR 52GG01B

1.9 Under operational conditions, it may well be found that the temperature differential between the aforementioned hot and cold gas is not sufficient to provide the heat exchange necessary to achieve the optimum temperature of 20°C required by the gas turbines. In this event, the hot gas will have to be further increased in temperature. This increase in hot gas temperature is achieved in the fuel gas heater.

1.10 The fuel gas heater utilises hot water to increase the gas temperature. The gas passes through the heater tubes, around which hot water is circulated. The required hot water temperature for the necessary heat exchange is maintained by thyristor controlled electric heaters. The thyristors are modulated in response to a temperature controller located in the fuel gas supply line to the gas turbines.

1.11 Each individual gas turbine supply line is fitted with its own knock-out pot and filters.

2 EQUIPMENT DETAILS

2.1 Fuel Gas Specification (at Users)

Pressure	–	20 barg
Dew-point	–	–10°C (in low temperature separator)
Temperature	–	+5°C minimum

2.2 Fuel Gas Heaters 50X07. E01A/B

Design pressure	–	Shell side – 6 barg Tube side – 171 barg
Operating pressure	–	Shell side – 2.5 barg Tube side – 149 to 90 barg
Design temperature	–	Shell side – 100°C Tube side – –20 to +100°C
Gas inlet operating temperature	–	30 to 50°C
Gas outlet operating temperature	–	See Graph No 1 (illustration C3.3) Required Outlet Temperature Against Inlet Pressure
Flow rate	–	Approx 36 600 to 1 500 000m^3/d
Differential pressure	–	1 bar
Heat exchanged per unit	–	See Graph No 2 (illustration C3.4) Heat Exchanged Against Inlet Pressure and Temperature (for a flow rate of 33 593m^3/d (1000kg/h))

2.3 Hot Water Pumps 50X07.P01A/B

Power supply	–	380V, 3-phase, 50Hz
Power consumption	–	15kW
Nominal flow	–	50 to 60m^3/h
Discharge pressure	–	2.5 barg
Discharge temperature	–	80°C

2.4 Electric Water Heaters 50X07.E02/03/04/05A/B

50X07.E02	–	Provided with two auto regulated electrical resistors of 112 and 128kW capacity each
50X07.E03/04/05	–	Provided with two manual/auto regulated electrical resistors of 112 and 128kW capacity each
Power supply	–	380V, 3-phase, 50Hz
Design temperature	–	–9 to +100°C
Design pressure	–	2.2 barg
Operating pressure	–	1.5 barg

2.5 **Methanol Pumps 50X01.P01A/B**

Power supply	—	380V, 3-phase, 50Hz
Power consumption	—	4kW
Discharge pressure	—	160 barg
Discharge flow	—	7.6 litres/h

2.6 **Methanol Tank 50X01.T01**

Capacity	—	1.5m^3
Design pressure	—	Atmospheric
Design temperature	—	Ambient

2.7 **Gas/Gas Exchangers 50X01A/B.E01**

Design temperature	—	Shell side — −20°C Tube side — 100°C
Operating temperature	—	Shell side In — −10°C Shell side Out —+20°C Tube side In — 50°C Tube side Out — 24°C
Design pressure	—	Shell side — 23 barg Tube side — 171 barg
Operating pressure	—	Shell side — 20 barg Tube side — 40 to 150 barg

2.8 **Low Temperature Separators 50X01A/B.B01**

Design pressure	—	23 barg
Operating pressure	—	20 barg
Operating temperature	—	−10°C
Design temperature	—	−20 to +60°C

2.9 **Fuel Gas Requirements of Gas Turbine Drivers**

2.9.1 **Turbogenerators**

Maximum fuel gas consumption of two turbogenerators on duty (assuming 14MW output):

140 000m^3/d (4166kg/h)

2.9.2 **Turbocompressors**

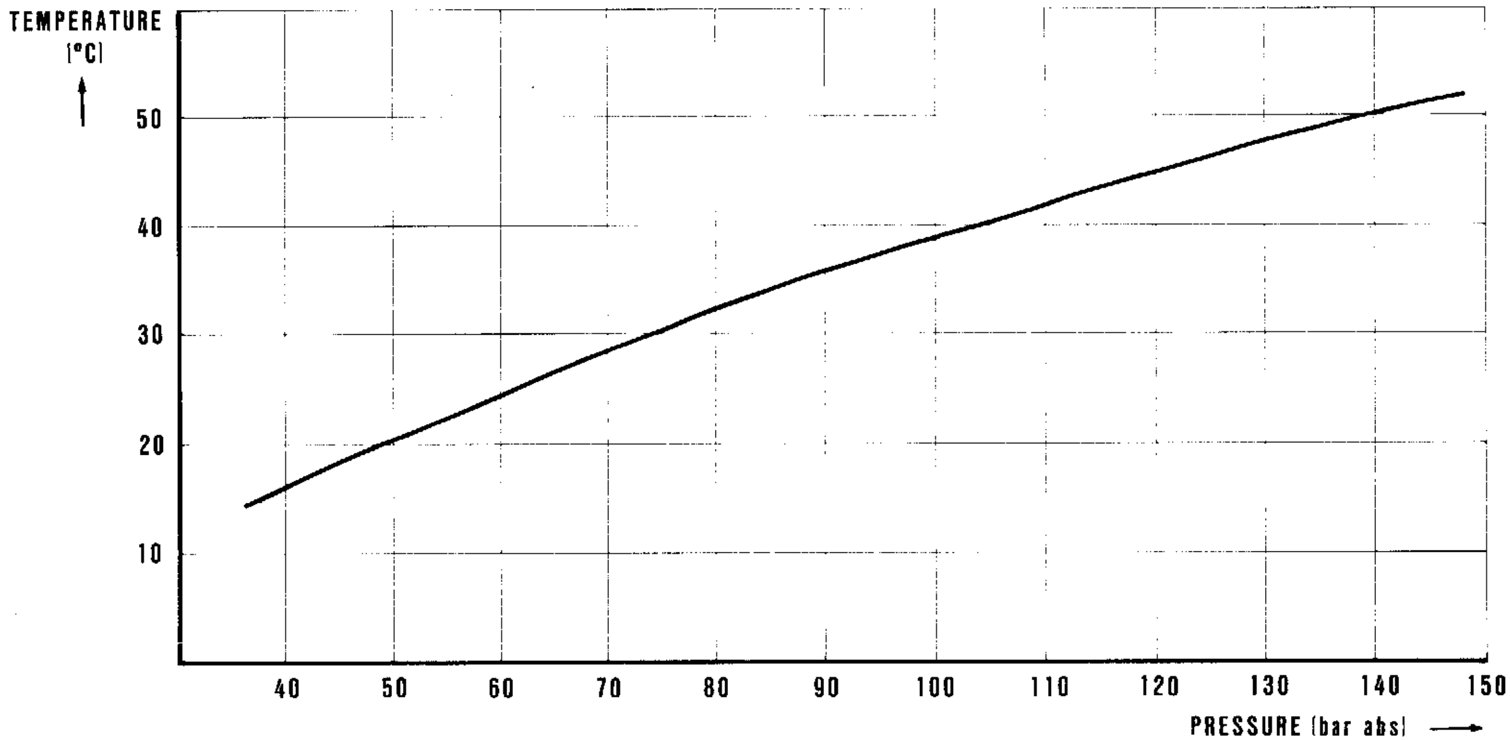
Maximum fuel gas consumption of two turbocompressors on duty:

550 000m^3/d (16 369kg/h)

2.9.3 **Output of Fuel Gas Treatment Unit**

Fuel gas output from fuel gas treatment unit (one stream on duty):

940 800m^3/d (28 000kg/h)


TEMPERATURE
(°C)
50
40
30
20
10
40
50
60
70
80
90
100
110
120
130
140
150
PRESSURE (bar abs)

3 EXTERNAL UTILITIES AND INTERFACES

3.1 External Utilities Required

(a) Electrical power – 380V and 220V ac
110V dc

(b) Instrument air.

(c) Fresh water/TEG for hot water system on fuel gas heaters.

(d) Methanol.

(e) Fire and gas detection.

(f) ESD System.

3.2 Interfaces

(a) LP Vent System.

(b) HP Relief System.

(c) Oily Water Recovery System.

(d) Open Drainage System.

(e) TP1 Sales Gas Header.

(f) Methanol System of TCP2 Treatment.

(g) Water Separator 11B02A.

(h) Gas Turbine Generators 52GG01A/B.

(j) Glycol Contactors CV2A/B/C in TCP2 Treatment.

SECTION 2 – OPERATION AND CONTROLS

1 OPERATING PHILOSOPHY

See illustrations C3.3 and C3.4

1.1 The ideal fuel gas temperature for efficient operation of the gas turbines is 20°C, the minimum being 5°C.

1.2 Having already taken into consideration, during the design stage, the required operating temperature and pressure inside the low temperature separator, and the known heat exchange in the gas/gas heat exchanger, the following factors affect the achievement of the required 20°C gas temperature to the users:

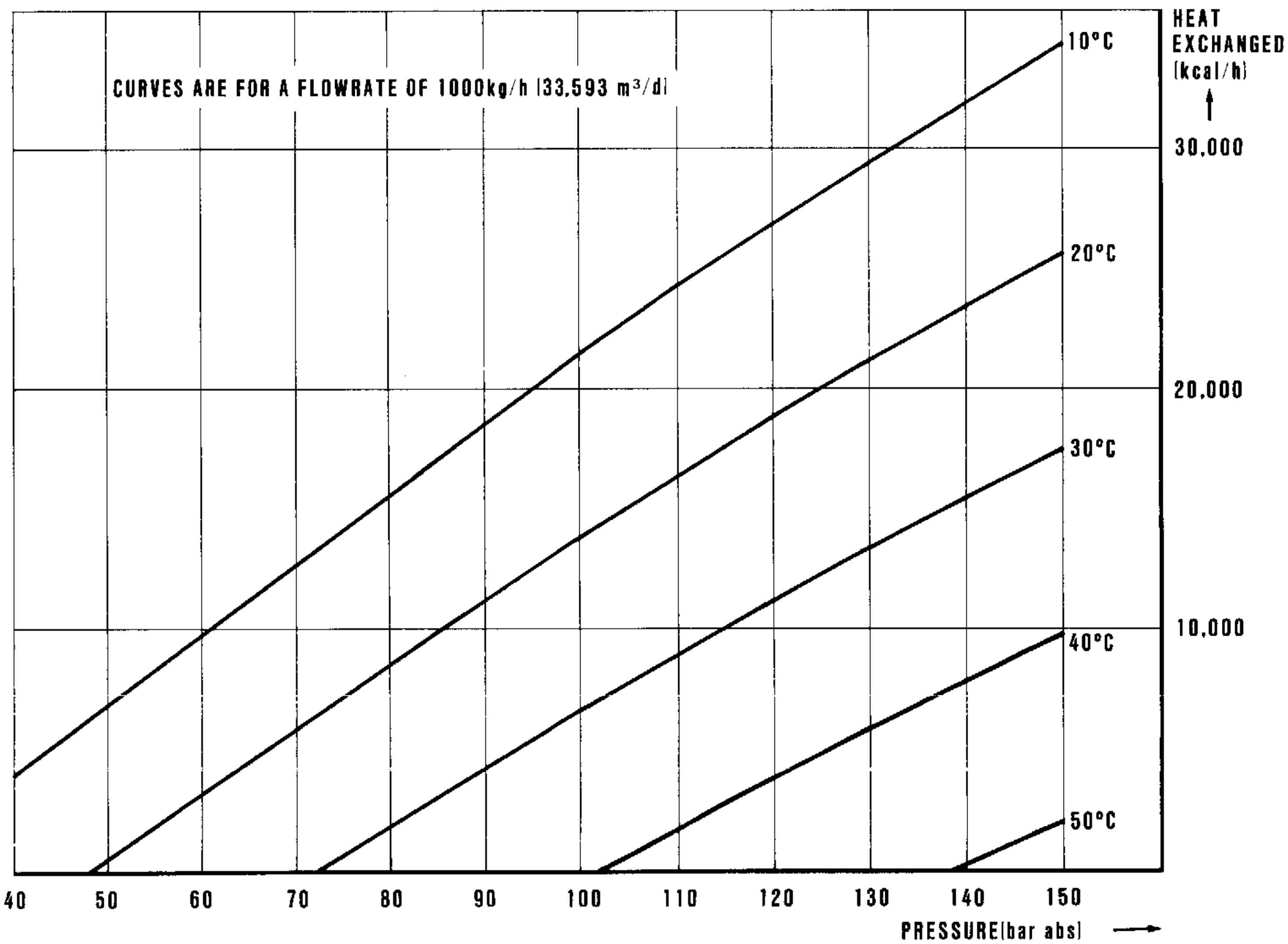
(a) Inlet pressure of the source gas.

(b) Inlet temperature of the source gas.

(c) Consumption rate of the users (system flow rate).

(d) Heat exchange inside the fuel gas heater.

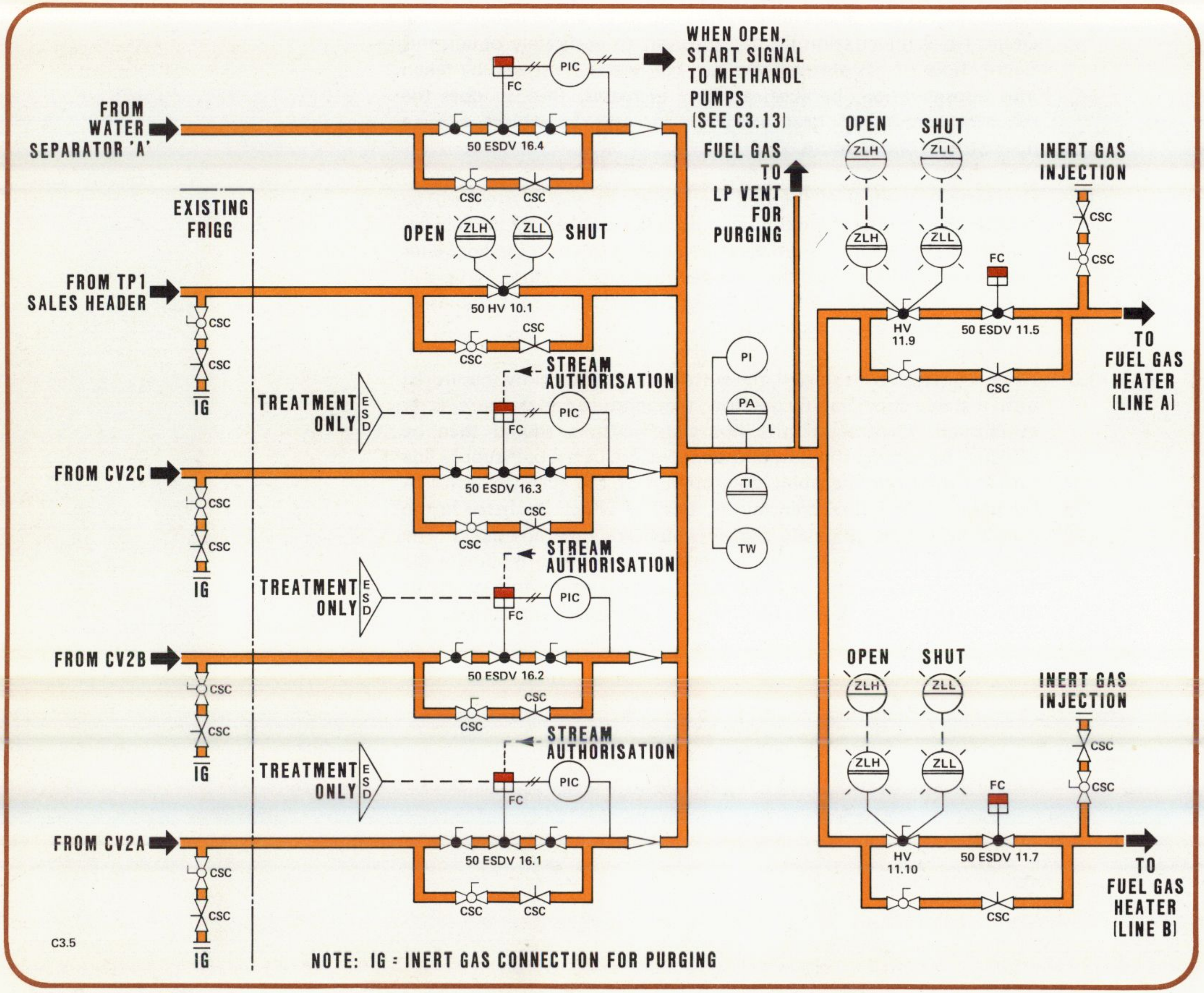
1.3 By consulting Graph No 1 (illustration C3.3) it can be seen that if, for example, the source gas pressure is 90 barg, then the required gas temperature downstream of the fuel gas heater is 35°C. Let us now presume that the source gas temperature is already 35°C or greater. In this event, it can be seen that it would not be necessary to use the fuel gas heater to boost the gas temperature unless it is found that for some reason the user supply temperature is still not within its design specifications. If, however, a second condition is considered, ie a source gas pressure of 90 barg at a temperature of 20°C, it can now be seen from Graph No 1 that the required temperature downstream of the fuel gas heater is still 35°C for an inlet pressure of 90 barg. Therefore the fuel gas heaters will be required to boost the gas temperature from 20°C to 35°C.


CURVES ARE FOR A FLOWRATE OF 1000kg/h (33,593 m³/d)
10°C
20°C
30°C
40°C
50°C
HEAT EXCHANGED (kcal/h)
30,000
20,000
10,000
40
50
60
70
80
90
100
110
120
130
140
150
PRESSURE(bar abs)

1.4 The necessary heat exchange required inside the fuel gas heater for a specific increase in gas temperature can be obtained by consulting Graph No 2 (illustration C3.4). However, to accurately obtain this figure, flow of gas through the fuel gas heater must also be taken into consideration, because, as flow increases, then so does the required amount of heat exchange increase to achieve a given downstream temperature.

1.5 On start-up, control of the fuel gas heater hot water system will be effected by sensing the gas temperature downstream of the fuel gas heater and modulating a temperature control valve on the hot water line accordingly to achieve the required temperature. This will initially be done manually but, when the temperature is stabilised, automatic control can be selected.

1.6 When a gas turbine is started, the system should be rigidly monitored until a stable condition (ie gas flow, temperature and pressure) is re-established. Control of the hot water system should then be effected by sensing the flow and temperature in the user supply line rather than from the point downstream of the fuel gas heater. A temperature and flow transmitter, both of which are fitted in the user supply line, originate signals which are then compared. The signal thus derived from the comparator is used to modulate the temperature control valve on the hot water system, to increase or decrease hot water flow through the fuel gas heater as required.


WHEN OPEN, START SIGNAL TO METHANOL PUMPS (SEE C3.13)
PIC
FC
FROM WATER SEPARATOR 'A'
50 ESDV 16.4
CSC
CSC
EXISTING FRIGG
OPEN
ZLH
ZLL
SHUT
FROM TP1 SALES HEADER
50 HV 10.1
CSC
STREAM AUTHORISATION
TREATMENT ONLY
ESD
IG
FROM CV2C
50 ESDV 16.3
FROM CV2B
50 ESDV 16.2
FROM CV2A
50 ESDV 16.1
FUEL GAS TO LP VENT FOR PURGING
PI
PA
L
TI
TW
INERT GAS INJECTION
HV 11.9
50 ESDV 11.5
TO FUEL GAS HEATER (LINE A)
HV 11.10
50 ESDV 11.7
TO FUEL GAS HEATER (LINE B)
C3.5
NOTE: IG = INERT GAS CONNECTION FOR PURGING

2 SYSTEM SOURCES

See illustration C3.5

2.1 Summary of Sources

2.1.1 As previously stated, the Fuel Gas System can be operated with gas from the following alternative sources:

(a) Dry gas from the TP1 sales gas header.

(b) Dry gas from the TCP2 Treatment area glycol contactors.

(c) Wet gas from Water Separator 11B02A.

2.1.2 The controls and indicators provided on the various source lines are summarised in succeeding paragraphs.

2.2 TP1 Sales Gas Header Source Line

2.2.1 This line is fitted with a single hand valve. The status of the valve is indicated in TCP2–C Control Room by illuminated OPEN or SHUT lamps.

2.2.2 The hand valve has a bypass line, the block valves of which are car-sealed closed during normal operation.

2.3 TCP2–T Glycol Contactor and Water Separator 11B02A Source Lines

2.3.1 ESDV's are fitted on each of the main inlet lines; these can be operated manually.

2.3.2 Each ESDV has a bypass line, the block valves of which are car-sealed closed during normal operation.

2.3.3 The ESDV's are each controlled by individual PIC's. The relevant controller closes the valve if the downstream pressure falls below a preset value.

2.3.4 In the case of the TCP2–T glycol contactor source ESDV's, their signals for valve closure during an emergency originate from the TCP2 Treatment area. (Treatment process fault or stream shut-down.)

2.3.5 When the ESDV on the water separator 11B02A source line is initially opened, its controlling PIC sends a START signal to the duty methanol pump.

2.3.6 All four source lines are fitted with check valves downstream of the ESDV's.

2.4 Common Supply Header and Lines to Fuel Gas Heaters

2.4.1 The common header from the source lines is fitted with:

(a) A local pressure indicator.

(b) A remote temperature indicator, located in TCP2–C Control Room.

(c) A local thermowell.

2.4.2 The inlet lines to the fuel gas heaters on lines A and B are fitted with a hand valve which has remote status indication (OPEN or SHUT) in both TCP2–C and QP Control Rooms.

2.4.3 Downstream of each of these hand valves there is an ESD valve (that can be operated manually) which will be closed either by an ESD signal or by the following signals:

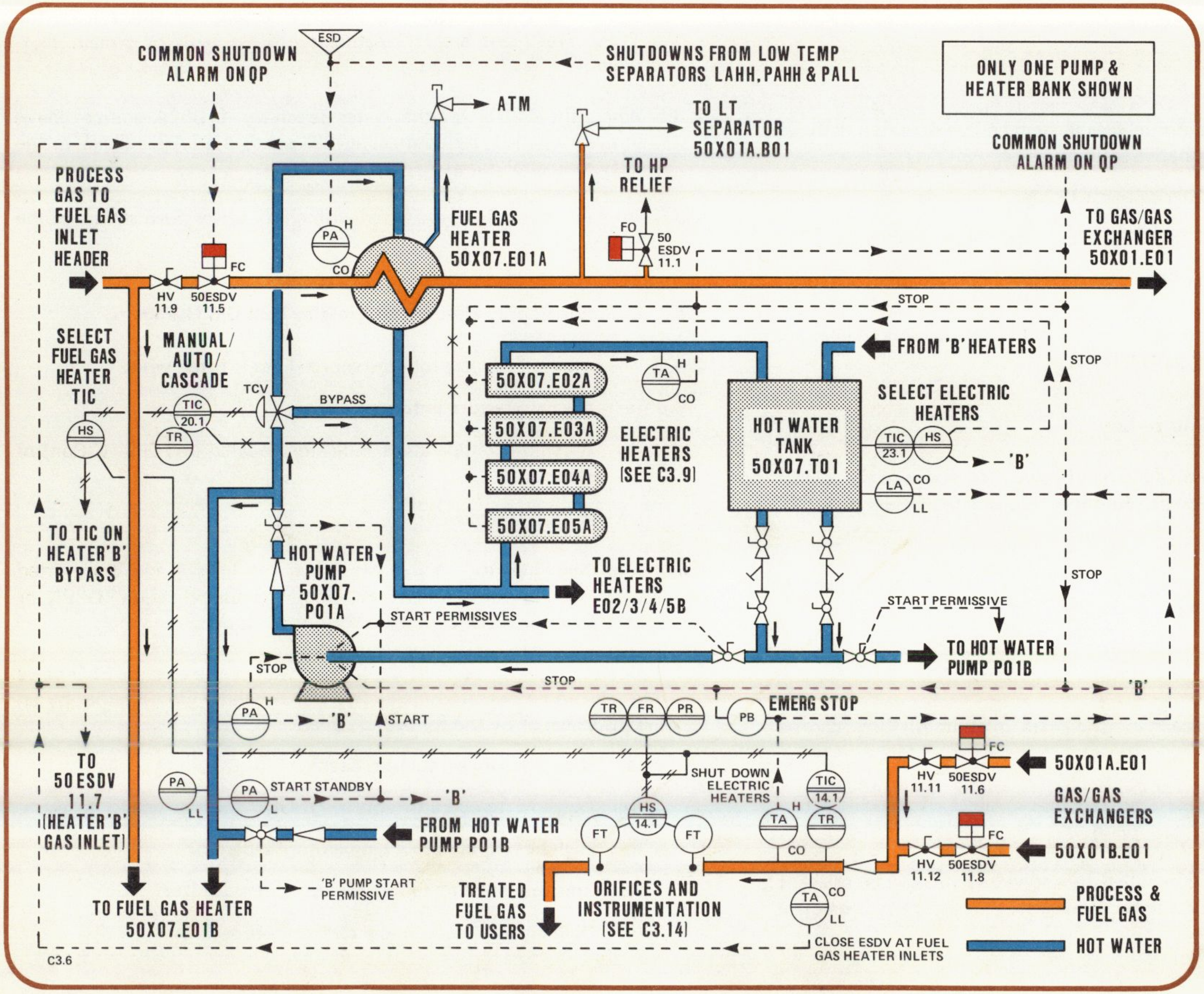
(a) High pressure on fuel gas heater.

(b) Low-low temperature on the treated fuel gas header to users.

(c) High-high level in low temperature separator.

(d) Low-low pressure in low temperature separator.

(e) High-high pressure in low temperature separator.


COMMON SHUTDOWN ALARM ON QP
ESD
SHUTDOWNS FROM LOW TEMP SEPARATORS LAHH, PAHH & PALL
ONLY ONE PUMP & HEATER BANK SHOWN
ATM
TO LT SEPARATOR 50X01A.B01
TO HP RELIEF
COMMON SHUTDOWN ALARM ON QP
PROCESS GAS TO FUEL GAS INLET HEADER
FUEL GAS HEATER 50X07.E01A
TO GAS/GAS EXCHANGER 50X01.E01
HV 11.9
50ESDV 11.5
FC
FO
50 ESDV 11.1
STOP
SELECT FUEL GAS HEATER TIC
MANUAL/ AUTO/ CASCADE
TCV
BYPASS
TIC 20.1
TR
HS
FROM 'B' HEATERS
50X07.E02A
50X07.E03A
50X07.E04A
50X07.E05A
ELECTRIC HEATERS (SEE C3.9)
HOT WATER TANK 50X07.T01
SELECT ELECTRIC HEATERS
TIC 23.1
LA
'B'
TO TIC ON HEATER 'B' BYPASS
HOT WATER PUMP 50X07. P01A
TO ELECTRIC HEATERS E02/3/4/5B
START PERMISSIVES
START PERMISSIVE
TO HOT WATER PUMP P01B
STOP
EMERG STOP
PA
PB
TR FR PR
START
SHUT DOWN ELECTRIC HEATERS
TO 50ESDV 11.7 (HEATER 'B' GAS INLET)
START STANDBY
FROM HOT WATER PUMP P01B
HS 14.1
FT
TIC 14.1
TA
50X01A.E01
GAS/GAS EXCHANGERS
50X01B.E01
HV 11.11
50ESDV 11.6
HV 11.12
50ESDV 11.8
'B' PUMP START PERMISSIVE
TO FUEL GAS HEATER 50X07.E01B
TREATED FUEL GAS TO USERS
ORIFICES AND INSTRUMENTATION (SEE C3.14)
CLOSE ESDV AT FUEL GAS HEATER INLETS
PROCESS & FUEL GAS
HOT WATER
C3.6

3 FUEL GAS HEATING

See illustrations C3.6, C3.7, C3.8 and C3.9

3.1 Heating Circuit

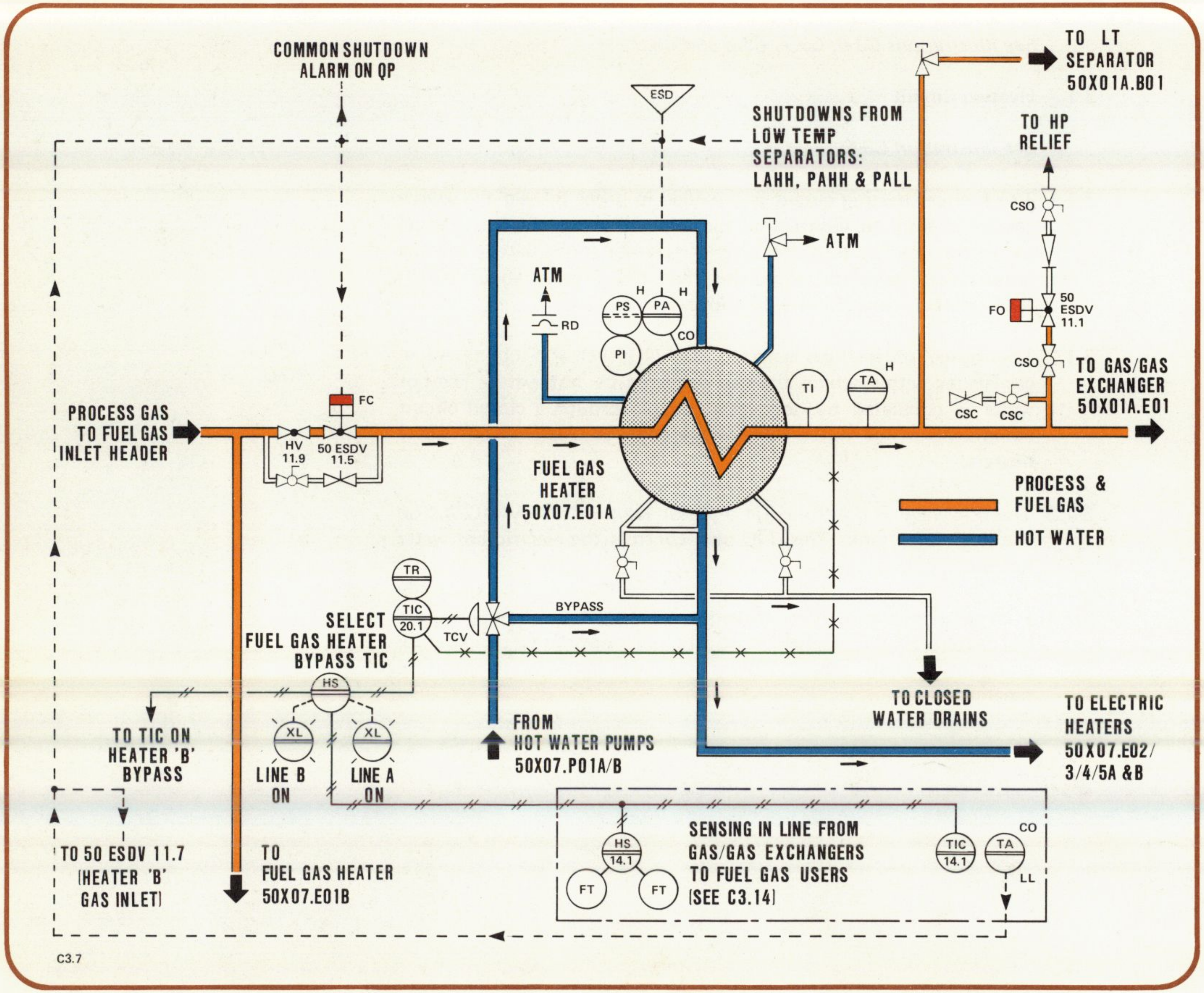
See illustration C3.6

3.1.1 The fuel gas heating circuit is provided in order to heat the source gas sufficiently to ensure that the temperature of the treated fuel gas to the user gas turbines, after removal of condensate in the low temperature separator, is greater than 5°C (ideally about 20°C); see Section 1, para 1.5 to 1.10 above.

3.1.2 The source (process) gas is passed through a shell-and-tube type fuel gas heater within which the gas is heated by hot water. The hot water is circulated by hot water pumps through a closed circuit comprising a hot water tank and a bank of electrical hot water heaters.

3.1.3 The hot water is controlled at a preset temperature by TIC23.1 on the hot water tank. This TIC also controls the electric hot water heaters.

3.1.4 Fuel gas temperature is controlled by TICV20.1 which bypasses the hot water around the fuel gas heater, in response to temperature and flow signals sensed downstream of the low temperature separator.


COMMON SHUTDOWN ALARM ON QP
ESD
SHUTDOWNS FROM LOW TEMP SEPARATORS: LAHH, PAHH & PALL
TO LT SEPARATOR 50X01A.B01
TO HP RELIEF
CSO
ATM
ATM
RD
PS
PA
H
H
CO
PI
FO
50 ESDV 11.1
CSO
TO GAS/GAS EXCHANGER 50X01A.E01
TI
TA
H
CSC
CSC
FC
PROCESS GAS TO FUEL GAS INLET HEADER
HV 11.9
50 ESDV 11.5
FUEL GAS HEATER 50X07.E01A
PROCESS & FUEL GAS
HOT WATER
TR
TIC 20.1
SELECT FUEL GAS HEATER BYPASS TIC
TCV
BYPASS
HS
XL
XL
TO TIC ON HEATER 'B' BYPASS
LINE B ON
LINE A ON
FROM HOT WATER PUMPS 50X07.P01A/B
TO CLOSED WATER DRAINS
TO ELECTRIC HEATERS 50X07.E02/3/4/5A &B
TO 50 ESDV 11.7 (HEATER 'B' GAS INLET)
TO FUEL GAS HEATER 50X07.E01B
HS 14.1
FT
FT
SENSING IN LINE FROM GAS/GAS EXCHANGERS TO FUEL GAS USERS (SEE C3.14)
TIC 14.1
TA
CO
LL

C3.7

3.2 **Fuel Gas Heaters (50X07.E01A/B)**

See illustration C3.7

3.2.1 Each fuel gas heater is fitted with the following controls and indicators:

(a) Local gas inlet pressure indicator located on the heater inlet.

(b) Remote pressure alarm (high) located on the TCP2 control panel.

(c) Local gas discharge temperature indicator located on the heater outlet.

(d) Remote hot water temperature alarm (high) located on the TCP2 control panel.

(e) A pressure safety valve fitted on the hot water line which opens should the pressure reach 6 barg.

(f) A rupture disc on the hot water line which bursts at a pressure of 6.5 barg.

3.2.2 Temperature control valve TCV20.1 is fitted on the hot water inlet to the heater. This valve is modulated by TIC20.1 which has three operating positions marked MANUAL/AUTO/CASCADE. When positioned at MANUAL, the controller is manually operated to modulate TCV20.1 as required. When positioned at AUTO, the controller senses the downstream gas temperature and automatically modulates TCV20.1 to maintain a preset gas temperature. When set at CASCADE the controller is bypassed by a resulting signal originating from one of two flow transmitters FT14.1 (two different flow ranges) and a single temperature transmitter, all of which are located in the fuel gas user supply line. (See C3.14).

3.2.3 Temperature transmitter TT14.1 has two positions marked MANUAL and AUTO. When positioned at MANUAL, TCV20.1 can be modulated (providing that TIC20.1 on the fuel gas heater is positioned at CASCADE) to achieve the required **user** temperature rather than the temperature downstream of the fuel gas heater. When positioned at AUTO (also providing that the aforementioned CASCADE position is selected on TIC20.1) TCV20.1 will be automatically modulated to maintain the preset required user temperature.

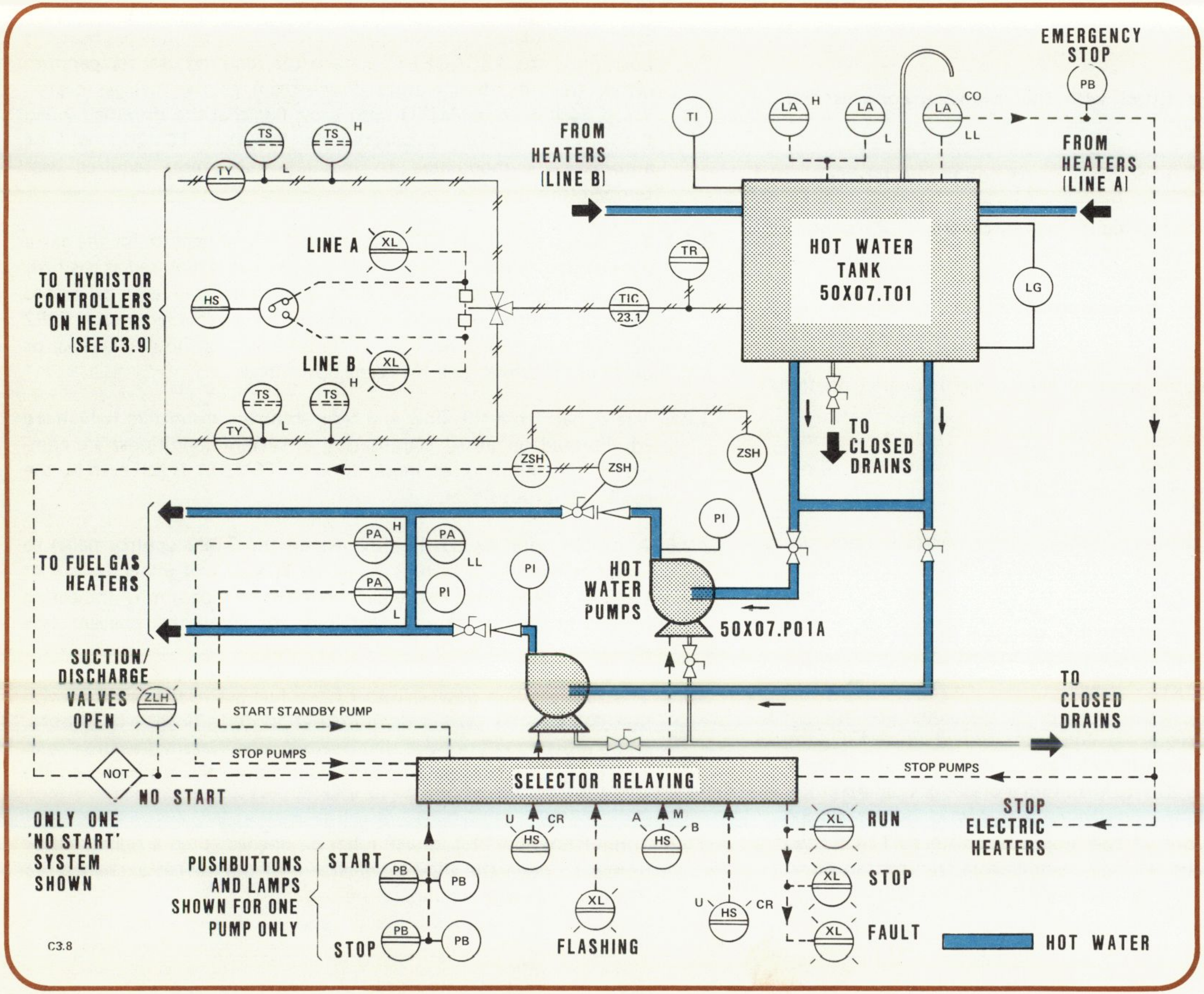
3.2.4 The flow transmitters FT14.1 are fitted to compensate for the extra heat exchange inside the fuel gas heater that is required as gas flow through them increases. Two transmitters are fitted, each calibrated for a different flow range. A hand selector is provided on the TCP2 control panel to switch over transmitters as flow increases or decreases between their different flow ranges.

3.2.5 The signals from the flow and temperature transmitters (which are equilibrated on initial stabilisation of system conditions) are compared, and the required modulation of TCV20.1 is achieved by the resulting output signal.

3.2.6 A further hand switch is provided on the TCP2 control panel to divert the resultant output signal to TCV20.1 of either Line A or Line B, depending on which one is in operation. Indicating lamps on the panel will illuminate to show the relevant line selection.

3.2.7 The fuel gas line downstream of the fuel gas heater is fitted with 50ESDV11.1 for system depressurisation under adverse conditions, and a pressure safety valve that opens should system pressure rise to 171 barg. In the event of overpressurisation, the gas passes to the low temperature separator.

3.2.8 Should 50ESDV11.1 to HP relief be opened, then a signal will be passed to open the PCV downstream of the gas/gas exchanger, to depressurise the low temperature separator.


EMERGENCY STOP
PB
TI
LA H
LA L
LA CO LL
FROM HEATERS (LINE B)
FROM HEATERS (LINE A)
TS L
TS H
TY
LINE A
XL
TR
HOT WATER TANK 50X07.T01
LG
TO THYRISTOR CONTROLLERS ON HEATERS (SEE C3.9)
HS
TIC 23.1
LINE B
XL
TS L
TS H
TY
TO CLOSED DRAINS
ZSH
ZSH
ZSH
PI
TO FUEL GAS HEATERS
PA H
PA LL
PA L
PI
PI
HOT WATER PUMPS
50X07.P01A
SUCTION/ DISCHARGE VALVES OPEN
ZLH
START STANDBY PUMP
STOP PUMPS
TO CLOSED DRAINS
NOT
NO START
SELECTOR RELAYING
STOP PUMPS
ONLY ONE 'NO START' SYSTEM SHOWN
U HS CR
A HS M B
XL RUN
STOP ELECTRIC HEATERS
PUSHBUTTONS AND LAMPS SHOWN FOR ONE PUMP ONLY
START
PB
PB
STOP
PB
PB
XL
FLASHING
U HS CR
XL STOP
XL FAULT
HOT WATER
C3.8

3.3 Hot Water Supply Pumps and Tank

See illustration C3.8

3.3.1 Hot Water Supply Pumps (50X07.P01A/B)

(a) Both pumps are fitted with the following controls and indicators:

(i) LOCAL/CONTROL ROOM start selector hand switches located on the TCP2 control panel.

(ii) START and STOP pushbuttons local to the pumps.

(iii) Remote START and STOP pushbuttons located on the TCP2 control panel.

(iv) Remote STOP, RUN and FAULT indicator lamps located on the TCP2 control panel.

(b) The pumps have a three-position hand switch located on the TCP2 control panel. The positions are marked A STAND-BY, MANUAL, and B STAND-BY and determine whether the duty and standby pumps start automatically or whether they can be started manually either from the local position or the Control Room.

(c) Under normal operation the hand switch will be set on B STAND-BY. With pump A running, the standby pump will only start if a low pressure is sensed at the discharge of the operating pump (1 barg).

(d) If MANUAL is selected or the standby pump starts, an illuminated flashing lamp lights up in TCP2 Control Room.

(e) Both pumps can only be started if valves on the suction and discharge side of the pumps are open. A READY TO START lamp illuminates in TCP2 Control Room when the valves are open.

(f) A local pushbutton can be used to stop the duty pump in an emergency. The same pushbutton also stops the resistors on the duty electrical water heaters.

(g) The discharge lines from the pumps are fitted with a pressure indicator local to the pumps and also a common pressure sensing manifold. This manifold is fitted with a pressure indicator and low, low-low and high pressure switches and alarms. The low pressure alarm annunciates in TCP2 Control Room and causes the standby pump to start. The low-low pressure alarm annunciates in TCP2 Control Room. The high pressure alarm annunciates in TCP2 Control Room and will cause automatic shutdown of the pumps.

3.3.2 **Hot Water Tank (50X07.T01)**

(a) The tank acts as the supply source for the hot water pumps. Fresh water/TEG is used for make-up and enters the system through electrical heaters 50X07.E03A/B.

(b) A level gauge is fitted and the following level switches:

(i) Low

(ii) Low-low

(iii) High

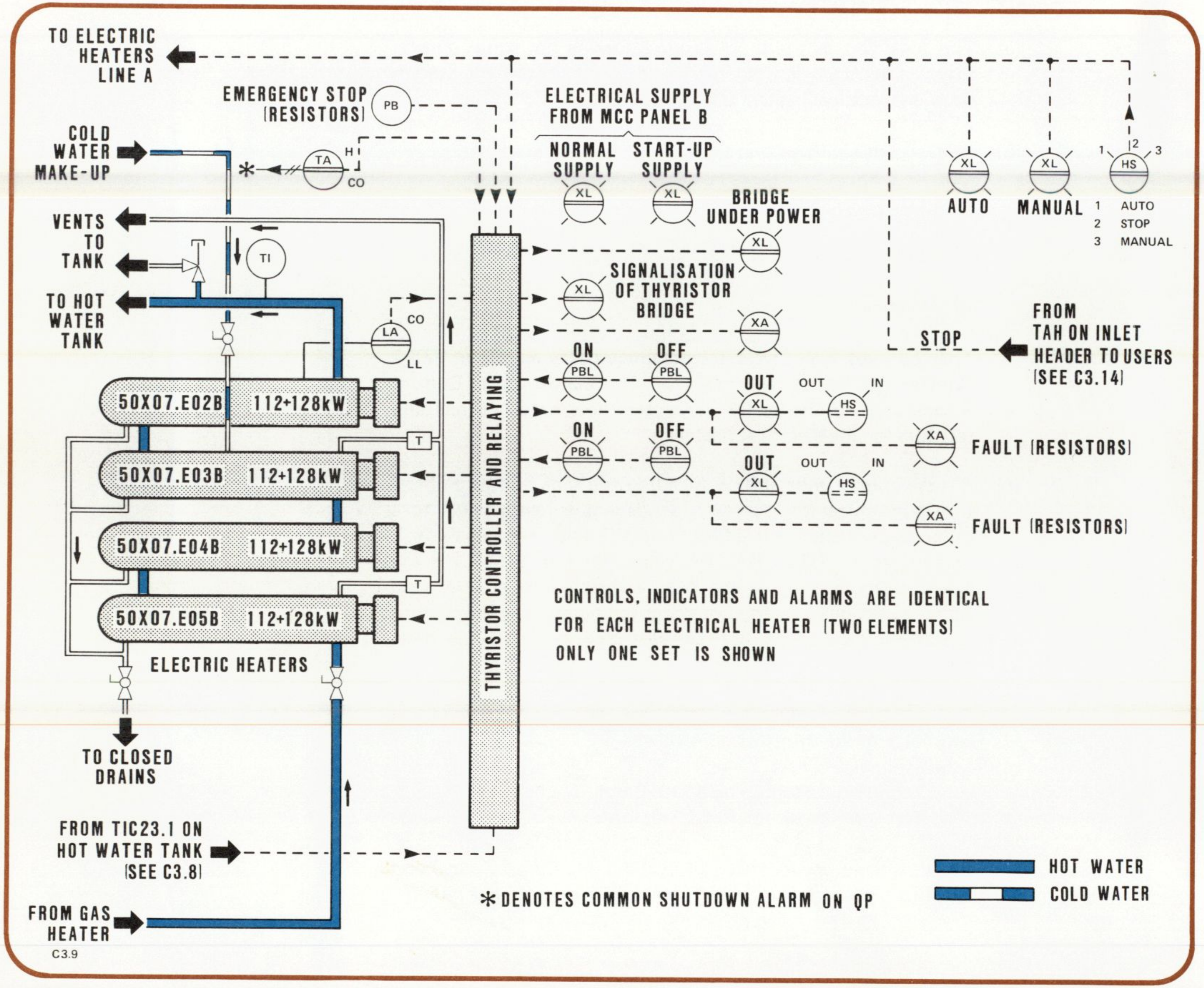
The low and high levels are annunciated as alarms in TCP2 Control Room. The low-low level also alarms in the Control Room and automatically stops the hot water pumps and resistors for the electrical heaters.

(c) A temperature indicator is fitted to the tank and a temperature transmitter on the tank sends a pneumatic signal to a temperature recorder in TCP2 Control Room. The same signal, maintained at 200 to 1000mb, passes through TIC23.1 in the Control Room and, having been converted to an electrical signal, maintains a steady hot water temperature at the fuel gas heater inlets by acting on the thyristor controllers of electrical heaters.

(d) Two switches are fitted in the pneumatic line from the three-way valve to the thyristor controllers:

Temperature switch high (1000mb).
Temperature switch low (200mb).

Both switches are located within the TCP2 control panel and serve to prevent saturation of the thyristor controller circuits.


TO ELECTRIC HEATERS LINE A
EMERGENCY STOP (RESISTORS)
PB
COLD WATER MAKE-UP
TA
H
CO
*
ELECTRICAL SUPPLY FROM MCC PANEL B
NORMAL SUPPLY
START-UP SUPPLY
XL
BRIDGE UNDER POWER
VENTS TO TANK
TI
TO HOT WATER TANK
LA
CO
LL
SIGNALISATION OF THYRISTOR BRIDGE
XA
AUTO
MANUAL
HS
1
2
3
1 AUTO
2 STOP
3 MANUAL
STOP
FROM TAH ON INLET HEADER TO USERS (SEE C3.14)
ON
OFF
PBL
OUT
IN
FAULT (RESISTORS)
50X07.E02B 112+128kW
50X07.E03B 112+128kW
50X07.E04B 112+128kW
50X07.E05B 112+128kW
T
THYRISTOR CONTROLLER AND RELAYING
ELECTRIC HEATERS
CONTROLS, INDICATORS AND ALARMS ARE IDENTICAL FOR EACH ELECTRICAL HEATER (TWO ELEMENTS) ONLY ONE SET IS SHOWN
TO CLOSED DRAINS
FROM TIC23.1 ON HOT WATER TANK (SEE C3.8)
FROM GAS HEATER
* DENOTES COMMON SHUTDOWN ALARM ON QP
HOT WATER
COLD WATER
C3.9

3.4 **Hot Water Heaters**

See illustration C3.9

3.4.1 The electrical hot water heaters heat the fresh water circulating in the fuel gas heater circuit. The electrical heaters are sited in the return line from the fuel gas heater, before the hot water tank and hot water supply pumps.

3.4.2 Two parallel banks of electrical heaters are installed (Line A and Line B). Each heating bank (or 'line') consists of four water heaters piped in series. Each water heater contains a pair of heating resistors (112 + 128kW; total 240kW), all of which may be controlled automatically by a thyristor controller and relay panel. When in manual control, one water heater is still controlled automatically by the thyristor control panel but the other three must be selected manually. Line A will normally be duty, with Line B at standby. All controls and indications are in TCP2 Control Room unless otherwise stated.

3.4.3 The following controls and indicators are common to both water heater lines:

(a) Hand switch for selection of either Line A or Line B water heaters.

(b) A common Emergency Stop pushbutton (local) for the hot water supply pumps and all water heaters.

(c) Hand switch (AUTO/STOP/MANUAL) for selection of mode of operation. When switched to AUTO, all resistors in all water heaters will be controlled by their respective thyristor control panel, in response to signals from fuel gas temperature sensors. When switched to MANUAL, the resistors of one water heater only will still be controlled automatically; all other water heater resistors must be selected ON or OFF by manual pushbutton.

(d) MANUAL and AUTO lamps associated with the mode hand switch mentioned in (c) above.

3.4.4 The following controls and indicators are provided for each water heater line:

(a) Two indicator lamps showing the power supply available from MCC 'B', ie NORMAL or START-UP.

(b) An indicator lamp showing that power is on to the thyristor bridge.

(c) An indicator lamp showing 'signalisation' from the thyristor bridge, ie control signals being generated.

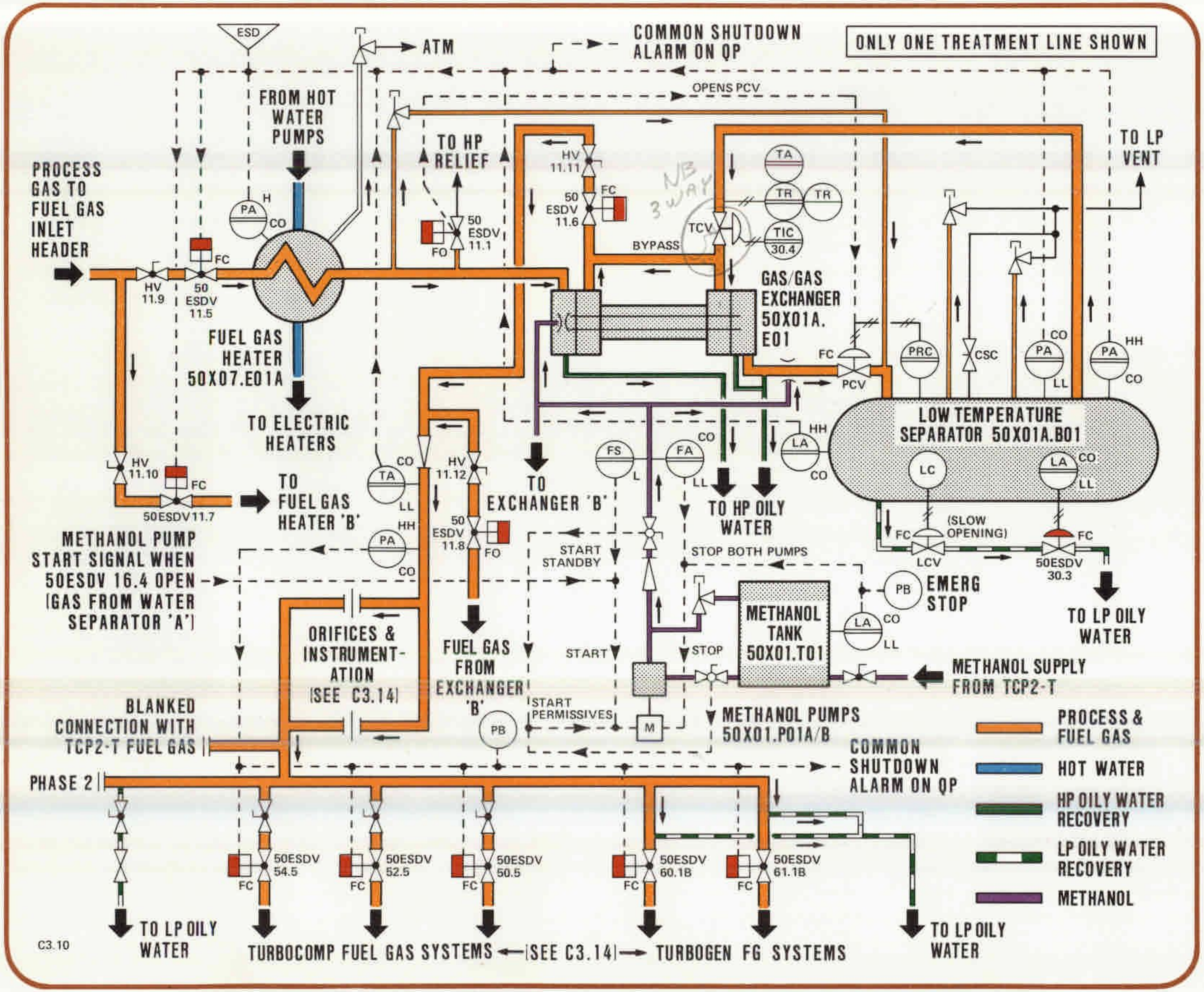
(d) An alarm lamp.

3.4.5 The following controls and indicators are provided for each of the three water heaters which can be controlled manually (see paragraph 3.4.4(c)):

(a) A hand switch (OUT/IN) mounted inside the TCP2 control panel, and associated OUT indicator lamp for each of the resistors.

(b) Two combined pushbutton/lamps (ON and OFF) for each resistor. This allows for manual control, or indication of resistor operation when under automatic control.

(c) A RESISTOR FAULT lamp for each resistor.


ESD
ATM
COMMON SHUTDOWN ALARM ON QP
ONLY ONE TREATMENT LINE SHOWN
OPENS PCV
FROM HOT WATER PUMPS
TO HP RELIEF
TO LP VENT
PROCESS GAS TO FUEL GAS INLET HEADER
HV 11.9
50 ESDV 11.5
FC
PA
H
CO
FUEL GAS HEATER 50X07.E01A
TO ELECTRIC HEATERS
50 ESDV 11.1
FO
HV 11.11
50 ESDV 11.6
BYPASS
TCV
TA
TR
TIC 30.4
NB 3 WAY
GAS/GAS EXCHANGER 50X01A. E01
PCV
PRC
CSC
LL
HH
LOW TEMPERATURE SEPARATOR 50X01A.B01
LC
LA
HV 11.10
50ESDV11.7
TO FUEL GAS HEATER 'B'
TA
HV 11.12
50 ESDV 11.8
TO EXCHANGER 'B'
FS
FA
TO HP OILY WATER
LCV
(SLOW OPENING)
50ESDV 30.3
TO LP OILY WATER
METHANOL PUMP START SIGNAL WHEN 50ESDV 16.4 OPEN (GAS FROM WATER SEPARATOR 'A')
START STANDBY
STOP BOTH PUMPS
PB
EMERG STOP
METHANOL TANK 50X01.T01
STOP
START
ORIFICES & INSTRUMENT-ATION (SEE C3.14)
FUEL GAS FROM EXCHANGER 'B'
METHANOL SUPPLY FROM TCP2-T
START PERMISSIVES
M
METHANOL PUMPS 50X01.P01A/B
BLANKED CONNECTION WITH TCP2-T FUEL GAS
PHASE 2
COMMON SHUTDOWN ALARM ON QP
PROCESS & FUEL GAS
HOT WATER
HP OILY WATER RECOVERY
LP OILY WATER RECOVERY
METHANOL
50ESDV 54.5
50ESDV 52.5
50ESDV 50.5
50ESDV 60.1B
50ESDV 61.1B
TO LP OILY WATER
TURBOCOMP FUEL GAS SYSTEMS ←(SEE C3.14)→ TURBOGEN FG SYSTEMS
TO LP OILY WATER
C3.10

4 FUEL GAS TREATMENT

See illustrations C3.10, C3.11, C3.12 and C3.13

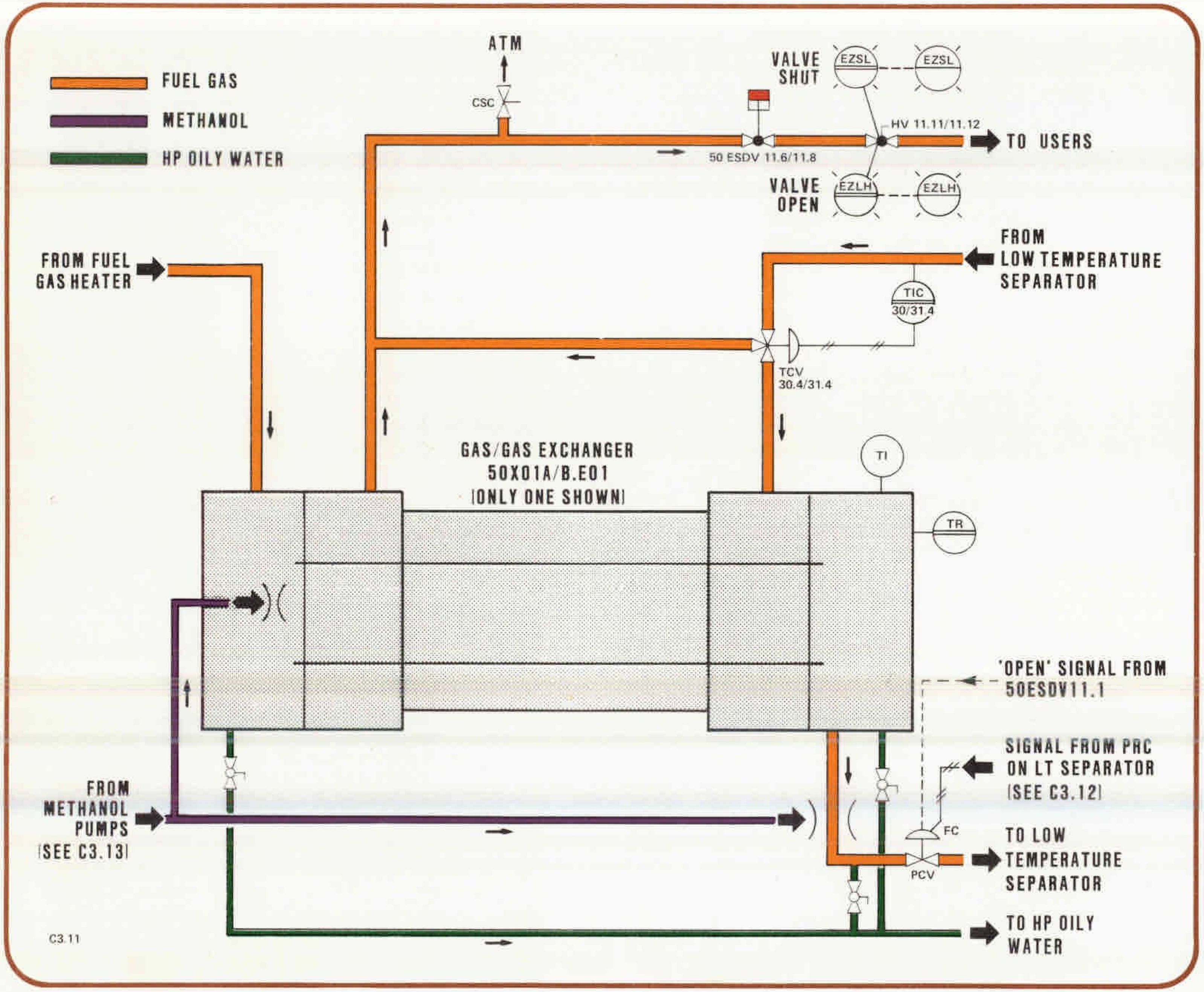
4.1 Treatment Summary

4.1.1 Fuel gas for the user gas turbines must be free of hydrocarbon condensate; this is removed in a low temperature (LT) separator or 'scrubber'. Since the separator operates at a temperature and pressure of −10°C and 20 barg respectively, the source (process) gas which has already been heated in the fuel gas heaters passes through a gas/gas exchanger and is expanded through a PCV to achieve the required drop in pressure, and therefore temperature. This PCV senses pressure in the LT separator.

4.1.2 The dried fuel gas from the LT separator is then reheated in the gas/gas exchanger (upstream of the separator), the temperature of the fuel gas being regulated by TICV30.4 which bypasses the 'cold' dried fuel gas around the gas/gas exchanger, in response to temperature signals sensed in the output line from the LT separator.

4.1.3 If the source (process) gas is being supplied from water separator 11B02A ('wet' gas), methanol injection is automatically started to the inlet of the gas/gas exchanger and to the 'expander' PCV upstream of the LT separator, in order to minimise the formation of hydrates.

4.1.4 Condensate passes from the LT separator to the LP Oily Water System under control of an LCV sensing separator level.


FUEL GAS
METHANOL
HP OILY WATER
ATM
CSC
VALVE SHUT
EZSL
EZSL
HV 11.11/11.12
TO USERS
50 ESDV 11.6/11.8
VALVE OPEN
EZLH
EZLH
FROM LOW TEMPERATURE SEPARATOR
TIC 30/31.4
FROM FUEL GAS HEATER
TCV 30.4/31.4
GAS/GAS EXCHANGER 50X01A/B.E01 (ONLY ONE SHOWN)
TI
TR
'OPEN' SIGNAL FROM 50ESDV11.1
SIGNAL FROM PRC ON LT SEPARATOR (SEE C3.12)
FC
FROM METHANOL PUMPS (SEE C3.13)
PCV
TO LOW TEMPERATURE SEPARATOR
TO HP OILY WATER
C3.11

4.2 Gas/Gas Exchangers (50X01A/B.E01)

See illustration C3.11

4.2.1 The gas/gas heat exchangers are fitted with the following indicators and controls:

(a) A local temperature indicator and a remote temperature recorder in TCP2 Control Room.

(b) Two methanol dosing points with individual injectors. One dosing point allows methanol to be introduced at the inlet side of the gas/gas exchanger and the other to the PCV in the discharge to the low temperature separator. Both dosing lines are fitted with an in-line strainer that can be isolated with block valves.

(c) The discharge line from the gas/gas exchanger to the users has an ESDV that fails closed on receipt of an ESD signal.

(d) Downstream of the ESDV, a hand valve is installed. The status of this valve is shown OPEN or SHUT by illuminated lamps in TCP2 and QP Control Rooms.

4.3 Fuel Gas Low Temperature Separators (50X01A/B.B01)

See illustration C3.12

4.3.1 The low temperature separator drums in the Fuel Gas Treatment System are fitted with the following indicators and controls:

(a) Two pressure safety valves with associated block valves, one in service and one standby. Both valves vent either to the Low Pressure Vent System or to atmosphere. Both PSV's are set to relieve at 23 barg.

(b) A pressure indicator controller in TCP2 Control Room, which receives a signal from the separator and, in turn, controls the 'expander' pressure control valve on the inlet to the separator drum. The pressure reading is recorded in the Control Room during operation.

(c) A local pressure indicator mounted on the separator drum.

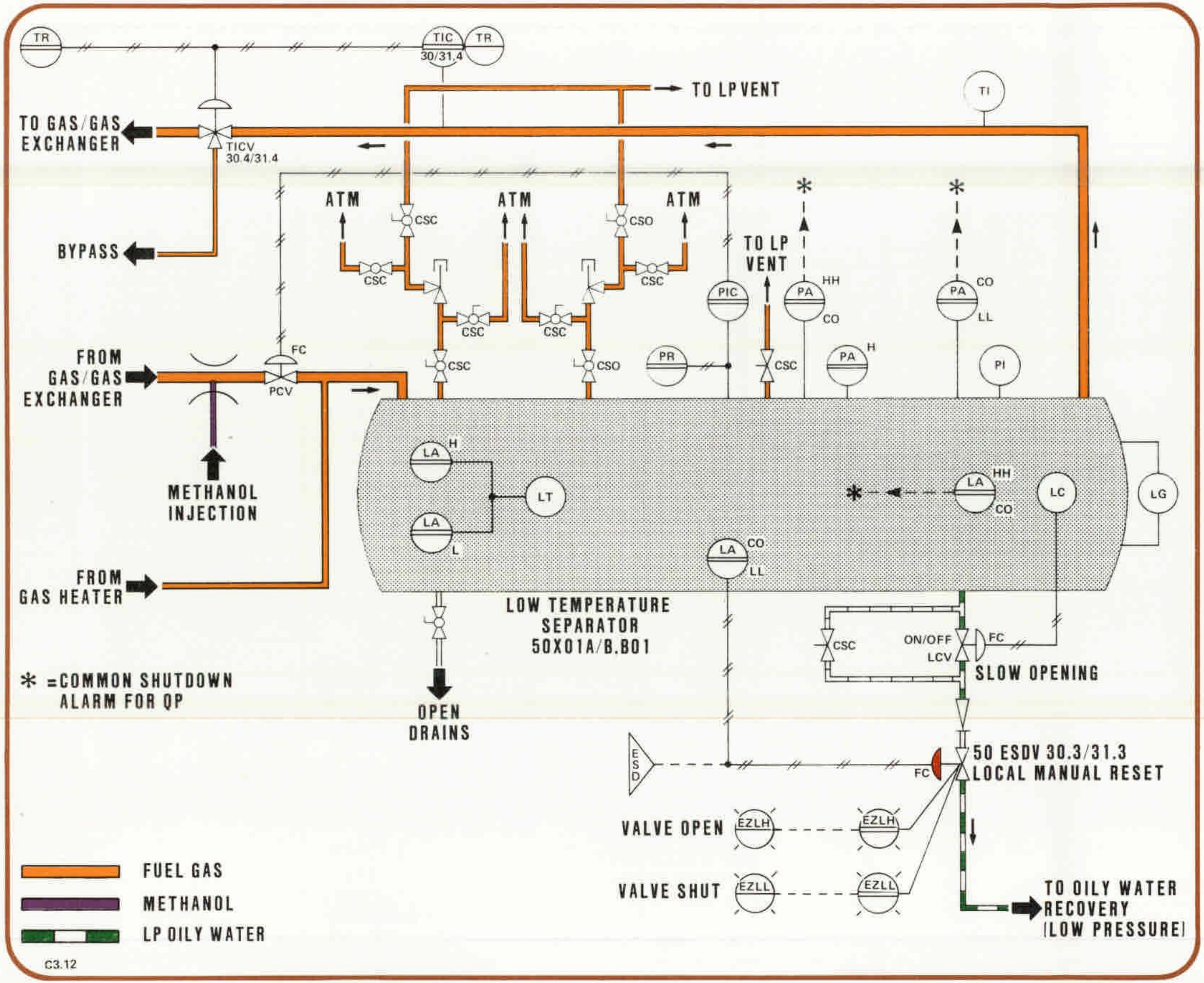
(d) A level gauge mounted on each separator to give local indication of fluid contents.

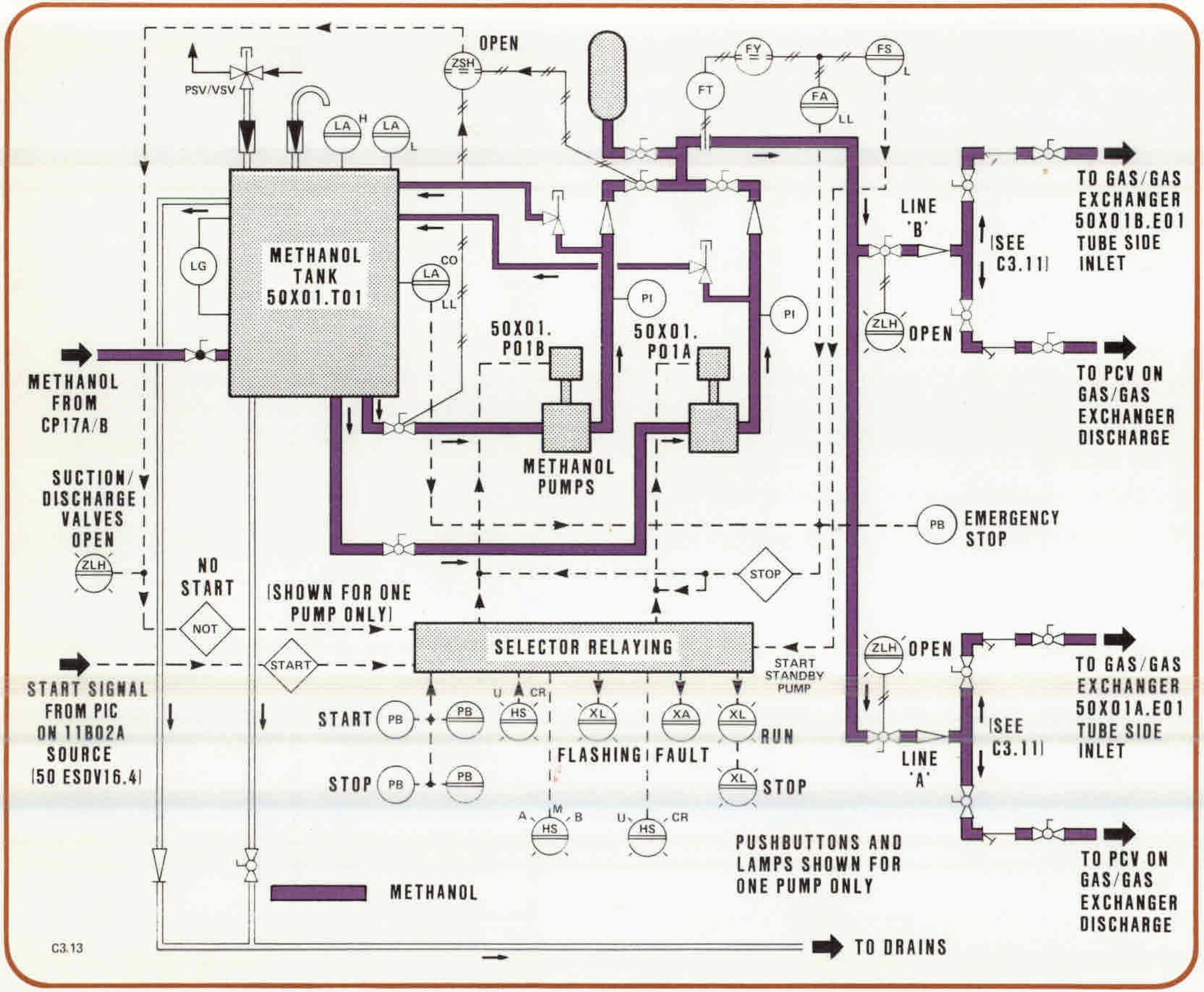
(e) A level controller inside the separator, which modulates the operation of a level control valve on the condensate outlet line to the Low Pressure Oily Water System. The valve is of the slow opening type and is fitted with a bypass. It fails closed on loss of instrument air.

(f) An ESDV downstream of the FCV in the oily water line, that will close if a low-low level signal is received from the separator drum. An ESD signal also closes the valve. The status of the valve is shown (OPEN or SHUT) by illuminated lamps in TCP2 and QP Control Rooms. The ESDV has to be reset manually after a shutdown.

(g) The discharge line from the separator to the gas/gas exchanger or users has a temperature indicator locally.

(h) The same discharge line has a temperature indicator controller in the TCP2 control panel that modulates a three-way temperature control valve. Actuation of this valve will allow cold fuel gas from the separator drum to be bled into the user header, bypassing the gas/gas exchanger. This bleeding of cold gas will allow fine adjustment of fuel gas temperature at the users. The temperature of fuel gas in the discharge line to the gas/gas exchanger is recorded in TCP2 and QP Control Rooms.


TR
TIC
30/31.4
TR
TO LP VENT
TI
TO GAS/GAS EXCHANGER
TICV
30.4/31.4
BYPASS
ATM
ATM
ATM
CSC
CSO
CSC
CSC
CSC
CSC
TO LP VENT
PIC
PA
HH
CO
PA
CO
LL
*
*
FROM GAS/GAS EXCHANGER
FC
PCV
CSC
CSO
PR
CSC
PA
H
PI
METHANOL INJECTION
LA
H
LT
LA
L
LA
HH
CO
LC
LG
LA
CO
LL
FROM GAS HEATER
LOW TEMPERATURE SEPARATOR 50X01A/B.B01
CSC
ON/OFF
LCV
FC
SLOW OPENING
* =COMMON SHUTDOWN ALARM FOR QP
OPEN DRAINS
ESD
FC
50 ESDV 30.3/31.3 LOCAL MANUAL RESET
VALVE OPEN
EZLH
EZLH
VALVE SHUT
EZLL
EZLL
TO OILY WATER RECOVERY (LOW PRESSURE)
FUEL GAS
METHANOL
LP OILY WATER
C3.12


OPEN
ZSH
PSV/VSV
LA H
LA L
FY
FS L
FT
FA LL
LG
METHANOL TANK 50X01.T01
LA CO LL
PI
PI
LINE 'B'
(SEE C3.11)
TO GAS/GAS EXCHANGER 50X01B.E01 TUBE SIDE INLET
ZLH OPEN
TO PCV ON GAS/GAS EXCHANGER DISCHARGE
METHANOL FROM CP17A/B
50X01. P01B
50X01. P01A
METHANOL PUMPS
SUCTION/ DISCHARGE VALVES OPEN
ZLH
PB EMERGENCY STOP
STOP
NO START
(SHOWN FOR ONE PUMP ONLY)
NOT
START
SELECTOR RELAYING
START STANDBY PUMP
ZLH OPEN
TO GAS/GAS EXCHANGER 50X01A.E01 TUBE SIDE INLET
START SIGNAL FROM PIC ON 11B02A SOURCE (50 ESDV16.4)
START PB
PB
U CR
HS
XL
XA
XL RUN
FLASHING FAULT
STOP PB
PB
XL STOP
(SEE C3.11)
LINE 'A'
A M B
HS
U CR
HS
PUSHBUTTONS AND LAMPS SHOWN FOR ONE PUMP ONLY
TO PCV ON GAS/GAS EXCHANGER DISCHARGE
METHANOL
TO DRAINS
C3.13

4.4 **Methanol Injection**

See illustration C3.13

4.4.1 **Methanol Pumps (50X01.P01A/B)**

(a) Both methanol pumps are fitted with the following controls and indicators:

(i) LOCAL/CONTROL ROOM, start selector hand switches located on the TCP2 control panel.

(ii) START and STOP pushbuttons, local to the pumps.

(iii) Remote START and STOP pushbuttons, located on the TCP2 control panel.

(iv) Remote STOP and RUN indicator lamps, located on the TCP2 control panel.

(b) The pumps have a three-position hand switch on the TCP2 control panel. The positions marked A STAND-BY, MANUAL, B STAND-BY determine whether the duty and standby pumps will start automatically or whether they can be started manually from the Control Room or locally.

(c) Under normal operation this hand switch will be set on B STAND-BY. The standby pump will only start if a low flow is sensed in the methanol discharge line. The duty pump starts automatically when 50ESDV16.4 on the source line from water separator 11B02A is opened.

(d) A flashing lamp illuminates in TCP2 Control Room when this hand switch is set at manual or when the standby pump automatically starts.

(e) Individual FAULT lamps are fitted in TCP2 control panel for each pump.

(f) Both pumps can only be started, manually or automatically, if the valves on the suction and discharge sides of the pumps are open. A READY-TO-START lamp will illuminate in TCP2 Control Room when these valves are open.

(g) Both pumps can be stopped, in emergency, by a local push-button. A low-low flow sensed in the discharge from the pumps in conjunction with low-low level in the tank also stops them.

(h) The discharge lines from each pump are provided with the following indicators and controllers:

(i) Pressure indication locally.

(ii) Pressure safety valves set at 170 barg. If the discharge pressure rises above this set-point, methanol is returned to the methanol tank when the PSV opens.

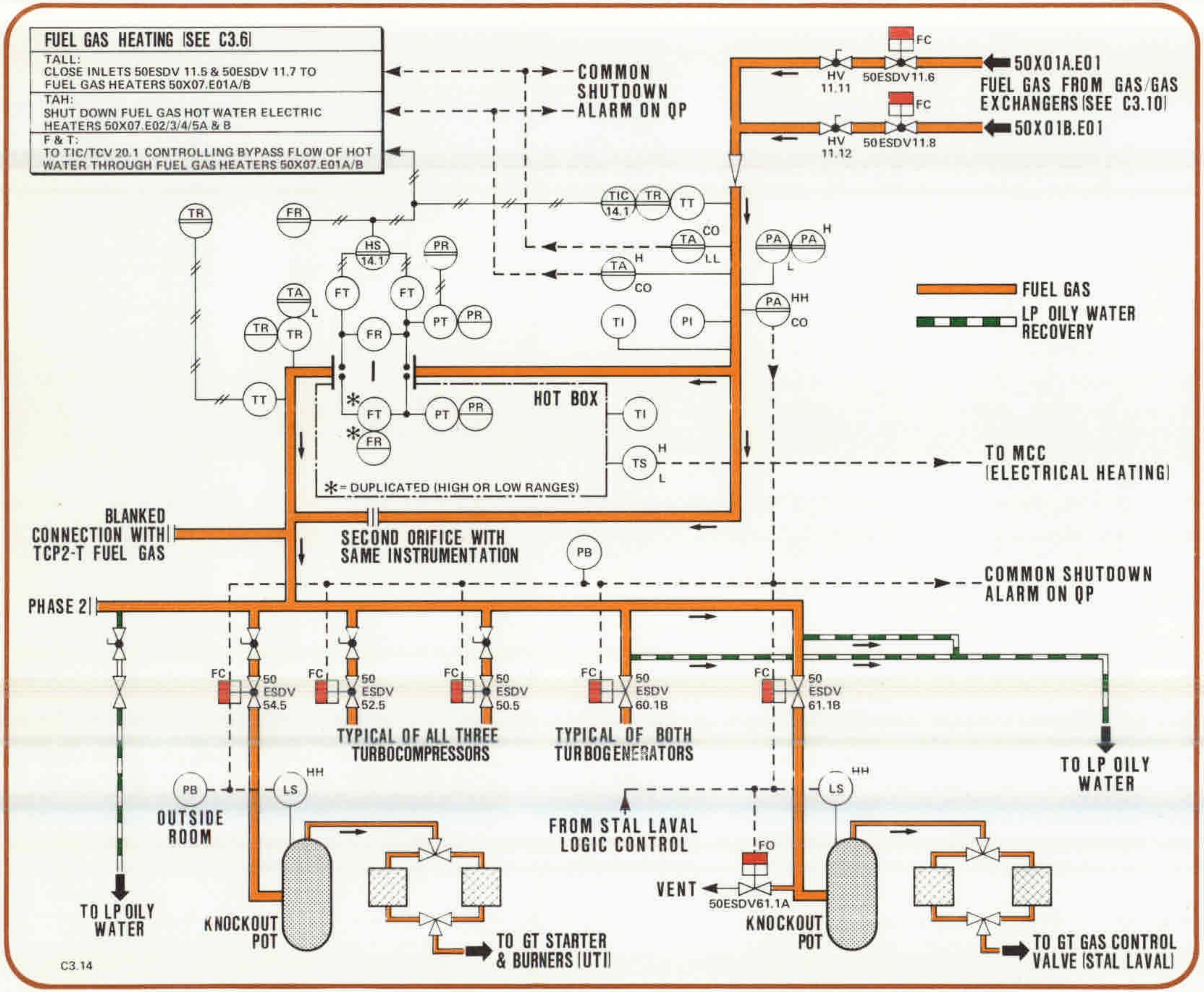
4.4.2 **Methanol Tank (50X01.T01)**

(a) The tank is supplied from the main methanol transfer pump, CP17A/B, in the TCP2 Treatment area.

(b) The tank has a level gauge and high and low level switches. These switches are limited to alarms in TCP2 Control Room.

(c) A low-low level switch and alarm in the tank will inhibit start-up of the methanol pumps and also stop the pumps in conjunction with a low-low flow signal on the pump discharge.

(d) The tank is fitted with a pressure safety valve which also acts as a vacuum safety valve. It is set at +100mbar and –5mbar with respect to atmospheric pressure. This ensures that neither a pressure nor a vacuum is built up in the tank.


FUEL GAS HEATING (SEE C3.6)
TALL:
CLOSE INLETS 50ESDV 11.5 & 50ESDV 11.7 TO FUEL GAS HEATERS 50X07.E01A/B
TAH:
SHUT DOWN FUEL GAS HOT WATER ELECTRIC HEATERS 50X07.E02/3/4/5A & B
F & T:
TO TIC/TCV 20.1 CONTROLLING BYPASS FLOW OF HOT WATER THROUGH FUEL GAS HEATERS 50X07.E01A/B
COMMON SHUTDOWN ALARM ON QP
50X01A.E01
FUEL GAS FROM GAS/GAS EXCHANGERS (SEE C3.10)
50X01B.E01
HV 11.11
50ESDV11.6
HV 11.12
50ESDV11.8
FC
FUEL GAS
LP OILY WATER RECOVERY
HOT BOX
*= DUPLICATED (HIGH OR LOW RANGES)
TO MCC (ELECTRICAL HEATING)
BLANKED CONNECTION WITH TCP2-T FUEL GAS
SECOND ORIFICE WITH SAME INSTRUMENTATION
COMMON SHUTDOWN ALARM ON QP
PHASE 2
50 ESDV 54.5
50 ESDV 52.5
50 ESDV 50.5
50 ESDV 60.1B
50 ESDV 61.1B
TYPICAL OF ALL THREE TURBOCOMPRESSORS
TYPICAL OF BOTH TURBOGENERATORS
TO LP OILY WATER
OUTSIDE ROOM
FROM STAL LAVAL LOGIC CONTROL
VENT
50ESDV61.1A
FO
KNOCKOUT POT
TO GT STARTER & BURNERS (UT)
TO GT GAS CONTROL VALVE (STAL LAVAL)
TO LP OILY WATER

5 FUEL GAS SUPPLY TO GAS TURBINES

See illustration C3.14

5.1 The treated fuel gas header to the turbine users is fitted with the following indicators and controls:

(a) A temperature indicator controller modulating fuel gas temperature at the fuel gas heaters by controlling hot water bypass flow (TCV). The TIC is located in TCP2 Control Room and the temperature is monitored in the Control Room by a temperature recorder. This temperature is sensed in the output line from the gas/gas exchangers.

(b) A local pressure indicator.

(c) A local temperature indicator.

(d) A local thermowell.

(e) Two pairs of flow transmitters; one pair sending signals to individual flow recorders on QP control panel. One transmitter of the alternative pair is selected as duty by a hand switch in TCP2 Control Room and signals to a local flow recorder and to a remote flow recorder on TCP2 Control Room panel. The same flow signal also modulates and controls the TIC/TCV on the fuel gas heaters, in conjunction with the temperature signals mentioned in (a) above.

(f) Two pressure transmitters, whose signals are recorded remotely on TCP2 and QP control panels.

(g) Two temperature elements linked to temperature transmitters, whose signals are recorded locally and remotely in TCP2 and QP Control Rooms.

(h) Local temperature switches signalling high and low temperature to the MCC electrical heating circuits via the TCP2 control panel. It has a local temperature indicator.

(j) A local temperature switch and associated temperature alarm high, sensing temperature in the output line from the gas/gas exchangers, which switches off the hot water electrical heaters in the fuel gas heating hot water circuit. This also initiates a common shutdown alarm on QP.

(k) A temperature switch and associated temperature alarm low-low, also sensing temperature in the output line from the gas/gas exchangers, which closes the ESDV on the source (process) gas inlets to the fuel gas heaters and initiates a common shutdown alarm on QP.

5.2 The three inlet lines from the treated fuel gas header to the turbo-compressors 11K01A/B/C are fitted with an ESDV which fails closed on receipt of a high-high level signal from the individual gas turbine knockout pots, or from a high-high pressure signal on the treated fuel gas header. These ESDVs can also be operated by individual local pushbuttons, situated outside the turbocompressor rooms.

5.3 The two inlet lines from the treated fuel gas header to the turbo-generators 52GG01A/B are fitted with an ESDV which fails closed on receipt of either:

(a) An ESD signal.

(b) A high-high pressure signal from the treated fuel gas header.

(c) A high-high level signal from the gas turbine knockout pots.

The status of these valves, OPEN or SHUT, is shown by illuminated lamps in TCP2 and QP Control Rooms.

5.4 On receipt of the 'Close' signal to the ESDV on the inlet line to the turbogenerators, a second ESDV on the downstream side automatically opens to vent gas from the knockout pots. This second valve also has its status, OPEN or SHUT, shown by illuminated lamps in TCP2 and QP Control Rooms.

5.5 All five ESDVs in the supply lines to the gas turbines can be operated simultaneously by a common local pushbutton.

SECTION 3 – START-UP

1 PRESTART CHECKS (ASSUMING ONLY ONE LINE OPERATIONAL)

Carry out the following checks:

(1) Electrical power available for equipment and alarms.

(2) Instrument air available and all required instrument root valves open.

(3) All system alarms cancelled in TCP2 Control Room.

(4) All the units purged of air and under positive gas pressure.

(5) All system drain valves closed.

(6) Hot water storage tank 50X07.T01 topped up with fresh water to the required level.

(7) Methanol storage tank 50X01.T01 filled to the required level from TCP2 Treatment area.

(8) System valves set in their appropriate start-up configuration.

(9) The PCV on the inlet fuel gas line to the low temperature separator set at 171 barg.

(10) The TCV on the outlet fuel gas line from the low temperature separator set at –10°C.

(11) Hand switches for electrical heaters 50X07.E02/3/4/5A/B selected 'IN', inside the TCP2 control panel.

2 START-UP

2.1 The Fuel Gas System start-up is performed in conjunction with QP Control Room.

2.2 It is assumed that the Fuel Gas System will be fed with dry gas from TP1 sales header for the purpose of this start-up procedure, and that Line A treatment is selected. Tag numbers of instruments are not shown on illustrations; see PID and PF diagrams.

2.3 Proceed as follows:

(1) Ensure that fuel gas is available at the hand valve on the TP1 fuel gas inlet source.

(2) From TCP2 Control Room, select the following hand switches for operation:

(a) 50HS14–1 set to LINE A fuel gas temperature control. 50TIC14–1 to be set on MANUAL.

(b) 50HS23–1 to LINE A hot water temperature control.

(c) 50HS23–2 to MANUAL for Line A thyristor controller.

(d) 50HS20–7 and 21–7 to LOCAL for hot water supply pumps 50X07.P01A/B.

(e) 50HS20–8 to MANUAL for hot water supply pumps 50X07.P01A/B.

(3) Ensure that the correct level has been attained in the hot water storage tank 50X07.T01.

(4) Start hot water supply pump 50X07.P01A, and circulate water through the system. Ensure that there is adequate water make-up into the hot water storage tank 50X07.T01.

(5) When the water levels in the electric heaters and hot water tank are normal (approximately 80 per cent full) stop the water make-up.

(6) Start electrical heater 50X07.E02A from the Control Room.

(7) Place hot water supply pump 50X07.P01B on standby by selecting B STAND-BY on hand switch 50HS20–8 in the Control Room.

(8) Increase the water temperature by switching on electrical heaters 50X07.E03A/4A/5A from the Control Room.

(9) Select AUTOMATIC on 50TIC23–1 (hot water temperature controller) and adjust to 80°C.

(10) Select AUTOMATIC on 50TIC20–1 (fuel gas temperature controller) and adjust for the required temperature according to Graph No 1 (illustration C3.3).

(11) Select AUTOMATIC on 50HS23–2 in the TCP2 Control Room. Hot water temperature control will now be modulated automatically by switching in and switching out the eight resistors in the four Line A electrical heaters.

(12) When the correct hot water circulation is achieved, open the bypasses of the inlet gas valve and the ESDV and hand valve upstream of the fuel gas heaters manually.

(13) Monitor the pressure on the low temperature separator 50X01A.B01, and ensure that the pressure recorder controller closes the pressure control valve on the inlet to the separator at 21 barg.

(14) When the gas pressure in the fuel gas heater 50X07.E01A is in balance with the inlet gas pressure from TP1 sales header, open the hand valve on the inlet source line, and the hand valve and ESDV upstream of the fuel gas heater. Close their bypasses.

(15) As soon as one gas turbine has been started, monitor the fuel gas temperature at the treatment unit outlet by either 50TI14–2 locally, or 50TR14–1 in TCP2 Control Room. If the temperature needs adjusting, it should be done by altering 50TIC20–1.

(16) As soon as fuel gas flow, pressure and temperature are steady at the treatment unit outlet, select 50TIC14–1 to control fuel gas temperature by:

(a) Selecting 50TIC14–1 for AUTO at 20°C.

(b) Selecting flow transmitter 50FT14A on hand switch 50HS14–1 in TCP2 Control Room.

(b) Balancing the outlet flow comparator 50FY14–1, in TCP2 control panel, with 50TIC20–1 indication.

(c) Selecting CASCADE on 50TIC20–1.

(17) Select hand switch 50HS32–2A/B to CONTROL ROOM from TCP2 Control Room, for methanol pumps.

(18) Select B STAND-BY on 50HS32–1 in TCP2 Control Room. If water separator 11B02A is used as a fuel gas source, the duty methanol pump will start automatically.

3 CHECKS AFTER START-UP

3.1 Fuel gas flow, temperature and pressure should be constantly monitored by the local flow, pressure and temperature indicators throughout the system and logged accordingly.

3.2 Treated fuel gas passing to the users will be indicated locally and should be recorded on log sheets. The same readings will be automatically recorded in TCP2 and QP Control Rooms and log sheets should be checked against these recordings.

3.3 The level gauge on the hot water tank should be checked regularly and the tank topped up with fresh water when required.

3.4 The hot water temperature and pressure is indicated locally and should be logged regularly. The temperature of the hot water is recorded remotely in TCP2 Control Room and should be checked against the logged figures at regular intervals.

3.5 If methanol dosing is operational, carry out the following:

(a) The discharge pressures from the hot water and methanol pumps should be regularly checked.

(b) The flow rate and dosing of methanol should be checked and the pump calibrated at regular intervals.

(c) The level gauge on the methanol tank should be checked and the tank (50X01.T01) topped up if necessary.

3.6 Pressure and temperature into and out of the low temperature separator is indicated locally and remotely on TCP2 control panel. Both should be checked against each other at regular intervals.

3.7 The level in the low temperature separator should be logged at intervals.

4 OPERATING VARIABLES

4.1 During normal operation on Line A or Line B (whichever is the duty line) the fuel gas temperature at the outlet of the fuel gas heater will be controlled automatically by a temperature indicator controller.

4.2 If this control mechanism is inoperative, the outlet temperature can be controlled by another controller acting on the discharge line from the hot water pumps.

4.3 Any adjustments should be made with reference to the fuel gas pressure/temperature correlation shown in Graph No 1 (illustration C3.3).

5 SHUTDOWNS

5.1 Normal Shutdown

Assuming that Line A of the Fuel Gas Treatment System is operational, a normal shutdown will automatically close the following valves:

(a) ESDV on the inlet side of the fuel gas heater.

(b) ESDV on the outlet side of the gas/gas exchanger.

(c) ESDV on the condensate outlet line of the low temperature separator.

5.2 Emergency or Abnormal Shutdown

Abnormal process conditions that initiate shutdown are listed in Section 4 — ALARMS AND TRIPS.

SECTION 4 – ALARMS AND TRIPS

	Type	Position	Setting	Control Room Alarm Annunciates		Result
				TCP2	QP	
1.	PAL	Fuel Gas Inlet Header	70 barg	X		
2.	PAH	Inlet Fuel Gas Heater	7 barg	X	X	Closes ESDV upstream of fuel gas heater
3.	TAH	Outlet Fuel Gas Heater		X		
4.	PAH	Discharge Hot Water Pumps		X		Stops both hot water pumps
5.	PAL	Discharge Hot Water Pumps	1 barg	X		Starts standby hot water pump
6.	PALL	Discharge Hot Water Pumps		X		
7.	TAH	Outlet Electrical Heaters		X	X	Stops electrical heaters
8.	LALL	Electrical Heater		X		Stops electrical heaters
9.	LAH	Hot Water Tank		X		
10.	LAL	Hot Water Tank		X		
11.	LALL	Hot Water Tank		X	X	(a) Stops hot water pumps (b) Stops electrical heaters
12.	FALL	Discharge of Methanol Pumps		X		Stops both pumps
13.	LAL	Methanol Tank		X		
14.	LAH	Methanol Tank		X		

Type	Position	Setting	Control Room Alarm Annunciates TCP2	QP	Result
15. LALL	Methanol Tank		X		Stops both pumps
16. LAL	Separator		X		
17. LAH	Separator		X		
18. LAHH	Separator		X	X	Closes ESDV upstream of fuel gas heater
19. LALL	Separator		X		Closes ESDV on condensate outlet
20. PAHH	Separator		X	X	Closes ESDV on inlet to fuel gas heater
21. PAH	Separator		X		
22. PALL	Separator		X	X	Closes ESDV on inlet to fuel gas heater
23. TALL	Fuel Gas Outlet		X	X	Closes ESDV on inlet to fuel gas heater
24. TAL	Fuel Gas Outlet	0°C	X		
25. TAH	Fuel Gas Outlet	15°C	X	X	Shuts down electric heaters
26. PAHH	Fuel Gas Outlet	22 barg	X	X	Closes ESDVs on turbine inlets
27. PAH	Fuel Gas Outlet		X		
28. PAL	Fuel Gas Outlet	15 barg	X		

Symptom	Possible Cause	Action
1. Methanol pump fails to start automatically when water separator source is used	(a) Hand switch not selected for CONTROL ROOM	Select CONTROL ROOM on appropriate hand switch (A or B)
	(b) Hand switch selected for CONTROL ROOM but pump hand switch selected incorrectly	Select 'B STAND-BY'
	(c) Suction and discharge valves of pump not open and READY TO START lamp in TCP2 Control Room not lit	Open valves if necessary
	(d) Low-low level in methanol tank	Fill up tank
2. No methanol at dosing points	Pressure safety valve on pump discharge incorrectly set or jammed open	Reset valve or replace
3. Methanol pump stops during operation	(a) Low-low flow in methanol discharge line (b) Low-low level in methanol tank	Stop the pump locally, investigate and check pump and check level gauge on methanol tank. Refill if necessary
4. Total fuel gas shutdown to users	Any of the temperature, pressure and flow alarm cut-outs may have closed the ESDV upstream of the fuel gas heater	Investigate all possible causes; rectify and reset and restart

Symptom	Possible Cause	Action
5. Fuel gas temperature rises above preset figure	(a) TICs modulating TCVs incorrectly set	Reset
	(b) Hot water heaters not cutting out on AUTO	Select MANUAL and switch in or switch out heaters until temperature is stable
	(c) Low temperature separator receiving gas at incorrect temperature	Pressure control valve upstream of separator inoperative and in need of adjustment or replace-ment
6. Duty hot water pump fails to start from Control Room	(a) 'A STAND-BY' or 'B STAND-BY' not selected in Control Room	Reselect
	(b) Suction and discharge valves shut	Open valves
7. Duty hot water pump fails to start locally	LOCAL not selected in Control Room	Reselect
8. Duty hot water pump stops during operation	(a) High pressure in circuit	Investigate cause and reset
	(b) Low level in hot water tank	Top up from cooling water circuit

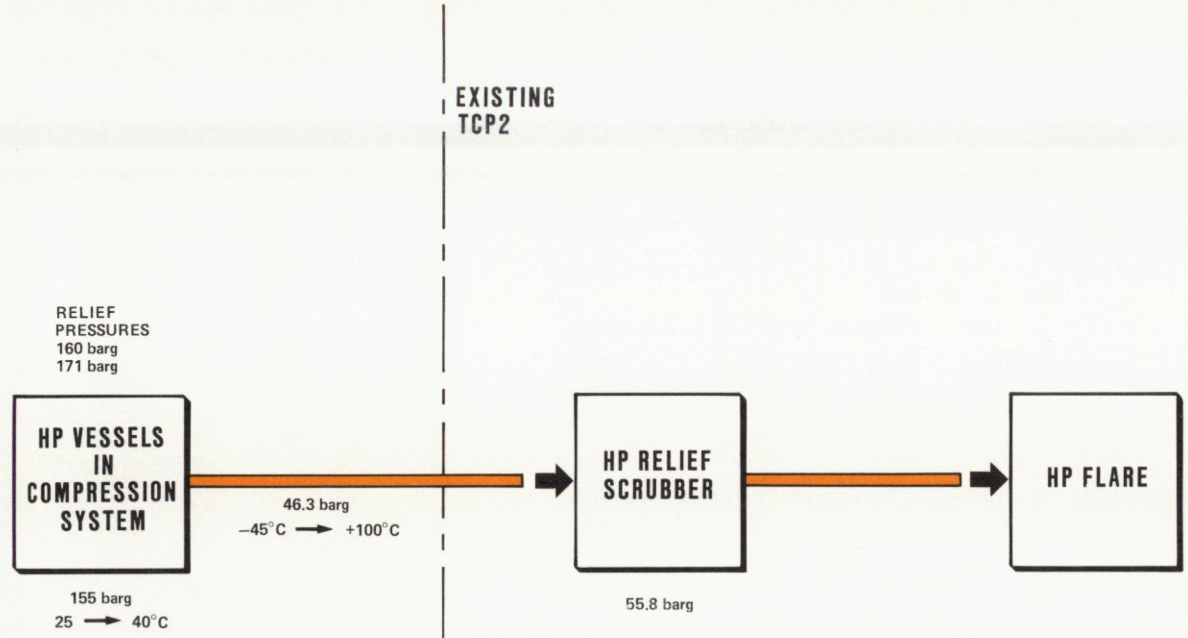
CHAPTER C4

HP RELIEF SYSTEM

CONTENTS

ILLUSTRATIONS

HP RELIEF SYSTEM. BLOCK DIAGRAM



SECTION 1 – DESCRIPTION

Reference: PID 5424W 6700 4001

1 SUMMARY

See illustrations C4.1, C4.2 and C4.3

1.1 The High Pressure Relief System collects gas from those equipment items in the Gas Compression Package which operate at above atmospheric pressure.

1.2 It has three main functions:

(1) To dispose of gas released through pressure relief valves when a vessel is subjected to excess pressure.

(2) To dispose of gas released from vessels when they are shut down during an emergency.

(3) To dispose of gas vented from vessels prior to being shut down for maintenance work.

1.3 Flow lines feed into the High Pressure Relief System through safety and blowdown valves on the following items of equipment:

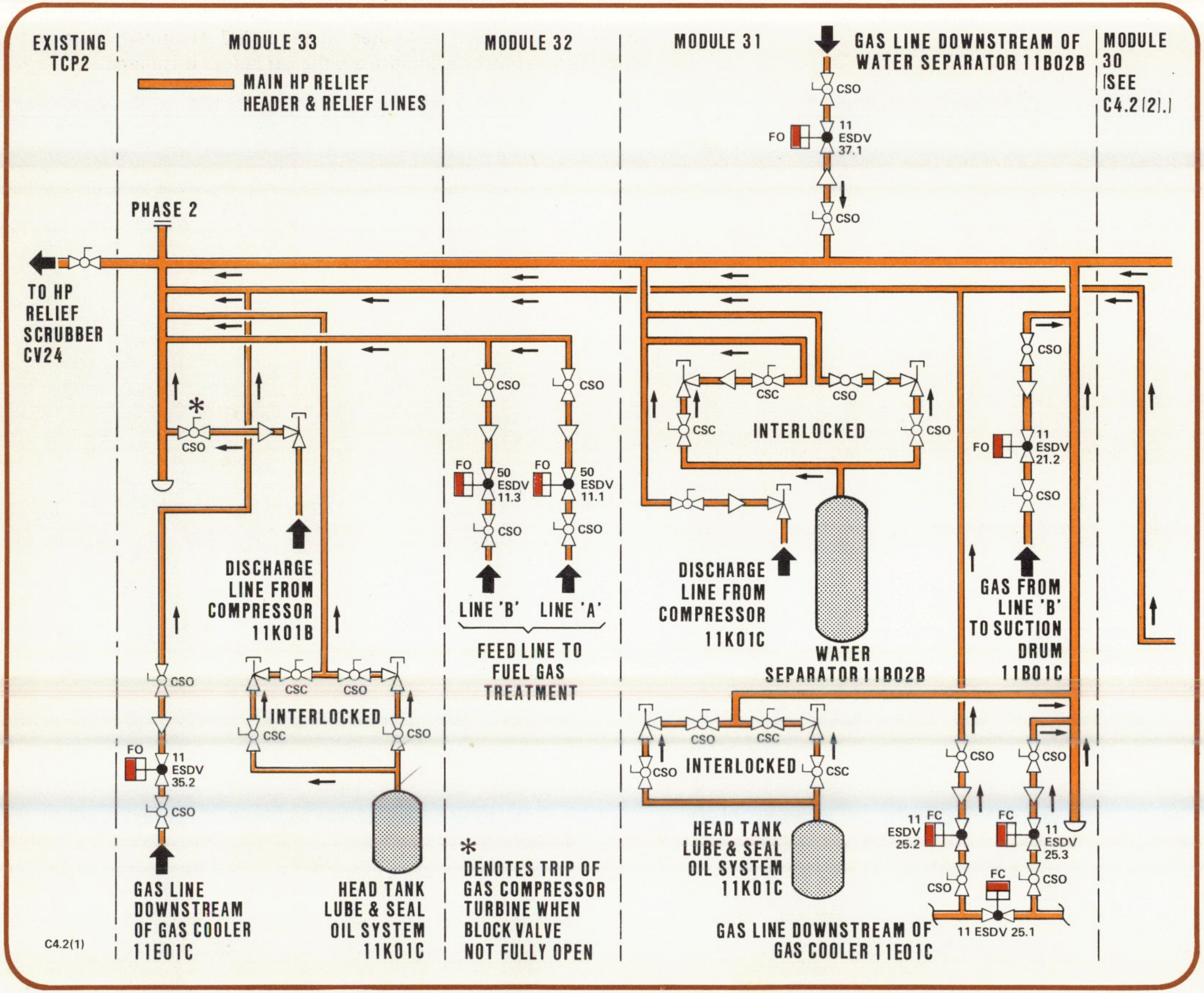
(a) Fuel Gas Heaters (tubes).

(b) Overhead Lube and Seal Oil Tanks.

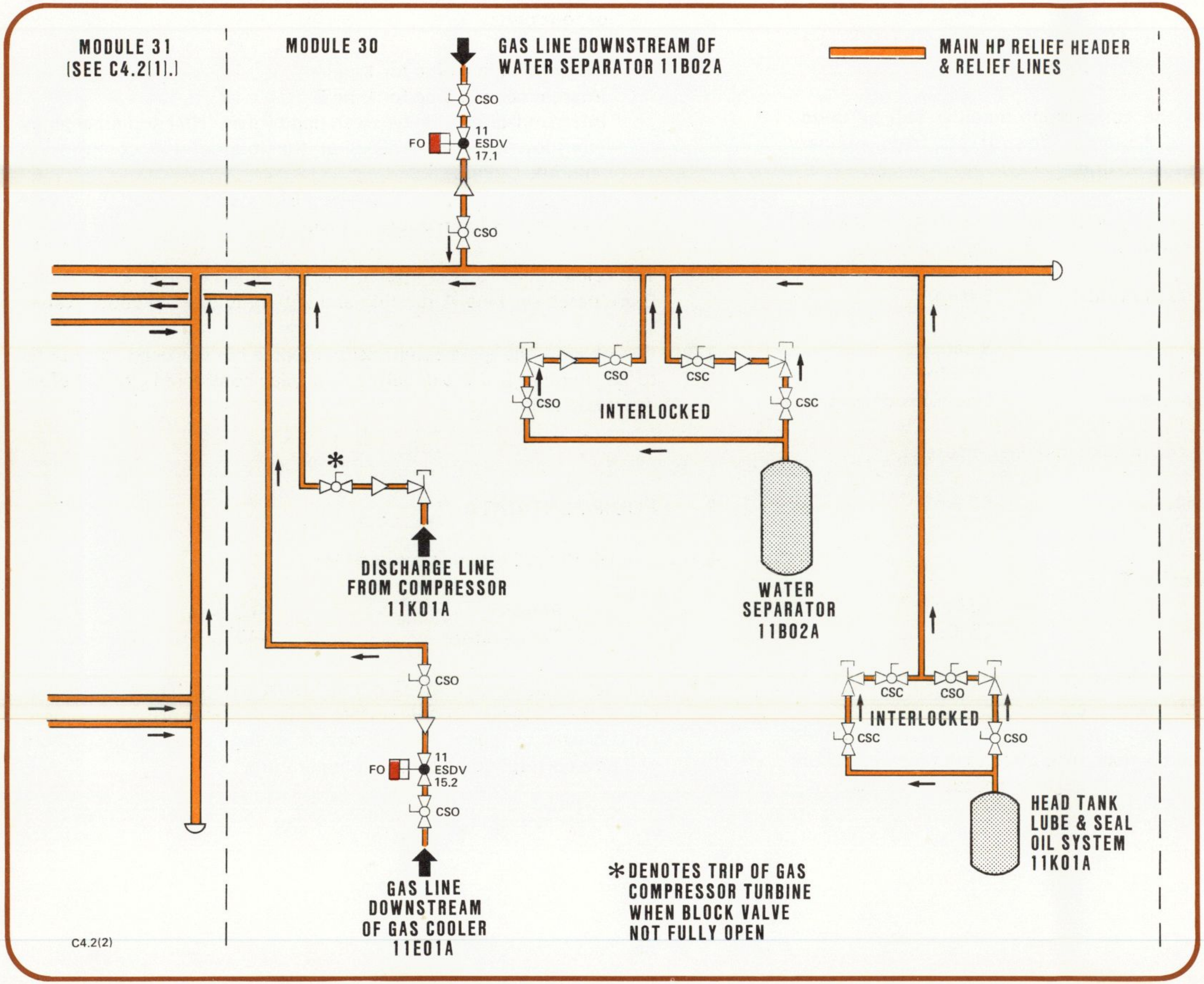
(c) Water Separators.

(d) Process Gas lines.

1.4 The network of flow lines from these equipments enter a single main header which transfers gas to the High Pressure Relief Scrubber CV24. This scrubber is located in the TCP2 Treatment Area and removes hydrocarbon liquid from the gas before it is flared.


EXISTING TCP2
MODULE 33
MODULE 32
MODULE 31
GAS LINE DOWNSTREAM OF WATER SEPARATOR 11B02B
MODULE 30 (SEE C4.2(2).)
MAIN HP RELIEF HEADER & RELIEF LINES
PHASE 2
TO HP RELIEF SCRUBBER CV24
CSO
CSC
FO
FC
11 ESDV 37.1
11 ESDV 35.2
50 ESDV 11.3
50 ESDV 11.1
11 ESDV 21.2
11 ESDV 25.2
11 ESDV 25.3
11 ESDV 25.1
INTERLOCKED
DISCHARGE LINE FROM COMPRESSOR 11K01B
DISCHARGE LINE FROM COMPRESSOR 11K01C
LINE 'B'
LINE 'A'
FEED LINE TO FUEL GAS TREATMENT
WATER SEPARATOR 11B02B
GAS FROM LINE 'B' TO SUCTION DRUM 11B01C
GAS LINE DOWNSTREAM OF GAS COOLER 11E01C
HEAD TANK LUBE & SEAL OIL SYSTEM 11K01C
* DENOTES TRIP OF GAS COMPRESSOR TURBINE WHEN BLOCK VALVE NOT FULLY OPEN
GAS LINE DOWNSTREAM OF GAS COOLER 11E01C

C4.2(1)


MODULE 31
(SEE C4.2(1).)
MODULE 30
GAS LINE DOWNSTREAM OF
WATER SEPARATOR 11B02A
MAIN HP RELIEF HEADER
& RELIEF LINES
CSO
FO
11
ESDV
17.1
CSO
CSO
CSO
CSC
CSO
INTERLOCKED
CSC
*
DISCHARGE LINE
FROM COMPRESSOR
11K01A
WATER
SEPARATOR
11B02A
CSO
FO
11
ESDV
15.2
CSO
CSC
CSO
INTERLOCKED
CSC
CSO
HEAD TANK
LUBE & SEAL
OIL SYSTEM
11K01A
GAS LINE
DOWNSTREAM
OF GAS COOLER
11E01A
*DENOTES TRIP OF GAS
COMPRESSOR TURBINE
WHEN BLOCK VALVE
NOT FULLY OPEN
C4.2(2)

2 GAS FLOWRATES IN HP RELIEF SYSTEM

2.1 Gas flowrates passing into the HP Relief System during depressurisation are based on the following assumptions:

(a) Depressurisation of the compression modules will be undertaken when there is no other flow of gas from auxiliary systems in the compression unit.

(b) The residual pressures at completion of depressurisation and decompression times are:

Compression modules individual pressure	–	5 barg.
Other parts	–	8 barg.
Decompression time	–	25 min.
Number of blowdown valves	–	One for each part.

(c) Depressurisation of compression modules, Phase 1:

Volume of gas for one compression module (Natural Gas Cooler designed for a temperature of 30°C)	–	51.9m^3.
Discharge pressure	–	153 barg.
Suction temperature	–	25°C.

Balanced temperature and pressure have been estimated to be 30°C and 150 bar abs respectively.
Balanced temperature and pressure figures have been obtained assuming that the compressor trips after the complete closure of the suction and discharge emergency shutdown valves.

(d) Depressurisation of interconnecting pipes, which are made up of four parts:

Interconnecting pipe for Line A.
Interconnecting pipe for Line B.
Interconnecting pipe between hand valves (HV) and emergency shutdown valves (ESDV) at the inlet of the compression module C, Phase 1.
Interconnecting pipe between ESDVs and HVs at the outlet of compression module C, Phase 1.

2.2 The calculations for the interconnecting pipe between Lines A and B are based on Line A running and with only one blowdown valve.

2.3 In each case, the spare compression module has not been considered to be running, and block valves have been considered closed before depressurisation.

3 EQUIPMENT DATA

3.1 The HP Relief System is designed for:

Pressure	–	46.3 barg.
Temperature	–	–45°C/+100°C.

3.2 The temperature of –45°C is the lowest design temperature that could be envisaged in the system when overpressurisation caused relief valves to open. When there is a large pressure drop there will be a corresponding drop in temperature.

4 EXTERNAL UTILITIES AND INTERFACES

4.1 The following external utility is required for the system:

Instrument air for operating valves.

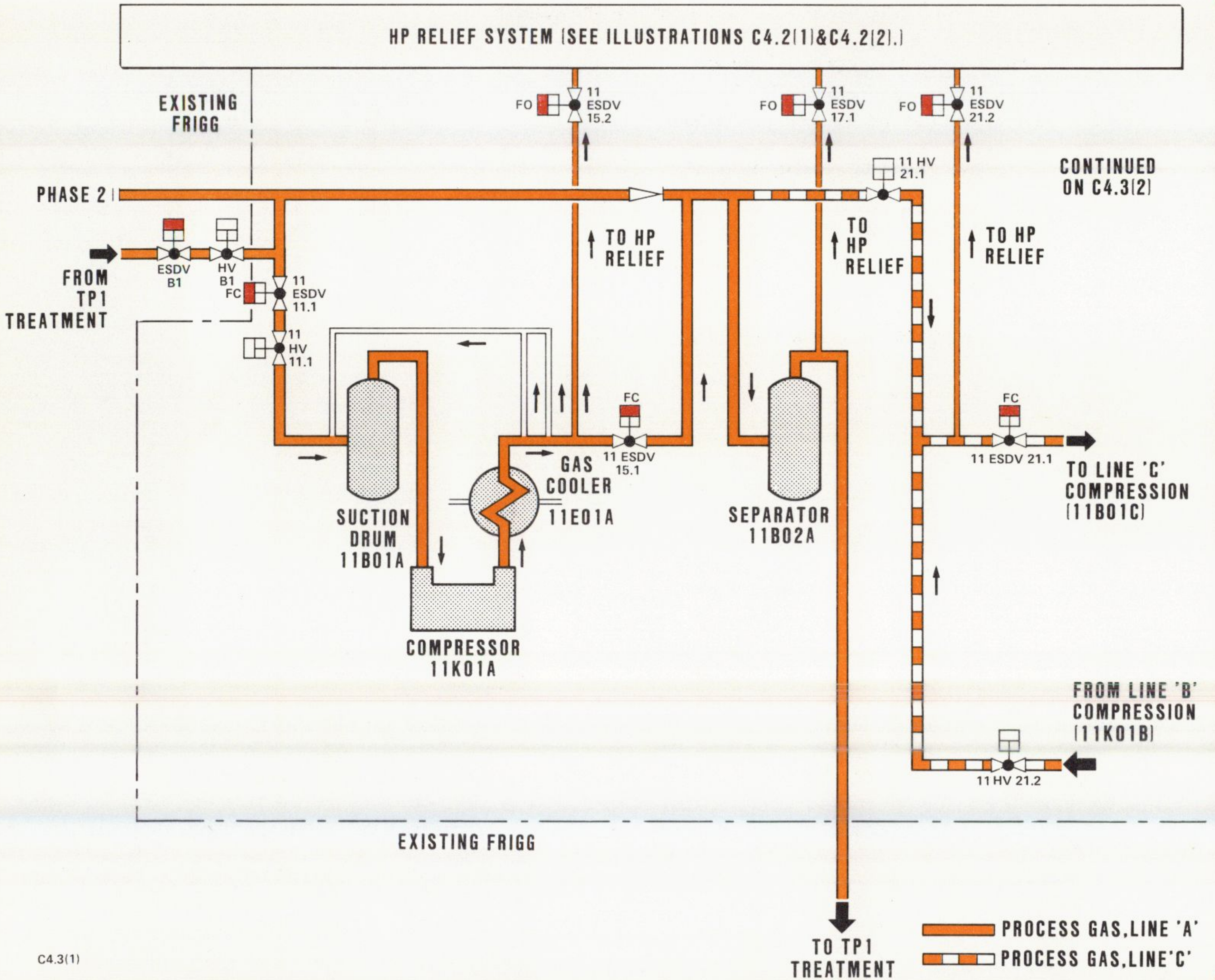
4.2 The system has the following interfaces:

(a) Water Separators, 11B02A/B.

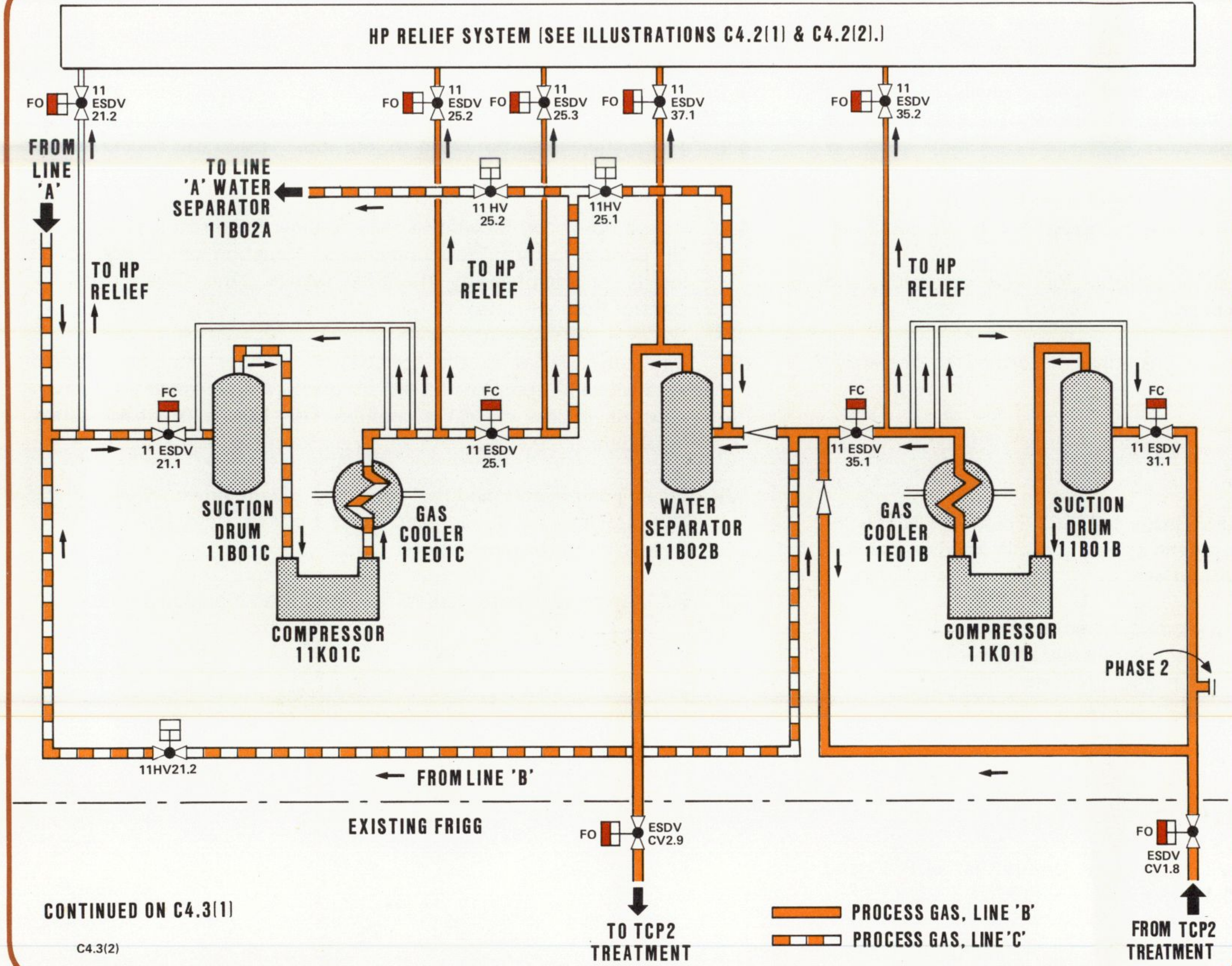
(b) Process gas lines.

(c) Fuel Gas System.

(d) Compressor Lube and Seal Oil Systems.


HP RELIEF SYSTEM (SEE ILLUSTRATIONS C4.2(1)&C4.2(2).)
EXISTING FRIGG
FO
11 ESDV 15.2
11 ESDV 17.1
11 ESDV 21.2
11 HV 21.1
CONTINUED ON C4.3(2)
PHASE 2
TO HP RELIEF
TO HP RELIEF
TO HP RELIEF
FROM TP1 TREATMENT
ESDV B1
HV B1
FC
11 ESDV 11.1
11 HV 11.1
11 ESDV 15.1
GAS COOLER 11E01A
SUCTION DRUM 11B01A
COMPRESSOR 11K01A
SEPARATOR 11B02A
11 ESDV 21.1
TO LINE 'C' COMPRESSION (11B01C)
FROM LINE 'B' COMPRESSION (11K01B)
11 HV 21.2
EXISTING FRIGG
TO TP1 TREATMENT
PROCESS GAS, LINE 'A'
PROCESS GAS, LINE 'C'

C4.3(1)



CONTINUED ON C4.3(1)

C4.3(2)

SECTION 2 – OPERATION AND CONTROLS

1 PRESTART CHECKS

1.1 The system should already have been purged of air, and will be under Nitrogen pressure. Purging is necessary in order to avoid explosive mixtures in the pipework.

1.2 Ensure that TCP2 Treatment HP Relief System is operational and that connections into it from the compression area are complete.

1.3 Ensure that instrument air is available for valve operation, and instrument root valves are open.

1.4 Check that hand valves are positioned according to the valve schedule.

2 START-UP

2.1 Once the cross-connection is made to TCP2 Treatment HP Relief System and hand valves on the system are correctly set, system venting is automatic via relief valves.

2.2 The settings for PSV valves should be either 160 or 171 barg. If these relief settings are incorrect, vessels and pipework could suffer from serious overpressurisation and permanent damage could be caused.

3 CHECKS AFTER START-UP

3.1 When the compression unit is under gas, ensure that all PSVs and ESDVs are de-isolated and not leaking.

4 SHUTDOWN

4.1 Shutdown can be achieved collectively by an emergency signal.

4.2 Blowdown valves on vessels can be operated manually by the appropriate hand valve.

4.3 The system is sectionalised so individual vessels can be shut down and vented for maintenance.

4.4 Actuation of any blowdown valve is under the direct supervision of QP Central Control Room operators. Actuation can be performed locally or remotely by the ESD system (2nd Level) from QP Control Room.

4.5 Blowdown valves in the compressor modules may be actuated automatically upon loss of seal oil pressure and loss of AC current resulting in loss of seal oil pumps. This feature is a basic safety procedure.

4.6 When compressor modules are being blown down, they will be depressurised to 4 barg and then isolated from the HP Relief System using the block valves.

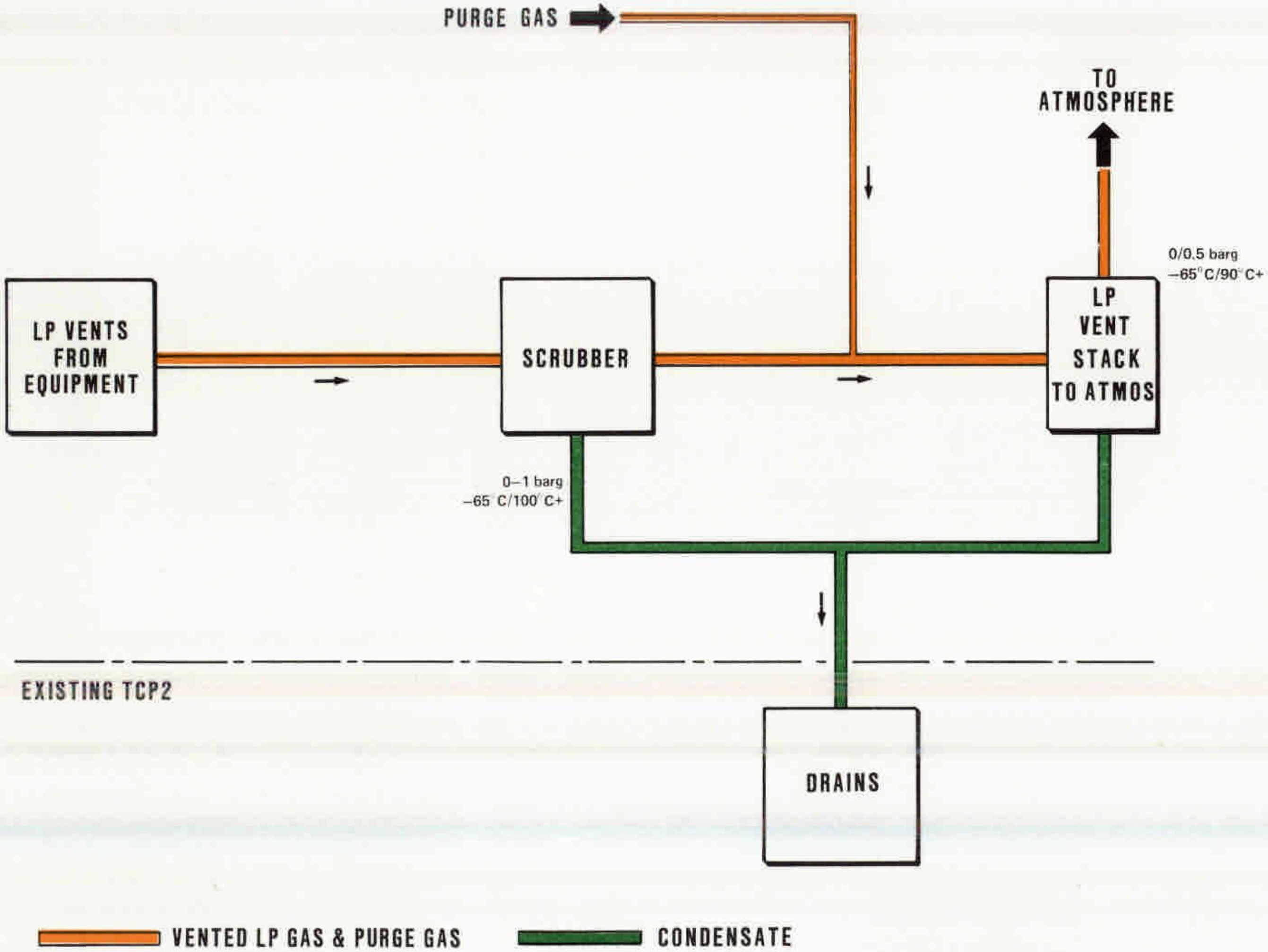
4.7 All blowdown valves are sized for 25 minutes blowdown time.

CHAPTER C5

LP VENT SYSTEM

CONTENTS

ILLUSTRATIONS


PURGE GAS
TO ATMOSPHERE
0/0.5 barg
−65°C/90°C+
LP VENTS FROM EQUIPMENT
SCRUBBER
LP VENT STACK TO ATMOS
0–1 barg
−65°C/100°C+
EXISTING TCP2
DRAINS
VENTED LP GAS & PURGE GAS
CONDENSATE

SECTION 1 – DESCRIPTION

Reference: PID 5424W 67 0040 02

1 SUMMARY

See illustrations C5.1, C5.2 and C5.3

1.1 The LP Vent System is designed to provide secondary protection of pressurised equipment. Vented gas is collected from that equipment in the Main Gas Compression Package which operates at or near atmospheric pressure. After collection in a pipeline network, the gas has hydrocarbons removed and is then vented to atmosphere.

1.2 The system comprises:

(a) A pipeline network that receives the gas through pressure safety valves or purge valves fitted on equipment items in the gas compression package and turbogenerator modules.

(b) A main header pipe which collects gas from this pipeline network.

(c) A scrubber (67B01), fed from the main header pipe, to remove hydrocarbons.

(d) A vent stack to discharge the dry gas to atmosphere as a 'cold flare'.

(e) A drain system on the scrubber and vent stack to pass the accumulated removed hydrocarbons to the process drain system of TCP2–T.

(f) A level control system to maintain the correct liquid level in the scrubber. This is fitted between the scrubber and the process drains.

(g) A purge gas line, emanating from the fuel gas inlet header. This line is connected into the LP Vent System between the scrubber gas outlet and the vent stack and ensures that no air enters the stack by forming the Light Gas Seal 67X02.

(h) Fire protection, provided by a Snuffing Package (67X01) discharging to the vent stack.

2 EQUIPMENT DETAILS

2.1 LP Vent Scrubber 67B01

Size	–	Height 3.5 m. ID 3.0 m.
Design Pressure	–	3.5 barg.
Working Pressure	–	Atm to 1.0 barg.
Design Temperature	–	–65°C/+100°C.
Working Temperature	–	–60°C to +90°C.
Capacity	–	31.35 m^3.

2.2 LP Vent Stack

Stack diameter	–	16 inches.
Stack height	–	24 m above upper deck level.

2.3 LP Vent Snuffing Package 67X01

2.3.1 The Snuffing Package can be activated manually or automatically. Automatic release is initiated by a signal from two ultra-violet detectors and one heat rise detector in the stack. The package is made up of two separate systems, Halon and Dry Chemical Powder.

2.3.2 **Halon 1301**

Two 80 kg bottles of Halon 1301 are fitted. One bottle can extinguish a fire in the stack under normal gas flow rate of 4620 m^3/h.

2.3.3 **Dry Chemical Powder (Potassium Bicarbonate)**

Two 250 kg sets of Dry Chemical Powder are fitted. One set can extinguish a fire in the stack at maximum gas flow rate of 3695 m^3/d. Dry powder will automatically be used when any fire in the stack is not extinguished by the Halon sets.

If the fire is not extinguished, the initial signal releasing Halon will continue and, after a time delay of 20 seconds, the first set of powder will be released.

Manual release can be initiated locally or from the TCP2 Control Room.

3 DISCHARGE CONDITIONS TO LP VENT SYSTEM

3.1 Maximum Discharge Rate

From relief valves (Fuel Gas Package)	=	3695 m^3/d.
Temperature	=	–20°C.

3.2 Normal Discharge Rate

From one gas expander turbine driver for an operating period of 2 minutes	=	140 m^3 in 2 minutes.
Minimum Temperature	=	–65°C.

3.3 Continuous Discharge Rates

From 1 to 4 seal oil drain traps	=	1000 to 4000 m^3/d.
Temperature	=	70°C max.

3.4 Abnormal Discharge Rates

Approximately 1008 m^3/d.

Temperature	=	100°C max.

4 EXTERNAL UTILITIES AND INTERFACES

4.1 The system requires the following utilities:

(a) Instrument air for valve operation.

(b) Electrical power for alarm transmission and equipment items.

4.2 The system has the following interfaces:

(a) Auxiliary Fuel Gas System for power generation Gas Turbines.

(b) Modules 30, 31, 33 Final Decompression.

(c) Seal Oil System for Compressors (trap vents).

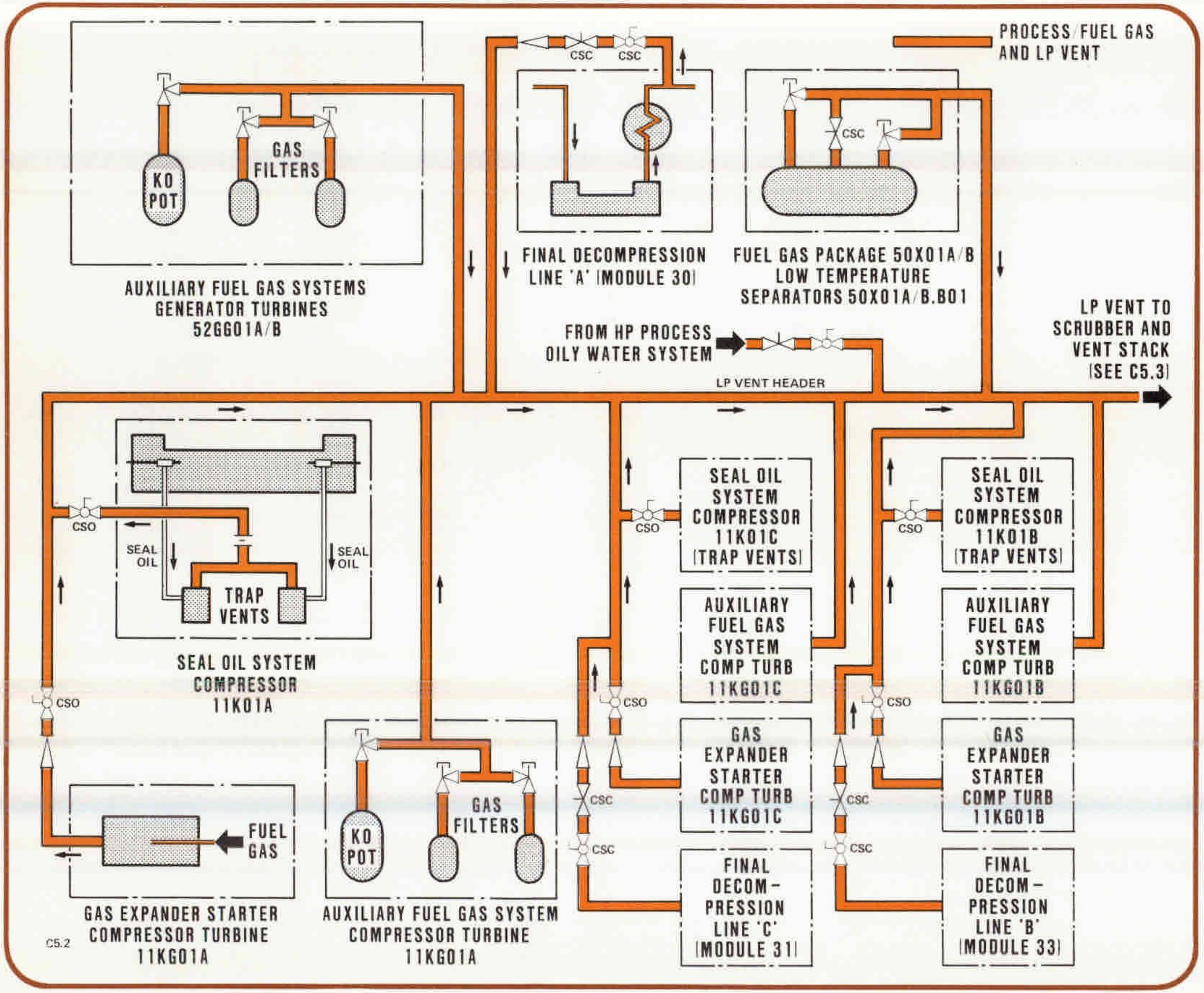
(d) Auxiliary Fuel Gas Systems for Compressor Gas Turbines.

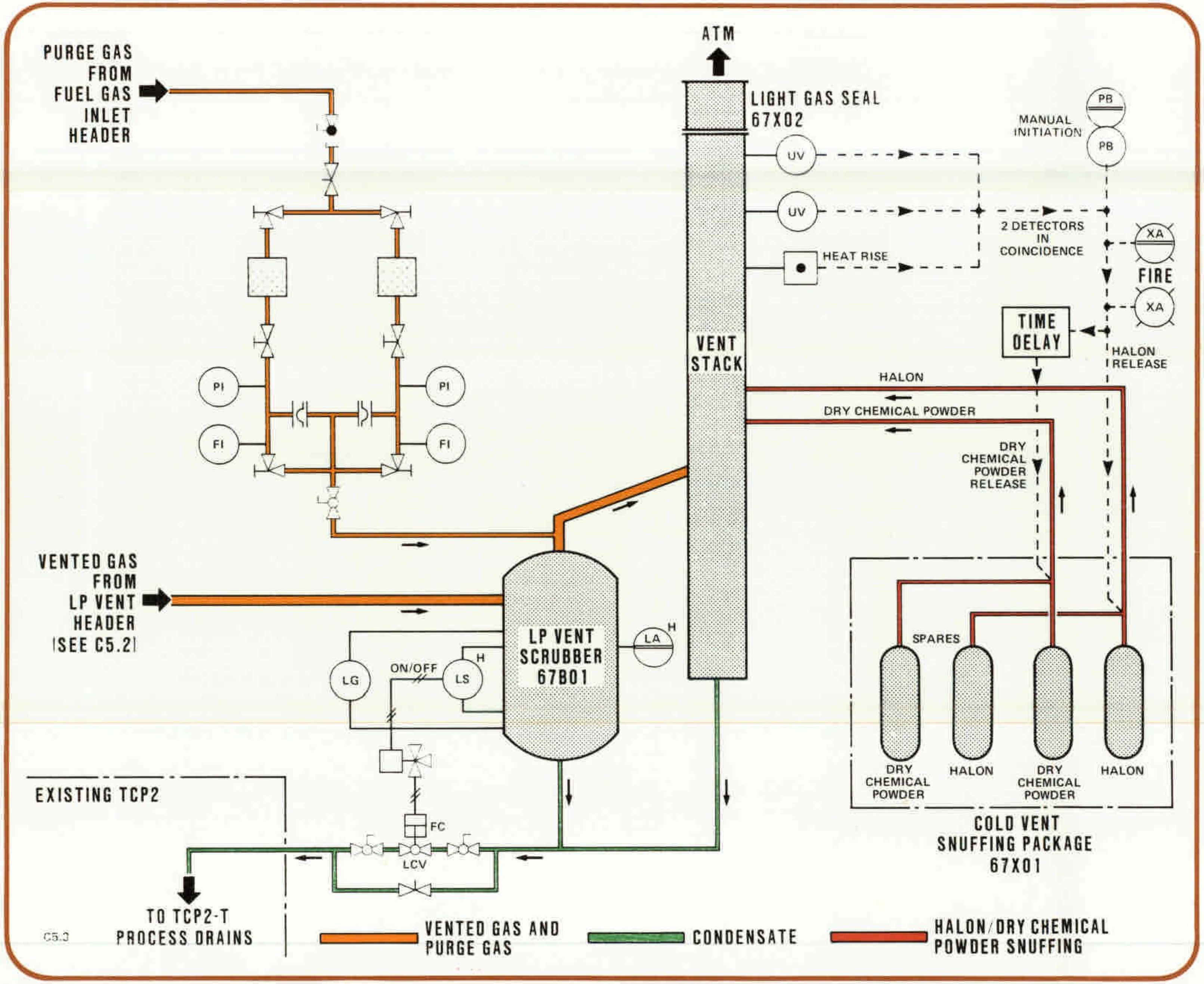
(e) Gas expander starters for Compressor Gas Turbines.

(f) Main Fuel Gas Package (purge gas supply).

(g) TCP2 Treatment Area Process Drains.

(h) Oily Water Recovery System (High Pressure Network).


PROCESS/FUEL GAS AND LP VENT
KO POT
GAS FILTERS
AUXILIARY FUEL GAS SYSTEMS GENERATOR TURBINES 52GG01A/B
CSC
CSC
FINAL DECOMPRESSION LINE 'A' (MODULE 30)
CSC
FUEL GAS PACKAGE 50X01A/B LOW TEMPERATURE SEPARATORS 50X01A/B.B01
FROM HP PROCESS OILY WATER SYSTEM
LP VENT HEADER
LP VENT TO SCRUBBER AND VENT STACK (SEE C5.3)
CSO
SEAL OIL
SEAL OIL
TRAP VENTS
SEAL OIL SYSTEM COMPRESSOR 11K01A
CSO
SEAL OIL SYSTEM COMPRESSOR 11K01C (TRAP VENTS)
SEAL OIL SYSTEM COMPRESSOR 11K01B (TRAP VENTS)
AUXILIARY FUEL GAS SYSTEM COMP TURB 11KG01C
AUXILIARY FUEL GAS SYSTEM COMP TURB 11KG01B
GAS EXPANDER STARTER COMP TURB 11KG01C
GAS EXPANDER STARTER COMP TURB 11KG01B
FINAL DECOM-PRESSION LINE 'C' (MODULE 31)
FINAL DECOM-PRESSION LINE 'B' (MODULE 33)
FUEL GAS
GAS EXPANDER STARTER COMPRESSOR TURBINE 11KG01A
KO POT
GAS FILTERS
AUXILIARY FUEL GAS SYSTEM COMPRESSOR TURBINE 11KG01A
C5.2


PURGE GAS FROM FUEL GAS INLET HEADER
ATM
LIGHT GAS SEAL 67X02
MANUAL INITIATION
PB
PB
UV
UV
HEAT RISE
2 DETECTORS IN COINCIDENCE
XA
FIRE
XA
TIME DELAY
HALON RELEASE
VENT STACK
HALON
DRY CHEMICAL POWDER
DRY CHEMICAL POWDER RELEASE
PI
PI
FI
FI
VENTED GAS FROM LP VENT HEADER (SEE C5.2)
LP VENT SCRUBBER 67B01
LA
H
LG
ON/OFF
LS
H
SPARES
DRY CHEMICAL POWDER
HALON
DRY CHEMICAL POWDER
HALON
COLD VENT SNUFFING PACKAGE 67X01
EXISTING TCP2
FC
LCV
TO TCP2-T PROCESS DRAINS
VENTED GAS AND PURGE GAS
CONDENSATE
HALON/DRY CHEMICAL POWDER SNUFFING

SECTION 2 – OPERATION AND CONTROLS

1 PRESTART CHECKS

See illustrations C5.2 and C5.3

1.1 Prior to start-up, all main headers of the LP Vent System will have been purged with Nitrogen.

1.2 All relief valves should be set closed.

1.3 Block valves on either side of relief valves should be locked open.

2 START-UP

2.1 As soon as fuel gas is available, a light gas seal has to be made in the vent stack. For this purpose, the main fuel gas line for purging should be opened and the flow of gas adjusted to approximately 70 m^3/h (50 kg/h).

2.2 The fire protection detectors on the vent stack are unlocked and valves on the Halon and Dry Chemical Powder lines opened.

3 CHECKS AFTER START-UP

3.1 Routine checks should be made for fuel gas flow and the oil level (condensate) in the LP vent scrubber (Level Gauge).

3.2 There are no operating variables on the system.

4 NORMAL SHUTDOWN

4.1 In the event of fire in the vent stack, Halon and/or Dry Chemical Powder should be released automatically from the Vent Snuffing Package.

4.2 If this does not occur, the systems must be activated manually from the local panel or from the control room. When the fire is extinguished, the detectors should be checked and the Snuffing Package must be shut down and recharged. Manual operation should be cancelled.

4.3 The failure of the automatic system must be investigated, rectified and the automatic system reset.

5 INSTRUMENTATION

5.1 The level control system that maintains a liquid level in the vent scrubber is shown in illustration C5.3.

5.2 A correct liquid level is important since it maintains a slight pressure in the vent system and helps to prevent the entry of air from the stack.

SECTION 3 – ALARMS AND EMERGENCY SHUTDOWN

1 ALARMS

1.1 A high level alarm is mounted on the LP vent scrubber and annunciates in the TCP2 Control Room.

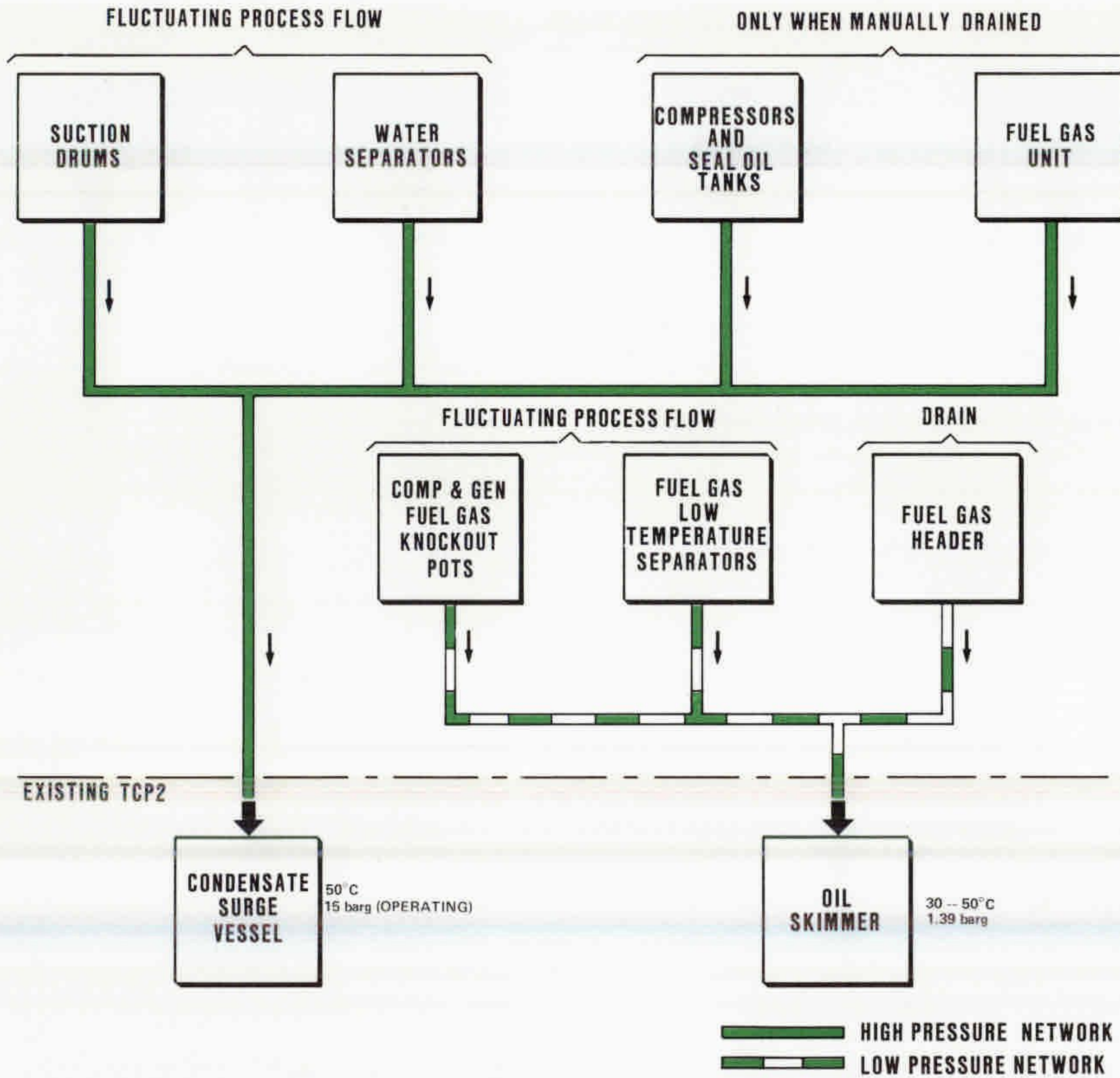
1.2 Fire detection alarms annunciate locally and in the TCP2 Control Room.

CHAPTER C6

OILY WATER RECOVERY SYSTEM

CONTENTS

ILLUSTRATIONS


FLUCTUATING PROCESS FLOW
ONLY WHEN MANUALLY DRAINED
SUCTION DRUMS
WATER SEPARATORS
COMPRESSORS AND SEAL OIL TANKS
FUEL GAS UNIT
FLUCTUATING PROCESS FLOW
DRAIN
COMP & GEN FUEL GAS KNOCKOUT POTS
FUEL GAS LOW TEMPERATURE SEPARATORS
FUEL GAS HEADER
EXISTING TCP2
CONDENSATE SURGE VESSEL
50°C
15 barg (OPERATING)
OIL SKIMMER
30 – 50°C
1.39 barg
HIGH PRESSURE NETWORK
LOW PRESSURE NETWORK

SECTION 1 – DESCRIPTION

Reference: PID 5424W 50 0040 03 – HP NETWORK
PID 5424W 50 0040 06 – LP NETWORK

1 SUMMARY

See illustrations C6.1, C6.2 and C6.3

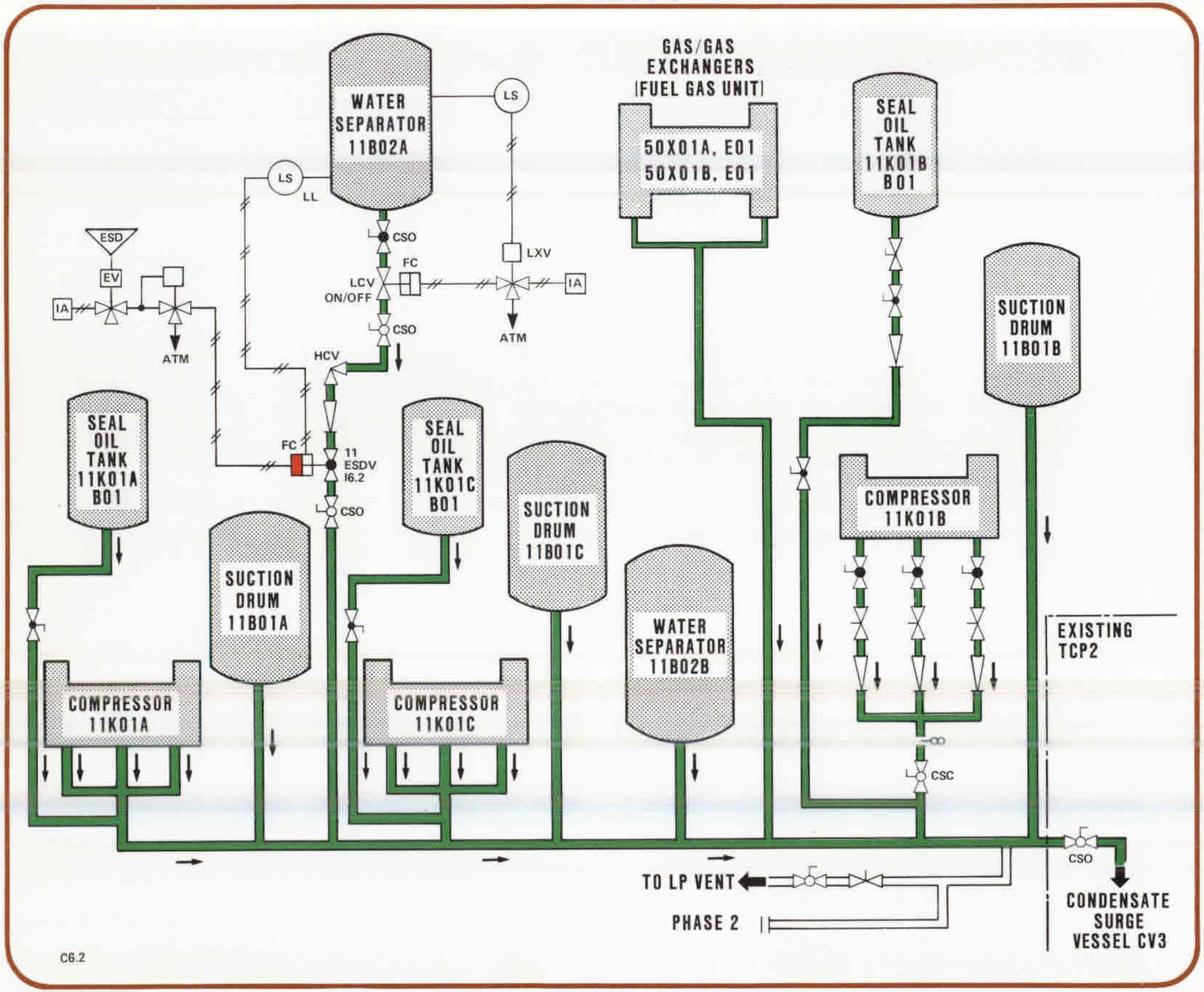
1.1 General

1.1.1 Oily water is removed from the inlet gas to the compressors to protect their internal structure and allow them to operate at maximum efficiency. Oily water recovered from the separator drums and at dead points in the Fuel Gas System is manually and automatically collected in the Oily Water Recovery System.

1.1.2 The system comprises two main networks which serve equipment operating at either high or low pressures respectively:

(a) High Pressure Network.

(b) Low Pressure Network.


WATER SEPARATOR 11B02A
LS
LS
LL
CSO
LCV ON/OFF
FC
LXV
IA
ATM
CSO
ESD
EV
IA
ATM
HCV
FC
11 ESDV I6.2
CSO
GAS/GAS EXCHANGERS (FUEL GAS UNIT)
50X01A, E01
50X01B, E01
SEAL OIL TANK 11K01B B01
SUCTION DRUM 11B01B
SEAL OIL TANK 11K01A B01
SUCTION DRUM 11B01A
SEAL OIL TANK 11K01C B01
SUCTION DRUM 11B01C
WATER SEPARATOR 11B02B
COMPRESSOR 11K01B
COMPRESSOR 11K01A
COMPRESSOR 11K01C
CSC
EXISTING TCP2
CSO
TO LP VENT
PHASE 2
CONDENSATE SURGE VESSEL CV3

1.2 High Pressure Network

See illustration C6.2

1.2.1 The High Pressure Network collects oily water from the following equipment items:

(a) Suction Drums 11B01A/B/C.

(b) Water Separators 11B02A/B.

(c) Compressors 11K01A/B/C (drains, including seal oil tanks).

(d) Fuel Gas Unit Gas/Gas Exchangers 50X01A/B.E01 (drains).

1.2.2 Each line from a suction drum or water separator is provided with the following valves and instrumentation prior to entering the High Pressure Oily Water Network:

(a) One On/Off level control valve with associated isolating valves. This valve is operated by air and controlled by a level switch which is mounted on the water separator. The level control valve fails closed in the event of a loss of air.

(b) One hand-operated angle valve which will allow pressure reduction prior to the condensate entering the High Pressure System.

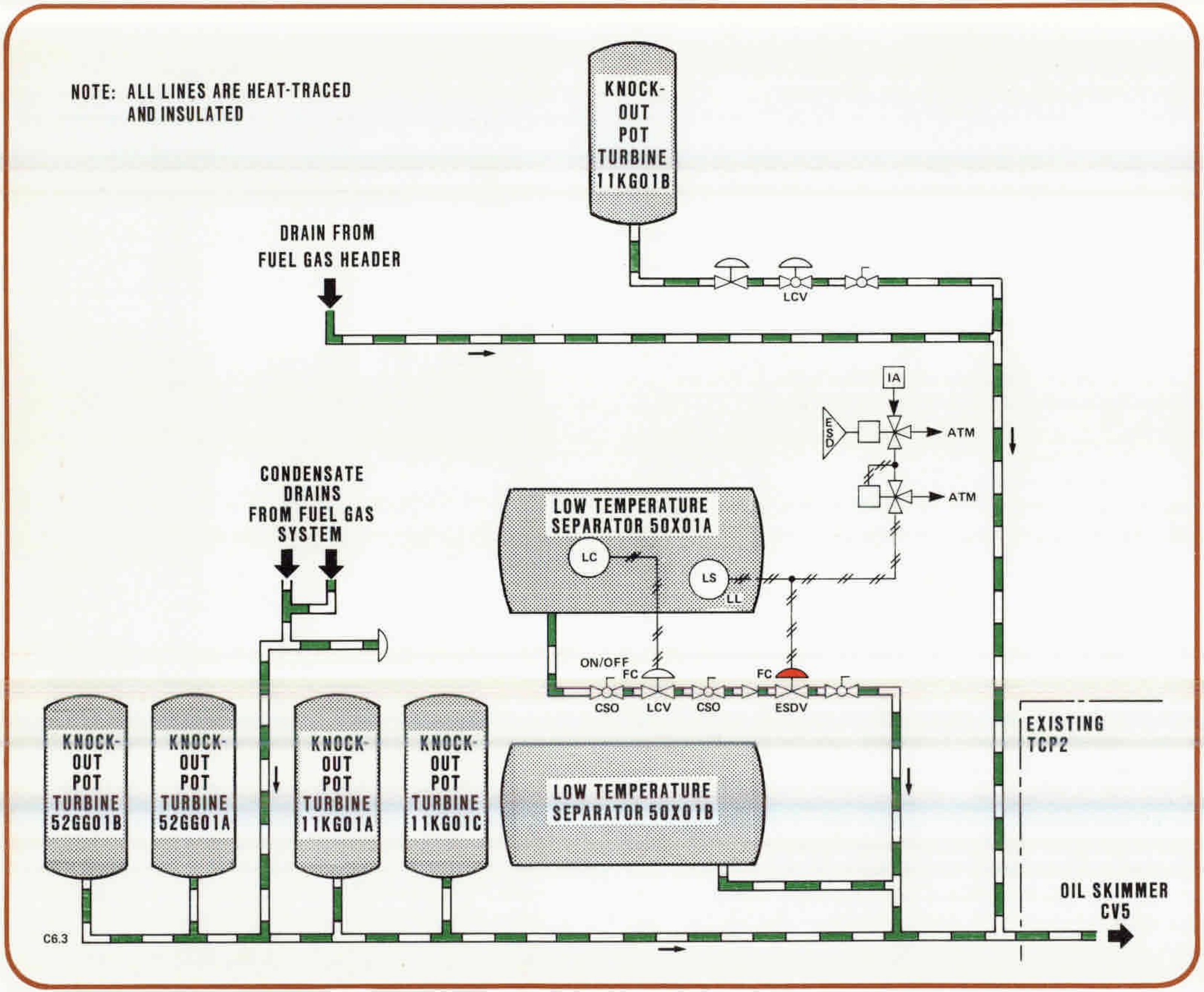
(c) One automatic air-operated shut-off valve responding to a low-low level signal in the water separator. The valve can be manually reset and fails closed on loss of air. It is connected to the ESD system.

1.2.3 Each compressor has three lines to the High Pressure Network and each line is provided with two isolating valves and a check valve. Each compressor seal oil tank has five drain lines, each with two isolating valves and a check valve.

1.2.4 All oily water entering the High Pressure Network is collected in one main header which in turn is connected to the existing condensate system of TCP2 Treatment.

1.2.5 The High Pressure Network is connected to the LP Vent System, via two isolating valves, just upstream of the oily water discharge to TCP2–T.

1.2.6 Oily water eventually enters the Condensate Surge Vessel, CV3.



NOTE: ALL LINES ARE HEAT-TRACED AND INSULATED
KNOCK-OUT POT TURBINE 11KG01B
DRAIN FROM FUEL GAS HEADER
LCV
IA
ESD
ATM
ATM
CONDENSATE DRAINS FROM FUEL GAS SYSTEM
LOW TEMPERATURE SEPARATOR 50X01A
LC
LS
LL
ON/OFF
FC
FC
CSO
LCV
CSO
ESDV
EXISTING TCP2
KNOCK-OUT POT TURBINE 52GG01B
KNOCK-OUT POT TURBINE 52GG01A
KNOCK-OUT POT TURBINE 11KG01A
KNOCK-OUT POT TURBINE 11KG01C
LOW TEMPERATURE SEPARATOR 50X01B
OIL SKIMMER CV5
C6.3

1.3 **Low Pressure Network**

See illustration C6.3

1.3.1 The Low Pressure Oily Water Network collects oily water from Knockout Pots on all five Gas Turbines. It takes this water from three dead points, located on the turbogenerator and turbo-compressor fuel header. In addition, it also removes oily water from the Fuel Gas System low temperature separators, 50X01A/B.

1.3.2 Each Fuel Gas Low Temperature Separator is provided with the following valves and instrumentation prior to entering the Low Pressure Network:

(a) One pneumatically operated level control valve and two manual isolating valves. The level control valve is operated by a level control switch on the separator drum, and fails closed on loss of instrument air. The level switch is an ON/OFF type and will open the valve when high level is detected in the separator.

(b) One air-operated automatic shut-off valve actuated by a low-low level switch in the drum, with manual reset facility and a connection to the ESD system.

1.3.3 All the oily water collected by the Low Pressure Network is collected in a single main header and discharged at 1.39 barg to the Oil Skimmer Unit, CV5, in TCP2 Treatment.

2 EXTERNAL UTILITIES AND INTERFACES

1. The following external utilities are required for both LP and HP Networks:

(a) Electrical power for solenoid valves and alarm transmissions.

(b) Instrument air for valve operation.

2. The Oily Water Recovery System interfaces with:

(a) Fuel Gas System.

(b) Water Separators.

(c) Gas Turbines.

(d) Compressors.

SECTION 2 – OPERATION AND CONTROLS

1 PRESTART CHECKS

Ensure that electrical power and instrument air are available and that valves are set according to the relevant Start-up procedure.

2 START-UP

When all the valves are at their correct settings, the system is considered operational in the Compression Package. However, neither the Oil Skimmer nor Condensate Surge Vessel can receive oily water unless the corresponding Oily Water Recovery System in the Treatment Area is also operational.

3 CHECKS AFTER START-UP

Valve settings should be checked regularly.

4 OPERATING VARIABLES

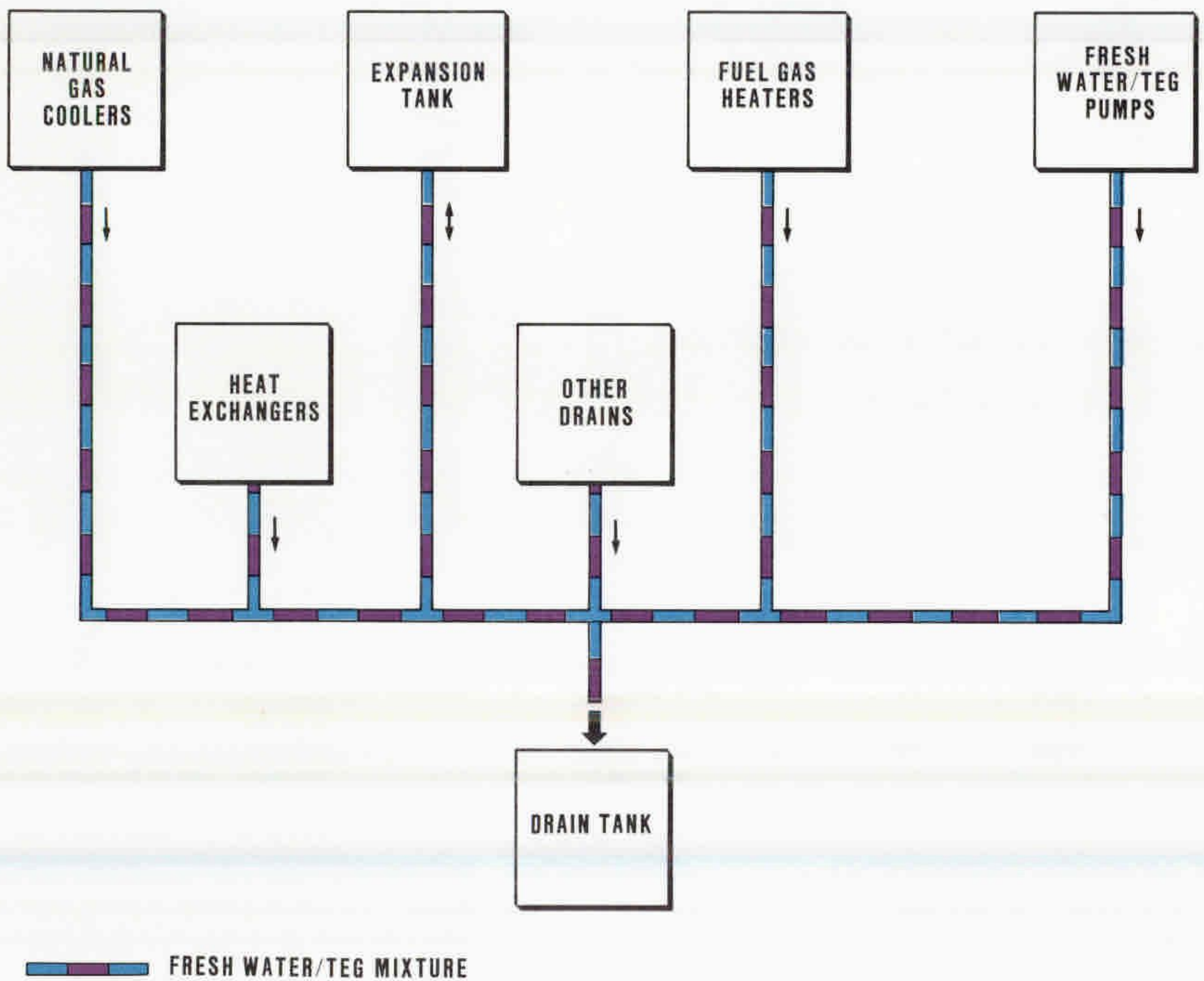
Low-low pressure on instrument air will cause all LC valves, automatic shut-off valves, and PC valves to fail closed. Valves must be reset to automatic operation as soon as instrument air is available again.

CHAPTER C7

CLOSED FRESH WATER/TEG DRAIN SYSTEM

CONTENTS

ILLUSTRATIONS


NATURAL GAS COOLERS
EXPANSION TANK
FUEL GAS HEATERS
FRESH WATER/TEG PUMPS
HEAT EXCHANGERS
OTHER DRAINS
DRAIN TANK
FRESH WATER/TEG MIXTURE

SECTION 1 – DESCRIPTION

Reference: PID 5424W 50 0040 07

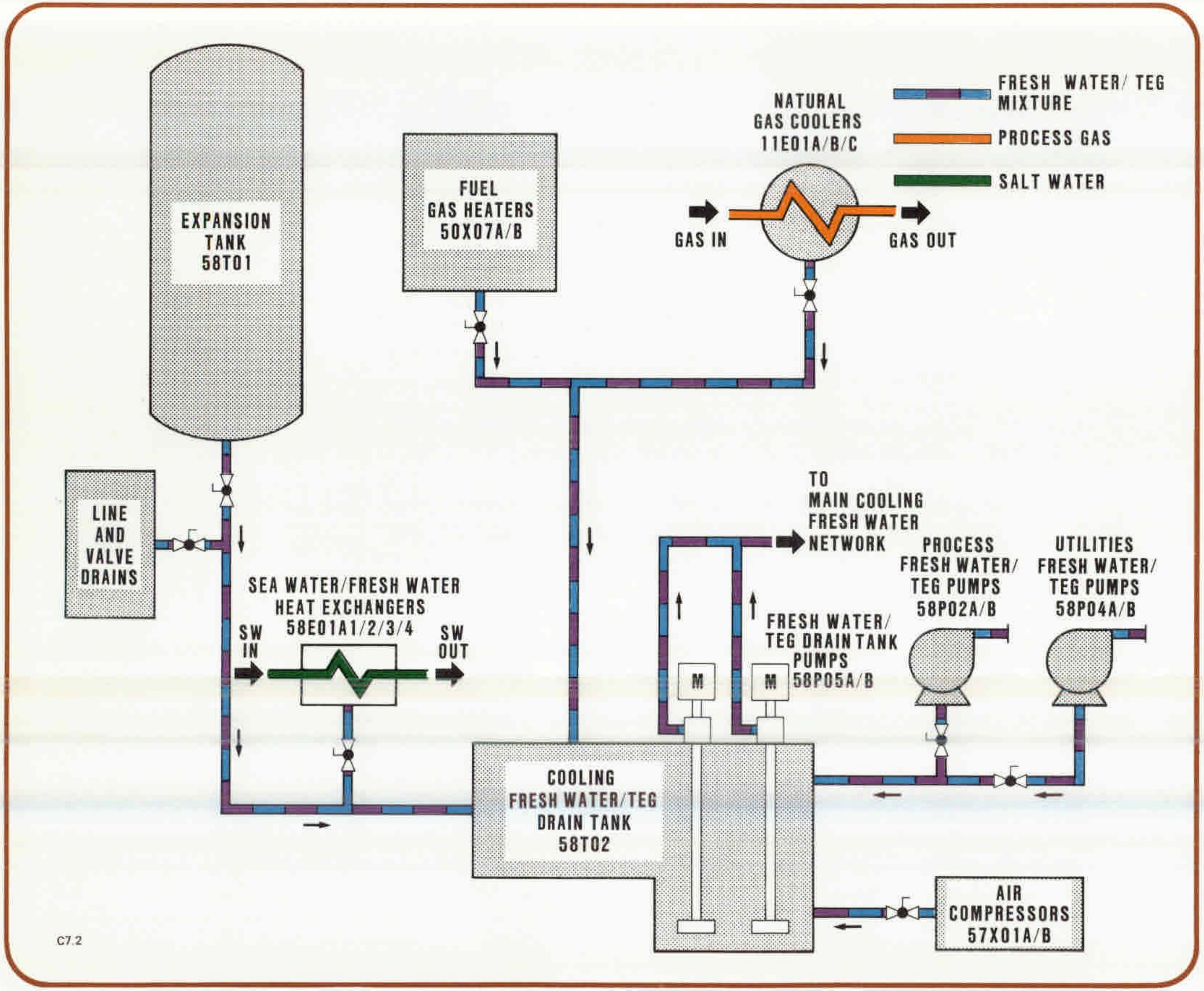
1 SUMMARY

See illustrations C7.1 and C7.2

1.1 The Closed Fresh Water/TEG Drain System is used to recover Fresh Water/TEG drained from the lowest points of lines and equipment associated with the Main Cooling Fresh Water Network. Flow through the system is only to be expected when items of equipment are isolated for maintenance work. The system is separated from the Open Drainage System in order to conserve TEG and to prevent its discharge to the sea.

1.2 All liquid from this system is recovered in the cooling fresh water/ TEG drain tank 58T02. Flow to this tank is by gravity.

1.3 Two pumps, 58P05A/B, are mounted in the drain tank and connect the drain system to the Utilities Fresh Water Cooling System. This interface is fully described in Chapter C14.



EXPANSION TANK 58T01
FUEL GAS HEATERS 50X07A/B
NATURAL GAS COOLERS 11E01A/B/C
GAS IN
GAS OUT
FRESH WATER/ TEG MIXTURE
PROCESS GAS
SALT WATER
LINE AND VALVE DRAINS
SEA WATER/FRESH WATER HEAT EXCHANGERS 58E01A1/2/3/4
SW IN
SW OUT
TO MAIN COOLING FRESH WATER NETWORK
PROCESS FRESH WATER/ TEG PUMPS 58P02A/B
UTILITIES FRESH WATER/ TEG PUMPS 58P04A/B
FRESH WATER/ TEG DRAIN TANK PUMPS 58P05A/B
M
M
COOLING FRESH WATER/TEG DRAIN TANK 58T02
AIR COMPRESSORS 57X01A/B

2 EQUIPMENT DETAILS

2.1 Drain Tank 58T02

Capacity	–	80 m^3.
Operating pressure	–	Atmospheric.
Operating temperature	–	–9°C to +45°C.

2.2 The system serves the following items of equipment:

(a) Expansion Tank 58T01.

(b) Natural Gas Coolers 11E01A/B/C.

(c) Fuel Gas Heating Package 50X07.

(d) Sea Water/Fresh Water Exchangers 58E01A1/2/3/4.

(e) Process Fresh Water/TEG Pumps 58P02A/B.

(f) Utilities Fresh Water/TEG Pumps 58P04A/B.

(g) Various flow lines in the fresh water cooling system.

3 EXTERNAL UTILITIES

None.

SECTION 2 – OPERATION AND CONTROLS

1 PRESTART CHECKS

Ensure that all drain valves are closed.

2 START-UP

Once the main fresh water cooling system is operational, all drain valves should remain fully closed, unless specific equipment items or lines have to be drained.

SECTION 3 – TROUBLESHOOTING

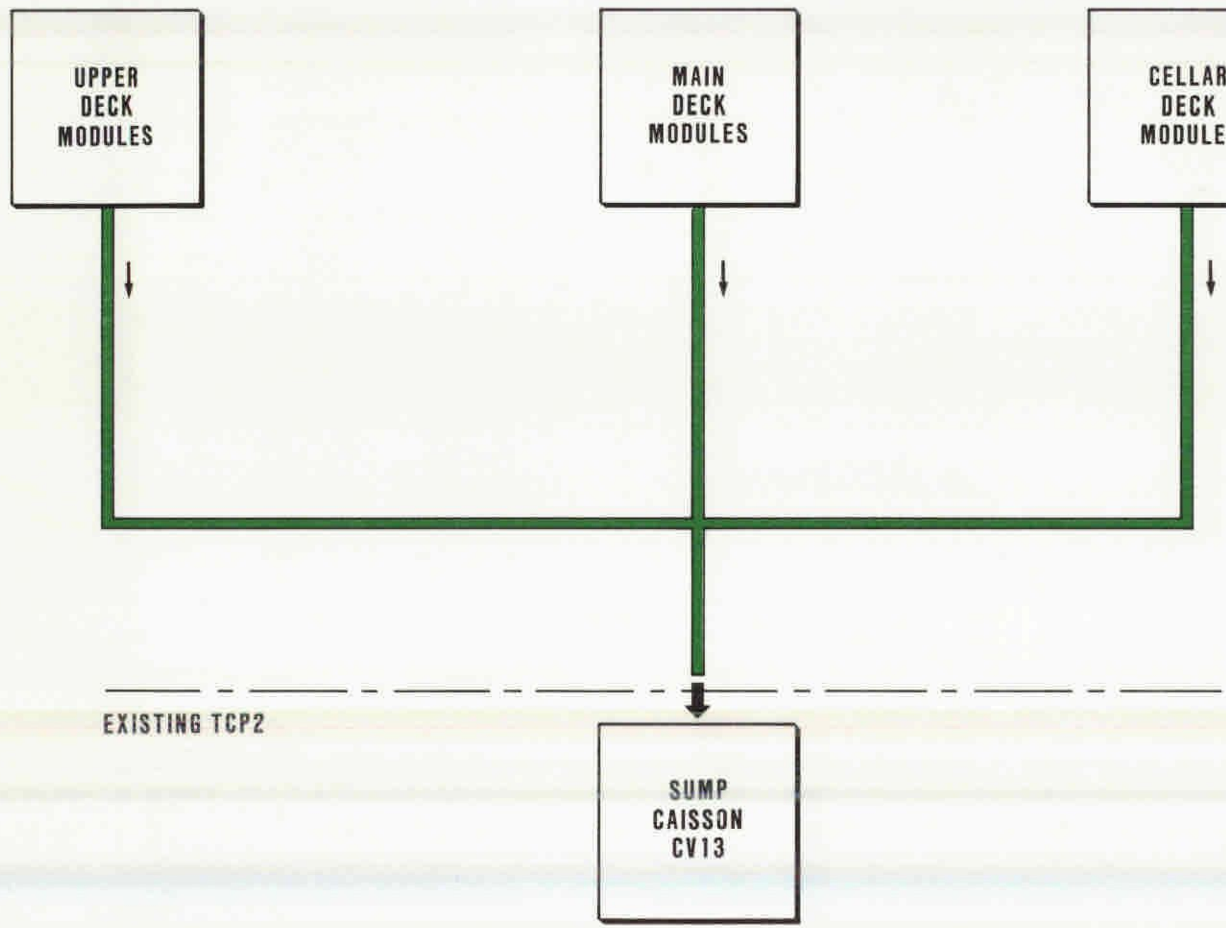
The level in the drain tank should be checked periodically and, if the level rises, valves on the drain system should be checked for leaks.

CHAPTER C8

OPEN DRAINAGE SYSTEM

CONTENTS

ILLUSTRATIONS


UPPER DECK MODULES
MAIN DECK MODULES
CELLAR DECK MODULES
EXISTING TCP2
SUMP CAISSON CV13

SECTION 1 – DESCRIPTION

Reference: PID 5424W 50 0040 08

1 SUMMARY

See illustrations C8.1 and C8.2

1.1 Maintenance drainage and washdown water from the closed decks of the Compression Package, and rainwater from module roofs, is collected in the Open Drainage System.

1.2 The upper levels, Main Deck and Cellar Deck of the Compression Package all have one or more drain lines collecting water from open gulleys and funnels placed beneath equipment items.

1.3 Water flows by gravity through three main headers to a sump caisson, CV13, located in the TCP2 Treatment area.

1.4 The caisson stands with its upper section above sea level and its lower section below sea level. The lower end is open to the sea. On passing into the caisson, any oil which may be mixed with the water separates, leaving oil floating on the surface.

1.5 In the caisson, oil level is sensed by a bubble system and, when sufficient oil has accumulated, it is pumped out by a waste oil sump pump, CP3.

1.6 The sump pump is manually operated and submersible. It discharges to the condensate slops header and thence to the oil skimmer, CV5.

1.7 To avoid explosive hydrocarbon products re-entering modules from the main drain headers through the open gulleys, the drain lines are of the 'goose-neck' type. The seal is made by drainage water.

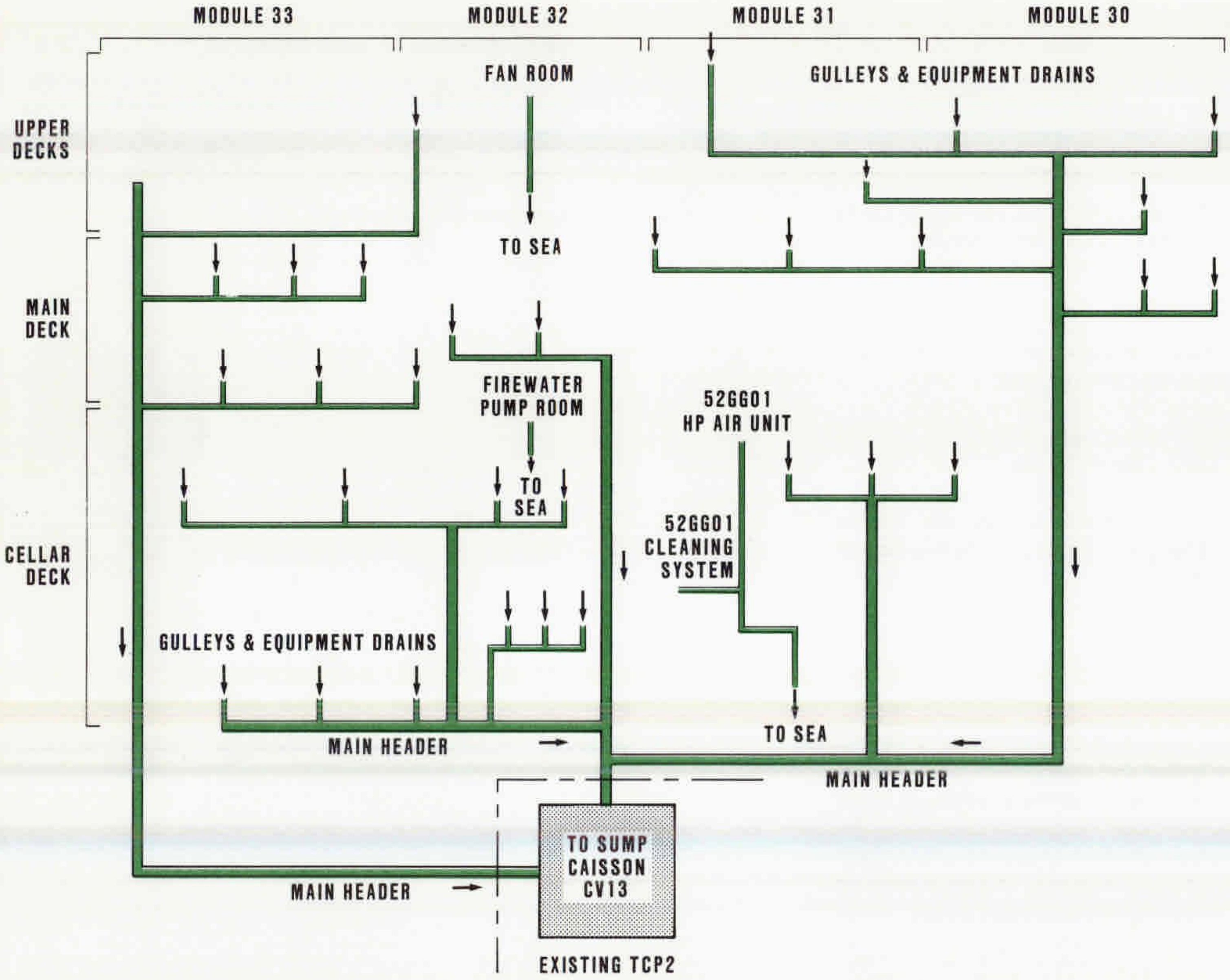
1.8 The following drainage lines do not discharge to the sump caisson but direct to sea:

(a) Firewater Pump Room on Cellar Deck.

(b) Cleaning system of Power Generators on Cellar Deck.

(c) HP air unit of Power Generators on Cellar Deck.

(d) Fan Room drain on Upper Deck.


MODULE 33
MODULE 32
MODULE 31
MODULE 30
UPPER DECKS
MAIN DECK
CELLAR DECK
FAN ROOM
TO SEA
GULLEYS & EQUIPMENT DRAINS
FIREWATER PUMP ROOM
TO SEA
52GG01 HP AIR UNIT
52GG01 CLEANING SYSTEM
GULLEYS & EQUIPMENT DRAINS
MAIN HEADER
TO SEA
MAIN HEADER
TO SUMP CAISSON CV13
MAIN HEADER
EXISTING TCP2

SECTION 2 – OPERATION AND CONTROLS

1 PRESTART CHECKS

Ensure that the oil level sensor and sump pump are operational in caisson CV13 (TCP2–T).

2 CHECKS AFTER START-UP (TCP2–T)

2.1 Ensure that valves on the discharge side of the sump pump are open when the sump caisson is being emptied of oil.

2.2 Periodically check the oil level in sump caisson CV13, on the level indicator.

PART D

GAS COMPRESSION – OPERATION

CONTENTS

CHAPTER D1

GAS COMPRESSION – OPERATION

CONTENTS

ILLUSTRATIONS

SECTION 1 – OPERATION AND CONTROL

NOTE
This Chapter should be read in conjunction with Chapter C2 and its references.

1 OPERATING PHILOSOPHY

See illustration C2.1

1.1 Compression unit start-up and all other operations must be performed in strict co-ordination with QP Control Room.

1.2 Before any major operation, a functional test of all the ESDVs in the treatment and compression lines must be made.

1.3 The treatment unit (TP1 for line 'A') upstream and downstream of the compression unit can be set as follows if compressor unit operation is imminent. The valve settings for line 'B' are similar:

(a) Trains 'A' and 'B' under field pressure and operating according to Treatment Operating Manual, but with FCV closed preventing delivery to the sales gas header. Train 'C' is isolated.

(b) Compression unit isolated from treatment unit in the following manner:

(i) Valves to compression unit downstream of the FWKOs, and their bypasses, closed. Namely HVV1A/B.3, and ESDVB.1, on TP1, and ESDVB.1 and HVB.1 in the compression unit.

(ii) Valves from compression unit upstream of the glycol contactors, and their bypasses, closed. Namely HVB.2 and ESDVB.2 in the compression unit, and ESDVB.2 and HVV1A/B.4.

1.4 Each turbocompressor is controlled from starting, through loading and shutdown by its own control panel in Module 32. This is termed 'Local Operation'. A remote panel may also be equipped to allow full operation. If this is the case, the remote panel must be selected by the Mode Select switch.

1.5 The unit will operate over the speed range 2000 to 4200 rev/min in response to operator or pipeline control inputs. Set speeds will be maintained up to the Base Load rating of the turbine as determined by platform conditions at the time.

1.6 Following the starting sequence, all operating functions are transferred to the remote panel if fitted. Stop and shutdown functions are paralleled so that shutdown may be initiated locally even while in remote operation. The instructions given in this Chapter deal solely with operation from the unit local panel.

2 PRESTART CHECKS (LINE 'A' ONLY)

2.1 Platform and Compression System Utilities

Check that all platform and compression system utilities are available.

2.2 Bringing the Line to the Compression Unit up to Pressure

See illustration C2.1

(1) Open bypasses of ESDVB.1 on TP1 and ESDVB.1 in the compression unit.

(2) Slowly open bypass of HVV1A.3 and increase pressure in interconnecting line in 20 barg steps.

(3) When upstream interconnecting line is in pressure equilibrium with the treatment unit, open HVV1A/B.3 and ESDVB.1 on TP1 and ESDVB.1 in the compression unit. Close bypasses.

2.3 Bringing Line from Compression Unit to Glycol Contactor up to Treatment Unit Pressure

See illustration C2.1

Note that HV1A/B/C.1 are on a direct line from the FWKO to the glycol contactor. Note also that blowdown ESDVB.4 and ESDVB.5 in the compression unit are ready, tested and with their block valves sealed open.

(1) Open bypasses of ESDVB.2 on TP1, and ESDVB.2 in the compression unit.

(2) Slowly open bypass of HVV1A.4.

(3) Open HVV1A/B.4 and ESDVB.2 on TP1, and ESDVB.2 in the compression unit. Close bypasses.

(4) Close HV1A/B.1 and close their bypasses.

(5) Open bypass of HVB.1 and increase pressure in compression line to pressure of treatment unit in 20 barg steps.

2.4 Initial Status of Compression System

2.4.1 All pre-commissioning sheets completed and signed off.

2.4.2 All the gas lines and compressors deaerated and under positive pressure of gas. (That includes lines 'A', 'B' and 'C'.)

2.4.3 Treatment unit and sales gas header ready for operation.

2.5 **Valve Settings**

In the following lists, line 'A' only is considered. The manual block valves of blowdown ESD valves in non-operational lines MUST BE CLOSED.

Identification	Open	Closed
ALL INSTRUMENT VALVES	X	
GAS INLET (see illustration C2.3)		
Block valves on 2in equilibrium line to 11B01A		X
Block valves on 2in equilibrium line to B01C		X
11ESDV11.1		X
11HV11.1		X
11ESDV11.1 bypass		X
11HV11.1 bypass		X
11B01A (see illustration C2.5 series)		
11LCV12.1		X
11LCV12.1 block valves	X	
11LCV12.1 bypass		X
11HCV12.3	X	
11ESDV12.2		X and Manually Reset
Sample connection valve		X

Identification	Open	Closed
GAS COMPRESSOR OUTLET (see illustration C2.5 series)		
11PSV13.14 block valve	X	
Anti-surge valves 11FCV13.1A/B	X	
11ESDV15.2		X and Reset
11ESDV15.2 block valves	X	
Block valves on 1in line to LP vent		X
11HV15.1		X
11HV15.1 bypass		X
11ESDV15.1		X
11ESDV15.1 bypass		X
Depressurising valves to LP vent		X
11B02A (see illustration C2.5 series)		
11PSV16.2 block valves	X	
11PSV16.3 block valves		X
11LCV16.1		X
11LCV16.1 block valves	X	
11LCV16.1 bypass		X
11HCV16.3	X	
11ESDV16.2		X and Manually Reset
Sample connection valve		X
GAS TO TP1 (see illustration C2.5 series)		
11ESDV17.1		X and Reset
11ESDV17.1 block valves	X	

Identification	Open	Closed
GAS TO FUEL GAS TREATMENT (see illustration C2.5 series)		
50ESDV16.4		X
50ESDV16.4 block valves		X
50ESDV16.4 bypass		X
GAS LINES TO/FROM LINE 'C' (see illustration C2.4 series)		
11HV21.1		X
11HV21.1 bypass		X
11HV25.2		X
11HV25.2 bypass		X
Block valves on 2in equilibrium line		X
Hand switch 11HS23.1 (to select Line 'A' or Line 'B')		Set to LINE 'C' OUT OF SERVICE
INLET AND OUTLET GAS LINES (see illustration C2.1)		
Main valves and bypass on gas lines between treatment and compression inlet		X
FCV on gas lines outlet to glycol contactors		X
FUEL GAS SYSTEM (see illustration C2.7)		
50ESDV50.5 on gas inlet line	X and Manually Reset	
LIQUID KNOCKOUT POT (see illustration C2.7)		
Manual valve on O.W. line		X
50LCV50.2/3 on O.W. line		X (automatically)
50PSV50.2 block valves	X	
50PSV50.3 block valves		X

Identification	Open	Closed
GAS FILTERS (see illustration C2.7)		
Purging connection valves		X
One filter set on operation by manual selector	X	
50PSV50.1 block valve	X	
50PSV50.2 block valve	X	
'Open drain' valves		X
50Pd150.4 block valves	X	
Fire valve 50ESDV51.1	Manually set	
Block Valve Downstream 50ESDV51.1	X	
50PCV51.1		X (by sequence)
50PXV51.2		X (by sequence)
50PXV51.1		X (by sequence)
50PCV51.2		X (by sequence)
GAS TURBINE LUBE OIL SYSTEM (see illustrations C2.8(2) & (3))		
Block valve on line to booster pump suction	X	
Block valve on line to main oil pump suction	X	
One oil cooler set on operation by manual interlock	X	
11TCV40.1 outlet cooler	Set for 82°C	
Cooling water inlet and outlet valves	X	
One filter set on operation by manual interlock	X	

Identification	Open	Closed
COMPRESSOR LUBE OIL SYSTEM (see illustration C2.10)		
Main LO pumps suction and discharge valves	X	
Standby LO pumps suction and discharge valves	X	
Spare standby LO pump suction and discharge valves	X	
One oil cooler set on operation by manual interlock	X	
Cooling water inlet and outlet valves	X	
Bypass of three-way valve upstream oil cooler	X	
One filter set on operation by manual interlock	X	
Bypass of three-way valve upstream oil filter	X	
Block valves on oil filters PDI	X	

Identification	Open	Closed
COMPRESSOR SEAL OIL SYSTEM (see illustration C2.11)		
Main SO pump suction and discharge valves	X	
Standby SO pump suction and discharge valves	X	
11PdCV51.7 block valves	X	
11PdCV51.7 bypass		X
11LCV54.1 block valves	X	
11LCV54.1 bypass		X
11PSV54.1 block valves	X	
11PSV54.2 block valves		X
Gas line valve from overhead seal oil tank to 11PdCV51	X	
Block valves upstream both seal oil traps	X	
Block valve on bypass line upstream seal oil traps		X
Block valves on seal oil traps vent lines	X	
LP vent orifice bypass valve		X

3 START-UP – INITIAL CONDITIONS

Proceed as follows at the main control panel:

(1) Set the Remote/Local selector switch to LOCAL.

(2) Set the Engine Lock-out switch to RUN.

(3) Set the lube and seal oil system to AUTO. In the ON position, the compressor lube and seal oil systems are energised and operate continuously – regardless of system requirements. Consequently the 'On' position is used only for start-up of a unit that has been shut down for a long time. The 'Auto' position will cause seal oil system to respond to process gas pressure in the unit and is used primarily for standby and normal operating conditions. Maintenance of the seal oil level will be based on overhead tank level and pressure in the process loop.

(4) Select and start the duty ventilation fan (see illustrations D1.1 and D1.2). The Secondary Fan Select switch serves to select which fan operates while a unit is in standby position. This is a safety consideration and is provided to allow equalisation of operating time on the fans while on standby. One fan is required while on standby at all times. During start-up, both fans run. After unit is on-line, both fans normally run; should they fail, the unit (still adequately ventilated) will continue to run. On a stop signal, if fans are inoperative, a normal trip will occur. (Turbine hood becomes a Class I hazard without ventilation.)

(5) Switch on the polluted seal oil tank heater.

(6) Switch the compressor lube oil tank heater to AUTO.

In the Control Room:

(7) Give authorisation for the following valves to be opened from their local panels:

(a) 11ESDV11.1 and 11ESDV15.1.

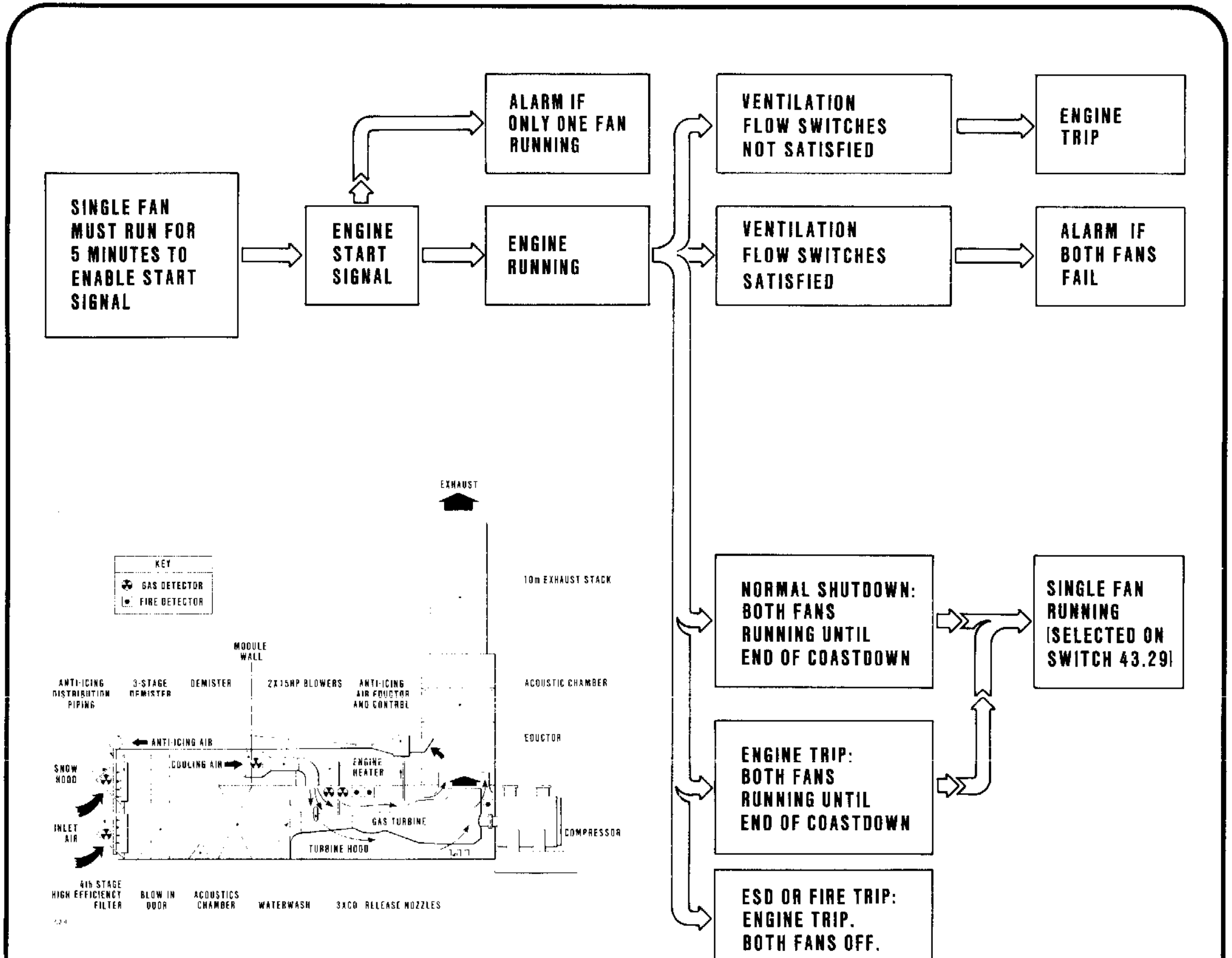
(b) 11HV11.1 and 11HV15.1.

(8) As soon as gas pressure is in balance between the compression unit and the treatment unit, open HVB1, HVB2 in the compression unit and close their bypasses.

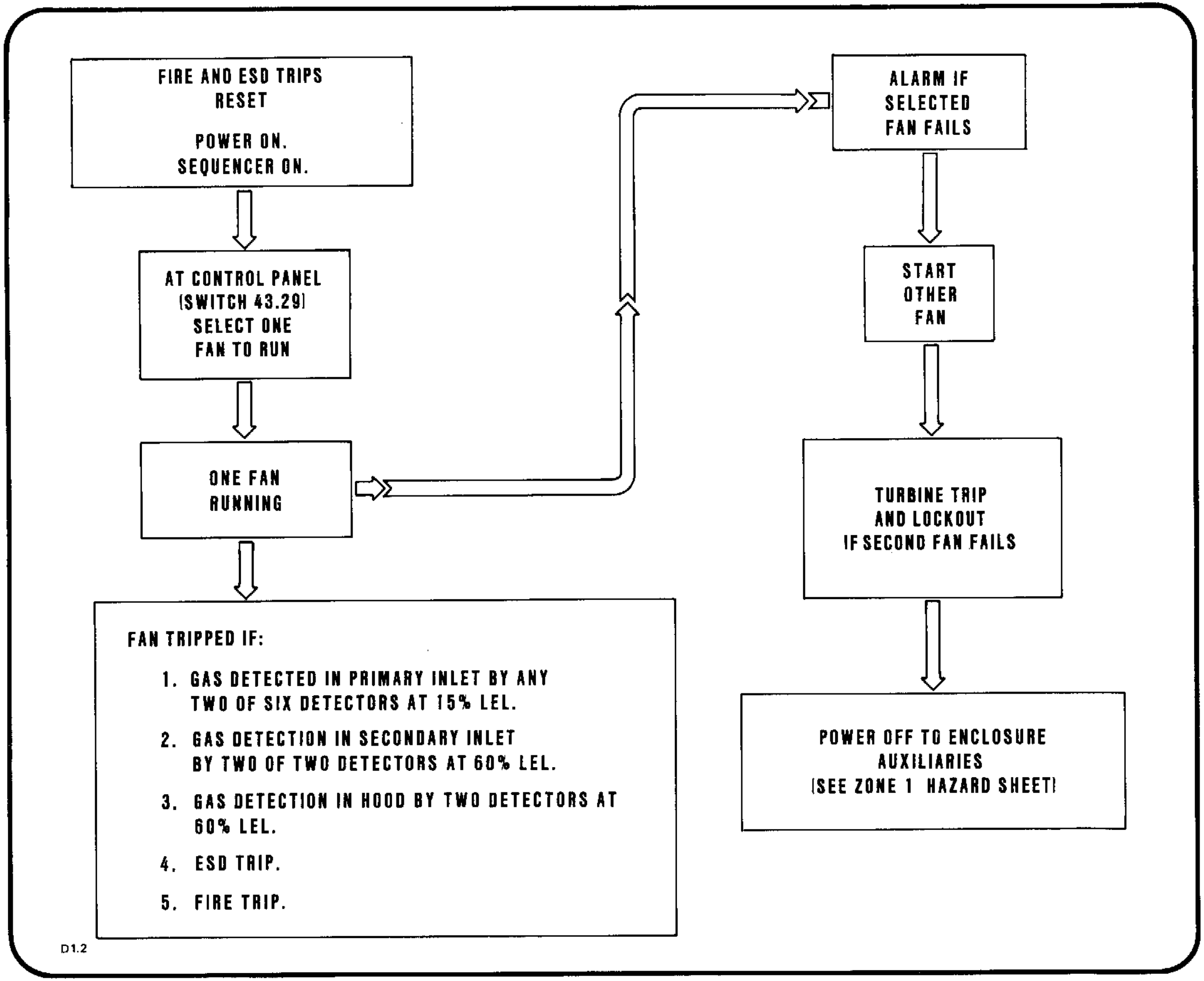
(9) Set compressor discharge pressure controller 11PIC13.7 to MANUAL.

(10) Open the starting anti-surge valve 11FCV13.1B.

(11) At the Motor Control Centre, ensure that all circuit breakers and motor starters are in the ON or AUTO position.


SINGLE FAN MUST RUN FOR 5 MINUTES TO ENABLE START SIGNAL
ENGINE START SIGNAL
ALARM IF ONLY ONE FAN RUNNING
ENGINE RUNNING
VENTILATION FLOW SWITCHES NOT SATISFIED
ENGINE TRIP
VENTILATION FLOW SWITCHES SATISFIED
ALARM IF BOTH FANS FAIL
NORMAL SHUTDOWN: BOTH FANS RUNNING UNTIL END OF COASTDOWN
SINGLE FAN RUNNING (SELECTED ON SWITCH 43.29)
ENGINE TRIP: BOTH FANS RUNNING UNTIL END OF COASTDOWN
ESD OR FIRE TRIP: ENGINE TRIP. BOTH FANS OFF.
EXHAUST
KEY
GAS DETECTOR
FIRE DETECTOR
10m EXHAUST STACK
MODULE WALL
ANTI-ICING DISTRIBUTION PIPING
3-STAGE DEMISTER
DEMISTER
2X15HP BLOWERS
ANTI-ICING AIR EDUCTOR AND CONTROL
ACOUSTIC CHAMBER
ANTI-ICING AIR
EDUCTOR
SNOW HOOD
COOLING AIR
ENGINE HEATER
INLET AIR
GAS TURBINE
COMPRESSOR
TURBINE HOOD
4th STAGE HIGH EFFICIENCY FILTER
BLOW IN DOOR
ACOUSTICS CHAMBER
WATERWASH
3XCO RELEASE NOZZLES

D1.1


FIRE AND ESD TRIPS
RESET
POWER ON.
SEQUENCER ON.
AT CONTROL PANEL
(SWITCH 43.29)
SELECT ONE
FAN TO RUN
ONE FAN
RUNNING
FAN TRIPPED IF:
1. GAS DETECTED IN PRIMARY INLET BY ANY TWO OF SIX DETECTORS AT 15% LEL.
2. GAS DETECTION IN SECONDARY INLET BY TWO OF TWO DETECTORS AT 60% LEL.
3. GAS DETECTION IN HOOD BY TWO DETECTORS AT 60% LEL.
4. ESD TRIP.
5. FIRE TRIP.
ALARM IF
SELECTED
FAN FAILS
START
OTHER
FAN
TURBINE TRIP
AND LOCKOUT
IF SECOND FAN FAILS
POWER OFF TO ENCLOSURE
AUXILIARIES
(SEE ZONE 1 HAZARD SHEET)
D1.2

4 START-UP – AUTOMATIC SEQUENCING

See illustrations D1.3(1) and (2)

Set the Stop/Start switch to START on the main control panel. The following automatic sequence will take place:

(a) Two cooling fans will switch on. If not, the Incomplete Sequencer trip will result.

(b) Five-minute purge of enclosure will start.

(c) Seal oil system/lube oil systems will start.

(d) Warning horn will sound for five seconds.

After five minutes' purge:

(e) Starter will energise, accelerating rotor of gas generator to 1500 (N_2) rev/min.

(f) A 15-second purge will occur. After the purge, the ignition is turned on and the fuel valves opened.

(g) After ignition and initial gas generator acceleration, starter and ignition will cut off. Self-sustaining operation is achieved at N_2 speed of approximately 3400 rev/min and starter is cut off. The ignition is de-energised at N_2 speed of 5200 rev/min. N_2 rotor speed will be driven up to approximately 6200 rev/min to a stable idle speed. The power turbine will slowly increase N_3 speed until 1000 rev/min is reached, at which point the gas generator is programmed to rapidly increase power turbine/compressor N_3 speed to 2000 rev/min. At N_3 speed of 2000 rev/min, the turbine will settle out awaiting pipeline control signals.

The starting sequence to N_3 speed of 2000 rev/min is fully automatic and progress of the sequence is indicated by the sequence lights on the panel.

Loading of the unit after stabilisation of N_3 speed at 2000 rev/min is either manual by use of the governor control switch (18–1) or automatic by the pipeline process controller 11PIC13.7. Selection is made at the Main Control Panel by operation of the Manual/Auto Selector.

(A) PRE-START ACTIONS

1. SELECT 'LOCAL' OR 'REMOTE'
2. SELECT 'AUTO' OR 'MANUAL'
3. RESET TRIPS & SHUTDOWNS
4. START ONE SECONDARY AIR FAN

⇩

(B) PERMISSIVES FOR START

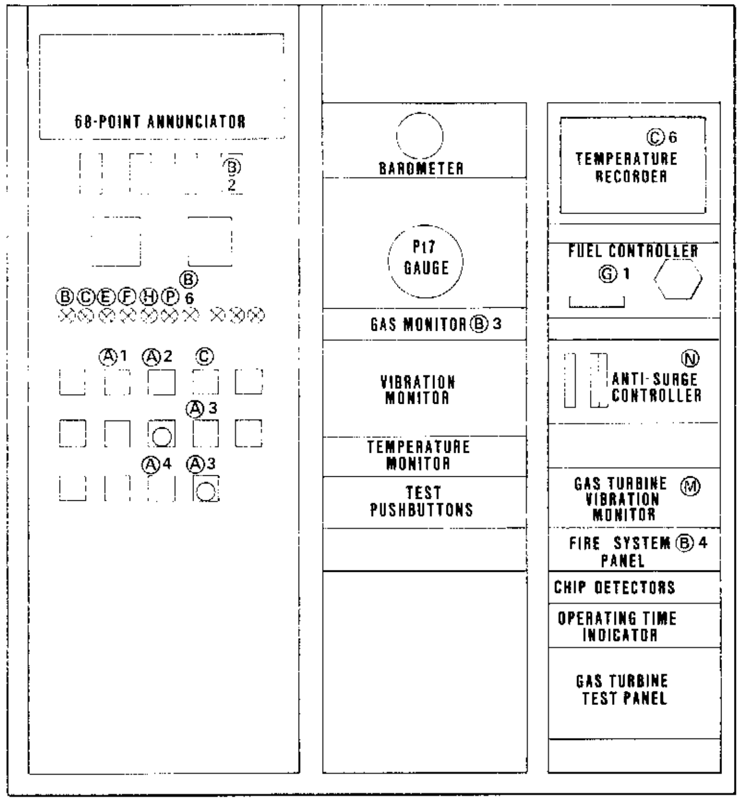
1. 5 MINUTES VENTILATION
2. SEAL OIL LEVEL OK
3. GAS DETECTION ON
4. FIRE SYSTEM RESET
5. LOCKOUTS RESET
6. PROCESS CHECKS OK
7. SURGE VALVES OPEN

⇩

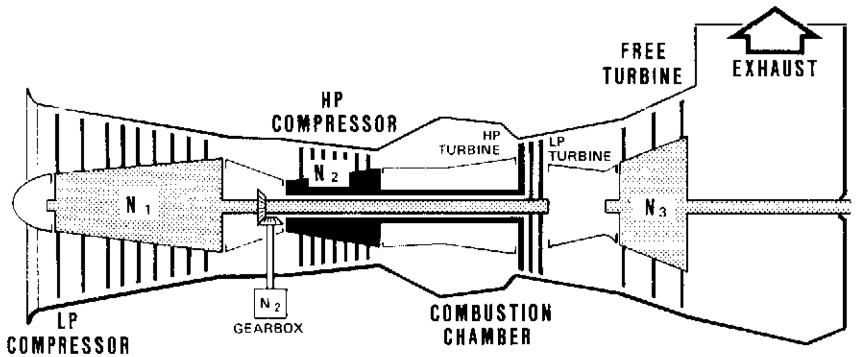
(C) SWITCH TO 'START'

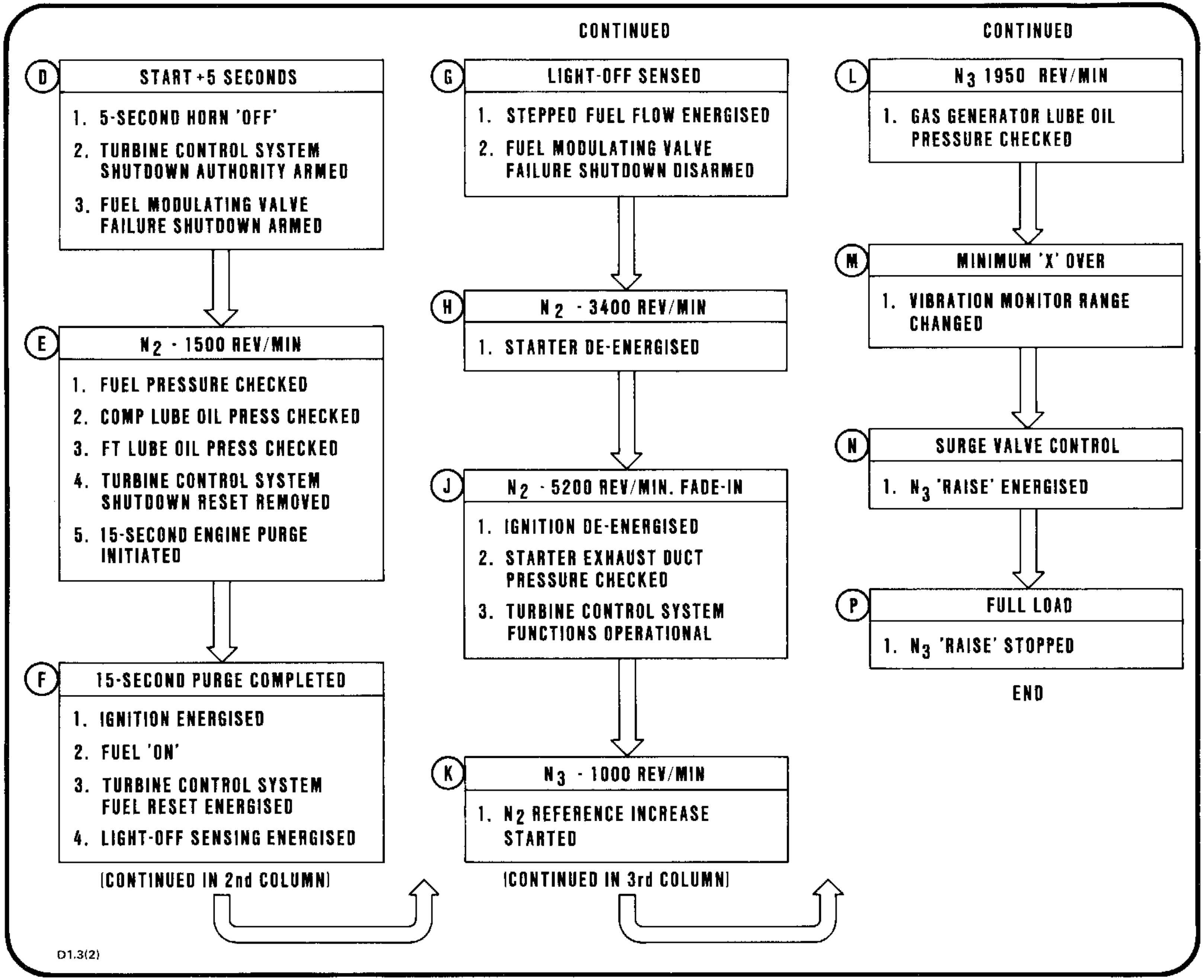
1. 5-SECOND HORN ACTIVATED
2. COMP LUBE OIL PUMP 'ON'
3. COMP SEAL OIL PUMP 'ON'
4. FT AC LUBE OIL PUMP 'ON'
*5. FT DC LUBE OIL PUMP 'ON'
6. TEMP RECORDER STARTED
7. STARTER ENERGISED
8. ENGINE HEATER 'OFF'
9. 2nd SECONDARY AIR FAN 'ON'

(CONTINUED ON D1.3(2) OPPOSITE)



*FT DC LUBE OIL PUMP STOPS WHEN WORKING PRESSURE REACHED




CONTINUED
CONTINUED
D
START +5 SECONDS
1. 5-SECOND HORN 'OFF'
2. TURBINE CONTROL SYSTEM SHUTDOWN AUTHORITY ARMED
3. FUEL MODULATING VALVE FAILURE SHUTDOWN ARMED
E
N_2 - 1500 REV/MIN
1. FUEL PRESSURE CHECKED
2. COMP LUBE OIL PRESS CHECKED
3. FT LUBE OIL PRESS CHECKED
4. TURBINE CONTROL SYSTEM SHUTDOWN RESET REMOVED
5. 15-SECOND ENGINE PURGE INITIATED
F
15-SECOND PURGE COMPLETED
1. IGNITION ENERGISED
2. FUEL 'ON'
3. TURBINE CONTROL SYSTEM FUEL RESET ENERGISED
4. LIGHT-OFF SENSING ENERGISED
(CONTINUED IN 2nd COLUMN)
G
LIGHT-OFF SENSED
1. STEPPED FUEL FLOW ENERGISED
2. FUEL MODULATING VALVE FAILURE SHUTDOWN DISARMED
H
N_2 - 3400 REV/MIN
1. STARTER DE-ENERGISED
J
N_2 - 5200 REV/MIN. FADE-IN
1. IGNITION DE-ENERGISED
2. STARTER EXHAUST DUCT PRESSURE CHECKED
3. TURBINE CONTROL SYSTEM FUNCTIONS OPERATIONAL
K
N_3 - 1000 REV/MIN
1. N_2 REFERENCE INCREASE STARTED
(CONTINUED IN 3rd COLUMN)
L
N_3 1950 REV/MIN
1. GAS GENERATOR LUBE OIL PRESSURE CHECKED
M
MINIMUM 'X' OVER
1. VIBRATION MONITOR RANGE CHANGED
N
SURGE VALVE CONTROL
1. N_3 'RAISE' ENERGISED
P
FULL LOAD
1. N_3 'RAISE' STOPPED
END
D1.3(2)

5 START-UP – LOADING AND CHECKS

See illustrations D1.4(1) and (2)

(1) Slowly increase the compressor discharge pressure by 11PIC13.7.

(2) Set 11TCV14.2 (cooling water through 11E01A) on automatic at 50°C.

(3) As soon as pressure at compressor discharge reaches 153 bar, slowly open HVB2 for gas delivery to sales header.

(4) Fully close the starting anti-surge valve 11FCV13.1B.

(5) When flow and pressure of gas are steady, set 11PIC13.7 to AUTO.

(6) Use the curves to assist determination of the optimum working point.

(7) Check the following after start-up:

(a) Gas temperature inlet and outlet.

(b) Gas pressure inlet and outlet.

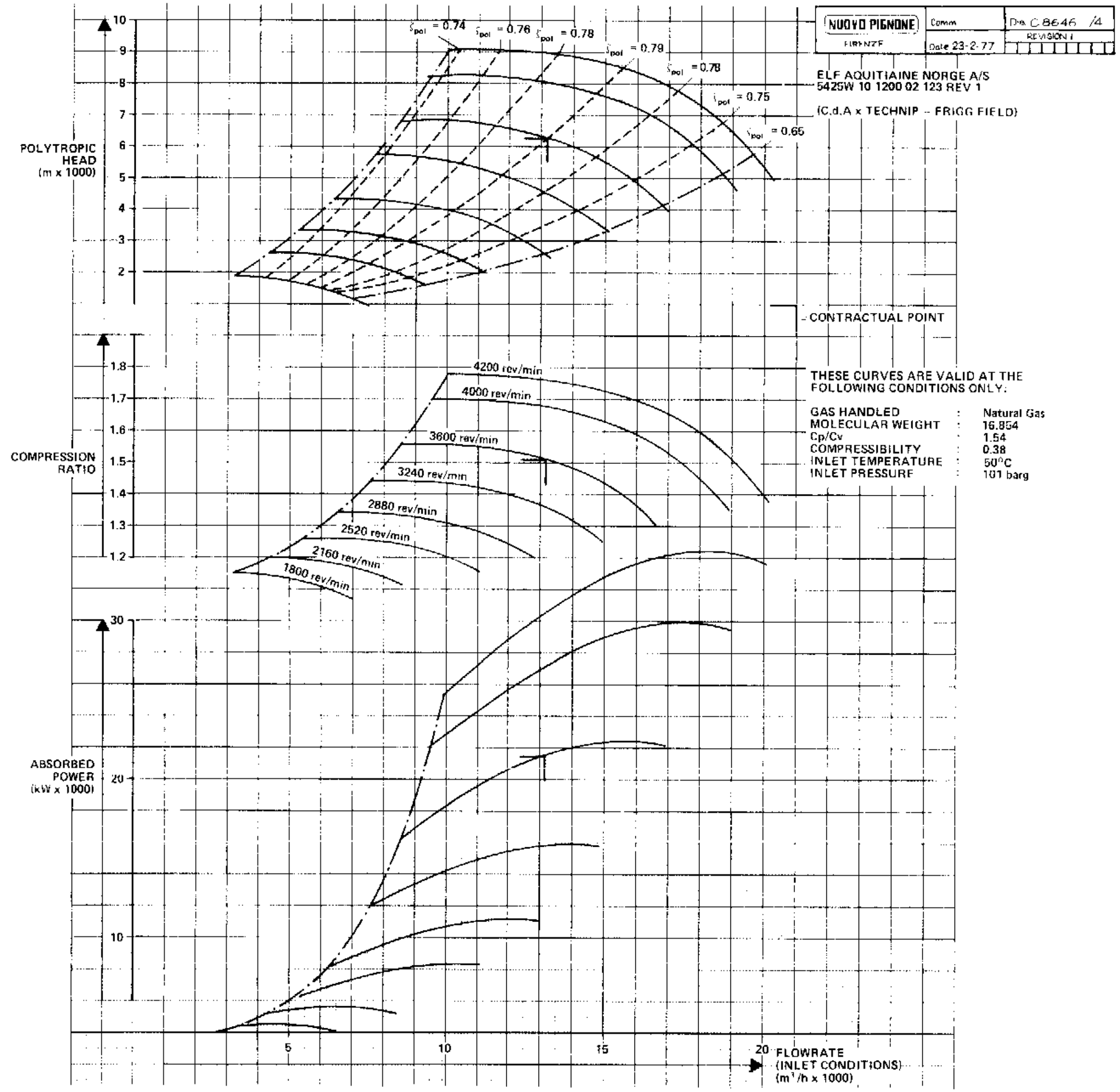
(c) Gas flow.

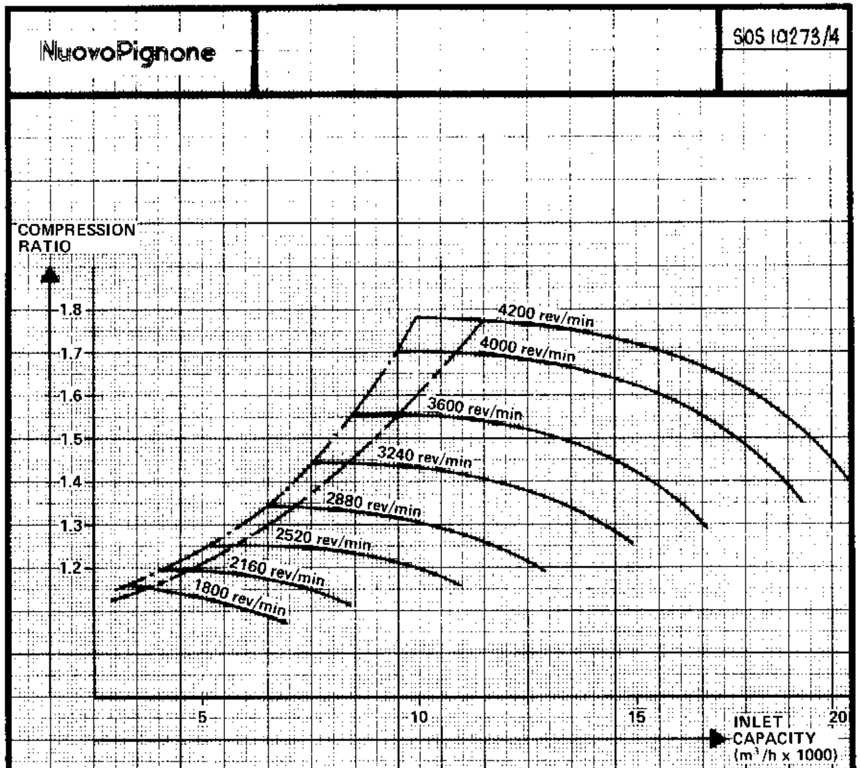
(d) Speed.

(e) Suction and discharge drum levels.

(f) Vibration, temperature, oil pressure and level.

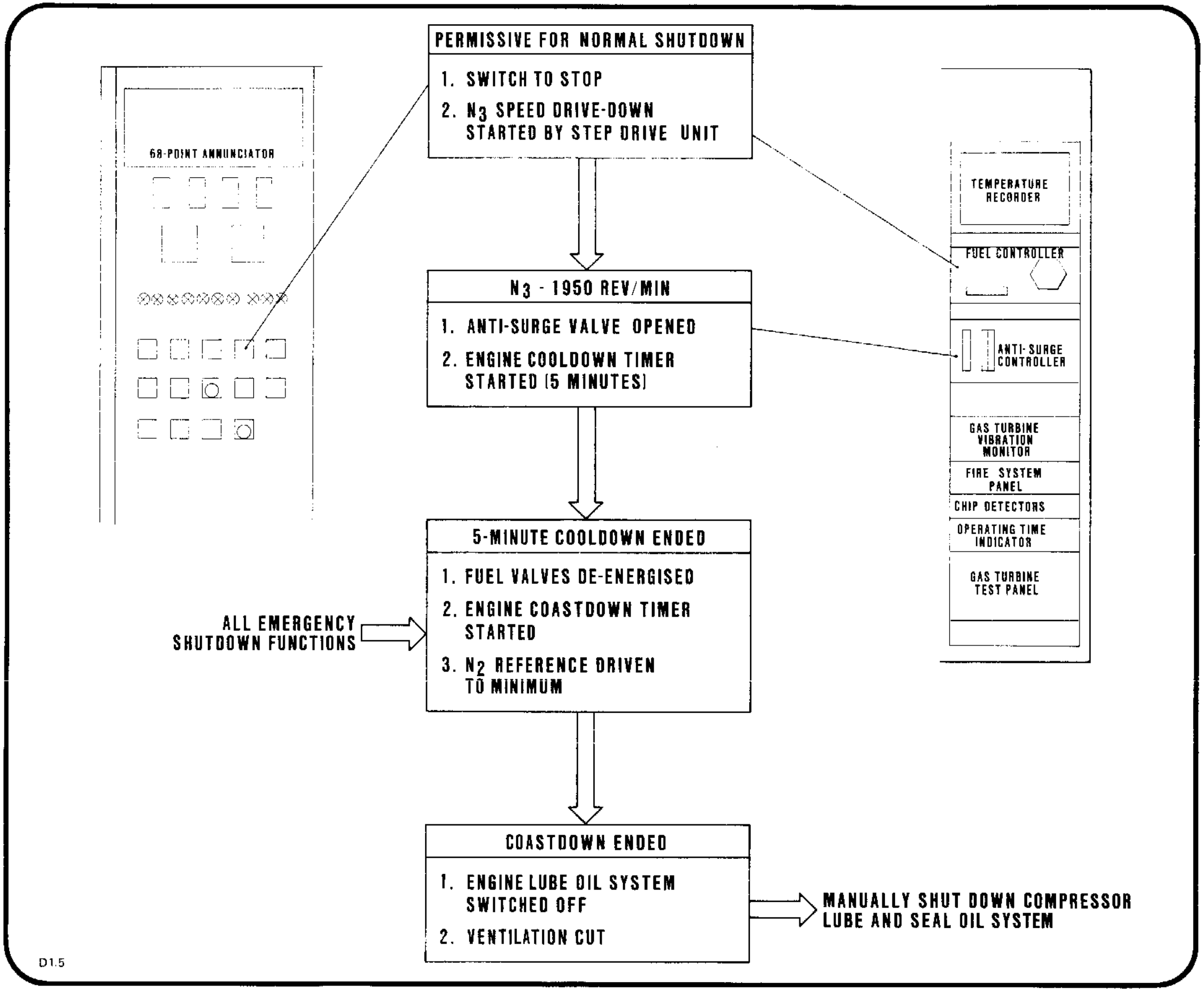
(8) Adjust gas flow rates to QP Control Room requirements by setting compressor discharge pressure controller 11PIC13.7.


NUOVO PIGNONE
FIRENZE
Comm
Date 23-2-77
Dis C 8646 /4
REVISION I
ELF AQUITIAINE NORGE A/S
5425W 10 1200 02 123 REV 1
(C.d.A x TECHNIP – FRIGG FIELD)
POLYTROPIC HEAD (m x 1000)
ζ_{pol} = 0.74
ζ_{pol} = 0.76
ζ_{pol} = 0.78
ζ_{pol} = 0.79
ζ_{pol} = 0.78
ζ_{pol} = 0.75
ζ_{pol} = 0.65
CONTRACTUAL POINT
COMPRESSION RATIO
4200 rev/min
4000 rev/min
3600 rev/min
3240 rev/min
2880 rev/min
2520 rev/min
2160 rev/min
1800 rev/min
THESE CURVES ARE VALID AT THE FOLLOWING CONDITIONS ONLY:
GAS HANDLED : Natural Gas
MOLECULAR WEIGHT : 16.854
Cp/Cv : 1.54
COMPRESSIBILITY : 0.38
INLET TEMPERATURE : 50°C
INLET PRESSURE : 101 barg
ABSORBED POWER (kW x 1000)
FLOWRATE (INLET CONDITIONS) (m³/h x 1000)



THESE CURVES ARE VALID AT THE FOLLOWING CONDITIONS ONLY:

GAS HANDLED	:	Natural Gas
MOLECULAR WEIGHT	:	16.854
C_p/C_v	:	1.54
COMPRESSIBILITY	:	0.88
INLET TEMPERATURE	:	50°C
INLET PRESSURE	:	101 barg


68-POINT ANNUNCIATOR
PERMISSIVE FOR NORMAL SHUTDOWN
1. SWITCH TO STOP
2. N3 SPEED DRIVE-DOWN STARTED BY STEP DRIVE UNIT
N3 - 1950 REV/MIN
1. ANTI-SURGE VALVE OPENED
2. ENGINE COOLDOWN TIMER STARTED (5 MINUTES)
5-MINUTE COOLDOWN ENDED
1. FUEL VALVES DE-ENERGISED
2. ENGINE COASTDOWN TIMER STARTED
3. N2 REFERENCE DRIVEN TO MINIMUM
ALL EMERGENCY SHUTDOWN FUNCTIONS
COASTDOWN ENDED
1. ENGINE LUBE OIL SYSTEM SWITCHED OFF
2. VENTILATION CUT
MANUALLY SHUT DOWN COMPRESSOR LUBE AND SEAL OIL SYSTEM
TEMPERATURE RECORDER
FUEL CONTROLLER
ANTI-SURGE CONTROLLER
GAS TURBINE VIBRATION MONITOR
FIRE SYSTEM PANEL
CHIP DETECTORS
OPERATING TIME INDICATOR
GAS TURBINE TEST PANEL

D1.5

6 NORMAL SHUTDOWN AND RESTART

See illustration D1.5

6.1 The Start/Stop switch may be set to STOP at any load level. The unit will unload to N_3 speed of 2000 rev/min, the anti-surge control will function automatically, and the unit will operate for five minutes at minimum load (approximately 3000kW). After five minutes the unit will shut down and coast to stop. Field auxiliaries will continue to operate for 15 minutes. After this time, the following occurs:

(a) Seal oil system will go on automatic, controlling pressure.

(b) Fans will go to standby.

(c) Turbine lube systems will shut down.

6.2 Restart may be accomplished with TCP2 Operations Supervisor approval when:

(a) The READY-TO-START lamp is lit.

(b) After N_2 rotor speed has decreased to 1000 rev/min and the power turbine N_3 speed is less than 1000 rev/min.

7 ANTI-ICING

See illustration C2.9

7.1 The Anti-ice control switch on the main control panel provides for totally manual control dependent upon operator judgement and action. It is used in conjunction with the unit annunciator window labelled 'Icing Conditions'. This will inform the operator if temperature conditions are conducive to icing. The operator must confirm the condition and, if judged appropriate, turn the anti-icing control switch to ON. The anti-ice system will maintain 3°C (37°F) temperature automatically thereafter. An alarm is provided for ICING CONDITIONS OVER, to allow operator to secure the anti-icing system.

7.2 The use of the anti-icing system results in using more fuel for the gas turbine, and directly influences operation costs. It should not be used unless relative humidity is above 40 per cent and temperature below 5°C (40°F).

8 WATER WASH

See illustration C2.9

8.1 The Water Wash Start/Stop switch provides for an automatic turbine and compressor fresh water wash. It must be initiated at every shutdown, or once every 200 hours/unit, whichever occurs first. Water wash is fully automatic and although it may be selected at any time the programme will not start until 90 minutes after shutdown.

CAUTION
SALT CORROSION (SULFIDATION) HAS BECOME A CLASSIC CORROSION MECHANISM IN HIGH POWERED GAS TURBINES. FAILURE TO WATER WASH PROPERLY MAY VOID OR NULLIFY CORROSION GUARANTEES.

8.2 The water wash system provides for a 1135 litre (300 gallon) compressor section wash plus a 91 litre (24 gallon) turbine wash in three equal wash/rinse cycles. This sequence is based upon many years of experience in removing corrosive contamination.

8.3 Each cycle requires approximately 90 seconds. Three cycles plus start to minimum N_3 rev/min represents a complete wash (approximately 35 minutes). This must be accomplished in the order of once each operating week.

SECTION 2 – SAFETY AND EMERGENCY SHUTDOWN

1 TURBOCOMPRESSOR UNIT SAFETY

1.1 The following tables list separately the Alarms and Trip/Alarms (Emergency Shutdowns), the primary devices that initiate the alarm or trip, the device settings, and functional remarks. The Lockout functions are listed in the remarks column. Several items appear in both schedules because alarms and trips occur at different settings.

Gen Panel Annun Pt No	Point Description	Alarm (only) and/or Trip/ Alarm	Primary Device or Relay No	Alarm Setting and/or Trip Setting	Remarks
1	Incomplete Sequence – Starter Speed Low	T/A	48–1		N_2 speed of 1500 rev/min not reached 35 seconds after start 86G–1.
2	GG Heat Valve Open or Heat Off	T/A	63EHX	59 mbar	86G–1 while engine running.
		A	26EH–2X	200°C	
3	Incomplete Sequence – No Light-Off	T/A	48–1		N_2 speed of 3400 rev/min not reached 35 seconds after ignition 86G–1.
4	Starter Duct Pressure High	T/A	63SDX	0.7 bar	86G–1.
5	Incomplete Sequence	T/A	48–1		Idle speed not reached 40 seconds after N_2 speed of 3400 rev/min 86G–1.
6	Gas Detectors Malfunction	A	Gas Monitor		

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Gen Panel Annun Pt No	Point Description	Alarm (only) and/or Trip/ Alarm	Primary Device or Relay No	Alarm Setting and/or Trip Setting	Remarks
7	Incomplete Sequence – Compressor Speed Low	T/A	48–1		
	An incomplete sequence results if the following occurs: 1. N_3 speed of 1000 rev/min not reached 30 seconds after fade-in. 2. N_3 speed of 1950 rev/min not reached 3 minutes after ignition. 3. Automatic surge valve fails to open.				
8	Engine vibration		Vibration Monitor		Alarm and trip levels up to N_3 speed of 2000 rev/min.
	(a) Alarm				
	Gas Generator	A		5 mils DA	Alarm signals must be sustained 2 seconds (minimum) to effect alarm.
	Free Turbine Inlet	A		4 mils DA	
	Free Turbine Exhaust	A		3 mils DA	
	(b) Trip				
	Gas Generator	T/A		10 mils DA	
	Free Turbine Inlet	T/A		5 mils DA	86G–1.
	Free Turbine Exhaust	T/A		4 mils DA	

Gen Panel Annun Pt No	Point Description	Alarm (only) and/or Trip/ Alarm	Primary Device or Relay No	Alarm Setting and/or Trip Setting	Remarks
9	N_3 Overspeed – Speed Monitor	T/A	12–1	4400 ± 50 rev/min	86G–1.
10	N_3 Speed Monitor Not Reset	T/A	12–1		Start Lockout.
11	N_3 Overspeed – SPC or Loss of N_3 Pickup	T/A	65 N_3–3X	4400 ± 50 rev/min	86G–1.
12	Lube Pump Backup Timer Trouble	A	62–5X		
13	SPC Shutdown or Mod Valve Trouble	T/A	65TX		Trip condition indicated on SPC panel. 86G–1.
14	DC Voltage Low or High	T/A	27DC–7, –8		86G–1.
15	Incomplete Stop Sequence	T/A	48–1		N_3 speed above 1000 rev/min 50 minutes after stop initiation. 86G–1.
16	Emergency Shutdown Monitor	T/A	ESD		External devices trip 86G–1.
17	Unit Trip	T/A	3–5		86G–1 Trip Monitor Start Lockout
18	Manual Trip	T/A	43–E		Emergency Stop button actuated 86G–1.

Gen Panel Annun Pt No	Point Description	Alarm (only) and/or Trip/ Alarm	Primary Device or Relay No	Alarm Setting and/or Trip Setting	Remarks
19	Gas Generator Lube Pressure Low	A	PSL42.2	2.4 bar	
		T/A	PSLL42.3	2.0 bar	86G–1.
20	Free Turbine Lube Pressure Low-Low	T/A	PSLL42.7	0.7 bar	N_2 speed above 1500 rev/min 2-second delay 86G–1.
21	Engine Lube Level Low or High	A	LSH40.2	161 litres	Start Lockout.
		A	LSL40.2	25.4cm (104 litres)	Measured from tank bottom.
		T/A	LSLL40.2	20cm (76 litres)	86G–1.
22	Free Turbine Lube Pressure High	A	PSH42.9	6.9 bar	N_3 speed above 1500 rev/min.
23	Engine Lube Temp High	A	TSH40.4	107°C	Temp Recorder 86G–1.
		T/A	TSHH40.3	121°C	
24	AC Lube Pump Trouble	A	27AC–2, –7		Free Turbine Standby Lube Pump
25	Engine Lube Filter Differential Pressure High	A	PdSH40.1	1 bar	
26	Free Turbine DC Lube Pump Trouble	A	MC8		Start Lockout.

Gen Panel Annun Pt No	Point Description	Alarm (only) and/or Trip/ Alarm	Primary Device or Relay No	Alarm Setting and/or Trip Setting	Remarks
27	Engine Lube Chip detector	A	XA41.1/ 42.1/42.2		
28	Free Turbine DC Lube Pump Running	T/A	MC8		86G–1.
29	Gas Generator Breather Pressure	A	11PSH41.7	345 mbar	
	High	T/A	11PSHH41.8	0.7 bar	86G–1.
30	Free Turbine Scavenge Pressure	A	11PSH42.4A	276 mbar	
	High	T/A	11PSHH42.5A	345 mbar	86G–1.
31	Temperature Recorder Open Thermocouple	A	TIR		Open thermocouple drives recorder upscale for an alarm.
32	Free Turbine Scavenge Temperature High	T/A	TSHH41.1/ 41.2	177°C	86G–1.
33	Engine Enclosure Temperature High	A			
	or Fan Off	T/A			86G–1.
34	Combustible Gas – Inlet	A	Gas Monitor		Any one inlet detector reaches 15 per cent LEL.
		T/A			Any two inlet detectors reach 15 per cent LEL.

Gen Panel Annun Pt No	Point Description	Alarm (only) and/or Trip/ Alarm	Primary Device or Relay No	Alarm Setting and/or Trip Setting	Remarks
35	Engine Enclosure	T/A	45FX	232°C	86G–1.
36	Combustible Gas – Enclosure or Inlet Detectors	A	Gas Monitor		Any enclosure or secondary inlet detector reaches 20 per cent LEL. If both secondary inlet or both enclosure detectors reach 60 per cent LEL.
37	Fire Valve Closed	T/A	33FVL		Start Lockout.
38	Fuel Gas Pressure	A		14.5 bar	
		T/A		13.8 bar	86G–1/Start Lockout.
		A		19.7 bar	
		T/A		20.7 bar	86G–1.
39	Gas Knockout Pot Level High	A	50LSH50.4	19 litres	
		T/A	50LSHH50.5	23 litres	86G–1.
40	Gas Knockout Pot Level Low	A	50LSL50.2		
41	Air Inlet Filter Differential Pressure High	A	63IFP		
42	Air Inlet Filter Blow-in Doors Open	A	33BPD –1, –2		
43	Icing Temperature	A	TIR	6.7°C	Icing Conditions Exist.

Gen Panel Annun Pt No	Point Description	Alarm (only) and/or Trip/ Alarm	Primary Device or Relay No	Alarm Setting and/or Trip Setting	Remarks
44	Anti-ice Valve Open	A			
45	AC Voltage Low or High	A	Onan		
46	Spare				
47	Compressor Lube Pressure Low	A	11PS53.2	1.8 bar	
		T/A	11PSLL53.1/ 53.7	1.2 bar	
48	Compressor Bearing Temperature High	A	11TSH52.10/ 52.11	80°C	
		T/A	11TSHH55.2/ 56.2	85°C	
49	Compressor Lube Temperature High	A	11TSH50.6	60°C	
50	Compressor Lube Temperature Low	A	11TSL53.1	30°C	
51	Compressor Oil Reservoir Level Low	A	11LSL50.2		
52	Compressor Oil Reservoir Temperature Low	A	11TSL50.2		
53	Compressor Lube Filter Differential Pressure High	A	11PDSH51.2		

Gen Panel Annun Pt No	Point Description	Alarm (only) and/or Trip/ Alarm	Primary Device or Relay No	Alarm Setting and/or Trip Setting	Remarks
54	Seal Oil Pump Low Suction Pressure	A			
55	Compressor Standby Lube Pump Running	A	11PSH50.5		
56	Compressor Spare Standby Lube Pump Running	A	11PSH52.2		
57	Compressor Lube Pump Trouble	A	MC1		
58	Seal Oil Standby Pump Running	A	11PSH51.4		
59	Overhead Seal Oil Tank Level High	A	11LSH54.2		
60	Overhead Seal Oil Tank Level Low	A	11LSL54.2		Starts standby seal oil pump.
61	Balance Gas Pressure High	A	11PSH55.7	0.4 bar	Starts main lube/seal oil pumps.
62	Polluted Seal Oil Traps Level High	A	11LSH57.1/ 57.3		
63	Polluted Seal Oil Tank Level Low	A	11LSL58.1		

Gen Panel Annun Pt No	Point Description	Alarm (only) and/or Trip/ Alarm	Primary Device or Relay No	Alarm Setting and/or Trip Setting	Remarks
64	Polluted Seal Oil Tank Temperature Low	A	11TSL58.3	70°C	
65	Compressor Vibration	A	Bentley-Nevada		
66	Spare				
67	Surge Valve Open	A	11ZLH13.1		
68	Spare				

2 GAS LINE SAFETY

2.1 Each gas line is provided with identical safety devices as follows:

Location	Item	Setting	Action
Suction drum 11B01	11LSHH12.3		Stops 11KG01
Suction drum 11B01	11LSLL12.2		Closes 11ESDV12.2
Gas Compressor suction	11PSLL13.11	60 bar	Stops 11KG01
Gas Compressor suction	11FSLL13.2		Stops 11KG01
Gas Compressor discharge	11PSLL13.13	70 bar	Stops 11KG01
Gas Compressor discharge	11PSHH13.15	154 bar	Stops 11KG01
Gas Compressor discharge	11TSHH13.3		Stops 11KG01
Gas Compressor discharge PSV block valve not fully open	11ZSH13.14		Stops 11KG01
11E01 shell side	11PSH14.3	7 bar	Stops 11KG01
Downstream 11E01	11TSHH14.1		Stops 11KG01
Discharge Drum 11B02	11LSLL16.2		Closes 11ESDV16.2

2.2 In addition to these automatic safety devices, a low gas temperature at the unit inlet involves a manual action by the Control Room operator.

CAUTION
WHEN GAS TEMPERATURE AT THE UNIT INLET (11TSL10.1, 11TSL30.1) BECOMES LOWER THAN 25°C, THE COMPRESSION UNIT MUST BE STOPPED AND DECOMPRESSED.

2.3 When a compression line is completely depressurised for maintenance, with inlet and outlet valves closed, an alarm (PAH13.10) set at 2 bar indicates that a block valve is leaking.

3 EMERGENCY SHUTDOWN

3.1 An Emergency Stop pushbutton is provided which sequences the unit and, in certain conditions, the entire module shutdown. It is used only if unusual conditions exist which circumvent the trip or ESD system. Requires approval of Operations Supervisor to initiate.

3.2 When an automatic or a manual emergency shutdown is initiated, the unit is sequenced for an immediate stop. There is no five-minute cooldown or unloading. Ventilation and seal oil are kept on.

4 RESTART AFTER EMERGENCY SHUTDOWN

4.1 After Emergency Shutdown

Restart may be accomplished with TCP2 Operations Supervisor approval when:

(a) All ESD relays are reset. The cause must be corrected prior to manually resetting the Master Trip Lockout Relay. This requires approval of TCP2 Operations Supervisor.

CAUTION
DO NOT ATTEMPT TO HOLD IN A RESET-TYPE RELAY. IT WILL BURN OUT.

(b) The fault or malfunction has been cleared.

(c) The READY-TO-START lamp is lit.

PART F

EMERGENCY SHUTDOWN SYSTEM

CONTENTS

CHAPTER F1

SAFETY LOGIC

CONTENTS

ILLUSTRATIONS

Refer to PID 5424W 00 0020.16 to 25 inclusive, and FF.00 16 0058.01 and 03

SECTION 1 – LOGIC CONCEPT

Reference: PID 5424W 00 0020.16 to 25 inclusive
FF.00 16 0058.01 and 03

1 GENERAL

1.1 A Safety System is installed in the compression plant as a complete package comprising automatic and manual systems. It is completely integrated with the platform safety system. Its purpose is to provide protection for personnel and equipment and is designed to the same philosophy as that for the treatment areas in the platform.

1.2 During normal operational conditions the compression plant may be operated remotely from QP. This means that individual turbine/compressor units may be started and shut down from QP and also that the unit speed is adjustable from QP by authority from TCP2 Control Room. If, however, an emergency shutdown occurs then it is impossible to start the units from QP.

1.3 There are four levels of manual shutdown and automatic Emergency Shutdown (ESD). If any of them occur, the event is annunciated in QP. They are as follows:

Level	Action	From
1st	Frigg field shutdown of process and electrical systems but WITHOUT decompression	QP Control Room
2nd	TCP2 compression plant shutdown excluding electrical systems, but WITH decompression	QP Control Room TCP2 Control Room TP1 and TCP2–T Interface Rooms
3rd	TCP2 compression plant shutdown, excluding fuel gas and electrical systems, but WITHOUT decompression	QP Control Room TCP2 Control Room Lifeboat Stations Escape Craft Station TCP2/TP1 Bridge
4th	Individual module turbocompressor unit shutdown	TCP2 Control Room Turbocompressor Room (two push-buttons in each)

1.4 The following essential and emergency equipments are not tripped by the automatic ESD system:

(a) **Essential**

Emergency Diesel Generator; Air Fan for Cooling System 380V (53GD01.AM01).
Emergency Diesel Generator: Water Circulation Pump 380V (53GD01.PM01).
Emergency Diesel Generator; Oil Circulation Pump 380V (53GD01.PM02).
Emergency Diesel Generator; Electrical Air Compressor 380V (53GD01.KM01).
Emergency Diesel Generator; Preheating Water 380V (53GD01.Y02A).

Emergency Diesel Generator; Preheating Water 380V (53GD01.Y02B).
Emergency Diesel Generator; Preheating Water 380V (53GD01.Y02C).
Turbogenerator 'A' Lube Oil Pump 110V dc (52GG01A. PM01C).
Turbogenerator 'A' Vent, Fan Fuel Unit 110V dc (52GG01A. AM01B).
Turbogenerator 'A' Gas Gen Hood Fan 110V dc (52GG01A. AM03B).

Turbogenerator 'B' Lube Oil Pump 110V dc (52GG01B. PM01C).
Turbogenerator 'B' Vent Fan Fuel Unit 110V dc (52GG01B. AM01B).
Turbogenerator 'B' Gas Gen Hood Fan 110V dc (52GG01B. AM03B).
Natural Gas Compressor 'A' Lube Oil Pump 110V dc (11KG01A.PM01C).
Natural Gas Compressor 'A' Lube Oil Pump 110V dc (11K01A.PM01C).
Natural Gas Compressor 'A' Secondary Air Fan 380V ac (11KG01A.AM02B).
Natural Gas Compressor 'B' Lube Oil Pump 110V dc (11KG01B.PM01C).
Natural Gas Compressor 'B' Lube Oil Pump 110V dc (11K01B.PM01C).
Natural Gas Compressor 'B' Secondary Air Fan 380V ac (11KG01B.AM02B).
Natural Gas Compressor 'C' Lube Oil Pump 110V dc (11KG01C.PM01C).

Natural Gas Compressor 'C' Lube Oil Pump 110V dc (11K01C. PM01C).
Natural Gas Compressor 'C' Secondary Air Fan 380V ac (11KG01C.AM02B).

(b) **Emergency**

Crane 60X01.
Panel 45 Lifeboat Floodlights.
Intercommunication System.
Emergency Lighting Switchboard.
Essential 110V dc Control Switchboard.
Essential 110V dc Signal Switchboard.
ESD Cubicle.
Flashing Light.
Public Address.
Cabinet 18 Essential Instruments 220V ac and 110V dc.

1.5 The following essential equipments are not tripped by first, second and third level shutdowns:

All those not tripped by the ESD System.
Pancake 42 Diesel Fire Pump Room H & V Fan Motor 'A' 380V (54X10004).
Pancake 42 Diesel Fire Pump Room H & V Fan Motor 'B' 110V dc (54X10005).
Pancake 46 Diesel Fire Pump Room H & V Fan Motor 'A' 380V (54X14004).
Pancake 46 Diesel Fire Pump Room H & V Fan Motor 'B' 110V dc (54X14005).

Substation and Fan Room H & V Fan Motor 'A' 380V (54X04009).
Control Room H & V Fan Motor 'A' 380V (54X05014).
Control Room H & V Fan Motor 'B' 110V dc (54X05015).
Battery Room H & V Fan Motor 'A' 380V (54X12004).
Battery Room H & V Fan Motor 'B' 380V (54X12005).
Emergency Substation H & V Fan Motor 380V (54X13003).

1.6 The following equipments are not tripped by the second level shutdown:

All essential equipments not tripped by ESD or first, second or third level shutdown.
Non-essential 110V dc control switchboards.
Non-essential 110V dc signal switchboard.
Cabinet 18 non-essential instruments 220V ac and 110V dc.

1.7 The heart of the combined manual and automatic system is the Programmable Logic Controller (PLC). This is programmed so that it will respond either to single signal inputs, or combinations thereof, that indicate trends towards predictable hazards. The response takes the form of a pattern of alarm annunciations to the control rooms and a limited number of output signals to trip key items of plant and to open or close Emergency Shutdown Valves (ESDVs). Those that are opened are generally vent valves while those that are closed have the effect of blocking-in sections of the plant. Ventilation systems may also be closed in automatically.

1.8 The input signals are generated by the following:

(a) Process limit detectors.

(b) Gas detectors.

(c) Fire detectors.

(d) Loss of ventilation.

1.9 Outputs to the ESDVs are 'generated' according to the logic and transmitted pneumatically to the local control panels for the ESDVs to be operated. The shutdown signal is in fact the venting of the pneumatic line to the control panel; the normal operating pressure is 1.0 barg.

1.10 Each ESDV has its own local control panel providing hydraulic or pneumatic operating power. Each has an accumulator which acts in the event of loss of external hydraulic or pneumatic power. The general scheme of ESDVs in the treatment and compression plant is shown in drawing FF.00 16 0058.03.

1.11 The general range of inputs and outputs to a hydraulic valve control panel is as follows:

(a) Pneumatic ESD signal – input.

(b) Instrument air for internal hydraulics control – input.

(c) Supply and return hydraulic lines from central hydraulic power unit.

(d) Supply and return hydraulic lines to the valve actuator.

(e) Valve OPEN/CLOSED indication – pneumatic outputs to local panel.

(f) Valve OPEN/CLOSED indication – pneumatic outputs to Control Room and to QP via telemetry.

(g) Authorisation from Control Room for local control – pneumatic input.

(h) Local manual control (provided authorisation has been obtained).

This type of valve control panel always closes a valve on ESD. It then requires authorisation and local operation to re-open it.

1.12 The general range of inputs to a pneumatic valve control panel is similar except for the substitution of hydraulic lines by pneumatic. However, some ESDVs notably for venting and depressurising are OPENED by ESD and not closed.

2 SUMMARY OF LOGIC SYSTEM

2.1 The cause and effect logic of the shutdown system is described in ten Kvaerner-Technip TCP2 drawings, 5424W 00 0020.16 to 25 inclusive. This family of drawings provides schematic detail of what is shown for the compressor plant in summary on drawing FF.00 16 0058.01. The logic can only be expressed in full diagrammatic form so that it is only possible to summarise main features in this description. No simplified diagrams are presented in this manual.

2.2 The PLC is designed so that its electronic circuits operate on the basis of two levels of voltage, one representing the presence of a signal, the other an absence. The logic details show how signals are positively generated, or not so, according to predetermined combinations of inputs.

2.3 The pattern of logic is split up over the drawings as follows:

No 16 Configuration of the main signals for shutdown and blowdown.

No 17 Turbocompressor line 'A', Module 30.

No 18 Turbocompressor Modules 30, 31 and 33 – Upper Deck areas.

No 19 Turbocompressor Modules 30, 31 and 33 – Main Deck areas.

No 20)
No 21) Turbogenerator units 'A' and 'B', Pancakes 40 and 41.

No 22 Fuel gas heaters and separators, top of Module 32.

No 23 Module 32 substation, Control Room and H & V Fan Room on Upper Deck.

No 24 Area under Module 32, Firewater Pump Rooms and Pancake 44.

No 25 Utilities and main gas lines in-out area, Cellar Deck – south.

2.4 To guard against spurious operation of any safety system due to incorrect transmission or reception of input signals, it is sometimes necessary for at least two signals to be present before the logic initiates an output.

3 DESCRIPTION OF LOGIC SYSTEM DRAWINGS

3.1 Drawing No 16

3.1.1 This shows the main pattern of shutdown paths, the majority of which are then detailed in the subsequent drawings. It defines the first, second and third levels of manual shutdown and shows the broad interfacing with the remainder of the TCP2 shutdown system. It particularly lists the essential, emergency and miscellaneous equipment that is not shut down by ESD or the three levels.

3.1.2 Two features which are important in the correct interpretation of this drawing are as follows:

(a) The two symbols which indicate 'output from PLC' and 'input to PLC'. Together they show what external signal inputs or outputs interface with the PLC. Some outputs are referenced to and from other drawings in this series and clearly do not have a PLC interface symbol in their connecting line, as their particular logic is contained wholly within the PLC.

(b) Timer devices. These provide an adjustable delay between input and output. For example: the second level manual shutdown has three outputs direct:

(i) Second level shutdown to TCP2 treatment for blowdown of bridge lines from TP1 to TCP2.

(ii) Second level shutdown of turbogenerators.

(iii) Second level shutdown of fuel gas systems.

A further output then passes through a timer before the following:

(i) Second level shutdown blowdown Module 30.

(ii) Second level shutdown blowdown Module 31.

(iii) Second level shutdown blowdown Module 33.

Clearly, the timer device is adjusted to give a sensible delay between the first three shutdowns and the second three. A further timed delay then follows after which four solenoid valves are energised to open, 11ESDV21.2/25.3/17.1/37.1.

3.2 Drawing No 17

3.2.1 This shows the fourth level shutdown logic for turbocompressor line 'A'. The logic for line 'B' and line 'C' compressors is identical and therefore not shown in the drawing. The drawing shows the inputs from pushbuttons, process limit sensors (such as 11LSHH12.3A, 11HZS13.4 etc) and from gas concentration detectors. There are also inputs from second and third level manual shutdowns.

3.2.2 As well as logic outputs to solenoid valves for the opening or closing of ESDVs and to the isolation of all non-essential electrical supplies, there are two turbocompressor control unit functions outside the PLC. These are for ESD inputs/outputs and for process trip. The former leads to the closure of 50ESDV51.1 (which is the shutdown valve in the fuel supply line to the gas turbine) and the latter trips the fuel modulating valve and shut-off valve only.

3.2.3 The drawing also shows the pneumatic connections for the operation of 50ESDV50.5 which is the shutdown valve in the fuel supply to the fuel gas liquid knockout pot. This valve is shut in by any one of three signals:

(i) High-high pressure in the fuel gas supply line.

(ii) PLC shutdown signal.

(iii) Shut-off by local manual operation outside the door to the turbocompressor room.

3.2.4 A simple style of representation in this and the remaining drawings details the place of annunciation for the majority of alarms for process limits and fire and gas detection. Arrowheads in input signal lines terminate at various levels on the drawing against which are detailed the type and place of alarm.

3.3 **Drawing No 18**

3.3.1 This shows the inputs which give rise to third level automatic shutdowns for fire or gas in the Upper Deck areas. It can be seen that in the event of fire in Modules 30, 31 or 33 deluge valves are ordered open by the PLC.

3.3.2 Annunciation and alarms are detailed for QP and TCP2.

3.4 **Drawing No 19**

3.4.1 This shows the inputs which give rise to third level automatic shutdowns for fire or gas in the Main Deck areas. It can be seen that in the event of fire in Modules 30, 31 or 33, deluge valves are ordered open by the PLC.

3.4.2 Also shown are fourth level shutdown and gas detection shutdown signals to items of electrical plant and ventilation fans. Gas detection in any of the modules except for west of the turbocompressor rooms and the fuel gas treatment sections, also has the effect of shutting down the turbocompressor in the affected area.

3.4.3 Annunciation and alarms are detailed for QP and TCP2.

3.5 **Drawing No 20**

3.5.1 This should be read in conjunction with Drawing No 21 and shows the various fire and gas detection signals that input to the turbogenerator control systems to give shutdown of the generator in the affected area and close in the ventilation.

3.5.2 Shutdown pushbuttons are provided both inside and outside the turbogenerator room.

3.5.3 Outputs to start fire pumps and Halon system are also shown. The fire pumps start in the event of either gas or fire detection.

3.5.4 Annunciation and alarms are detailed for QP and TCP2.

3.6 **Drawing No 21**

3.6.1 This drawing shows further fire and gas detection signals to those in Drawing No 20. It also shows first, second and third level shutdown inputs and shutdown signals to the turbogenerator control systems on the previous drawing.

3.6.2 Annunciation and alarms are detailed for QP and TCP2.

3.7 **Drawing No 22**

3.7.1 This shows shutdowns of the fuel gas heaters and separators on the top of Module 32 and the shutdown of non-essential electrical supplies initiated by any one of the following:

(a) First level shutdown from QP.

(b) Abandon platform.

(c) Second level shutdown from QP or TCP2.

(d) Third level shutdown.

(e) Turbocompressor and fuel gas lines shutdown from QP.

(f) Turbocompressor and fuel gas lines shutdown from TCP2.

(g) Fire detection in some of the TCP2 treatment pancakes.

(h) Local fire or gas detection.

3.7.2 The firewater pumps are started in the event of fire or gas detection.

3.7.3 Annunciation and alarms are detailed for QP and TCP2.

3.8 **Drawing No 23**

3.8.1 This shows the Halon release and the closing in of ventilation systems as a result of fire or gas detection in Module 32 sub-station. In the event of either, the firewater pumps are started.

3.8.2 Annunciation and alarms are detailed for QP and TCP2.

3.9 **Drawing No 24**

3.9.1 This shows the effects of fire or gas detection in various areas under Module 32, the firewater pump rooms and Pancake 44. Ventilation is closed in in the affected area and electrical equipment is shut down. Halon is released in the event of fire, and firewater pumps started in the event of fire or gas detection.

3.9.2 Loss of pressure in the air ducts in the floors of the firewater pump rooms 'A' and 'B' is also accounted for.

3.9.3 If gas is detected in the air inlet ducts to the diesel generator room or emergency substation in Pancake 44, the diesel generator is stopped or inhibited from starting.

3.9.4 Annunciation and alarms are detailed for QP and TCP2.

3.10 **Drawing No 25**

3.10.1 This shows the inputs which give rise to third level automatic shutdowns for fire or gas in the utilities and main gas lines in-out area in Cellar Deck – south.

3.10.2 Annunciation and alarms are detailed for QP and TCP2.