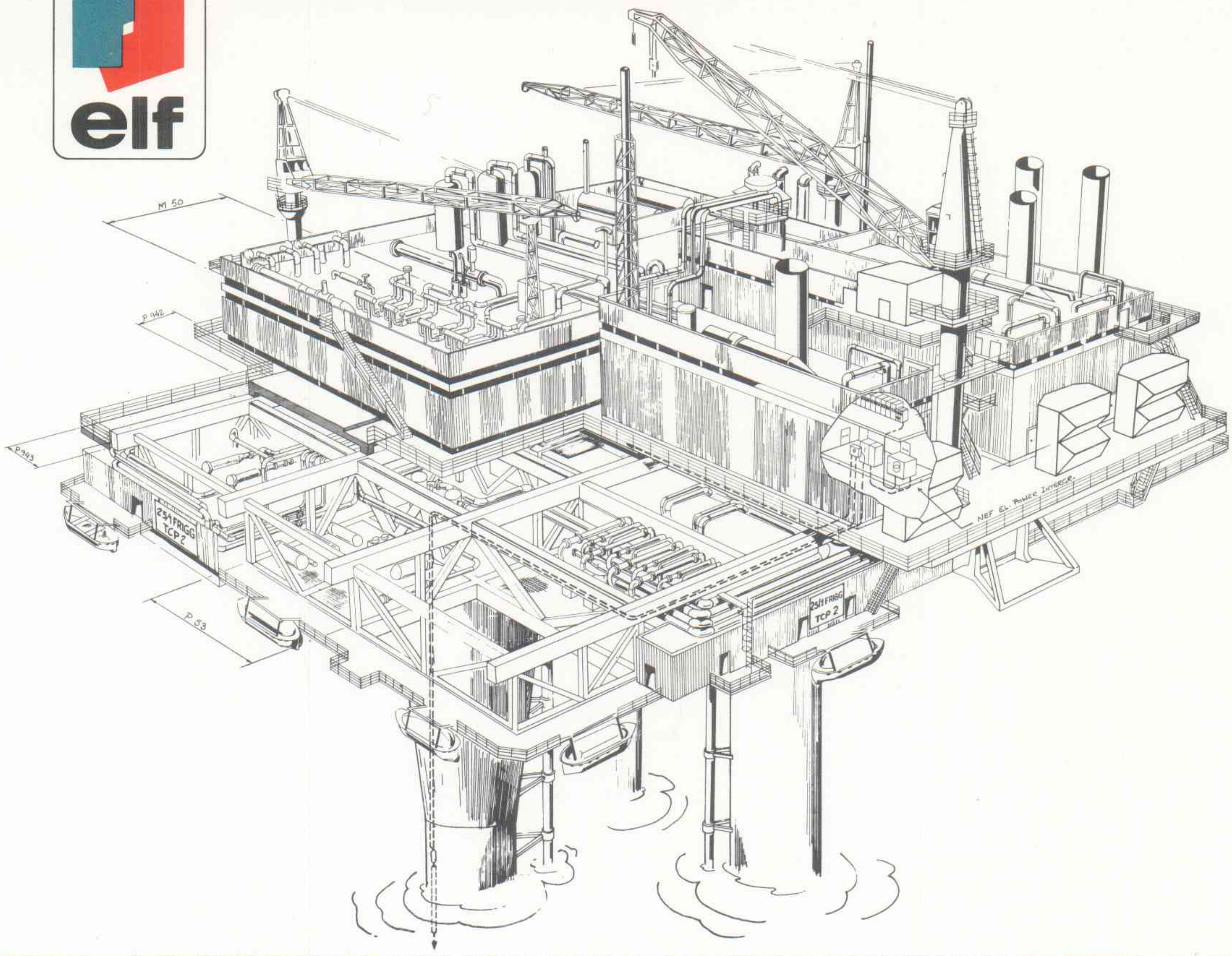
elf aquitaine norge a/s



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FRIGG FIELD — TCP2 EXTENSION

FINAL REPORT
VOLUME 1

PROJECT DESCRIPTION

STAVANGER

FEBRUARY 1984

TCP-2 EXTENSION FINAL REPORT

VOLUME I

PROJECT DESCRIPTION

TCP-2 EXTENSION FINAL REPORT

GENERAL INDEX

TCP2 EXTENSION FINAL REPORT

GENERAL INDEX FOR ALL VOLUMES

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2. PRINCIPLES OF ENGINEERING DESIGN

3. NEF - ELECTRICAL POWER SUPPLY

4. APPENDICES

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VOLUME I

PROJECT DESCRIPTION

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Index Continued

Index Continued

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Index Continued

Index Continued

1 GENERAL DESCRIPTION OF TCP-2 EXTENSION PROJECT

1.1 INTRODUCTION

The purpose of the new facilities installed on the Frigg Field is to:

- Process wet gases coming from the NORTH-EAST FRIGG (NEF) and ODIN fields.
- Recover and treat the condensates.
- Measure for royalty purposes the treated gases and condensates.
- Inject the gases into the FRIGG gas production system for a last treatment (glycol dehydration), compression (using FRIGG main compressors) and for transportation to Scotland.
- Inject the condensates, using existing equipment, into the FRIGG gas transportation system.

For this purpose a new gas treatment facility called Module M50 and a condensate recovery package called Pancake P53 have been constructed and integrated by connection pieces into the existing facilities on the TCP-2, QP and DP-2 Platforms on the Frigg Field.

A simple process sketch of the new installations is shown on drawing:

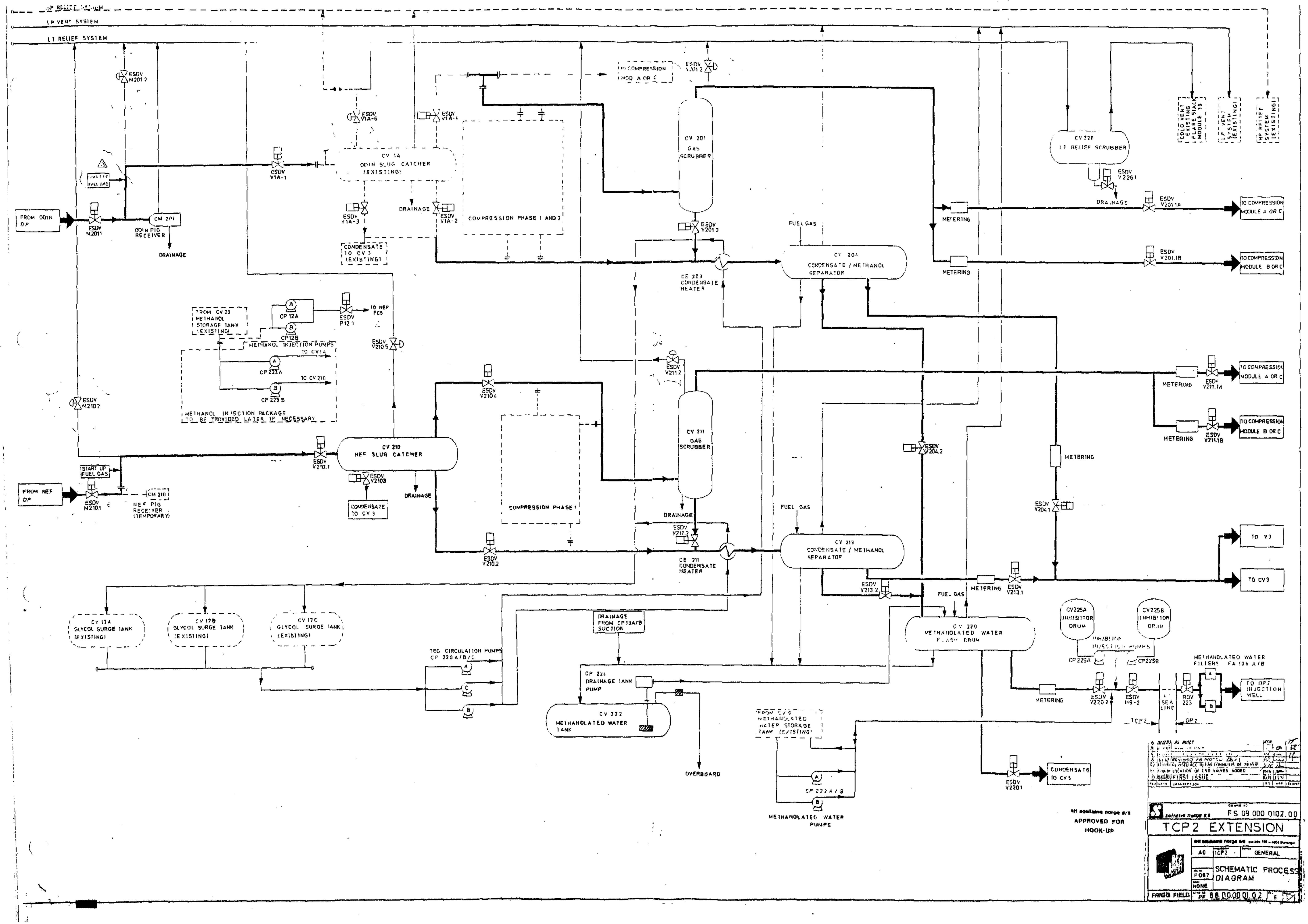
FF 88 00 00 0102 - Schematic Process Diagram (Figure 1.1)

The models of Module 50 and Pancake 53 are shown on the enclosed pictures.

FIGURE 1.1

Drawing No.: FF 88 00 00 0102

Schematic Process Diagram



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3	[illegible]	REVISED AS NOTED			
02	[illegible]	REVISED ACC TO EAI COMMENTS OF 20.10.81			
01	[illegible]	LOCATION OF ESD VALVES ADDED			
0	[illegible]	FIRST ISSUE	GN	JIN	

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FS 09.000 0102.00

TCP2 EXTENSION

elf aquitaine norge a/s

A0 | TCP2 | GENERAL

F 067

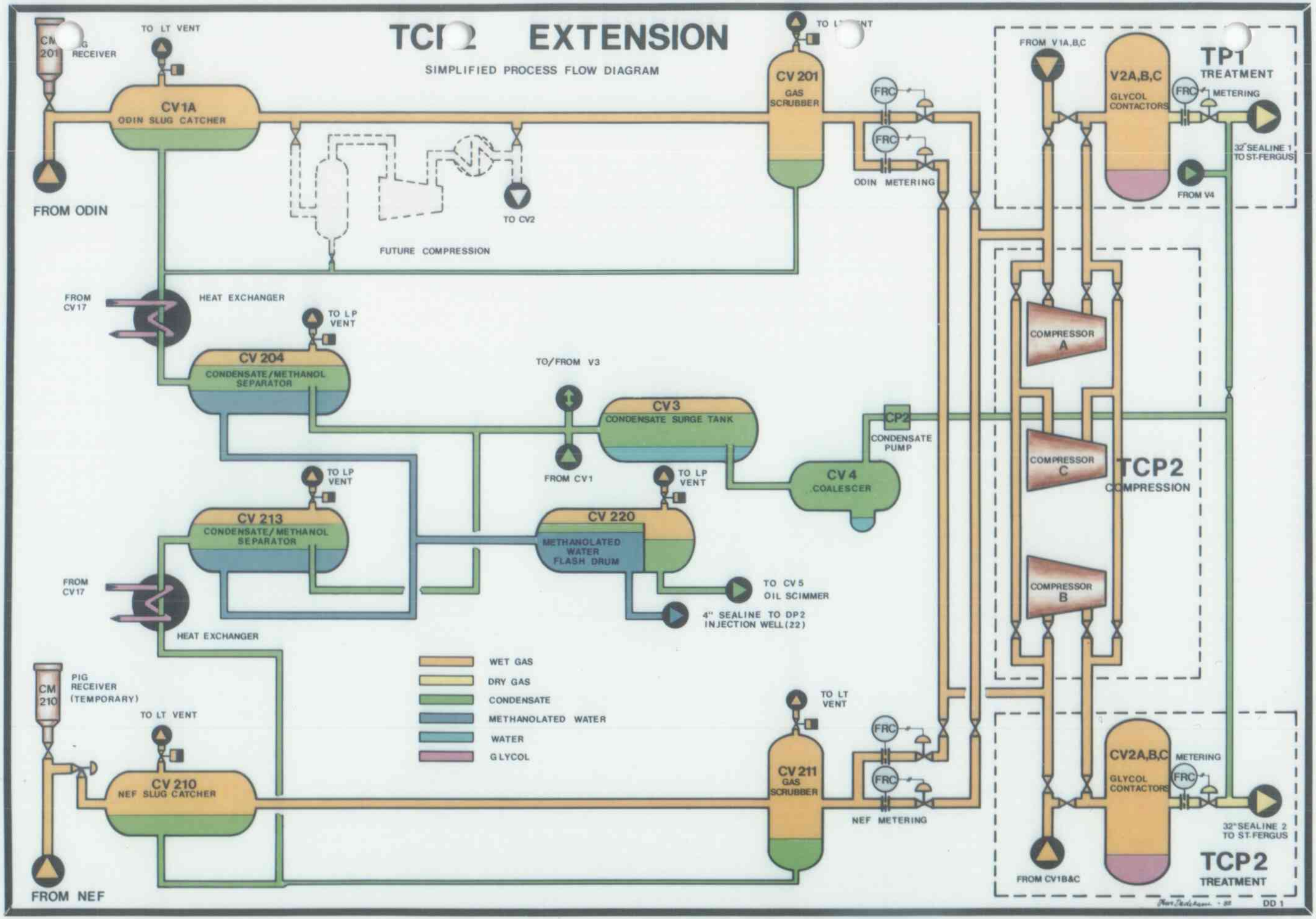
NONE

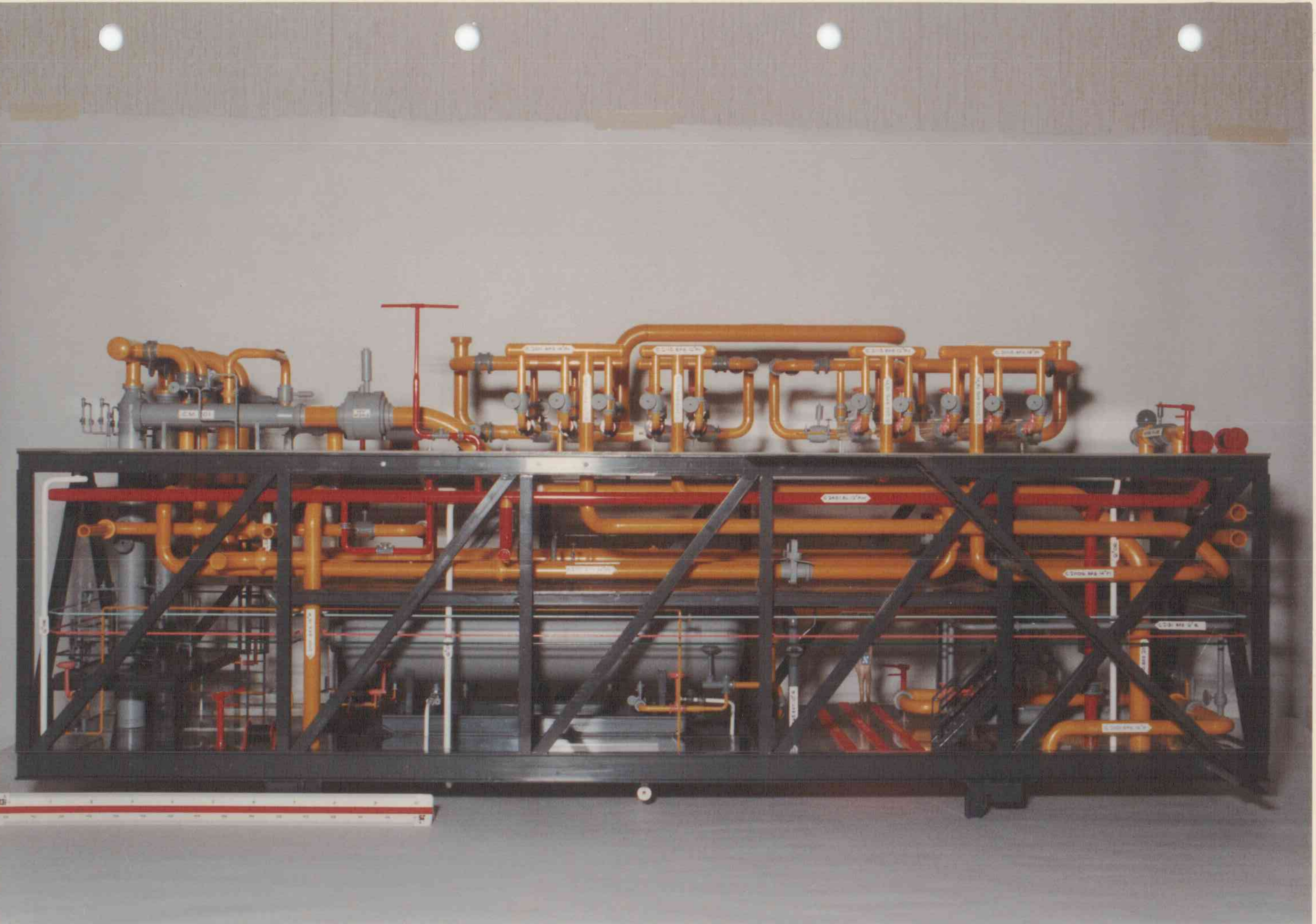
SCHEMATIC PROCESS DIAGRAM

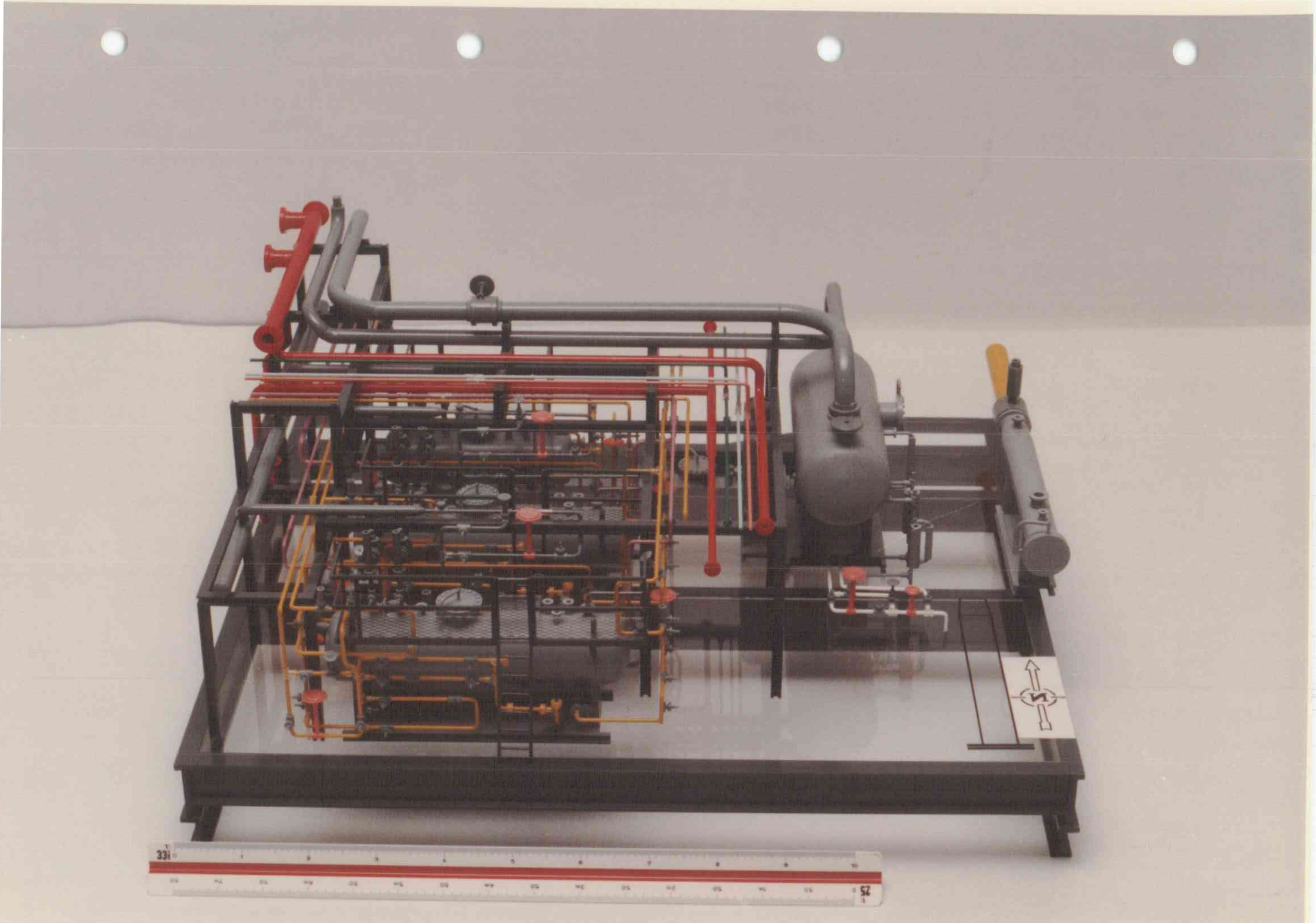
FRIGG FIELD | PF 88.00.00.01.02 | 6

TCP2 EXTENSION

SIMPLIFIED PROCESS FLOW DIAGRAM







1.2 FIELDS LOCATION

Frigg Field, North-East Frigg Field (NEF) and the Odin Field are located in the northern part of the North Sea about 190 km off the Norwegian coast, 190 km from the Shetland Islands and 350 km from Scotland.

The map Figure No. 1.2 gives the relative location of NEF and Odin Fields in reference to the Frigg Field.

The Odin Field is located at a distance of about 22 km from the Frigg Field.

The NEF Field is located at a distance of about 17 km from the Frigg Field.

These fields are located inside the Norwegian coast water boundaries.

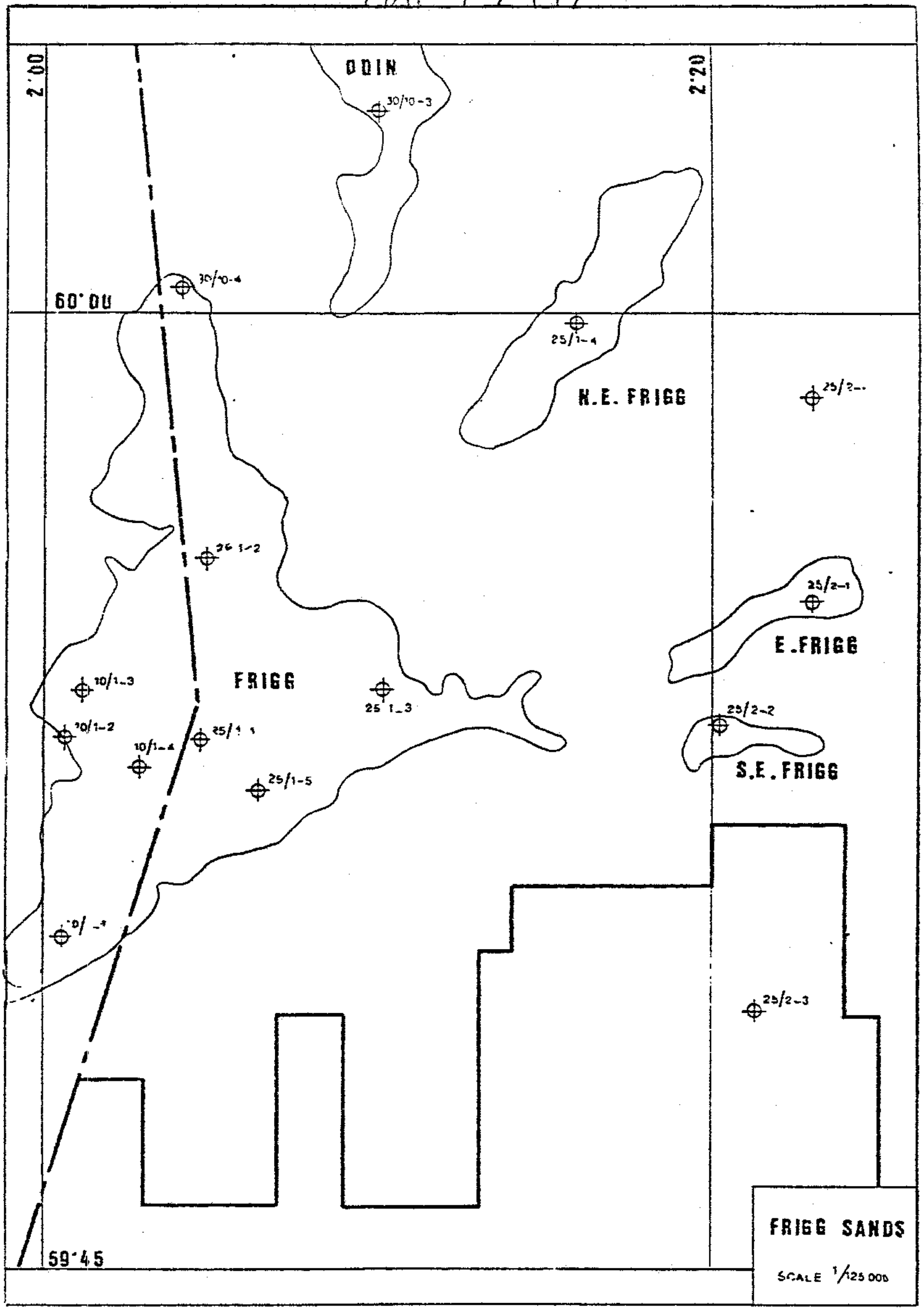
The Odin Field is developed in a conventional way; i.e. a fixed drilling / production platform of the jacket type.

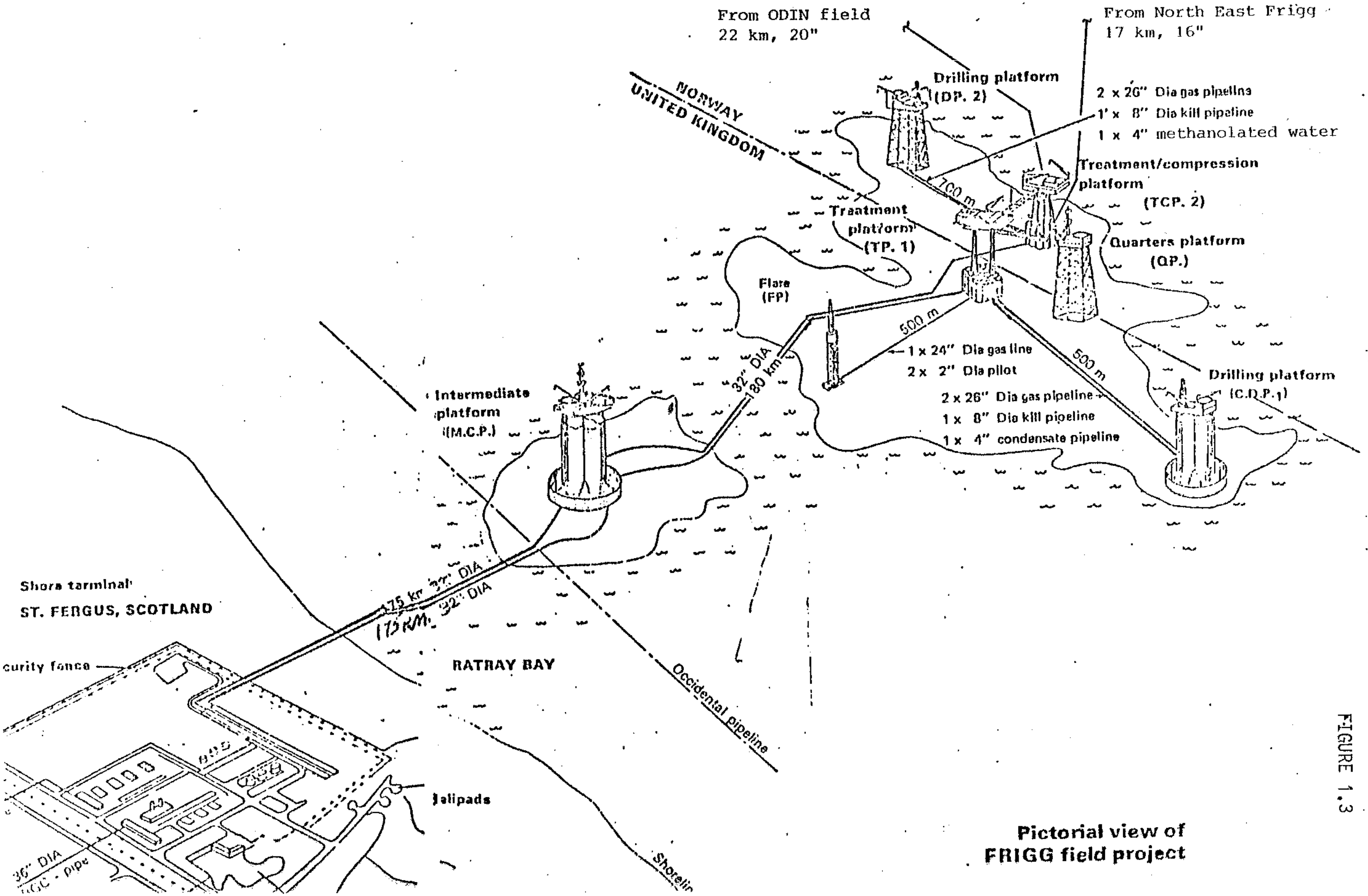
The NEF Field is developed by means of a sub-sea technology with remote control from the Frigg Field through an articulated column located at the field.

Figure 1.3 shows the lay-out of the Frigg field treatment and transportation facilities.

FIGURE 1.2

MAP 1-2 (1)





Pictorial view of
FRIGG field project

FIGURE 1.3

1.3 EXTENSION LOCATION

The locations of M50 and P53 onboard TCP-2 platform are shown on drawing Nos.:

FF 85 00 00 0030 - Admissible Load on Main Deck for Module 50 (Figure 1.4)

and

FF 85 00 00 0031 - Admissible Load on Cellar Deck Pancake 53 (Figure 1.5)

The gas from the ODIN field is received on TCP-2 through an existing 20" riser.

The gas from the NEF Field is received on TCP-2 through an existing 16" riser.

The gas treatment facilities and the condensate recovery facilities of the two gases are located on TCP-2.

The DP-2 platform shall support the waste methanolated water facilities.

FIGURE 1.4

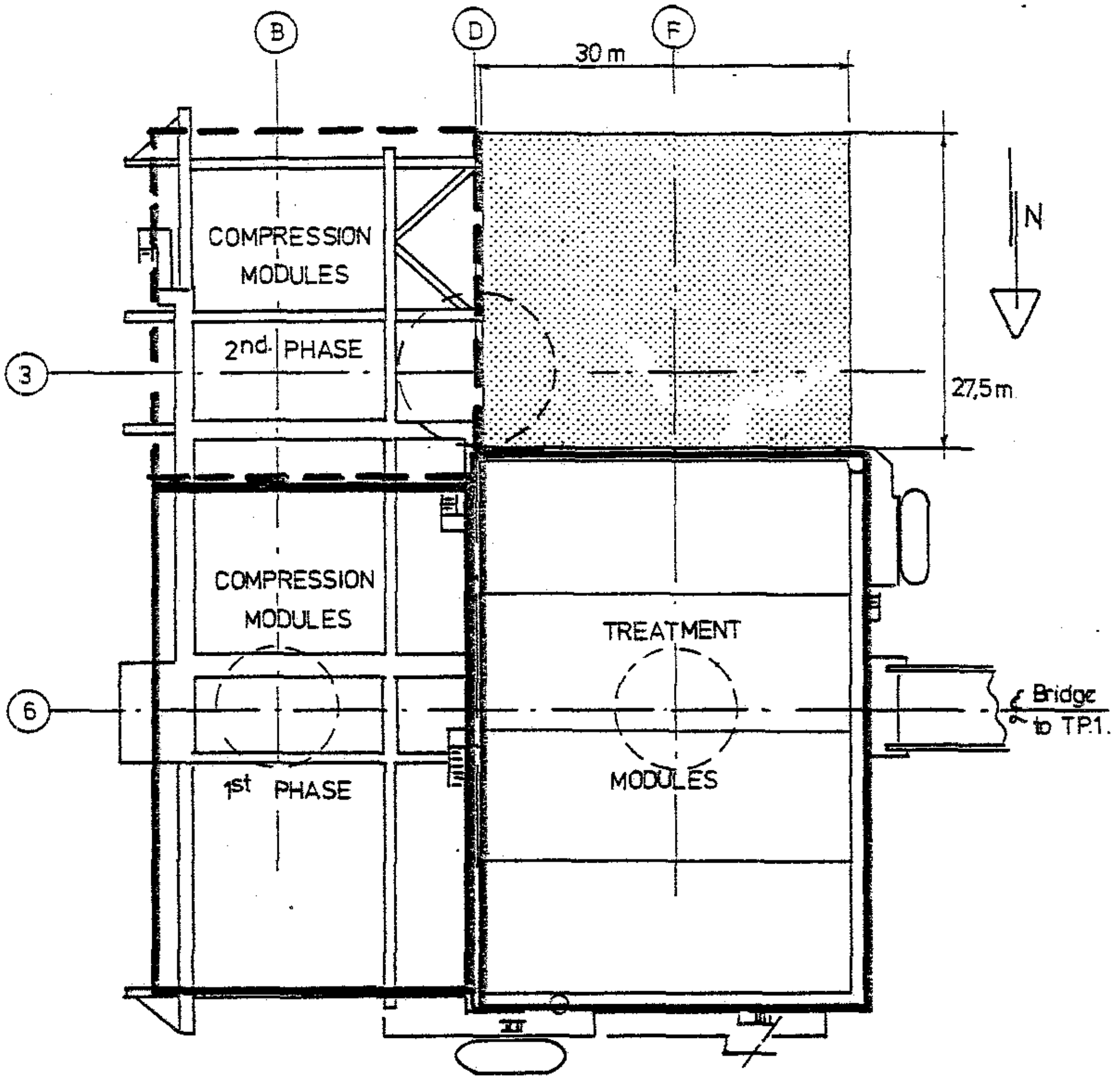
Drawing No.: FF 85 00 00 0030

Admissible Load on Main Deck for Module 50

FIGURE 1.5

Drawing No.: FF 85 00 00 0031

Admissible Load on Cellar Deck Pancake 53



A 825 m² area is available in the South West corner of Main deck (level: +35m) in the alignment of the existing Treatment modules.

TOTAL LOAD: 1800MT.

0	4.12.79	First issue	S.B	
Rev.	Date	DESCRIPTION	by	app.

Contractor

elf aquitaine norge a/s
p.o.box 168
4001 Stavanger

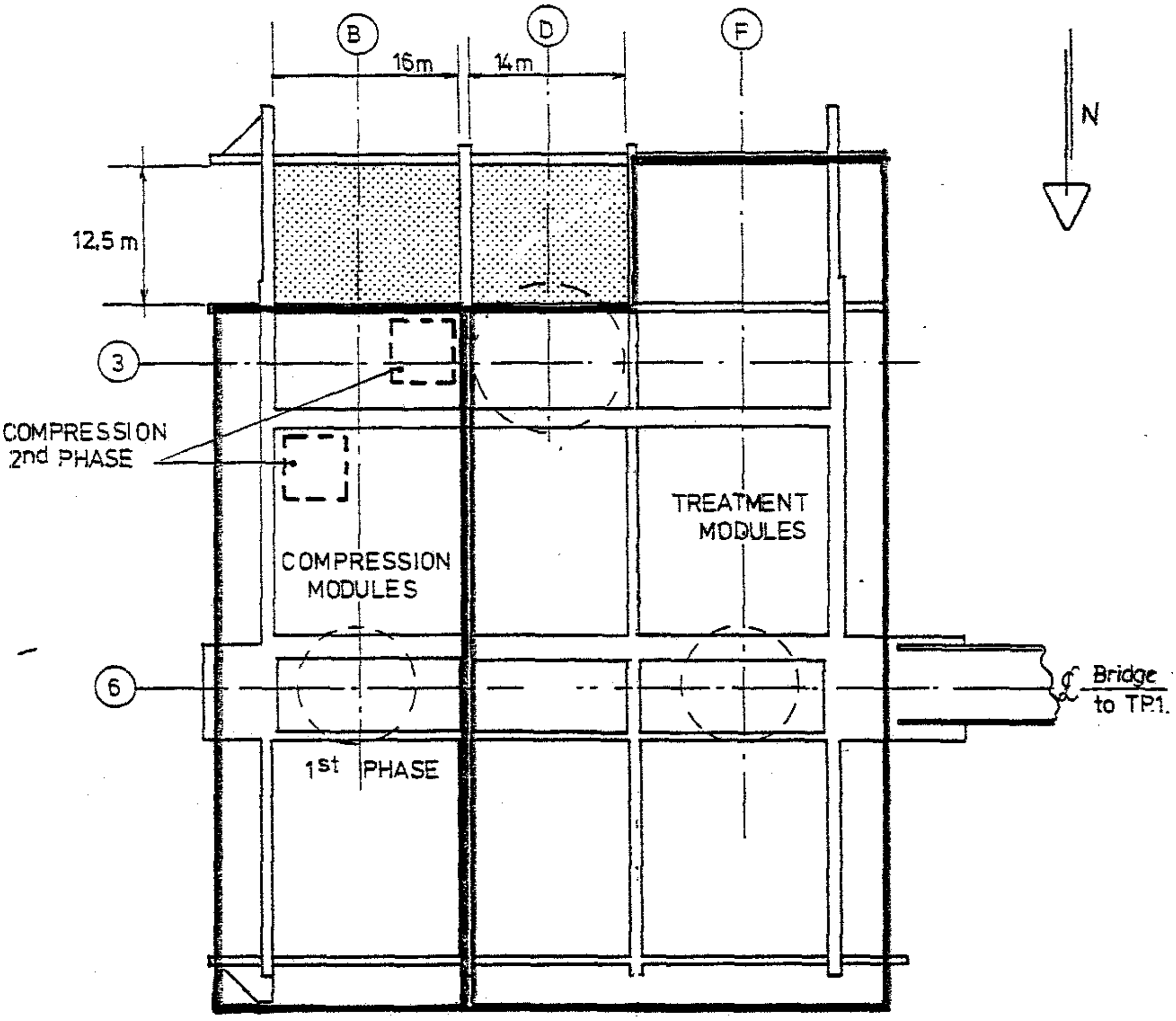
FRIGG FIELD

Installation TCP 2
System
Job no.
Scale

AVAILABLE AREA
MAIN DECK

Drwg. no. FF 85 00 00 0030
Rev. 0
Sheet /

1979 - 40361
Size A4 Form 100.315



A 375 m² area is available in the South East corner of the Cellar deck (level +27m) included in the Support frame structure.

TOTAL LOAD : 1000 MT.

Rev.	Date	DESCRIPTION	by	app.
0	4.12.79	First issue	S.B	

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norge a/s
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4001 Stavanger

FRIGG FIELD

Installation TCP 2
System
Job no.
Scale

AVAILABLE AREA
CELLAR DECK.

Drwg. no. FF 85 00 00 0031
Rev. 0
Sheet 1

Size A4. Form 100.315

1.3.1 Outline of M50, P53 and Integration

1.3.1.1 Module M50

The overall dimensions of this module are:

- Length	31	metres
- Width	8.1	metres
- Height	8.2 to 11.2	metres

Total weight at lifting stage: About 700 tons.

The plot plan drawing FF 88 20 00 0105 gives an outline of the main equipment. (Figure 1.6)

1.3.1.2 Pancake 53

P53 is a steel floor which supports the equipment.

The overall dimensions in plan are:

- Length	13	metres
- Width	11.5	metres
- Height of equipment and pipework:	4.25	metres above steel floor plating

Total weight at lifting stage: About 100 tons.

The plot plan drawing FF 88 20 00 0101 gives an outline of the main equipment locations. (Figure 1.7)

1.3.1.3 Tie-In Installations

Prefabricated piping spools, structural works, electric equipment and instrumentation are installed to perform the integration between:

- M50 and P53
- M50 and existing facilities
- P53 and existing facilities
- Existing facilities

An outline of the tie-in installations is given on the following drawings:

FF 88 20 00 7300 - Tie In Piping Arrangement Cellar Deck - El. 100.000. (Figure 1.8)

FF 88 20 00 7305 - Tie In Piping Arrangement Main Deck - El. 108.850. (Figure 1.9)

FF 88 20 00 7307 - Tie In Piping Arrangement Upper Deck - El. 116.350. (Figure 1.10)

FF 83 20 00 8860 - General Arrangement of DP-2 Package of Methanolated Water Injections. (Figure 1.11)

These drawings give mainly an outline of the piping and mechanical installations.

A major part of the electrical and instrumentation work is integration into existing systems for safety, process operations, shut down system and power distribution in TCP-2 area M32 and P13 and on QP platform.

FIGURE 1.6

Drawing No.: FF 88 20 00 0101

Pancake 53 - Plot Plan

FIGURE 1.7

Drawing No.: FF 88 20 00 0105

Static Module 50 - Plot Plan

FIGURE 1.8

Drawing No.: FF 88 20 00 7300

Tie-In Piping Arrangement Cellar Deck

FIGURE 1.9

Drawing No.: FF 88 20 00 7305

Tie-In Piping Arrangement Main Deck

FIGURE 1.10

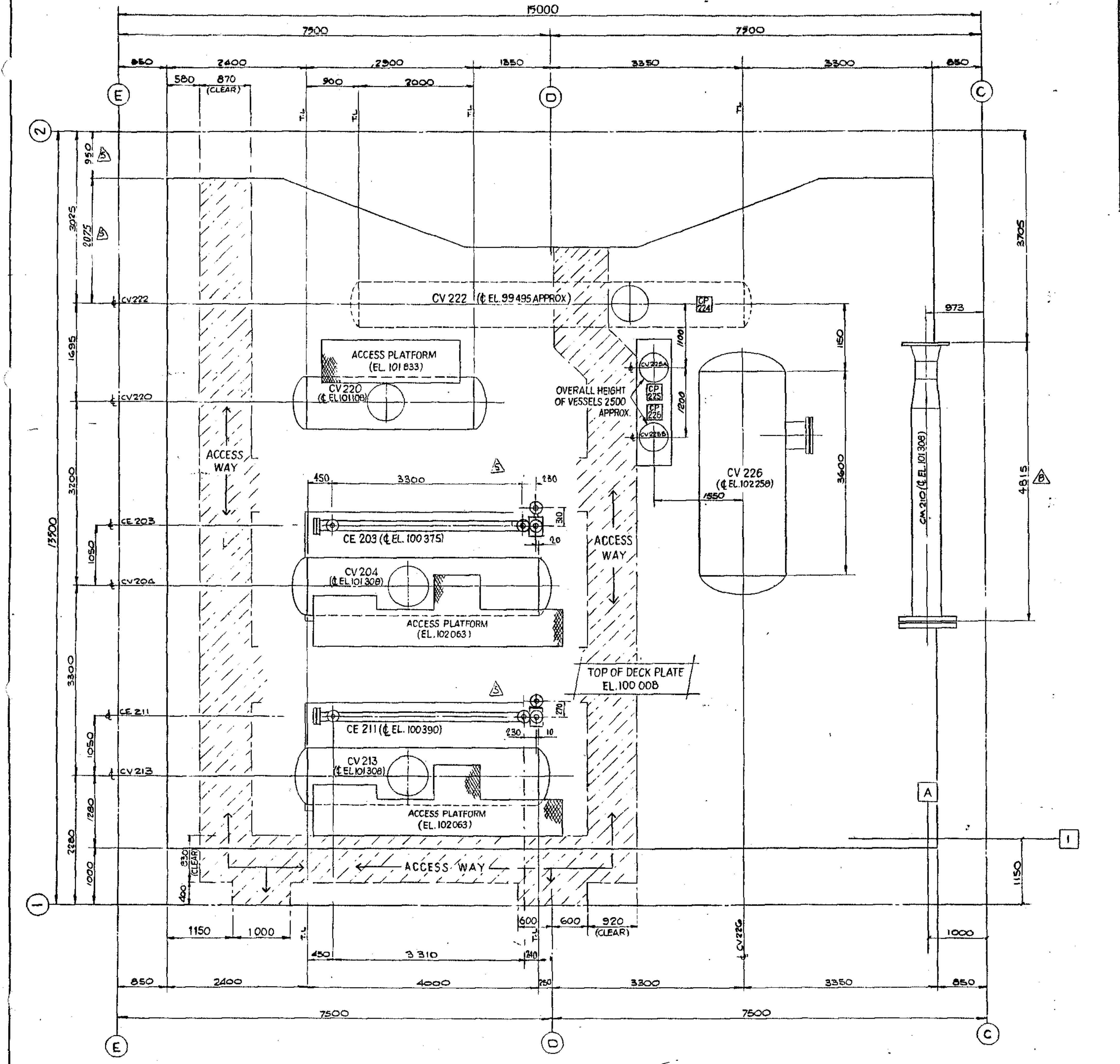
Drawing No.: FF 88 20 00 7307

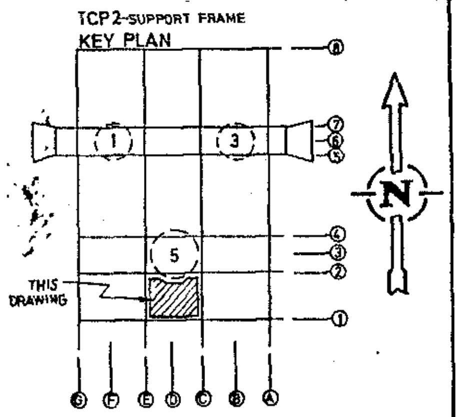
Tie-In Piping Arrangement Upper Deck

FIGURE 1.11

Drawing No.: FF 83 20 00 8860

General Arrangement of DP-2 Package of Methanolated Water Injections





ITEM	DESIGNATION	DRY WEIGHT	OPER. WEIGHT	TEST WEIGHT	REMARKS
CE 203	ODIN CONDENSATE HEATER	13	15	15	
CV 204	ODIN CONDENSATE METHANOL SEPARATOR	25	45	60	
CE 211	NEF CONDENSATE HEATER	13	15	15	
CV 213	NEF CONDENSATE METHANOL SEPARATOR	25	45	60	
CV 220	METHANOLATED WATER FLASH DRUM	17	48	48	
CV 222	METHANOLATED WATER DRAINAGE TANK	20	45	50	REMOVABLE
CP 224	(WITH PUMP)				
CV 225A CV 225B	INHIBITOR DRUMS	10	16	16	
CP 225 CP 226	(WITH PUMPS)				
CV 226	L.T. RELIEF SCRUBBER	45	75	120	
CM 210	NEF PIG RECEIVER	55	60	70	TEMPORARY ⚠5
		(LOADS IN KILONEWTONS)			

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TCP2 EXTENSION
HOOK UP
AS BUILT
DRAWING

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APPROVED FOR
CONSTRUCTION

REV.	DATE	DESCRIPTION	BY	APP	CLIENT
10	21.12.83	AS BUILT	KB		[illegible]
9	18.1.83	APPROVED FOR Hook-UP			
8	18.8.82	LENGTH OF CM 210 WAS 4865	[illegible]		
7	17.6.82	LENGTH OF CM210 WAS 4562	P.R		
6	22.7.82	ISSUE FOR CONSTRUCTION APPROVAL	P.K	[illegible]	DC
5	22.1.82	CE 203 - CE 211 REDRAWN	CHS	[illegible]	[illegible]
4	30.10.81	ISSUE FOR YARD TENDER.	HJ	[illegible]	
3	18.9.81	REDRAWN TO LARGER SCALE.	PC	[illegible]	—
2	12.6.81	REVISED IN ACCORDANCE WITH EAN REQUIREMENTS	BAO	[illegible]	
1	21.3.81	REVISED IN ACCORDANCE WITH EAN COMMENTS	DB	[illegible]	
0	11.5.80	[illegible]	DB	[illegible]	

solresid norge a.s DRWG. NO.: PP 04 P53 1008

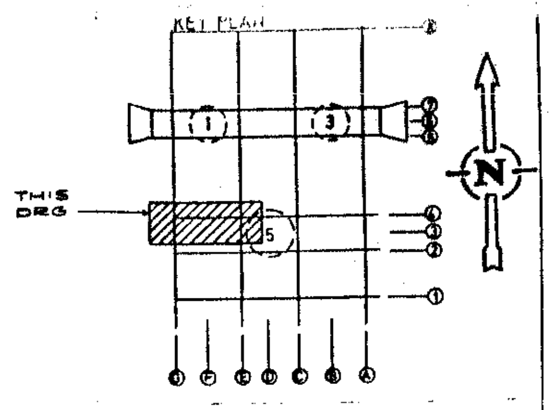
TCP 2 EXTENSION

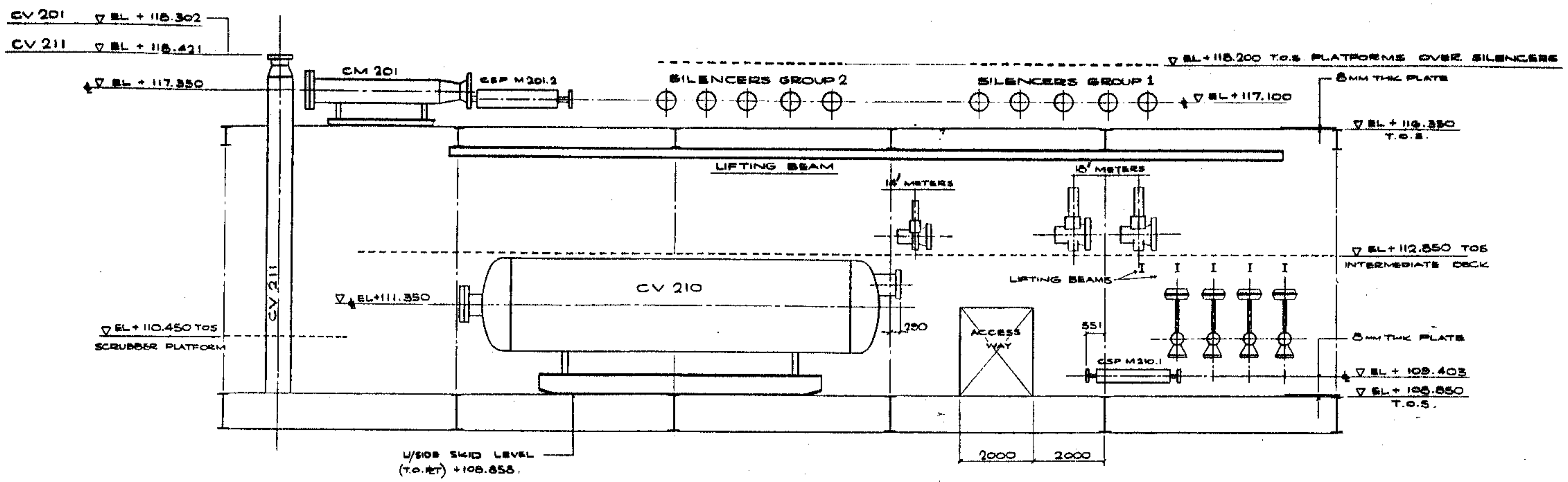
elf aquitaine norge a/s P.O. Box [illegible] — [illegible] Stavanger

A1	Installation TCP 2	System GENERAL
Job no. F 087	PANCAKE 53	
Scale 1:33⅓	PLOT PLAN	

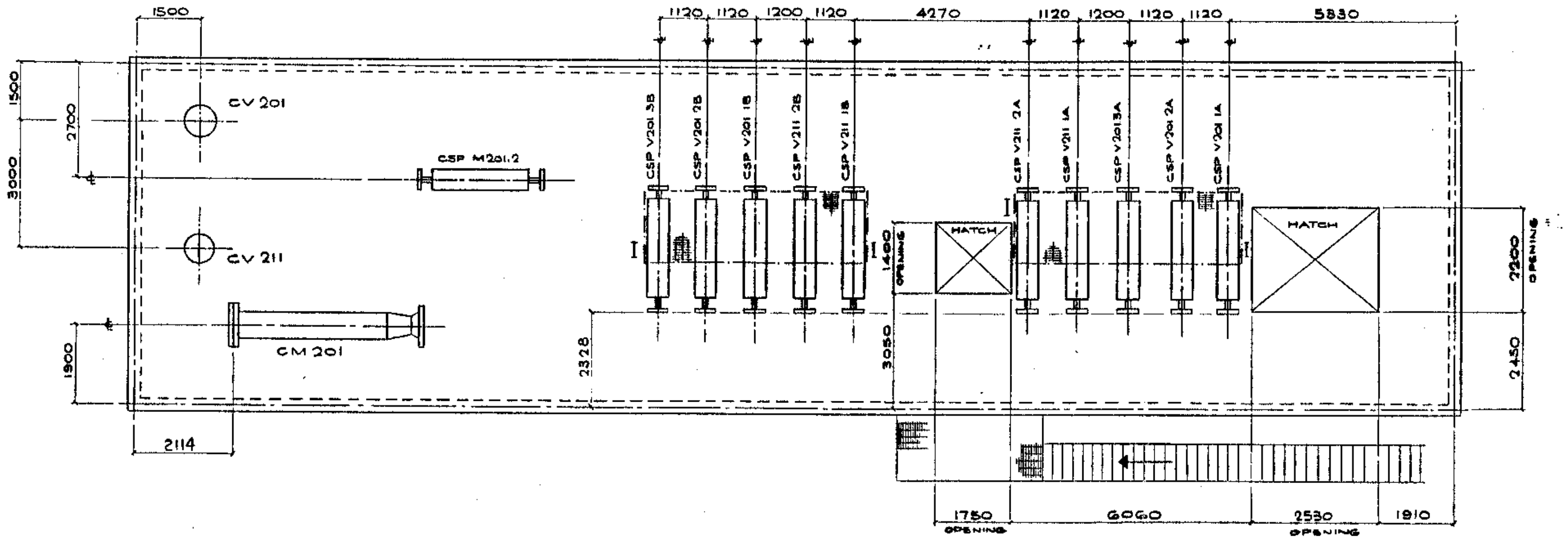
FRIGG FIELD
Drwg. no. FF 88 20 00 0101
Rev. 10
Sheet 1/1

3

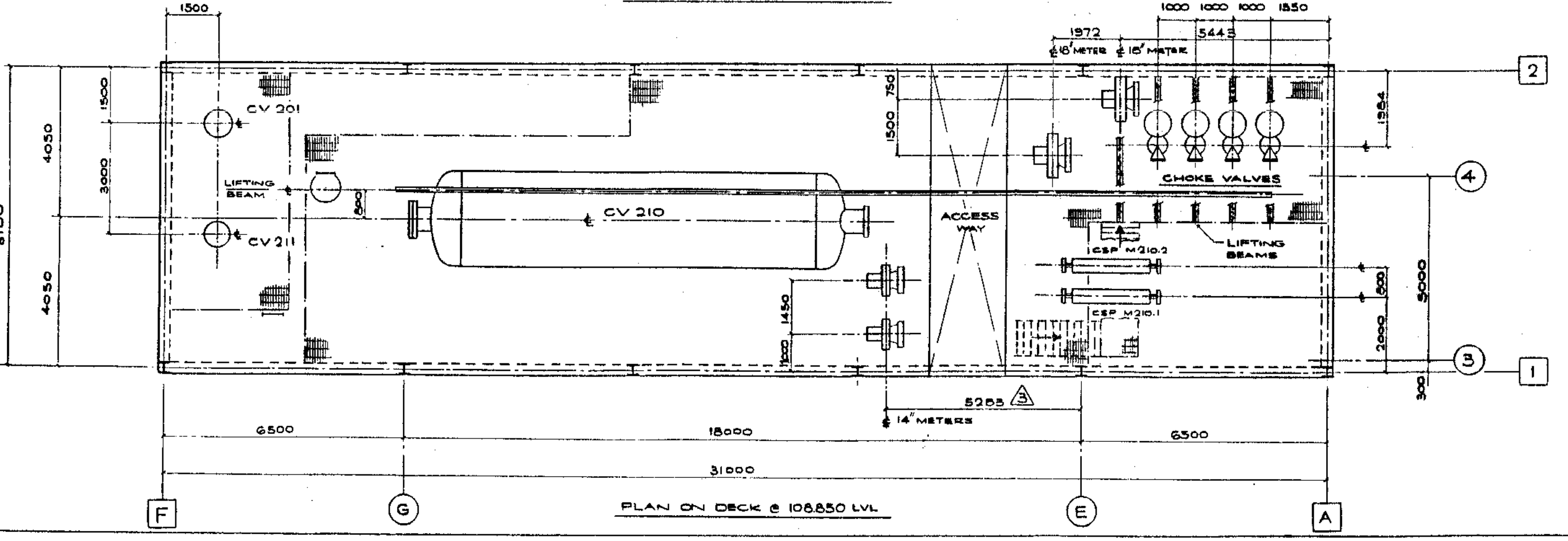




ELEVATION LOOKING NORTH



PLAN ON DECK @ 116.350 LVL



PLAN ON DECK @ 108850 LVL

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CM 201	ODIN PIG RECEIVER	75	80	90	WITH SUPPORTS
CV 201	ODIN GAS SCRUBBER	90	105	110	WITH SUPPORTS
CV 211	NEF GAS SCRUBBER	70	80	85	WITH SUPPORTS
CV 210	NEF SLUG CATCHER	1000	1450	1520	WITH SUPPORTS & SKID
	18" METER 'DANIEL'	40	40	41	
	14" METER 'DANIEL'	30	30	31	
CSP M 201.2	SILENCER	10	10	10	
CSP M 210.1	SILENCER	10	10	10	
CSP M 210.2	SILENCER	10	10	10	
	SILENCERS . GROUP.1.	75	75	75	
	SILENCERS GROUP.2.	75	75	75	

TCP2 EXTENSION
HOOK UP
AS BUILT
DRAWING

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HOOK-UP

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APPROVED FOR
CONSTRUCTION

REV.	DATE	DESCRIPTION	BY	APP	CLIENT
8	27.12.88	AS BUILT	Eb		57
7	18.2.83	APPROVED FOR HOOK-UP			AV
6	14.6.82	2114 WAS 2314	P.E		
5	22.2.82	ISSUED FOR CONSTRUCTION APPROVAL	P.R	EBL	DE
4	30.10.81	ISSUE FOR YARD TENDER	HJ		
3	30.9.81	DIMENSION AMMENDED	HJ		
2	22.9.81	REDRAWN	HJ		
1	13.5.81	ISSUED FOR COMMENTS	SPS	TSL	
0	23.3.81	First Issue	SPS	TSL	

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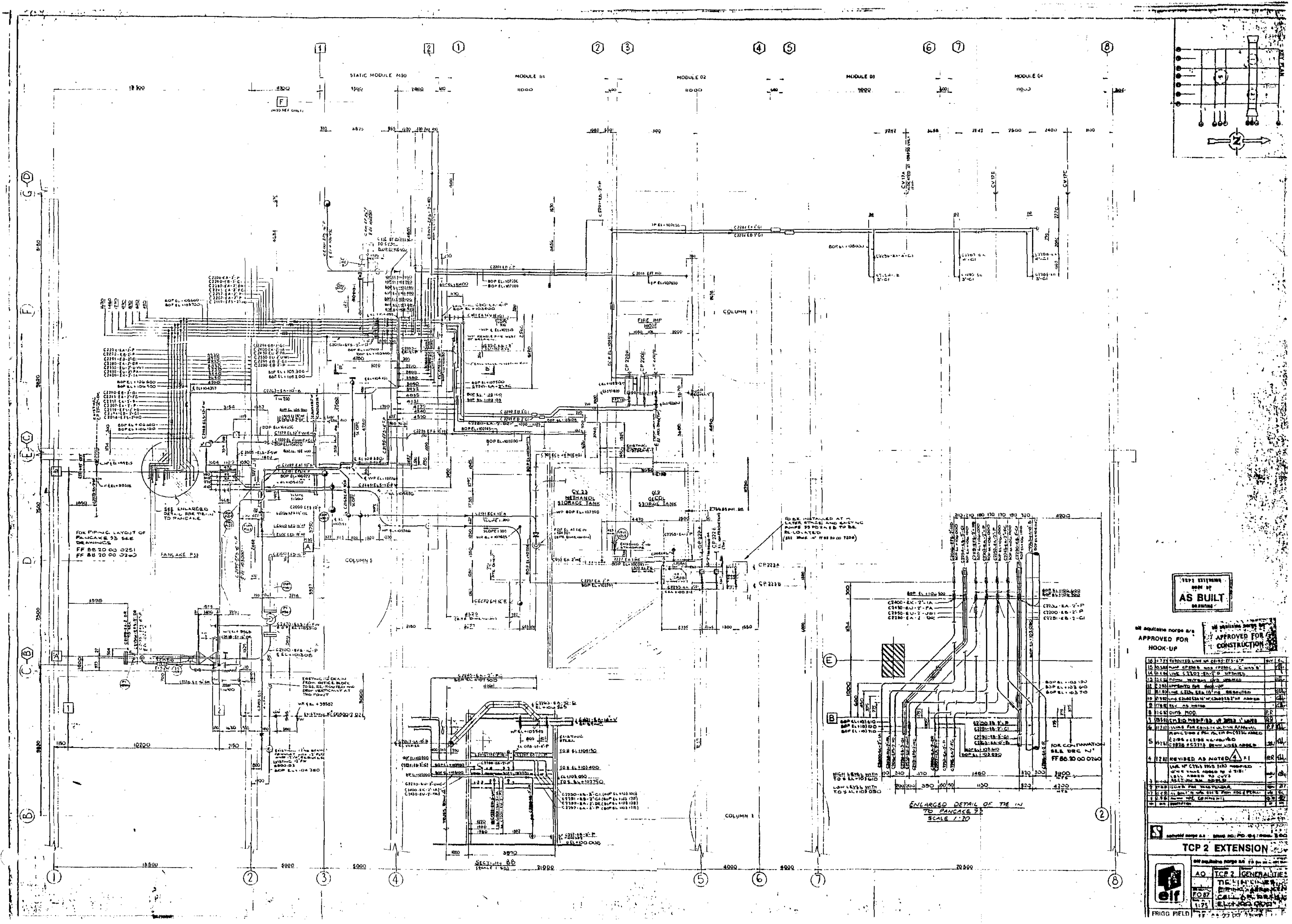
TCP 2 EXTENSION

elf aquitaine norge a/s P.O. Box 168 – 4001 Stavanger
A1
Installation TCP 2
System GENERAL
STATIC MODULE 50
Job no. F087
PLOT PLAN
Scale 1:75
FRIGG FIELD
Drwg. no. FF 88 20 00 0105
Rev. 8
Sheet 1/1

2



AS BUILT DRAWING

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APPROVED FOR
HOOK-UP

elf aquitaine norge a/s
APPROVED FOR
CONSTRUCTION

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15	[illegible]	[illegible] "C" WAS "B"		[illegible]
14	[illegible]	LINE C2202-EA-2"P UPDATED		
13	[illegible]	[illegible]		[illegible]
12	[illegible]	APPROVED FOR HOOK-UP		
11	[illegible]	LINE C2254-EE-1½" HE REROUTED		[illegible]
10	[illegible]	LINE C2402-EA-1½"HF, C2403-EA-2"HF ADDED		[illegible]
9	17.6.82	REV. AS NOTED		[illegible]
8	[illegible]	DIMS. MOD.	RR	
7	[illegible]	[illegible]	RR	
6	[illegible]	ISSUED FOR CONSTRUCTION APPROVAL	RR	[illegible]
5	[illegible]	[illegible] C2196 + C2198 RE-ROUTED C2828 + C2773 DRAIN LINES ADDED	[illegible]	[illegible]
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3	[illegible]	LINE Nº C2163 [illegible] MODIFIED [illegible] SECTION BB ADDED	[illegible]	[illegible]
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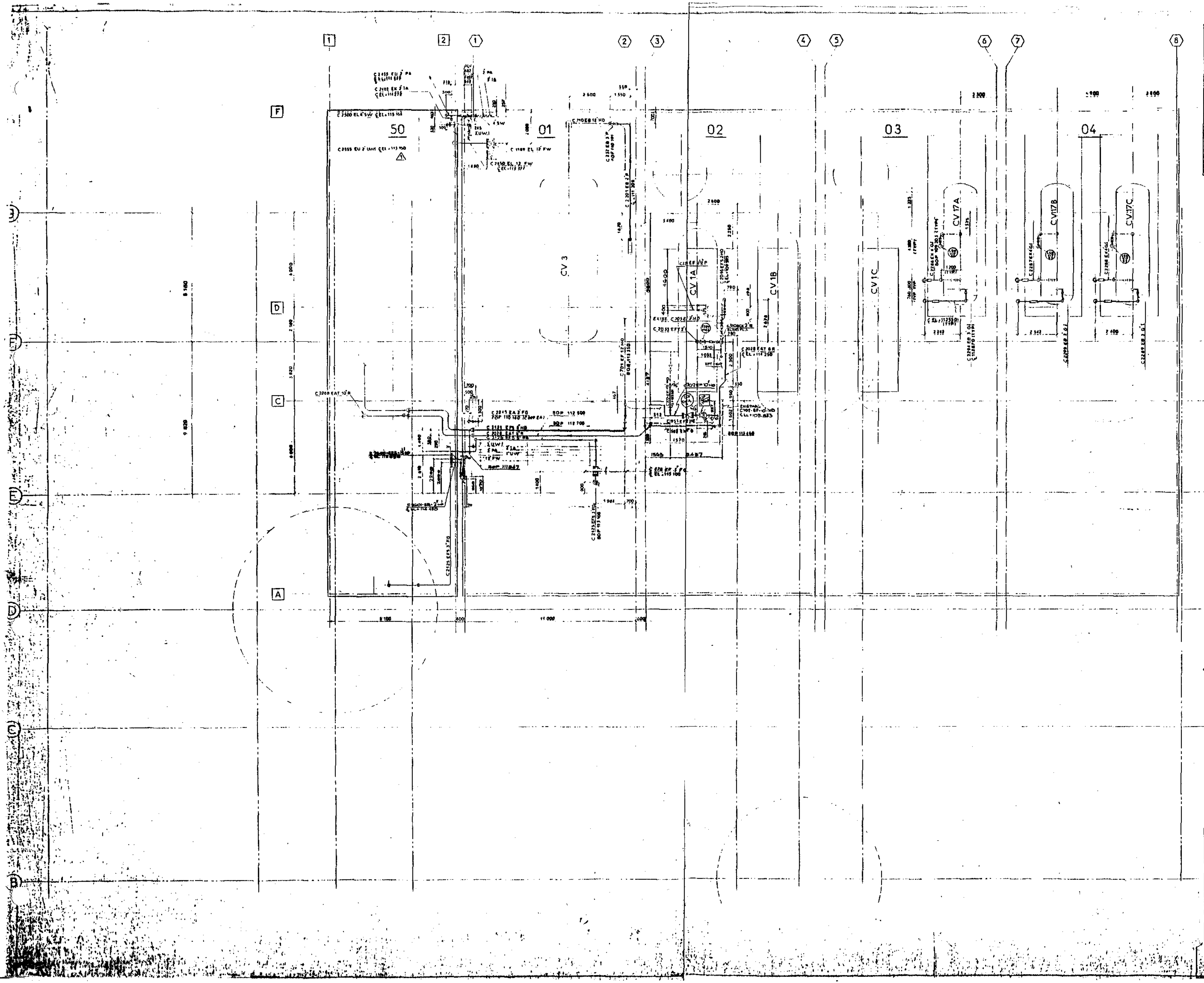
1	[illegible]	AS BUILT [illegible]	[illegible]	[illegible]
1	[illegible]	[illegible] COMMENTS	[illegible]	[illegible]
nr	dat	description		

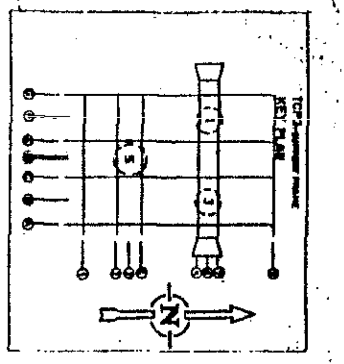
solvold norge a.s · DRWG NO.: PO-047 [illegible]

TCP 2 EXTENSION

elf aquitaine norge a.s

AO
TCP 2
GENERALITIES
TIE IN LINES PIPING ARRANGEMENT CELL 6 [illegible] EL [illegible]
FO 87
1:75
FRIGG FIELD
FF 88 22 00 [illegible]





"TCP2 EXTENSION"
HOOK-UP
AS BUILT
DRAWING

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APPROVED FOR
HOOK-UP

elf aquitaine norge a/s
APPROVED FOR
CONSTRUCTION

8	2.12.85	AS BUILT TO [illegible]	KO	[illegible]	
7	1.3.83	APPROVED FOR HOOK-UP			[illegible]
6	17.3.82	[illegible] VERSION [illegible] - LINE CODE [illegible] MODIFIED	[illegible]		[illegible]
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3	5.1.82	GENERAL REVISION	HJ	[illegible]	
2	[illegible]	ISSUE FOR YARD TENDER	HJ	[illegible]	
1	[illegible]	UPDATED - ISSUED FOR COMMENTS	[illegible]	[illegible]	
0	1.09.81	[illegible] FOR COMMENTS	[illegible]	[illegible]	
REV	DATE	DESCRIPTION			

solvold norge a.s DRWG. NO.: PD 04 000 105

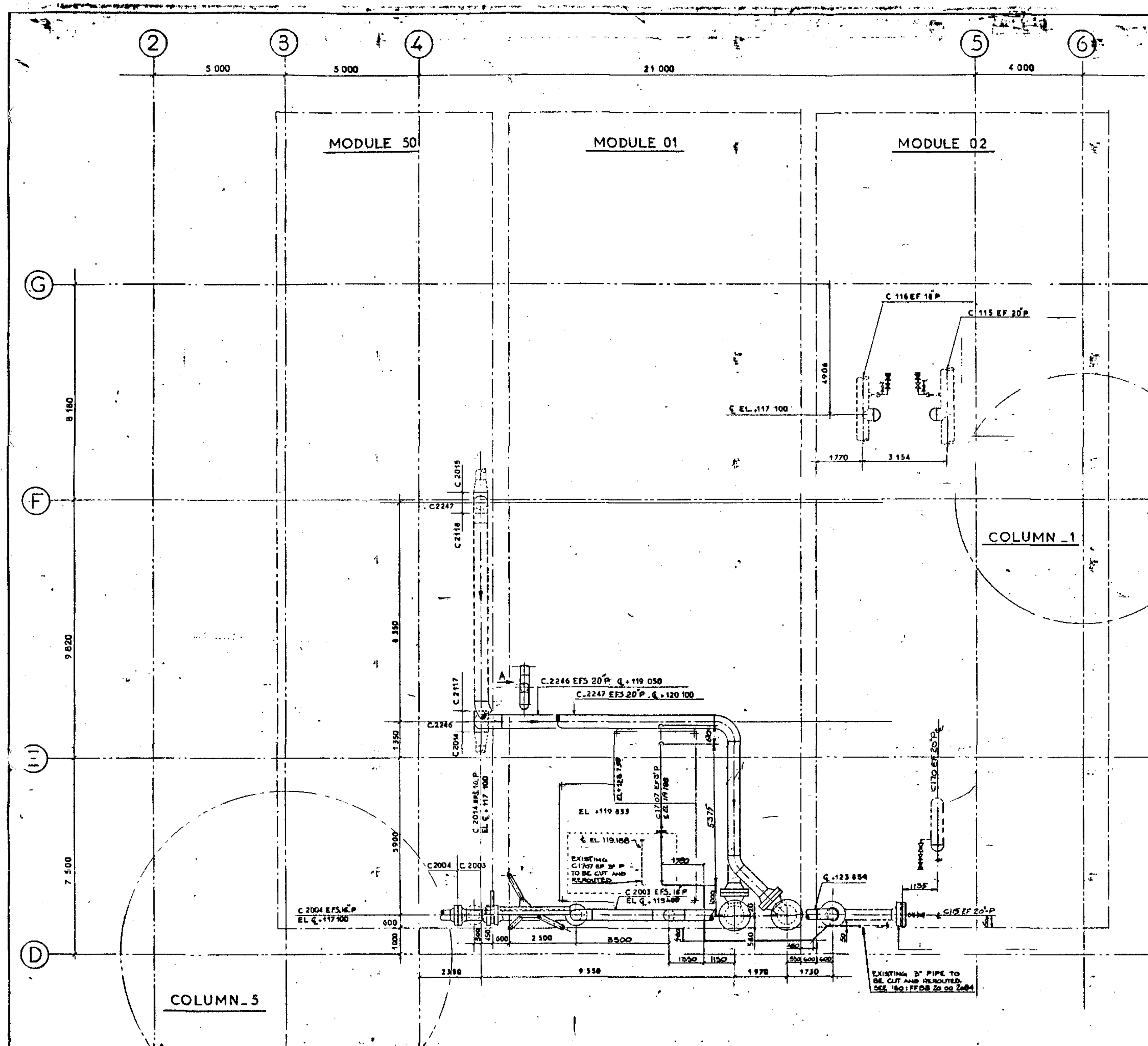
TCP 2 EXTENSION

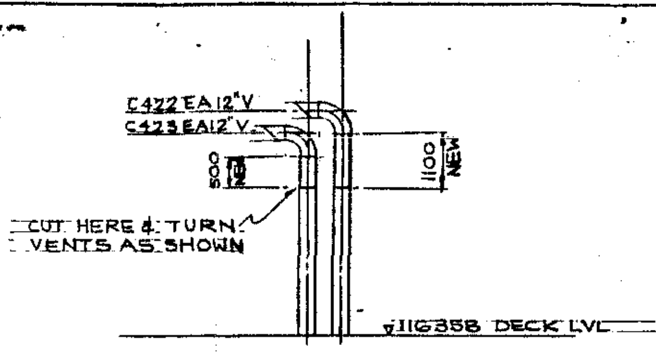
elf aquitaine norge a/s

A0 | TCP 2 | GENERAL [illegible]

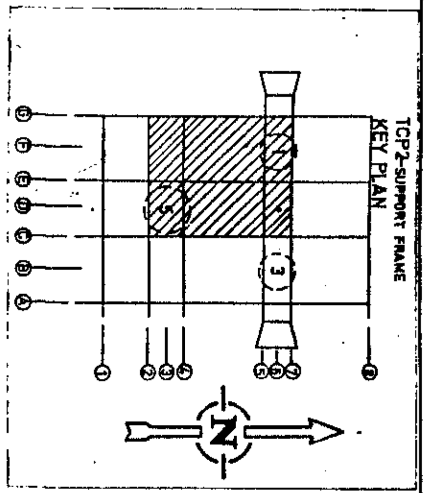
PIPING ARRANGEMENT
MAIN DECK [illegible]
EL. [illegible]

FRIGG FIELD





VIEW ON 'A'
SHOWING MODS TO EXIST^G VENTS



TCP2 EXTENSION
HOOK UP
AS BUILT
DRAWING

elf aquitaine norge a/s
APPROVED FOR
CONSTRUCTION

REV.	DATE	DESCRIPTION	BY	APP.	CLIENT
8	2.3.83	APPROVED FOR HOOK-UP			R/
7	12.12.82	EXISTING 3" PIPE REROUTED			
6	22-2-82	ISSUED FOR CONSTRUCTION APPROVAL	P.R		DE
5	15-2-82	MODS AS NOTED ⚠5 ×4	P.R		
4	28.1.82	REVISION AS NOTED ⚠4 × 1	HJ		
3	15.1.82	GENERAL REVISION	HJ		
2	30.10.81	ISSUE FOR YARD TENDER	HJ		
9	2.12.80	'AS BUILT' TO INFO REC'D FROM HDG & P'CELL	KG		
0	4/15 81	[illegible] FOR COMMENTS			

selvaag norge a.s DRWG. NO.: L0_04 000 0307

TCP 2 EXTENSION

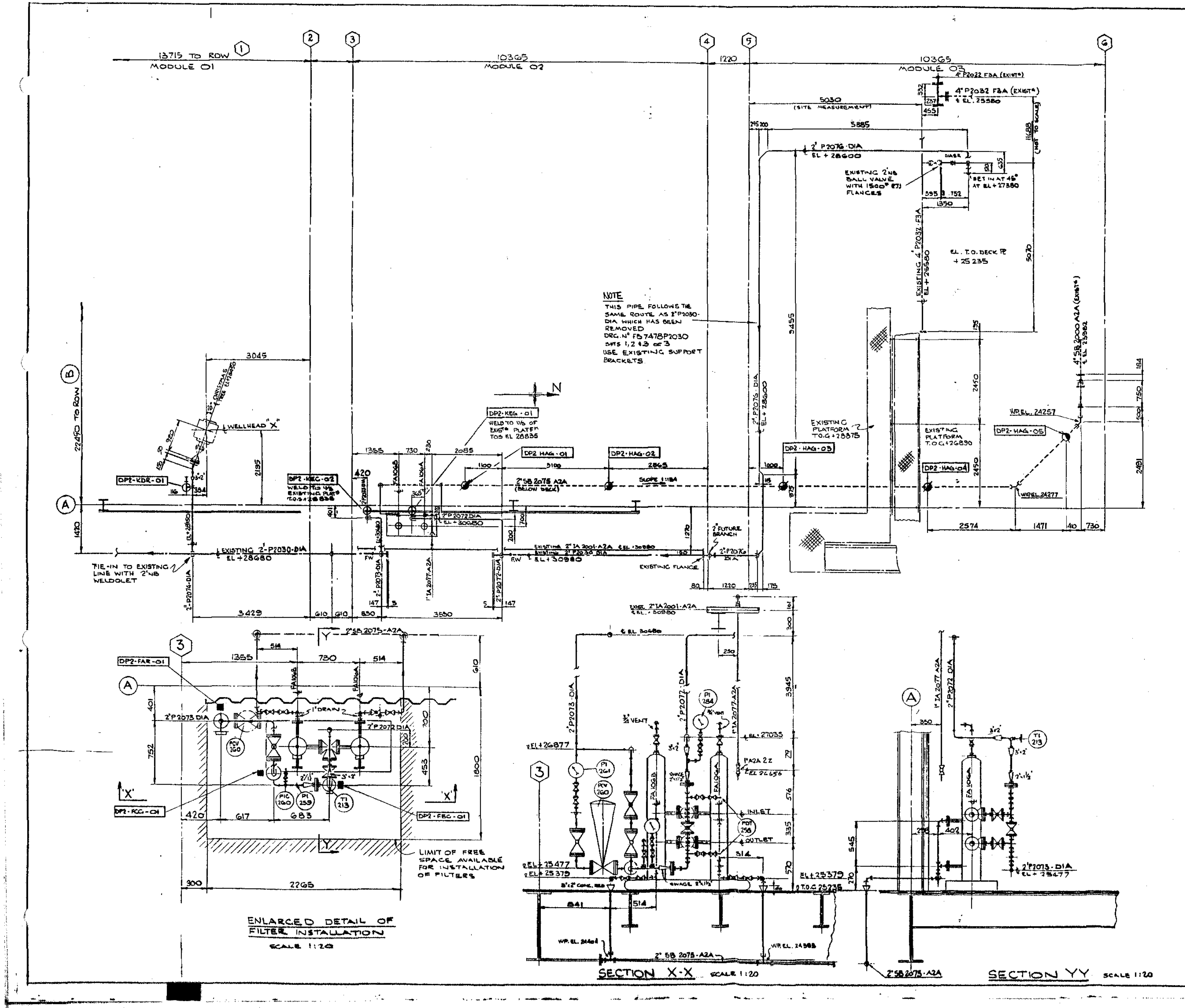
elf aquitaine norge a/s P.O. Box 168 — 4001 Stavanger

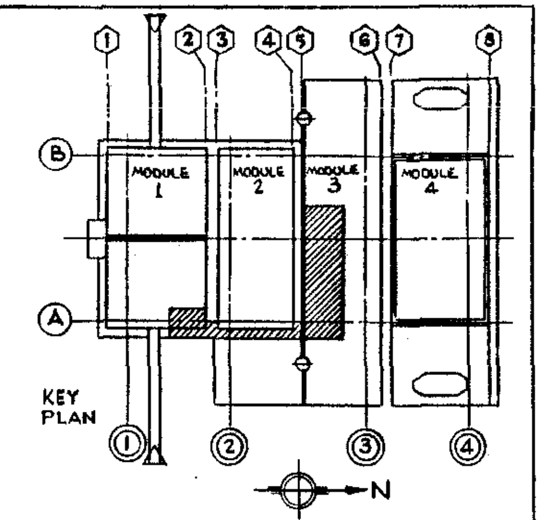
A1 | TCP2 | GENERALITIES

PIPING ARRANGEMENT
UPPER DECK TIE-INS
EL+ 116 350

F087
1/75

FRIGG FIELD | 66 20 00 7302





TCP2 EXTENSION
HOOK UP
AS BUILT
DRAWING

elf aquitaine norge a/s
APPROVED FOR
HOOK-UP.

REV.	DATE	DESCRIPTION	BY	APP	CLIENT
6	21.2.83	AS BUILT TO INFO REC'D FROM HDG & P'CELL	KB	EA	
5	16.5.83	C. UP ISSUE	-		DB
4	22.4.83	LINE 2" SB 2075 A2A, 4" P2022-FBA ADDED			
3	2.3.83	APPROVED FOR HOOK-UP			AV
2	28.8.82	LINE 2" IA 2001-A2A & 1" IA 2077 A2A ADDED			
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TCP 2 EXTENSION

elf aquitaine norge a/s P.O. Box 168 — 4001 Stavanger

A1	Installation DP2	System METHANOLATED WATER
Job no. F087	GENERAL ARRANGEMENT OF DP2 PACKAGE OF METHANOLATED WATER INJECTION	
Scale 1:50		

FRIGG FIELD	Drwg. no. FF 83 70 00 6860	Rev. 6	Sheet 1/1

1.4 PROCESS DESCRIPTION

1.4.1 Introduction

The purpose of the new installation on the TCP-2 platform is to:

- Treat the gas coming from the NORTH EAST FRIGG (NEF) and ODIN fields.

- Recover the condensate

- Meter the treated gases and the condensates

- Inject the gases into the FRIGG gas production system for gas compression and glycol dehydration and further transportation to Scotland.

- Inject the condensates into the FRIGG condensate system.

Methanol will be injected in the ODIN and NEF field streams at the wellhead to prevent hydrate formation in the sea line. The methanolated water facilities on TCP-2 are common to both fields.

The ODIN and NEF gases may eventually have to be compressed in the future. This depends on the reservoir pressure decline. There are two possibilities for each field:

- Slow pressure decline (corresponding to a water drive in the reservoir)

- Steep pressure decline (corresponding to no water drive in the reservoir)

NEF gas composition, reservoir pressure and production profile is given in Appendix 1.

ODIN gas composition, reservoir pressure and production profile is is given in Appendix 2.

In the case of water drive, no compression of ODIN and NEF is required to raise the pressure up to FRIGG gas pressure. In the case of no water drive, compression is required.

A hydrocarbon material balance has been carried out for the sizing case, which corresponds to the start-up year and no water drive in the reservoir. This balance was based on computer simulations for the Slug Catchers CV 1A/CV 210 and for the Condensate/Methanol Separators CV 204/CV 213.

The sizing case for ODIN methanol/water material balance corresponds to year 1987 and no water drive in the reservoir, while the same material balance for NEF corresponds to year 1984 and no water drive.

The Process Flow Diagrams showing the material balance are attached in Appendix 3.

1.4.2 Description

1.4.2.1 NEF Gas Treatment (Ref. drawing FF 88 00 00 5031 - Appendix 3)

The 16" sea line from NEF which is 17.4 km long, will contain gas, hydrocarbon liquid and methanolated water. The design flowrate is 7.7 MSCM/D, which corresponds to the start-up year and no water drive in the reservoir. The purpose of the methanol, is to prevent hydrate formation in the sea line.

At the arrival on TCP-2, the gas pressure is adjusted by four choke valves (HIC M 210 A/B/C/D), before the fluid enters vessel CV 210 which is the NEF Slug Catcher.

A Pig Receiver, CM 210,, will be used for start-up purposes during dewatering of the sea line. After the start-up period is over, this Pig Receiver will be disconnected and removed.

In vessel CV 210, the gas is separated from the condensate and methanolated water. The operating pressure in the vessel, will vary between the values 14 - 136 bara depending on the reservoir pressure decline and on the time elapsed after start-up. The fluid enters vessel CV 210 which is designed for a pressure of 177.5 bara at 5°C.

In order to get a good separation, the vessel contains internals as inlet diffuser, dixon plates and mist extractor. The diffuser is an inlet device which is mainly used as deflector. Here the primary separation of the liquid and gas takes place. The dixon plates arrangement over the settling section eliminates agitation of the separated liquid. This greatly reduces chances of foaming and the possibility of revaporizing any of the liquid into the gas phase.

Liquid droplets that will not settle out of the gas stream due to little or no gravity difference between them and the gas phase, will be entrained and carried out of the Slug Catcher with the gas. This is the reason why a mist extractor has been installed near the gas outlet. Small liquid droplets will coalesce and collect and form larger droplets, which will by gravity be drained back into the liquid phase. Thereby the liquid carry over in the gas phase is limited to complete removal of liquid droplets entrainment in the 20 micron range.

The Slug Catcher effluent gas is sent to the NEF Metering Scrubber CV 211, which will later become the compression outlet scrubber if NEF gas compression is required (ref. chapter 1.4.1).

The purpose of this scrubber is to make sure that the gas is maintained in single phase at the metering station.

This vessel will therefore prevent residual water and condensate carry over in the downstream gas line. In addition the scrubber is provided with a wire mesh located at the gas outlet. The liquid content in the gas is thereby reduced such that 95% of the droplets will not exceed 10 micron at the outlet of the vessel.

The gas is further sent to the metering station which is located upstream the flow control valves. Here the gas line is split into two separate lines:

> One going to compression module A or C, while
> other goes to compression module B or C.

In order to have a good flow control rangeability, the flow control valves are connected in split range for each of the lines. The normal operation condition for this station, will be one line on manual control, and one line on either pressure or flow control. One thereby obtain a constant pressure for the metering tubes which is important for the metering accuracy. This set up is in conformity with the existing facilities on FRIGG TCP-2 platform.

During normal operating conditions the set point for the flow control valves are such that the flow is equally distributed in the two parallel lines. The reason for this is to have an even distribution of the flow to the main FRIGG compressors 11K01 A/B/C. Normal operating conditions corresponds to compressors 11K01 A/B working, while 11K01 C is used as stand-by.

It may happen, however, that only one of the metering tubes is used, i.e. in case of maintance, calibration etc. Then the total flow will have to go through just one of the tubes, which means that they will have to be designed for a flow rate of 6.4 MSCM/D, which is equal to the average daily production rate.

The liquid hydrocarbons and the methanolated water which is separated from the gas in vessels CV 210 and CV 211, are sent under level control to the condensate separation system (ref. chapter 1.4.2.3). This corresponds to normal operating conditions. In addition the vessel CV 210 is provided with an automatic flush.

<u>Equipment Design Data</u>

CV 210 NEF Slug Catcher

Design pressure	177.5 bara
Design temperature	50°C / -28°C
Capacity	7.7 MSCM/D
Dimensions	2400 ID x 9140 T/T

CV 211 NEF Metering Scrubber

Design pressure	177.5 bara
Design temperature	65°C / -28°C NOTE 1
Capacity	7.7 MSCM/D

NEF gas composition, reservoir pressure and production flow rates are given in Appendix 1.

NOTE 1:

The reason why CV 211 has a design temperature of +65°C and not +50°C, is because the vessel will become the compression outlet scrubber if NEF gas compression is required. Thus the vessel will be part of the future gas compression treatment and must therefore follow the design conditions given for future compressions.

1.4.2.2 ODIN Gas Treatment (Ref. drawing FF 88 00 00 5030 - Appendix 3)

The 20" sea line from ODIN field is 22 km long and will contain gas, condensate and methanolated water. The design flowrate is 11.2 MSCM/D, which corresponds to the start-up year and no water drive in the reservoir. The purpose of the methanol, is to prevent hydrate formation in the sea line.

At design flow this fluid enters the ODIN Slug Catcher CV 1A, which is the existing FRIGG FWKO vessel at 149 bara and 50°C. The operating pressure will, however, vary between the values 11 - 149 bara depending on reservoir pressure decline and time elapsed after start-up. Upstream this Slug Catcher a permanent Pig Receiver CM 201 is provided for the pigs which will be launched from the ODIN platform.

In vessel CV 1A, the gas is spearated from the condensate and methanolated water.

In order to get a good separation, the vessel contains internals as angle iron, baffle plates and mist extractor. The angle iron is an inlet device which is mainly used as deflector. Here the primary separation of the liquid and gas takes place. The baffle arrangements over the settling section eliminates agitation of the separated liquid. This greatly reduces changes of foaming and the possibility of revaporizing any of the liquid into the gas phase.

Liquid droplets that will not settle out of the gas stream due to little or no gravity difference between them and the gas phase, will be entrained and carried out of the Slug Catcher with the gas. This is the reason why a mist extractor has been installed near the gas outlet. Small liquid droplets will coalesce and collect and form larger droplets which will by gravity be drained back into the liquid phase. Thereby the liquid carry over in the gas phase is limited to complete removal of liquid droplets entrainment in the 20 micron range.

The overhead gas is sent to the ODIN Metering Scrubber CV 201, which will later become the compression outlet scrubber if ODIN gas compression is required (ref. chapter 1.4.1).

The purpose of this scrubber is to make sure that the gas is maintained in single phase at the metering station.

This vessel will therefore prevent residual water and condensate carry over in the downstream gas line. In addition the scrubber is provided with a wire mesh located at the gas outlet. The liquid content in the gas is thereby reduced such that 95% of the droplets will not exceed 10 micron at the outlet of the vessel.

The gas is further sent to the metering station which is located upstream the flow control valves. Here the gas line is split into two separate lines:

- One going to compression module A or C while other is going to compression module B or C.

In order to have a good flow control rangeability, the flow control valves are connected in split range for each of the lines. The normal operation condition for this station, will be one line of manual control, and one line on either pressure or flow control. One thereby obtain a constant pressure for the metering tubes which is important for the metering accuracy. This set up is in conformity with the existing facilities on FRIGG TCP-2 platform.

During normal operation conditions the set point for the flow control valves are such that the flow is equally distributed in the two parallel lines. The reason for this is to have an even distribution of the flow to the main FRIGG compressors 11K01 A/B/C. Normal operating conditions corresponds to compressors 11K01 A/S working, while 11K01 C is used as stand-by.

It may happen, however, that only one of the metering tubes is used, i.e. in case of maintenance, calibration etc. Then the total flow will have to go through just one of the tubes, which means that they will have to be designed for a flow rate of 10.2 MSCM/D, which is equal to the average daily production rate.

The liquid hydrocarbons and the methanloated water which is separated from the gas in vessels CV 1A and CV 201, are sent under level control to the condensate separation system (ref. chapter 1.4.2.3). This corresponds to normal operation conditions. In adition the vessel CV 1A is provided with an automatic flush valve (LCV V 1A.5), which will open if the liquid level increases to a high level as could be in the case if liquid slug enters the vessel (ref. chapter 1.4.2.10).

Equipment Design Data

CV 1A ODIN Slug Catcher

Design pressure	177.5 bara
Design temperature	50°C/ -28°C
Capacity	11.2 MSCM/D
Dimensions	2388 ID x 9144 T/T

CV 201 ODIN Metering Scrubber

Design pressure	177.5 bara
Design temperature	65°C/ -28°C Note 1
Capacity	11.2 MSCM/D

ODIN gas composition, reservoir pressure and production flow rates are given in Appendix 2.

NOTE 1:

The reason why CV 211 has a design temperature of +65°C and not +50°C, is because the vessel will become the compression outlet scrubber if ODIN gas compression is required. This the vessel will be part of the future gas compression treatment and must therefore follow the design conditions given for future compression.

1.4.2.3 Condensate Separation (Ref. drawing FF 88 00 11 5032 - Appendix 3)

The condensate separation system consists of two independent treatment streams, one for NEF and one for ODIN. The treatment is, however, identical for the two streams.

The liquid effluent from vessel CV1A and CV 201 - having passed through level control valves LCV V1A.1 and LCV V201.1 respectively - feeds the heat exchanger CE 203 at a weight flowrate equal to 3382 kh/hr. In the same manner the liquid effluent from vessel CV 210 and CV 211 - having passed through level control valves LCV V210.1 and LCV V211.1 respectively - feeds the heat exchanger CE 211 at a weight flowrate equal to 2177 kg/hr.

CE 203 is the Condensate Heater for the ODIN stream and CE 211 is the Condensate Heater for the NEF stream. Here the liquid - which is a mixture of condensate and methanolated water - is heated up from 2°C to 20°C at 20 bara. Triethylene glycol (TEG) solution is used as heating medium (ref. chapter 1.4.2.5).

The condensate heaters are shell and tube heat exchanger, where condensate and methanolated water are going on the tube side and TEG on the shell side. The reason for the heaters, is to speed up the rate of separation between the gas and liquid in the three phase separators downstream the heat exchangers.

The ODIN liquid stream is further sent to Condensate/Methanol Separator CV 204, and the NEF stream is sent to Condensate/Methanol Separator CV 213, operating at 20°C and 20 bara. The hydrocarbon condensate and the methanolated water are separated. The effluent gas which is produced due to the pressure drop across level control valves LCV V1A.1 and LCV V 210.1 respectively, is sent to the LP vent system under pressure control (ref. chapter 1.4.2.8).

The vessels are provided with wire mesh a the gas outlet to remove liquid droplets in the 20 micron range.

The condensate is sent under level control to the existing vessels CV 3 or V 3 after being metered, before it is injected into the main FRIGG gas, transportation system. Total flow of condensate equals 4.2 m^3/hr. The metering device is located just upstream the level control valves LCV V 204.4/LCV 213.4

Since the condensate from ODIN/NEF fields is being mixed with that from the existing production facilities, it will be necessary to provide acceptably accurate metering systems on the condensate outlet lines from CV 204 and CV 213, so that the condensate production of each field can be determined. The accuracy of these systems must be at least equal to that of the existing systems installed on TCP-2. This is necessary because the condensate production from the Frigg Field will be determined by subtracting the ODIN and NEF quantities from the total flow injected into the pipe line.

Each condensate stream will consist of three meters. Two of these will be installed such that the flow may be passed through either meter. The third meter will be installed down stream of these two meters. Each meter will be installed with isolating block valves and drain/bleed valves to enable a meter to be removed without a complete shut down. The series meter will be fit with a bypass loop to enable it to be removed for servicing or checking.

The methanolated water from vessel CV 204 and CV 213 - which is located at a lower level than the condensate due to the difference in specific gravity - ties into one common line and is sent to the methanolated water system (ref. chapter 1.4.2.4).

Fuel gas injection is provided as blanketing gas in order to prevent a pressure decrease in the vessels (ref. chapter 1.4.2.9.1).

Equipment Design Conditions

CE 203 ODIN Condensate Heater

Shell side	Design pressure	25 bara
	Design temperature	107°C
Tube side	Design pressure	177.5 bara
	Design temperature	107°C

CE 211 NEF Condensate Heater

Shell side	Design pressure	25 bara
	Design temperature	107°C
Tube side	Design pressure	177.5 bara
	Design temperature	107°C

CV 204 ODIN Condensate / Methanol Separator

Design pressure	25 bara
Design temperature	50°C
Capacity	3.1 m^3
Dimensions	1000 ID x 4000 T/T

CV 213 NEF Condensate / Methanol Separator

Identical to vessel CV 204

1.4.2.4. Methanolated Water System (Ref. drawings FF 88 00 10 5033 FF 83 00 54 5101 FF 88 00 00 5034 - Appendix 3)

The methanolated water disposal system is common to NEF and ODIN. This methanolated water which has been separated from the condensate in vessels CV 204/CV 213, is sent to the Methanolated Water Flash Drum CV 220 which operates at 10 bara and 20°C.

The actual liquid flowrate corresponds to 2.2 m^3/hr. The flash gas which is created due to the pressure decrease, goes to the LP vent system under pressure control. A wire mesh is installed at the gas outlet to remove liquid droplets in the 20 micron range. Fuel gas is used as blanketing gas in case of a pressure decrease in the vessel.

The methanolated water which contains about 14 litres of liquid condensate per hour, is skimmed in vessel CV 220. The flash drum is divided into two independent chambers, one for the methanolated water and one for the condensate. The condensate which has the lowest specific gravity will be located above the methanolated water phase and flows to the condensate part of the vessel. The liquid hydrocarbon is further sent by a level control valve to the oil skimmer CV 5, which is part of the existing condensate recovery system.

The methanolated water is flowing under level control from vessel CV 220 to DP-2 in a 4" existing sea line. A metering device is located just upstream the LCV V 220.1 on TCP-2 platform. The liquid enters the DP-2 platform at 4 bara and passes through a 10 micron filter bag before it is injected into well No. 22.

Just downstream these filters (FA 106 A/B) a pressure control valve PCV 260 is installed. This valve controls the backpressure in the system, and protects the upstream pipeline and sealine from having vacuum conditions due to siphoning in the downflow piping. Downstream the pressure control valve, the minimum pressure could be equal to the vapour pressure of methanolated water at 5°C which is 0.008 bara.

This pressure could also exist in the filters if the well is not shut off when the injection is stopped. The filters have, however, been designed for this minimum pressure.

In addition to the above mentioned protections, a pressure switch PSL M 9.3 is installed on TCP-2. This switch will close valve ESDV M 9.2 on TCP-2 and ROV 223 on DP-2, thereby isolating the sea line upon low pressure in this line (i.e. in case of a rupture in the sea line).

If the injection well is closed, in case of work over, shut down etc., the ESDV M 9.2 will be closed and the liquid is sent to the CV 9 Methanolated Water Storage Tank. This tank has earlier been used as a triethylene glycol (TEG) storage tank, but the connections with the glycol facilities will be obsolete and disconnected.

The capacity of the storage tank, which is 100 m^3, is suitable for approx. 45 hours production at normal flowrate (2.2 m^3/hr).

When injection into well No. 22 becomes possible, the methanolated water is pumped from CV 9 to DP-2, using Methanolated Water Injection Pumps CP 222 A/B. This line ties into the 2" line from vessel CV 220 downstream the metering device FQ V 220.1 A/B.

Inhibitor injection into the methanolated water line going to DP-2 is possible using Inhibitor Pumps CP 225 A/B. These pumps take suction from Inhbitor Drums CV 225 A/B which are operating at atmopheric conditions. The inhibitor is injected upstream the ESDV M 9.2.

Equipment Design Conditions

CV 220 Methanolated Water Flash Drum

Design pressure	16.2 bara
Design temperature	50°C
Capacity	3.05 M^3
Dimensions	900 ID x 2900 T/T

1.4.2.5 Triethylene Glycol (TEG) System (Ref. drawing FF 88 00 00 5034 - Appendix 3)

Hot TEG loop will be used to increase the temperature of the condensate and methanolated water from 2°C to 20°C. The hot glycol is pumped through TEG Circulation Pumps CP 220 A/B/C. These pumps takes suction from Glycol Surge Tanks CV 17 A, B or C, which are existing vessels operating at 2.0 bara, and the glycol is returned back to the same vessel. The reason for this is to have control with the liquid level in the tank, thus preventing it from being overfilled. In addition a level switch is installed which will give an alarm in the control room, upon high liquid level in the vessel.

During normal operating conditions, the glycol inlet temperature to CV 17 from the reboiler section is 80°C. The surge drum that is heating condensate and methanolated water, will however have an equilibrium tempeature of 58°C.

This hot glycol passes through the heat exchangers CE 203/CE 211 on the shell side and exchange heat with the liquid which is on the tube side. The temperature for the TEG solution decreases from 58°C to 52°C, and is sent back to the surge tank CV 17.

As vessel CV 9 will be used as methanolated water storage tank (ref. chapter 1.4.2.4), it will not be possible to send TEG from CV 9 to CV 17 A/B/C using the glycol fill header. This function is achieved using Glycol Fill Pumps P 13 A/B which takes suction from Glycol Storage Tank V 9 located on TP-1.

If it is required to empty any of the glycol surge drums (in case of accident, work-over, etc.) the vessel will be drained using Glycol Fill Pumps CP 13 A/B. The load of these pumps are provided by the liquid height in the glycol drain header. The pumps are manually stopped according to the level in CV 17. The remaining TEG is drained by gravity to the Methanolated Water Drainage Tank CV 222.

Equipment Design Conditions

CP 220 A/B/C TEG Circulation Pumps

Design pressure	25 bara
Design temperature	107°C

CP 13 A/B Glycol Fill Pumps

Design 113.6 l/min. at 3.08 bara

CV 17 A/B/C Glycol Surge Tank

Design pressure	3.05 bara
Design temperature	107.2°C
Capacity	21.6 m^3
Dimensions	1980 ID x 6400 T/T

1.4.2.6 Methanol Injection System (Ref. drawing FF 88 00 09 5036 - Appendix 3)

1.4.2.6.1 General

Methanol injection is provided in the ODIN and NEF field streams at the wellhead exit to prevent hydrate formation in the sea lines.

The gas which is separated from the condensate and methanolated water in vessels CV 1A and CV 210, is not any longer in contact with liquid methanol. A small amount of water condensation could therefore initiate formation of hydrates. In order to prevent such a risk, provisions are made for future methanol injection into the gas stream at the outlet of the slug catcher.

1.4.2.6.2 Injection to the Articulated Column on Field Control Station (FCS) for NEF Field.

The methanol stored in Methanol Storage Tank CV 23 - which is an existing tank operating at atmospheric conditions - is sent to NEF articulated platform through a 1 1/2" line using Methanol Injection Pumps CV 12 A/B (already existing). The pump flow rate is manually adjusted according to the needs from the FCS located on NEF.

The flowrate will vary within the following limits:

	Flow rate litres/hr.	m^3/day	Discharge pressure bara
Mini	8	2.0	-
Normal	275	6.6	7
Max	1000	24.0	22

The capacity of the storage tank CV 23 - which is 100 m^3 - is suitable for 15 days of production at normal flow conditions.

The maximum flow rate, used only for special conditions and during short periods could be provided by the two pumps working in parallel.

1.4.2.6.3 Injection Downstream ODIN and NEF Slug Catchers

Two reciprocating pumps CP 223 A/B - Methanol Injection Pumps - can be used to inject methanol in gas lines downstream the Slug Catchers CV 1A/CV 210. These pumps will also take suction from CV 23. This package will be provided later if necessary. Necessary piping stubs are provided for future connections.

Equipment Design Conditions

CV 23 Methanol Storage Tank

Design pressure	1.35 bara at 21°C
Capacity	100 M^3
Dimensions	7300 L x 3550 W x 4000 H

CP 12 A/B Methanol Injection Pumps

$0-10^3$ l/hr at 153 bars ΔP

CP 223 Methanol Injection Pumps

Design pressure	177.5 bara
Design temperature	21°C.

1.4.2.7 Process Drainage System (Ref. drawing FF 88 00 10 5100 - Appendix 3)

The drainage of the pressure vessels (NEF and ODIN gas treatment) is connected to the existing process drainage on TCP-2.

A methanolated water drainage system is added to drain all low pressure vessels containing methanolated water, i.e. CV 220 - Methanolated Water Flash Drum, CV 204 and CV 213 - Condensate/Methanol Separator. Also the glycol drain header at the suction of the pumps CP 13 A/B - Glycol Fill Pumps - is connected to this system (ref. chapter 1.4.2.5). The drains are gathered into a header going to the Methanolated Water Drainage Tank CV 222. The drainage volume of this tank equals 3.05 m^3.

A drainage Tank Pump CP 224, is located on the top of the drainage tank. If a high methanolated water level is reached in CV 222, a high level switch LSH V 222.2 will start the pump automatically. This pump discharges into vessel CV 220. In the same manner the pump will be stopped by low level switch LSL V 222.1. In addition the pump can be started and stopped manually.

If the level in the drainage tank should increase to a very high level, the level switch LSHH V 222.3 will give an alarm in the control room for the operator to take the necessary steps to prevent the drainage tank from being overfilled.

The pumping design capacity is equal to 3 m^3/hr. The time required to empty the vessel (i.e. going from high to low liquid level) will be in the order of 1 hour.

As the volume of vessel CV 220 is equal to the volume of the drainage tank, the following protection has been made to prevent the flash drum from being overfilled: A level switch LSH V 220.6 will automatically stop the pump CP 224, if the level in vessel CV 220 increases to a very high level.

Equipment Design Conditions

CV 222 Methanolated Water Drainage Tank

Design presure	3 bara
Design temperature	50°C
Capacity	3.05 M^3
Dimensions	800 ID x 6000 T/T

CP 224 Drainage Tank Pump

Design pressure	16 bara
Design temperature	50°C.

1.4.2.8 Flare System (Ref. drawing FF 88 00 04 5090 - Appendix 3)

1.4.2.8.1 General

The flare system for NEF and ODIN consists of:

- Low pressure relief system (LP system)
- High pressure relief system (HP system)
- Low temperature relief system (LT system)

The temperature downstream of the blowdown valves can be as low as -75°C with an initial upstream temperature of 5°C. Consequently a new flare system is required which can tolerate very low temperatures.

1.4.2.8.2 LP System

The gas release to this system originates from pressure safety valves or breather control valves on equipment containing low pressure process gas or liquid i.e. from:

CV 204 - ODIN Condensate/Methanol Separator
CV 220 - Methanolated Water Flash Drum
CV 213 - NEF Condensate/Methanol Separator
Density Transmitter - Gas Metering.

Maximum relief rate is 0.348 MSCM/D, which corresponds to fire exposure on Pancake 53. The existing LP vent system, having the following design conditions:

max gas relief - 0.503 MSCM/D
design relief - 1.30 MSCM/D

will have sufficient capacity to handle the relief flow rates from low pressure vessels for TCP-2 Extension.

The vents from the above equipment tie into a 10" header which is connected to the existing header C 446 EA 14" V going to LP Vent Scrubber CV 7. Here the liquid phase is sent - via effluent water treatment unit - to the sump caisson under level control and the gas phase is released to the LP vent stack.

1.4.2.8.3 HP System

The gas release to this system originates from fire safety valves on CV 1A - ODIN Slug Catcher, and from depressurization of NEF sea line (ref. chapter 1.4.2.10.2).

The system is existing. The high pressure gases from TCP-2 which have to be flared are collected in the HP headers and sent to CV 24 - HP Relief Scrubber.

The liquid phase is sent - via effluent water treatment unit - to the sump caisson under level control. The gas is sent to the articulated flare.

1.4.2.8.4 LT System

The emergency release to this system originate from:

- Blow down valves on equipment containing high pressure process gas
- Fire safety valves on equipment containing high pressure process gas (except CV 1A)
- Depressurization of ODIN and NEF sea lines.

The flare gas from the different equipment and lines are collected in a 10" header feeding CV 226 LT Relief Scrubber located in Pancake 53. The maximum relief rate is 2.8 MSCM/D, which corresponds to depressurization of the sea lines. Any liquid that may be collected in the Scrubber, is sent under level control to the process drainage system (ref. chapter 1.4.2.7).

The gas evacuates in a 12" line and ties into the existing compression LP vent stack located in Module 33. The capacity in this stack is sufficient to handle the maximum relief rates for the LT Relief System (3.8 MSCM/D and 2.8 MSCM/D respectively).

Equipment Design Conditions

CV 7 LP Vent Scrubber

Design pressure	4.46 bara
Design temperature	100°C
Capacity	1.3 MSCM/D
Dimensions	1829 ID x 2483 T/T

CV 24 HP Relief Scrubber - TCP-2

Design pressure	59.3 bara
Design temperature	-55°C
Capacity	34 MSCM/D
Dimensions	1662 ID x 4050 T/T

CV 226 LT Relief Scrubber

Design pressure	14.2 bara
Design temperature	-75°C/100°C
Capacity	2.8 MSCM/D
Dimensions	1500 ID x 3600 T/T

1.4.2.9 Fuel Gas System (Ref. drawing FF 88 00 02 5040 - Appendix 3)

1.4.2.9.1 Fuel Gas for Blanketing

Fuel gas used as blanketing gas in case of vessel pressure decrease, is provided for the following equipment:

CV 204 - ODIN Condensate/Methanolated Water Separator
CV 213 - NEF Condensate/Methanolated Water Separator
CV 220 - Methanolated Water Flash Drum.

The fuel gas is taken from the existing fuel gas supply header C 867 EA 4" FG; which comes from the glycol contactors outlet. This fuel gas is treated in the existing cold fraction unit in order to obtain the required dew point. Then it is sent to the CV 17 glycol surge tank, where it is heated up from -25˚C to 50˚C.

1.4.2.9.2 Fuel Gas Used AS Start Up Gas

The ODIN sea line pressurization will be performed from the ODIN field production platform by progressive opening of one or two choke-valves.

This process cannot be used to pressurize NEF sea line because of the submarine wells which imply that the choke valves have to be located on TCP-2.

A high pressure start up gas line is provided for this purpose.

This gas is taken from the existing fuel gas supply heater C852-EF3"FG (which comes from glycol contactors outlet).

1.4.2.10 Upset Operating Conditions

1.4.2.10.1 Slug Formation

A slug disposal system is provided to handle any slug that enters the TCP-2 platform through the ODIN and NEF sea lines. The Slug Catchers CV 1A/CV 210 level controller is operating with a minimum condensate inventory in order to have a maximum slug receiving capacity.

When a liquid slug enters the slug catchers the liquid level will start increase. Upon high level in the vessels an automatic flush valve LCV V1A.5/LCV V 210.5 will open and send condensate to the condensate slops header which is feeding the existing vessel CV3 operating at 15 bara and 30°C.

The total slug receiving capacity is 31 m^3 for ODIN and 43 m^3 for NEF.

If the liquid level is further increased the slug catchers are provided with very high level switches (LSHH V1A.8 and LSHH V210.8 respectively), which will close the inlets to vessels thus preventing them from being overfilled.

1.4.2.10.2 Depressurization

High pressure process euqipment located in Module 50, is sectionalized by means of ESD valves. In case of an emergency (fire etc.) these valves can be closed upon signal from the control room.

After isolation of the various sections, it is possible to depressurize manually one section (local action on the valve or the whole gas treatment plant (level 2 shut down from QP Central Control Room). Such blowdown valves are installed on the slug catchers CV 1A and CV 210, on the scrubbers CV 201 and CV 211 and on the feed lines upstream the slug catchers.

Total blowdown rate is equal to 1.874 MSCM/D, which is below the design capacity of the LT relief system (3.8 MSCM/D). By depressurizing in this way, one thereby reduces the pressure by removal of gases from high pressure vessels, which elsewhere would be weakened by excessive heating when exposed to fire.

NEF Sea Line Depressurization (Ref. P & ID FF 88 00 00 5031 - Appendix 3)

The NEF sea line blowdown is performed using both the LT relief system and the HP relief system. During the initial blowdown period, i.e. when the pressure in the sea line is greater than 100 bara, the gas will have to be released through the LT relief system. The reason for this is the low temperature of the gas downstream the blowdown valve due to the great pressure drop across the valve. (Temperature down to -75°C can be reached when the gas is depressurized from 160 bara and down to near atmospheric pressure.

In this stage depressurization valve FCV M 210.1 and the manual operated isolation valve HV M 210.3 will be open, while depressurization valve FCV M 210.2 and the manual operated isolation valve HV M 210.4 will be closed. The gas will then pass through to the LT relief system and is further vented to atmosphere in the existing cold vent stack.

A flow switch located at the outlet of the LT relief scrubber CV 226, will prevent the flow rate in the system from exceeding the design flow which is 2.8 MSCM/D.

As the pressure in the sea line decreases to below 100 bara, the temperature downstream of the blowdown valves is such that it is possible to tie into the HP relief system. This is done by opening the depressurization valve FCV M 210.2 and isolation valve HV M 210.4, while the corresponding valves for the LT relief system will be closing. The gas then passes through to the HP relief system and ties into the existing 24" relief header just upstream vessel CV 24 - HP Relief Scrubber.

A temperature switch (TSL M 210.2) and a pressure switch (PS M 210.5) will protect the HP relief system in such a way that it is not possible to change from LT relief to HP relief before the temperature and the pressure are satisfactory (i.e. the pressure upstream of depressurization valves should be equal or lower than 100 bara and the temperature downstream of the isolating valve HV M 210.4 should be equal or higher than -46°C).

The advantage of depressurizing in this way, is that the gas will be flared instead of vented and that the blowdown flow rate can be increased due to the design conditions for the HP relief system (HP relief system is designed for a flaring flow rate equal to 34 MSCM/D).

When the HP relief system is used for depressurization of NEF sea line, the max. flow rate equals 8.4 MSCM/D.

The reason for the value 8.4 MSCM/D is due to limitations on the criteria of flare pipe sizing, which is:

$$\rho v^2 \leq 100\ 000 \text{ kgm/s}^2$$
$$\text{and gas velocity} \leq 0.45 \text{ Mach}$$

A differential pressure transmitter PDT M 210.1 and a differential pressure recorder PDR M 210.1 gives the flaring flow rate.

Initial conditions:

System : LT relief
Pressure : 160 - 100 bara
Flow rate : 2.8 MSCM/D (at 160 bara)

Final conditions:

System : HP relief
Pressure : 100 bara -->

ODIN sea line depressurization (Ref. P & ID FF 88 00 00 5030 - Appendix 3)

The ODIN sea line will be depressurized from the ODIN platform. Provisions have however been made to depressurize partially the ODIN pipeline from TCP-2 in case of plugging of the line by pigs or other unusual situations.

The blowdown is performed by opening of the choke valve CSP M 201.3. This valve has been calculated to deliver a depressurization flow rate of 2.8 MSCM/D at 160 bara.

As for the NEF blowdown line, the flaring flowrate is measured using a PD-transmitter and a PD-recorder. PDT M 201.1/PDR M 201.1.

1.5 DESCRIPTION OF PROCESS SAFETY SYSTEMS

1.5.1 General Description of Process Safety Systems

All vessels, heat exchangers, pumps and the following lines:

- Incoming sealines from NEF/ODIN fields
- Methanol injection line to NEF articulated column
- Methanolated water well injection to DP-2

are protected against undesirable events as described in API Recommended Practice 14C.

For analysis of the process safety systems, references are made to the following documents:

CH-FF 88 00 00 4142 - Safety Analysis Table (SAT) TCP-2 Extension. (Appendix 4)

CH-FF 88 16 00 4143 - TCP-2 Extension - Safety Analysis Function Evaluation Chart Gas and Liquid Treatment. (Appendix 5)

It should be noted that the only exception from API RP 14C, is the fuel gas system. Fuel gas will be used as blanketing gas for vessels CV 204, CV 213 and CV 220 to prevent a pressure decrease. These vessels are protected against leakage by PSL sensors that will shut off incoming feed line, which is a mixture of gas, condensate and methanolated water. The fuel gas inlet to the vessels will however not be shut off by this PSL. The reason for this is that the fuel gas system is protected in the following way:

i) In case of very large leakage:

1) Primary protection - Gas detectors will initiate a 3rd level shutdown which will stop fuel gas supply.

2) Secondary protection - The pressure will fall in existing vessel CV 6 - Fuel Gas Scrubber and PSL V6.9 will close fuel gas supply.

ii) In case of small leakage:

1) Primary protection - As above.

2) Secondary protection - A PSL sensor actuator and ESDV valve closing the fuel gas supply would be inactive. This is because the fuel gas will try to balance the leakage in order to prevent the pressure from decreasing.

For a functional description of the ESD system ref. is made to document No.: S-FF 88 16 08 9520 attached in Appendix 6. For a description of the process safety system, ref. is made to document No.: S-FF 88 16 08 9521 attached in Appendix 7.

1.5.2 Fire Protection

1.5.2.1 Introduction

All vessels are protected against fire exposure by pressure safety valves.

The calculation assumptions are in accordance with API RP 520 and API RP 521.

1.5.3 Protection Against Process Over Pressure

1.5.3.1 Protection for High Pressure Gas Vessels CV 1A, CV 210, CV 201 and CV 211.

No protection for blocked lines is required for NEF Slug Catcher and Metering Scrubbers.

The reason is that the MAWP, which is 177.5 bara, is higher than the maximum static well head pressure.

For the ODIN Slug Catcher, protection agaist over pressure will be provided in accordance with the final rerating on CV 1A.

1.5.3.2 ODIN Condensate Lines Downstream the ESDV V1A.2 and ESDV V201.3

During normal operating conditions, the pressure in these lines will be 20 bara. In case of high process pressure downstream these ESD valves, the primary protection is the PSH V 204.5. This PSH will close the valves ESDV V1A.2 and ESDV V201.3.

The secondary protection is the PSV V204.1 or PSV V204.2 with a set pressure of 25 bara. These protections are located on the Condensate/Methanol Separator CV 204.

The over pressure sizing case is caused by an uncontrolled flow from the condensate line. The flow rate is calculated based upon full opening of the manual globe valve which bypasses the level control valve LCV V1A.1.

The upstream liquid is supposed to be condensate without methanolated water and the valve calculation gives a volumetric flow rate of 186.1 USGPM or 42.3 m^3/hr. This corresponds to a mass flow rate of 2870 kg/hr.

This fluid enters vessel CV 204, where the vapour released is evacuated through PSV V204.1/2, and further sent to LP Vent Scrubber CV 7 which is an existing equipment.

The PSV valves have been sized for max. release, which is in case of fire.

1.5.3.3 NEF Condensate Lines Downstream the ESDV V210.2 and ESDV V211.3

The preceding description for the ODIN safety protection against over pressure applies to NEF liquid treatment. The assumptions are the same, but the instrument tag numbers are to be changed to:

ESDV V210.2
ESDV V211.3
PSH V213.5
PSV V213.1
PSV V213.2
LCV V210.1

1.5.3.4 Protection of Methanolated Water System

Protection of Vessel CV 220 - Methanolated Water Flash Drum

At normal conditions, the operating pressure in the vessel is equal to 10 bara. If the pressure by accident increases (as could happen in case of blocked outlet from the vessel or an uncontrolled flow into the vessel), the primary protection is a PSH V220.3 closing the inlet to the vessel. The secondary protection is the PSV V220.1/2 having a set pressure equal to 16.2 bara.

These PSV valves have been sized for max. release which is in case of fire.

Protection of Vessel CV 222 - Methanolated Water Drainage Tank

This vessel is not in continuous service and will only be used for drainage of vessels CV 204, CV 213 and CV 220 (the suction of glycol pumps CP 13 A/B also ties into this system).

The vessel is protected against process over pressure by a vent going to atmosphere. The drainage tank is

Methanolated Water Storage Tank CV 9

The CV 9 - Methanolated water storage tank which is designed at 1.35 bara, was previously used as a glycol storage tank. The protection of this vessel has been modified to take into account the function as methanolated water storage.

This safety protection will be identical to the existing vessel CV 33.

This includes:

PSV V 9.3	- Emergency vent and manhole to relieve internal pressure of the vessel.
PSV V 9.2 A/B	- Pressure and vacuum breather valves to relieve internal pressure and vacuum of the vessel during filling or emptying.

1.5.4 Thermal Expansion in CE 203/CE 211

The condensate / methanolated water is heated using the exchangers CE 203/CE 211. At normal conditions the temperature at the outlet of the heaters will be 20°C.

If the temperature of the fluid is increased to a certain value (the value to be defined later), a temperature switch (TSH E 203.5 and TSH E 211.5) will shut off the heating medium which is the TEG solution. These switches are located just downstream the heaters.

Such an excess heat input could happen if the condensate/ methanolated water is allowed to stay within the pipe without being withdrawn. Any pressure built up in the system because of vapour released due to heating, will be evacuated through the pressure control valves PCV V204.2 for the ODIN separator and PCV V213.2 for the NEF separator.

These valves are connected to the LP vent system.

1.5.5 Protection on Shell Side of Condensate Heaters, TEG Lines and Glycol Surge Drums CV 17 A/B/C.

The design pressure on the shell side of the condensate heaters CV 203/CE 211 is 25 bara. The tube side of these heaters are protected by a PSH and two PSVs set at 25 bara, located at downstream components CV 204 and CV 213.

In case of tube side failure, the three phases condensate, gas and methanolated water will leak into the shell side, because the operating pressure is lower than on the tube side (5 bara and 20 bara respectively). From the shell, the fluid enters the glycol piping, which is designed at 25 bara.

The glycol return line will be used as relief system. The condensate, gas and methanolated water are sent to existing vessels CV 17 A/B/C. The gas is evacuated through a 2" existing breather line which leads to the LP vent system. The glycol surge drum design pressure which is 3.05 bara, will not be reached.

Since the only isolation device between the heat exchangers and the vessels are manually block valves which will be locked open, the exchanger and vessel are considered as one unit regarding safety on the process side. A PSV on the shell side of the heaters and on the glycol piping, is therefore not required. The safety protection is made by the existing vent lines C 434/435/436-EA-2"-V.

1.5.6 Pumps Discharge

All outlets of reciprocating pumps are protected by pressure safety valves.

The protection of the outlets of centrifugal pump is not necessary, since the maximum discharge pressure will not exceed the rated working pressure of the piping.

1.6 DESCRIPTION OF GAS RELIEF SYSTEM

1.6.1 General

The flare and relief system consists of:

- A low pressure vent system (LP vent system)
- A high pressure relief system (HP relief system)
- A low temperature relief system (LT relief system)

The LP vent system and the HP relief system are existing systems already installed on the Frigg Field.

For the high pressure vessels, the temperature downstream of the blow down valves can reach as low temperature as -75°C with an initial upstream temperature of 5°C.

Consequently it is necessary to connect the relief system to the low temperature system.

1.6.2 Basis of Design

1. The LP vent system, HP and LT relief system have been designed in agreement with the guidelines in:
    - API Recommended Practice 14C
    - API Recommended Practice 520
    - API Recommended Practice 521

2. The criteria for the flare pipe sizing have been:

    a) HP and LT relief lines and headers:

    $$\rho V^2 \leq 100\ 000 \text{ kg/ms}^2$$

    gas velocity $\leq$ 0.45 Mach

    where

    ρ = gas density kg/m^3

    V = gas velocity m/s

    b) LP vent lines and headers:

    to be designed for low pressure drop.

1.6.3 Description of the Relief / Vent Systems

1.6.3.1 Low Pressure Vent System

The gas release to this system originates from pressure safety valves or breather control valves on equipment containing low pressure process gas or liquid. The relief gases are collected in a 10" LP vent header. This line is connected to the existing header C 466 EA 14" V, and sent to the LP vent scrubber CV 7.

The liquid phase from this vessel flows to the process drainage system under level control, and the gas phase is released into the existing LP vent stack.

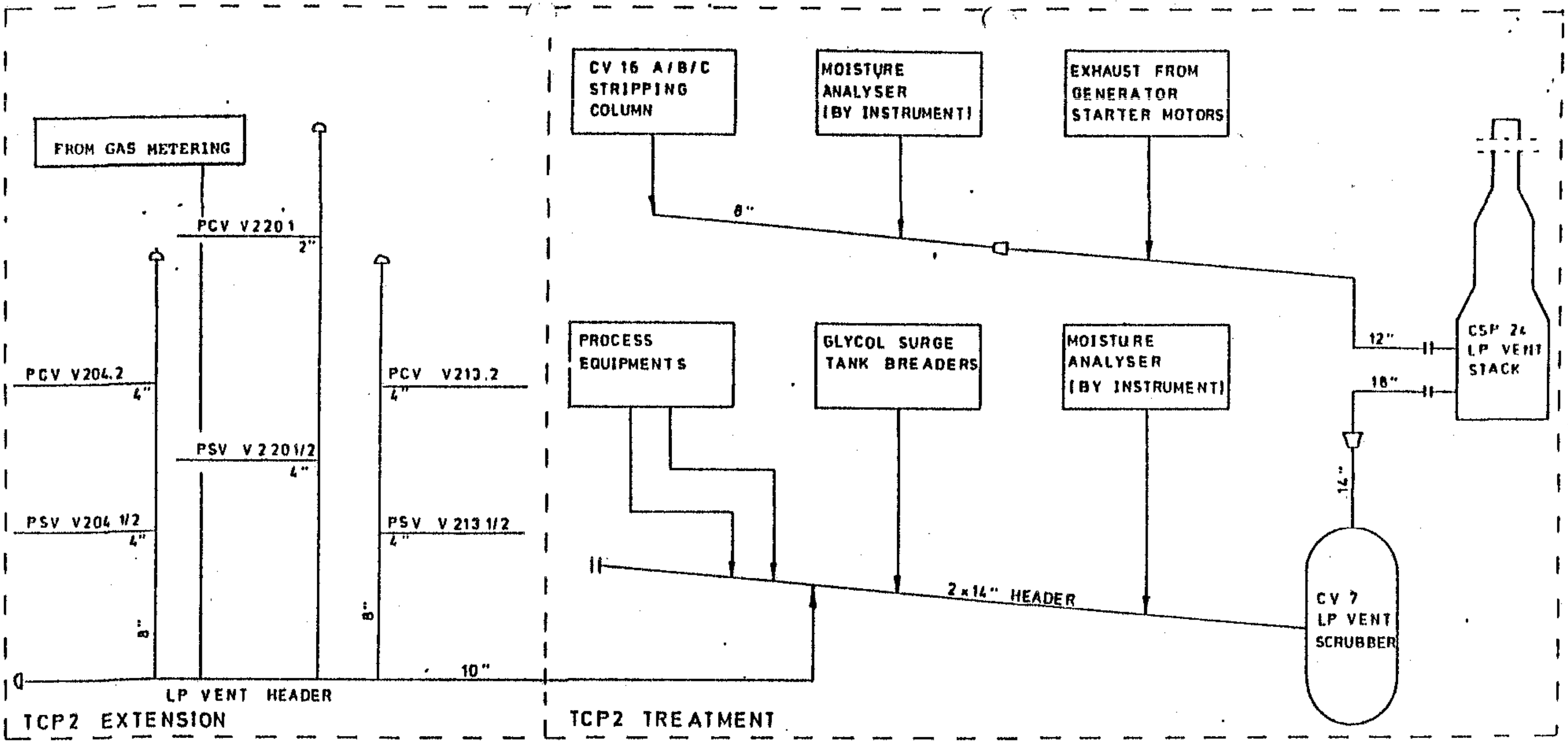
A schematic diagram of this system is given on figure 1.12.

Design Data

Maximum back pressure : 2.6 bara
Piping class EA, flange rating : 150 lb
CV 7 scrubber - design pressure : 4.6 bara
- design temperature : 100°C

Relief Rates TCP-2 Treatment

Max. continuous relief : 0.059 MSCM/D
Max. gas relief : 0.53 MSCM/D
Design relief flow rate : 1.3 MSCM/D



LP VENT SYSTEM SCHEMATIC DIAGRAM

FIGURE 1.12

REV NO	REVISION	DATE	BY	APPR	APPR BY CLIENT

CLIENT

DATE	CONSTR.	APPR.	SCALE

TITLE

sofresid norge a.s

APPR BY CLIENT

DATE SIGN

DRWG NO

Relief Rates TCP-2 Extension (Summary)

The relief flow rates are summarized in the following table:

PRESSURE RELIEF RATES (MSCM/D) - TCP-2 EXTENSION

	FIRE EXPOSURE PANCAKE	FROM BREATHER CONTROL VALVES
		Note 1
PSV V204.1/2	0.134	
PSV V213.1/2	0.134	
PSV V220.1/2	0.080	
PCV V204.2		0.0063
PCV V213.2		0.0033
PCV V220.1		0.0010
TOTAL RELEASE	0.348	0.0106

Note 1 : Continuous flow rates.

The maximum relief rate corresponds to fire exposure on the pancake, i.e. 0.348 MSCM/D.

Reference is made to chapters 1.6.5 and 1.6.6 for detailed calculations and to Appendix 8 for back pressure calculations.

1.6.3.2 High Pressure Relief System

The gas release to this system orginates from fire safety valves on ODIN Slug Catcher CV 1A, and from depressurization of NEF Sea Line (ref. chapter 1.6.4.2.2). The high pressure relief system is existing.

The gases from TCP-2 which have to be flared are collected in the HP headers and sent to the HP Relief Scrubber CV 24.

The liquid phase from CV 24 is sent via an effluent water treatment unit, to the sump caisson under level control.

Gases from CV 24 and V 24 are mixed and further sent to the articulated flare.

Design Data

TCP-2 HP Relief System:

Theoretical maximum back pressure 45 bara at PSV outlet
Piping: class ECX Flange rating: 600 lbs
temperature: -55°C

CV 24 Scrubber:

design pressure: 59.3 bara
design temperature: -55°C

TP-1 HP Relief System:

Piping: class EC Flange rating: 300 lbs

V 24 Scrubber:

design pressure: 49.3 bara
design temperature: -50°C

Common Header to Flare:

Sea line to articulated flare: Class ECS

Design Flow Rates:

Articulated flare: 34 MSCM/D

Relief rates TCP-2 Extension:

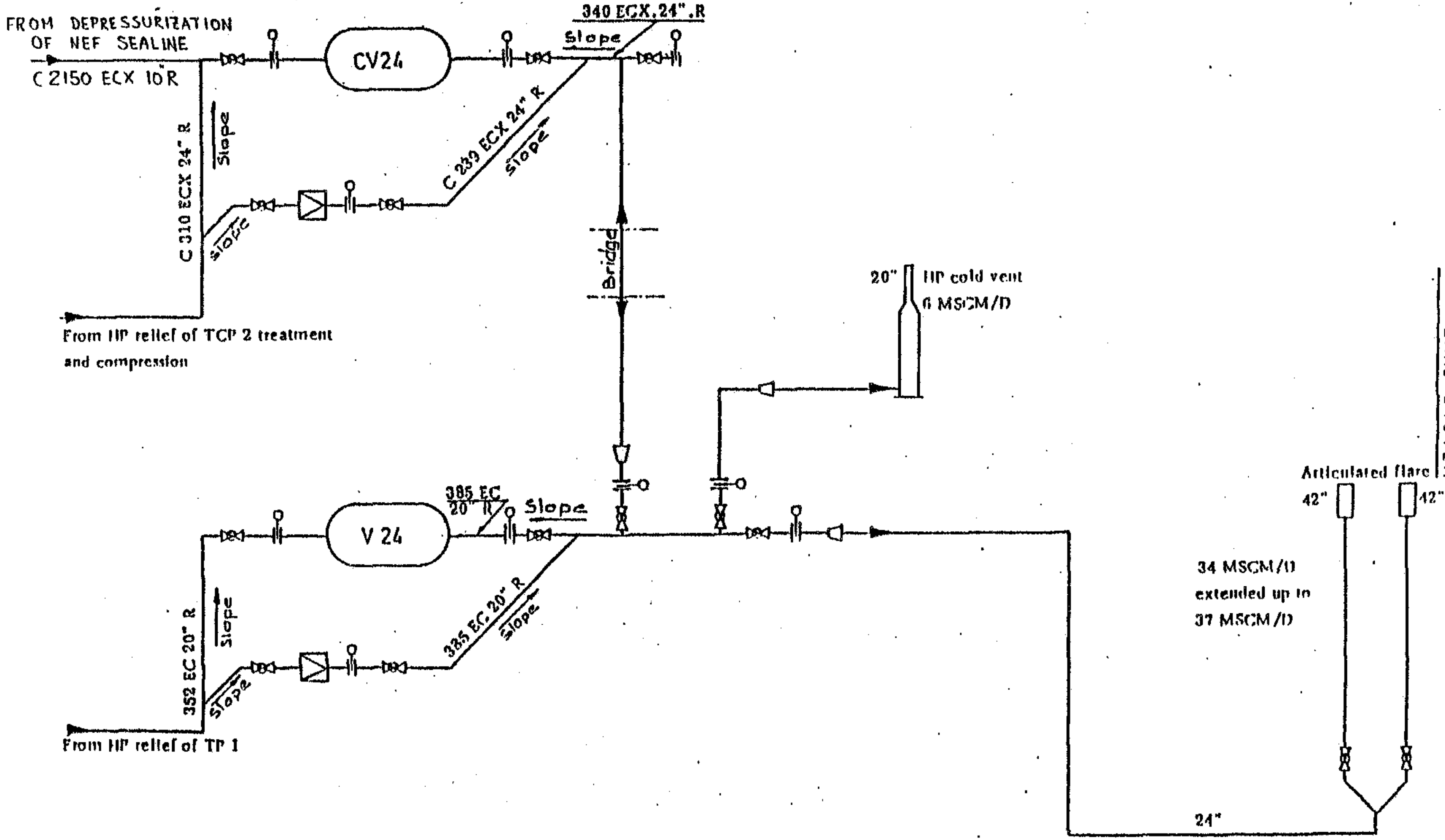
Fire exposure on vessel CV 1A : 0.45 MSCM/D
Depressurization of NEF sea line : 8.40 MSCM/D
Maximum back pressure : 17.4 bara

Reference is made to chapters 1.6.4 and 1.6.5 for detailed calculations and Appendix 9 for back calculations.

Regarding heat radiation and dispersion calculations, vibration and noise calculations reference is made to the following documents:

Elf Aquitaine Norge A/S 311E ENG 80/134/TEH/ej	FRIGG FIELD HIGH PRESSURE FLARE SYSTEM
SR 99012	INCREASING OF FLARE CAPACITY UP TO 37 MMSCM/D

A schematic diagram of the HP flare system is shown on figure 1.13.



HP FLARE SYSTEM

FIGURE 1.13

1.6.3.3 Low Temperature Relief System

1.6.3.3.1 System Description

The emergency releases to this system originate from:

- Blow down valves on equipment containing high pressure process gas.
- Fire safety valves on equipment containing high pressure process gas (except for vessel CV 1A).

For piping simplification it has been chosen to connect the two above systems into the same low temperature relief header.

This 10" header feeds the CV 226 scrubber located in Pancake 53. The liquid from this vessel is sent to the drainage system under level control, and the gas is released through a 12" pipeline into the existing LP vent stack for TCP-2 Compression, located in Module 33.

A schematic diagram of this system is shown on figure 1.14.

Design Data

Maximum back pressure:		5.7 bara
Piping: Class EAT	Flange rating:	150 lbs
CV 226 Scrubber -	design pressure :	14.2 bara
	design temperature:	100°C to - 75°C

LT RELIEF SYSTEM - SCHEMATIC DIAGRAM

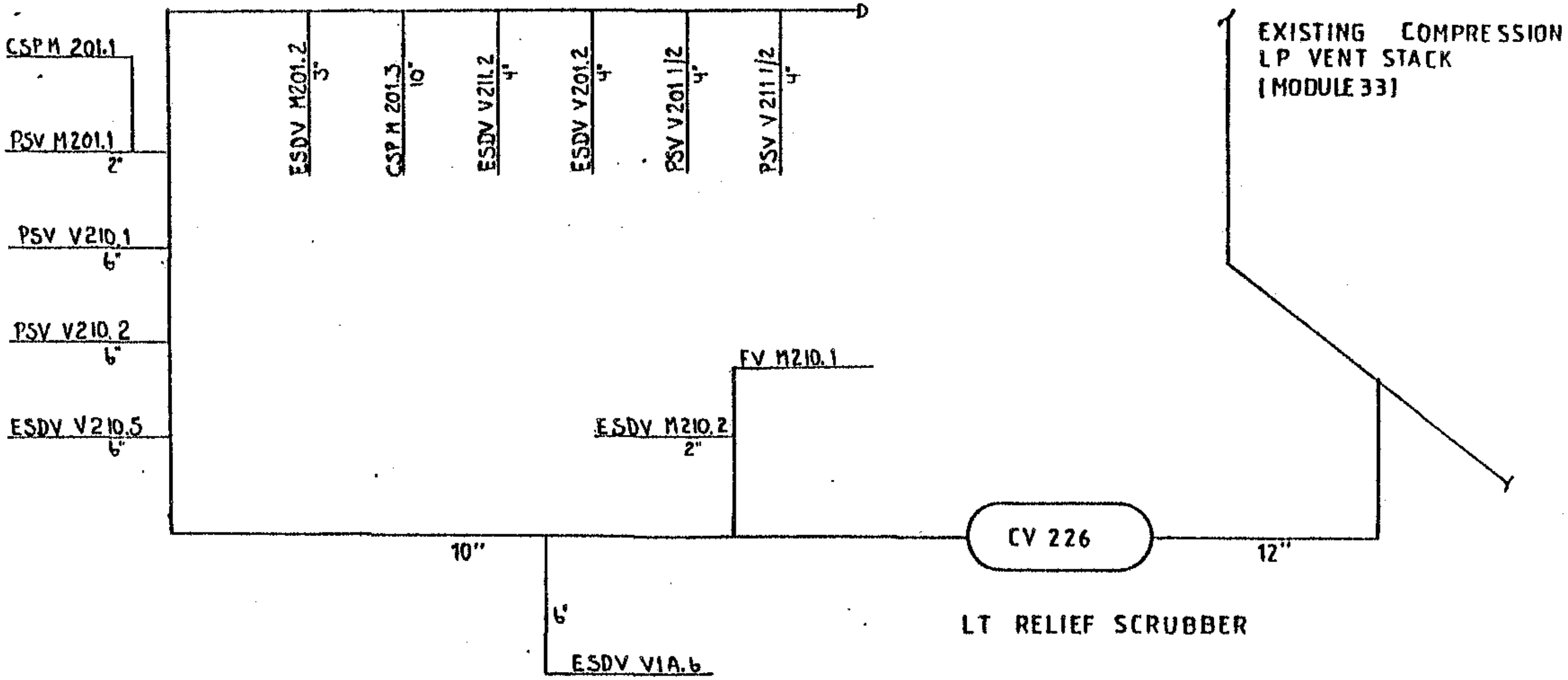


FIGURE 1.14

REV NO	REVISION	DATE	BY	APPR	APPR BY CLIENT

CLIENT

DATE | CONSTR. | APPR. | SCALE

TITLE

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APPR. BY CLIENT

DATE | SIGN

DRWG NO

Relief Rates (Summary)

- No continuous flow rate.
- Flaring flow rates are summarized in the following table:

PRESSURE RELIEF RATES (MSCM/D) - TCP-2 EXTENSION

	ODIN Fire Exposure	NEF Fire Exposure	Blow Down Group W	ODIN Sea Line Depressurization	NEF Sea Line Depressurization
PSV V201.1/2	.656 (1)				
PSV V210.1/2		.489			
PSV V211.1/2		.319 (1)			
PSV M201.1	.050				
ESDV M201.2			.203		
ESDV M210.2			.064		
ESDV V1A6			.546		
ESDV V201.2			.246		
ESDV V210.5			.546		
ESDV V211.2			.269		
CSP M201.3				2.8 (1)	
FV M210.1					2.8 (1)
TOTAL RELEASE	.706	.808	1.874	2.8	2.8

The maximum relief rate corresponds to depressurization of the sea lines.

Design relief rate : 2.8 MSCM/D

1.6.3.3.2 Calculation Summary

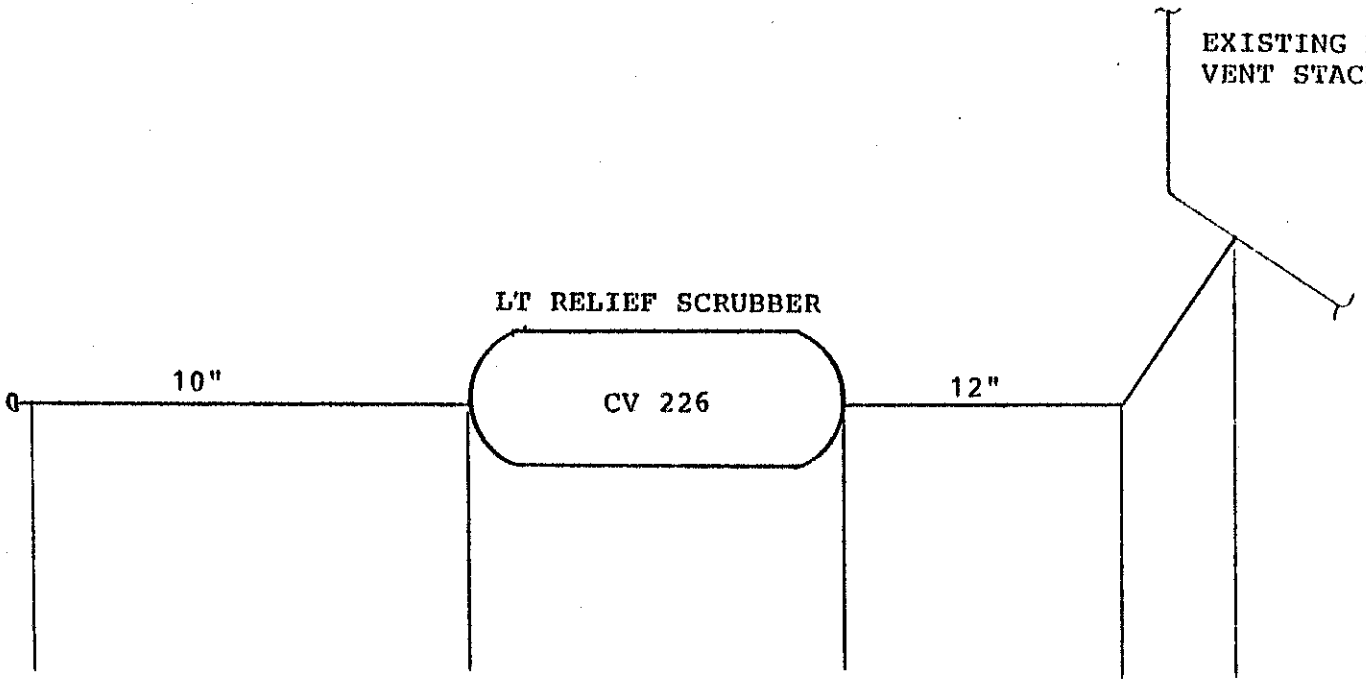
A calculation summary for the LT relief system, is shown on table 1.15. It gives the pressure, gas velocity, Mach number and ρV^2 at different locations in the system.

Reference is made to chapters 1.6.4, 1.6.5 and 1.6.6 for detailed calculations. Back pressure calculations are given in Appendix 9.

Regarding heat radiation and dispersion calculations, vibration and noise calculations, reference is made to the following document:

Elf Aquitaine Norge A/S	TCP-2 Compression
311E ENG 80/407/TEH/ih	RELIEF AND FLARE SYSTEM

LT SYSTEM CALCULATION △1



Flaring flow rate: 2.8 MSCM/D and discharge temperature - 55°C (actual need)

Pressure bara	5.23	3.3	3.07	2.0	1.373
Gas velocity, m/s	86	136	104	159	232
Mach number	0.23	0.364	0.277	0.424	0.62
ρV^2 kg/ms^2	36163	57308	30884	47023	69006

FIGURE 1.15

1.6.4 Depressurization of High Pressure Vessels, Lines and Sea Lines

1.6.4.1 Depressurization of High Pressure Vessels and Lines

1.6.4.1.1 Introduction

High pressure process equipment located in Module 50, are sectionalized by means of ESD valves.

In case of an emergency (fire etc.) these valves can be closed upon signal from the control room.

After isolation of the various sections, it is possible to depressurize manually these sections or the whole treatment plant from the control room.

By doing this, one thereby reduce the pressure by removal of gases from the high pressure vessels and lines. This equipment would elsewhere be weakened by excessive heating when exposed to fire.

All blow down valves are connected to the LT relief system.

1.6.4.1.2 Basis for Calculations

A. Blow Down Flow Rates

The calculation method is based on the fact that:

- The back pressure is low enough to ensure a critical flow rate through the blow down valves.
- The change of the temperature and the compressibility factor inside the equipment during the decompression period is not considered.

The blow down formula is:

$$Wo = Po \frac{MW \times V}{ZRT} \frac{1}{tf} \quad LN \quad \frac{Po}{Pf}$$

Wo	: Initial flow rate	kg/hr
Po	: Initial pressure	160 bara
Pf	: Residual pressure	8 bara (100 psig)
tf	: Depressurization time	hr
MW	: Molecular weight	16.9 kg/kmole
Z	: Compressibility factor	0.73 (at 160 bara 5°C)
T	: Initial vessel temperature	278°K
R	: .0831 with bara, m^3, °K, kmole	kg
V	: System volume	m^3

B. Temperature Downstream of the Blow Down Valves

The method used to calculate the temperature downstream of the blow down valves, is based upon the guidelines given in GPSA Engineering Data Book, Section 17.

The assumptions made are as follows:

Upstream pressure	160 bara
Downstream pressure	2 bara
Upstream temperature	5°C

ODIN gas is taken as the relief composition

Calculation results are given in Appendix 10.
Here it can be concluded that the temperature downstream of the blow down valves will be -75°C.

1.6.4.1.3 Calculation Results

The valves below are connected to the ESD system and depressurize the high pressure lines and vessels.

Depressurization time (1) : 1.5 hrs (90 mins)

ITEM (1)	System Volume m^3 (2)	Initial Blow Down Flow	
		kg/hr	MSCM/D
ESDV M201.2	19	6.083	.203
ESDV V1A.6	51	16.330	.546
ESDV V201.2	23	7.364	.246
ESDV M210.2	6	1.921	.064
ESDV M210.5	51	16.330	.546
ESDV V211.2	13	8.062	.269

(1) Identical to TCP-2 Treatment Plant
(2) System Volume = Vessel Volume + Line Volume between ESDV

Total initial blow down rate : 1.874 MSCM/D

1.6.4.2 Sea Line Depressurization

1.6.4.2.1 Introduction

The sea lines blow down is not connected to the ESD system. This blow down is a voluntary action which is performed when the operating conditions and valve positions are satisfied, and which can be stopped at any time if necessary.

1.6.4.2.2 NEF Sea Line Depressurization (Ref. P & ID FF 88 00 00 5031 - Appendix 3)

The NEF sea line blow down is performed using both the LT relief system and the HP relief system. During the initial blow down period, i.e. when the pressure in the sea line is greater than 100 bara, the gas will have to be released through the LT relief system. The reason for this is the low temperature of the gas downstream the blow down valve due to the great pressure drop across the valve. (Temperature down to -75°C can be reached when the gas is depressurized from 160 bara and down to near atmospheric pressure).

In this stage depressurization valve FCV M210.1 and the manual operated isolation valve HV M210.3 will be open, while depressurization valve FCV M210.2 and the manual operated isolation valve HV M210.4 will be closed. The gas will then pass through to the LT relief system and is further vented to atmosphere in the existing cold vent stack.

A flow switch located at the outlet of the LT relief scrubber CV 226, will prevent the flow rate in the system from exceeding the design flow which is 2.8 MSCM/D.

As the pressure in the sea line decreases to below 100 bara, the temperature downstream of the blow down valves is such that it is possible to tie into the HP relief system. This is done by opening the depressurization valve FCV M210.2 and isolation valve HV M210.4, while corresponding valves for the LT relief system will be closing. The gas then passes through to the HP relief system and ties into the existing 24" relief header just upstream vessel CV 24 - HP Relief Scrubber.

A temperature switch (TSL M210.2) and a pressure switch (PSL M210.5) will protect the HP relief system in such a way that it is not possible to change from LT relief to HP relief before the temperature and the pressure are satisfactory (i.e. the pressure upstream of depressurization valves should be equal or lower than 100 bara and the temperature downstream of the isolating valve HV M210.4 should be equal or higher than -40°C).

The advantage of depressurizing in this way, is that the gas will be flared instead of vented and that the blow down flow rate can be increased due to the design conditions for the HP relief system (HP relief system is designed for a flaring flow rate equal to 34 MSCM/D).

When the HP relief system is used for depressurization of NEF sea line, the max. flow rate equals 8.4 MSCM/D from TCP-2 Extension area. The reason for this value is due to limitation on the criteria of flare pipe sizing, which is:

$$\rho V^2 \leq 100\ 000 \text{ kgm/s}^2$$

and gas velocity $\leq$ 0.45 Mach

A differentital pressure transmitter PDT M210.1, and a differential pressure recorder PDR M210.1 gives the flaring flow rate.

Initial conditions:

System : LT relief
Pressure : 160 - 100 bara
Flow rate : 2.8 MSCM/D

Final conditions:

System : HP relief
Pressure : 100 bara and below
Flow rate : 8.4 MSCM/D

System Protection

Protection during blow down of NEF sea line is achieved as follows:

Before any depressurization of NEF sea line is possible, an authorization signal will have to be given from CCR. Protection during blow down of this sea line is achieved as follows:

During the initial stage of blow down when the LT relief system is used, the released gas will be through valve FCV M210.1. This depressurization valve is opened by HIC M210.1 which is locally located, and it has been sized to pass 2.8 MSCM/D at 110 bara inlet pressure with 90% lift.

The flow to the LT relief, is measured by two annubar elements located downstream of vessel CV 226. Protection against excessive flow is by means of FSH V226.2, which will be set at design flow, i.e. 2.8 MSCM/D. If the flow by some means should exceed the design flow, the FSH will close valve FCV M210.1, thereby stopping the blow down of sea line. Before depressurization again is possible, a new authorization signal will have to be given from CCR.

Once the sea line pressure is at 100 bara, the PSL M210.5 provides permissive signal which together with a CCR authorization to use the HP flare system, enables the FCV M210.2 to be opened by HIC M210.2. This HIC is locally mounted. FCV M210.2 is sized for 8.4 MSCM/D at 100 bara inlet and 60% lift. Protection against malfunction of the HP relief system is:

1) PSL M210.5 which will not pass any gas through to the HP relief before the pressure is less or equal to 100 bara.

2) TSL M210.2 protects the HP relief piping (class ECX) from too low a temperature. This means that FCV M210.2 will close if the temperature in the piping system is less than -40°C.

Further protection is given by the overreading authorization signal from CCR. This applies to both systems. The flow to either system is measured by means of a pitot tube in line C2131 EFT 6" R. The status of the system will be monitored by means of position switches on the manual isolating valves HV M210.3 and HV M210.4, which will give indication in the CCR about which system that is in operation.

1.6.4.2.3 ODIN Sea Line Depressurization (Ref. PID FF 88 00 00 5030 - Appendix 3)

The ODIN Sea Line will be depressurized from the ODIN platform. Provisions have however been made to depressurize partially the ODIN pipeline from TCP-2 in case of plugging of the line by pigs or other unusual situations.

The blow down is performed by opening of the choke valve CSPM 201.3. This valve has been calculated to deliver a depressurization flow rate of 2.8 MSCM/D at 160 bara.

As for the NEF blow down line, the flaring flow rate is measured using a PD-transmitter and a PD-recorder:

PDT M201.1/PDR M201.1

1.6.5 Fire Protection

1.6.5.1 Introduction

All vessels are protected against fire exposure by pressure safety valves.

The calculation assumptions are in accordance with API RP 520 and API RP 521.

1.6.5.2 Liquid Vapourization Risk

Main assumptions:

- Vessels are not insulated which means that F = 1 in the formula:

  $$Q = 2100 \times F \times A^{0.82}$$

  Q = total heat absorption (input) to the wetted surface

  A = total wetted surface

- The maximum liquid level (LSHH) is used to calculate the wetted surface.
- The total heat input is used as latent heat of vapourization.
- The condensate heat of vapourization is 72 kcal/kg and the relieved vapour is gas of molecular weight 16.9.
- The calculations for the vessels are shown in Appendix 11.

1.6.5.3 Gas Expansion Risk

The following calculations are applicable to CV 201 and CV 211.

They consider a total exposed area which includes the vessel itself plus surrounding pipe lines.

The calculations of the gas flow rates to be relieved are in accordance with the API 520:

The calculations are shown in Appendix 11.

1.6.5.4 Calculation Results

Table 1.16 summarizes the flaring flow rates due to fire exposure.

TABLE 1.16

FIRE PROTECTION

3) Relief Device	1) Fire Risk	Wetted Area m^2	Total Exposed area m^2	Total Heat Absorption Kcal/Hr	Mass Flow Rate Kg/Hr	Standard Flow Rate MSCM/D	2) Flare System
PSV CV 1A 6/7	L.V.	51		970.200	13.475	0.450	H.P.
PSV CV 201 1/2 1)	G.E.	-	104		19.506	0.656	L.T.
PSV CV 204 1/2	L.V.	11.8	-	286.500	3.978	0.134	L.P.
PSV CV 210 1/2	L.V.	60	-	1.048.000	14.550	0.489	L.T.
PSV CV 211 1/2 1)	G.E.	-	51		9.482	0.319	L.T.
PSV CV 213 1/2	L.V.	11.8	-	286.500	3.978	0.134	L.P.
PSV CV 220 1/2	L.V.	6.6	-	174.400	2.424	0.080	L.P.
PSV CM 201 1	L.V.	3.5	-	102.600	1.425	0.050	L.T.

(1) Fire Risk
L.V. = Liquid vapourization
G.E. = Gas expansion

(2) Flare System
L.P. = Low pressure
L.T. = Low temperature
H.P. = High pressure

(3) The PSV CV 1A 6/7 are existing equipment.

FIRE PROTECTION - CONTINUED

Relief Device	Set Pressure barg	Relieving Pressure bara (Note 1)	Temp. Upstream Valve °C (Note 2)	Temp. Drop across Valve °C	Max. Back Pressure barg.
PSV CV 1A 6/7	176.5	195.15	94	64	44
PSV CV 201 1/2	176.5	195.15	94	64	4.7
PSV CV 204 1/2	24.0	27.4	149	14	1.0
PSV CV 210 1/2	176.5	195.15	129	49	4.7
PSV CV 211 1/2	176.5	195.15	129	49	4.7
PSV CV 213 1/2	24.0	27.4	149	14	1.0
PSV CV 220 1/2	15.2	17.72	246 (2)	8	1.0
PSV CM 201 1	176.5	195.15	94	64	4.7

Note 1 : Relieve pressure = set pressure + over pressure + 1
where over pressure equals 10% of set pressure.

Note 2 : Temp. upstream valve is determined from the relationship $T_1 = \frac{P_1}{P_n} \cdot T_n$

where P_1 = relieve pressure, bara

T_1 = relieve temperature, °K

P_n = normal operating pressure, bara

T_n = normal operating temperature, °K

1.6.6 Protection Against Process Over Pressure

1.6.6.1 Protection for High Pressure Gas Vessels CV 1A, CV 210, CV 201 and CV 211

No protection for blocked lines is required for NEF Slug Catcher and Metering Scrubbers.

The reason is that the MAWP, which is 177.5 bara, is higher than the maximum static well head pressure.

For the ODIN Slug Catcher, protection against over pressure will be provided in accordance with the final rerating on CV 1A.

1.6.6.2 ODIN Condensate Lines Downstream the ESDV V1A.2 and ESDV V201.3

1.6.6.2.1 Description

During normal operating conditions, the pressure in these lines will be 20 bara. In case of high process pressure downstream these ESD valves, the primary protection is the PSH V204.5. The PSH will close the valves ESDV V1A.2 and ESDV V201.3.

The secondary protection is the PSV V204.1 or PSV V204.2 with a set pressure of 25 bara. These protections are located on the Condensate/Methanol Separator CV 204.

The over pressure sizing case is caused by an uncontrolled flow from the condensate line. The flow rate is calculated based upon full opening of the manual globe valve which bypasses the level control valve LCV V1A.1.

1.6.6.2.2 Calculation Results

Basis Calculation Formula:

$$Q = CV\sqrt{\Delta P/G}$$

Q = Flow rate, USGPM

CV = Liquid sizing coefficient

P = Max. allowable differential pressure, psi

G = Specific gravity (water = 1.0)

Bypass valve (1" globe valve) : CV = 3.5
Upstream pressure : 149 bara
Downstream pressure : 20 bara
Specific gravity : 0.662

The upstream liquid is supposed to be condensate without methanolated water and the valve calculation gives a volumetric flow rate of 186.1 USGPM or 42.3 m^3/hr. This corresponds to a mass flow rate of 28070 kg/hr.

This fluid enters vessel CV 204, where the vapour released is evacuated through PSV V204.1/2. Maximum vapour flow rate is 2378 kg/hr, which is found by taking the ratio of normal operating gas flow to normal operating gas plus liquid condensate flow and multiply by 28070. This maximum gas flow is less than the figure given in Chapter 5 for Fire Exposure, which is 3978 kg/hr.

The gas is further sent to LP Vent Scrubber CV 7, which is an existing equipment (Ref. Schematic Diagram in Chapter 1.6.3).

1.6.6.3 NEF Condensate Lines Downstream the ESDV V210.2 and ESDV V211.3

1.6.6.3.1 Description

The preceeding description of the ODIN safety protection against over pressure applies to NEF liquid treatment. The assumptions are the same, but the instrument tag numbers are to be changed to:

ESDV V210.2
ESDV V211.3
PSH V213.5
PSV V213.1
PSV V213.2
LCV V210.1

1.6.6.3.2 Calculation Results

Basis

Bypass valve (1" globe valve) : CV 3.5
Upstream pressure : 136 bara
Downstream pressure : 20 bara
Specific gravity : 0.663

This corresponds to a mass flow rate of 26550 kg/hr.

The vapour released through PSV V213.1/2 is 2063 kg/hr, which is less than the gas released in case of fire exposure, which is 3978 kg/hr. (Ref. is made to chapter 1.6.5).

1.6.6.4 Thermal Expansion in CE 203 / CE 211

The condensate/methanolated water is heated using the exchangers CE 203/CE 211. At normal conditions the temperature at the outlet of the heaters will be 20°C.

If the temperature of the fluid is increased to a certain value (the value to be defined later), a temperature switch (TSH E203.5 and TSH E211.5) will shut off the heating medium which is the TEG solution. These switches are located just downstream the heaters.

Such an excess heat input could happen if the condensate/methanolated water is allowed to stay within the pipe without being withdrawn. Any pressure built up in the system because of vapour released due to heating, will be evacuated through the pressure control valves PCV V204.2 for the ODIN separator and PCV V213.2 for the NEF separator.

These valves are connected to the LP vent system.

1.6.6.5 Protection of Methanolated Water System

1.6.6.5.1 Protection of Vessel CV 220 - Methanolated Water Flash Drum

At normal conditions, the operating pressure in the vessel is equal to 10 bara. If the pressure by accident increases (as could happen in case of blocked outlet from the vessel or an uncontrolled flow into the vessel), the primary protection is a PSH V220.3. closing the inlet to the vessel. The secondary protection is the PSV V220.1/2 having a set pressure equal to 16.2 bara.

These PSV valves have been sized for max. release which is in case of fire (Ref. chapter 1.6.5).

1.6.6.5.2 Protection of Vessel CV 222 - Methanolated Water Drainage Tank

This vessel is not in continuous service and will only be used for drainage of vessels CV 204, CV 213 and CV 220 (the suction of glycol pumps CP 13 A/B also ties into this system).

The vessel is protected against process over pressure by a vent going to atmosphere. The drainage tank is operated at atmospheric conditions.

1.6.6.6 Protection on Shell Side of Condensate Heaters, TEG Lines and Glycol Surge Drums CV 17 A/B/C

The design pressure on the shell side of the condensate heaters CV 203/CE 211 is 25 bara. The tube side of these heaters are protected by a PSH and two PSVs set at 25 bara, located at downstream components CV 204 and CV 213.

In case of tube side failure, the three phases condensate, gas and methanolated water will leak into the shell side, because the operating pressure is lower than the tube side (5 bara and 20 bara respectively). From the shell, the fluid enters the glycol piping, which is designed at 25 bara.

The glycol return line will be used as relief system. The condensate, gas and methanolated water are sent to existing vessels CV 17 A/B/C. The gas is evacuated through a 2" existing breather line which leads to the LP vent system. The glycol surge drum design pressure which is 3.05 bara, will not be reached (Ref. Appendix 12).

Since the only isolation device between the heat exchanger and the vessels are manually block valves which will be locked open, the exchanger and vessel are considered as one unit regarding safety on the process side. A PSV on the shell side of the heaters and on the glycol piping, is therefore not required. The safety protection is made by the existing vent lines C 434/435/436-EA-2"-V.

1.6.6.7 Methanolated Water Storage Tank CV 9

The CV 9 - Methanolated water storage tank which is designed at 1.35 bara, was previously used as a glycol storage tank. The protection of this vessel has been modified to take into account the function as methanolated water storage.

This safety protection will be identical to the existing vessel CV 33.

This includes:

PSV V9.3 : - Emergency vent and manhole to relieve internal pressure of the vessel.

PSV V9.2 A/B : - Pressure and vacuum breather valves to relieve internal pressure and vacuum of the vessel during filling or emptying.

1.6.6.8 Pumps Discharge

All the outlets of reciprocating pumps are protected by pressure safety valves.

The protection of the outlets of centrifugal pump is not necessary, since the maximum discharge pressure will not exceed the rated working pressure of the piping.

1.7 GENERAL DRAWING LIST

1.7.1 General Drawings

The main Process Flowsheets, P. & I.D.s and Plot Plans/General Arrangement drawings are:

1.7.1.1 Process Flowsheets - Schematic Drawings

FF 88 00 00 0102	Schematic Process Diagram
FF 88 00 00 5100	Process Flowsheet - Gas Treatment
FF 88 00 00 5101	Process Flowsheet - Liquid Treatment
FF 88 00 00 0901	NEF and ODIN ESDV and Flare Systems Schematic Diagram

1.7.1.2 Process / Utilities Drawings - PIDs

FF 88 00 00 5030	Odin Gas Treatment - Separation
FF 88 00 00 5031	North East Frigg Gas Treatment - Separation
FF 88 00 11 5032	NEF and ODIN Liquid Treatment - Condensate Separation
FF 88 00 10 5033	NEF and ODIN Liquid Treatment - Methanolated Water
FF 88 00 00 5034	NEF and ODIN Liquid Treatment - TEG and MW Facilities
FF 88 00 54 5101	NEF and ODIN Liquid Treatment - Methanolated Water Injection DP-2
FF 88 00 04 5090	NEF and ODIN Treatment - Flare System
FF 88 00 09 5036	NEF and ODIN Treatment - Methanol Injections
FF 88 00 10 5100	NEF and ODIN Treatment - Process Drainage System
FF 88 00 02 5040	NEF and ODIN Treatment - Fuel Gas System
FF 88 00 00 0300	NEF and ODIN Treatment - Condensate and Gas Tie Ins
FF 88 00 10 5046	Deck Drainage System - Utility Flow Sheet
FF 88 00 00 5043	Utility Water - Utility Flow Sheet
FF 88 00 01 5041	Instrument Air, Plant Air - Utility Flow Sheet.

FF 88 00 17 5044	Fire Water and Washdown Piping - Utility Flow Sheet
FF 88 00 08 5045	Hydraulic Power Distribution
FF 88 00 00 5555	Legend for Piping and Instrument Diagrams Sheet No. 1.

1.7.1.3 Plot Plans - Arrangement Drawings

FF 88 20 00 0105	Static Module M50 - Plot Plan.
FF 88 20 00 0101	Pancake 53 - Plot Plan
FF 88 20 00 7300	Tie In Piping Arrangement Cellar Deck - El. 100.000
FF 88 20 00 7305	Tie-In Piping Arrangement Main Deck El. 108.850
FF 88 20 00 7307	Tie-In Piping Arrangement Upper Deck El. 116.350
FF 88 20 00 8860	General Arrangement of DP 2 Package of Methanolated Water Injections.

2 PRINCIPLE OF ENGINEERING DESIGN

2.1 ENVIRONMENTAL CONDITIONS

2.1.1 Wind

2.1.1.1 Wind Profile

The wind speed has been calculated as a function of height above the mean water level and averaging time interval by the power law.

$$V = V_{1hr, 10} \left(\frac{Z}{10}\right)^{\beta}$$

Where:

V_{tz}	is the wind speed averaged over a time interval as defined by α and β, Z metres above the mean water level.
$V_{1hr, 10}$	The wind speed averaged over one hour, 10 metres above the mean water level.
α	gust factor; referenced to
β	height exponent

2.1.1.2 Factors in the Power Law for Wind Profile

	AVERAGE TIME INTERVAL					
	1 hr	10 min.	1 min.	15 sec.	5 sec.	3 sec.
α	1.000	1.060	1.180	1.300	1.370	1.390
β	0.150	0.130	0.113	0.106	0.102	0.100

2.1.1.3 Reference Wind Speed

The reference wind speed has been taken as the averaged wind speed over one hour, 10 metres above the mean water level, and with a 100 years return period.

$$V_{1hr} = 42.45 \text{ m/s.}$$

2.1.1.4 Prevailing Winds

Prevailing winds are from W S W to N W sector.

2.1.1.5 Storm Wind Direction

Storm winds on Frigg Field vary in direction throughout the year according to prevailing directions stated below.

Storm wind $\geq$ 10 BEAUFORT (25 m/s).

MONTHS	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
NW & N	44	40	35	27	19	12	28	18	51
W & SW	35	47	40	35	37	31	28	28	33
S & SE	18	13	20	34	40	57	43	54	16
E & NE	3	<1	5	4	4	<1	1	<1	<1
	100	100	100	100	100	100	100	100	100

2.1.2 Ambient Air Conditions

2.1.2.1 Ambient Air Temperature

The expected extreme daily averaged temperatures are:

Minimum	- 9°C
Maximum	+22°C.

2.1.2.2 Ambient Air Relative Humidity

Maximum	99 %
Minimum	35 %

and saliferous atmoshpere.

2.1.2.3 Rainfall

Rainfall yearly average 990 mm

Maximum 24 hours 86 mm

Average number of rainy days: 195 days/year.

2.1.2.4 Atmospheric Pressure

Mean pressure monthly average at sea level:

753 mm/Hg (Dec)
761 mm/Hg (June).

2.1.2.5 Snow and Ice Accumulation

Snow and ice accumulation has not been considered in the the overall calculation.

2.1.3 Sea Water Characteristics

2.1.3.1 Sea Water Temperature

Extreme temperatures at the sea surface:

Minimum + 4°C
Maximum + 17°C

Extreme temperatures at - 50 m LAT:

Minimum + 5°C
Maximum + 12°C

Extreme temperatures at - 100 m LAT: (Sea bottom)

Minimum + 4.8°C
Maximum + 9.5°C.

2.1.3.2 Sea Water Salinity

The extreme value of the sea water salinity expressed in weight percentage is:

at the sea surface : minimum 31.27 o/oo
maximum 35.40 o/oo

Current velocity at 30 metres above sea bottom	0.70 m/s
Current velocity at sea bottom	0.30 m/s.

at - 50 metres LAT : minimum 34.02 o/oo
maximum 35.41 o/oo

at - 100 metres LAT : minimum 34.30 o/oo
: maximum 35.48 o/oo

2.1.3.3 Sea Water Oxygen Content

The sea water oxygen contents based upon a monthly average is:

at the sea surface : minimum 5.69 ml/l
: maximum 7.16 ml/l

at - 50 metres LAT : minimum 5.51 ml/l
: maximum 6.89 ml/l

at - 100 metres LAT : minimum 5.56 ml/l
: maximum 6.60 ml/l

2.1.4 Water Depth - Sea Level

2.1.4.1 Water Depth

On the site of TCP-2 Platform, the sea water depth is 103 metres from the LAT (Lower Astronomical Tide).

2.1.4.2 Tide in Storm Conditions

Maximum astronomical tide range above LAT	1.70 m
Maximum wind drift surge	0.30 m

2.1.4.3 Tide in Operating Conditions

Maximum astronomical tide range above LAT	1.70 m
Maximum wind drift surge	0.30 m

2.1.5 Waves and Current

2.1.5.1 Storm Conditions

Wave height	29 m
Wave period	16 s
Current velocity at surface	1.35 m/s

2.1.5.2 Operating Conditions

Wave height	17.4 m
Wave period	12 s
Current velocity at surface	1.00 m/s
Current velocity at 30 m above sea bottom	0.58 m/s
Current velocity at sea bottom	0.30 m/s.

2.1.5.3 Prevailing Wave Direction

See 2.1.1.5 - "Storm Wind Direction".

It has to be noted that storms from W and SW, and especially from NE and E have a short fetch which limits the wave height.

The waves which are liable to present the maximum height are from:

NW to N

SE to S.

2.2 DOCUMENT NUMBERING, DISTRIBUTION AND ROUTING

2.2.1 Foreword

This document is based upon the Annex C of the F.087 contract.

2.2.2 Units of Measurements

The System International (SI) system has been used for all the project documents except for pipe nominal diameters, schedules and flange rating for which English units apply.

2.2.3 Numbering System

2.2.3.1 Numbering Equipment

A) Numbering of Main Equipment

All significant items of equipment have been given an equipment number that comprises a prefix and suffix. The indices of prefixes are as follows:

CV	Vessels, Filters
CP	Pumps
CC	Compressors
CT	Turbines
CE	Heat Exchangers, Air Coolers
CH	Heaters
CQ	Glycol Regeneration Units and Package Units
CM	Pig Launchers and Receivers, Miscellaneous Mechanical Equipment
CPS	Miscellaneous Piping (Strainers, Silencers, Choke Valves).

The suffixes are assigned sequentially for each item of equipment starting at:

200 for ODIN equipment
210 for North East Frigg equipment
220 for equipment common to North East Frigg and ODIN effluents treatment.

In the event of two or more identical items of equipment existing, a further suffix A, B, C etc. is assigned.

i.e. CV 5A
CV 5B
etc.

B) Line Identification (for Piping only)

The line identification consists of six parts, and the following is an illustration:

```
                           C 2026 EC 10" P 1
                           :  :   :   :  : :
Platform TCP-2------------:  :   :   :  : :
Line Number-------------------:   :   :  : :--Type of
Pipe Specification----------------:   :  :    Insulation
Nominal Line Size---------------------:  :
                                         :----Commodity
                                              in Line
```

B.1 Platform : TCP-2 = C

B.2 Line number : For the TCP-2 Extension the following series were used:

ODIN Lines : 2000 to 2099
NEF Lines : 2100 to 2199
Lines common to ODIN & NEF: 2200 to 2399
Utility Lines : 2400 to 2599

B.3 Pipe Specification

Specification identification is defined in the piping specification S-FF 88 20 5406.

B.4 Commodity in Line

The following identification was be used:

Commodity	Commodity Identification
Process	P
Relief	R
Vents	B
Process and Deck Drains	DR
Glycol	G
Hydrocarbon Dump	HD
Fuel Gas	FG
Diesel Oil	DO
Methanol Air	ME
Instrument Air	IA
Plant Air	PA
Fire Water	FW
Sea Water	SW
Utility Water	UW
Hydraulic Fluid	HF
Mud	M
Potable Water	PW

B.5 Type of Insulation

1. Calcium silicate
2. Cellular Glass

C. Structural Identification

Welding symbols are according to AWS D1.0 and AWS D1.

D. Electrical Identification

The IEC 117 graphical symbols are used.

E. Instrument Identification

The I.S.A: - S5.1, Instrumentation, Symbols and Identification were for tagging of instruments.

2.2.3.2 Numbering of Engineering Drawings (Including Isometrics)

A. General

The drawings were coded as follows:

- 2 letters for site identification (1)
- 2 digits for the installation (2)
- 2 digits for the speciality (3)
- 2 digits for the system (4)
- 4 digits for the chronological number (5)
- 2 digits for the revision index (6)

Example:

```
                               FF 88 20 11 5137 04
                               :  :  :  :   :   :
(1)  Site (Frigg Field)--------:  :  :  :   :   :
(2)  Installation (TCP-2 Ext.)----:  :  :   :   :
(3)  Speciality (Piping)-------------:  :   :   :
(4)  System (Corrosion inhibitor--------:   :   :
     injection)                             :   :
(5)  Chronological--------------------------:   :
(6)  Revision-----------------------------------:
```

B. Codification of Site

All new developed drawings had a site identification:

FF (series 88).

The originals from the Frigg existing installations which were modified (for integration works) were coded FE (Frigg Extension) until the As Built stage. At that time the "FE" code was replaced by the original one. Through all stages the other numbers except the revision number remained the same.

C. Codification of Installation

00. If more than one main class is concerned.

10. Standards

60. <u>North East Frigg Development</u>

61. Field Control Station

62. Sub-sea Wells

63. Pipeline

64.

65.

66. Experimental Equipment

67.

68.

69.

70. <u>Frigg Field Line and Cable Connection</u>

80. <u>Frigg Field Development Phase 2</u>

81.

82.

83. <u>DP-2</u> = Drilling Platform No. 2

84. Wells DP-2

85. <u>TCP-2</u> = Treatment and Compression Platform No.2
(Treatment)

86.

87. Compression Facilities of TCP-2

88. TCP-2 Extension

90. Frigg Field Development Phase 1

91. CDP-1 = Concrete Drilling Platform No. 1.

92.

93. DP-1 = Drilling Platform No. 1.

94. Wells CDP-1

95. TP-1 = Treatment Platform No. 1.

96. QP = Quarters Platform

97.

98.

99. FP = Flare Platform

D. Codification of Speciality

00 - General document if more than one speciality concerned (P and I Diagrams).

Including - General view of installation.

- Plot plan
- Area classification
- Architectural
- Safety Plot Plan

16 - Instrumentation
20 - Piping, Casing
21 - Steel Structures (except jacket and support frame)
22 - Offshore Platform (jacket, support frame)
23 - Electricity
24 - Civil Work (concrete structure)
26 - Mechanical
30 - Process
36 - Underwater Intervention Equipment
37 - Sea Fastening, Temporary Equipment, Erection

E. System Identification

The equipment identification system is different from platform to platform.

E.1 Installation : DP-2 (83)

Index of systems

System No.:	Designations
00	Generalities
01	Air System Air Compressors Dryers Nitrogen System Plant Air (10 bars) Instrument Air (3 bars) Instrument Outlet Signals
02	Electrical System (5.5kV Distribution System inside Module A).
03	Electrical System (380 V and 220 V Distribution) MCC and Distribution Interlocks Normal Lighting Generator Earthing
04	Electrical System (48 V Distribution) Battery and Chargers Switchboard 48 V DC and Distribution
05	Detection System Smoke Fusible Plugs Gas Detectors Fire Detection Panel
06	Protection System Deluge System Halon System CO_2 Firepumps (SPP) Monitor Hose Extinguishers Remote Start Fire Pumps ESD DSD Emergency Lighting 24 hrs Emergency Lighting 1 hr

07	Evacuation Lifeboats (Two Lifeboats only in Module 4) Escape Routes Lifesaving Equipment Life Raft Supports on Module Framing
08	Warning Alarm Horn (for DSD Fire) Public Address Telephone Cable Pulling
09	Beaconing Navigation aids Warning Lights Horn
10	Soft Water System
11	Utility Sea Water System
12	Gas Oil System
13	Ventilation - Air Conditioning - Pressurization
14	Test Separator and Flare
15	Gas Circuit by Well
16	Gas Outlet Scrubbers (inside Modules)
17	Vent System
18	Condensate System (inside Modules)
19	Kill Lines (inside Modules)
20	Methanol System
21	Corrosion Inhibitor System
22	Hydraulic Pneumatic and Electrical System for Valves.
23	Hydraulic Pneumatic and Electrical System for ROV Valves (except ROVs 201-202 and 203) West Cluster East Cluster
24	Slop Line (inside Modules)
25	Drain System (inside Modules and Support Frame).

26	Lifting Devices (inside Modules)
27	Living Quarters
28	Steel Structures
29	Chlorination Lines
30	Offshore Work Site Handling Mobilization of Site Installation Site Administration Demobilization of Site Installation
35	Miscellaneous
50	Life Rafts
51	Telephone Installation
52	Geotechnical and Mechanical Syminex Syntef Comsip
54	Methanolated Water Disposal

E.2 Installation : QP (96)

Index of Systems

System No.:	Designation:
01	Firewater and Fire
Detection	
02	Potable Water
03	Utility Water
04	Transformer and Emergency Generator
05	Drainage and Condensate
06	Instrument and Plant Air
07	Safety Systems
08	Diesel Oil
09	Washdown Water
10	Air Conditioning
11	Telecommunications
13	Incineration - Fuel Gas
14	Control Room
15	Aviation Fuel
16	Sewage
17	Electrical
18	Steel Structure and Module
19	Geotechnical and Mechanical
20	Oceano - Meteo Equipment
25	Miscellaneous
26	Cathodic Protection
27	Computer

E.3 Installation : TCP-2 Extension (88)

- only 2 digits are used for numbering of engineering drawings.
- subsystems coded as A, B, C, etc... were used later on for progress, planning, commissioning and start-up purposes.
- some systems are deleted as they do not correspond to any function in the TCP-2 Extension project.

INDEX OF SYSTEMS

00	Generalities, Loop Diagram
01	Instrument and Plant Air Supply
	a) Instrument Air Distribution b) Service Air Distribution
02	Fuel Gas
03	Electrical Systems
	a) Cable Trays b) 380 V Power Distribution c) Normal Lighting d) Emergency Lighting e) Emergency Power (220 V No Break) f) 24 V DC g) Grounding h) Trace Heating
04	High Pressure Relief
	a) High Pressure Relief to CV 24 b) Low Temperature Relief
05	Low Pressure Relief
06	Safety Systems
	a) Public Address and Public Alarm b) Gas Detection c) Fire Detection
08	Hydraulic and Shut Down System
09	Methanol High and Low Pressure
	a) Methanol High Pressure b) Methanol Injection to NEF

10	Drainage
	a) Open Drainage b) Closed Drainage c) Methanolated Water
11	Condensate
12	Gas CV 1A - CV 210 to Compression Header
14	Gas Inlet (from Riser to CV 1A, CV 210 Inlets).
16	Glycol Heating Medium
17	Fire Water and Extinguishing System
	a) Fire Water b) Deluge Water c) Extinguishing System
18	Washdown
22	Miscellaneous
25	Steel Structure and Modules
	a) Structure b) Access and Escape Ways
27	Corrosion Inhibitor
29	Lifting Equipment
30	Cathodic Protection

F. Chronological Number Breakdown

This number is established for each speciality per installation.

F.1 TCP-2 Extension : Site Code : 88

F.1.1 Discipline 00 : General

0001 to 0999 : Plot Plan - Layout
1000 to 1999 : Architectural General Platform
2000 to 2999 : No Allocation
3000 to 3999 : General Loading Drawings
4000 to 4999 : Safety
5000 to 5999 : PID
6000 to 9999 : No Allocation

F.1.2 Discipline 16 : Instrumentation

0001 to 0999 : Reserved for temporary drawings
1000 to 9999 : No special breakdown

F.1.3 Discipline 20 : Piping

0001 to 1999 : Arrangement Drawings
2000 to 2099 : Isometrics for ODIN Lines
2100 to 2199 : Isometrics for NEF Lines
2200 to 2399 : Isometrics for Common Lines to ODIN & NEF
2400 to 2599 : Isometrics for Utility Lines
2600 to 3999 : No Allocation
4000 to 4999 : Pipe Supports
5000 to 9999 : Others

F.1.4 Discipline 21 : Structural

0001 to 1099 : General
1100 to 1999 : Support Frame
2000 to 2999 : Structural Module Upper Deck (M50)
3000 to 3999 : Main Deck : T.O.S. - Skid Beams
4000 to 4999 : Columns C1-C3-C5 Equipment
5000 to 5999 : Cellar Deck (P53) - Bridge TP1 - TCP-2
6000 to 6999 : Weight Estimate
7000 to 7999 : Miscellaneous, Projects, Sketches
8000 to 8999 : Sketches (Installation Drawings)
9000 to 9999 : No Allocation

F.1.5 Discipline 23 : Electricity

0001 to 9999 : No special breakdown

F.1.6 Discipline 26 : Mechanical

0001 to 9999 : No special breakdown

F.1.7 Discipline 30 : Process

0001 to 9999 : No special breakdown

Note : This discipline does not exist for EAN Engineering, but is allowed for TCP-2 Extension Project.

F.2 TCP-2 Extension : Other Site Codes

The new drawings to be issued for works connected to TCP-2 Extensions project but to be carried out within the Frigg Field existing facilities i.e.:

Site Code:		
	83	DP-2
	85	TCP-2 Treatment
	87	TCP-2 Compression
	95	TP-1
	96	QP

have, whatever the discipline is, chronological numbers taken within the range 8800 to 8899.

F.3 Revision Index

All revisions are mentioned on the drawings, and the updating of the drawings register shall be done accordingly.

2.2.3.3 Numbering of Technical Documents Other Than Drawings

2.2.3.3.1 Prefix

The FF Site Code will be preceeded by:

S	for Specifications, Data Sheets, Tie-In Files
C	for Calculation Notes
CH	for Charts
P	for Procedures
M	for Manuals
L	for Lists - M.T.O.
R	for Requisitions

2.2.3.3.2 Field Specification

FF are always used for types of documents listed in paragraph 2.2.3.3.1.

2.2.3.3.3 Codification of Installation

Refer to paragraph 2.2.3.2.3.

2.2.3.3.4 Codification of Speciality

Refer to paragraph 2.2.3.2.4.

2.2.3.3.5 Chronological Number

Refer to paragraph 2.2.3.2.6.

Exception

For the following instrumentation equipment, the chronological number is taken within the given ranges:

Flow Transmitter	10 00 to 10 99
Local Flow Meter	11 00 to 11 99
Flow Meter with Totalizer	12 00 to 12 99
Level Transmitter/Controller	20 00 to 20 99
Pneumatic Level Switch	21 00 to 21 99
Electrical Level Switch	22 00 to 22 99
Level Gauge	23 00 to 23 99
Pressure Transmitter	30 00 to 30 99
Pneumatic Pressure Switch	31 00 to 31 99
Electric Pressure Switch	32 00 to 32 99
Pressure Gauge	33 00 to 33 99
Temperature Probe	40 00 to 40 99
Transducer/mA	41 00 to 41 99
Thermometer	42 00 to 42 99
Control Valve	50 00 to 50 99
Choke Valve	51 00 to 51 99
ESDV Valves	52 00 to 52 99
Safety Valves	53 00 to 53 99
Electro Valve	54 00 to 54 99
Recorders	60 00 to 60 99
Indicators	61 00 to 61 99
P/I Transducers	62 00 to 62 99
Alarm System	63 00 to 63 99
Control Panel	70 00 to 70 99
Interface Cabinet	71 00 to 71 99
Fire Detection	80 00 to 80 99
Gas Detection	81 00 to 81 99

2.2.3.3.6 Revision Index

Refer to paragraph 2.2.3.2.7.

2.2.3.3.7 Numbering Sample

S - FF 88 16 5301 00

1 2 3 4 5 6

1 : Prefix (Specification here)
2 : Field Specification
3 : Codification of Installation
4 : Codification of Speciality
5 : Chronological Number (Safety Valves here)
6 : Revision Index

2.2.3.4 Numbering of Inquiries

The numbering will be as follows (sample).

FO 20 0001 00

1 2 3 4

1 : Project Reference : FO
2 : Speciality : refer to paragraph 2.2.3.2.4
3 : Chronological number : from 0001 and so on.
4 : Revision index : two figures from 00 and so on.

2.2.3.5 Numbering of Engineer´s Purchase Orders

The numbering will be as follows (sample):

FO 1 20 0001 00

1 2 3 4 5

1 : Project Reference : FO
2 : Nature of the order : 1 for equipment
2 for service contract
3 for mixed contract
3 : Speciality : refer to paragraph 2.2.3.2.4
4 : Chronological number : from 0001 and so on.
5 : Revision index : two figures from 00 and so on.

2.2.3.6 Numbering of Letters, Transmittals, Telexes, Minutes of Meeting

2.2.3.6.1 Numbering of Letters

A. Correspondence from Company to Engineer.

Letters have been numbered in sequence as follows:

LCE = Letter Company to Engineer
001 = First number of sequence

Any equipment mentioned in letters has been identified by its tag number whenever possible.

B. Correspondence from Engineer to Company.

Letters have been numbered in sequence as follows:

LEC = Letter Engineer to Company
001 = First number of sequence

Any equipment mentioned in letters has been identified by the tag number whenever possible.

2.2.3.6.2 Numbering of Telexes

Telexes have been similarly numbered as follows:

A. Telexes from Company to Engineer

where TCE = Telex Company to Engineer.

B. Telexes from Engineer to Company.

where TEC = Telex Engineer to Company.

2.2.3.6.3 Numbering of Transmittals

Drawings and specifications have been accompanied by a data transmittal form. These forms carried letter numbers as mentioned in paragraph 2.2.3.6.1.

2.2.3.6.4 Numbering of Minutes of Meeting

The minutes of meeting were numbered as follows:

A. - Minutes of meeting from Engineer

MEC
001 : First number of sequence

B. - Minutes of meeting from Company

MCE
001 : First number of sequence

All the minutes of meetings were transmitted by a numbered covering letter.

2.2.4 Document Distribution

The Engineering contractor distributed the various documents as follows:

Legend (O) : Original
(R) : Reproducible

Documents (not limited to)	EAN DUSAVIK	EAN YARD	EAN SITE	TOTAL
A. Contract Correspondence				
- Letters	4+1(0)			5
- Minutes of Meeting	4+1(0)			5
- Contractual Documents	6+1(0)			7
B. General Correspondence				
- Letters	4+1(0)	1	1	7
- Minutes of Meeting	4+1(0)	1	1	7
C. Engineering Documents				
Engineering correspondence				
- Letters	4+1(0)	1	1	7
- Minutes of Meeting	4+1(0)	1	1	7
Documents for approval				
- Basic Engineering Documents	8			8
- Detailed Engineering Documents	8			8

Documents (not limited to)	EAN DUSAVIK	EAN YARD	EAN SITE	TOTAL
- Documents established by Engineer	8			8
- Documents established by Supplier for Engineer				
. Documents before approval by Engineer	4			4
. Documents with Engineer˜s comments	6			6
Documents "Approved for Construction" or final documents				
- Basic Engineering Documents	15+1(R)			16
Detailed Engineering Documents:				18
. Documents established by Engineer	15+1(R)			16
. Documents established by Supplier	10+1(R)			11

D. <u>Procurement Documents</u>

Correspondence				
- Correspondence between Engineer and Company				
. Letters	4+1(0)			5
. Minutes of Meetings	4+1(0)			5
Correspondence between Engineer and Suppliers or Contractors				
. Before Purchase Order	3+1(0)			4
. After Purchase Order	4+1(0)			5
Tenderer˜s List				
- Before approval	4+1(0)			5
- Approved	4+1(0)			5

Documents (not limited to)	EAN DUSAVIK	EAN YARD	EAN SITE	TOTAL
Inquiry requests				
- General Purchase Conditions	4+1(0)			5
- Requests for Bids	4+1(0)			5
- Requests for Purchases	4+1(0)			5
Bids and Bid Tabulation				
- Acknowledgement of receipt	4+1(0)			5
- Bids	4+1(0)			5
- Bid Tabulations for approval with associated correspondence	6+1(0)			7
- Signed Bid Tabulation	6+1(0)			7
Purchase Orders				
- Purchase Orders and Changes in Orders for signing	4+1(0)			5
- Signed Purchase Orders and Changes in Orders	4+1(0)	1	1	7
- Purchase Order Lists	4+1(0)	2	2	9
- Spare Parts Lists	4+1(0)			5
- Shipping Lists	4+1(0)	2	2	9
Acknowledgement of Receipt of Orders				
Expediting/Inspection				
- Expediting Reports	4+1(0)	1	1	7
- Inspection Reports	4+1(0)	1	1	7
- Procurement Schedule Report	4+1(0)	1	1	7
- Manufacturing Schedules	4+1(0)	1	1	7
- List of Suppliers¯ Subcontractors	4+1(0)	1	1	7
- Test Reports	4+1(0)	1	1	7
- Acceptance Documents	4+1(0)	1	1	7
Invoices	4+1(0)			5
E. Project Control				
Project Schedule	10	1	1	12
Cost Control Report	6	1	1	8
Financial Report	5			5
Monthly Progress Report	10	1	1	12

	Documents (not limited to)	EAN DUSAVIK	EAN YARD	EAN SITE	TOTAL
F.	<u>Manuals</u>				
	Safety Manual	12-1(R)			12+1(R)
	Operating Manual	12-1(R)			12+1(R)
	Maintenance Manual	12+1(R)			12+1(R)
G.	<u>Engineering Dossier</u>	10+1(0)			10+1(0)
H.	<u>All Other Items</u>	5+1(0)			5+1(0)

2.3 ENGINEERING DESIGN

2.3.1 Structural Design

The structural design of TCP-2 Extension Project (Module M50 and Pancake P53) has been founded on the following limitations given by EAN:

1) Decks to be flushed with adjacent decks
2) Length of module to be equal to the adjacent module (M01)
3) Trusswork of module to be equal to adjacent module.
4) Pancake configuration conforms to present temporary pancake.

In addition the design has been based on "TCP-2 EXTENSION PROJECT; STRUCTURAL BASIS OF DESIGN", which contains:

5) 6.3.2 - Steel Structure; Basis of Design
6) SP M/NT No 43 BO A 301 ; Materials for Welded Steel Structures.
7) SP M/NT No 43 BO A 303 ; Fabrication of Steel Structures of Deck Modules

Module M50

Consists of:

- Two longitudinal trusses which are supported each 2 places.
- Lower deck on transverse beams spanning between the trusses.
- Upper deck on transverse beams spanning between the trusses.
- Mezzanine (intermediate) deck which is partly supported on the two trusses and partly by columns to the lower deck
- Sway bracing between the ends of the trusses.

Sway bracings, trusses, lower and upper decks forming a rigid box.

The truss members H-shapes are designed with vertical flanges which correspond to vertical node plates at each side of the nodes.

The node plates form areas with poor access for sandblasting and painting. These areas are therefore sealed by 8 mm plates. Also the support nodes (footings) are sealed areas.

A lifting rig is designed 5 m above upper deck. This rig reduces the amount of offshore work, and it contributes to the overall strength of the module during lifting which is the true design condition.

Lifting rig is temporary and shall be removed after installation.

Pancake P53

Pancake P53 is a pure beam structure with a deck plate on angle stringers which are spanning between primary and secondary beams.

A pipe support rack is located on the Pancake.

A lifting rig is designed to avoid conflicts between lifting slings and equipment. Lifting rig is temporary and shall be removed after installation.

2.3.2 Mechanical Design

The basis of the mechanical design was information obtained from Process Flow Diagrams. All equipment was designed to be exposed to a severe salt water atmosphere, 100% humidity and ambient temperature; - 9°C to 32°C.

All equipment has been designed in strict accordance with:

1) NPD - Regulations for Production and Auxiliary Systems on Production Installations

2) DnV - Technical Notes, Vol. B.

3) Codes and Standards listed below

4) Applicable Job Specifications.

Furthermore a great effort has been made in order to ensure compliance with the design document and to ensure good practice of QC-functions at the vendors in the lack of good working QA/QC systems.

2.3.2.1 Applicable Codes / Standards

Pressure Vessels: BS 5500

Heat Exchangers : BS 5500 and TEMA Class R

Pumps : API 610 with the exceptions mentioned in the Purchase Order

2.3.3 Piping Design

2 3.3.1 Design

The piping design for this project was based upon following codes and standards:

- ANSI / ASME B31.3 - Chemical Plant and Petroleum Refinery Piping (1980 edition)
- ASTM Material Standards
- Material requirements in accordance with the relevant ASTM standard and Det norske Veritas (DnV) "Technical Notes for Fixed Offshore Installations Volume B".

2 3.3.2 Piping Materials

2 3.3.2.1 Piping Materials on TCP-2

Material specification of pipework to be erected on TCP-2 was, to the extent possible, based upon the original "Piping Material Specification No. 2110-50-1" prepared by McDermott-Hudson. Some piping classes in this specification were, however, revised/replaced mainly due to following:

- Specified ASTM standard had been withdrawn (Class EFS)
- Non-existing in McDermott-specification (Class EFT)
- Process calculations showed design pressures allowing a lower flange pressure rating (Class EAT)
- Experienced problems with existing installations (Class EZS - hydraulic fluid)
- Additional corrosion allowance for sea water piping (Class ELS).

2.3.3.2.2 Piping Materials on DP-2

Specification of materials for pipework to be erected on DP-2 was based on original Lummus Engineering Specification No. H.102 rev. 2.

Operating / design pressure for the methanolated water disposal line on DP-2 did not require more than 150 lbs flange rating. However, as some of the existing piping in class D1A (600 lbs) was to be utilized, decision was made to maintain this pressure rating throughout the system.

2.3.3.3 Piping Design Pressure Classes

Pressure Rating	Piping Material	Piping Class	Service
150 lbs	Carbon Steel	A2A, EA, EK, ELS, EU	Drainage, instrument air, plant air, process hydrocarbons, firewater, seawater, utility water, glycol, methanolated water, fuel gas, hydraulic fluid return
150 lbs	Stainless Steel	EAT	Low Temperature Relief System
300 lbs	Carbon Steel	EB	Process hydrocarbons, glycol, low pressure relief.
600 lbs	Carbon Steel	D1A, ECX	Methanolated water, high pressure relief
1500 lbs	Carbon Steel	EFS	Process hydrocarbon gas, H.P. methanol, process drains, fuel gas, condensate / methanolated water
1500 lbs	Stainless Steel	EFT	Hydrocarbon gas to relief
* 2300 lbs	Stainless Steel	EZS	Hydraulic fluid

* Design Pressure

2.3.3.4 Piping Stress Analysis

The major high pressure gas process lines and the entire low temperature relief system have been stress calculated utilizing a computer program for flexibility analysis.

2.3.4 Electrical Design

2.3.4.1 Motor Control Centre MCC

The 380 volt motor control centre for TCP-2 Extension is located in main substation M32.

The two existing TCP-2 Compression MCCs S.52.32.3.3 and S.52.32.2.3 are extended with two new switchboards delivered from National Elektro.

Each switchboard is split into two sections, "A" and "B"-sides. The interconnection between existing TCP-2 Compression MCC and new MCC extension is by an air circuit breaker rated at 1600 amps.

The following is a list of consumers for each switchboard.

S.52.32.3.3 MCC "A" Ext.

CP 220 A	TEG Circulation Pump
CP 220 C	TEG Circulation Pump
CP 222 A	Methanolated Water Injection Pump
CP 224	Methanolated Water Drainage Pump
W14	Welding Socket.

S.52.32.2.3 MCC "B" Ext.

CP 220 B	TEG Circulation Pump
CP 222 B	Methanolated Water Injection Pumps
W15	Welding Socket
DB 321	Normal Lighting Panel.

2.3.4.2 Lighting Distribution Board "DB"

There are two types of lighting DBs. Both are located in TCP-2 Treatment cabling room P08. The cabinet is of normal industrial type. Manufactor ELDON IP 55. The cabinet is equipped with Merlin Gerin fuses.

Normal Lighting

The normal lighting distribution board DB 321 is fed from new TCP-2 Extension S.52.32.2.3 MCC. The fluorescent fixture is normal outdoor type IFA Ex (e).

Maintained Lighting

The new TCP-2 Extension emergency lighting DB 322 is supplied from the existing TCP-2 Treatment DB 308, a distribution board connected to the emergency power system. The lighting fixture is manufactured by IFA Ex (e).

2.3.4.3 Power Distribution Board "DB"

There are two types of power distribution boards. Both are located in TCP-2 Treatment interface room P13. The cabinet is of normal industrial type. Manufactor ELDON IP 55. The cabinet is equipped with Merlin Gerin contr. fuses.

Emergency Supply

The emergency supply cabinet DB 324, supplies the instrument and fire & gas system with 24 V DC. DB 324 is supplied from the existing TCP-2 Treatment DB 310 maintained instrument supply.

No Break

The no break cabinet DB 323 is fed from the TCP-2 Compression no break system in PC 44 S.53.44.3.9 interface room P13. This cabinet DB 323 feeds the instrument fire and gas, telemetry and zener barrier rack with 220V AC.

2.3.4.4 Trace Heating

The trace heating cabinet DB 316 is located in the cabling room P08. Each outgoing circuit is going directly to a marshalling box and then splitted to each different heating cable. Phyretenox heating cable is used.

2.3.4.5 Hazardious Areas

The two modules for TCP-2 Extension, M50 and P53 are classified as Division 2 area.

2.3.4.6 Design

The design of electrical drawings and calculations is executed according to EAN standard, specification and integrated drawings.

2.3.5 Instrument Design

2.3.5.1 Instrument Installation M50 & P53

The instrument installation on TCP-2 extension comprises following functions:

1) Process Control & Monitoring
2) Emergency Shut Down & Process Safety System
3) Fire Detection & Protection Safety System
4) Public Address System

2.3.5.2 Process Control & Monitoring

The process control is based mainly upon local control loops except for gas flow through gas metering system where the set point can be remote controlled from central control room, (CCR) on QP platform. All control loops and various other parametres are monitored on mimic panel which is part of main control panel installed in CCR. Both local and remote recorders in main control panel are used.

Ref. (Appendix 3):

FF 88 00 00 5030	ODIN Gas Treatment
FF 88 00 00 5031	NEF Gas Treatment
FF 88 00 11 5032	NEF and ODIN Liquid Treatment Condensate Separation
FF 88 00 10 5033	NEF and ODIN Liquid Treatment Methanolated water
FF 88 00 00 5034	NEF and ODIN Liquid Treatment TEG and MW Facilities
FF 88 00 09 5036	NEF and ODIN Treatment Methanol Injection
FF 88 00 04 5090	NEF and ODIN Treatment Flare System
FF 88 00 10 5100	NEF and ODIN Treatment Process Drainage System
FF 83 00 54 5101	NEF and ODIN Liquid Treatment Methanolated Water Injection on DP-2.

2.3.5.3 ESD and Process Safety

The ESD system is split in five different levels of which 4th and 5th levels are considered as process safety system.

1st level is field shut down with isolation of platforms.

2nd level shut down for TCP-2 is total shut down and also decompression of bridge and treatment lines.

3rd level is process shut down and this level can also be released by fire or gas detection system.

4th and 5th levels are process safety and shuts down either one production stream or part of the stream.

Ref.:

S-FF 88 16 08 9521	Description of Process Safety System
S-FF 88 16 9520	Functional Description of the ESD System
FE 00 16 00 5801	Frigg Field Shut Down General Logic Diagram
FF 88 16 08 9557	Shut Down Detail Logic Diagram

2.3.5.4 Fire and Gas, Public Address System

The fire detection system consists of UV flame detectors, smoke detectors and manual fire alarm buttons.

A fire control panel is installed in the interface room in P13.

Action is either fire alarm or 3rd level shut down release of deluge system depending of activation of sensors/pushbuttons. Operation of a push button will cause fire alarm, 3rd level shut down and release of deluge system in affected area. Activation of one UV detector or smoke detector will cause fire alarm whilst activation of two sensors in coincidence will cause 3rd level shut down and release of deluge in affected area.

Eight loudspeakers are installed in Module M50, 4 on upper and 4 on lower level. 2 loudspeakers are installed on P53. These are integrated in the existing PA system.

Ref.:

S-FF 88 16 9620	Description of Fire Detection System
S-FF 88 16 9720	Description of Gas Detection System
S-FF 88 16 9820	Description of Public Address and Alarm System

2.3.6 Safety / Loss Prevention

2.3.6.1 Area Classification

As for the rest of the Frigg Field the IP Model Code of Safe Practice, part 1 of 1965 with supplement and part 8 of 1972, is the basis for the area classification.

Definitions and classification of types of release and zones are based upon "Provisional Regulations for Electrical Installations in Explosive Areas", communications 1/77 from the Norwegian Water Resources and Electricity Board, NVE.

Reference is made to the following drawings:

FE 85 23 00 0020	Area Classification Upper Deck
FE 85 23 00 0021	Area Classification Main Oeck
FE 85 23 00 0022	Area Classification Cellar Deck
FE 85 23 00 0023	Area Classification East and South Elevations
FE 85 23 00 0024	Area Classification West and North Elevations.

2.3.6.2 Escape Routes

Escape routes are in accordance with Norwegian Petroleum Directorate (NPD) regulations.

2.3.6.3 Firewater System

The firewater systems for M50 and P53 are supplied from and integrated into the existing firewater network on TCP-2. Both M50 and P53 have interconnected dual supply from Treatment Area and Compression Area.

Firewater spray system capacity and coverage is in accordance with regulations laid down by NPD:

Process area	10 l/min^2
Surface of pressure vessels and tasks containing combustibles	10 l/min^2

The deluge/spray system is designed in accordance with NFPA 15.

2.3.6.4 Fire Fighting Equipment

Folllowing firefighting equipment is installed:

M50:

2 Firewater Hose Reels

2 Firewater Hose Reels connected to AFFF Foam Tank

2 Wash Down Hose Reels

4 Firewater Monitor with 2 1/2" NOR Lock Hydrant

P53:

1 Firewater Hose Reel

1 Firewater Hose Reel connected to AFFF Foam Tank

1 Wash Down Hose Reel

2 Fire Monitor with 2 1/2" NOR Lock Hydrant.

3 NEF - ELECTRICAL POWER SUPPLY

3.1 GENERAL DESCRIPTION OF NEF POWER SUPPLY INSTALLATION

The North East Frigg facilities are linked to the TCP-2 Frigg Field platform via a 16" gas line, a 1 1/4" hydrate inhibitor (methanol) supply line and an electric power/signal supply cable which provides the FCS with both electrical power and remote control signals. Control signals are also transmitted through a radio link system.

The electrical sub sea cable between TCP-2 Frigg Field and FCS at North East Frigg is 18 km long. The penetration of the sub sea cable into the TCP-2 platform is through the J5-tube in Column 5. The length of the J5-tube is 150 m, the bending radius is 30 m and it contains four plastic tubes. One of these is used for the 1 1/4" hydrate inhibitor supply and one for the sub sea cable. On top of the J5-tube inside Column 5 a hang off table is installed, in which the sub sea cable has its anchor point.

Just a few meters above the anchor point the sub sea cable is spliced to the emerged power cable and the emerged signal cable. The emerged power cable and the emerged signal cable are running in parallel on the 12kV high voltage cable ladder to the 12kV high voltage room in Module 32.

From the anchor point and up to el. 99.000 the tray is running up inside column 5. From el. 99.000 to el. 101.000 a solide pipe is installed to protect the cables. After rising from el. 101.000 the cable tray bends into el. 104.000. When entering PC 43 the tray rises to el. 106.000. After turning north in PC 43 the tray rises to el. 107.400 to avoid pipes and crossing beams. The tray continues in this elevation through PC 45 till it rises into the 12kV high voltage room Module 32.

The 12kV high voltage cable ladder is of stainless steel, 300 mm wide and covered all the way in order to protect the 12kV high voltage cable. To meet the requirements of EAN regulations of full insulation between racks/trays of stainless steel and supports of mild steel, P.V.C. shims are used.

The 12kV high voltage room in Module 32 was formerly a workshop. To meet the requirements of NPD regulations for high voltage rooms, the following structural and HVAC tasks have been executed. An air lock is built in connection with existing entry in west end of the room. A wire mesh-wall with door is installed by the staircase. A sliding door is replaced with a bolted panel with emergency exit - door. The drain has been moved and relocated under the HVAC unit. Further a steel plate is mounted under the three water pipes which are crossing the 12kV high voltage room.

The ventilation system in the 12 kV high voltage room comprises a new moisture eliminator, new fine filter, new sparkproof fan, heater, ductwork, new purging fan and accessories necessary to supply the sufficient amount of air, approximately 8000 m^3/hr, to the H.V. room. In order to maintain an internal pressure of 6 mm WG above ambient, fresh air is drawn in from outside safe area. To remove moisture and entrained salt/dirt particles, the air is passed through a three stage moisture eliminator system, and through a centrifugal fan. In the H.V. room the air passes across 40 kW electric air heater. Via a rigid galvanized ductwork system the air is delivered to the H.V. room. Exhaust air is relieved to outside via a modulating fire damper, maintaining the area over pressure via an extract purging fan - not working under normal conditions.

The system will run automatically under normal platform operating conditions, and will shut down under ESD closure or by manual stop. After an emergency shut down, the H.V. room will be purged by the same system.

During purging the electric heater will be isolated and the extract purging fan will be working (approx. 5000 m^3/hr). The modulating fire damper will be kept fully open.

In the 12 kV high voltage room a cast resin power transformer and a 12 kV switchgear are installed. The transformer is fabricated at Asea Lepper works in Brilon, West Germany, and its power rating is 630 kVA, voltage rating 5,5/12kV + 2 x 2.5 %, frequency 50 Hz, Vector group Dyn II and protective housing IP 23. The transformer is fitted with devices for service earthing on both the primary and secondary side, by fixed lockable earthing switches. The neutral point of the secondary winding is connected directly to earth. A two - core transformer 30/1/1A is fitted in the neutral inside the housing, one core rated 10 VA and CL.5 and the other core rated 10 CA CL.1.

The 12 kV switchgear is fabricated at the Merlin Gerin works in Grenoble, France, and consists of one voltage transformer cubicle and one drawout circuit - breaker cubicle. Voltage transformers are mounted in the voltage transformer cubicle. A 630A SF6 circuit breaker, current transformers, equipment for protection, measure, control etc. are located in the circuit - breaker cubicle. Both cubicles have incomming and outgoing cables from below.

A drawout truck comprising a 400 A vacuum contactor and 350 A HCR fuses, manufactured at the G.E.C. works in Rugby, England, is installed in a spare 5,5 kV switchgear cubicle, tagged VC 622, in existing 5,5 kV high voltage room module 32. Voltage and current transformers, equipment for measure, protection, control etc., circuit earthing switch and space heaters are mounted in the cubicle.

From VC 622 to the 630 kVA transformer a 3 x 120 mm^2 6 kV cable is installed on existing high voltage cable trays. All supply, control, heating, measurement and alarm cables in connection with the NEF power project are mainly clamped on existing trays, except under Module 32, where new low voltage cable trays are installed.

The electrical control board on mezzanine in MCC room, Pancake 08 on TCP-2 Treatment, is extended to display the mimic diagram of NEF Power Supply. The NEF mimic panel is manufactured at the Setram works in Salies - du - Salat, France, and fixed to the existing mimic panel's right side (front viewed). The length of extension panel is 72 cm. A new NEF alarm annunciator panel is mounted on the existing mimic panel to give alarm signals from NEF via a radio link system.

In the 12 kV high voltage room a signal isolation cabinet is installed. The purpose of this is to segregate high voltage from the signal circuit.

A signal cable is routed from the signal isolation cabinet via TP-1 platform to the central control room on QP platform.

The utility panel in central control room on QP platform is modified and shows the mimic diagram for the power supply to North East Frigg facilities.

3.2 DESIGN PHILOSPHY

The electrical power supply from TCP-2 platform to the FCS on the NEF Field is the main power supply source for the FCS.

This is the first known high voltage power distribution plant via a combined power and signal cable over a relative long distance of 18 km. A lot of different calculations and investigations have been performed in order to ensure as high as possible reliability both for the power supply and the signal transmission line. As an example of calculation performed, it could be mentioned; a dynamical electrical network analysis for the whole Frigg Field. The calculation has been performed by EFI - the Norwegian Research Institute for Electricity Supply in Trondheim.

This analysis cover the following aspects:

- Short circuit levels in the network.
- Dynamical behaviour of the network due to short circuits and motorstarting on different platforms.
- Dynamical stability of the network. (Small signal disturbances)

As an example of investigations, an overharmonic rippel current measurement and a study regarding an eventual installation of a special harmonics filter in case of disturbances on signal transmission line, could be mentioned.

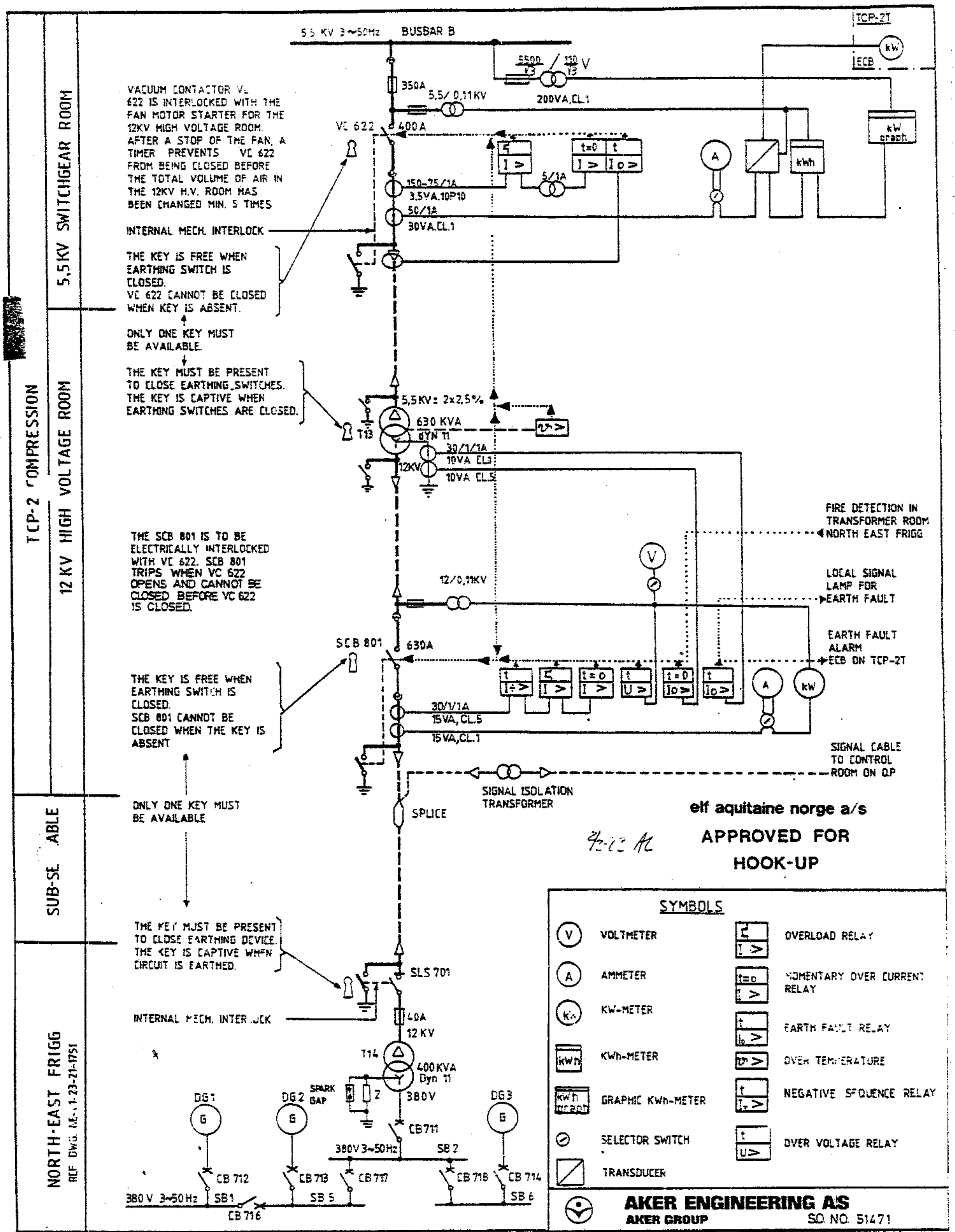
The choice of equipment such as the transformer, switchgear and other electrical equipment have been based upon well known design and references within the offshore industry. The high voltage equipment protection devices and settings have been selected in such a way that in case of a fault in the system, the fault shall be islanded without any interruption of other parts of the network.

For more detailed information concerning how the system is built up and tied into existing electrical network on TCP-2 the one line diagram - FF 88 23 03 0001 (Figure 1.17).

FIGURE 1.17

Drawing No.: FF 88 23 03 0001

NEF Power Supply One Line Diagram



VACUUM CONTACTOR VC 622 IS INTERLOCKED WITH THE FAN MOTOR STARTER FOR THE 12KV HIGH VOLTAGE ROOM. AFTER A STOP OF THE FAN, A TIMER PREVENTS VC 622 FROM BEING CLOSED BEFORE THE TOTAL VOLUME OF AIR IN THE 12KV H.V. ROOM HAS BEEN CHANGED MIN. 5 TIMES

INTERNAL MECH. INTERLOCK

THE KEY IS FREE WHEN EARTHING SWITCH IS CLOSED.
VC 622 CANNOT BE CLOSED WHEN KEY IS ABSENT.

ONLY ONE KEY MUST BE AVAILABLE.

THE KEY MUST BE PRESENT TO CLOSE EARTHING SWITCHES. THE KEY IS CAPTIVE WHEN EARTHING SWITCHES ARE CLOSED.

THE SCB 801 IS TO BE ELECTRICALLY INTERLOCKED WITH VC 622. SCB 801 TRIPS WHEN VC 622 OPENS AND CANNOT BE CLOSED BEFORE VC 622 IS CLOSED.

FIRE DETECTION IN TRANSFORMER ROOM NORTH EAST FRIGG

LOCAL SIGNAL LAMP FOR EARTH FAULT

EARTH FAULT ALARM ECB ON TCP-2T

THE KEY IS FREE WHEN EARTHING SWITCH IS CLOSED.
SCB 801 CANNOT BE CLOSED WHEN THE KEY IS ABSENT

SIGNAL CABLE TO CONTROL ROOM ON QP

ONLY ONE KEY MUST BE AVAILABLE

THE KEY MUST BE PRESENT TO CLOSE EARTHING DEVICE. THE KEY IS CAPTIVE WHEN CIRCUIT IS EARTHED.

INTERNAL MECH. INTERLOCK

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APPROVED FOR

HOOK-UP

4-12 AL

SYMBOLS

(V)	VOLTMETER	⌐ I >	OVERLOAD RELAY
(A)	AMMETER	t=0 I >	MOMENTARY OVER CURRENT RELAY
(kW)	KW-METER	t Io >	EARTH FAULT RELAY
kWh	KWh-METER	ϑ >	OVER TEMPERATURE
kWh graph	GRAPHIC KWh-METER	t I÷ >	NEGATIVE SEQUENCE RELAY
⊘	SELECTOR SWITCH	t U>	OVER VOLTAGE RELAY
⧄	TRANSDUCER		

AKER ENGINEERING A/S
AKER GROUP
SO. NO. 51471

Rev	Date	DESCRIPTION	by	app
3	12-01-83	VENDOR COMMENTS INCORPORATED	HF	TM
5	24.05.83	APPROVED FOR HOOK UP		
4	24.05.83	VENDOR COMMENTS INCORPORATED	HF	TM
0	25-05-82	First issue	TM	DH

Contractor

elf
aquitaine
norge a/s
P.O. Box 168
4001 Stavanger

elf

FRIGG FIELD

Job no F089/02
Scale
Dwg. no FF 88 - 23 - 03 - 0001

Installation TCP-2
System ELECTRICAL
NEF- POWER SUPPLY
ONE LINE DIAGRAM

Rev. 5
Sheet 1 1

APPENDIX 1

NEF GAS COMPOSITION, RESERVOIR PRESSURE AND PRODUCTION PROFILE

NEF GAS COMPOSITION, RESERVOIR PRESSURE AND PRODUCTION PROFILE

GAS COMPOSITION NEF

COMPONENT	MOLE %
N 2	.6682
CO2	.3010
C1	94.2498
C2	4.6479
C3	.0722
iC4	.0099
nC4	.0100
iC5	.0001
nC5	.0002
C6	.0012
C7	.0058
C8	.0082
C9	.0083
C10	.0073
C11	.0043
C12	.0028
C13	.0013
C14	.0007
C15	.0003
C16+	.0005

NORTH EAST FRIGG

Hypothesis: With water drive

Date	Static Bottom Pressure (bar a)	Well Head Flowing Pressure (bar a)	Average Daily Quantity (MSm3/D)	Design Flow Rate (MSm3/D)	Minimum Delivery Pressure on TCP2 (bar a)
01.01.1984	176.8	146	5.78	7.0	136.
30.09.1984	168	138	5.78	7.0	128.
" 1985	155	129	5.78	7.0	119.
" 1986	144	121	5.40	6.5	111.
" 1987	136	114	5.04	6.1	105.
" 1988	128	108	4.00	4.8	101.

NORTH EAST FRIGG

Hypothesis: Without water drive

Date	Static Bottom Pressure (bar a)	Well Head Flowing Pressure (bar a)	Average Daily Quantity (MSm3/D)	Design Flow Rate (MSm3/D)	Minimum Delivery Pressure on TCP2 (bar a)
30.09.1984	160	129.5	6.38	7.7	115.
" 1985	133	106	6.1	7.3	93.
" 1986	107	86	5.08	6.1	76.
" 1987	88	70	4.2	5.0	61.
" 1988	70	56	3.44	4.1	48.
" 1989	58	45	2.86	3.4	37.
" 1990	46	35	2.36	2.8	30.
" 1991	37	28	1.92	2.3	23.
" 1992	30	22	1.6	1.9	18.
" 1993	24	18	1.3	1.6	14.

APPENDIX 2

ODIN GAS COMPOSITION, RESERVOIR PRESSURE AND PRODUCTION PROFILE

ODIN GAS COMPOSITION, RESERVOIR PRESSURE AND PRODUCTION PROFILE

GAS COMPOSITION ODIN

COMPONENT	MOLE %
N 2	.92
CO2	.24
C1	94.81
C2	3.85
C3	.06
iC4	.01
nC4	.02
iC5	.02
nC5	.02
C6+	C6+ .05

ODIN

Hypothesis: With water drive

Date	Static Bottom Pressure (bar a)	Well Head Flowing Pressure (bar a)	Average Daily Quantity (MSm3/D)	Design Flow Rate (MSm3/D)	Minimum Delivery Pressure on TCP2 (bar a)
01.01.1985	171.5	147	10.19	11.2	137.
30.09.1985	156	133	10.19	11.2	123.
" 1986	142	123	10.19	11.2	110.
" 1987	131	111	10.19	11.2	101.
" 1988	121	104	9.28	10.2	95.
" 1989	114	99	7.08	7.8	92.
" 1990	110	96	5.29	5.8	91.
" 1991	109	94	4.10	4.5	90.
" 1992	109	93	3.28	3.6	90.
" 1993	109	92	2.89	3.2	90.

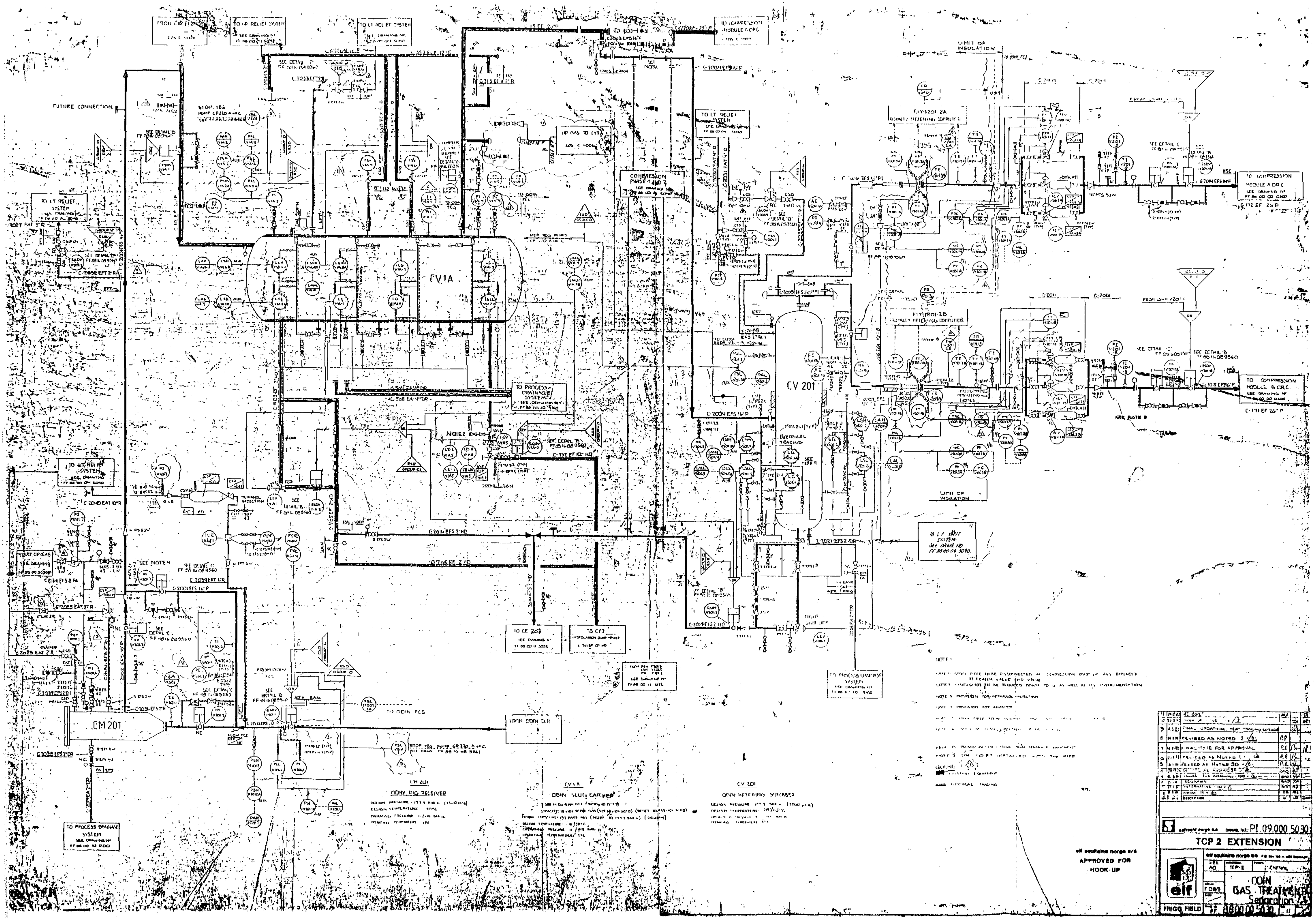
ODIN

Hypothesis: Without water drive

Date	Static Bottom Pressure (bar a)	Average Daily Quantity (MSm3/D)	Design Flow Rate (MSm3/D)	Minimum Delivery Pressure on TCP2 (bar a)
01.01.1985	183	10.19	11.2	149.
30.09.1985	160	10.19	11.2	128.5
" 1986	130	10.19	11.2	101.5
" 1987	107	10.19	11.2	69.
" 1988	85	9.28	10.2	50.
" 1989	64	7.08	7.8	38.
" 1990	48	5.29	5.8	28.
" 1991	32	4.10	4.5	19.5
" 1992	28	3.28	3.6	13.
" 1993	25	2.89	3.2	11.

APPENDIX 3

PROCESS FLOW DIAGRAMS



CM 201

ODIN PIG RECEIVER

DESIGN PRESSURE 177.5 BAR G (2500 psig)
DESIGN TEMPERATURE 50°C
OPERATING PRESSURE [illegible] BAR G
OPERATING TEMPERATURE [illegible]

CV 1A

ODIN SLUG CATCHER

[illegible]
CAPACITY [illegible] (RESET [illegible])
DESIGN PRESSURE [illegible] BAR G (RESET [illegible]) (2500 psig)
DESIGN TEMPERATURE [illegible]
OPERATING PRESSURE [illegible] BAR G
OPERATING TEMPERATURE [illegible]

CV 201

ODIN METERING SCRUBBER

DESIGN PRESSURE 177.5 BAR G (2500 psig)
DESIGN TEMPERATURE -28/+50°C
OPERATING PRESSURE [illegible] BAR G
OPERATING TEMPERATURE [illegible]

NOTES

NOTE 1 SPOOL PIECE TO BE DISCONNECTED AT COMPRESSION START UP AND REPLACED BY A CHECK VALVE AND VALVE

NOTE 2 LINE C-2108 TO BE REDUCED DOWN TO [illegible] AS WELL AS ITS INSTRUMENTATION

NOTE 3 PROVISION FOR METHANOL INJECTION

NOTE 4 PROVISION FOR INHIBITOR

NOTE 5 SPOOL PIECE TO BE [illegible]

NOTE 6 [illegible]

NOTE 8 [illegible]

NOTE 9 [illegible] TO BE INSTALLED [illegible] THE PIPE

LEGEND

▮ EXISTING EQUIPMENT

ELECTRICAL TRACING

11	[illegible]	AS BUILT			
10	[illegible]	[illegible]			
9	4.5.82	FINAL UPDATING, HEAT TRACING EXTENDED			
8	[illegible]	REVISED AS NOTED 2	P.R.		
7	[illegible]	FINAL ISSUE FOR APPROVAL	P.R.		
6	[illegible]	REVISED AS NOTED	P.R.		
5	[illegible]	REVISED AS NOTED 30	P.R.		
4	[illegible]	REVISED AS NOTED			
3	[illegible]	ISSUED FOR APPROVAL 100			
2	[illegible]	REDRAWN			
1	[illegible]	INTERPRETIVE			
0	[illegible]	[illegible]			
REV	DATE	DESCRIPTION			

elf aquitaine norge a/s
APPROVED FOR HOOK-UP

eufrasid norge a.s DRWG. NO.: PI.09.000 5030

TCP 2 EXTENSION

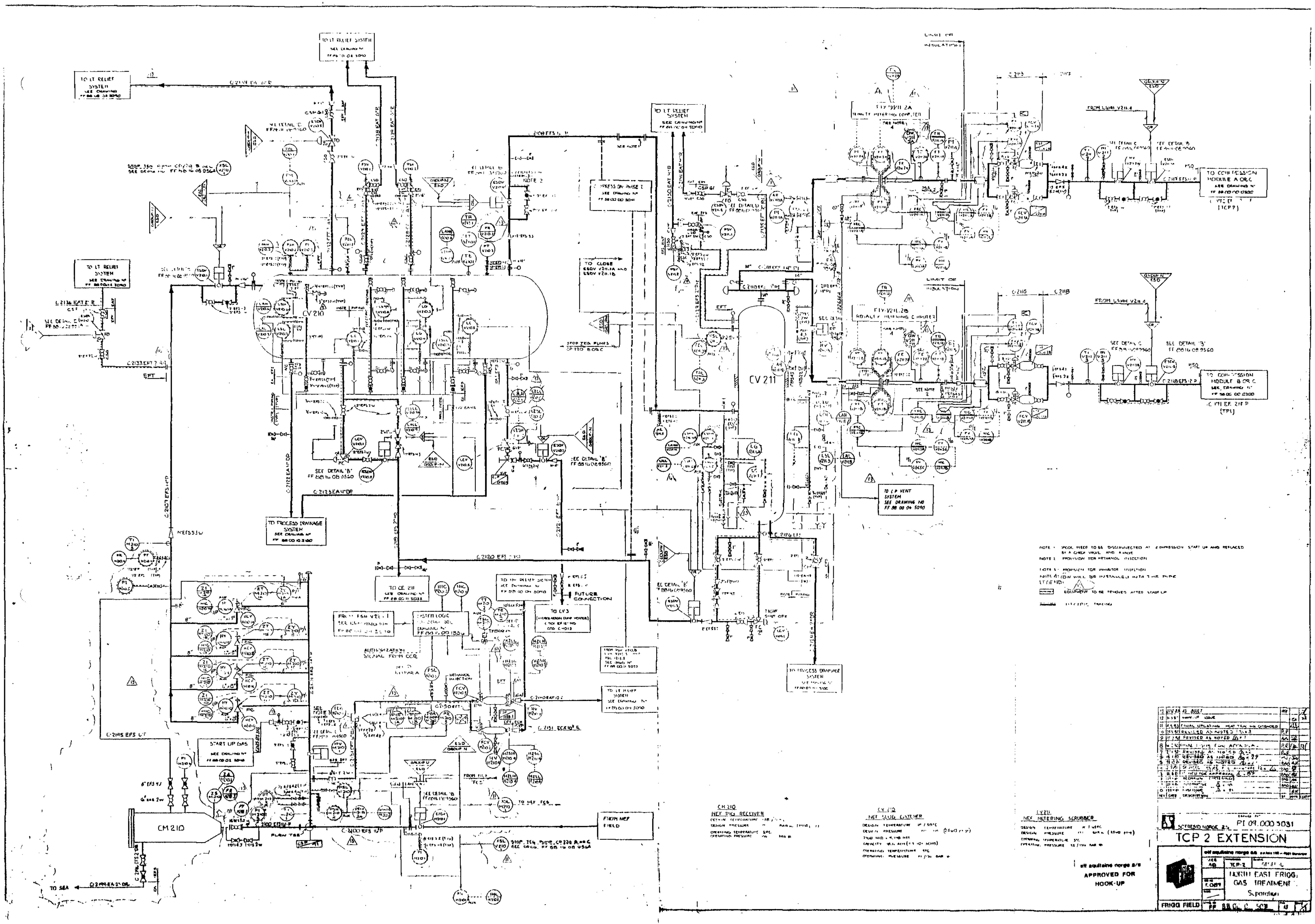
elf aquitaine norge a.s

AO | TCP-2 | GENERAL

F 087

ODIN GAS TREATMENT Separation

FRIGG FIELD FF 88 00 00 5030 11



NOTE 1 SPOOL PIECE TO BE DISCONNECTED AT COMPRESSION START UP AND REPLACED BY A CHECK VALVE AND A VALVE

NOTE 2 PROVISION FOR METHANOL INJECTION

NOTE 3 PROVISION FOR INHIBITOR INJECTION

NOTE 4 FOW WILL BE INSTALLED INTO THE PIPE

LEGEND:

▭ EQUIPMENT TO BE REMOVED AFTER START UP

ELECTRIC TRACING

CM 210
NEF PIG RECEIVER
DESIGN TEMPERATURE
DESIGN PRESSURE
OPERATING TEMPERATURE 5ºC
OPERATING PRESSURE

CV 210
NEF SLUG CATCHER
DESIGN TEMPERATURE
DESIGN PRESSURE
OPERATING TEMPERATURE 5ºC
OPERATING PRESSURE

CV 211
NEF METERING SCRUBBER
DESIGN TEMPERATURE
DESIGN PRESSURE
OPERATING TEMPERATURE 5ºC
OPERATING PRESSURE

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PI 09.000 5031

TCP 2 EXTENSION

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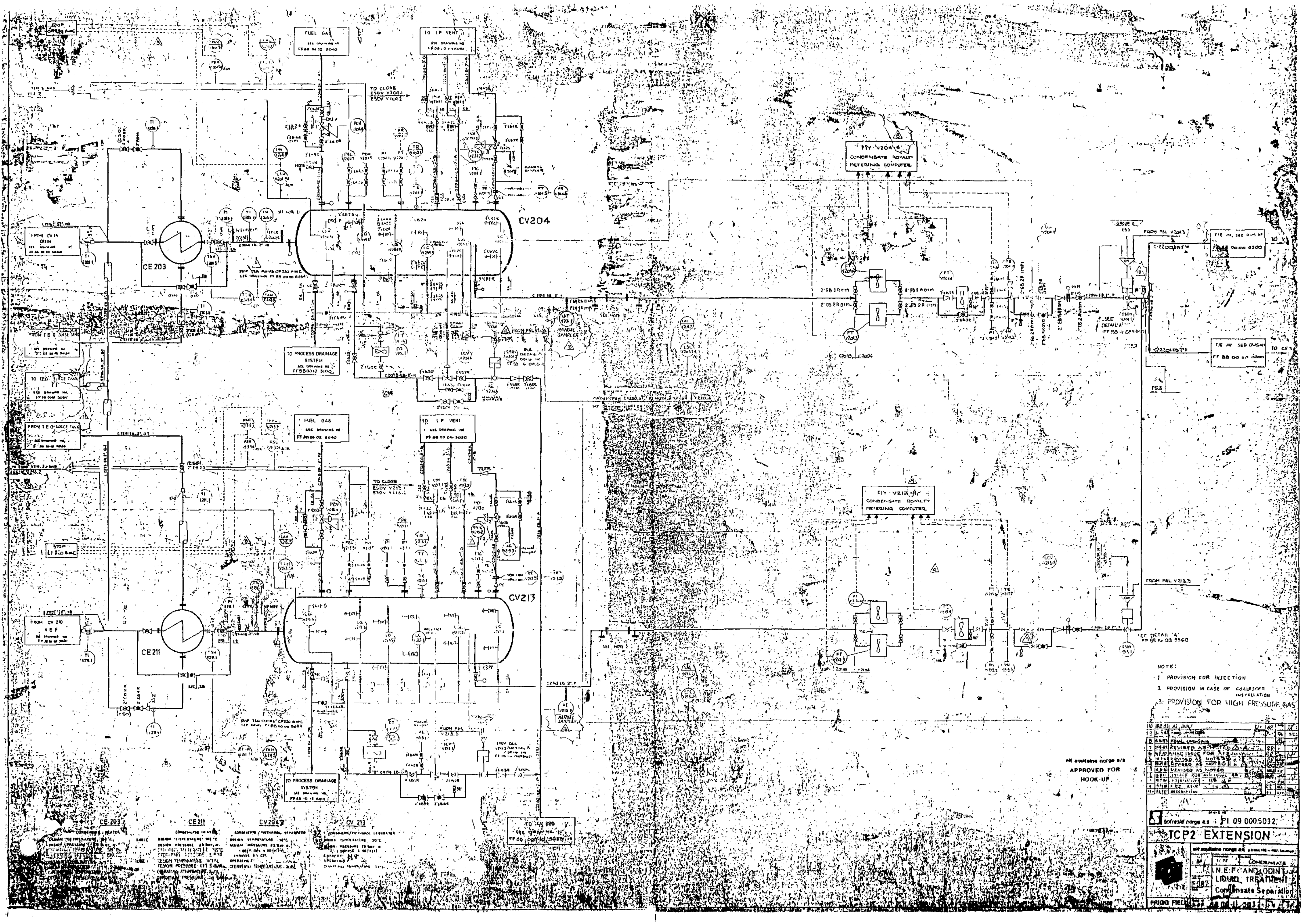
AQ
TCP-2
NORTH EAST FRIGG:
GAS TREATMENT
Separation
F.089
FRIGG FIELD
FF 88 C C 5031



NOTE:

1. PROVISION FOR INJECTION
2. PROVISION IN CASE OF COALESCER INSTALLATION
3. PROVISION FOR HIGH PRESSURE GAS

10		AS BUILT			
9					
8		FINAL UPDATING			
7		REVISED AS NOTED			
6		FINAL ISSUE FOR APPROVAL			
5		REVISED AS NOTED			
4		REVISED AS NOTED			
3		REVISED AS NOTED			
2		ISSUED FOR APPROVAL			
1					
0		FIRST ISSUE			
REV	DATE	DESCRIPTION		BY	APP

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PI. 09 0005032

TCP2 EXTENSION

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CONDENSATE

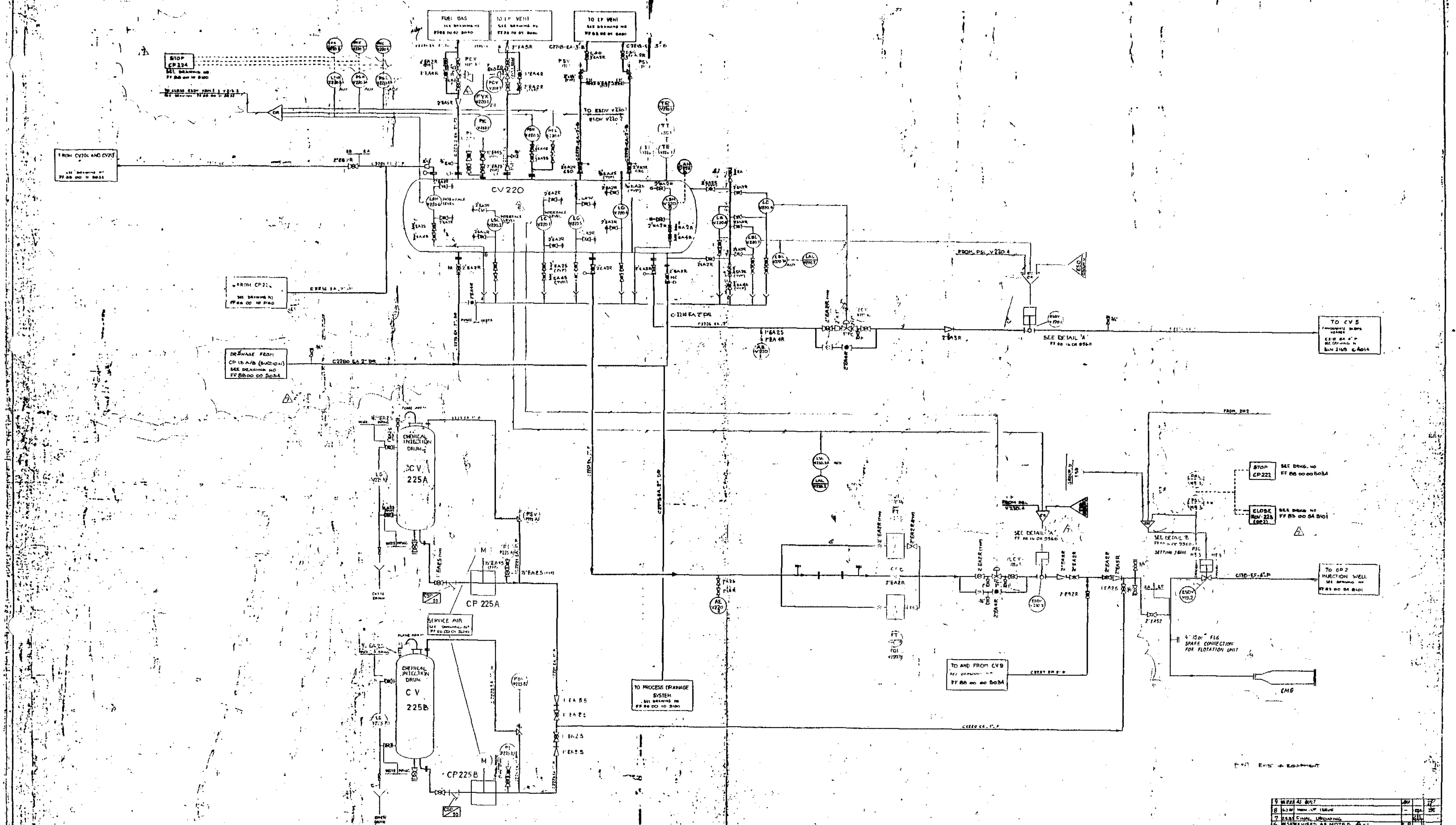
N.E.F. AND ODIN

LIQUID TREATMENT

Condensate Separation

E087

FRIGG FIELD 88 00 11 5032



Exist in equipment

CV 220

METHANOLATED WATER FLASH DRUM
DESIGN TEMPERATURE 90°C
DESIGN PRESSURE 16.2 BAR A
0.9 (H-ID) × 3.3 (HTT)
CAPACITY 3.05 CM
OPERATING PRESSURE : 10 BAR A
OPERATING TEMPERATURE : 20°C

CV 225 A

CHEMICAL INJECTION DRUM
DESIGN TEMPERATURE 50°C
DESIGN PRESSURE 1.4 Bar a
0.8 (H-ID) × 6 (HTT)
CAPACITY 1530 LITERS
OPERATING PRESSURE : ATM
OPERATING TEMPERATURE 20°C

CV 225 B

CHEMICAL INJECTION DRUM
DESIGN TEMPERATURE 50°C
DESIGN PRESSURE 9 BAR A
2.6 (H-ID) × 2.6 (HTT)
CAPACITY 53L LITERS
OPERATING PRESSURE : ATM
OPERATING TEMPERATURE 20°C

CP 225 A

INHIBITOR PUMP
DESIGN TEMPERATURE 30°C
DESIGN PRESSURE 16 Bar a
OPERATING PRESSURE : 10 BAR
OPERATING TEMPERATURE : 20

CP 225 B

INHIBITOR PUMP
DESIGN TEMPERATURE 30°C
DESIGN PRESSURE 16 Bar a
OPERATING PRESSURE : 10 BAR G
OPERATING TEMPERATURE 20°C

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HOOK-UP

REV	DATE	DESCRIPTION	BY	APP	
9	[illegible]	AS BUILT	[illegible]		
8	[illegible]	[illegible] OF ISSUE	–	[illegible]	[illegible]
7	[illegible]	FINAL UPDATING		[illegible]	
6	[illegible]	REVISED AS NOTED ⚠ ×1	[illegible]		
5	[illegible]	FINAL ISSUE FOR APPROVAL	[illegible]	[illegible]	[illegible]
4	[illegible]	REVISED AS NOTED ⚠	HJ	[illegible]	
3	[illegible]	REVISED AS NOTED ⚠	[illegible]	[illegible]	
2	[illegible]	REVISED AS NOTED ⚠	[illegible]	[illegible]	
1	[illegible]	ISSUED FOR APR T/AL 55 ⚠	[illegible]	[illegible]	
0	[illegible]	FIRST ISSUE ⚠	[illegible]	[illegible]	

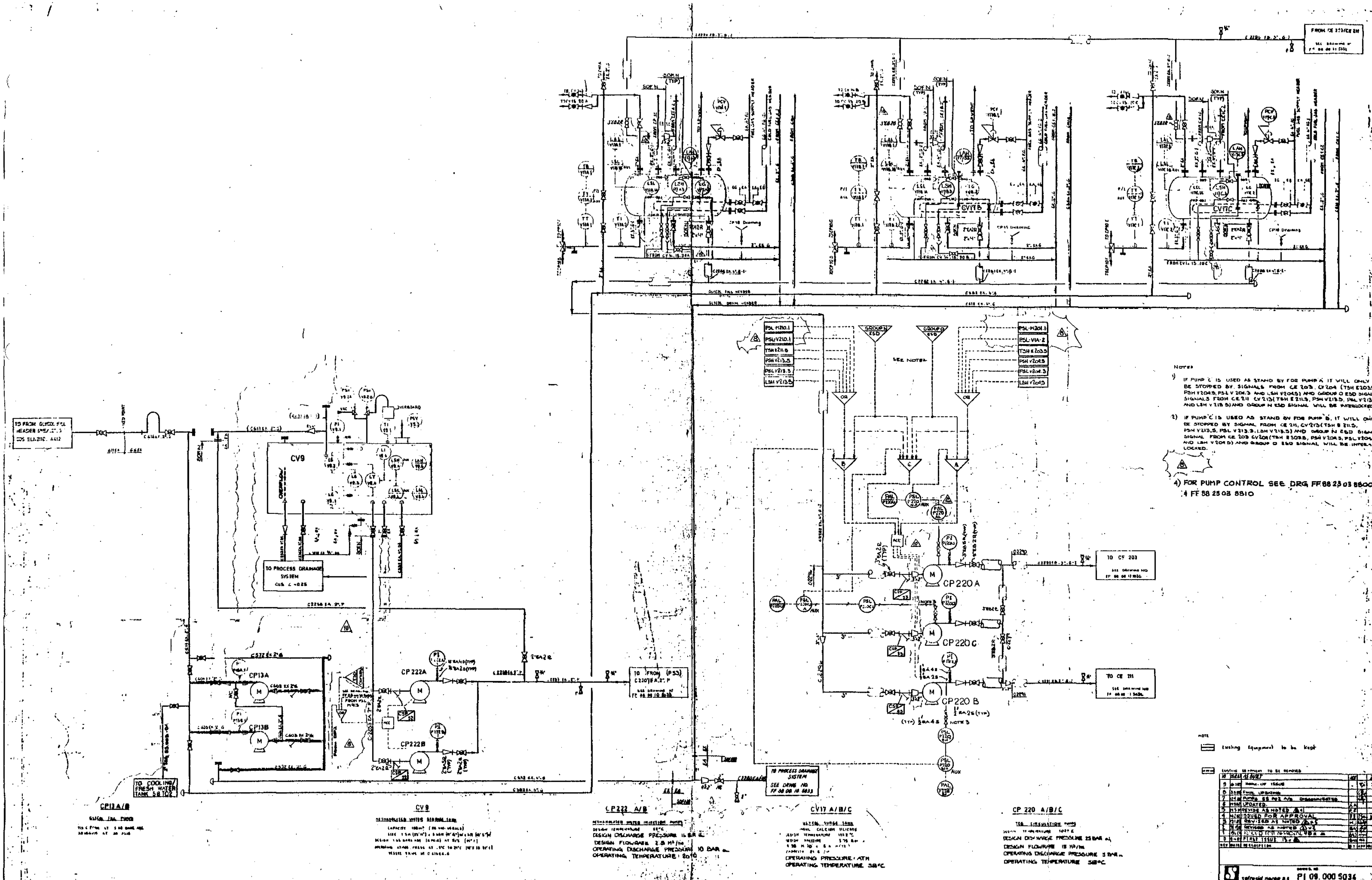
solresid norge a.s P1.09.000.5033.

TCP2 EXTENSION

elf aquitaine norge a.s

SITE		
AO	TCP-2	METHANOLATED WATER
F087	NEF AND ODIN LIQUID TREATMENT Methanolated water	

FRIGG FIELD FF 88 00 10 5033 1



Notes

1) IF PUMP C IS USED AS STAND BY FOR PUMP A IT WILL ONLY BE STOPPED BY SIGNALS FROM CE 203, CV204 (TSH E203.5, PSH V204.5, PSL V 204.3 AND LSH V204.5) AND GROUP O ESD SIGNAL. SIGNALS FROM CE 211 CV213 (TSH E 211.5, PSH V213.5, PSL V213.3 AND LSH V 213.5) AND GROUP N ESD SIGNAL WILL BE INTERLOCKED.

2) IF PUMP C IS USED AS STAND BY FOR PUMP B, IT WILL ONLY BE STOPPED BY SIGNAL FROM CE 211, CV213 (TSH E 211.5, PSH V213.5, PSL V 213.3, LSH V213.5) AND GROUP N ESD SIGNAL. SIGNAL FROM CE 203 CV204 (TSH E203.5, PSH V204.5, PSL V204.3 AND LSH V204.5) AND GROUP O ESD SIGNAL WILL BE INTERLOCKED.

4) FOR PUMP CONTROL SEE DRG FF 88 23 03 8800 & FF 88 25 08 8810

NOTE

▭ Existing Equipment to be kept

▭ Existing equipment to be removed

REV	DATE	DESCRIPTION	BY	APP	
10		AS BUILT			
9		HOOK-UP ISSUE			
8		FINAL UPDATING			
7		PUMPS 88 P02 A/B DISCONNECTED			
6		UPDATED.			
5		REVISED AS NOTED			
4		ISSUED FOR APPROVAL			
3		REVISED AS NOTED			
2		REVISED AS NOTED			
1		ISSUED FOR APPROVAL			
0		FIRST ISSUE			

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APPROVED FOR
HOOK-UP

MW: Methanolated Water

sofresid norge a.s PI 09. 000 5034

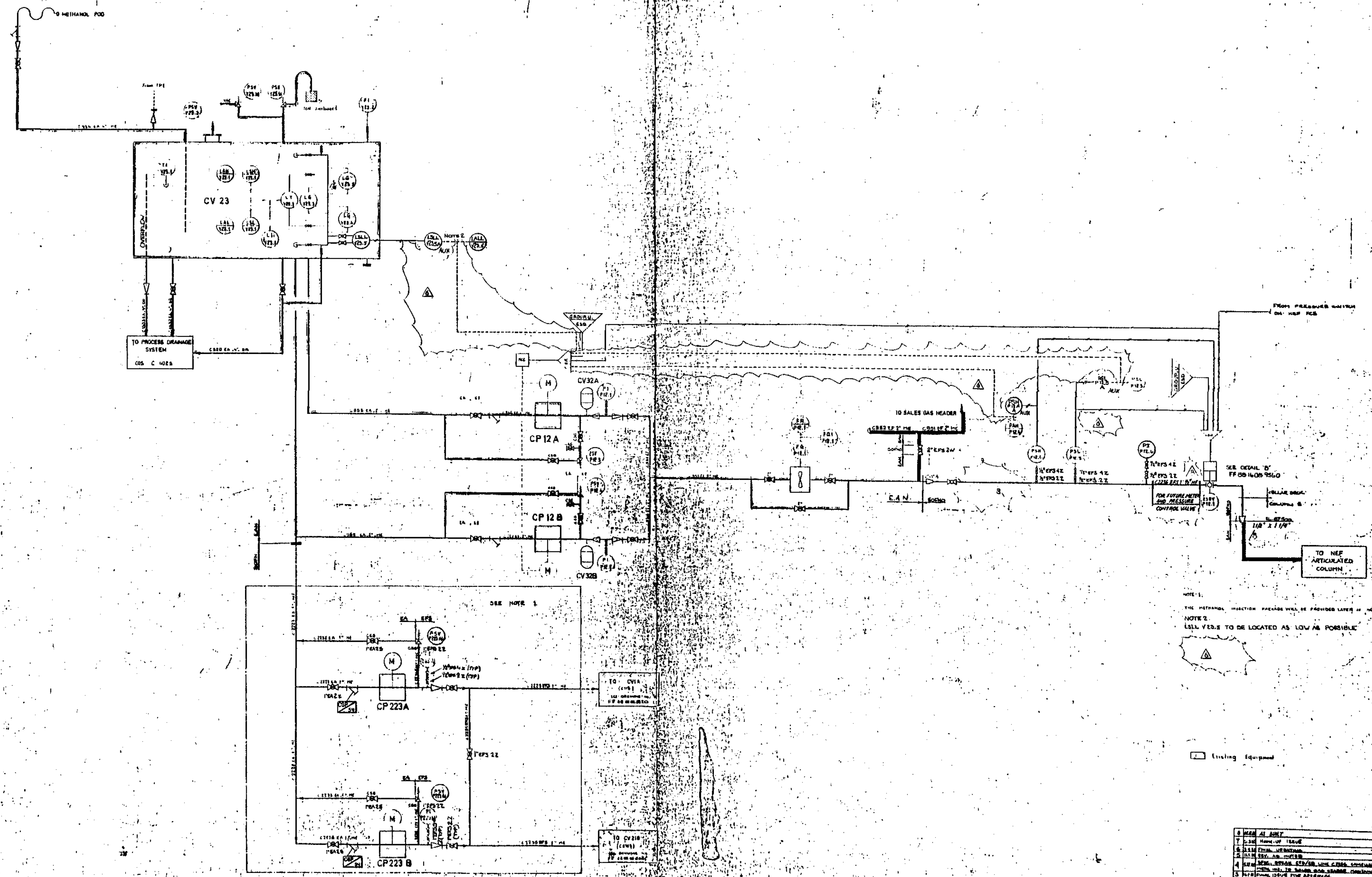
TCP2 EXTENSION

elf aquitaine norge as

AC
TCP
GENERAL
F 087

N.E.F AND ODIN
LIQUID TREATMENT
T.E.G and MW Facilities

FRIGG FIELD
FF 88 00 00 50 34
10



NOTE 1.
THE METHANOL INJECTION PACKAGE WILL BE PROVIDED LATER IF NECESSARY.

NOTE 2.
LSLL Y 23.5 TO BE LOCATED AS LOW AS POSSIBLE

CV 23

METHANOL STORAGE TANK

[illegible]

CP12

METHANOL INJECTION PUMP

[illegible]

OPERATING TEMPERATURE : 20°C

DESIGN TEMPERATURE : 121°C

DESIGN DISCHARGE PRESSURE : 153 BAR

CP 223

METHANOL INJECTION PUMPS

DESIGN TEMPERATURE [illegible]

DESIGN DISCHARGE PRESSURE [illegible] BAR

DESIGN FLOWRATE 5 L/H

OPERATING DISCHARGE PRESSURE 154 BAR

OPERATING TEMPERATURE 20°C

CV 32

METHANOL PULSATION DAMPENERS

CAPACITY 8 LITRES

OPERATING PRESSURE 154 BAR

DESIGN PRESSURE 350 BAR

8	[illegible]	AS BUILT			
7	[illegible]	HOOK-UP ISSUE			
6	[illegible]	FINAL UPDATING			
5	[illegible]	REV. AS NOTED			
4	[illegible]	[illegible]			
3	[illegible]	FINAL ISSUE FOR APPROVAL			
2	[illegible]	REVISED AS NOTED			
1	[illegible]	ISSUED FOR APPROVAL			
0	[illegible]	FIRST ISSUE			
REV	DATE	DESCRIPTION	BY	APP	

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PI 09.000 5036

TCP2 EXTENSION

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TCP 2

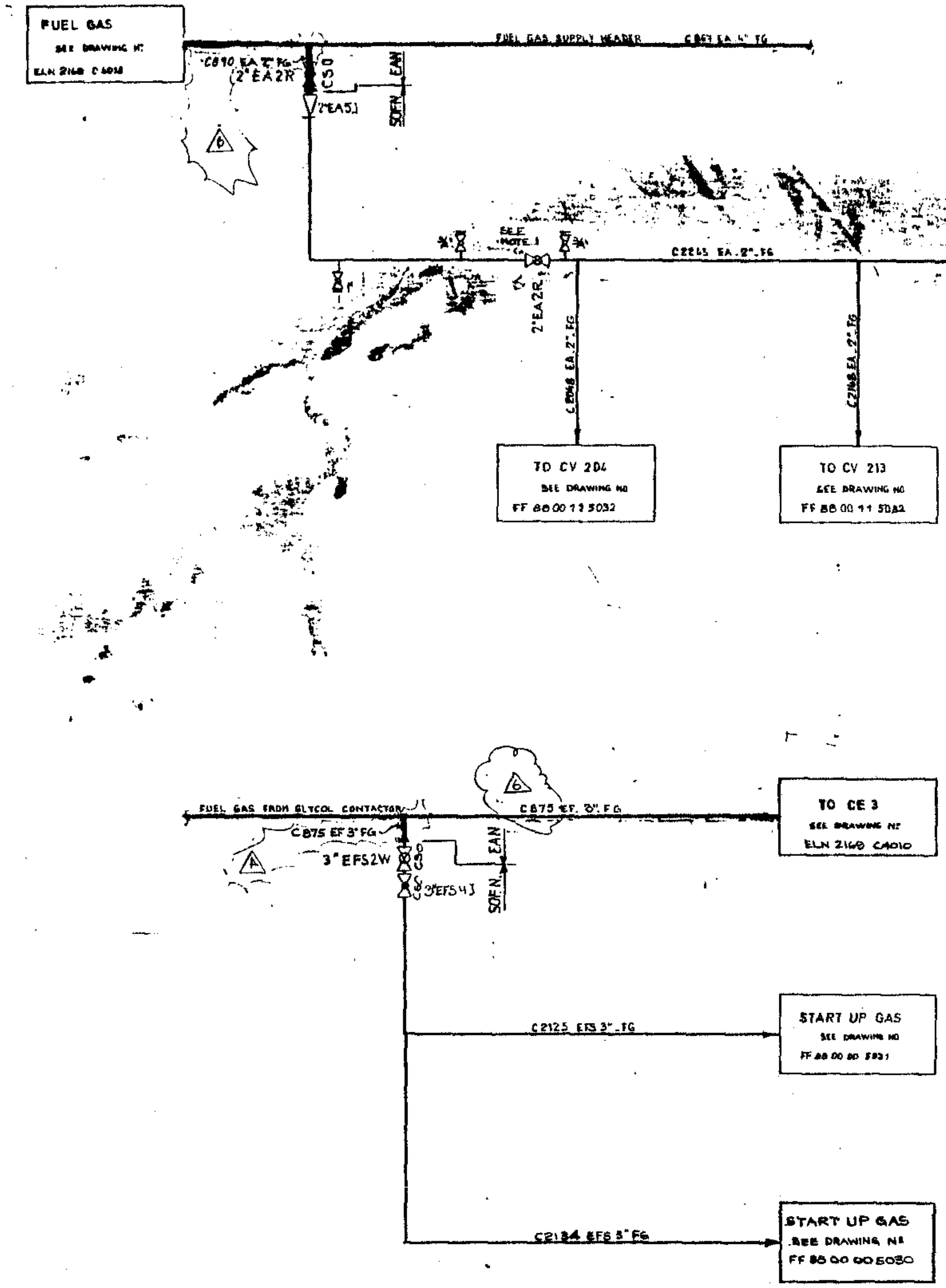
METHANOL

F087

N.E.F AND ODIN TREATMENT
Methanol Injections

FRIGG FIELD

[illegible] 09 000 9 5036



NOTES

1. VALVE TO BE INSTALLED CLOSE TO PANCAKE

▭ EXISTING EQUIPMENT

elf aquitaine norge a/s
APPROVED FOR
HOOK-UP

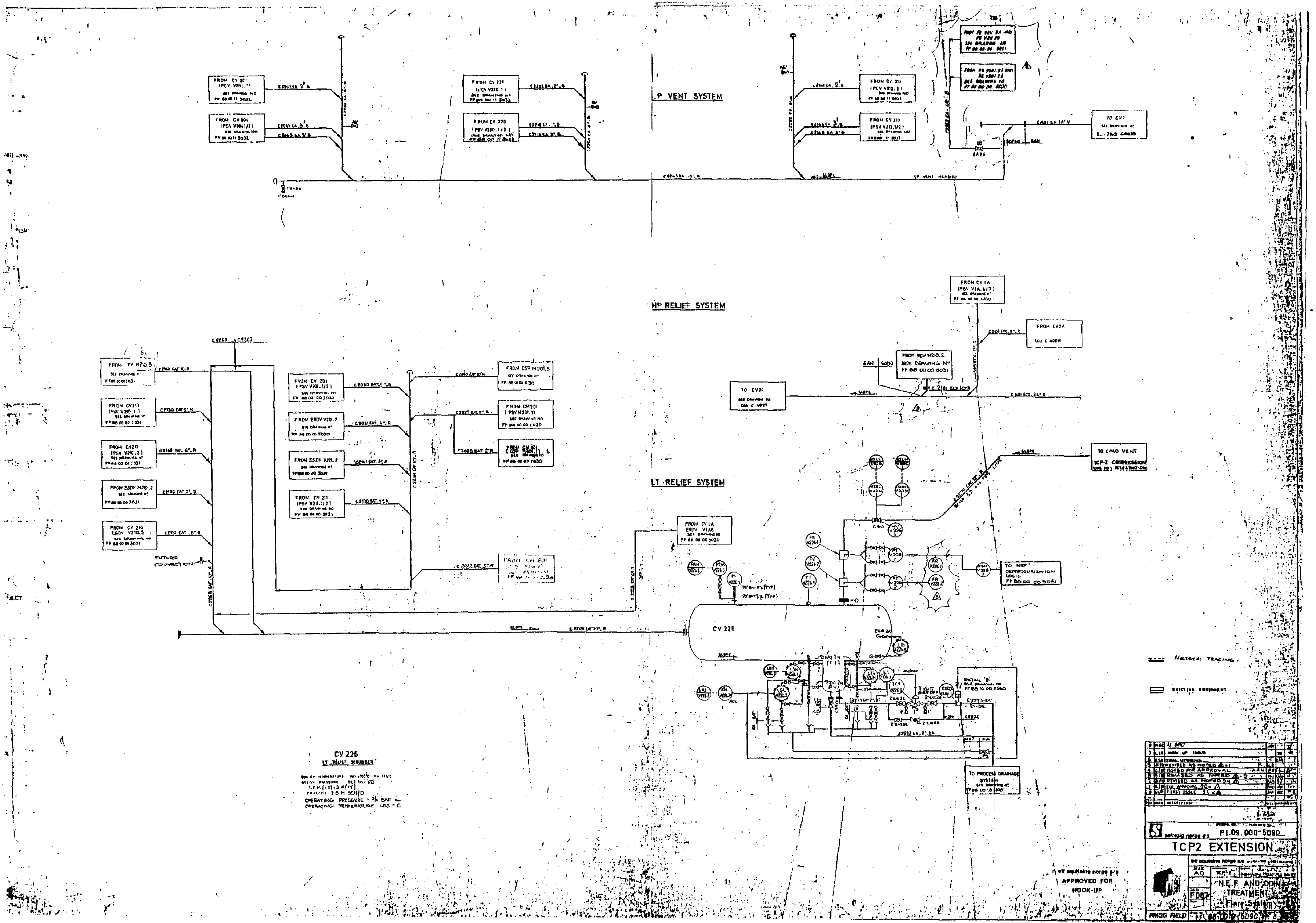
REV	DATE	DESCRIPTION	BY	APP.	CLI
6	[illegible]	AS BUILT	[illegible]		[illegible]
5	[illegible]	HOOK-UP ISSUE	-	[illegible]	[illegible]
4	[illegible]	FINAL UPDATING		[illegible]	
3	[illegible]	ISSUED FOR APPROVAL	R.R	[illegible]	[illegible]
2	[illegible]	REVISED AS NOTED △ 2	[illegible]	[illegible]	
1	[illegible]	ISSUED FOR APPROVAL 5x △	BAO	[illegible]	
0	[illegible]	FIRST ISSUE 10 x △	BAO	[illegible]	

sofresid norge as
P.1 09:000.5040

TCP2 EXTENSION

elf aquitaine norge as
A1 TCP-2 FUEL GAS
F087
N.E.F AND ODIN
TREATMENT
Fuel Gas System

FRIGG FIELD FF 88 00 025040 6



CV 226
LT RELIEF SCRUBBER

DESIGN TEMPERATURE
DESIGN PRESSURE
1.5 M (ID) × 3.6 (TT)
CAPACITY 2.8 M SCM/D
OPERATING PRESSURE · 3/4 BAR
OPERATING TEMPERATURE -55 °C

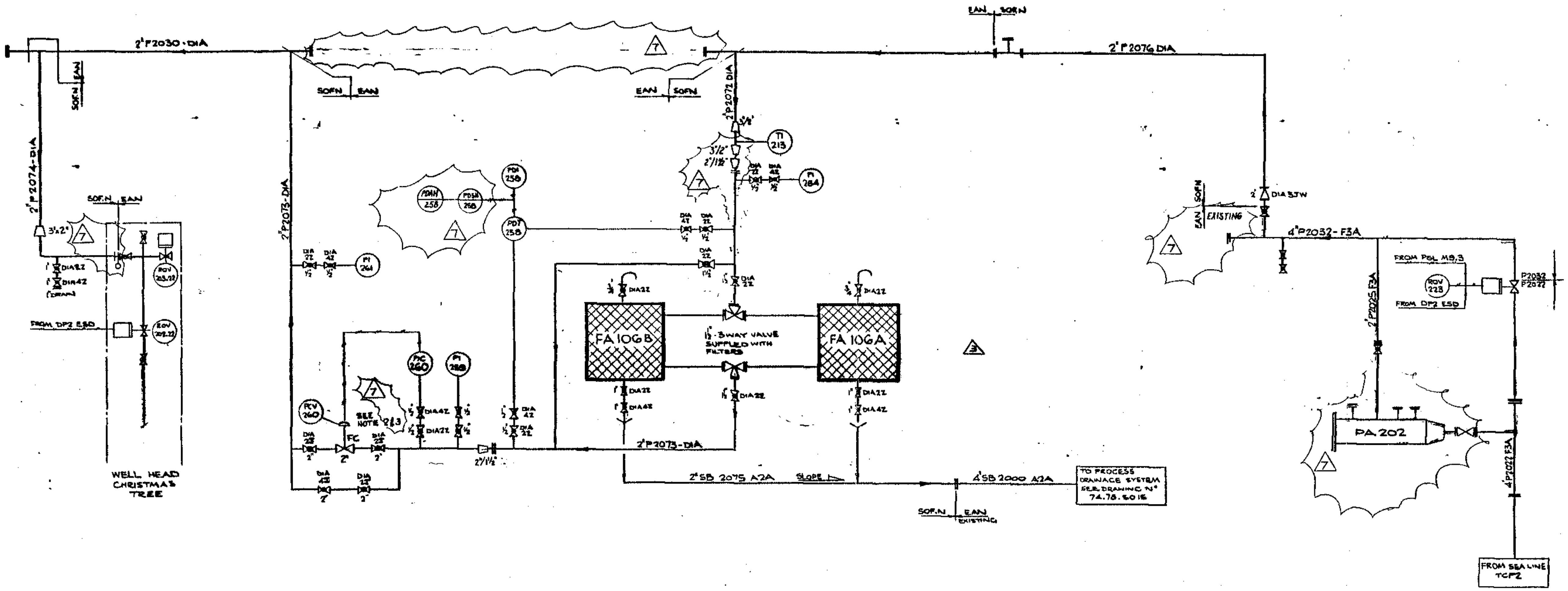
8		AS BUILT			
7		HOOK-UP ISSUE			
6					
5		REVISED AS NOTED			
4		ISSUED FOR APPROVAL			
3		REVISED AS NOTED			
2		REVISED AS NOTED			
1		FOR APPROVAL			
0		FIRST ISSUE			
No	DATE	DESCRIPTION			

selresid norge a.s
P1.09.000-5090

TCP2 EXTENSION

elf aquitaine norge a/s
AO
F087
N.E.F AND ODIN TREATMENT
Flare System
FRIGG FIELD

elf aquitaine norge a/s
APPROVED FOR
HOOK-UP



elf aquitaine norge a/s
APPROVED FOR
HOOK-UP

FA 106A & B

METHANOLATED WATER FILTERS,
DESIGN TEMPERATURE ~ 30°C
DESIGN PRESSURE ~ MAX. 16 Bar a.
~ MIN. 0.008 Bar. a.
OPERATING TEMPERATURE ~ 5°C
OPERATING PRESSURE ~ 3 Bar a.

EXISTING EQUIPMENT TO BE KEPT.

NOTE 1: FOR SPECIFICATION OF VALVES SEE LUMMUS PIPING MATERIAL - SPEC.

NOTE 2: PCV 260 AND 2" BY-PASS LINE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE INJECTION WELL

NOTE 3 AIR SUPPLY TO PCV 260
REF. ISOMETRIC DRAWING FF 88 20 01 2077

7

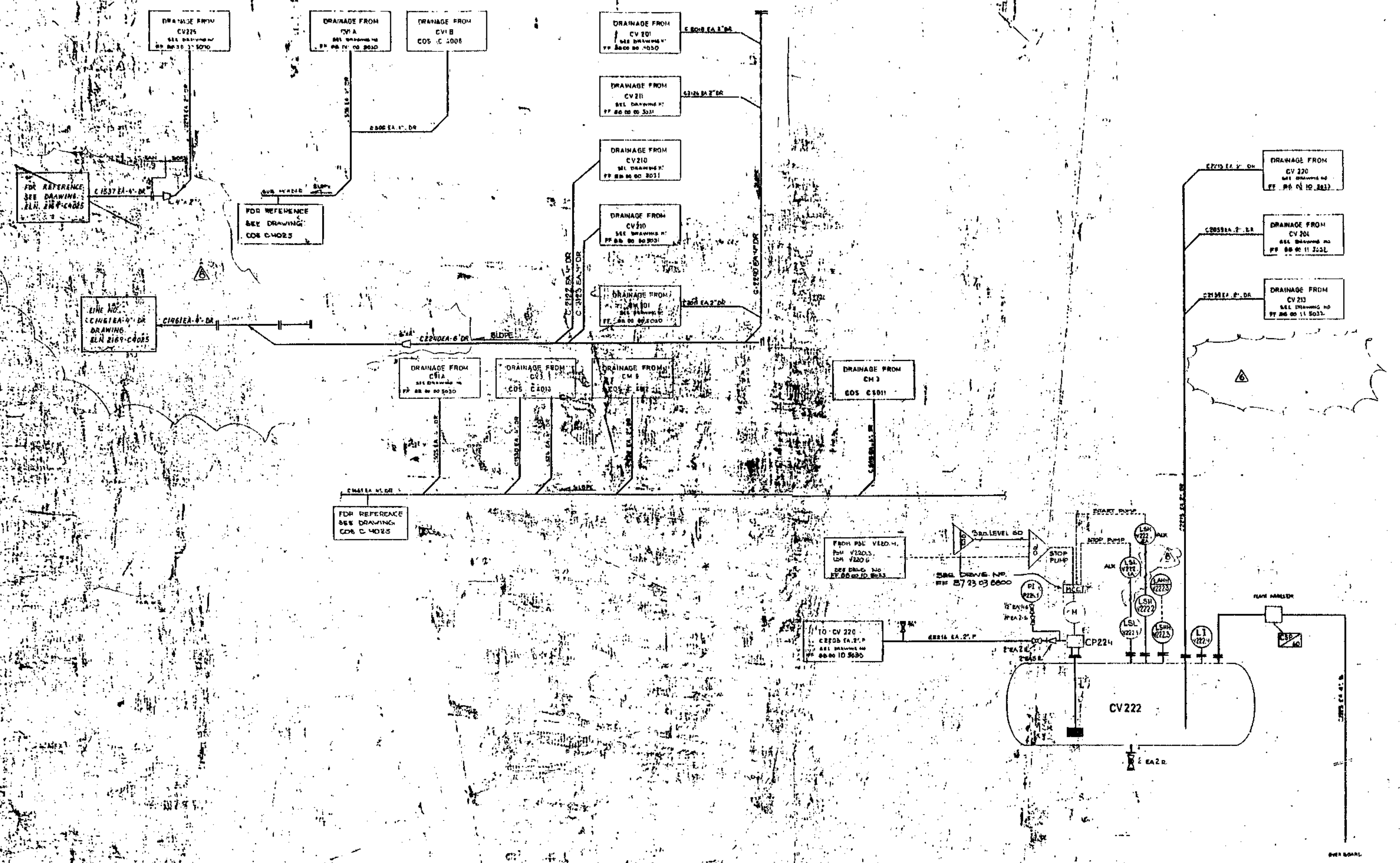
7	06.12.83	AS BUILT	AA		TR
6	24.5.83	HOOK-UP ISSUE	-		DE
5	3.5.81	FINAL UPDATING. LINE 2"SB2075A2A was 1½"			
4	1.6.82	REVISED TO EAN COMMENTS	P.R		
3	6.4.82	REDRAWN, 3 WAY VALVE TO FILTERS ADDED, VALVE REF. N° ADDED, SERVICE AIR DELETED			
2	19.1.82	REVISED AS NOTED △×2	HJ		
1	19.4.81	ISSUED FOR APPROVAL △×8	BAO		
0	4.4.81	[illegible] △×15	BAO		
REV.	DATE	DESCRIPTION	BY	APP.	CLIENT

selvaag norge a.s DRWG. NO.: P1.05.000.5035

TCP 2 EXTENSION

elf aquitaine norge a/s [illegible]

A1
DP2
METHANOLATED WATER
NEF AND ODIN
LIQUID TREATMENT
METHANOLATED WATER
INJECTION ON DP2
F087
FRIGG FIELD
7



CP 224

DRAINAGE TANK PUMP

DESIGN TEMPERATURE 50°C
DESIGN DISCHARGE PRESSURE 15 BAR g.
OPERATING DISCHARGE PRESSURE 10 BAR g.
OPERATING TEMPERATURE 20°C
DESIGN FLOWRATE 3 m³/h

CV222

METHANOLATED WATER DRAINAGE TANK

DESIGN TEMPERATURE 50°C
DESIGN PRESSURE 3 BAR g.
0.8 (HID) × 6.7 (MTT)
CAPACITY 3.51 CM
OPERATING PRESSURE : ATM
OPERATING TEMPERATURE : 20°C

elf aquitaine norge a/s
APPROVED FOR HOOK-UP

8		AS BUILT			
7					
6					
5		LSL V222.1A, LSH V222.2A ADDED			
4		ISSUED FOR APPROVAL			
3		REVISED AS NOTED 3			
2		REVISED AS NOTED 2			
1		ISSUED FOR APPROVAL			
0		FIRST ISSUE			
REV	DATE	DESCRIPTION	BY	APP	CLIENT

sofresid norge a.s P1.09.000.5100

TCP2 EXTENSION

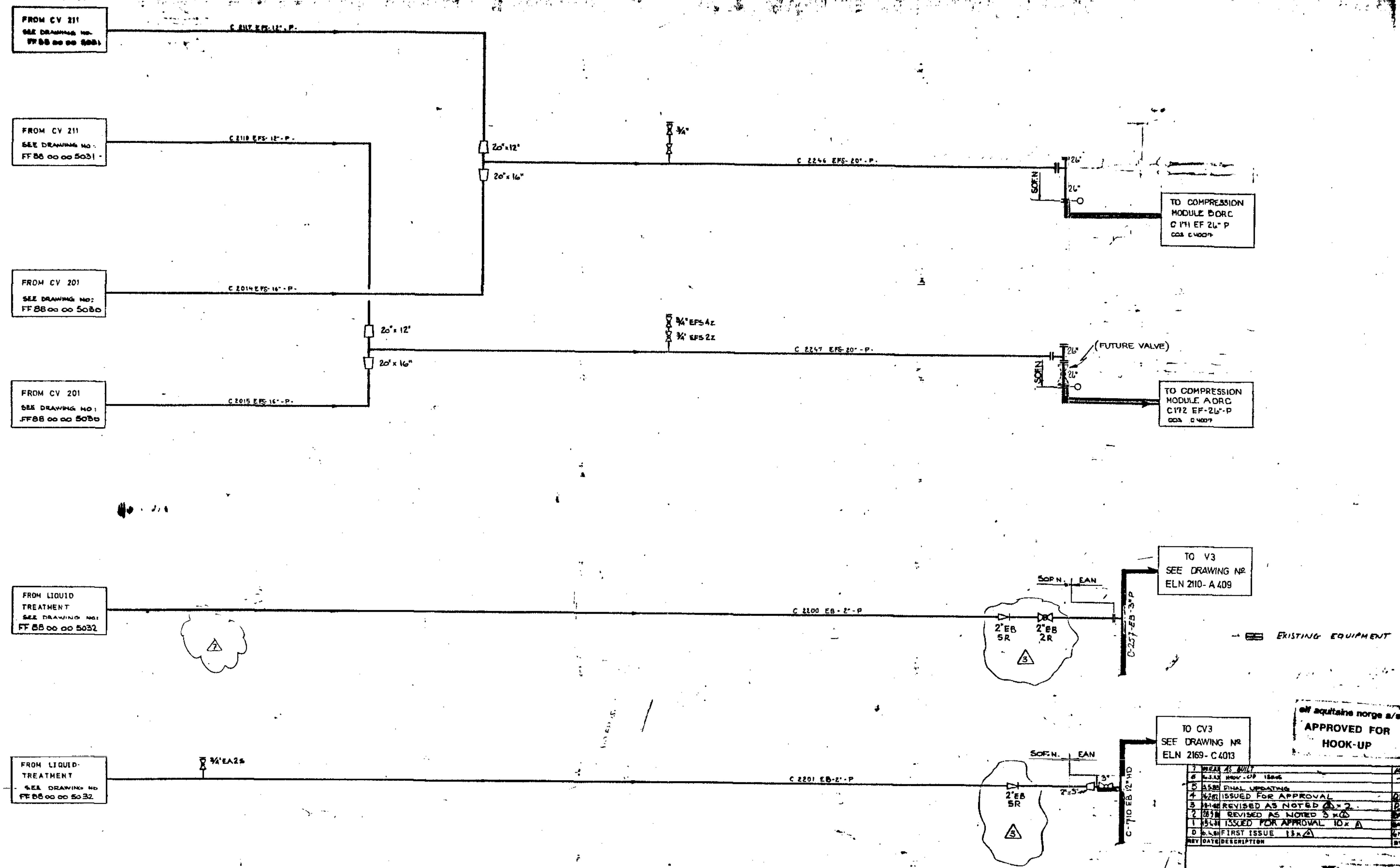
elf aquitaine norge a/s

DRAINAGE

N.E.F AND ODIN TREATMENT
Process Drainage System

F087

FRIGG FIELD PF 86 00 10 5100



elf aquitaine norge a/s
APPROVED FOR
HOOK-UP

REV	DATE	DESCRIPTION	BY	APP	CLIENT
7	[illegible]	AS BUILT	[illegible]		[illegible]
6	[illegible]	HOOK-UP ISSUE	-	[illegible]	[illegible]
5	3.5.82	FINAL UPDATING		[illegible]	
4	16.2.82	ISSUED FOR APPROVAL	[illegible]	[illegible]	[illegible]
3	11.1.82	REVISED AS NOTED △ x 2.	[illegible]	[illegible]	
2	28.9.81	REVISED AS NOTED 3 x △	[illegible]	[illegible]	
1	15.4.81	ISSUED FOR APPROVAL 10 x △	[illegible]	[illegible]	
0	6.4.81	FIRST ISSUE 13 x △	[illegible]	[illegible]	

sofresid norge a.s

DRWNG. NO. P1 09. 000.11300.

TPC 2 EXTENSION

elf aquitaine norge a/s

SIZE A1

Installation TCP 2

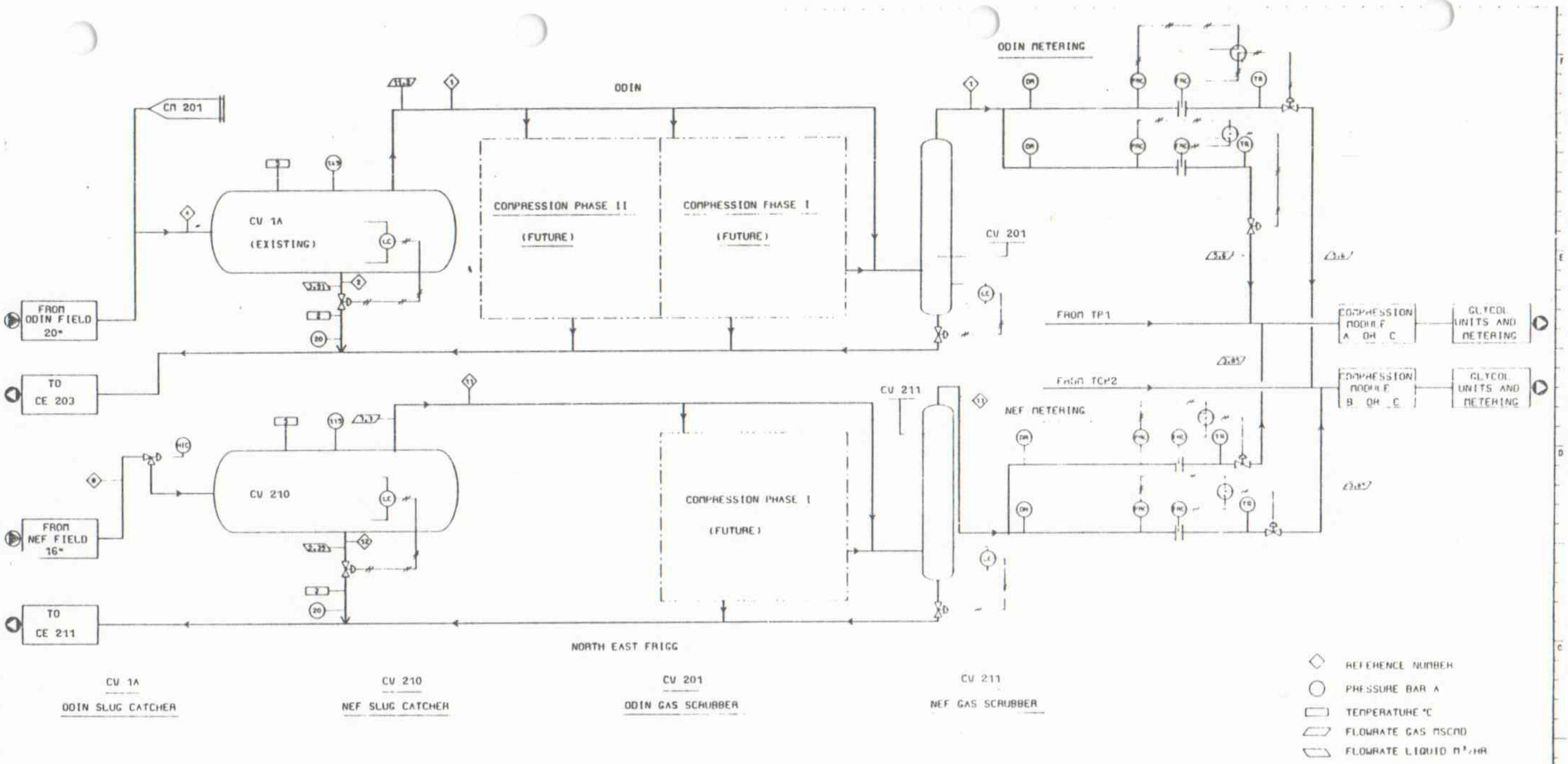
System GENERAL

Job no. F 087

NEF AND ODIN TREATMENT condensate and gas Tie ins

FRIGG FIELD

Drwg. no. PF 88 00000300. 47 7/49



NOTE: THIS PROCESS FLOW SHEET CORRESPONDS TO ODIN AND NEF PRODUCING WITHOUT WATER DRIVE

MATERIAL BALANCE						
STREAM NO.	A	1	2	B	11	12
DESCRIPTION	ODIN CV 1A FEED	GAS FROM CV 1A	LIQUID FROM CV 1A	NEF CV 210 FEED	GAS FROM CV 210	LIQUID FROM CV 210
PHASE	M	V	L	M	V	L
COMPONENT, KGMOLE/HR						
N_2	1[illegible].020	181.980	0.040	90.920	90.900	0.020
CO_2	47.510	47.440	0.070	40.780	40.740	0.040
C_1	18755.340	18745.080	10.260	12814.060	12808.000	6.060
C_2	762.120	761.040	1.060	632.890	631.750	1.140
C_3	11.880	11.850	0.030	9.800	9.760	0.040
C_4	5.940	5.900	0.040	2.720	2.700	0.020
C_5	7.960	7.850	0.110	0.050	0.040	0.010
C_6	1.000	0.970	0.030	0.200	0.170	0.030
C_7	0.610	0.570	0.040	1.100	0.870	0.230
C_8	1.040	0.920	0.120	1.820	1.260	0.560
C_9	1.080	0.860	0.220	2.300	1.380	0.920
C_{10}^+	16.230	6.460	9.770	8.160	2.520	5.640
WATER	54.160	2.600	51.560	29.330	2.050	27.280
METHANOL	14.040	3.930	10.110	9.770	3.470	6.300
TOTAL	19860.930	19777.450	83.480	13643.900	13595.610	48.290
TEMPERATURE °C	5.000	5.000	5.000	5.000	5.000	5.000
PRESSURE BAR A	149.000	149.000	149.000	115.000	115.000	115.000
KG/HR	337013.500	333650.300	3363.200	232333.000	230309.700	2023.300
MOLECULAR WEIGHT	16.960	16.870	40.300	17.020	16.940	41.900
STD DENSITY KG/M³	0.722	0.715	858.500	0.724	0.718	840.500
STD M³/HR	466777.000	466645.000	3.920	320907.000	320166.000	2.400
ACT.DENSITY KG/M³	143.500	142.300	860.000	109.600	108.900	845.000
ACTUAL M³/HR		2345.000	3.910		2115.000	2.390
COMPRES. FACTOR Z		0.766			0.775	

5	[illegible]	ISSUED FOR APPROVAL	JTN	[illegible]	
4	[illegible]	UP RATING	[illegible]	[illegible]	
3	[illegible]	UP RATING FOLLOWING EAN COMMENTS	[illegible]		
2	[illegible]	UP RATING	[illegible]		
1	[illegible]	UP RATING	[illegible]		
0	[illegible]	[illegible]	[illegible]		
REV	DATE	DESCRIPTION	[illegible]	[illegible]	[illegible]

aafroald norge a.s DRWG. NO.: FS 09000 0100

TCP 2 EXTENSION

elf aquitaine norge a/s P.O. Box [illegible] – [illegible] Stavanger

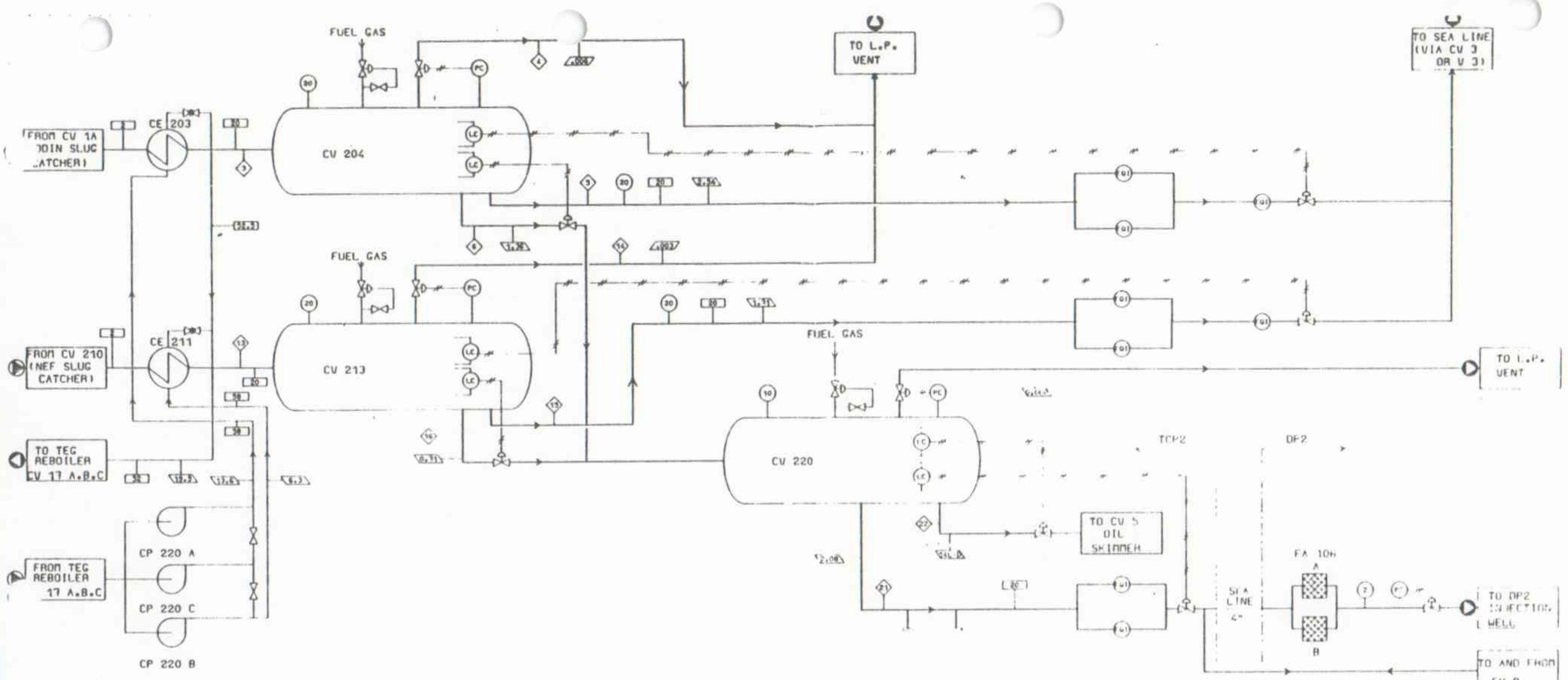
SIZE A1

TCP-2

GENERAL

F 087

PROCESS FLOWSHEET
GAS TREATMENT



CE 203	CE 211	CP 220 A/B/C	CV 204	CV 213	CV 220	FA 106 A/B
ODIN CONDENSATE HEATER DUTY=47000 KCAL/H	NEF CONDENSATE HEATER DUTY=28000 KCAL/H	TEG CIRCULATION PUMPS	ODIN CONDENSATE/METHANOL SEPARATOR	NEF CONDENSATE/METHANOL SEPARATOR	METHANOLATED WATER FLASH DRUM	METHANOLATED WATER FILTERS

◇ REFERENCE NUMBER
○ PRESSURE BAR A
▭ TEMPERATURE °C
▱ FLOWRATE GAS MSCMD
▱ FLOWRATE LIQUID M³/HR

NOTE: THIS PROCESS FLOW SHEET CORRESPONDS TO ODIN AND NEF PRODUCING WITHOUT WATER DRIVE

MATERIAL BALANCE

STREAM NO.	3	4	5	6	13	14	15	16	21	22
DESCRIPTION	CE 203 EFFLUENT	GAS FROM CV 204	LIQUID HC TO SEA LINE	LIQUID MW+HC	CE 211 EFFLUENT	GAS FROM CV 213	LIQUID HC TO SEA LINE	LIQUID MW+HC	MW TO DP2 6 + 16	LIQUID HC TO CV5 (+1.E-3)
PHASE	M	V	L	L	M	V	L	L	L	L
COMPONENT, KGMOLE/HR										
N_2	0.040	0.040			0.020	0.020				
CO_2	0.070	0.060	0.010		0.040	0.030	0.010			
C_1	10.260	9.090	1.170		6.060	5.170	0.890			0.100
C_2	1.080	0.690	0.390		1.140	0.580	0.560			0.100
C_3	0.030	0.010	0.020		0.040	0.010	0.030			
C_4	0.040	0.010	0.030		0.020	0.010	0.010			
C_5	0.110	0.010	0.100		0.010		0.010			
C_6	0.030		0.030		0.030		0.030			
C_7	0.040		0.040		0.230		0.230			
C_8	0.120		0.120		0.560		0.560			0.100
C_9	0.220		0.220		0.920		0.920			0.200
$C_{10}+$	9.110		9.110	1.1(-3)	5.640		5.640	6.1(-3)		2.000
WATER	52.030			51.560	27.280			27.280	78.840	
METHANOL	0.280			10.110	6.300			6.300	16.410	
TOTAL	83.480	9.910	11.900	61.670	48.290	5.820	8.890	33.580	95.250	2.500
TEMPERATURE °C	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
PRESSURE BAR A	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	10.000	10.000
KG/HR	3363.200	112.500	1866.100	1324.600	2023.300	103.200	1227.600	692.500	2017.100	423.000
MOLECULAR WEIGHT		11.400	156.800	21.500		17.730	138.050	20.600	21.200	171.650
STD DENSITY KG/M³		0.773	736.800			0.790	720.830			743.550
STD M³/HR		223.000	2.530			130.600	1.700			0.568
ACT. DENSITY KG/M³		14.820	732.500	970.000		15.240	718.000	970.000	970.000	741.000
ACTUAL M³/HR		11.640	2.540	1.360		6.800	1.710	0.710	2.080	0.570
COMPRES. FACTOR Z		0.958				0.955				

5	[illegible]	ISSUED FOR APPROVAL	JTh		
4	[illegible]	UP DATING			
3	[illegible]	UP DATING FOLLOWING EAN COMMENTS			
2	[illegible]	UP DATING			
1	[illegible]	UP DATING			
0	[illegible]	[illegible]			
		DESCRIPTION			

sofresid norge a.s DRWG. NO. FS 09 000 0101

TCP 2 EXTENSION

elf aquitaine norge a/s

A1	TCP 2	GENERAL
F 087	PROCESS FLOWSHEET LIQUID TREATMENT	

FRIGG FIELD 88 00 00 5 101

APPENDIX 4

SAFETY ANALYSIS TABLE (SAT)

ITEM CM 201 SERVICE ODIN PIG RECEIVEF FLOW DIAGRAM REFERENCE FF 88 00 00 503 REV. 8

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED OUTLET	HIGH PRESSURE		PSV M201.1	OVERPRESSURE NOT POSSIBLE SINCE MAWP IS HIGHER THAN MSWHP. NO OTHER PROTECTION REQUIRED SINCE THE SYSTEM IS ONLY IN SERVICE DURING PIGGING OF THE SEA LINE.

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
00	FIRST ISSUE	26/03/81	JIN		
01	REVISED	13/06/81	JIN		

CLIENT
elf aquitaine norge a/s P.O.Box 168 - 4001 Stavanger
FRIGG FIELD

DATE 26, 03/81
CONSTR. JIN
APPR
SCALE

sofresid norge a.s

TITLE
SAFETY ANALYSIS TABLE
(SAT)
TCP 2 EXTENSION

CH 05 1430

DRWG NO
CH-FF 88 00 00 4142
Sheet 1/ 28

ITEM NO CV 1A SERVICE ODIN SLUG CATCHER FLOW DIAGRAM REFERENCE FF 88 00 00 5030 REV. 8

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED OUTLET	HIGH PRESSURE		PSV V1A.6+7	OVERPRESSURE NOT POSSIBLE SINCE MAWP IS HIGHER THAN MSWHP.
OVERFLOW	LIQUID INFLOW EXCEEDS LIQUID OUTFLOW LEVEL CONTROL FAILURE	HIGH LIQUID LEVEL	LSHH V1A.8A	LSHH V201.4 (DOWNSTREAM)	
GAS BLOW BY	LEVEL CONTROL FAILURE	LOW LIQUID LEVEL	LSLL V1A.7A	PSV V204 1+2 PSH V204.5 (DOWNSTREAM)	3 SECONDARY PROTECTION PSH V3.8, PSV V3.5 AND PSV V3.6 AT CV3 (EXISTING EQUIPMENT DOWNSTREAM)
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE AND BAKCFLOW	PSL V1A.2 FSV	ESS	

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
00	FIRST ISSUE	23/03/81	JIN	TEL	
01	ISSUED FOR APPROVAL	02/04/81	JIN	TEL	
02	REVISED	13/06/81	JIN		
03	REVISED AS NOTED	25/08/81	JIN		

CLIENT
elf aquitaine norge a/s P.O.Box 168 4001 Stavanger
FRIGG FIELD

DATE	CONSTR	APPR	SCALE
23/03/81	JIN		

sofresid norge a.s

TITLE
SAFETY ANALYSIS TABLE (SAT)
TCP 2 EXTENSION

CH 05 1430
DRWG NO
CH-FF 88 00 00 4142
Sheet 2/28

ITEM NO. CV 201 SERVI ODIN GAS SCRUBBER FLOW DIAG REFERENCE FF 88 00 00 5030 REV

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED OUTLET	HIGH PRESSURE		PSV V201.1+2	OVERPRESSURE NOT POSSIBLE SINCE MAWP IS HIGHER THAN MSWHP.
OVERFLOW	LIQUID INFLOW EXCEEDS LIQUID OUTFLOW LEVEL CONTROL FAILURE	HIGH LIQUID LEVEL	LSHH V201.4	11 LSHH 12/3.A 11 LSHH 22/3.A 11 LSHH 32/3.A	SECONDARY PROTECTION AT DOWNSTREAM EXISTING EQUIPMENT.
GAS BLOWBY	LEVEL CONTROL FAILURE	LOW LIQUID LEVEL	LSLL V201.5	PSV V204 1 +2 PSH V204.5 (DOWNSTREAM)	
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE AND BACKFLOW	FSV PSL V201.3	ESS	

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
00	FIRST ISSUE	23/03/81	JIN	TEC	
01	ISSUED FOR APPROVAL	02/04/81	JIN	TEC	
02	REVISED	13/06/81	JIN		

CLIENT
elf aquitaine norge a/s P.O.Box 168 - 4001 Stavanger

FRIGG FIELD

DATE	CONSTR	APPR	SCALE
23/03/81	JIN		

TITLE

SAFETY ANALYSIS TABLE (SAT)

TCP 2 EXTENSION

sofresid norge a.s

CH 05 1430

DRWG NO
CH-FF 88 00 00 4142
Sheet 3/ 28

ITEM NO. CV 210 SERVICE NEF SLUG CATCHER FLOW DIAGRAM REFERENCE FF 88 00 00 5031 RE

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED OUTLET	HIGH PRESSURE		PSV V210.1+2	OVERPRESSURE NOT POSSIBLE SINCE MAWP IS HIGHER THAN MSWHP.
OVERFLOW	LIQUID INFLOW EXCEEDS LIQUID OUTLFOW LEVEL CONTROL FAILURE	HIGH LIQUID LEVEL	LSHH V210.8	LSHH V211.4 (DOWNSTREAM)	
GAS BLOWBY	LEVEL CONTROL FAILURE	LOW LIQUID LEVEL	LSLL V210.7	PSH V213.5 PSV V213 1+2 (DOWNSTREAM)	3 SECONDARY PROTECTION PSH V3.8 PSV V3.5 AND PSV V3.6 AT CV3 (EXISTING EQUIMENT DOWNSTREAM)
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE AND BACKFLOW	PSL V210.1 FSV	ESS	

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
00	FIRST ISSUE	23/03/81	JIN	TEC	
01	ISSUED FOR APPROVAL	02/04/81	JIN	TEC	
02	REVISED	13/06/81	JIN		
03	REVISED AS NOTED	25/08/81	JIN		

CLIENT
elf aquitaine norge a.s P O Box 168 4001 Stavanger
FRIGG FIELD

DATE	CONSTR	APPR	SCALE
23/03/81	JIN		

TITLE
SAFETY ANALYSIS TABLE (SAT)
TCP 2 EXTENSION

sofresid norge a.s

CH 05 1430
DRWG NO
CH-FF 88 00 00 4142
Sheet 4/28

ITEM NO. CV 211 SERVIC NEF GAS SCRUBBER FLOW DIAGR REFERENCE FF 88 00 00 5031 I 10

DESIRABLE EVENT	CAUSE	D TABLE C DITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED OUTLET	HIGH PRESSURE		PSV V211.1+2	OVERPRESSURE NOT POSSIBLE SINCE MAWP IS HIGHER THAN MSWHP.
OVERFLOW	LIQUID INFLOW EXCEEDS LIQUID OUTFLOW LEVEL CONTROL FAILURE	HIGH LIQUID LEVEL	LSHH V211.4	11 LSHH 12/3.A 11 LSHH 22/3.A 11 LSHH 32/3.A	SECONDARY PROTECTION AT DOWNSTREAM EXISTING EQUIPMENT
GAS BLOWBY	LEVEL CONTROL FAILURE	LOW LIQUID LEVEL	LSLL V211.5	PSH V213.5 PSV V213 1+2 (DOWNSTREAM)	
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE AND BACKFLOW	FSV PSL V211.3	ESS	

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
00	FIRST ISSUE	23/03/81	JIN	TEL	
01	ISSUED FOR APPROVAL	02/04/81	JIN	TEL	
02	REVISED	13/06/81	JIN		

CLIENT

elf aquitaine norge a/s P.O.Box 168 - 4001 Stavanger

FRIGG FIELD

DATE 23/03/81
CONSTR. JIN
APPR
SCALE

sofresid norge a.s

TITLE

SAFETY ANALYSIS TABLE
(SAT)

TCP 2 EXTENSION

CH 05 1430

DRWG NO
CH-FF 88 00 00 4142
Sheet 5/28

ITEM NO. CE 203 SERVICE ODIN CONDENSATE HEATER FLOW DIAGRAM REFERENCE FF 88 00 11 5032 REV. 7

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED OUTLET △3 (CONDENSATE + METHANOLATED WATER)	HIGH PRESSURE	PSH V204.5 (DOWNSTREAM)	PSV V204. 1+2 (DOWNSTREAM)	
OVERPRESSURE	BLOCKED OUTLET (GLYCOL)	HIGH PRESSURE			PROTECTION NOT REQUIRED SINCE MAX. PUMP DISCHARGE PRESS IS LESS THAN PIPING DESIGN PRESSURE.
LEAK (INTERNAL)	DETERIORATION RUPTURE	HIGH PRESSURE ON SHELL SIDE			PROTECTION NOT REQUIRED SINCE THE EXISTING GLYCOL LINE TO CV17 A/B/C IS USED AS RELIEF SYSTEM.
LEAK (EXTERNAL)	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE	PSL V204.3 (CONDENSATE LINE DOWNSTREAM) PSL-P220A.1/ PSL-P220C.1 △3 (GLYCOL LINE UPSTREAM)	ESS	
EXCESS TEMPERATURE	EXCESS HEAT INPUT	HIGH TEMP	TSH-E203.5		NO SECONDARY PROTECTION REQUIRED SINCE MAX. BUILT UP PRESSURE IS BELOW DESIGN PRESSURE OF TUBES AND PIPING.

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
00	FIRST ISSUE	23/03/81	JIN		
01	ISSUED FOR APPROVAL	02/04/81	JIN		
02	REVISED	13/06/81	JIN		
03	REVISED AS NOTED	25/08/81	JIN		

CLIENT
elf aquitaine norge a/s P.O.Box 168 - 4001 Stavanger
FRIGG FIELD

DATE 23/03/81 CONSTR. JIN APPR. SCALE

TITLE

SAFETY ANALYSIS TABLE (SAT)

TCP 2 EXTENSION

sofresid norge a.s

CH 05 1430

DRWG NO.
CH-FF 88 00 00 4142
Sheet 6/ 28

TEM NO. CE 211 SERVIC MEF CONDENSATE HEATER FLOW DIAGR.. REFERENCE FF 80 00 11 5032 RE

UNDESIRABLE EVENT	CAUSE	DE ABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED OUTLET △3 (CONDENSATE + METHANOLATED WATER)	HIGH PRESSURE	PSH V213.5 (DOWNSTREAM)	PSV V213 1+2 (DOWNSTREAM)	
OVERPRESSURE	BLOCKED OUTLET (GLYCOL)	HIGH PRESSURE			PROTECTION NOT REQUIRED SINCE MAX. PUMP DISCHARGE PRESSURE IS LESS THAN PIPING DESIGN PRESSURE.
LEAK (INTERNAL)	DETERIORATION RUPTURE	HIGH PRESSURE ON SHELL SIDE			PROTECTION NOT REQUIRED SINCE THE EXISTING GLYCOL LINE TO CV17 A/B/C IS USED AS RELIEF SYSTEM.
LEAK (EXTERNAL)	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE	PSL V213.3 (CONDENSATE LINE DOWNSTREAM) PSL P220B.1 / PSL P220C.1 △3 (GLYCOL LINE UPSTREAM)	ESS	
EXCESS TEMPERATURE	EXCESS HEAT INPUT	HIGH TEMP	TSH-E211.5		NO SECONDARY PROTECTION REQUIRED SINCE MAX. BUILT UP PRESSURE IS BELOW DESIGN PRESSURE OF TUBES AND PIPING.

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
00	FIRST ISSUE	23/03/81	JIN		
01	ISSUED FOR APPROVAL	02/04/81	JIN		
02	REVISED	13/06/81	JIN		
03	REVISED AS NOTED	25/08/81	JIN		

CLIENT

elf aquitaine norge a/s P.O.Box 168 - 4001 Stavanger

FRIGG FIELD

DATE	CONSTR.	APPR.	SCALE
23/03/81	JIN		

sofresid norge a.s

TITLE

SAFETY ANALYSIS TABLE (SAT)

TCP 2 EXTENSION

CH 05 1430

DRWG. NO

CH- FF 88 00 00 4142

Sheet 7/28

ITEM NO. CV 204 SERVICE N CONDENSATE/METHANOL FLOW DIAGRAM REFERENCE FF 88 00 11 5032 REV

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	INFLOW EXCEEDS OUTFLOW BLOCKED OUTLET	HIGH PRESSURE	PSH V204.5	PSV V204.1+2	
OVERFLOW	LIQUID INFLOW EXCEEDS LIQUID OUTFLOW LEVEL CONTROL FAILURE	HIGH LIQUID LEVEL	LSH V204.5	LSH V 7.4	SECONDARY PROTECTION AT EXISTING LP VENT SCRUBBER (ALARM ONLY)
GAS BLOWBY (CONDENSATE LINE)	LEVEL CONTROL FAILURE	LOW LIQUID LEVEL	LSL V204.2	PSV V3.5 and V3.6	SECONDARY PROTECTION AT DOWNSTREAM COMPONENT V3 OR CV3 (EXISTING EQUIPMENT)
GAS BLOWBY (WATER LINE)	*LEVEL CONTROL FAILURE*	*LOW LIQUID LEVEL*	*LSL V204.2*	PSH V220.3 PSV V220.1/2 (DOWNSTREAM)	
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE AND BACKFLOW	FSV PSL V204.3	ESS	
EXCESS TEMPERATURE	EXCESS HEAT INPUT	HIGH PROCESS TEMPERATURE	TSH E203.5		EXCESS TEMP ONLY POSSIBLE IN CASE OF BLOCKED OUTLETS. ANY PRESSURE BUILT UP WILL BE RELEASED THROUGH PSV V204.1+2.

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
00	FIRST ISSUE	23/03/81	JIN	TR	
01	ISSUED FOR APPROVAL	02/04/81	JIN	TR	
02	REVISED	13/06/81	JIN	BJ	

CLIENT

elf aquitaine norge a/s P.O.Box 168 - 4001 Stavanger

FRIGG FIELD

DATE	CONSTR.	APPR.	SCALE
23/03/81	JIN		

sofresid norge a.s

TITLE

SAFETY ANALYSIS TABLE
(SAT)

TCP 2 EXTENSION

CH 05 1430

DRWG NO
CH-FF 88 00 00 4142
Sheet 8/28

ITEM NO. CV 213 SERVIC EF CONDENSATE/METHANOL FLOW DIAGR REFERENCE FF 88 00 11 5032 REV.

JESIRABLE EVENT	CAUSE	DE TABLE CO TION AT COMPONENT	PROTECTION		JMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	INFLOW EXCEEDS OUTFLOW BLOCKED OUTLET	HIGH PRESSURE	PSH V213.5	PSV V213.1+2	△3
OVERFLOW	LIQUID INFLOW EXCEEDS LIQUID OUTFLOW LEVEL CONTROL FAILURE	HIGH LIQUID LEVEL	LSH V213.5	LSH V 7.4	SECONDARY PROTECTION AT EXISTING LP VENT SCRUBBER (ALARM ONLY)
GAS BLOWBY (CONDENSATE LINE)	LEVEL CONTROL FAILURE	LOW LIQUID LEVEL	LSL V213. 2	PSV V3.5 AND V3.6	SECONDARY PROTECTION AT DOWNSTREAM COMPONENT V3 OR CV3 (EXISTING EQUIPMENT)
GAS BLOWBY (WATER LINE)	LEVEL CONTROL FAILURE	LOW LIQUID LEVEL	LSL V213.2	PSH V220.3 PSV V220.1/2 (DOWNSTREAM)	
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE AND BACKFLOW	FSV PSL V213.3	ESS	
EXCESS TEMPERATURE	EXCESS HEAT INPUT	HIGH PROCESS TEMPERATURE	TSH E211.5		EXCESS TEMP ONLY POSSIBLE IN CASE OF BLOCKED OUTLETS. ANY PRESSURE BUILT UP WILL BE RELEASED THROUGH PSV V213.1+2.

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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CLIENT

elf aquitaine norge a/s P.O.Box 168 - 4001 Stavanger

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23/03/81	JIN		

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ITEM NO. CV 226 SERVICE LT RELIEF SCRUBBER FLOW DIAGRAM REFERENCE FF 88 00 04 5090 REV.5

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERFLOW	LIQUID INFLOW EXCEEDS LIQUID OUTFLOW	HIGH LIQUID LEVEL	LSH V226.2 (ALARM ONLY)		PROTECTION NOT REQUIRED SINCE VESSEL IS ONLY USED IN CASE OF EMERGENCY (FIRE AND BLOW-DOWN).
GAS BLOWBY	LEVEL CONTROL FAILURE	LOW LIQUID LEVEL	LSL V226.3	VENT	VENT AT DOWNSTREAM COMPONENT CV 13 SUMP CAISSON (EXISTING).
OVERPRESSURE	BLOCKED OUTLET	HIGH PRESSURE	PSH V226.2 △2		ALARM ONLY PROTECTION NOT REQUIRED SINCE MAX BUILT-UP BACK PRESSURE IS LESS THAN VESSEL DESIGN PRESSURE
LEAK	DETERIOZATION RUPTURE ACCIDENT	LOW PRESSURE BACKFLOW		ESS	PRIMARY PROTECTION NOT REQUIRED SINCE VESSEL COULD WORK NEAR ATMOSPHERIC CONDITIONS WHILE IN SERVICE

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26.'03/81	JIN		

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SAFETY ANALYSIS TABLE (SAT)

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Sheet 10/23

ITEM NO. CV 220 SERV METHANOLATED WATER FLASH DRUM FLOW DIAGRAM REFERENCE FF 88 00 10 5033 REV. 6

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	INFLOW EXCEEDS OUTFLOW BLOCKED OUTLET	HIGH PRESSURE	PSH V220.3	PSV V220.1+2	
OVERFLOW	LIQUID INFLOW EXCEEDS LIQUID OUTFLOW LEVEL CONTROL FAILURE	HIGH LIQUID LEVEL	LSH V220.6	LSH V 7.4	SECONDARY PROTECTION AT EXISTING LP VENT SCRUBBER (ALARM ONLY)
GAS BLOWBY (CONDENSATE LINE)	LEVEL CONTROL FAILURE	LOW LIQUID LEVEL	LSL V220.7	PSV V5.4+5	SECONDARY PROTECTION AT DOWNSTREAM CV5 (EXISTING EQUIPMENT).
GAS BLOWBY (METHANOLATED WATER LINE)	LEVEL CONTROL FAILURE	LOW LIQUID LEVEL	LSL V220.2		NO SECONDARY PROTECTION REQUIRED SINCE DOWNSTREAM PIPELINE DESIGN PRESSURE IS GREATER THAN ANY GAS BLOWBY PRESSURE
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE AND BACKFLOW	FSV PSL V220.4	ESS	

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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SAFETY ANALYSIS TABLE (SAT)

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ITEM NO. CV 225 A SERVICE INHIBITOR DRUM FLOW DIAGRAM REFERENCE FF 88 00 10 5033 REV.

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED OUTLET	HIGH PRESSURE	VENT+ SPARK ARRESTOR		NO OTHER PROTECTION REQUIRED SINCE THE VESSEL IS MANUALLY FILLED AND OPERATING AT ATMOSPHERIC CONDITIONS. SYSTEM NOT IN CONTINUOUS SERVICE.

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00	FIRST ISSUE	26/03/81	JIN	ZEL	
01	REVISED	13/06/81	JIN	BJ	

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DATE 26/03/81
CONSTR. JIN
APPR
SCALE

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SAFETY ANALYSIS TABLE (SAT)
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CH 05 1430

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ITEM NO. CV 225 B SERVIC INHIBITOR DRUM FLOW DIAGR REFERENCE FF 88 00 10 5033 REV. 6

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED OUTLET	HIGH PRESSURE	VENT+ SPARK ARRESTOR		NO OTHER PROTECTION REQUIRED SINCE THE VESSEL IS MANUALLY FILLED AND OPERATING AT ATMOSPHERIC CONDITIONS. SYSTEM NOT IN CONTINUOUS SERVICE.

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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ITEM NO. CP 225 A SERVICE INHIBITOR PUMP FLOW DIAGRA.. REFERENCE FF 88 00 10 5033 REV. D

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED DISCHARGE LINE	HIGH PRESSURE		PSV P225 A.1	NO OTHER PROTECTION REQUIRED SINCE SYSTEM IS MANUALLY OPERATED. NOT IN CONTINUOUS SERVICE.
LEAK	RUPTURE DETERIORATION ACCIDENT	LOW PRESSURE AND BACKFLOW	PSV		ONLY SMALL AMOUNTS △2

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ITEM NO. CP 225 B SERVICE INHIBITOR PUMP FLOW DIAGRAM REFERENCE FF 88 00 10 5033 REV. [illegible]

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED DISCHARGE LINE	HIGH PRESSURE		PSV P225 B.1	NO OTHER PROTECTION REQUIRED SINCE SYSTEM IS MANUALLY OPERATED. NOT IN CONTINUOUS SERVICE.
LEAK	RUPTURE DETERIORATION ACCIDENT	LOW PRESSURE AND BACKFLOW	FSV		ONLY SMALL AMOUNTS 2\

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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SAFETY ANALYSIS TABLE (SAT)

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ITEM NO. CV 23 (EXISTING) SERVICE METHANOL STORAGE TANK FLOW DIAGRAM REFERENCE FF 88 00 09 5036 REV. 03

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	INFLOW EXCEEDS OUTFLOW BLOCKED OUTLET	HIGH PRESSURE	PSV V23.1A	PSV V23.3	
UNDERPRESSURE	WITHDRAWALS EXCEEDS INFLOW	LOW PRESSURE	PSV V23.1B	PSV V23.3	
OVERFLOW	LIQUID INFLOW EXCEEDS LIQUID OUTFLOW	HIGH LIQUID LEVEL			OVERFLOW OF THE TANK CAN ONLY OCCUR DURING FILLING OF THE UNIT. THIS IS DONE MANUALLY AND THE VESSEL IS PROTECTED BY AN OVERFLOW LINE GOING TO THE DRAINAGE SYSTEM.
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW LIQUID LEVEL			PROTECTION NOT REQUIRED SINCE THE FEED TO THE VESSEL IS THE FILLING LINE. THIS IS OPERATED MANUALLY AND IS NOT IN CONTINUOUS SERVICE.

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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DATE 26/03/81
CONSTR. JIN
APPR.
SCALE

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SAFETY ANALYSIS TABLE
(SAT)

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ITEM NO. CP 12 A/B SERV. METHANOL INJECTION PUMPS FLOW DIAGRAM REFERENCE FF 88 00 09 5036 REV. 03

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED DISCHARGE LINE	HIGH PRESSURE	PSH P12.4	PSV 12.3+4	
LEAK	RUPTURE DETERIORATION ACCIDENT	LOW PRESSURE AND BACKFLOW	PSL 12.5 FSV	ESS	

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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26.03/81	JIN		

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SAFETY ANALYSIS TABLE
(SAT)
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DRWG. NO.
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Sheet 17/28

ITEM NO. CP 223 A/B SERVIC METHANOL INJECTION PUMPS FLOW DIAGR. REFERENCE FF 88 00 09 5036 REV. 03

UNDESIRABLE EVENT	CAUSE	DE[illegible]ABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
					METHANOL INJECTION PACKAGE WILL BE PROVIDED LATER IF NECESSARY.

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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DATE	CONSTR.	APPR.	SCALE
26/03/81	JIN		

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ITEM NO. CV 9 (EXISTING) SERVICE THANOLATED WATER STORAGE TANK FLOW DIAGRAM REFERENCE FF 88 00 00 5034 REV. 5

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	INFLOW EXCEEDS OUTFLOW BLOCKED OUTLET	HIGH PRESSURE	PSV V9.2B	PSV V9.3	
UNDERPESSURE	OUTFLOW EXCEEDS INFLOW	LOW PRESSURE	PSV V9.2A	PSV V9.3	
OVERFLOW	LIQUID INFLOW EXCEEDS LIQUID OUTFLOW BLOCKED OUTLET	HIGH LIQUID LEVEL			THE TANK IS NOT IN CONTINUOUS SERVICE. OVERFLOW IS ONLY POSSIBLE WHEN INJECTION WELL ON DP2 IS CLOSED. VESSEL IS PROTECTED BY AN OVERFLOW LINE GOING TO THE DRAINAGE SYSTEM. NONE HAZARDIOUS EVENT.
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW LIQUID LEVEL			NONE HAZARDIOUS EVENT. PROTECTION NOT REQUIRED. THE TANK IS NOT IN CONTINUOUS SERVICE.

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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DATE	CONSTR.	APPR.	SCALE
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TITLE
SAFETY ANALYSIS TABLE (SAT)
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ITEM NO. CP 222 A/B SERVICE ETHANOLATED WATER INJECTION PUMPS FLOW DIAGRAM REFERENCE FF 88 00 00 5034 REV. 5

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED DISCHARGE LINE	HIGH PRESSURE			PSH AND PSV NOT REQUIRED SINCE MAX PUMP DISCHARGE PRESSURE WILL NOT EXCEED RATED WORKING PRESSURE ON DISCHARGE PIPING.
LEAK	RUPTURE DETERIORATION ACCIDENT	LOW PRESSURE AND BACKFLOW	PSL M9.3 AND FSV		SECONDARY PROTECTION NOT REQUIRED SINCE THE EVENT IS NOT HAZARDIOUS.

REV NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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CH 05 1430

DRWG. NO.
CH-FF 88 00 00 4142
Sheet 21/2

ITEM NO. CP 13 A/B SERVICE GLYCOL FILL PUMP FLOW DIAGR. REFERENCE FF 88 00 00 5034 REV.D

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED DISCHARGE LINE	HIGH PRESSURE			PSH AND PSV IS NOT REQUIRED SINCE MAX PUMP DISCHARGE PRESSURE IS LESS THAN THE RATED WORKING PRESSURE ON DISCHARGE PIPING.
LEAK	RUPTURE DETERIORATION ACCIDENT	LOW PRESSURE AND BACKFLOW	FSV		PSL NOT REQUIRED SINCE OPERATING PRESSURE IS NEAR ATMOSPHERIC.

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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CLIENT
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SAFETY ANALYSIS TABLE
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CH 05 1430

DRWG NO.
CH-FF 88 00 00 4142
Sheet 20, 28

ITEM NO. CP 220 A/B/C SERVICE TEG CIRCULATION PUMPS FLOW DIAGRAM REFERENCE FF 88 00 00 5034 RE 3

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED DISCHARGE LINE	HIGH PRESSURE			PSH AND PSV NOT REQUIRED SINCE MAX PUMP DISCHARGE PRESSURE WILL NOT EXCEED RATED WORKING PRESSURE ON DISCHARGE PIPING.
LEAK	RUPTURE DETERIORATION ACCIDENT	LOW PRESSURE AND BACKFLOW	FSV PSL P220A.1/ P220B.1/ P220C.1		NO SECONDARY PROTECTION REQUIRED SINCE THE LIQUID IS NOT HYDROCARBONS.

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CH 05 1430

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Sheet 22/28

ITEM NO. CV222 SERVIC METHANOLATED WATER DRAINAGE TANK FLOW DIAGR REFERENCE FF 88 00 10 5100 REV. 4

UNDESIRABLE EVENT	CAUSE	D ABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED DISCHARGE	HIGH PRESSURE	VENT+ SPARK ARRESTOR		NO OTHER PROTECTION REQUIRED SINCE THE VESSEL IS OPERATED MANUALLY AND AT ATMOSPHERIC CONDITIONS. THE SYSTEM IS NOT IN CONTINUOUS SERVICE.
OVERFLOW	LIQUID INFLOW EXCEEDS LIQUID OUTFLOW	HIGH LIQUID LEVEL	VENT (LSHH V222.3)		LSHH V222.3 GIVES ALARM ONLY
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW LIQUID LEVEL			△2 NONE HAZARDIOUS EVENT. CV 222 IS LOCATED WITHIN THE BEAMS, BELOW CELLAR DECK ELEVATION.

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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SAFETY ANALYSIS TABLE
(SAT)
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CR 05 1430

DRWG. NO
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ITEM NO. CP 224 SERVICE DRAINAGE TANK PUMP FLOW DIAGRAM REFERENCE FF 88 00 10 5100 REV. 4

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED DISCHARGE LINE	HIGH PRESSURE			PSH AND ISV NOT REQUIRED SINCE MAX PUMP DISCHARGE PRESSURE WILL NOT EXCEED RATED WORKING PRESSURE ON DISCHARGE PIPING. PSL AND SECONDARY PROTECTION NOT REQUIRED SINCE NONE HAZARDIOUS EVENT.
LEAK	RUPTURE	LOW PRESSURE AND	FSV		
	DETERIORATION	BACKFLOW			
	ACCIDENT				

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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CH 05 1430

DRWG. NO.
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[illegible]EM NO. C2000 EFS 20"P/C2001 EFS 16"P SERVIC[illegible] IN INCOMING PIPELINE FLOW DIAGRA[illegible] REFERENCE FF 88 00 00 5030 Rev. 2

[illegible]ESIRABLE EVENT	CAUSE	DET[illegible]ABLE CON[illegible]ION AT COMPONENT	PROTECTION		[illegible]MENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED LINE	HIGH PRESSURE			OVERPRESSURE NOT POSSIBLE SINCE MAWP IS HIGHER THAN MSWHP
LEAK	DETERRIORATION RUPTURE ACCIDENT	LOW PRESSURE BACKFLOW	PSL M201.1 FSV	ESS	

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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ITEM NO. C2100 EFS 16"P/C2107 EFS 14"P SERVICE [illegible]F INCOMING PIPELINE FLOW DIAGRAM REFERENCE FF 88 000 0 5031 Rev. 10

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED LINE	HIGH PRESSURE			OVERPRESSURE NOT POSSIBLE SINCE MAWP IS HIGHER THAN MSWHP
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE BACKFLOW	PSL M210.1 FSV	ESS	

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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ITEM NO. C178 EF 4"P/4"P 2032 F3A SERVICE METHANOLATED WATER INJECTION TO DP2 FLOW DIAGRAM REFERENCE FF 88 00 10 5033 Rev 6 /83 00 54 51( )v 4

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED LINE PLUGGED FORMATION	HIGH PRESSURE			PROTECTION NOT REQUIRED SINCE MAX INJECTION PRESSURE IS LESS THAN THE WORKING PRESSURE OF THE PIPING
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE BACKFLOW	PSL M9.3 FSV △1	ESS	

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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ITEM NO. C 2236 EFS 11"ME SERVICE ARTICULATED COLUMN FLOW DIAGRAM REFERENCE FF 88 00 09 5036 Rev. 3

UNDESIRABLE EVENT	CAUSE	DETECTABLE CONDITION AT COMPONENT	PROTECTION		COMMENTS
			PRIMARY	SECONDARY	
OVERPRESSURE	BLOCKED LINE	HIGH PRESSURE	PSH P12.4		SECONDARY PRETECTION NOT REQUIRED SINCE MAX PRESSURE IS LESS THAN THE WORKING PRESSURE OF THE PIPING
LEAK	DETERIORATION RUPTURE ACCIDENT	LOW PRESSURE BACKFLOW	PSL P12.5 FSV	ESS	

REV. NO.	REVISION	DATE	BY	APPR.	APPR. BY CLIENT
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elf aquitaine norge a/s P.O.Box 168 - 4001 Stavanger

FRIGG FIELD

DATE	CONSTR.	APPR.	SCALE
13/06/81	JIN		

TITLE

SAFETY ANALYSIS TABLE (SAT)

TCP 2 EXTENSION

sofresid norge a.s

CH 05 1430

DRWG. NO.
CH-FF 88 00 00 4142
Sheet 28/28

APPENDIX 5

SAFETY ANALYSIS FUNCTION EVALUATION CHART

SAFETY ANALYSIS FUNCTION EVALUATION CHART (SAFE)

PLATFORM IDENTIFICATION
TCP 2 EXTENSION

PROCESS COMPONENT IDENTIFICAT	SERVICE	DEVICE ID	SAT REF NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	
				FUNCTION PERFORMED	CLOSE ODIN SEA LINE	BLOW DOWN		CLOSE GAS INLET CV1A	CLOSE COND. OUTLET CV1A	CLOSE COND. OUTLET CV1A	CLOSE GAS OUTLET CV1A	BLOW DOWN CV1A		CLOSE GAS OUTLET CV 201	CLOSE GAS OUTLET CV 201	CLOSE COND. OUTLET CV 201	BLOW DOWN CV 201		CLOSE METH. WATER TO CV 220		CLOSE COND. OUTLET CV 204		CLOSE NEF SEA LINE	BLOW DOWN		CLOSE GAS INLET CV 210	CLOSE COND. OUTLET CV 210	CLOSE COND. OUTLET CV 210	CLOSE GAS OUTLET CV 210	BLOW DOWN CV 210		CLOSE GAS OUTLET CV 211	CLOSE GAS OUTLET CV 211	CLOSE COND. OUTLET CV 211	BLOW DOWN CV 211		CLOSE METHWATER OUTLET CV 213		ESD SIGNAL TO NEF FC	ESD SIGNAL TO ODIN P	ESD SIGNAL TO DP			CLOSE COND. OUTLET CV 213		CLOSE COND. OUTLET FROM CV 220	CLOSE METH. WATER FROM CV 220	CLOSE DRAINAGE FROM CV 226		CLOSE METH. TO NEF FCS	CLOSE METH. WATER TO DP 2		CLOSE METH. WATER TO DP 2		STOP METH. WATER PUMPS		STOP METH. TO NEF		START FIRE WATER PUMP	OPEN DELUGE VALVE	STOP TEG PUMP	STOP TEG PUMP	STOP TEG PUMP		START DRAINAGE TANK PUMP		STOP DRAINAGE TANK PUMP		MINIMIZE BACK FLOW		VACUUM RELIEF		PRESSURE RELIEF		SHUT DOWN ALL FIELD		PRE ALARM CCR		SHUT DOWN ALARM CCR	
				SHUT DOWN OR CONTR. DEVICE ID EQUIP OR LINE NO	C 2000EFS 20"P	C 2032EFS 2"R		CV1A	CV1A	CV1A	CV1A	CV1A		CV 201	CV 201	CV 201	CV201		CV204		C2056EB 2"P		C2100EF 16"P	C2133EFS 2"R		CV 210	CV 210	CV 210	CV 210	CV 210		CV 211	CV 211	CV 211	CV 211		CV 213							C2154EB 2"P		CV 220	CV 220	C2271EAI 2"P			C178EF 4"P																														
				TAG NO	ESDV-M201.1	ESDV-M201.2		ESDV-V1A.1	ESDV-V1A.2	ESDV-V1A.3	ESDV-V1A.4	ESDV-V1A.5		ESDV-V201.1A	ESDV-V201.1B	ESDV-V201.3	ESDV-V201.2		ESDV-V204.2		ESDV-V204.1		ESDV-M210.1	ESDV-M210.2		ESDV-V210.1	ESDV-V210.2	ESDV-V210.3	ESDV-V210.4	ESDV-V210.5		ESDV-V211.1A	ESDV-V211.1B	ESDV-V211.3	ESDV-V211.2		ESDV-V213.2							ESDV-V213.1		ESDV-V220.1	ESDV-V220.2	ESDV-V226.1		ESDV-P12.1	ESDV-M8.2		ROV 223		CP 222 A/B		CP 12 A/B		CP 6 A/B		CP 220 A	CP 220 B	CP 220 C		CP 224		CP 224													
CP2000EFS 20"P	PRESSURE IN ODIN WET GAS HEADER	PSL-M201.1	CH-FF 88 00004142	1	●			●	●	●	●			●	●	●			●		●																			●																					●		●																●	1
		PSH-M201.2	SHT. 25/28	2	●																																			●																																								●	2
		FSV	"	3																																																													●											3
C2037EFS 2"R	PIG RECEIVER PRESSURE	PSV M201.1	SHT 1/28	4																																																																●							4
			"	5																																																																									5
CV 1A SLUG CATCHER	PRESSURE PROTECTION	PSL-V1A.2A	SHT. 2/28	6				●	●	●	●			●	●	●			●		●																																						●		●																●	6
		PSH-V1A.2A	"	7																																																																						●			7
		PSV-V1A.6	"	8																																																																		●							8
		PSV-V1A.7	"	9																																																																		●							9
	LEVEL PROTECTION	LSL-V1A.2A	"	10																																																																							●			10
		LSH V1A.6A	"	11																																																																							●			11
		LSLL V1A.7A	"	12					●	●																																																																		●	12
		LSHH-V1A.8A	"	13				●			●																																																																			●	13
		FSV	"	14																																																													●											14
CV 201 GAS SCRUBBER	PRESSURE PROTECTION	PSL-V201.3	SHT. 3/28	15				●	●	●	●			●	●	●			●		●																																						●		●																●	15
		PSV-V201.1	"	16																																																																		●							16
		PSV-V201.2	"	17																																																																		●							17
	LEVEL PROTECTION	LSL-V201.3	"	18																																																																							●			18
		LSH-V201.2	"	19																																																																							●			19
		LSLL-V201.5	"	20												●																																																													●	20
		LSHH-V201.4	"	21							●			●	●																																																														●	21
		FSV 3 PCS	"	22																																																												●											22
CE 203 COND HEATER	TEMP PROTECTION	TSH-E203.5	SHT 6/28	23																																																					●		●																●	23
CV 204 CONDENSATE METH SEPARATOR	PRESSURE PROTECTION	PSL-V204.3	SHT 8/28	24					●							●			●		●																																									●		●																●	24
		PSH-V204.5	"	25					●							●																																													●		●																●	25
		PSV-V204.1	"	26																																																																		●							26
		PSV-V204.2	"	27																																																																		●							27
		FSV 3 PCS	"	28																																																												●											28
	LEVEL PROTECTION	LSL-V204.2	"	29															●		●																																																											●	29
		LSH-V204.5	"	30					●							●																																													●		●																●	30
C2100 EF 16"P	PRESSURE IN NEF WET GAS HEADER	PSL-M210.1	SHT 26/28	31																			●				●	●	●	●			●	●	●			●		●					●																		●	●																●	31
		PSH-M210.2	"	32																		|●|															|●|																																									|●| 32
		FSV	"	33																																																												●											33
CV-210 NEF SLUG CATCHER	PRESSURE PROTECTION	PSL-V210.1	SHT. 4/28	34																			●				●	●	●	●			●	●	●			●							●																		●	●																●	34
		PSH-V210.2	"	35																																																																							●			35
		PSV-V210.1	"	36																																																																		●							36
		PSV-V210.2	"	37																																																																		●							37
		FSV	"	38																																																												●											38
	LEVEL PROTECTION	LSL-V210.2	"	39																																																																							●			39
		LSH-V210.6	"	40																																																																							●			40
		LSLL-V210.7	"	41																								●	●																																																			●	41
		LSHH-V210.8	"	42																							●			●																																																		●	42
CV 211 GAS SCRUBBER	PRESSURE PROTECTION	PSL-V211.3	SHT. 5/28	43																							●	●	●	●			●	●	●			●							●																		●	●																●	43
		PSV-V211.1	"	44																																																																		●							44
		PSV-V211.2	"	45																																																																		●							45
		FSV	"	46																																																												●											46
	LEVEL PROTECTION	LSL-V211.3	"	47																																																																							●			47
		LSH-V211.2	"	48																																																																							●			48
		LSLL-V211.5	"	49																														|●|																																															|●| 49
		LSHH-V211.4	"	50																									|●|	|●|●|																																																	|●| 50
CE 211 COND. HEATER	TEMPERATURE PROTECTION	TSH-E211.5	SHT 7/28	51																																																							●	●																	●	51
				52																																																																										52
CV-213 CONDENSATE METH. SEPARATOR	PRESSURE PROTECTION	PSL-V213.3	SHT 9/28	53																								●							●			●								●																			●	●																●	53
		PSH-V213.5	"	54																								●							●																															●	●																●	54
		PSV-V213.1	"	55																																																																		●							55
		PSV-V213.2	"	56																																																																		●							56
		FSV 3 PCS	"	57																																																												●											57
	LEVEL PROTECTION	LSL-V213.2	"	58																															|●|					|●|																																							|●| 58
		LSH-V213.5	"	59																								●							●																																●	●																●	59
CV 220 METH. WATER FLASH DRUM	PRESSURE PROTECTION	PSL-V220.4	SHT 11/28	60														|●|																|●|										|●|●|																					|●|											|●| 60
		PSH-V220.3	"	61														|●|																|●|																																			|●|											|●| 61
		PSV-V220.1	"	62																																																																		●							62
		PSV-V220.2	"	63																																																																		●							63
		FSV	"	64																																																												●											64
		FSV	"	65																																																												●											65
		FSV	"	66																																																												●											66
	LEVEL PROTECTION	LSL-V220.2	"	67																																							|●|																																				|●| 67
		LSL-V220.7	"	68																																						|●|																																					|●| 68
		LSH-V220.6	"	69														|●|																|●|																																			|●|											|●| 69
		LSH-V220.8	"	70																																																																							●			70
CP225A INH.PUMP	PRESSURE PROTECTION	PSV-V225A.1	SHT 14/28	71																																																																		●							71
		FSV	"	72																																																											●											72
CP225B INH PUMP	PRESSURE PROTECTION	PSV V225B.1	SHT 15/28	73																																																																		●							73
		FSV	"	74																																																												●											74
C178EF 4"P	PRESS. PROTECT	PSL-M8.3	SHT. 27/28	75																																											●		●		●																									●	75
CV 8 METHANOLATED WATER STORAGE TANK	PRESSURE PROTECTION	PSV-8.2A	SHT 18/28	76																																																																●									76
		PSV-8.2B	"	77																																																																		●							77
		PSV-8.3	"	78																																																																●		●							78
	LEVEL PROTECTION	LSL-V8.4	"	79																																																																							●			79
		LSH-V8.4	"	80																																																																							●			80
CP 222A MW INJ PUMP			SHT. 21/28	81																																																																									81
		FSV	"	82																																																												●											82
CP 222B MW INJ PUMP			"	83																																																																										83
		FSV	"	84																																																												●											84
CP220 A TEG PUMP		PSL-P220A-1	SHT 22/28	85																																																						●																			●	85
		FSV	"	86																																																												●											86
CP220B TEG PUMP		PSL-P220B-1	"	87																																																							●																		●	87
		FSV	"	88																																																												●											88
CP220C TEG PUMP		PSL-P220C-1	"	89																																																								●																	●	89
		FSV	"	90																																																												●											90
CV17A GLYCOL SURGE TANK	LEVEL PROTECTION	LSL-V17A-1A		91																																																																								●			91
		LSH-V17A.3		92																																																																								●			92
CV17B GLYCOL SURGE TANK	LEVEL PROTECTION	LSL-V17B.1A		93																																																																								●			93
		LSH-V17B.3		94																																																																									●			94
CV 17C GLYCOL SURGE TANK	LEVEL PROTECTION	LSL-V17C.1A		95																																																																								●			95
		LSH-V17C.3		96																																																																								●			96
CV 23 METH TANK	LEVEL PROTECTION	LSL-V23.1	SHT 16/28	97																																																																								●			97
		LSH-V23.1	"	98																																																																								●			98
		LSLL-V23.5	"	99																																																			●																							●	99
	PRESSURE PROTECTION	PSV-V231A	"	100																																																																	●							100
		PSV-V231B	"	101																																																																●									101
		PSV-V23.3	"	102																																																																●		●							102
CP 12 A/B METHANOL INJ PUMPS	PRESSURE PROTECTION	PSV-P12.3	SHT 17/28	103																																																																●							103
		PSV-P12.4	"	104																																																																		●							104
		FSV	"	105																																																											●											105
		FSV	"	106																																																												●											106
		PSL-P12.5	SHT.28/28	107																																											●								●																							●	107
		PSH-P12.4	"	108																																											●								●																							●	108
CV 222 METH WATER DRAIN TANK	LEVEL PROTECTION	LSL-V222.1	SHT 23/28	109																																																													●													109
		LSH-V222.2	"	110																																																												●															110
		LSHH-V222.3	"	111																																																																								●			111
CP 224 OR PP	PRESS PROTECT.	FSV	SHT 24/28	112																																																												●											112
CV 226 LL RELIEF SCRUBBER	LEVEL PROTECTION	LSL-V226.3	SHT 10/28	113																																									●																																				●	113
		LSH-V226.2	"	114																																																																								●			114
	PRESS PROTECT	PSH-V226.2	"	115																																																																								●			115
PUSH BUTTON	1ST LEVEL SD	1 PC		116	●			●	●	●	●			●	●	●			●		●		●			●	●	●	●			●	●	●			●		●	●	●			●		●	●			●	●		●		●		●		●		●	●	●				●								●				●	116
" "	2ND LEVEL SD	2 PCS		117	●	●		●	●	●	●	●		●	●	●	●		●		●		●	●		●	●	●	●	●		●	●	●	●		●		●	●	●			●		●	●			●	●		●		●		●		●		●	●	●				●												●	117
" "	3RD LEVEL SD	2 PCS		118	●			●	●	●	●			●	●	●			●		●		●			●	●	●	●			●	●	●			●		●	●	●			●		●	●			●	●		●		●		●		●		●	●	●				●												●	118
" "	4TH LEVEL SD	3 PCS	ODIN	119				●	●	●	●			●	●	●			●		●																																									●		●																●	119
" "	4TH LEVEL SD	3 PCS	NEF	120																							●	●	●	●			●	●	●			●							●																		●	●																●	120
DETECTORS	FIRE DETECTOR	5 PCS	FAB	121	●			●	●	●	●			●	●	●			●		●		●			●	●	●	●			●	●	●			●		●	●	●			●		●	●			●	●		●		●		●		●		●	●	●				●												●	121
"	FIRE DETECTOR	18 PCS	UV & SD	122	●			●	●	●	●			●	●	●			●		●		●			●	●	●	●			●	●	●			●		●	●	●			●		●	●			●	●		●		●		●		●	●	●	●	●				●												●	122
"	GAS DETECTOR	20 PCS	GD	123	●			●	●	●	●			●	●	●			●		●		●			●	●	●	●			●	●	●			●		●	●	●			●		●	●			●	●		●		●		●		●	●	●	●	●				●												●	123
ESD SIGNALS FROM OTHER PLATFORMS	SD SIGNAL		FROM ODIN	124 |●|																																																																											|●| 124
	SD SIGNAL		FROM NEF	125																			●																																																										●	125
	SD SIGNAL		FROM DP 2	126																																											●				●																									●	126
				127																																																																										127
				128																																																																										128

03	30 11 83	AS BUILT
02	19 10 83	UPDATED ACC TO EAN COMM.
01	07 10 83	UPDATED
00	16.05.81	

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TCP 2

TCP 2 EXTENSION
SAFETY ANALYSIS FUNCTION
EVALUATION CHART
GAS AND LIQUID TREATMENT

FF

88 16 00 4143

03

APPENDIX 6

FUNCTIONAL DESCRIPTION OF THE ESD SYSTEM

S-FF 88 16 9520

REV.	DATE	DESCRIPTION	BY	APP.	CLIENT
2	26.11.81	UPDATED PAGE 4, 5 AND 6	JKa		
1	13.10.81	UPDATED ACCORDING TO EAN COMMENTS	JKa		
0	12.6.81	First issue	JKa		

sofresid norge a.s

NO.: PR 08 000 01202

TCP 2 EXTENSION

elf aquitaine norge a/s P.O. Box 168 — 4001 Stavanger

	Installation	System
A4	TCP 2	HYDR. AND SHUT DOWN

Job no.
F 087

Scale
–

FUNCTIONAL DESCRIPTION
OF THE ESD SYSTEM

FRIGG FIELD

Drwg. no.	Rev.	Sheet
S-FF 88 16 9520	02	1/6

TABLE OF CONTENTS

1.0 GENERAL

The emergency shut down system (ESD) for TCP 2 extension is fully integrated in the existing ESD system for the TCP 2 platform and based on the same philosophy.

The intention with the ESD system is to avoid dangerous situations or limit the consequences of same, to avoid disturbances in parts of the process or damage on process equipment.

The system is split into five levels, and the consequences of the action on each level is described in section 2.0.

The system can be released either manually by push buttons or automatically by fire/gas detection or process fault depending upon which level it is released. The ESD valves can only be opened again when the reason for ESD action is eliminated and authorization signal is given from control center.

Time response for the system will be within 45 seconds i.e. the time from the signal is initiated by the sensor till the ESD valve is fully closed shall not exceed 45 seconds.

Three auxiliary systems are utilized to operate the ESD system. These are as follows:

A. Hydraulic Power System
See Hydraulic System Description Appendix B.

B. Instrument Air
See drawing FF 87 00 00 1003 - Plant and Instrument Air System on TCP 2

Instrument air at 1.4 bar, 2.5 bar and 7 bar, is supplied from the existing Instrument Air System and is provided with back-up air bottles in order to provide safe operation in case of failure in air supply.

C. Electric power is fed from the existing No Break System which has a battery back-up.

Voltages: 220 V AC
110 V DC
48 V DC
24 V DC

See drawing FF 85 23 03 00 84.

2.0 SYSTEM DESCRIPTION

Location of the ESD valves is shown on drawing FF 88 00 00 0102 Schematic Process Diagram.

The ESD logic for the field is shown on drawing FE 00 16 00 5801 Frigg Field Shut Down General Logic Diagram. Drawing FF 88 16 08 9551 Shut Down Detail Logic Diagram presents the ESD logic for TCP 2 treatment extension which is incorporated in the total system. 4th and 5th level is defined as process safety system, see S-FF 88 16 08 9521 Description of Process Safety System.

1st level:

1st level shut down can only be released manually by using the push button in QP Central Control Room (CCR). The action is shut down of all field included isolation of the platforms by closing ESD valves on bridge lines. It also includes Disaster Shut Down signal (DSD) on DP 2 and CDP 1. There is no cascade action to level 2 and hence no decompression. 5.5 kV generators TA 4, 5 and 6 will be shut down. Non essential electrical consumers is isolated and fire water pumps CP6A and CP6B will start.

2nd level:

2nd level shut down of TCP 2 treatment is also only manually released by push buttons located in QP CCR and TCP 2 Interface Room. The action is the same as for 1st level with following exceptions:

5.5 kV generators are not affected.
ESD signal only to DP 2.
Decompression of bridge and treatment lines.

3rd level:

3rd level shut down can be released either manually by push buttons or automatically by fire or gas detection. 7 push buttons are located on different places for manual release (See drawing FF 88 16 08 9551 Shut Down Detail Logic Diagram). Note that 4 of these push buttons also will cause 3rd level shut down both on treatment and compression part of TCP 2.

Action on 3rd level is as for 2nd level with following exceptions:

No ESD signal to DP 2. Automatic release of Deluge Valves for relevant fire/gas affected area in parallel with 3rd level shut down. Note that Deluge Valves will not be released by operating of push buttons.

<u>4th and 5th level:</u>

4th and 5th level shut down are defined as process safety system. Release on 4th level is both manually and automatically, whilst 5th level is only automatically released by process faults. The ESD valves are grouped together in three groups. Group "O" is ODIN stream isolation, group "N" is NEF stream isolation and group "U" is closing of sealines. Group "U" will only be closed by 3rd level shut down or higher levels, whilst group "O" and "N" will also be closed by 4th level shut down. 5th level is only selective i.e. a process fault will only close one or a certain number of ESD valves. For further information about 4th and 5th level shut down, see FF 88 16 08 9521 Description of Process Safety System.

3.0 REFERENCE LIST, DRAWINGS AND SPECIFICATIONS

FF 88 00 00 0102	Schematic Process Diagram
FE 88 16 00 5801	Frigg Field Shut Down General Logic Diagram
FF 88 16 08 9155	Shut Down & Safety Functions TCP2 Extension Overall Block Diagram
FF 88 16 06 9152	Fire Detection Logic Principal Diagram
FF 88 16 06 9153	Gas Detection Logic Principal Diagram
FF 88 16 06 9151	Public Address and Alarm System Block Diagram
FF 88 16 08 9551	Shut Down Detail Logic Diagram
FF 88 16 08 9561	ESD Pneumatic Schmatics Group "O".
FF 88 16 08 9562	ESD Pneumatic Schematics Group "U".
FF 88 16 08 9564	Pneumatic Schematics Group "N".
ELD 2169 Sheet 7379	Safety Plot Plan Main Deck
FF 88 00 00 4012	Safety Plot Plan M50 Main Deck
FF 88 16 08 1832	Type A Pneumatic ESDV Control Schematic
FF 88 16 08 1833	Type B Hydraulic ESDV Control Schematic
FF 88 16 08 1835	Type D Pneumatic ESDV Control Schematic
S-FF 88 20 2600	Specification for ESD Valves
S-FF 88 16 2940	Specification for Hydraulic & Pneumatic Control Enclosures
S-FF 88 16 1512	Specification for Level Switches
S-FF 88 16 3110	Specification for Pressure Switches
S-FF 88 16 4002	Specification fo Temperature Switches
Appendix B	Hydraulic System Description
FF 85 23 03 00045	Master One Line Diagram for Emergency Supplies
FF 87 00 00 1003	Plant and Instrument Air System on TCP 2
FF 87 23 03 8800	Low Voltage Consumers for 380 V MCC "A"
FF 87 23 03 8810	Low Voltage Consumers for 380 V MCC "B"

APPENDIX B

DESCRIPTION OF HYDRAULIC SYSTEM

APPENDIX B

HYDRAULIC SYSTEM DESCRIPTION

HYDRAULIC POWER GENERATION

Hydraulic power for Module M50 and ESDV's on sealines will be derived from the existing treatment hydraulic power generator by extending the existing ring main shown schematically on drawing no. FF 88 00 0800 02.

The existing system has the following capacity:

Max. Press	138 Bar
Min. Press	125 Bar
Pumping Rate	100 l/min.

It is estimated that with the present load its recovery time is approximately 7 minutes if the full ESDV back up is utilized.

The additional load imposed by the extension amounts to approximate 100 litres if the full ESDV back up is used.

Therefore the new recovery time will be approximately 9 minutes.

The hydraulic system for M50 will consist of a ring main with dedicated local accumulator stations for each ESDV valve.

Each ESDV will be controlled by means of a local control enclosure. This will provide either a local or remote facility to close the valve, with the local control having priority. Opening of the valve is accomplished locally, but requires that an ESDV status does not exist, that there is no remote close requirement and that authorization has been given to open the valve. Pneumatic valves in Pancake 53 operate in a similar manner.

The control enclosure schematics are shown on drawings no.:

FF 88 16 00 1832 - Type A Pneumatic ESDV Control Schematic
(DD 08 P53 06807)

FF 88 16 08 1833 - Type B Hydraulic ESDV Control Schematic
(DD 08 M50 06808)

FF 88 16 08 1834 - Type C Hydraulic HV Control Schematic
(DD 08 M50 06809)

FF 88 16 08 1835 - Type D Pneumatic ESDV Control Schematic
(DD 08 M50 06810)

For hydraulic valves these schematics are identical to those on the existing treatment unit.

Actuators are of the double acting hydraulic type except for those valves located in the Pancake 53 which are of the double acting pneumatic type. The blow down valves are conventional fail open control valves fitted with travel stops to limit the flow through the valve.

Provision is made to supply all ESDV valves except blow down valves with either a hydraulic or pneumatic back up accumulator/volume tank capable of providing 2 cyclic (4 single strokes) operations of the valve.

APPENDIX 7

DESCRIPTION OF PROCESS SAFETY SYSTEM

S-FF 88 16 08 9521

REV.	DATE	DESCRIPTION	BY	APP.	CLIENT
1	20.10.81	Updated acc. to EAN comments	JKa	JEL	
00	13.10.81	First issue	JKa	JL	

sofresid norge a.s NO.: SP 08 000 6801

TCP 2 EXTENSION

elf aquitaine norge a/s P.O. Box 168 — 4001 Stavanger

	Installation	System
A4	TCP 2	HYDR. & SHUT DOWN

Job no. F 087

Scale –

DESCRIPTION OF PROCESS
SAFETY SYSTEM

FRIGG FIELD

Drwg. no. S- FF 88 16 08 9521

Rev. 01

Sheet 1

TABLE OF CONTENT

1.0 GENERAL

The Process Safety System is an integrated part of the total ESD System, which is split in five levels. Ref. FF 88 16 08 9520 - Functional description of the ESD System. The Process Safety System is formed by 5th and 4th level in the ESD System. The intention with the Process Safety System is to close either one or a certain number of ESD valves in the process when abnormal conditions occur, in order to avoid dangerous situations, disturbances in other parts of the process or damage on process equipment. Thus, a process safety function is to be defined as closing of an ESD valve/valves or a pump to be switched off.

All process safety functions on 5th level are initiated automatically by sensors located in different places in the process. 4th level signals are initiated either automatically by sensors or manually by push buttons. The push buttons are located in QP central control room, interface room on TCP 2 and locally in the field. (See drawing ELN 2169 sheet C7379 - Safety Plot Plan Main Deck FF 88 00 00 4012 - Safety Plot Plan M50 Main Deck.). Note that signals from 4th level will close the whole stream on either NEF or ODIN.

Three auxiliary systems are utilized to operate the ESD and Process Safety System. These are as follows:

A. Hydraulic Power System
See Hydraulic System Description Appendix I.

B. Instrument Air
See drawing FF 87 00 00 1003 - Plant and Instrument Air System on TCP 2

Instrument air at 1.4 bar, 2.5 bar & 7 bar, is supplied from the existing Instrument Air System and is provided with back-up air bottles in order to provide safe operation in case of failure in air supply.

C. Electric power is fed from the existing No Break System which as a battery back-up.

Voltages: 220 V AC
110 V DC
48 V DC
24 V DC

See drawing FF 85 23 03 0045.

Time response for the system will be within 45 seconds i.e. the time from the signal is initiated by the sensor till the ESD valve is fully closed shall not exceed 45 seconds.

2.0 PROCESS SAFETY CONTROL LOOPS, GENERAL

A process safety control loop consists of following components:

A. Sensors monitoring the process condition, i.e. pressure, temperature and liquid level in the different vessels. These are all switches with air supply and pneumatic on/off output signal.

B. Auxiliary Components

  B.1 Pneumatic/electric switches located in pneumatic switch cabinet in interface room.

  B.2 Relays and solenoid valves located in ESD cabinet in interface room.

  B.3 Pneumatic operated pilot valves located close to the different control enclosures and ESD valves.

  B.4 Pneumatic/hydraulic control enclosures located close to the ESD valve.

C. ESD valve with built on pneumatic or hydraulic actuator depending on valve size and torque.

D. Alarm circuit with visual and audible signal in QP control room.

3.0 PROCESS SAFETY CONTROL LOOPS, PNEUMATIC

Closing of ESD Valves

Ref. drwg.'s no.:

FF 88 16 08 9561	Pneumatic Schematic Group "O"
FF 88 16 08 9562	Pneumatic Schematic Group "U"
FF 88 16 08 9564	Pneumatic Schematic Group "N"

On 5th and 4th level the ESD valves are closed almost directly when the output signal from the sensor in the process is removed.

Example: High liquid level in CV1A. See drawing FF 88 16 08 9561 - Pneumatic Schematics Group "O".

When in normal condition there is a continuous control signal from LSHH V1A.8A to pilot valve LV V1A.8A which keeps this open between inlet and outlet and allows for the air supply to the control enclosure and ESDV V1A.1 is in open position. If the level in CV1A rizes and pass the set point for LSHH V1A.8A the control signal to LV V1A.8A is vented and this will switch over to vent position. Air supply to the control enclosure is vented and ESDV V1A.1 will close. For functioning of pneumatic/ hydraulic control enclosures see following drawings:

FF 88 16 00 1832	- Type A	Pneumatic ESDV Control Schematic
FF 88 16 08 1833	- Type B	Hydraulic ESDV Control Schematic
FF 88 16 08 1835	- Type D	Pneumatic ESDV Control Schematic

All types of control enclosures are equipped with devices for local closing of the valve and also devices for testing of ESD valve functioning.

The alarm circuit will be activated by a pneumatic/electric switch in interface room from where the signal is passed via telemetry to alarm circuit in control room on QP. The input signal to the pneumatic/electric switch in interface room comes from the same sensor as closes the ESD valve. The ESD valve status is also shown on a mimic panel in control room and the input signal for this is provided from two limit switches mounted on the ESD valve.

When automatically closed, valves will remain closed even if the relevant cause of shut-down has disappeared. The operator will have to restart the process manually after investigation and elimination of the prime cause and after authorization signal is given for central control room.

4.0 PROCESS SAFETY CONTROL LOOPS, ELECTRICAL

Stop of Pumps

All control loops for stop of pumps are electrical except the primary signal from the sensor in the process which is pneumatic. This signal is transferred to an electric signal in the pneumatic switch cabinet in interface room and passed from there to the ESD cabinet where it operates a relay. A contact set on the relay is connected to the pump motor starter circuit and will switch off the power to this.

Ref. drwg.'s:

FF 87 23 03 8800 - Low Voltage Consumers for 380 V MCC "A"

FF 87 23 03 8810 - Low Voltage Consumers for 380 V MCC "B"

5.0 REFERENCE LIST, DRAWINGS AND SPECIFICATIONS

FF 88 00 00 5030	ODIN Gas Treatment
FF 88 00 00 5031	NORTH EAST FRIGG Gas Treatment
FF 88 00 11 5032	NEF and ODIN Liquid Treatment Condensate Separation
FF 88 00 10 5033	NEF and ODIN Liquid Treatment Methanolated Water
FF 88 00 00 5034	NEF and ODIN Liquid Treatment TEG & MW Facilities
FF 88 00 09 5036	NEF and ODIN Treatment Methanol Injections
FF 88 00 04 5090	NEF and ODIN Treatment Flare System
FF 88 00 10 5100	NEF and ODIN Treatment Process Drainage System
FF 83 00 54 5101	NEF and ODIN Liquid Treatment Methanolated Water Injection on DP 2

All drawings above are relevant P & ID's to this description.

FF 88 16 00 4143	TCP 2 Extension Safety Analysis Function Evaluation Chart (SAFE)	
FF 88 16 08 9551	Shut Down Detail Logic Diagram	
FF 88 16 08 9561	ESD Pneumatic Schematics Group "O"	
FF 88 16 08 9562	ESD Pneumatic Schematics Group "U"	
FF 88 16 08 9564	Pneumatic Schematics Group "N"	
ELN 2169 Sheet 7379	Safety Plot Plan Main Deck	Location of ESD push buttons level 4
FF 88 00 00 4012	Safety Plot Plan M50 Main Deck	
FF 88 16 08 1832	Type A Pneumatic ESDV Control Schematic	
FF 88 16 08 1833	Type B Hydraulic ESDV Control Schematic	
FF 88 16 08 1835	Type D Pneumatic ESDV Control Schematic	
S-FF 88 20 2600	Specification for ESD Valves	
S-FF 88 16 2940	Specification for Hydraulic & Pneumatic Control Enclosures	

S-FF 88 16 1512	Specification for Level Switches
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APPENDIX B

DESCRIPTION OF HYDRAULIC SYSTEM

APPENDIX B

HYDRAULIC SYSTEM DESCRIPTION

HYDRAULIC POWER GENERATION

Hydraulic power for Module M50 and ESDV's on sealines will be derived from the existing treatment hydraulic power generator by extending the existing ring main shown schematically on drawing no. FF 88 00 0800 02.

The existing system has the following capacity:

Max. Press	138 Bar
Min. Press	125 Bar
Pumping Rate	100 l/min.

It is estimated that with the present load its recovery time is approximately 7 minutes if the full ESDV back up is utilized.

The additional load imposed by the extension amounts to approximate 100 litres if the full ESDV back up is used.

Therefore the new recovery time will be approximately 9 minutes.

The hydraulic system for M50 will consist of a ring main with dedicated local accumulator stations for each ESDV valve.

Each ESDV will be controlled by means of a local control enclosure. This will provide either a local or remote facility to close the valve, with the local control having priority. Opening of the valve is accomplished locally, but requires that an ESDV status does not exist, that there is no remote close requirement and that authorization has been given to open the valve. Pneumatic valves in Pancake 53 operate in a similar manner.

The control enclosure schematics are shown on drawings no.:

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(DD 08 P53 06807)

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(DD 08 M50 06808)

FF 88 16 08 1834 - Type C Hydraulic HV Control Schematic
(DD 08 M50 06809)

FF 88 16 08 1835 - Type D Pneumatic ESDV Control Schematic
(DD 08 M50 06810)

For hydraulic valves these schematics are identical to those on the existing treatment unit.

Actuators are of the double acting hydraulic type except for those valves located in the Pancake 53 which are of the double acting pneumatic type. The blow down valves are conventional fail open control valves fitted with travel stops to limit the flow through the valve.

Provision is made to supply all ESDV valves except blow down valves with either a hydraulic or pneumatic back up accumulator/volume tank capable of providing 2 cyclic (4 single strokes) operations of the valve.

APPENDIX 8

PRESSURE DROP CALCULATIONS FOR LP VENT SYSTEM

CALCULATION NOTES

CLIENT:	E.A.N.	PROJECT:	TCP-2 Extension	SHEET 1	OF 2
DISCIPLINE:	Process	ENGINEER:	JIN	REF.:	
SUBJECT:	LP vent header pressure drop calculation				

The below calculations are based on maximum flow rate released through the LP vent system. This flow rate corresponds to fire on the pancake, which will release 0.348 MSCM/D or 10608 kg/hr.

The pressure drop is calculated using the Darcy formula:

$$(\Delta P_{100}{}^{1}) = \frac{4f \times 0.000336 \times W^2}{(ID)^5 \times \rho}$$

where $(P_{100}{}^{1})$ = the pressure drop in psi/100 ft
f = fanning friction factor
W = flow rate in lb/hr (23387 lb/hr)
ID = internal diameter of pipe in inches (10.02)
ρ = gas density in lb/cuft

The friction factor "f" is determined from Reynolds number:

$$Re = \frac{6.32 \times W}{\mu d}$$

where μ = gas viscosity in cp (0.011)

$$Re = \frac{6.32 \times 23387}{0.011 \times 10.02} = 1341007$$

Since $Re > 4000$, $f = \frac{0.04}{Re^{0.172}} = 0.00353$

CALCULATION NOTES

CLIENT:	E.A.N.	PROJECT:	TCP-2 Extension	SHEET 2 OF 2	
DISCIPLINE:	Process	ENGINEER:	JIN	REF.:	
SUBJECT:	LP vent header pressure drop calculation				

Gas density @ 1.5 bara : $\rho = \frac{1.5 \times 17.3}{293.15 \times 0.08314} = 1.065 \text{ kg/m}^2$

(0.0665 lb/cuft)

Pressure drop

$$\left(\Delta P_{100}{}^{1}\right) = \frac{4 \times 0.00353 \times 0.000336 \times (23387)^2}{(10.02)^5 \times 0.0665} = \underline{0.386 \text{ psi/100 ft}}$$

Equivalent length:

75 m = 246 ft
6 ellbows = 72 ft
1 enlargement 10"/14" = 7 ft
325 ft

Total pressure drop: 0.386 x 3.25 = 1.25 psi = **0.1 bar**

Pressure at tie in point between the 10" LP vent header and the existing 14" header is 1.3 bara. (Ref. is made to Document 5532 N12 "Process Studies for Flare and Vent", first part).

Maximum back pressure for the 10" LP vent header will be 1.4 bara.

APPENDIX 9

BACK PRESSURE CALCULATIONS - LT RELIEF SYSTEM

- HP RELIEF SYSTEM

CALCULATION NOTES

CLIENT: E.A.N.	PROJECT: TCP-2 Extension	SHEET 1 OF 9
DISCIPLINE: Process	ENGINEER: JIN	REF.: JIN/asb
SUBJECT: Back pressure calcs - LT Relief header		

Basis

The method for calculating the back pressure is based on the guidelines given in API RP 521 section 5.3A.1. The critical mass flow is determined using the equation:

$$Gci = 12.6\ P_o \left(\frac{M}{To}\right)^{0,5}$$

Gci = critical mass flow, lb/sec, sqft
P_o = upstream pressure, psia
M = molecular weight of vapour (16.9)
T_o = upstream temperature, ^oR (393^oR or $- 55^oC$)

Total line resistance is calculated using the equation:

$$N_T = \frac{4fL}{D} + K$$

N_T = total equivalent resistance factor, dimensionless
f = fanning friction factor
L = equivalent length of line, ft
K = values for pipe fittings, dimensionless

i) LT RELIEF SYSTEM

1. Back pressure from 1 to 2. (Ref. is made to fig. 1)
Calculation of friction factor f.

Reynolds no: $Re = \frac{\rho VD}{\mu}$

ρ (at 2.0 bara and $- 55^oC$): $\frac{16.9 \times 2.0}{0.08314.218} = 1.86\ kg/m^3$

D (internal diameter) = 0.315 m

Flowrate (2.8 MSCM/D) = 83380 kg/hr

CALCULATION NOTES

CLIENT: E.A.N.	**PROJECT:** TCP-2 Extension	**SHEET** 2 **OF** 9
DISCIPLINE: Process	**ENGINEER:** JIN	**REF.:** JIN/asb

SUBJECT: Back pressure calculation - LT relief header

$$V = \frac{83380}{1.86 \times 3600 \times 0.073} = 171 \text{ m/s}$$

μ = 0.0083 (from chart 16 - 26 NGPSA)

$$Re = \frac{1.86 \times 171 \times 0.315}{0.0083 \times 0.001} = 12070952$$

Since Re > 4000 $f = \frac{0.04}{Re^{0.172}} = \underline{0.0024}$

Calculation of N_T

Length: 11.5 m = 38 ft

$$N_T = \frac{4 \times 0.0024 \times 38}{1.03} = 0.4$$

Back pressure calcs

Results

Downstream pressure (P_1) 1.373 bara	TRIAL 1	TRIAL 2	TRIAL 3
Upstream pressure P_o	1.573	1.973	2.373
P_1/P_o	0.87	0.696	0.58
G/Gci	0.64	0.84	0.875
Gci lb/sec, sqft	59.61	74.77	89.93
G lb/sec, sqft	38.15	62.8	79.14

CALCULATION NOTES

CLIENT: E.A.N.	PROJECT: TCP-2 Extension	SHEET 3 OF 9
DISCIPLINE: Process	ENGINEER: JIN	REF.: JIN/asb
SUBJECT: Back pressure calculation - LT relief system		

"Actual" G is (12" pipe):

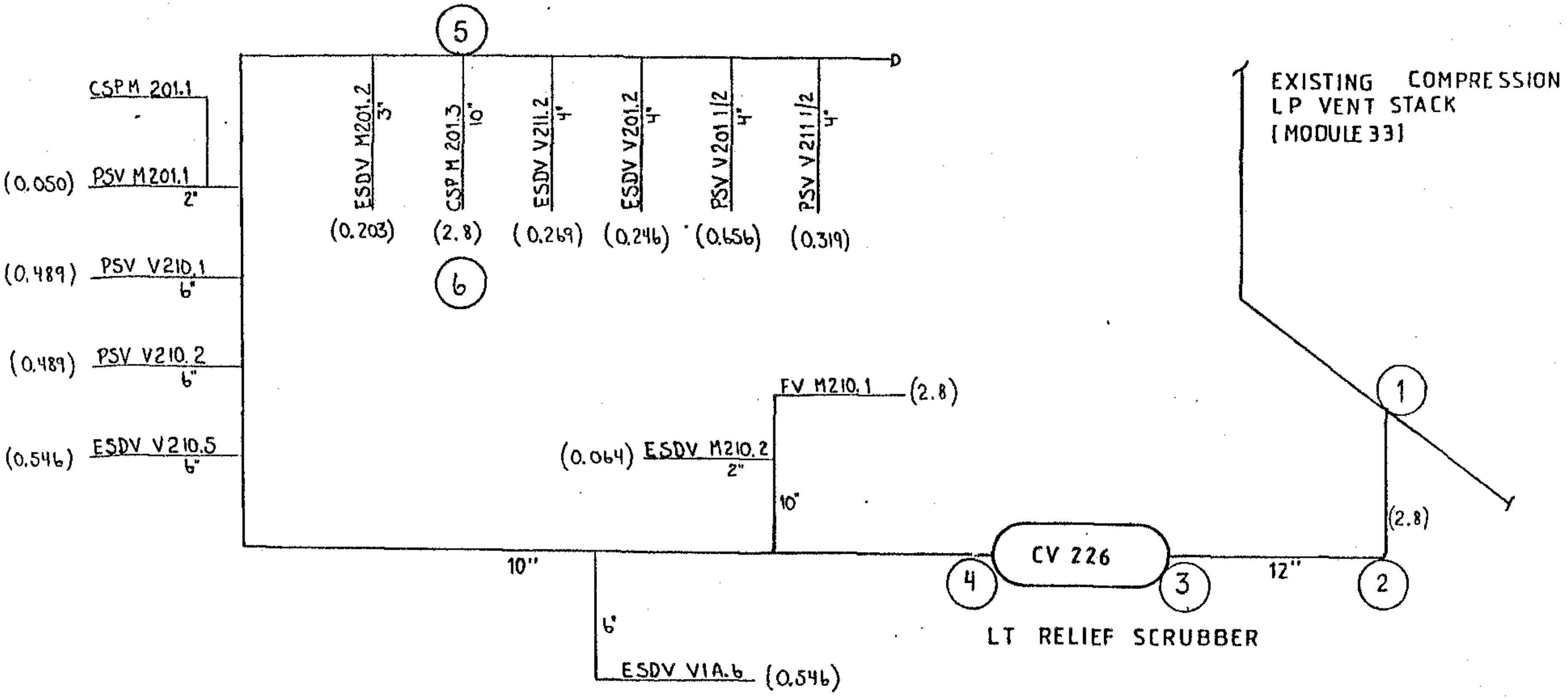
$$\frac{83380 \times 2.20462}{3600 \times \pi/4(1.03)^2} = \underline{61.3 \text{ lb / sqft,s}}$$

The above results are presented in fig. 2.

Conclusion: The pressure at point 1 is 1.95 bara

LT RELIEF SYSTEM – SCHEMATIC DIAGRAM

FIG.1



NOTE: Flowrates in brackets are in MSCM/D. Max flowrate in LT relief header corresponds to sea line depressurizing

REV.NO.	REVISION	DATE	BY	APPR	APPR BY CLIENT

CLIENT

DATE	CONSTR.	APPR.	SCALE

TITLE

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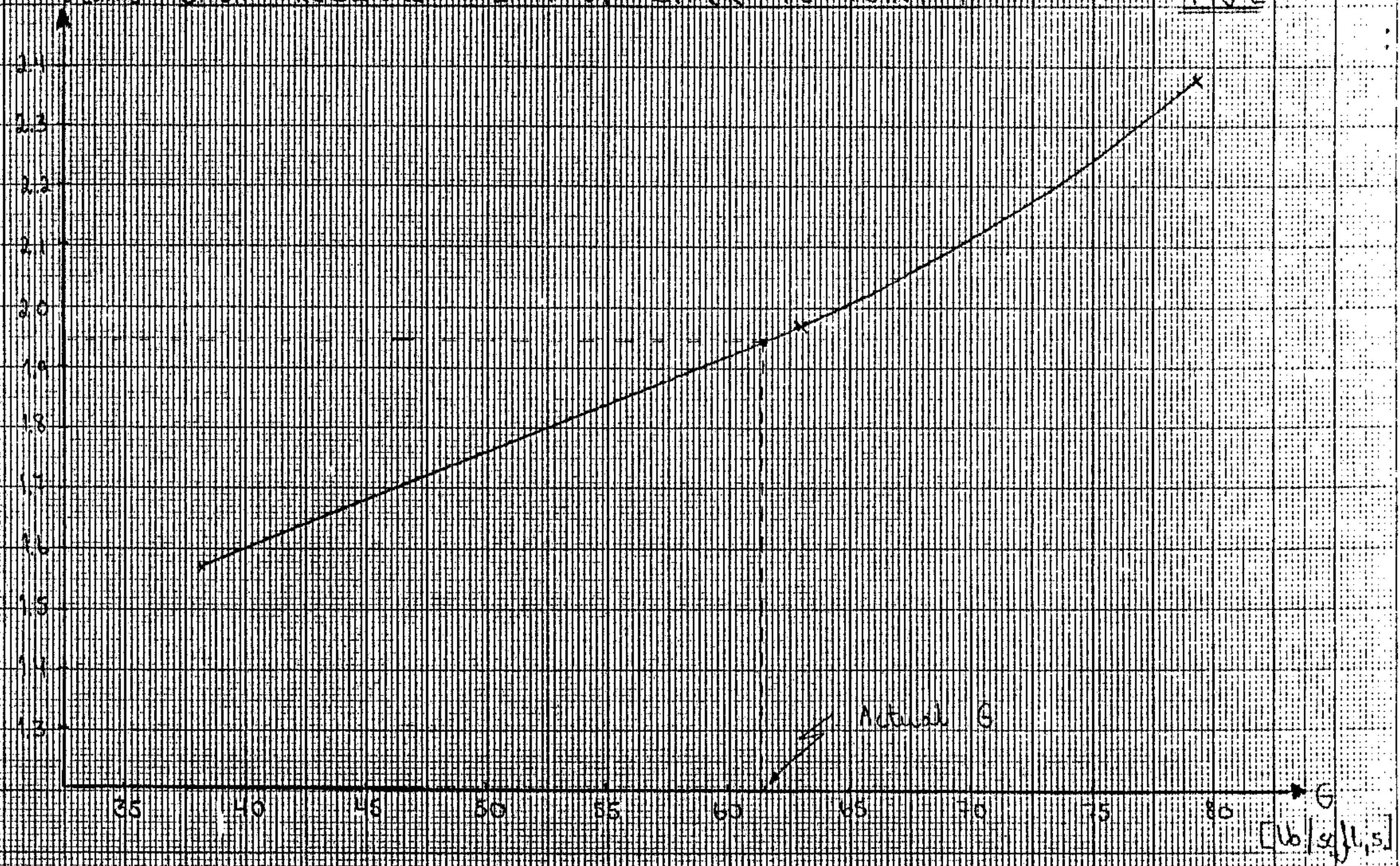
APPR. BY CLIENT

DATE
SIGN

DRWG NO.

P0 [BARA] BACK PRESSURE - LP VENT STACK TO POINT 1

FIG 2



10.02.81 JIN

CALCULATION NOTES

CLIENT: E.A.N. PROJECT: TCP-2 Extension SHEET 4 OF 9

DISCIPLINE: Process ENGINEER: JIN REF.: JIN/asb

SUBJECT: Back pressure calcs - LT relief header

2. Back pressure from 2 to 3 (Ref. fig. 1)

Calculation of N_T

Length 38.1 m = 125 ft

5 long rad 90° ell (K = 0.45 x 5) = 2.25

3 long rad 45° ell (K = 0.20 x 3) = 0.60

$$N_T = \frac{4 \times 0.0024 \times 125}{1.03} + 2.25 + 0.60 = \underline{4.05}$$

Back pressure calcs

Results

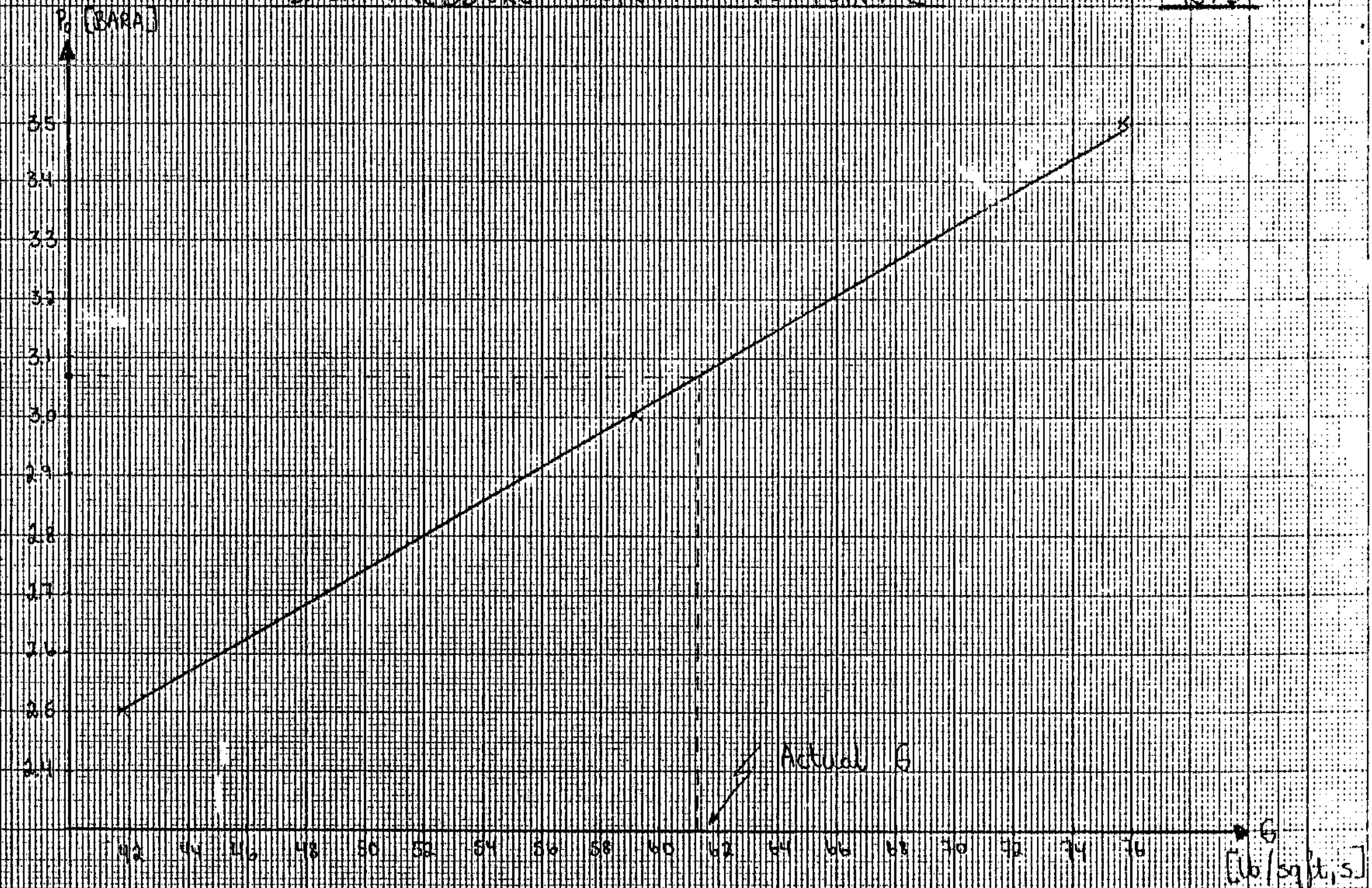
Downstream pressure (P_1) 1.95 bara	TRIAL 1	TRIAL 2	TRIAL 3
Upstream pressure P_o	2.5	3.0	3.5
P_1/P_o	0.78	0.65	0.56
G/Gci	0.44	0.52	0.57
Gci lb/sec, sqft	94.75	113.7	132.64
G lb/sec, sqft	41.69	59.12	75.60

The above results are presented in fig. 3.

Conclusion: The pressure at point 2 is 3.07 bara

BACK PRESSURE - POINT 1 TO POINT 2

FIG. 3



10.02.81 JIN

CALCULATION NOTES

CLIENT: E.A.N. PROJECT: TCP-2 Extension SHEET 5 OF 9

DISCIPLINE: Process ENGINEER: JIN REF.: JIN/asb

SUBJECT: Back pressure calcs - LT relief header

3. Pressure drop through LT - relief scrubber

Pressure drop is calculated using the formula

$$\Delta p = \frac{K\rho V^2}{9266}$$

Sudder enlargement $K_1 = (1 - \beta_1^{\,2})^2$

Sudder contraction $K_2 = 0.5\ (1 - \beta_2)^2$

$$\beta_1 = \frac{\text{small diameter}}{\text{large diameter}} = \frac{0.305}{1.5} = 0.20$$

$$\beta_2 = \frac{0.254}{1.5}\ 0\ 0.17$$

$K_1 = (1-(0.2)^2)^2 = 0.922,\ K_2 = 0.5\ (1 - 0.17^2) = 0.485$

$K = 1.407$

$$\rho \text{ (at 3.1 bara)} = \frac{16.9 \times (3.1 \times 14.5038)}{10.73 \times 393} = 0.180 \text{ lb/cuft}$$

$$v = \frac{61.3 \text{ lb/sqft,s}}{0.180 \text{ lb/cuft}} = 340.2 \text{ fps}$$

$$\Delta p = \frac{1.407 \times 0.180 \times (340.2)^2}{9266} = 3.16 \text{ psi} = 0.22 \text{ bar}$$

Pressure just upstream the relief scrubber is (3.07 + 0.22)bar

= 3.3 bara

CALCULATION NOTES

CLIENT: E.A.N.	PROJECT: TCP-2 Extension	SHEET 6 OF 9
DISCIPLINE: Process	ENGINEER: JIN	REF.: JIN/asb
SUBJECT: Back pressure calcs - LT relief header		

4. Back pressure from 4 to 5 (Ref. fig. 1)

Calculation of N_T

Length 55 m	180.5 ft
11 long rad 90° ell (K= 11 x 0.45)	K = 4.95
2 long rad 45° ell (K = 0.2 x 2)	K = 0.40

$$N_T = \frac{4 \times 0.0024 \times 180.5}{10.42/12} + 5.35 = \underline{7.3}$$

Back pressure calcs

Results

Downstream pressure (P_1) 3.3 bara	TRIAL 1	TRIAL 2	TRIAL 3
Upstream pressure P_o	4.4	4.9	5.4
P_1/P_o	0.75	0.67	0.61
G/Gci	0.39	0.42	0.44
Gci lb/sqft,s	166.75	185.70	204.65
G lb/sqft,s	65.0	78.0	90.1

"Actual" G is (10" pipe)

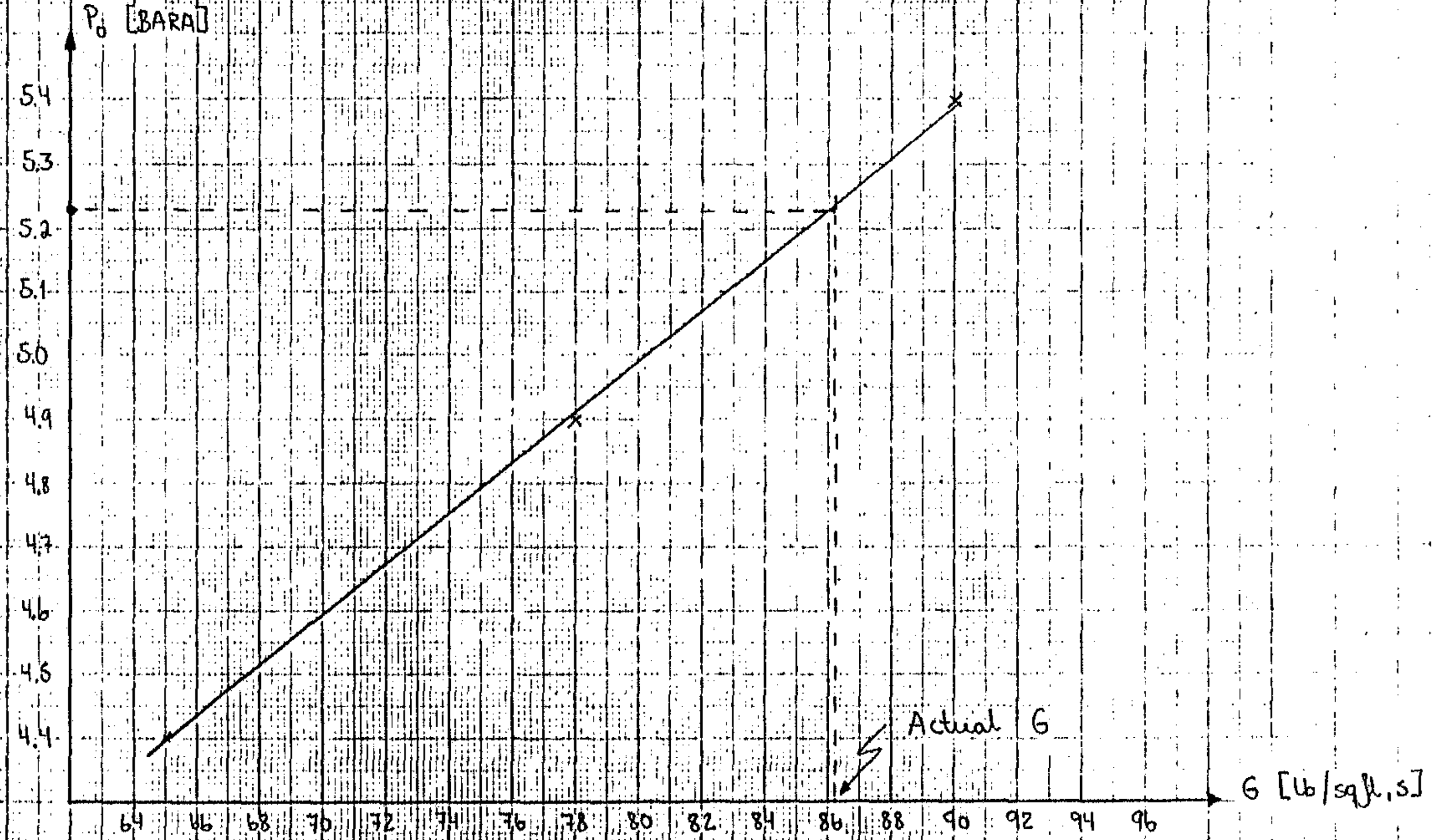
$$\frac{83380 \times 2.20462}{3600 \times \frac{\pi}{4}\left(\frac{10.42}{12}\right)^2} = 86.2 \text{ lb/sqft,s}$$

The above results are presented in fig. 4.

Conclusion: The pressure at point 5 is 5.23 bara

BACK PRESSURE - POINT 4 TO POINT 5

FIG 4



14.07.81 JIN

CALCULATION NOTES

CLIENT: E.A.N. PROJECT: TCP-2 Extension SHEET 7 OF 9
DISCIPLINE: Process ENGINEER: JIN REF.: JIN/asb
SUBJECT: Back pressure calcs - LT relief header

5. Back pressure from 5 to 6 (Ref. fig. 1)

Calculation of N_T

Lenght 7.1 m = 23 ft
1 long rad 90° ell (K = 0.45) = 0.45
1 Tee through branch (K=1.0) = 1.0

$$N_T = \frac{4 \text{ x } 0.0024 \text{ x } 23}{10.42/12} + 1.45 = 1.7$$

Back pressure calcs

Results

Downstream pressure (P_1) 5.23 bara	TRIAL 1	TRIAL 2	TRIAL 3
Upstream pressure bara	5.4	5.5	5.8
P_1/P_o	0.97	0.95	0.90
G/Gci	0.23	0.31	0.44
Gci lb/sqft,s	204.65	208.44	219.80
G lb/sqft,s	47.07	64.62	96.71

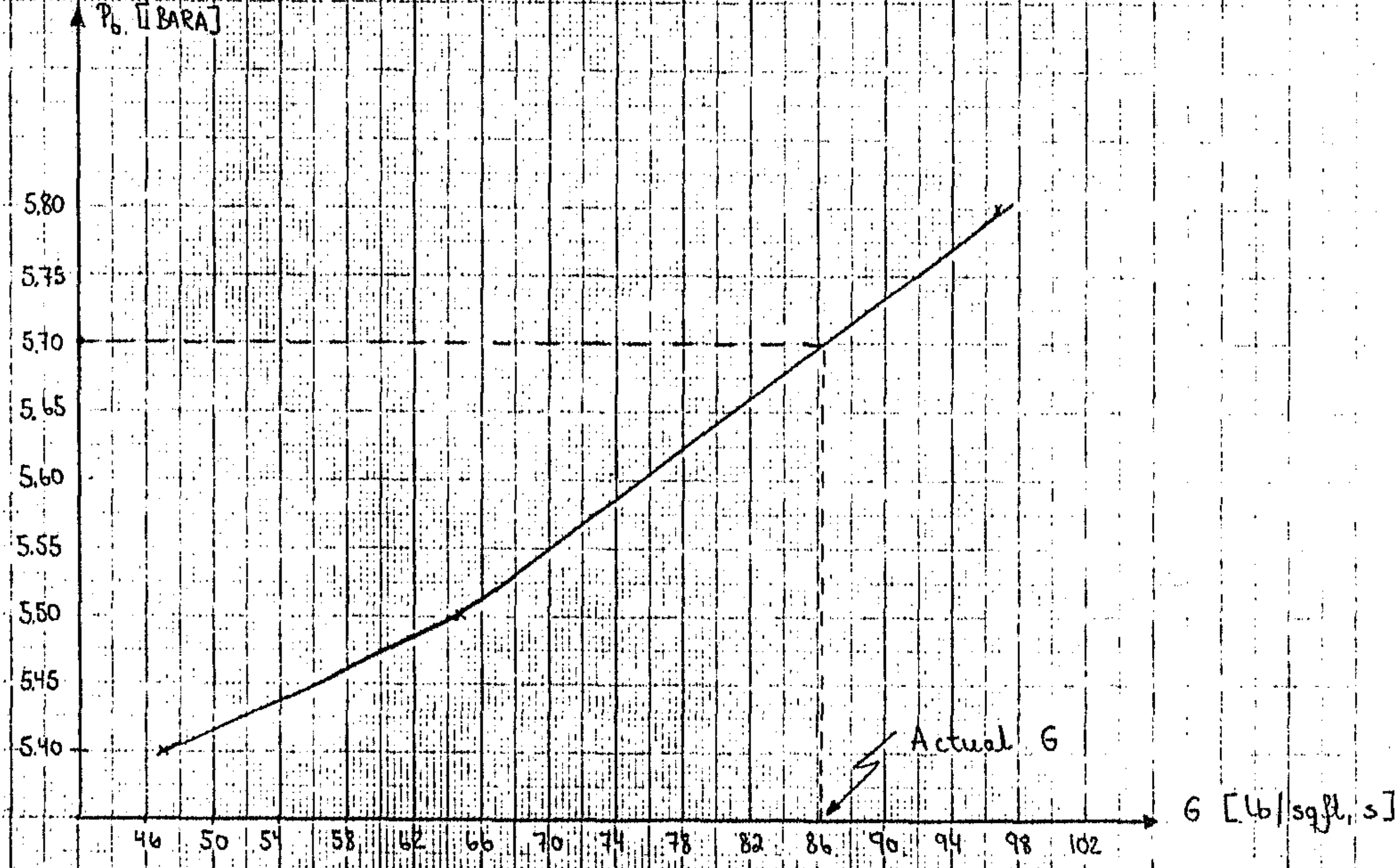
The above results are presented in fig. 5.

Conclusion: The pressure at point 6 is 5.70 bara

Max back pressure in LT relief system is 5.7 bara

BACK PRESSURE - POINT 5 TO POINT 6.

FIG 5



14.07.81 UIN

CALCULATION NOTES

CLIENT: E.A.N   PROJECT: TCP-2 Extension   SHEET 8 OF 9

DISCIPLINE: Process   ENGINEER: JTN   REF.:

SUBJECT: HP Relief system (Bypass of cold vent)

ii) HP - RELIEF SYSTEM

Piping class ECX

Pipe size $10'' \Rightarrow ID = (10.75 - 2\cdot 0.56)'' = 9.63$ in

Flowing area: $\pi/4 \; 1D^2 = 0.04699 \; m^2 = \underline{0.506 \; ft^2}$

Back pressure at tie in (ref. fig. 7) : 7.3 bara

Flowrate 8.4 MSCMD = 250140 kg/hr (551463 lb/hr)

Density: $$\rho = \frac{16.9 \cdot 7.3}{0.08314 \cdot 233 \cdot 0.97} = 6.6 \; kg/m^3$$

Velocity $$v = \frac{250140}{6.6 \cdot 3600 \cdot 0.04699} = 224.0 \; m/sec$$

Mach no: $$\frac{224}{386.4} = \underline{0.58}$$

Reynold no: $$R_e = \frac{\rho VID}{\mu} = \frac{6.6 \cdot 224 \cdot 0.245}{0.011 \cdot 0.001} = 32934295$$

$$f = \frac{0.04}{R_e^{0.172}} = \underline{0.00203}$$

Calculation of N_T

Length 13m		= 43.00 ft
8 long rad ell	K = 8 · 0.32	= 2.56
1 Tee	K	= 1.72
1 enlagement	K	= 0.41
1 check valve	K	= 2.3
1 ball valve	K	= 0.21
		Σ 43 ft + 7.20

$$N_T = \frac{4f \cdot L}{ID} + \sum K = \frac{4 \cdot 0.00203 \cdot 43}{0.8025} + 7.2 = \underline{7.6}$$

CALCULATION NOTES

CLIENT: E.A.N	PROJECT: TCP-2 Extension		SHEET 9 OF 9
DISCIPLINE: Process	ENGINEER: JIN	REF.:	
SUBJECT: HP Relief system (Bypass of cold vent)			

$$G_{ci} = 12.6\ P_o\ \left(\frac{M}{T_o}\right)^{0.5}$$

$$= 12.6\ P_o\ \left(\frac{16.9}{420}\right)^{0.5} = 2.527\ P_o$$

P_1 = 7.3 BARA	TRIAL 1	TRIAL 2	TRIAL 3
Upstream pressure, P_o	10	14	18
P_1 / P_o	0.73	0.52	0.405
G / G_{ci}	0.38	0.44	0.48
G_{ci}	366.6	513.2	659.8
G	139.3	225.8	316.7

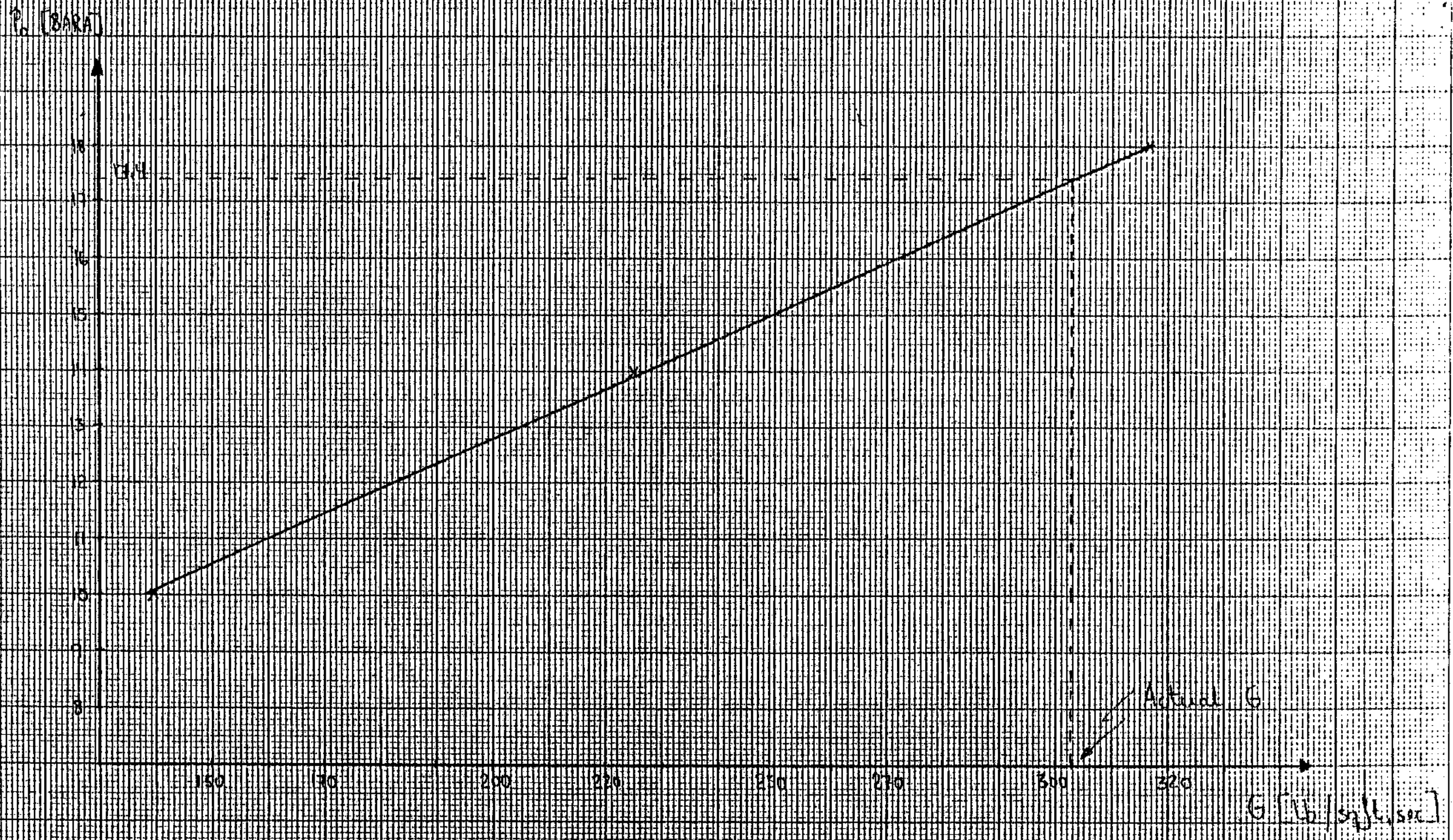
Calculation of "actual" G:

$$G = \frac{551463}{3600 \cdot 0.506} = 302.7 \text{ lb/sec,sqft}$$

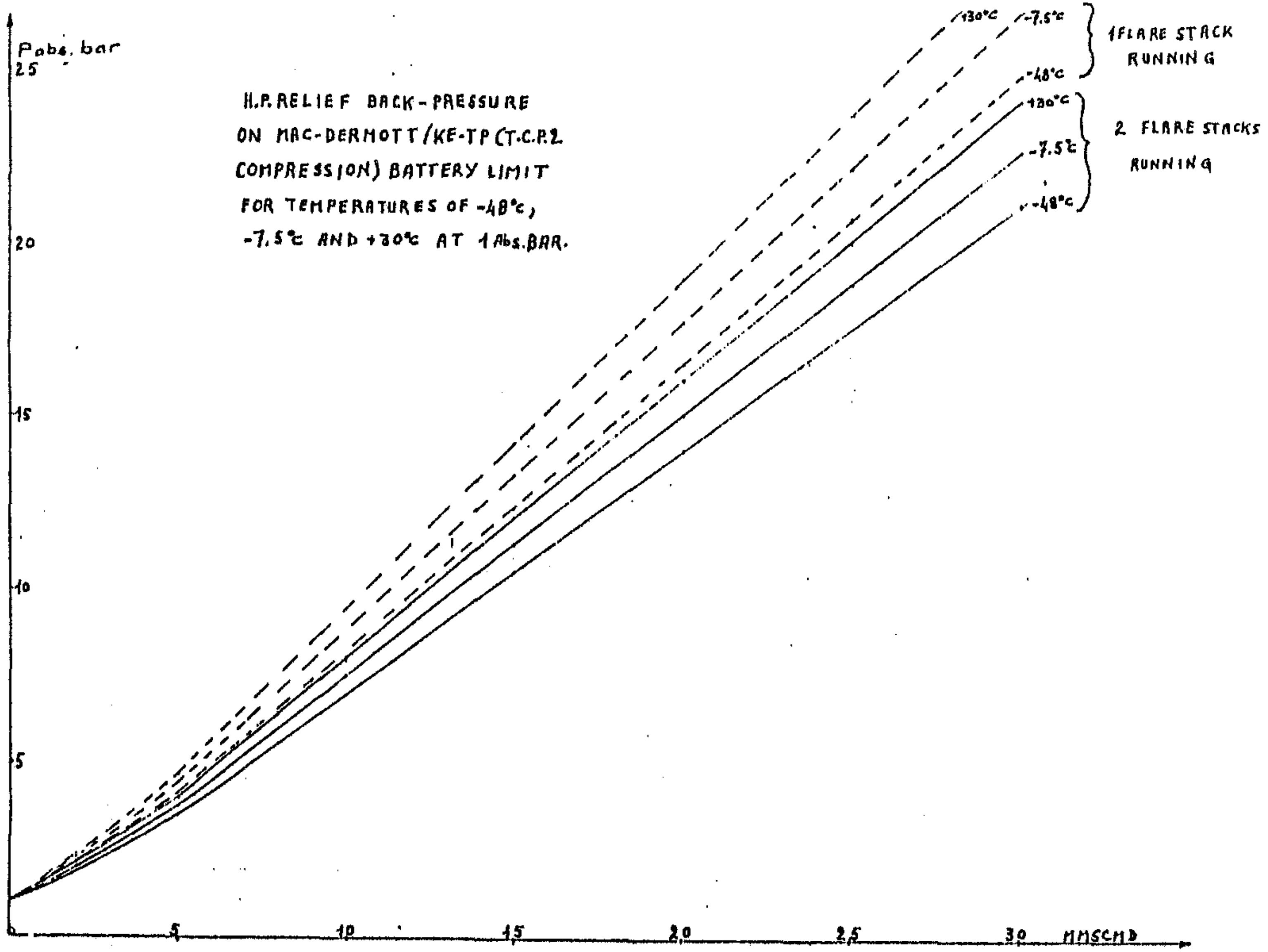
From attached figure, the max back pressure in the HP relief system for TCP 2 Extension is 17.4 Bara.

BACK PRESSURE - HP RELIEF SYSTEM

FIG. 6



2/07/81 J/N



H.P. RELIEF BACK-PRESSURE ON MAC-DERMOTT/KE-TP (T.C.P.2 COMPRESSION) BATTERY LIMIT FOR TEMPERATURES OF -48°c, -7.5°c AND +30°c AT 1 Abs.BAR.

APPENDIX 10

CALCULATION OF TEMPERATURE DOWNSTREAM OF THE BLOW DOWN VALVES

CALCULATION NOTES

CLIENT: E.A.N. PROJECT: TCP-2 Extension SHEET 1 OF 1

DISCIPLINE: Process ENGINEER: JIN REF.: JIN/asb

SUBJECT: Calculation of temperature downstream the blowdown valves

Basic

The method for calculating the temperature downstream of the blowdown valves, is based on the correlations outlined in GPSA Engineering Data Book, section 17. (Page 17-6 is attached for information.)

Assumptions:

1. The gas composition is identical to the ODIN gas composition.
2. The upstream pressure is taken at 160 bara, the downstream pressure at 2 bara.
3. The upstream temperature is 5°C (41°F)

The calculation results are given below.

Conclusion: Temperature downstream of the blowdown valves is estimated to be around - 75°C.
(Based on extrapolation between the values given below).

chart. The pure component critical temperatures (T_c), critical pressures (P_c) and acentric factors (ω) are given in the table of physical constants, Section 16, Physical Properties

The reduced temperature and pressure are defined as $T_r = T/T_c$ and $P_r = P/P_c$, where absolute temperatures and pressures are used. *The units of* $(H^o - H)$ will depend on the units of R, the universal gas constant, and T_c. For $(H^o - H)$ values of Btu /lb mole, R = *1.986* Btu */lb mole* – °R., and T_c is in °R.

Note that the ideal gas state enthalpies are given in units of Btu /lb; therefore, the component molecular weight must be used for converting either the ideal gas state enthalpy or the effect of pressure on the enthalpy before substituting into Equation 3.

Undefined mixtures—Very often the enthalpy of petroleum fractions or of the C_7+ in natural systems must be calculated. For this case average or pseudo properties are used for the undefined mixture. Generally the specific gravity, molecular weight and ASTM or true boiling point distillation will be known.

Figs. 16-18 through 16-20, Section 16 relate ASTM distillation, molecular weight, specific gravity, critical temperature, and critical pressure of petroleum fractions. Once the last four quantities are known, the ideal gas state enthalpy for the petroleum fraction can be obtained from Fig. 17-12.

An acentric factor can be estimated by using Fig. 16-21, Section 16. Then the effect of pressure on enthalpy for the petroleum fraction is found using the figures for $[(H^o - H)/RT_c]^{(o)}$ and $[(H^o - H)/RT_c]^{(')}$ and Equation 4 exactly as was done for a pure component. The enthalpy of the undefined mixture is calculated as shown by Equation 3.

Defined mixtures—The enthalpy of a mixture for which a component analysis is known can be calculated by combining pure component data and constants. The mixture ideal gas state enthalpy is calculated by a mole fraction average of the pure component ideal gas state enthalpies.

$$H^o_m = \sum_i x_i H^o_i, \qquad (5)$$

where x_i *is the mole fraction of the* i^{th} component.

Equation 5 assumes no heat of mixing in the ideal state because the molecules are at infinite attenuation and should not *affect one another.*

Pseudocritical temperatures and pressures can be calculated for the mixture using Kay's rule.[4]

$$T_{cm} = \sum_i x_i T_{ci} \text{ and } P_{cm} = \sum_i x_i P_{ci} \qquad (6)$$

The mixture acentric factor is also calculated as a mole fraction *average of pure component* acentric factors.

$$\omega_m = \sum_i x_i \omega_i \qquad (7)$$

Other methods for obtaining pseudocriticals are more sophisticated than Kay's rule and in many cases give better results. These sophisticated methods usually involve complex equations and/or interaction parameters. For desk calculations Kay's rule is very convenient, while for computer calculations a more complex method can be used.

The pseudocriticals are used to calculate pseudo-reduced temperature and pressure in order to obtain values of $[H^o - H)/RT_c]^{(o)}$ and $[H^o - H)/RT_c]^{(')}$. The mixture acentric factor and pseudocritical temperature are then used to calculate $(H^o - H)_m$, the effect of pressure on enthalpy for the mixture.

$$(H^o - H)_m = RT_{cm} \{[(H^o - H)/RT_c]^{(0)} + \omega_m [(H^o - H)/RT_c]^{(')}\} \qquad (8)$$

The value of the mixture enthalpy at the desired temperature and pressure is found by substituting H^o_m and $(H^o - H)_m$ for H^o and $(H^o - H)$ in Equation 3.

The enthalpy of a two-phase mixture should be calculated by *first performing a flash calculation in* order to obtain the moles and composition of each phase at the desired conditions. Then the enthalpy *of each phase should be calculated as described above.* The molar enthalpy of the total mixture is calculated by combining the gas and liquid phase enthalpies on *a mole basis.*

Total enthalpy charts. Total enthalpy charts are included in Figs. 17-20 through 17-28 in order to offer a rapid means of calculating heat balances essentially on the same basis as outlined in the preceding sections of the Enthalpy Correlation. They may be used in lieu of the detailed component-wise calculations for all vapor, all liquid, or vapor-liquid mixture enthalpies. The charts cover the range of composition, temperature and pressure encountered in most natural gas systems from wellhead separators through liquified natural gas systems.

The total enthalpy charts were developed in a computer program by synthesizing binary mixtures of *normal paraffin hydrocarbons using the pure* component lighter and heavier than the molecular weight for which enthalpies are to be calculated. *Molecular weights were calculated in increments* of 2 from 16 to 30 MW and in increments of 5 from 30 MW through 160 MW.

The ideal gas state enthalpy for each component of the binary mixture was calculated and then the mixture ideal enthalpy calculated. The ideal gas state enthalpy for methane, ethane, and propane is a curve fit of the data in Fig. 17-11A. For butane and heavier, a fourth order polynomial was used with the same coefficients as listed in the API Data Book, Table A1.2 page 7-9. The fifth coefficient, "E", was dropped to convert to 0°R, 0 psia enthalpy datum.

The ideal gas state enthalpy was then corrected for the effect of pressure on enthalpy of the simple and real fluid using interpolation of tabular data used to derive Figs. 17-13 and 17-14. Pressure calculations were made from reduced pressures of 0.2 to 3000 psia in increments of 100 psi. Temperatures used ranged from −300°F. minimum or T_R = 0.35 minimum to 600°F. in increments of 50°F.

Caution. Inevitably some mixtures encountered in the natural gas industry lie inside the phase envelopes of Figs. 17-13 and 17-14. Rather than extrapolate into the phase envelopes of Figs. 17-13 and 17-14 for enthalpy pressure corrections, the total enthalpies were first generated, plotted, and then extrapolated.

Extensions of vapor enthalpies to lower tempera-

(Text cont'd. p. 17-18)

CALCULATION OF TEMPERATURE DOWNSTREAM
THE BLOWDOWN VALVES

								TRIAL I		TRIAL II	
COMP	MW	IDEAL GAS STATE ENTHALPIES AT 41°F		FRACTION	CRITICAL TEMP, °R	CRITICAL PRES, PSIA	ACENTRIC FACTOR	IDEAL GAS STATE ENTHALPIES AT - 100°F		IDEAL GAS STATE ENTHALPIES AT - 90°F	
		BTU/LB	BTU/LB-MOL					BTU/LB	BTU/LB-MOL		
N2	28	124	3473.2	0.92	227.6	493	0.040	88	2464.9	84	2352
CO2	44	84	3696.8	0.24	547.6	1071	0.225	56	2464.6	58	2552.6
C1	16	250	4010.0	94.81	343.1	667.8	0.0104	175	2807.0	182	2919.3
C2	30.1	157	4721.0	3.85	549.8	707.8	0.0986	102	3067.1	110	3207.7
C3	44.1	130	5733.0	0.06	665.7	616.3	0.1524	80	3528.0	85	3748.5
iC4	58.1	120	6974.4	0.01	734.7	529.1	0.1848	70	4068.4	75	4357.5
C4	58.1	130	7555.6	0.02	765.3	550.7	0.2010	80	4649.6	85	4938.5
iC5	72.15	120	8658.0	0.02	828.8	490.4	0.2223	70	5050.5	75	5411.3
C5	72.15	127	9163.1	0.02	845.4	488.6	0.2539	78	5627.6	85	6132.8
C6	86.2			0.05	912.0	470	0.290				

Temperature, °F	41	-100	-90°
Pressure, PSIA	2320	29.0	29.0
Pseudocritical temp, °R	351.3	351.3	351.3
Pseudocritical pres, PSIA	668.5	668.5	668.5
Reduced temp	1.426	1.02	1.05
Reduced pres	3.47	0.04	0.04
Acentric factor	0.015	0.015	0.015
$(H^{o}-H)/RTc^{o}$	1.85	0.042	0.038
$(H^{o}-H)/RTc^{1}$	0.34	-	-
$(H^{o}-H)/RTc = (H^{o}-H)/RTc^{o} + \omega_m(H^{o}-H)/RTc^{1}$	1.85	0.042	0.038
$(H^{o}-H)m$ BTU/lb mol	1291	29.30	26.51
$H^{o}m$ BTU/lb mol	4033.7	2813.6	2928.9
Hm BRU/lb mol	2743	2784.3	2902.4
Enthalpy Difference		41.3	159.4

10.02.81 JIN

APPENDIX 11

FIRE PROTECTION - LIQUID VAPOURIZATION

- GAS EXPANSION

CLIENT: E.A.N.	PROJECT: TCP-2 Extension	SHEET 1 OF 8
DISCIPLINE: Process	ENGINEER: JIN	REF.: JIN/asb
SUBJECT: Fire protection - Liquid vapourization		

Formula used (ref. API RP 520)

Total heat absorption from fire

$$Q = 21000\ F \times A^{0.82}$$

Q = total heat absorption BTU/hr

A = total wetted area sqft

F = environment factor, for bare vessel F = 1.0

1. Slug catcher CV 210 (PSV V 210 1/2)

Max liquid level (which corresponds to LSHH) is at 1650 mm. Vessel size is 2400 ID x 9140 T/T.

Wetted area $A = \left[\pi \times ID \times L + \pi \times ID^2\right] \frac{1650}{2400} = 60\ m^2$

$= 632$ sqft

$Q = 21000 \times 632^{0.82} = 4.157\ 261$ BTU/hr

Condensate latent heat is 72 kcal/kg

Weight flow rate $\frac{4157\ 261 \times 0.252}{72} = 14550$ kg/hr

(0.489 MSCM/D)

2. Condensate / Methanolated water separator - ODIN CV 204 (PSV V 204 1/2)

Vessel size is 1000 ID x 4000 T/T.
Max liquid height is equal to 750 mm.

Wetted area $A = (\pi \times 1.0 \times 4.0 + \pi \times 1.0^2)\ 0.75 = 11.8\ m^2$

(130 sqft)

$Q = 21000 \times 130^{0.82} = 1136718$ BTU/hr

Weight flow rate $\frac{1136718 \times 0.252}{72} = 3978$ kg/hr

(0.134 MSCM/D)

3. Condensate / Methanolated water separator NEF CV 213 (PSV V 213 1/2)

The vessel is identical to CV 204
Flow rate will therefore be 3978 kg/hr
(0.134 MSCM/D)

4. Methanolated water flash drum - CV 220

Vessel size is 900 ID x 2900 T/T.
Max liquid height is equal to 550 mm.

Wetted area $A = (\pi \times 0.9 \times 2.9 + \pi \times 0.9^2)\ \frac{0.55}{0.9} = 6.6\ m^2$

(71 sqft)

CALCULATION NOTES

CLIENT: E.A.N. PROJECT: TCP-2 Extension SHEET 3 OF 8

DISCIPLINE: Process ENGINEER: JIN REF.: JIN/asb

SUBJECT: Fire protection - Liquid vapourization

$$Q = 21000 \times 71^{0.82} = 69261 \text{ BTU/hr}$$

Weight flow rate $\frac{69261 \times 0.252}{72} = 2424$ kg/hr

(0.080 MSCM/D)

5. Pig receiver - ODIN CM 201 (PSV M 201.1)

△2 Size of equipment is 550 ID x 4000 T/T.

Wetted area $A = \pi \times 0.55 \times 4 \times \frac{1}{2} = 3.46$ m^2 (37.2 sqft)
(assuming pig receiver half full of liquid)

$$Q = 21000 \times (37.2)^{0.82} = 407441 \text{ BTU/hr}$$

Weight flow rate $\frac{407441 \times 0.252}{72} = 1425$ kg/hr

(0.050 MSCM/D

CALCULATION NOTES

CLIENT: E.A.N. PROJECT: TCP-2 Extension SHEET 4 OF 8

DISCIPLINE: Process ENGINEER: JIN REF.: JIN/asb

SUBJECT: Fire protection - Liquid vapourization

6. Slug catcher CV IA (PSV VIA 6/7)

This is an existing vessel. In case of fire the vapour will release to the HP relief system. The relief flowrate is identical to

0.455 MSCM/D

Summary - Liquid vapourization

Vessel	Wetted area m^2	Flowrate		Flare system
		KG/hr	MSCM/D	
CV 210	60.0	14550	0.489	Low temperature
CV 1A	-	-	0.455	High pressure
CV 204	11.8	3978	0.134	Low pressure
CV 213	11.8	3978	0.134	Low pressure
CV 220	6.6	2424	0.080	Low pressure
△2 CM 201	3.5	1425	0.050	Low temperature

Relief rates from thermal gas expansion due to fire

The relief rates from gas expansion due to fire has been calculated according to API RP 520 appendix C paragraph C 3 for the calculation without insulation and section 6 △1 paragraph 6.3.1 for the insulation effect on the above calculations.

The discharge area for safety relief valves on gas containing vessels exposed to open fires, can be determined using the formula

△1 $$A = \frac{F^1 A_3}{\sqrt{P_1}}$$

where A = effective discharge area of the valve in sqin

P_1 = upstream relieving pressure in psia

△1 A_3 = exposed surface area of vessel plus surrounding pipes in sqft

F^1 = an operating factor determined by

$$F^1 = \left(\frac{0.1406}{C \cdot K}\right) \left(\frac{\Delta T^{1.25}}{T_1^{\;0.6506}}\right)$$

where $$C = 520 \sqrt{k \left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$$

$k = \frac{CP}{CV}$ = ratio of specific heats

K = coefficient of discharge = 0.975

T_1 = gas temperature in degrees F +460 at the upstream pressure.

It is determined from the relationship

$$T_1 = \left(\frac{P_1}{P_n}\right) T_n$$

where T_n = normal operating gas temperature in degrees F +460

P_n = normal operating pressure in psia

$\Delta T = T_w - T_1$ = difference between wall temperature and the temperature of gas at P_1

T_w = vessel wall temperature in degrees F +460

△1 As the vessel and the surrounding pipes are insulated, this must be taken into account in order to estimate the vessel wall temperature.

From API RP 520 page 15:

> The outside temperature of the insulation jacket in case of fire exposure will reach an equilibrium temperature of 1660°F.

From API RP 520 page 11:

> In practice it is recommended that insulation jacket selected to provide a temperature difference of at least 1000°F.

From this is concluded that the max temperature of the vessel wall is:

$$T_w = (1660 - 1000)^{\circ}F = \underline{660^{\circ}F}$$

Calculation of F^1

$$T_w = 660^{\circ}F + 460 = 1120^{\circ}R$$

$$T_n = 5^{\circ}C = 41^{\circ}F + 460 = 501^{\circ}R$$

$$P_n = 149 \text{ bara} = 2161 \text{ psia}$$

$$P_1 = 177.5 \text{ bara} \times 1.1 = 2832 \text{ psia}$$

$$T_1 = \frac{2832}{2161} \times 501 = 656.6^{\circ}R = 196.6^{\circ}F$$

$$\Delta T = T_w - T_1 = 1120 - 656.6 = 463.4$$

$$k = \frac{CP}{CV} = 1.30 \text{ at standard conditions}$$

$$C = 520\sqrt{1.3\ (\frac{2}{2.3})^{\frac{2.3}{0.3}}} = 347$$

CALCULATION NOTES

CLIENT: E.A.N. PROJECT: TCP-2 Extension SHEET 7 OF 8

DISCIPLINE: Process ENGINEER: REF.:

SUBJECT: Fire protection - Gas expansion

$$F^1 = \left(\frac{0.1406}{347 \text{ x } 0.975}\right) \left(\frac{463.4^{1.25}}{656.6^{0.6505}}\right) = 0.01314$$

Gas flow rate to be relieved is calculated using

$$W = CKAP_1 \frac{M}{ZT_1}$$

where W = flow through valve in lb/hr

M = molecular weight = 16.9

Z = compressibility factor at T_1 and P_1 = 0.98

CALCULATION NOTES

CLIENT:	E.A.N.	**PROJECT:**	TCP-2 Extension	**SHEET** 8 **OF** 8	
DISCIPLINE:	Process	**ENGINEER:**	JIN	**REF.:**	
SUBJECT:	Fire protection - Gas expansion				

Calculation for Scrubber CV 211

The total exposed area used in the below calculations is based upon the area of the vessel itself plus surrounding pipelines. The area of the surrounding pipelines is defined as the area of the pipes to/from CV 211 within Module 50.

Area of vessel: 8.2 m^2
Area of pipes: 42.5 m^2

Total area A_3 = 50.7 m^2 = 545.4 sqft

△1 $$A = \frac{0.01314 \times 545.4}{\sqrt{2832}} = 0.1346 \text{in}^2$$

△1 $$W = 347 \times 0.975 \times 0.1346 \times 2.832 \sqrt{\frac{16.9}{0.98 \times 656.6}} = 20903 \text{ lb/hr}$$

9482 kg/hr

(0.319 MSCM/D)

Calculation for Scrubber CV 201

Area of vessel: 11.9 m^2
Area of pipes: 92.3 m^2

Total area A_3 = 104.2 m^2 = 1122 sqft

△1 $$A = \frac{0.01304 \times 1122}{\sqrt{2832}} = 0.277$$

△1 $$W = 347 \times 0.975 \times 0.277 \times 2832 \sqrt{\frac{16.9}{0.98 \times 656.6}} = 43003 \text{ lb/hr}$$

19506 kg/hr

(0.656 MSCM/D)

APPENDIX 12

BACK PRESSURE CALCULATIONS

LP VENT SYSTEM TO GLYCOL SURGE DRUMS CV 17

CALCULATION NOTES

CLIENT: E.A.N. PROJECT: TCP-2 Extension SHEET 1 OF 2
DISCIPLINE: Process ENGINEER: JIN REF.:
SUBJECT: Back pressure calculations CV 17

An important leakage on the tube side of the condensate heaters, may reduce the TEG circulation flow to zero because the tube side pressure is higher than the shell side pressure.

In this case the flow of condensate, gas and methanolated water will pass through on the shell side. The maximum flow rate corresponds to 3382 kg/hr which is the figure given on Process Flowsheet 88 00 00 5101.
The released gas will be evacuated through the existing 2" breather line to the LP vent system.

The back pressure is calculated using the Darcy formula:
(Ref. is made to Appendix 7)

$$\frac{\Delta P}{L} = \frac{4 \times f \times 0.000336\ W^2}{(ID)^5 \times \rho}$$

W = 971 kg/hr (Ref. Technical Specifications, Chapter 3.6.2.4.5)

Friction factor "f" is determined from Reynolds number:

$$Re = \frac{6.32 \times W}{ID \times} = \frac{6.32 \times 2141}{2.067 \times 0.013} = 503485$$

$$f = \frac{0.04}{Re^{0.172}} = 0.00418$$

CALCULATION NOTES

CLIENT:	E.A.N.	PROJECT:	TCP-2 Extension	SHEET 2 OF 2	
DISCIPLINE:	Process	ENGINEER:	JIN	REF.:	
SUBJECT:	Back pressure calculations CV 17				

$$\left(\Delta P_{100}{}^{1}\right) = \frac{4 \times 0.00418 \times 0.000336 \times (2141)^{2}}{(2.067)^{5} \times 0.0665} = \underline{10.3 \text{ psi/100 ft}}$$

Total length 30 m = 98.43 ft

ΔP = 10.3 x 0.9843 = 10.1 psi = 0.7 bar

Back pressure: 2.0 bara
Pressure drop: 0.7 bara
CV 17 pressure: 2.7 bara
CV 17 design pressure: 3.07 bara

The above calculations show that the CV 17 design pressure will not be reached.

APPENDIX 13

DATA SHEETS FOR SAFETY RELIEF VALVES

PROCESS SPECIFICATION

sofresid norge a.s

FUNCTION / ITEM : SAFETY VALVES
CLIENT : ELF AQUITAINE NORGE A/S
PROJECT : TCP 2 EXTENSION

ITEM		PSV V204.1	PSV V204.2	PSV V213.1
REF. P & ID		8800115032	8800115032	8800115032
NATURE OF FLUID		G	G	G
FLANGE RATING / FACING INLET		300 RF	300 RF	300 RF
FLANGE RATING / FACING OUTLET	△3	150 RF	150 RF	150 RF
CASE FOR RELIEF		FIRE	FIRE	FIRE
SET PRESSURE	BARA	25	25	25
OVERPRESSURE PERMISSIBLE	%	10	10	10
REQUIRED CAPACITY	KG/HR	3978	3978	3978
RELIEVING TEMPERATURE	△3 °C	149	149	149
MOLECULAR WEIGHT (OF VAPOURIZED LIQUID)		17.7	17.7	17.7
COMPRESSIBILITY FACTOR		0.98	0.98	0.98
VISCOSITY (AT OPERATING CONDITIONS)	cPo			
SP GR LIQUID (AT OPERATING CONDITIONS)				
C_p / C_v RATIO		1.3	1.3	1.3
BACK PRESSURE BARA (MAX)		2	2	2

NOTES

3	REVISED AS NOTED	15/9/8	JIN		
2	FOR APPROVAL	12/6/81	JIN		
REV NO	REVISION	DATE	BY	APP	APP BY CLIENT

FILE NO
S.N NO.
CLIENT

sofresid norge a.s

PROCESS SPECIFICATION

FUNCTION/ ITEM :	SAFETY VALVES
CLIENT	ELF AQUITAINE NORGE A/S
PROJECT :	TCP 2 EXTENSION

ITEM	PSV V213.2	PSV V220.1	PSV V220.2
REF. P & ID	8800115032	8800105033	8800105033
NATURE OF FLUID	6	6	6
FLANGE RATING / FACING INLET	300 RF	150 RF	150 RF
FLANGE RATING / FACING OUTLET	150 RF △3	150 RF	150 RF
CASE FOR RELIEF	FIRE	FIRE	FIRE
SET PRESSURE BARA	25	16.2	16.2
OVERPRESSURE PERMISSIBLE %	10	10	10
REQUIRED CAPACITY KG/HR	3978	2424	2424
RELIEVING TEMPERATURE △3 °C	149	246	246
MOLECULAR WEIGHT (OF VAPOURIZED LIQUID)	17.7	17.7	17.7
COMPRESSIBILITY FACTOR	0.98	1.0	1.0
VISCOSITY (AT OPERATING CONDITIONS) cPo			
SP GR LIQUID (AT OPERATING CONDITIONS)			
Cp / Cv RATIO	1.3	1.3	1.3
BACK PRESSURE BARA (MAX)	2	2	2

NOTES

REV NO	REVISION	DATE	BY	APP	APP BY CLIENT
3	REVISED AS NOTED	15/9/81	JIN		
2	FOR APPROVAL	12/6/81	JIN		

FILE NO

S.N NO.

CLIENT

SHT 38/3

sofresid norge a.s

PROCESS SPECIFICATION

FUNCTION / ITEM : SAFETY VALVES

CLIENT : ELF AQUITAINE NORGE A/S

PROJECT : TCP 2 EXTENSION

ITEM		PSV P 223 A.1	PSV P 223 B.1	
REF. P & ID		8800095036	8800095036	
NATURE OF FLUID		METHANOL	METHANOL	
FLANGE RATING / FACING INLET		1500 RTJ	1500 RTJ	
FLANGE RATING / FACING OUTLET		150 RF	150 RF	
CASE FOR RELIEF		BLOCKED LINE	BLOCKED LINE	
SET PRESSURE	BARA	177.5	177.5	
OVERPRESSURE PERMISSIBLE	%	0	0	
REQUIRED CAPACITY	KG/HR	0.005 M^3/HR	0.005 M^3/HR	
RELIEVING TEMPERATURE	°C	21	21	
MOLECULAR WEIGHT				
COMPRESSIBILITY FACTOR				
VISCOSITY (AT OPERATING CONDITIONS)	cPo	0.7	0.7	
SP GR LIQUID (AT OPERATING CONDITIONS)		0.8	0.8	
C_p / C_v RATIO				
BACK PRESSURE BARA		~0	~0	

NOTES

2	FOR APPROVAL	12/6/81	JIN		
REV NO	REVISION	DATE	BY	APP	APP BY CLIENT

FILE NO	S N NO.	CLIENT

sofresid norge a.s

SHT 37 | 38

sofresid norge a.s

PROCESS SPECIFICATION

FUNCTION / ITEM :	SAFETY VALVES
CLIENT	ELF AQUITAINE NORGE A/S
PROJECT	TCP 2 EXTENSION

ITEM △3	PSV P 225 A.1	PSV P 225 B.1	
REF. P & ID	8800105033	8800105033	
NATURE OF FLUID	INHIBITOR	INHIBITOR	
FLANGE RATING / FACING INLET	150 RF	150 RF	
FLANGE RATING / FACING OUTLET	150 RF	150 RF	
CASE FOR RELIEF	BLOCKED LINE	BLOCKED LINE	
SET PRESSURE BARA	16	16	
OVERPRESSURE PERMISSIBLE %	0	0	
REQUIRED CAPACITY KG/HR	0.002 M^3/HR	0.002 M^3/HR	
RELIEVING TEMPERATURE °C	21	21	
MOLECULAR WEIGHT			
COMPRESSIBILITY FACTOR			
VISCOSITY (AT OPERATING CONDITIONS) cPo	0.6	0.6	
SP GR LIQUID (AT OPERATING CONDITIONS)	0.8	0.8	
C_p / C_v RATIO			
BACK PRESSURE BARA	1.5	1.5	

NOTES

REV NO	REVISION	DATE	BY	APP	APP BY CLIENT
3	REVISED AS NOTED	15/9/81	JIN		
2	FOR APPROVAL	12/6/81	JIN	~~87~~	

FILE NO.	S.N NO.	CLIENT