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2.3.1 INTRODUCTION

This section describes the primary structure of TCP2 and the pipelines and risers connected to it. In addition it also describes the utility systems for dewatering/flooding and the structural monitoring system in use.

2.3.2 PLATFORM STRUCTURE, PRINCIPLE ELEVATIONS AND SPECIFICATIONS

The platform is a concrete gravity platform constructed in two parts, namely a steel main deck and other deck structures, mounted on a concrete substructure. The substructure comprises various post-tensioned concrete components centred around three central support columns.

The concrete substructure extends from the seabed to the central columns/main deck transition at elevation +129.700m.

All structural elements are prestressed using the Freyssinet cable system.

The main design, construction and installation contractors of the concrete substructure were Norwegian Contractors AS, Oslo. The substructure was constructed in Andalsnes, Norway. The main deck structure was split between Stord Verft in Norway, the CPM yards in Mardyck and Dunkerque, and the UIE yard in Cherbourg, France. Other deck structures were constructed in Spie Batignolles - Vigor, Orkanger, Norway.
The platform was designed and constructed in accordance with the criteria set out in the following documents:

- Elf-Norge AS, Oslo: Specifications for Engineering, Procurement and Construction of Frigg Treatment and Compression Platform No 2 (TCP2), June 1974.
- Norwegian Contractors/Grøner: Elf-Norge AS, Frigg-TCP2 Concrete Design Criteria, 14.11.74, based on the following Norwegian Standards:
  NS3473 Norwegian Code of Practice for the design of concrete structures.
  NS3474 Norwegian Code of Practice for the construction of concrete structures.
- Det norske Veritas: Concrete Design Criteria (Special DNV requirement of 28.11.74).
- Det norske Veritas: Technical Notes, 'A 6/5 impact loads from boats' and 'A 6/1 wave shock pressure on columns'.
- Elf-Norge AS Frigg TCP2 - Concrete Specifications Part II, Construction, February 1975.
- API6A, 14A and RP14C (ACI318-71 Building Code Requirements for Reinforced Concrete).
- ANSI B31 (Piping) and Specification for Design, Fabrication and Erection of Structural Steel for Buildings.
- ASME, Section VIII, Pressure Vessel Design Standard.
- AWS, Structural Welding, D11, Code 1977.
- BSI, BS302 (Wire Ropes for Cranes, Excavators and General Engineering Purposes).
- BSI, BS1515, Part 1 (Carbon Ferritic Alloy Steels).
- BSI, BS1663 (Higher Tensile Steel Chain Grade 40 for Lifting Purposes), and BS3243 (Hand-operated Chain Pulley Blocks), and BS4018 (Pulley Blocks for Use with Wire Rope for a Maximum Lift of 25 tonf/in² Combination).

2.3.2 PLATFORM STRUCTURE, PRINCIPLE ELEVATIONS AND SPECIFICATIONS (cont.)

- BSI, BS5345 (Code of Practice for the Selection, Installation and Maintenance of Electrical Apparatus for use in Potentially Explosive Atmosphere), and BS5405 (Code of Practice for the Maintenance of Electrical Switchgear for Voltages up to and including 145kV).
- Department of Energy, Offshore Installations, Guidance on Design and Construction.
- Department of Trade (Marine Division), Continental Shelf Act, Section 4, 1964, and Markings of Offshore Structures, 1976.
  Det Norske Veritas, Rules for Fixed Offshore Structures, 1974.
- Elf-Norge, Fabrication Specification 1052, No 3/155, Rev 2/TPS, February 1974.

The main deck structure extends from the column/main deck transition at elevation +129.700m to elevation +139.300m. It was designed by Kvaerner Engineering AS as consultants to Norwegian Contractors, the main contractor, in accordance with the criteria set out in the following documents:

- Technical Specifications for steel support frame design TCP2, Elf-Norge AS, February 1975, 1st revision.
- Manual of Steel Construction, 7th edition, AISC.
- Rules for Design, Construction and Inspection of Fixed Offshore Structures, Det norske Veritas 1974.
- NS3473, Norwegian Standard for Steel Structures, Norwegian Standard Association, May 1973.
- Fabricating Specification 1052, No 3/155, Rev 2/JPS, Elf-Norge, February 1974.
- Minutes of meeting, Elf, DNV and Norwegian Contractors at Elf-Norge, Paris Office, 4.11.75
- American Welding Society (AWS D.1.1-72), Structural Welding Code.
- Painting Specification for Steel Structures 1052, No 3/169, Rev 1, Elf-Norge, March 1974.
- General Equipment Specification, Coating for Main Structure, SGP07, Class P, Rev 0, September 1972.

Other deck structures extend from elevation +131.700m to +149.050m. The main design and fabrication contractor was McDermott Hudson, London, in accordance with the following criteria:

- Elf-Norge, Frigg Field, Material Specifications No 1052 and No 3/145 Rev 3.
- Elf-Norge, Frigg Field, Fabrication Specifications No 1052/155, Rev 1.
- DNV Technical Notes C1/2 and C1/3.

Phase IIIa Compression, Electrical Generation and Control facilities were added during 1980-81. They were designed by a Kvaerner Technip consortium under the supervision of an Elf project team in accordance with the criteria set out in the following documents:

- Recommended Practice for the Planning, Design and Construction of Fixed Offshore Platforms - API.
- Specification for the Design, Fabrication and Erection of Structural Steel for Buildings and Bridges - AISC.
- Steel Construction Manual - AISC.
- Structural Welding Code - AWS.
- Rules for Construction and Classification of Fixed Offshore Units - DNV.
- Fabricating Specification 1052 No 3/155 JPS/HR/hl, and other specifications for coating, painting etc - Elf Norge.
- Testing and Inspection of Cranes for Fixed Offshore Installations.

2.3.2 PLATFORM STRUCTURE, PRINCIPLE ELEVATIONS AND SPECIFICATIONS (cont.)

All equipment is located in pancakes or modules placed on or within the support frame. The modules and pancakes were built ashore and installed as completed units.

The Phase IIIa Compression, Electrical Generation and Control facilities were constructed in three Norwegian yards:

- Spie Batignolles - Vigor at Orkanger - three compressor modules and the control module.
- Einan Ogrey at Kristiansand - power generation and emergency units.
- Nymo at Grimstad - utilities.

The Extension Area was added in 1983. This comprised the addition of a new module (M50) and a new pancake (P53) for the treatment of North East Frigg and ODIN gas. The new structures were designed by Sofresid Norge A/S under the supervision of an Elf project team. The designs incorporated up-to-date specifications and regulations stipulated by the certifying authority.

Development of the East Frigg Field required further facilities for the treatment of gas. This new gas treatment facility was housed in a new module (M51) and was integrated with the existing facilities on TCP2. A new pancake (P950) was also installed (on the Cellar Deck) for laydown purposes on the south side of Module 51.

Two additional structures were required for the Lille Frigg Tie-in equipment and were incorporated onto the platform in 1993. Module M52 was designed and built by Kværner Rosenberg at their Stavanger yard and Pancake P48 was designed and built by NYMO Mekaniske Verksted at their Grimstad yard. The design of each structure, which was under the supervision of an Elf project team, followed up-to-date specifications and regulations stipulated by the certifying authority.

When the Frøy Field was developed, an additional module (M35) was added for the separation and treatment of oil and gas from Frøy. The module consisted of five levels and included equipment that routed the separated gas to the existing sub-sea line to St. Fergus, while the oil joined the condensate from Lille Frigg in the Frostpipe to Oseberg.

2.3.3 PRIMARY STRUCTURE

Reference diagram: 2.3.3 Fig 1

General

The primary structure consists of a concrete substructure which supports the main steel deck upon which stands the pancakes and modules housing production facilities.
Main elements of the substructure are as follows:

(a) A hexagonal foundation slab.
(b) A caisson of 19 cylindrical cells, three of which are extended into three columns which support the deck structure.

The substructure, standing in 104.46m of water, is designed to withstand 100-year wave conditions.

2.3.3 PRIMARY STRUCTURE (cont.)

In addition to the normal reinforcement and the prestressing cables, numerous steel parts are embedded in the structure, mainly in the form of steel fixing plates flush with the concrete surface and anchored in the concrete. These include:

(a) Towing and installation fixing plates.
(b) Mooring and towing eyes.
(c) Utility riser fixing plates.

Description

Foundation Slab
The foundation slab is a 9340m² area raft.

The space between the seabed and the base of the foundation slab is filled with cement grout which was injected immediately after platform installation.

A drainage (anti-liquefaction) system with drains in the dowels and skirts allows for drainage of the foundation slab should the pore pressure build up during storms.

Support Columns
Each column has an internal base diameter of 18.80m which tapers to an outside diameter of 10.40m at nominal elevation +95.00m, and increases to an outside diameter of 12.82m at elevation +126.90m.
The three columns which provide the main rigid support for the Main Deck structure extend from domed Cells 1, 3 and 5.
The columns, excluding the condensate storage tank (Cell 21) in Column 5 and the ballast cylinder (Cell 20) in Column 1, are filled with water for ballast only. Cell 20, which is kept permanently dry, terminates at elevation +112.00m, and Cell 21 at +42.70m.

The permanent depression draw-down in the structure (25T/m²) is relative to the external water pressure. The water level in Columns 3 and 5 is however equal to the external water level. Draw-down is controlled by the annulus water level of Column 1, into which overflow pipes from each cell empty freely at elevation + 80.00m.

Columns 3 and 5 may be pumped dry for periodic maintenance but are not to be emptied simultaneously.

Temperature control of Column 3 which contain hot gas risers, is by water circulation holes.

Cells
A total of 19 domed cells, including the three column support cells, form part of the substructure, each being connected by a star cell. The domed cells are constructed as units of outer caisson walls and lower and upper domes. The walls and upper domes connect at elevation +42.70m, and the lower domes are formed into the foundation slab.

Each domed cell has an internal diameter of 18.80m.

2.3.3 PRIMARY STRUCTURE (cont.)

Steel skirts are fixed to the foundation under the outer and centre caisson cells, and along the periphery of the base slab.

Structural Monitoring

Originally the platform was equipped with instrumentation to accurately measure the platform's behaviour and environmental conditions.

This equipment has now been taken out of service as the initial objective of comparing design values against in-service measurements has been attained.

Originally the installed equipment measured:
- Waves
- Mean water level
- Stress (strain gauges)
- Earth pressure
- Pore pressure
- Tilt
- Settlement and horizontal displacement

Wave and mean water levels are at present measured from the QP platform, which, being only 200m away, is considered representative for TCP2.

The stress and earth/pore pressure measurements are no longer performed due to breakdown of the system and it is not considered necessary to install a new system. The tilt, settlement and horizontal displacement measurements are performed by optical levelling measurements from QP to TCP2 and back to QP.

Utility Systems for Primary Structure

The following utility systems are installed in the primary structure:
- Antiliquefaction system
- Drainage/Dewatering system
- Overflow and Draw-down system
- Temperature Measurement system
- Recirculation system
- Cell Water Measurement system

All the above systems, with the exception of the Antiliquefaction system, are still operational.

2.3.4 STRUCTURAL REFERENCING SYSTEM

A structural referencing system is provided for TCP2 details of which can be found in the TCP2 Operations Manual, Volume 10 (Part 2) IIS For Structures.

2.3.5 FOUNDATION

Reference Diagram: NGI Report No. 893032-2 Fig. 2 - Simplified Soil Profile and Static Strengths

Soil Foundation

The Norwegian Geotechnical Institute, Oslo, as consultants to Norwegian Contractors AS, were responsible for the interpretation of soil investigations and geotechnical data and for determining the soil parameters used in platform settlement and geotechnical stability calculations.

Soil Profile

Tabulated below is the soil profile as defined by samples taken from a boring in TCP2 location; Fig. 2 gives a simplified pictorial view of the soil profile and also details the static strengths.

Depth Below Seabed (m)	Soil Description	Water Content (%)
0 to 3.5	Brownish to grey fine-to-medium-sand with shell fragments; very dense (phi. u39°).	
3.5 to 5.5	Brownish soft clay with silt and sand seams. Normally consolidated.	22.4
5.5 to 9.0	Brownish clay with silt seams. Over consolidated.	20
9 to 11	Hard brownish clay with extensive silt seams. Over consolidated.	
11 onwards	Sand.	

2.3.6 MAIN DECK STRUCTURE

Reference Diagrams:
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FF-21-21-02-0289 - Module 52, Main Steel
FF-21-21-02-0137 - Pancake P48, Main Steel
2.3.6 Fig. 10 - Frøy Module 35

General

The Main Deck structure (steel support frame) consists of four longitudinal and six transverse trusses. Four of the transverse trusses are rigidly connected to the primary structure support columns by prestressed bolts.

The main truss members are welded box sections, stiffened by bulkheads at the nodes. They are rigidly interconnected by diagonal and upright members.

The pancakes and modules are simply supported on the Cellar Deck and the Main Deck respectively.

Pancakes, Modules and Other Deck Structures

The pancakes are steel slab elements which make up the Cellar Deck. They are beam rafts with steel top plating, simply supported on cantilevers on the Main Deck structure.

The pancake concept allows for flexible Cellar Deck loading, with maximum allowable uniformly distributed loads ranging from 2.5kN/m² to 15kN/m².

The framings over the primary structure support columns are effectively pancake structures with a top grating.

Two pipe support frames are supported on cantilevers on the Main Deck structure, on the east and west side of the Cellar Deck.

The modules are situated on top of the Main Deck structure. Each module is a simple truss structure, enclosed within corrugated sheeting at the sides, with a steel roof and floor.

The modules on the Upper Deck and the Main Deck are supported on 8mm thick deckplates. These deckplates must **not** be removed under any circumstances as they contribute to the global stiffening of the Module Support Frame (MSF).

2.3.6 MAIN DECK STRUCTURE (cont.)

The Main Deck structure has been built to withstand pre-determined loads. Information on the TCP2 Weight Database will be available in October 1995. Until it is available, any questions related to this subject should be referred to the Engineering Dept, Mechanical Section.

The modules terminate at elevation +148.050m.

Four crane pedestals are installed externally at Main Deck level, each supported by rigid members. One is secured to the transverse truss of Module 01 (not in use), one to the longitudinal truss of Module 04 (crane 60 X01), and one to a transverse truss of Module 32 (not in use) and one to the frame of Module 35 (Crane CM7).

Bridge (Connecting TCP2 to TP1)

Reference Diagram: FF-85-21-25-5055 - General Arrangement of Bridge.

The main contractor for design was McDermott Hudson Engineering, London and the fabrication was carried out at Mercantile Marine Engineering and Graving Docks, Antwerp.

The main codes and standards for the bridge design were:
- ANSI A58 American National Standard Institute (Loads only).
- API RP2A American Petroleum Institute (for design of tubulars).
- AWS Structural Welding Code
- AISC Design of all other members.
- NV-65-67 Wind

The main codes and standards for the bridge fabrication were:
- Elf Norge Fabrication Specification 1052 - No 3/155, rev 2/JPS of February 1974
- AWS D.1.1 - 1977 Structural Welding Code.

Complete design calculations are to be found in TCP2 Engineering Data Book 6.

2.3.7 RISERS

Reference Diagram: FF-85-36-25-0522 - General Perspective View, South - East Side

General

Platform risers and J-tubes transporting process products and utility services are installed in the primary structure support columns, and the domed cells supporting these columns.

All J-tubes enter the platform support columns through tunnels in the foundation slab via bellmouths. **Risers are defined as internal or external. Internal risers are those which enter the platform support columns through tunnels in the foundation slab and are designated R1, R2, etc. External risers enter the platform support column at overdome level and are designated R1E, R2E etc.**

All risers and J-tubes are supported by anchor flanges in the support columns at elevation +117.70m.

2.3.7 RISERS (cont.)

Risers were designed and constructed in accordance with the criteria in the following documents:

(i) Structural design report for TCP2, Internal and External Risers and Subsea Piping, EP0002 and EP0003, Volumes 1 and 2.
(ii) ANSI Code B31.8, 1975 and DnV Rules applicable at that time (1974/75).
(iii) Guides for external risers, May 1975.
(iv) Vertical clamp on caisson wall design, July 1975.
(v) J-tube analysis, July 1975.
(vi) Anchor flange platform, October 1975.
(vii) External riser tripod support design, October 1975.
(viii) Report on safety factors incorporated in the design of penetration through TCP2 concrete shaft and cell walls, 25.10.76.
(ix) Design Resumé, Riser at TCP2, Frostpipe document RE-PL-41-36-0421, 1993.
(x) Design Resumé (DFI), Riser/Spool System, Lille Frigg document RE-PL-21-36-0324, 1992.

External Risers

The following external risers are installed in Column 3:

(i) 32in riser R1E, back-up for R1 (gas to St. Fergus),
(ii) 16in riser R2E oil export to Oseberg,
(iii) 26in riser R3E back-up gas from DP2,
(iv) 24in riser R7E riser, available for future use.

These risers are supported by strategically located clamps and guides on the foundation slab and the domed cells.

The following external risers are installed in Column 5:

(i) 10in riser R4E wet gas import from Lille Frigg,
(ii) 16in riser R5E. injection water to Frøy.
(iii) 20in riser R6E, gas from Odin (Esso).

These risers are supported in a similar manner to those of Column 3.

Internal Risers

The following internal risers are installed in Column 3:

(i) 32in riser R1, gas export to St. Fergus.
(ii) 26in riser R2 from DP2, gas from Frøy. (12” flexible pipe)
(iii) 26in gas R3 from DP2.

The following internal riser is installed in Column 5:

12in flexible pipe riser from East Frigg located within J-tube J7.

The tunnels in the foundation slab through which these risers pass are sealed and filled with stagnant sea water.

2.3.7 RISERS (cont.)

Pipeline Emergency ShutdownValves

All risers, apart from the Lille Frigg riser, are fitted with emergency shutdown valves (ESDVs) immediately after leaving the concrete column and entering the cellar deck. These pipeline ESDVs are located at elevation 133.5m approx. The ESDV for the Lille Frigg riser is located in the column immediately below cellar deck level.

2.3.8 CONDUCTORS AND J-TUBES

Conductors

No conductors are located on TCP2.

J-Tubes

Column 3
The following J-tubes are installed in Column 3:

(i) A 10.3/4" J-tube J1, for the 4.1/2" methanolated water line interconnected with DP2, which passes under Cell 11.
(ii) An 18" J-tube J2, oil sea line from Frøy. (12" flexible pipe)
(iii) A 12.3/4" J-tube J3, containing the power cables which are interconnected with DP2.

Column 5
The following J-tubes are installed in Column 5:

(i) An 18" J-tube J4, containing the East Frigg umbilical and cable and the Lille Frigg cable and umbilical.
(ii) An 18" J-tube J5, containing the East Frigg service line and cable.
(iii) A 12 3/4in J-tube J6, containing the Lille Frigg service line and injection line.
(iv) An 18" J-tube J7, containing the 12" East Frigg gas riser (see 2.3.7 above) (12" flexible pipe)

2.3.9 UTILITY RISERS

Column 1

The following utility risers are installed in or about Column 1:

(i) A 16in diameter external casings serving washdown pump CP37A/B/C, which terminate at elevation +91.10m.
(ii) A 32in diameter internal casing, serving sump pump CP3, which terminates at elevation +62.46m.
(iii) A 22in diameter external casing, serving fire pump CP6B, which terminates at elevation +88.70m.

2.3.9 UTILITY RISERS (cont.)

Column 3

The following utility risers are installed in or about Column 3:

(i) Four 54in diameter internal casings, which terminate at elevation +83.70m.
(ii) A 16in diameter external casing, for washdown pump 50PO2, which terminates at elevation +91.10m.
(iii) Two 16in diameter external casings, for future pumps, one of which is used as sewage outfall, and which terminate at elevation +91.10m.
(iv) A 22in diameter external casing, for fire pump 68PO1A, which terminates at elevation +88.70m.

Column 5

The following utility risers are installed in or about Column 5:

(i) A 22in diameter external casing, serving fire pump CP6A, which terminates at elevation +68.10m.
(ii) A 22in diameter external casing, serving fire pump 68PO1B, which terminates at elevation +68.10m.
(iii) Two 54in diameter internal casings, for future sea water pumps 58PO1E and F, which terminate at elevation +83.70m.
(iv) Two internal sea water rejection shafts (58C01 and 02) which terminate at elevation +99.70m.

2.3.10 PIPELINES AND FLOWLINES

For the purpose of this document pipelines and flowlines are defined as follows:

- A pipeline is any subsea gas line, condensate line, oil line or similar, including expansion loops, spool pieces or portions thereof, linking different fields together or linking a field to the shore.
- A flowline is any subsea gas line, flare line, umbilical, condensate line, kill line or similar, including expansion loops, spool pieces or portions thereof, linking different installations within a field.

The pipelines and flowlines connected to TCP2 have been designed in accordance with the requirements given in the following documentation:

- API 5LX
- ANSI B31.8 (modified)
- API 1104
- Elf Spec. S65
- TCP2-L-102, Submarine and Riser Steel Piping
- Structural design reports for Elf Norge A/S, EP0002, EP0003, Frigg Field Development Phase II, Volumes 1 and 2
- Minutes of Meeting Elf Frigg Phase I and II, dated 3.3.77, Report No. 57-15-77
- DnV Rules for Submarine Pipeline Systems, 1981
- Design Report for Sealine System, Lille Frigg document RE-LF-21-00-001
- Pipeline In-place Analysis, Frostpipe document RE-PL-41-35-0421
- DnV RPE305, On Bottom Stability of Submarine Pipelines, Oct. 1988
- DnV 1976, Rules for the Design, Construction and Inspection of Submarine Pipelines and Risers.

2.3.10 PIPELINES AND FLOWLINES (cont.)

The following pipelines and flowlines are connected to TCP2:

Reference Diagrams: FF-00-00-00-0111
FF-00-00-00-0112

Pipeline/Flowline	Design Press (bar)	Spool Piece
32in gas export to St Fergus	148.9	No
16in condensate/oil to Oseberg	167	Yes
26in gas from DP2	172	No
4½in methanolated water to DP2	16	No
10in gas from Lille Frigg	530	Yes
12in gas from East Frigg	170	Yes - flexible spool and riser
12in gas line from Frøy	149	Yes - flexible spool and riser
12in oil line from Frøy	149	Yes - flexible spool and riser
16in water injection line to Frøy	220	

CONTENTS

2.4.1 PLATFORM AND BRIDGE MATERIALS

Platform

General
The limits of the concrete substructure are from the seabed to the concrete structure and steel deck connections at elevation +129.70m.

The limits of the Main Deck structure are from support columns/main deck transition at elevation +131.70m to elevation +139.30m.

Materials
The concrete structure is constructed from the following materials:

(i) Concrete:

Class C45 (according to NS3473/74) 28 days' cube strength = 45N/mm²
- air void content in splash zone : 4 to 6%
- water/cement ratio:
  - submerged zone : < 0.45
  - splash and atmospheric zone : < 0.40

(ii) Concrete mixes

Structure feature	Cement PC300 DALEN (kg/cm³)	Sand (0 to 10mm) Veblungsnes (kg/m³)	Coarse Aggr (10 to 25mm Ørlandet (kg/cm³)	Water (litres/m³)	Admixtures Betoken LP/R/L (litres/m³)	Slump (cm)	Air content %
Concrete skirts	460	800	980	185	6/2/-	10	
Lower domes	420	800	980	180	6/2/-	14	
Cell walls	480	880	880	190	3-6/-/-	8-12	
Upper domes							
- A	460	800	980	190	6/2/-	8-10	
- B	480	790	970	195	6/2/-	10-14	
Columns	480	790	970	190	1-3/-/0.1	8-10	4

(iii) Reinforcement steel:

KS40 (yield strength = 400N/mm²)
KS40S (weldable reinforcement steel) was used in the splash zone of Columns 1, 3 and 5 in order to facilitate possible future repairs.

2.4.1 PLATFORM AND BRIDGE MATERIALS (cont.)

Concrete cover to reinforcement:

	below elevation +85.700m	**above elevation +85.700m**
Minimum cover to ordinary reinforcement	7.5 ± 1.0cm	8.5 ± 1.0cm
Minimum cover to prestressing steel ducts	10cm	10cm

(iv) Prestressing steel:

(a) FREYSINET 12T15 post-tensioning system:

Cross-section area of 12T15 tendon = 1716mm²
Yield strength of steel (f_{02}) = 1566N/mm²
Breaking strength of steel (f_u) = 1783N/mm²

Post-tensioning anchorages:

Active anchorage Freyssinet type 12T15 (model 294)
Passive anchorage STUP type 12T15 and 12T15A.

(b) DYWIDAG bolts - Connection the support columns to the Main Deck structure.

Yield strength (f_{02}) = 1100N/mm²
Breaking strength (f_u) = 1250N/mm²

(v) Grout:

Grout for prestressing cable/bolt ducts (batch weight):

Cement: 100kg
Water: 40 litre
Admixture: 1.5% Intraplast B or 1.5% Betokem In(B)

2.4.1 PLATFORM AND BRIDGE MATERIALS (cont.)

Main Deck

The selection of materials for construction of the Main Deck structure was based on Plate Material Specifications for Fixed Offshore Structures, 1052 No 5/302, Rev 0/JPS, Elf-Norge, May 1975. Materials used are as tabulated below:

Designation	Steel Grade (DIN 17100)	Thickness (mm)	Classification (DNV Rules)	Typical Application
SHS20	St 52-3N (modified)	12-15-20-25	Special	Nodes, girders, trusses
SHS40	St 52-3N (modified)	30-40-50-60-80-100	Special	Heavy wall nodes, girders, trusses
ML0	St 37-3U	various	Secondary	Plating, sections
ML20	St 37-3N	various	Primary	Plating, sections profiles

Note: For St 52-3N steel, a minimum yield strength of 3400kp/m² is used for all plate thickness calculations.

The selection of materials for construction of other deck structures was based on the following:

(i) Elf-Norge, Frigg Field, 1052 No 3/145, Fixed Offshore Structures Material Specifications for TP1 and QP, Rev 0, November 1970.
(ii) Elf-Norge, Frigg Field, 1052 No 3/620, Fixed Offshore Structures Special Material Specifications for TP1 and QP, Rev 0, November 1970.

Materials used for construction of other deck structures are as tabulated below:

Designation	Steel Grade According to DIN 17100	Classification According to DNV rules	Typical Application
HS20	St 52-3N	Primary structure steel	Main module, girders, members, pad-eyes, crane pedestals.
	St 37-2	Secondary structure steel	Beams and plates, ladders and stairs.

Materials to the following specifications were used for the Phase IIIa structural and architectural work:

(i) Main support frame - DIN17100-ST52-3N.
(ii) Module structure - DIN17100-ST52-3N (Charpy tested at -20°C).
(iii) Wall plate, deck plate - MLD.

2.4.1 PLATFORM AND BRIDGE MATERIALS (cont.)

(iv) Stringers - DIN17100-ST37-3U.
(v) Corrugated wall plate - SS Z2 CND A/B.

Paints and Coatings
Preparation and coating of structural surfaces complies with the following codes and regulations:

(i) Swedish Standards SIS:05.5900 (Pictorial Surface Preparation Standards for Painting Steel Surfaces), 1967.
(ii) SSPC, Surface Preparation Specification, VIS1.
(iii) BSI, BS4232 (Surface Finish of Blast Cleaned Steel for Painting), 1967.
(iv) European Scale of Degree of Rusting for Anti-corrosive Paints, Stockholm, 1961.
(v) Elf-Re, Standard Specification P7 (Coating for Marine Structures), Rev 1, March 1975.
(vi) Elf-Norge, Frigg Field, Painting Specification for Steel Structures, DEP1052, No 3/169, Rev 1, March 1974.
(vii) ASTM, A123, Zinc Coating (hot galvanised) on Products Fabricated from Rolled, Pressed or Forged Steel Shapes, Plates, Bars and Strips.
(viii) ASTM, A153, Zinc Coating (hot dip) on Iron and Steel Hardware.
(ix) ASTM, A143, Safeguarding against Embrittlement of Hot Galvanised Structural Steel Products.
(x) Brown and Root Specifications for TCP2-X-101, 102, 106, 108, 109, 110, 112, 116, 117 and 118.
(xi) General Equipment Specification, Coating for Marine Structures, SGP07, Class P, Rev 0, September 1972.

Platform risers and J-tubes are coated as follows:

(i) Above water - chlorinated rubber (195 microns minimum) or Scotchcote 206 epoxy (300 microns minimum)
(ii) Tidal zone - Monel cladding (3mm thickness), coated with coal tar epoxy (400 microns minimum) with antifouling paint.
(iii) Below water - coal tar epoxy (400 microns minimum) or Scotchcote epoxy 312 (400 microns minimum).

Risers passing through the internal tidal zone in the support columns are clad with Monel 400 (3mm thickness) and coated with coal tar epoxy (400 microns minimum) with a top coat of Durovinyl (800 microns minimum) antifouling paint.

Risers passing through the sealed tunnels in the foundation slab are coated with zinc metal spray (250 microns minimum) with a top coat of marking paint.

The 8.5/8in nitrogen storage and 4.1/2in methanolated water risers in J-tubes are coated with coal tar enamel of a nominal 5 to 6mm thickness.

2.4.1 PLATFORM AND BRIDGE MATERIALS (cont.)

Bridge (Connecting TCP2 to TP1)

Materials

The selection of high strength and mild steels for plates, sections and welded tubular members was based on the following material specifications:

(i) Elf Norge - Frigg Field - 1052 No. 3-145, Fixed Offshore Structures, Materials Specification, rev. 4, December 1973.
(ii) Elf Norge - Frigg Field - 1052 No. 3-155, Fixed Offshore Structures, Fabrication Specification, rev. 2, February 1974.

Non structural mild steel has been used for the walkways, pipe support frames and cladding rails (= DIN 17100 ST-37-2U).

Corrosion Protection

(i) Elf Norge - Frigg Field "Painting Specification for Steel Structures" DEP.1052 No. 3-169, rev. 1 of March 1974.
(ii) Elf - R.E. "Standard Specification P7 Coating for Marine Structures" DGEP 01.E.90 No. 2-530, rev. 0 of September 1972.
(iii) Secco "Standard Specification for Application of Coating on Steel Parts", Secco A922-HZ/Mg of April 1974.

2.4.2 MATERIALS FOR CONDUCTORS, J-TUBES, CASINGS AND RISERS

Conductors

There are no conductors on the TCP2 platform.

J-tubes

J-tube Materials

- Column 3

J-tube	Size	Material Grade
J1	10 3/4in	API 5LX 42
J2	18in	API 5LX 42
J3	12 3/4in	API 5LX 42

2.4.2 MATERIALS FOR CONDUCTORS, J-TUBES, CASINGS AND RISERS (cont.)

- Column 5

J-tube	Size	Material Grade
J4	18in	API 5LX 42
J5	18in	API 5LX 42
J6	12 3/4in	API 5LX 42
J7	18in	API 5LX 42

J-tube Contents

- Column 3

J1 - 4½in methanol riser (refer to Risers, below);
J2 - Available for future use;
J3 - Power cables (x 2) to DP2.

- Column 5

J4 - Umbilical and cables to East Frigg and Lille Frigg;
J5 - 1in service line and electrical cable to East Frigg;
J6 - Service line and injection line to Lille Frigg;
J7 - 12in flexible riser for East Frigg (refer to Risers, below).

Casings
Column 1

- 16in for washdown pumps CP37A/B/C,
- 32in for sump pump CP3,
- 22in for firewater pump CP6B.

Column 3

- Four 54in for pumps 58P1A to D (pumps removed),
- 16in for washdown pump 58P02,
- Two 16in, one for a future pump and one used for sewage outfalls,
- 22in for firewater pump 68P01A.

Column 5

- 22in for firewater pump CP6A,
- 22in for firewater pump 68P01A,
- Two 54in for seawater pumps 58P01E and F (pumps removed),
- Two seawater rejection shafts, 58C01 and 58C02.

Further information about the casings is given in Part 2, Section 2.3.

2.4.2 MATERIALS FOR CONDUCTORS, J-TUBES, CASINGS AND RISERS (cont.)

Risers

Column 3

Riser	Diameter/Thickness	Material	Use
R1	32in x 1.094in	OX 602 E/API 5LX 65	Gas to St. Fergus
R1E	32in x 1.094in	OX 602 E/API 5LX 65	Gas to St. Fergus (back-up)
R2	26in x 1.0in	API 5LX 60	Gas from Frøy
R2E	16in x 1.01in	API 5LX 52	Frostpipe
R3	26in x 1.0in	API 5LX 60	Gas from DP2
R3E	26in x 1.0in	API 5LX 60	Future use
R7E	24in x 0.94in	API 5LX 60	Future use
J1	4½in x 0.337in	API 5LX 60	Methanolated water
J2	457mm x 12.7mm	API 5LX 42	Oil from Frøy

Column 5

Riser	Diameter/Thickness	Material	Use
R4E	10in x 1.25in	API 5LX 65	Lille Frigg
R5E	16in x 1.0in	API 5LX 60	Injection water to Frøy
R6E	20in x 1.0in	API 5LX 60	Odin *(not in use)*
J7	11.63in x 1.98in	See note below	Flexible riser

Note: J7 - riser is a Coflexip flexible line pulled down J-tube J7. This flexible line is made up of seven layers of steel, plastic sheathing and armour. This line extends from the pipeline connection up to the platform topsides.

Pipelines/Flowlines

Pipelines/Flowlines connecting with risers in Column 3

Pipeline/Flowline	Diameter/Thickness (1)		Material	Spool Piece
	Zone 1	Zone 2		
32in line to St. Fergus	32in x 0.75in	32in x 0.75in	API 5LX 65	No
16in Frostpipe	16in x 0.625in	16in x 1.01in	API 5LX 52	Yes (2)
26in from DP2	26in x 1.0in	26in x 1.0in	API 5LX 60	No
4½in methanolated water to DP2	4½in x 0.337in	4½in x 0.337in	API 5LX 60	No
12in oil line from Frøy	323.9mm x 14.3mm	as Zone 1	API 5LX 65	Yes
12in gas line from Frøy	323.9mm x 14.3mm	as Zone 1	API 5LX 65	Yes

2.3.2 MATERIALS FOR CONDUCTORS, J-TUBES, CASINGS AND RISERS (cont.)

Pipelines/Flowlines connecting with risers in Column 5

Pipeline/Flowline	Diameter/Thickness Zone 1	Diameter/Thickness Zone 2	Material	Spool Piece
10in Lille Frigg	10in x 0.85in	10in x 1.25in	API 5LX 65	Yes (2)
20in from Odin	20in x 0.69in	20in x 0.69in	API 5LX 60	Yes (3)
12in from East Frigg	12¾in x 0.56in	12¾in x 0.41in	API 5LX 65	Flexible (4)
16in injection water line to Frøy	406.4mm x 20.6mm	as Zone 1	API 5LX 65	Yes

Notes: 1. Zone 1 outside platform 500m safety zone; Zone 2 inside platform 500m safety zone.
2. Spool piece same material and dimensions as Zone 2 pipe.
3. Odin spool piece dimensions: 20in x 0.874in.
4. The flexible spool piece/riser is laying on the seabed and pulled up J-tube J7. This Coflexip line is made up of seven layers of steel, plastic sheathing and armour. Flexible dimensions are 15.59in x 1.98in.

2.4.3 CATHODIC PROTECTION

General

Cathodic protection is provided for the protection of all underwater and buried parts of the structure, the risers and the subsea lines by a system of sacrificial zinc anodes.

The system was designed in accordance with the following criteria:

(i)	Life requirement - refer to report 311E MS/90/31520/KO/SVS	60 years
(ii)	Current requirement for bare steel in mud	32mA/m²
(iii)	Current requirement for non-flowing sea water	53.8mA/m²
(iv)	Current requirement for flowing sea water	150.6mA/m²
(v)	Current to polarise steel in concrete	1.08mA/m²
(vi)	Assumed bare steel area of coal-tar enamelled or paint-coated items in static environment (See Note)	10 %
(vii)	Assumed bare steel area of paint-coated items in exposed environment (See Note)	20%
(viii)	Zinc sacrificial anodes with theoretical consumption	10.72kg/A/year
(ix)	Zinc efficiency	90%
(x)	Utilisation factor for zinc anodes	85%
(xi)	Sea water resistivity	30 ohm/cm
(xii)	Sea bed resistivity	150 ohm/cm

In the application of these criteria, allowances have been made for:
(i) Current draining to reinforcing bars, 10A per column.
(ii) Accelerated coating deterioration above - 20m elevation due to turbulent water.
(iii) Increased consumption of anodes in tunnels due to riser movement and elevated water temperature.

2.4.3 CATHODIC PROTECTION (cont.)

Electrical contact is established between the reinforcement and steel fixing plates for riser supports, tunnels and skirts by a welded "rebar" system or negative skeleton.

Sacrificial Anodes

Various parts of the steelwork (cathodes) and the zinc anodes are permanently connected by bonding which creates low resistance paths under all platform service conditions.

On all flat surfaces, bar or block anodes of high quality zinc with cast-in steel cores are used. The steel cores are thermit-welded to the structure to ensure good electrical connection.

On risers and pipelines, anodes - either in halves or as bracelets made up of segments mounted on steel rings - are clamped into position. Each half of the anode or segment-bearing steel ring is electrically connected to its associated riser or pipeline by means of stranded copper cable thermit-welded to the pipe surface.

Extra anode capacity on steel skirts, pipelines, risers and riser supports also protects all temporary embedded fixing plates on the submerged part of the concrete structure.

To give additional protection to platform risers, bonding cables are installed between the risers and the zinc anodes fitted to the inside of the tunnels in the foundation slab.

Zinc Reference Electrodes

Three zinc reference electrodes are installed on the outside of the structure to monitor it.

Columns 3 and 5 each have six reference electrodes installed at different elevations.

The cables from each electrode are led to a junction box at the top of each column. Multicore cables connect the junction boxes with the control monitoring panel.

Monitoring System

A monitoring system constantly reviews the protection levels of each individual pipeline and the platform structure in general. A monitoring control panel is located in the Instrument Interface Room.

Using the selector switches on the monitoring panel, the appropriate reference electrode and pipeline or structure are selected. A voltmeter indicates the relevant potential.

Additional potential measurements are taken inside the columns by lowering a Ag/AgCL reference electrode. The validity of the results can then be checked.

CONTENTS

2.5.1 100-YEAR STORM CONDITIONS

The design criteria regarding the wind, wave height and frequency, storm surge and surface current are detailed in diagram 2.5.1 Fig. 1.

2.5.2 TEMPERATURE

The maximum and minimum air and surface sea water temperatures are detailed in diagram 2.5.1 Fig. 1.

2.5.3 MARINE GROWTH

Marine growth was not considered as a design criteria of TCP2.

2.5.4 SCOUR

No specific measures for scour protection have been taken.

CONTENTS

DIAGRAMS

2.6.1 MODULE IDENTIFICATION

The Upper and Main Decks of TCP2 are divided into the following modules and pancakes:

- Module 01: Frigg gas treatment equipment
- Module 02: Frigg gas treatment equipment
- Module 03: Frigg gas treatment equipment
- Module 04: Frigg gas treatment equipment
- Module 30: Gas compression stream A equipment (passivated)
- Module 31: Gas compression stream C equipment (passivated)
- Module 32: Gas compression control room (upper)/MCC room (main)
- Module 33: Gas compression stream B equipment (passivated)
- Module 35: Frøy oil and gas treatment equipment (passivated)
- Module 50: Lille Frigg and passivated Odin gas treatment equipment (passivated)
- Module 51: East Frigg gas treatment equipment (passivated)
- Module 52: Lille Frigg gas and condensate treatment equipment (passivated)
- Pancake 946: Laydown area
- Pancake 969: Laydown area

The Cellar Deck of TCP2 is made up of the following pancakes, pipe support frames and miscellaneous areas:

- Pancake 05: Valve manifold/pig receiver (from DP2)
- Pancake 06: Valve manifold
- Pancake 07: Miscellaneous equipment
- Pancake 08: Air compressor packages
- Pancake 09: Miscellaneous equipment
- Pancake 11: Laydown area
- Pancake 12: Laydown area
- Pancake 13: Instrument interface room
- Pancake 14: Lifeboat muster area
- Pancake 40: Turbo-generator equipment
- Pancake 41: Turbo-generators
- Pancake 42: Miscellaneous equipment
- Pancake 43: Sea water/fresh water exchangers
- Pancake 44: Diesel generator package
- Pancake 45: Miscellaneous equipment
- Pancake 46: Fire pump room
- Pancake 48: Lille Frigg gas and condensate treatment equipment (passivated)
- Pancake 53: Miscellaneous equipment
- Pancake 48: Lille Frigg equipment (passivated)
- Central Area: Miscellaneous equipment
- Pipe Support Frame 01: Pipe support area
- Pipe Support Frame 02: Pipe support area
- Column 1: Sump caisson/pumps
- Column 3: Risers/J-tubes/pumps
- Column 5: Risers/J-tubes/outfalls/pumps

2.6.2 EQUIPMENT LAYOUT AND IDENTIFICATION

Reference Diagrams: FT-85-20-00-5079 Plot Plan - Cellar Deck
FF-85-20-00-5080 Plot Plan - Main and Intermediate Decks
FT-85-20-00-5081 Plot Plan - Upper and Weather Decks
FF-85-20-00-5095 Plot Plan - M35 Mezz, Weather and Metering Decks
FF-85-21-02-0114 Crane Coverage Plan

Equipment Identification

All equipment, except gas compression equipment or equipment added to the platform during the gas compression phase, is tagged and identified by a single, double or triple equipment code letter followed by a single, double or triple sequence number. An additional letter will follow the sequence number in the event of identical items of equipment.

For example:
CP = equipment code letters (pump)
33 = sequence number
A = identical to pump 'B'

Equipment added to the platform during the compressor phase is tagged and identified by a double-figure system number followed firstly by a single or double-letter equipment code and then a double-figure sequence number. An additional letter will follow the sequence number in the event of identical items of equipment.

For example:
11 = system number (gas compressors)
KG = equipment code letters (compressor turbines)
01 = sequence number
A = identical to turbines 'B' and 'C'

Equipment Layout

The layout of the equipment is shown in the above reference diagrams and is tabulated in alphanumeric sequence by decks below.

UPPER AND WEATHER DECK EQUIPMENT		
Equipment No	Description	Location
CE2A/C	Glycol air cooler, CE2B is passivated	Module 04
CE311	Condensate heat exchanger (passivated)	Module 51
CE508	DEG cooler (passivated)	Module 04
CE509 (part of K506)	Gas lift compressor aftercooler (passivated)	Module 52
CE601A/B	1st stage gas comp aftercoolers (passivated)	Module 35
CE602A/B	2nd stage gas comp aftercoolers (passivated)	Module 35
CE 603	1st stage fuel gas aftercooler (passivated)	Module 35
CE604	Fuel gas / gas heat exchanger (passivated)	Module 35
CE605	2nd stage fuel gas aftercooler (passivated)	Module 35
CE607	Oil inlet heater (passivated)	Module 35
CE615	Gas inlet heater (passivated)	Module 35

2.6.2 EQUIPMENT LAYOUT AND IDENTIFICATION (cont.)

UPPER AND WEATHER DECK EQUIPMENT (cont.)		
Equipment No	Description	Location
CM3	Pig launcher (gas to Scotland)	Module 01
CM7	Crane	Module 35
CM201	ODIN pig receiver (passivated)	Module 50
CM601	Frøy oil pig receiver (passivated)	Module 35
CM602	Frøy gas pig receiver (passivated)	Module 35
CP14A/B	Corrosion inhibitor pumps (passivated)	Module 04
CQ1A/B	TEG regeneration unit	Module 03
CQ1C	DEG regeneration unit (passivated)	Module 04
CQ7	Central hydraulic power unit	Module 01
CQ8A	Local control station (for pigs)	Module 01
CQ519	Wax inhibitor injection package (passivated)	Module 51
CQ530	LF ammonia injection package (passivated)	Module 04
CSP24	LP vent stack	Module 04
CSPM201.2	Silencer (passivated)	Module 50
CV2A/B	Glycol contactors ("B" is passivated)	Module 02
CV2C	DEG glycol storage tank (passivated)	Module 03
CV8A/B	Corrosion inhibitor tanks (passivated)	Module 04
CV201	ODIN metering scrubber (passivated)	Module 50
CV211	Lille Frigg metering scrubber (passivated)	Module 50
CV311	East Frigg metering scrubber (passivated)	Module 51
CV313	Condensate/methanol separator (passivated)	Module 51
CV320	Methanolated water flash drum (passivated)	Module 51
CV360	Methanol flash tank (passivated)	Module 51
CV516	LF heating medium make-up tank (passivated)	Module 04
CV517	LF heating medium expansion tank (passivated)	Module 04
CV605	Fuel gas discharge scrubber (passivated)	Module 35
CV623A/B	Rundown tanks (passivated)	Module 35
CV626	Gas separator - Frøy (passivated)	Module 35
CV628	1st stage oil separator - Frøy (passivated)	Module 35
CV629	2nd stage oil separator - Frøy (passivated)	Module 35
CV634	Rundown tank (passivated)	Module 35
CV646	Deaerator tower (passivated)	Module 35
CV65	Corrosion Inhbitor tank	Module 01
K506	Gas lift compressor - Frøy (passivated)	Module 52
K507	LF Off-gas compressor (passivated)	Module 52
11E01A	Natural gas cooler (passivated)	Module 30
11E01B	Natural gas cooler (passivated)	Module 33
11E01C	Natural gas cooler (passivated)	Module 31

LF = Lille Frigg

2.6.2 EQUIPMENT LAYOUT AND IDENTIFICATION (cont.)

UPPER AND WEATHER DECK EQUIPMENT (cont.)		
Equipment No	Description	Location
50X01A/B	Fuel gas packages	Module 32
50X07A/B	Fuel gas heater packages	Module 32
54X04	H & V fan equipment	Module 32
56X01	Hydraulic package	Module 32
58T01	Expansion tank	Module 32
60X01	Crane	Module 04
67X01	LP vent snuffing package	Module 33
67X02	LP vent light gas seal	Module 33
68X10.1/2	Foam packages	Module 32

INTERMEDIATE AND MAIN DECK EQUIPMENT		
Equipment No	Description	Location
CE501	Condensate/condensate exchanger (passivated)	Module 52
CE502	Condensate heater (passivated)	Module 52
CE504 (not in use)	LF 1st stage compressor aftercooler (passivated)	Pancake 48
CE505 (not in use)	LF 2nd stage compressor aftercooler (passivated)	Pancake 48
CE506 (not in use)	LF 2nd stage comp. gas/gas exchanger	Pancake 48
CE517A/B	(passivated)	Pancake 40
CE612A/B	Waste heat recovery units (passivated)	Module 35 (Intermed)
CE613A/B	Lub oil heat exchanger (passivated)	Module 35 (intermed)
CE614A/B	Lub oil heat exchanger (passivated)	Module 35 (intermed)
	Lub oil heat exchanger (passivated)	
CM501		Module 52
CM502	Lille Frigg pig trap (passivated)	Module 52
CM7	Frostpipe pig launcher (passivated)	Module 35
CM8	Crane	Module 01
CM9	Crane	Module 01
	Pig receiver *(not in use)*	
CO340		Module 51
CO350	East Frigg hydraulic package (passivated)	Module 51
CO370	East Frigg methanol injection (passivated)	Module 51
	East Frigg corrosion inhibitor (passivated)	

LF = Lille Frigg

2.6.2 EQUIPMENT LAYOUT AND IDENTIFICATION (cont.)

INTERMEDIATE AND MAIN DECK EQUIPMENT (cont.)		
Equipment No	Description	Location
CP11	Fire water pump	Module 30
CP32A/B	Methanol injection pumps (Passivated)	Module 01
CP228A/B	Methanol injection pump (“B” passivated)	Module 04
CP546	DEG booster pump (passivated)	Module 04
CP619A/B	LF Condensate Frøy pumps (passivated)	Module 52
CP605A/B	Oil export pumps (passivated)	Module 35(Intermed)
CP607A/B	Water injection pumps (passivated)	Module 35 (Main)
CP618A/B	Oil transfer pumps (passivated)	Module 35 (Intermed)
CP620A/B	Recycled condensate pumps (passivated)	Module 35 (Intermed)
CP626A/B	Pre-booster pumps (passivated)	Module 35 (Main)
CP632A/B	Vacuum pumps (passivated)	Module 35 (Main)
CP52 A/B	Corrosion Inhibitor Pumps	Module 01
CQ1A/B	TEG regeneration unit	Module 03
CQ1C	DEG regeneration unit (passivated)	Module 04
CQ516	Heating medium system skid (passivated)	Module 04
CQ602	Electro-chlorination unit (passivated)	Module 35 (Mezz)
CQ603	Injection water fine filters (passivated)	Module 35 (Main)
CQ605	Injection water chemical injection (passivated)	Module 35 (Main)
CQ608	Process chemical injection (passivated)	Module 35 (Main)
CQ609	Lub oil skid (passivated)	Module 35 (Intermed)
CQ610	Lub oil skid (passivated)	Module 35 (Intermed)
CQ611	Lub oil skid (passivated)	Module 35 (Intermed)
CQ614	Frøy oil metering (passivated)	Module 35 (Main)
CQ616	LF oil metering (passivated)	Module 35 (Mezz)
CQ618	Recycled condensate metering (passivated)	Module 35 (Mezz)
CSP24	LP vent stack	Module 04
CSPM210.1/2	Silencers (passivated)	Module 50
CV1A	FWKO separator (ODIN)- passivated	Module 02
CV1B	TEG dump storage	Module 02
CV1C	FWKO separator (DP2)	Module 03
CV2A/B	Glycol contactors ("B" is passivated)	Module 02
CV2C	DEG storage tank (passivated)	Module 03
CV3	Condensate surge tank	Module 01
CV201	ODIN gas scrubber (passivated)	Module 50
CV210	Lille Frigg slug catcher (passivated)	Module 50
CV211	Lille Frigg metering scrubber (passivated)	Module 50
CV227	Methanol tank (passivated)	Module 50
CV310	East Frigg slug catcher (passivated)	Module 51
CV311	East Frigg gas scrubber (passivated)	Module 51
CV350A/B	East Frigg methanol tanks (passivated)	Module 51

LF = Lille Frigg

2.6.2 EQUIPMENT LAYOUT AND IDENTIFICATION (cont.)

INTERMEDIATE AND MAIN DECK EQUIPMENT (cont.)		
Equipment No	Description	Location
CV370	Corrosion inhibitor storage tank (passivated)	Module 51
CV601A/B	1st stage suction scrubber (passivated)	Module 35 (Intermed)
CV602A/B	2nd stage suction scrubber (passivated)	Module 35 (Intermed)
CV603	1st stage fuel gas scrubber (passivated)	Module 35 (Intermed)
CV604	2nd stage fuel gas scrubber (passivated)	Module 35 (Intermed)
CV630	Produced water degassing tank (passivated)	Module 35 (Main)
CV638A/B	Lub oil reservoirs (passivated)	Module 35 (Mezz)
CV640	Lub oil reservoir (passivated)	Module 35 (Mezz)
CV646	Deaerator tower (passivated)	Module 35 (Intermed)
FE.CV311.2A/B	East Frigg fiscal metering (passivated)	Module 51
K601A/B	1st stage gas compressors (passivated)	Module 35 (Intermed)
K602A/B	2nd stage gas compressors (passivated)	Module 35 (Intermed)
K603	1st stge fuel gas compressor (passivated)	Module 35 (Intermed)
K604	2nd stage fuel gas compressor (passivated)	Module 35 (Intermed)
T.52.32.1.9	Transformer	Module 32
T.52.32.1.10	Transformer	Module 32
T.52.32.1.11	Transformer	Module 32
T.52.32.1.12	Transformer	Module 32
11B01A	Suction drum (passivated)	Module 30
11B01B	Suction drum (passivated)	Module 33
11B01C	Suction drum (passivated)	Module 31
11B02A	Water separator (passivated)	Module 30
11B02B	Water separator (passivated)	Module 31
11K01A	Natural gas compressor (passivated)	Module 30
11K01B	Natural gas compressor (passivated)	Module 33
11K01C	Natural gas compressor (passivated)	Module 31
11KG01A	Gas compressor turbine (passivated)	Module 30
11KG01B	Gas compressor turbine (passivated)	Module 33
11KG01C	Gas compressor turbine (passivated)	Module 31
53GD01.501	Diesel generator silencer	Module 30
54X01	Ventilation system	Module 30
54X02	Ventilation system	Module 31
54X03	Ventilation system	Module 33
60X01	Crane	Module 04
67B01	LP vent scrubber	Module 33

LF = Lille Frigg

2.6.2 EQUIPMENT LAYOUT AND IDENTIFICATION (cont.)

CELLAR DECK EQUIPMENT		
Equipment No	Description	Location
CE3	Fuel gas exchanger (not in use) (passivated)	Pancake 07
CE8A to D	Fresh water air coolers	Pancake 12
CE203	ODIN condensate heater (passivated)	Pancake 53
CM2	Pig receiver (gas from DP2)	Pancake 05
CP2A/B	Condensate return pump	Pancake 07
CP6A	Fire water pump	Central Area
CP6B	Fire water pump	Pancake 07
CP8A/B	Diesel pumps	Pancake 09
CP9A/B	Slop oil pumps	Pancake 07
CP12A/B	Methanol injection pumps (passivated)	Central Area
CP13A	Methanolated water booster pump	Central Area
CP13B	Glycol drain pump	Central Area
CP15A/B	Condensate recycle pump/ methanolated water injection pump	Pancake 07
CP17A/B	Methanol transfer pumps (passivated)	Central Area
CP33A/B	Diesel transfer pumps	Pancake 09
CP36A/B	Cooling water circulation pumps	Pancake 08
CP37A to C	Sea water pumps	Column 1
CP220A and C	TEG circulation pumps (passivated)	Pancake 07
CP222A/B	Methanolated water injection pumps	Central Area
CP224	LF closed drain tank pump	Pancake 53
CP227	Condensate recycle pump	Central Area
CP320A/B	TEG circulation pumps (passivated)	Pancake 07
CP502A to C	LF DEG injection pumps (passivated)	Pancake 48
CP503A/B/C	LF & Frøy cond./oil buster pumps (passivated)	Pancake 48
CP506A/B	LF 2nd stage discharge scrubber pumps (passivated)	Pancake 48
CP513A/B	DEG drain pumps (passivated)	Pancake 07
CP535A/B	Hot DEG recirculation pump (passivated)	Pancake 05
CP660A/B	Open drain pump (Passivated)	Below Cellar Deck (Zone 10)
CP661A/B	Closed drain pumps (Passivated)	Below Cellar Deck Zone 12)
CQ14	Water treatment package (removed)	Pancake 07
CQ15	Corrosion inhibitor injection package	Pancake 09
CQ21	Air dryer package	Pancake 42
CQ22A to C	Air compressors	Pancake 08
CQ23	Air dryer	Pancake 08
CQ502	Surface hydraulic power unit	Pancake 42
CQ510	Chemical injection unit	Pancake 48
-	LF Condensate metering package (passivated)	Pancake 48
-	LF Fuel gas metering package (passivated)	Pancake 48

LF = Lille Frigg

2.6.2 EQUIPMENT LAYOUT AND IDENTIFICATION (cont.)

CELLAR DECK EQUIPMENT (cont.)

Equipment No	Description	Location
CV5	Oil skimmer	Pancake 07
CV6	Fuel gas scrubber (passivated)	Pancake 07
CV7	LP vent scrubber	Pancake 09
CV9	Methanolated water storage tank	Central Area
CV10	Diesel storage tank	Pancake 09
CV13	Sump caisson	Column 1
CV21	Diesel oil filter	Pancake 09
CV23	Methanol storage tank (passivated)	Central Area
CV24	HP relief scrubber (passivated)	Central Area
CV33	Condensate recycle tank	Pancake 07
CV34A	Air receiver (Fire Pump House A)	Central Area
CV34B	Air receiver (Fire Pump House B)	Pancake 07
CV45	Glycol slop tank	Central Area
CV49	Methanolated water filter (passivated)	Central Area
CV51	Fresh water tank (passivated	Central Area
CV204	ODIN cond/methanol separator (passivated)	Pancake 53
CV220	Methanolated water flash drum (passivated)	Pancake 53
CV222	LF closed drain tank (passivated	Pancake 53
CV225A/B	Inhibitor drums *(not in use)*	Pancake 53
CV226	LT relief scrubber	Pancake 53
CV502	Glycol/condensate separator (passivated)	Module52
CV503	LF & Frøy stablized crude separator (passivated)	Pancake 48
CV504	LF 1st stage suction scrubber (passivated)	Pancake 48
CV505	LF 2nd stage suction scrubber (passivated)	Pancake 48
CV506	LF 2nd stage discharge scrubber (passivated)	Prancake 48
CV660	Hazardous open drain tank (Passivated)	Below Cellar Deck (Zone 10)
CV661	Closed drain tank (Pasivated)	Blow Cellar Deck (Zone 12)
J1	4in methanolated water J-tube	Column 3
J2	Oil from Frøy (passivated)	Column 3
J7	18in East Frigg riser (passivated)	Column 5
K504	LF 1st stage fuel gas compressor (passivated)	Pancake 48
K505	LF 2nd stage fuel gas compressor (passivated)	Pancake 48
R1	32in gas riser to St Fergus	Column 3
R2/3	26in gas risers from DP2	Column 3
R5E	16in injection water to Frøy	Column 5
R6E	20in gas riser from ODIN*(not in use)*	Column 5
50P02	Washdown pump	Central Area

LF = Lille Frigg

2.6.2 EQUIPMENT LAYOUT AND IDENTIFICATION (cont.)

CELLAR DECK EQUIPMENT (cont.)		
Equipment No	Description	Location
52GG01A/B	Turbo-generator turbines	Pancake 41
53DG01	Diesel generator	Pancake 44
53DG01.S01	Diesel generator silencer	Pancake 44
55P01A/B	Fire water make-up pumps	Pancake 42
55P03	Turbine wash pump (passivated)	Pancake 42
55X01A/B	Fresh water makers (not in use)	Pancake 42
57X01.T01	Air receiver	Pancake 42
58C01/2	Sea water outfalls	Column 5
58E01A.1 to 4	Sea water/fresh water exchangers	Pancake 43
58P02A/B	Process fresh water/TEG pumps	Pancake 42
58P04A/B	Utilities fresh water/TEG pumps	Pancake 42
58P05A/B	Drain tank pumps	Pancake 42
58S01A/B	Sea water strainers	
68P01A	Fire water pump	Pancake 42
68P01B	Fire water pump	Pancake 46

2.6.3 LIFTING EQUIPMENT

Reference Diagrams:FF-85-21-02-0114

Purpose

The platform lifting equipment provides the means of handling and transporting stores and equipment between the platform and supply vessels and within the platform in a safe manner. Details of the installed equipment are given below.

Principle of Operation

Pedestal cranes are used for the movement of stores and equipment on the Upper Deck, for vertical movement within the platform (via hatches), and for the transfer of items between the platform and supply vessels. They are also used for the handling of bulk transfer hoses.

Various other items of lifting equipment, ie monorail hoists and winches, are situated about the platform and are either portable or fixed; fixed items are designed for the use of one area or for one particular item of equipment.

2.6.3 LIFTING EQUIPMENT (cont.)

PEDESTAL CRANES		
Equipment No	Service	Safe Working Load
CM7	General lifting duties	Refer to the load chart, on page 9A/12.
60X01	General lifting duties	Refer to the Dynamic Load Chart on page 9B/12.

MONORAIL HOISTS AND WINCHES			
Equip No	Description	Service	SWL
CM16A/B	Hand-operated monorail hoist beams	Fire water pumps, Pancakes 07 and 47	10t
CM18	Electric-driven monorail hoist beam	Workshop/Stores, Module 04	5t
CM19	Hand-operated monorail hoist beam	Workshop, Module 04	5t
CM20	Hand-operated monorail hoist beam	Instrument Interface Room, Pancake 13	5t
CM24A to C	Hand-operated monorail hoist beam	Air Compressor Room, Pancake 08	10t
CM25	Winch	Water curtain pumps Central Area	5t
CM27	Winch	Inspection purposes, Column 5	2t
CM28	Winch	Inspection purposes, Column 1	2t
CM29		Emergency services, Column 5	1t

2.6.3 LIFTING EQUIPMENT (cont.)

MONORAIL HOISTS AND WINCHES (cont.)			
Equip No	Description	Service	SWL
CM31	Winch	Riser inspection, Column 3	1t
CM32	Winch	Emergency services, Column 3	1t
CM350	Manual overhead hoist	General handling duties, Module 51, Upper Deck	5t
CM351	Manual overhead hoist	General handling duties, Module 51, Mezz Deck	5t
CM352 A.B.	Manual overhead hoist	Choke valve maintenance, Module 51, Main Deck	1.2t
CM660	Chain hoist	M35	1t
CM661	Geared trolley	M35	1t
CM662	Chain hoist	M35	3t
CM663	Geared trolley	M35	3t
CM664	Chain hoist	M35	5t
CM665	Geared trolley	M35	5t
CM660	Chain hoist	M35	10t
CM667	Geared trolley	M35	10t
ME003 A.B.	Monorail hoist	CE501 and CE502	1t
ME004	Monorail hoist	CP501A/B	2t
ME005	Monorail hoist	CP501A/B	2t
ME006	Geared runway trolley	Use on ME004 and ME005	2t
ME007A/B	Geared runway trolleys	Use on ME003	2t
ME600	Monorail	CP626A	1t
ME601	Monorail	CP626B	1t
ME602	Monorail	CP632A/B	1t
ME603	Monorail	CP632A/B	1t
ME604	Monorail	CQ603	3t
ME605	Monorail	CQ603	3t
ME606	Monorail	CQ603	3t
ME607	Monorail	CP607B	8t
ME608	Monorail	CP607A	8t
ME609	Monorail	CP607A/B	5t

2.6.3 LIFTING EQUIPMENT (cont.)

MONORAIL HOISTS AND WINCHES (cont.)			
Equip No	Description	Service	SWL
ME610	Monorail	HV Room	1t
ME611	Monorail	K603/K604	8t
ME612	Monorail	K603/K604	2t
ME613	Monorail	CE613A	1t
ME614	Monorail	CE613B	1t
ME615	Monorail	K601A/K602A	5t
ME616	Monorail	K601A/K602B	10t
ME617	Monorail	K601B/K602B	5t
ME618	Monorail	K601B/K602B	10t
ME619	Monorail	CP605B	8t
ME620	Monorail	CP605A	8t
ME621	Monorail	CE607	3t
-	Monorail hoist	Maintenance of compressors K504/505, Pancake 48	1.2t
60X05A to C	Electric driven overhead hoists	Maintenance of turbines 11KG01A to C, Modules 30, 31, 33	8t
60X06A to C	Electric-driven monorail hoists	Maintenance of compressors 11K01A to C, Modules 30, 31, 33	12t
60X08A/B	Monorail hoists - air driven	Heavy handling duties, Module 32	25t
60X09A/B	Monorail hoists	Maintenance of generators 52G01A/B, Pancake 41	5t
60X10	Monorail hoist	Maintenance of fire water pump 68P01A, Pancake 42	10t
60X11A	Monorail hoists	Maintenance of diesels 68PD01A, Pancakes 42, 46	5t

2.6.4 BULK LOADING STATIONS AND FACILITIES

Purpose

The purpose of the bulk loading station is to provide a means of handling the transference of supplies to the platform from supply boats in a safe manner.

2.6.4 BULK LOADING STATIONS AND FACILITIES (cont.)

Description

Glycol is normally supplied to the platform from TP1 via a 2in fill line, but it may also be replenished from a supply boat through flexible hoses and 4in lines from the loading stations. The level in the storage tank is indicated locally at the loading stations.

Methanol is normally supplied in 5.7m³ transportable pods and gravity fed into the storage tank, but it may also be supplied from TP1 via a 3in line.

Diesel fuel is normally supplied to the platform from TP1 via a 4in fill line but it can alternatively be supplied from a supply boat. When bunkering from a supply boat, diesel fuel is taken on through flexible hoses and 4in lines from the loading stations. The level in the storage tank is indicated locally at the loading stations.

Boat loading from supply boats is not to be attempted under the following conditions:

- Current greater than 1.5 knots (0.77m/s);
- Wind greater than 40 knots (20.5m/s)
- Waves higher than 5m and at a frequency greater than 8.5s.

The bulk loading stations are floodlit by 500W tungsten lamps.

CONTENTS

2.7.1 PURPOSE

The purpose of the process systems on TCP2 is to treat the incoming oil and gas by separating water from the products and thereby preventing water condensation and hydrate formation.

2.7.2 GENERAL DESCRIPTION

Reference Diagrams: FF-00-00-00-5000 (see Section 1.4)
FF-00-00-00-5002 (see Section 1.4)
FF-00-00-00-5013 (see Section 1.4)
FF-00-00-00-5014, Sheets 1 and 2 (see Section 1.4)

Frigg Gas

Wet gas from DP2 enters TCP2 via a 26" subsea line into a free water knock-out (FWKO) separator and is then metered and routed to the glycol contractor (CV2A). Free liquid is removed in the FWKO separator and then the gas is dried to the required dewpoint in the glycol contactor. The gas is then discharged from the glycol contactor through a common metering facility and flow control valves before it enters the sealine to St. Fergus.

East Frigg Gas

System is passivated.

Lille Frigg Gas

System is passivated.

Frøy Gas

System is passivated.

2.7.2 GENERAL DESCRIPTION (cont.)

Condensate

Condensate collected from the various process equipment during the treatment of gas from DP2 passes through the condensate surge tank to remove entrained water before it is injected into the gas export line for recovery at St Fergus, by use of CP2A.

Methanolated Water

Methanolated water is treated in the methanolated water flash drums before being sent to the methanolated water storage tank. The condensate collected is transferred to the oil skimmer and the water is transferred to DP2 for injection into well No 3.

2.7.3 MAIN CHARACTERISTICS

Production Rates

The gas production rate is defined in terms of daily contractual quantity (DCQ) of exported gas. A DCQ of 1.0 is the average daily production to meet the contractual yearly production. The production rates for Frigg are as follows.

Field	Production	Normal Operation 1996-97	
		Winter	Summer
Frigg	Gas (10^6 x std m^3/d Condensate (tonnes/d)	1.56 (1.3 dcq) 5	0.84 (0.7 DCQ) 3

Main Operating Parameters

- Gas inlet separator pressure:
  - Frigg: 70 to 120 barg

- Gas export pressure at riser (FNA) inlet: 70 to 100 barg

Export Sealines

Gas export (FNA) line to St. Fergus:

- Length: 355km
- Diameter - nominal: 32in
  - internal: 0.7747m
- Wall thickness: 0.011m

2.7.4 PARTICULAR PRODUCTION CONSIDERATIONS AND FLEXIBILITIES

Automatic Production Turn-down

According to Elf operating philosophy for Frigg, there is no automatic production turn-down of the process. In the event of certain process upsets or other operating problems, the process will be stopped by automatic shutdown functions. The process can also be manually stopped from the Frigg Control Room.

Sales Gas Dewpoint Flexibility

The sales gas hydrocarbon dewpoint specification to the United Kingdom is -2°C at 69 barg.

Water Content in Condensate/Oil

The maximum water content in the condensate injected into the FNA pipeline to St Fergus should not exceed 0.5%.

CONTENTS

DIAGRAMS

PART A METHANOLATED WATER

The purpose of this system is to separate condensate from the methanolated water and to inject the methanolated water into a well on DP2.

The system comprises the following:

(a) Methanolated water storage tank CV9;
(b) Methanolated water injection pumps CP222 A/B;
(c) Methanolated water filter unit CV49 (filter element removed);
(d) Booster pump CP13A
(e) Methanolated water injection pumps CP15A/B

The remaining condensate in the methanolated water is taken out in CV9 by keeping a constant level 65% in the tank. Condensate separated at the surface of the tank is pumped by CP227 to the oil skimmer CV5. CV9 operates at atmospheric pressure and has a capacity of 99 m^3. Nitrogen at 10 mbar at a flow of approximately 4 m^3/h is used as a blanket gas to prevent the ingress of oxygen.

The methanolated water from CV9 is pumped by CP222 A/B or CP15 A/B to well 3 on DP2. CP222 A/B are electric motor-driven pumps each having a capacity of 3 m^3/h at a delivery pressure of 13 barg. The pumps can be run in series when a high injection pressure is required. CP15 A/B are vertical centrifugal pumps with a 35 bar delivery pressure.

The methanolated water was filtered in CV49 on TCP2 before injection into the well, but the filter element has been removed and a PALL filter unit has been fitted in its place. On DP2 the filter FA106 is considered as a supplementing filter to the main filtration installed on TCP2. The filter element in FA106 is removed.

If CV9 cannot take all the produced methanolated water, the condensate storage tank (CV33) can be used for methanolated water storage.

PART B OILY WATER TREATMENT

Oily water from various process vessels and tanks is collected in the oil skimmer (CV5), which separates entrained water and recycles the condensate.

The system comprises the following:

(a) Oil skimmer CV5;
(b) Slop oil pumps CP9 A/B.

The oil skimmer receives all the low pressure oily water from treatment and extension areas. The oil skimmer is a horizontal 3-phase vessel with a capacity of 3000 bbl/d, in which the water and condensate are separated.

Blanket gas, under pressure control, is maintained in CV5 via a tapping from the fuel gas system. The vessel operates at 0.5 barg at a temperature close to ambient, and is protected against overpressure by duplicate pressure safety valves.

Slop oil pumps CP9 A/B take suction from the condensate “bucket” part of CV5 and discharge to the condensate surge tank, CV3. CP9 A/B are reciprocating motor-driven pumps, each having a capacity of 38 litres/min at 0.8 barg suction pressure, and 20 barg discharge pressure. The discharge of each pump is protected against overpressure by a safety valve.

The water from CV5 is let down under level control to the methanolated water storage tank CV9.

PART C TEG STORAGE, SEPARATION AND REGENERATION

Storage

CV1B is the TEG storage facility for glycol on TCP2. Tank CV9, which was previously used as a glycol storage tank, is now converted to a methanolated water storage tank.

Glycol fill pump CP13B takes suction from CV1B and delivers via the fill header to the two glycol streams and also to the cooling fresh water tank (58T02).

PART C TEG STORAGE, SEPARATION AND REGENERATION (cont.)

Separation and Regeneration

Reference Diagrams: FF-85-00-16-5023
FF-85-00-16-5024

Two independent, skid-mounted, closed-circuit glycol regeneration streams (A/B) are installed, serving the gas process stream. Stream B is not in use. Hot glycol is also used to heat the East Frigg liquids (see Extension TEG System).

Water-rich glycol from the glycol contactor (CV2 A) is regenerated to its original concentration by boiling-off the water. The regenerated glycol is cooled and recycled back to the contactor.

The regeneration stream comprises the following:

(a) Condensate separators CV14A
(b) Glycol filter CV15 A
(c) Charcoal filter CV20A
(d) Reflux condenser CE4A, CE4B
(e) Stripping column, CV16A, CV16B
(f) Reboilers CH1A, CH1B
(g) Duplicate glycol/glycol heat exchanger CE1 A 1 and 2;
(h) Glycol surge tank CV17 A, CV17B
(i) Duplicate glycol pump CP10 A/B
(j) Glycol air cooler CE2A

Rich glycol from glycol contactor CV2A enters condensate separator CV14A. Glycol, under level control, is let down to glycol filter CV15A.

Separator CV14A operates under pressure control with a maximum glycol flowrate of 16 m^3/h. (The average glycol circulation rate is about 14 m^3 of glycol per million cubic metres of gas.) If produced off-gas is insufficient to maintain operating pressure, supplementary gas is supplied from the fuel gas system. The vessel is protected against overpressure by duplicate pressure safety valves set to lift at 10.4 barg. Low, high and high/high liquid levels indicate in the Control Room.

After the removal of entrained solids in filter CV15A, a nominal 10% of glycol flow is diverted through charcoal filter CV20A in which dissolved hydrocarbons, fatty acids, well inhibitor and glycol degradation compounds are removed. Filtered glycol discharges to reflux condenser CE4A.

Filters CV15A and CV20A operate at 4.5 barg and approximately 27°C. High differential pressure alarms indicate in the Control Room.

PART C TEG STORAGE, SEPARATION AND REGENERATION (cont.)

Glycol passes through condenser CE4A where it is preheated, and at the same time provides reflux by cooling the effluent vapour. Glycol at 2.5 barg discharges to the tubed sides of glycol/glycol heat exchangers CE1A1 and 2, which raise the glycol temperature from 49 to 149°C before it enters stripping column CV16A.

Glycol from the heat exchangers enters CV16A and, together with glycol from the reflux condenser, flows down over five "bubble cap" trays against a counter flow of steam released from the glycol in the reboiler and stripping gas, into reboiler CH1A.

In reboiler CH1A the glycol is heated to approx. 200°C, boiling-off any water remaining in the glycol. This temperature, together with stripping gas contact, regenerates the glycol to 99.8% purity. Steam and stripping gas is released from the top of column CV16A to LP vent. The regenerated glycol overflows a weir and gravitates to the shell sides of heat exchangers CE1A1 and 2, which reduce glycol temperature from 200 to 107°C.

A tapping from the fuel gas system supplies, under pressure control, filtered fuel for the reboiler burner and stripping gas. An emergency shutdown (ESD) block valve is incorporated in the common supply line.

Cool glycol from heat exchangers CE1A1 and 2 discharges into surge tank CV17A, which provides system surge capacity and acts as a holding tank. CV17A, which has a capacity of 21.65 m^3, operates at atmospheric pressure at 108°C. A low liquid level alarm will indicate in the Control Room.

The heating requirement of the fuel gas system is effected by flowing cold fuel through a coil in the base of surge tank CV17A. Heated fuel gas discharges to the fuel gas supply header. A continuous flow of blanket gas, under pressure control, is maintained in CV17A via a tapping off the fuel gas heating coil discharge.

Reciprocating glycol pumps CP10 A/B take suction from surge tank CV17A and discharge, via air cooler CE2A, into glycol contactor CV2A, recirculating glycol through the system. The pumps are in parallel and normally operate one duty, one standby, controlled by local start/stop pushbuttons. Each pump, driven by a 90kW electric motor, has a capacity of 15.2 m^3/h at 176 barg. The discharge of each pump is protected against overpressure by a pressure safety valve.

Hot glycol discharged by the duty glycol pump is cooled from 135°C to working temperature by air blast cooler CE2A. To maintain the temperature of the glycol entering contactor CV2A at a temperature approximately 5°C above the gas temperature, a temperature control loop bypasses proportional glycol flow around CE2A. A high glycol temperature alarm will indicate in the Control Room.

Cooler CE2A comprises a tube and fin radiator surmounted by a cowled four-blade fan driven by a 15kW electric motor.

PART D METHANOL STORAGE AND INJECTION

Treatment Areas

The methanol storage and injection system comprises the following:

(a) Storage tank CV23; (passivated)
(b) Transfer pumps CP17 A/B; (passivated)
(c) Injection pumps CP 32A/B (passivated)
(d) Injection pumps CP12 A/B; (passivated)
(e) Storage tank CV 350 A/B - Ref. East Frigg System, page 9/44 (passivated)
(f) Storage tank CV227; (passivated)
(g) Williams injection pump CP228A/B. Moved to Zone 4 MB
(h) CV17C Storage tank (passivated)
(i) Portable transport tank (4m3)

Methanol from portable transport tank is feeding two Williams injection pumps CP 228 A/B. These pumps are used for methanol injection to DP2 treatment areas.

Air driven diaphragm type Williams pumps CP 228 A/B are installed in parallel, normally one duty, one standby. The discharge pressure from the pumps will be limited of a PSV at 180 bar.

Start/stop of CP 228 A/B is by local operation of the air supply valve to the individual pump.

PART E FUEL GAS

Treatment Area

The fuel gas system CV6/CE3 passivated:

Compression Area

The fuel gas system in the Compression area can provide supply to the following:

(a) Treated fuel gas to turbo-generators 52GG01 A/B;
(b) Untreated fuel gas for LP vent purging;
(c) Treated fuel gas to treatment area.

Fuel gas for treatment is supplied from the following sources:

(a) Dry gas from TCP2 sales gas header, dry gas interconnection line and sealine 2;
(b) Gas from treatment area glycol contactors CV2 A.

Two fuel gas treatment streams are provided, one working, one standby. Each stream is capable of treating 940 800 m³/d (28 000 kg/h). Fuel gas is supplied to users at 20 barg, dewpoint -10°C, and at a minimum temperature of 5°C.

Each fuel gas treatment stream comprises a fuel gas heat exchanger, water heater, hot water pump gas/gas heat exchanger and low temperature separator. A common hot water tank is also provided. The water heaters, hot water pumps, fuel gas heaters and hot water tank form fuel gas heating package 50X07. The gas/gas heat exchangers and low temperature separators form fuel gas package 50X01. Methanol can be injected from a mobile injection pump.

Assuming that treatment stream A is in use, fuel gas for treatment is heated as required in fuel gas heat exchanger 50X07A. The heating medium for 50X07A is hot water which is circulated round a closed-loop system by hot water pump 50X07P01A. The water is heated by four electric immersion heaters arranged in series. Each heater is provided with two heating elements, one of 112 kW and one of 128 kW. One heater is provided with auto-regulated elements, the remainder with auto/manually regulated elements. The temperatures of the hot water and fuel gas are controlled so as to maintain optimum temperature of fuel gas at the treatment unit outlet.

Fuel gas passes from the fuel gas heating package through the tube side of gas/gas heat exchanger 50X01AE01. The gas is then expanded through a pressure control valve and passed into low temperature separator 50X01AB01 where any condensates or methanol (when used) are removed. The gas, now at 21 barg and -10°C, is passed to the shell side of 50X01AE01 where it is reheated to 20°C. Treated fuel gas is then distributed to users, each of which is provided with its own ESDV, knockout pot and filters.

PART E FUEL GAS (cont.)

The block valves in the fuel gas supply lines are manually selected. Each of the four ESD valves is controlled by a PIC which closes if the pressure downstream falls to a predetermined level. The ESD valves in the supply lines from glycol contactors CV2 A/B are closed on operation of the relevant ESD in the treatment area.

Low temperature separators 50X01AB01 and 50X01BB01 are protected against overpressure by relief valves set to lift at 23 barg. Any gas so released is vented to the LP vent system.

The compression area fuel gas metering stream parameters (temperature, flow and pressure) are registered by the flow computer.

East Frigg Supply

Fuel gas for the East Frigg equipment is passivated.

Lille Frigg System

NOTE: THE LILLE FRIGG FUEL GAS SYSTEM IS PASSIVATED

Frøy System
Frøy fuel gas system is passivated.

PART F HYDRAULICS

Treatment Area

Reference Diagram: 2.8.1.F1

The hydraulic system provides the motive power for the hydraulic operated-hand valves (HV) and emergency shutdown (ESD) block valves.

The system comprises the following:

(a) Central hydraulic power unit CQ7 which incorporates a reservoir, two pumps, main accumulator sets, and distribution and control circuits;
(b) Local accumulator sets;
(c) Local control stations;
(d) Valve controllers and actuators;
(e) Pneumatic control circuits.

Hydraulic fluid is stored in reservoir CV42 which has a capacity of 4500 litres. An alarm will indicate in the Control Room should the fluid content fall below 1000 litres. Replenishment is by a filter/breather on top of the reservoir. Hydraulic fluid can be supplied from the compression area system through a 1.1/2in line between CQ7 and the hydraulic oil storage tanks located in Module 30 in the compression area.

Two parallel installed gear type pumps, CP22 A/B, normally operate one on duty and one on standby to pressurise the system. Each pump, driven by a 30 kW electric motor, has a capacity of 100 litres/min at 150 barg. The pumps take suction from reservoir CV42 through individual lines, and discharge to the distribution circuits serving the valve controllers through a common discharge manifold. Duty pump operation is controlled by high and low pressure switches set at 100 barg (stop pump) and 90 barg (start pump), excess pressure being relieved into the reservoir by a pump discharge pressure safety valve. An alarm will indicate in the Control Room should the system pressure fall below 100 barg.

The operation of pumps CP22 A/B is controlled from a local control panel, provided with auto/manual and duty selector switches. Should the duty pump fail, the standby pump is brought into automatic operation by selecting it with the duty selector switch.

PART F HYDRAULICS (cont.)

An emergency hand pump, installed in parallel with the motor-driven pumps, can be used in the event of main pump failure or maintenance. This pump has a capacity of 0.045 litres per double stroke.

The 62 main accumulator sets each comprise a 50-litre accumulator, and a nitrogen storage bottle charged to 80 barg. Each set is protected against overpressure by a fusible plug, incorporated in the accumulator nitrogen connection, which melts at 145°C. The accumulator sets permit valve operation on failure of the central hydraulic power unit, CQ7.

The four distribution systems each comprise supply and return lines to which each valve actuator is connected, via its controller. Each system is supplied separately from pumps CP22 A/B discharge manifold. The return lines from these systems discharge into the reservoir through four strainers. Three spring-loaded check valves provide relief should the strainers become partially blocked.

Two groups of accumulator sets, one of six and one of thirteen, similar to those in central hydraulic power unit CQ7, are provided as a standby hydraulic supply for specific ESDVs. Other ESDVs have standby accumulators incorporated in their controllers.

The three types of valve controllers used are as follows:

(a) Type F: movement of the valve actuator is determined by a directional control valve, which is controlled by either a local manual valve or a remote control valve;
(b) Type B: similar to Type F, differing only in that the supply line incorporates an integral accumulator (5 litres/min valve controllers) or is connected to a local accumulator set (50 and 100 litres/min valve controllers);
(c) Type C: used for locally controlled valves. The valve actuator is positioned either by a manual valve (50 litres/min controllers) or a directional control valve (100 litres/min controllers).

East Frigg Module M51

The hydraulic power for East Frigg module ESDVs and HVs is passivated

Compression Area and Frøy Module M35

Reference Diagram: 2.8.1.F2

NOTE: THE HYDRAULIC FOR THE FRØY MODULE M35 IS PASSIVATED

The hydraulic system provides the motive power for the hydraulically operated hand (HV) and emergency shutdown (ESD) block valves. However, following passivation of the gas compression streams, all lines leading to hydraulically operated valves on the passivated streams have been blinded.

PART F HYDRAULICS (cont.)

The system comprises the following:

(a) Central hydraulic power unit 56X01 which incorporates a reservoir, two pumps, main accumulator set, and distribution and control circuits;
(b) Local accumulator sets;
(c) Valve control stations;
(d) Valve controllers and actuators;
(e) Pneumatic control circuits.

Hydraulic fluid is stored in reservoir 56X01T01 which has a capacity of 4500 litres. An alarm will indicate in the Control Room should the fluid content fall below 1000 litres. Replenishment is by a filter/breather on top of the reservoir. Hydraulic fluid can be supplied to the reservoir and the treatment central hydraulic power unit CQ7 through a 1.1/2in line from the hydraulic oil storage tanks located in Module 30.

Gear type pumps 56X01P01 A/B are set in parallel and normally operate one duty, one standby to pressurise the system. Each pump, driven by a 37 kW electric motor, has a capacity of 80 litres/min at 206 barg. The pumps take suction from the reservoir through individual lines, and discharge to the distribution circuits serving the valve controllers through a common discharge manifold. Duty pump operation is controlled by high and low pressure switches set at 138 barg (stop pump) and 125 barg (start pump), excess pressure being relieved into the reservoir by a pump discharge pressure safety valve. An alarm will indicate in the Control Room should the system pressure fall to 118 barg.

The operation of pumps 56X01P01 A/B is controlled from a local control panel, provided with manual on/off and duty selector switches. Should the duty pump fail, the standby pump is brought into automatic operation by selecting it with the duty selector switch.

The 6 main accumulator sets each comprise a 50-litre accumulator, and a nitrogen storage bottle charged to 138 barg. Each set is protected against overpressure by a fusible plug, incorporated in the accumulator nitrogen connection, which melts at 145°C. The accumulator sets permit valve operation on failure of the central hydraulic power unit, 56X01.

The two distribution systems each comprise supply and return lines to which each valve actuator is connected, via its controller. Each system is supplied separately from pumps 56X01P1 A/B discharge manifold. The return lines from these systems discharge into the reservoir through four strainers. Three spring-loaded check valves provide relief should the strainers become partially blocked.

The three types of valve controllers used are as follows:

(a) Type F: movement of the valve actuator is determined by a directional control valve, which is controlled by either a local manual valve or a remote control valve.
(b) Type B: similar to Type F, differing only in that the supply line incorporates an integral accumulator (5 litres/min valve controllers) or is connected to a local accumulator set (50 and 100 litres/min valve controllers).
(c) Type C: used for locally controlled valves. The valve actuator is positioned either by a manual valve (50 litres/min valve controllers).

PART F HYDRAULICS (cont.)

East Frigg Wellhead System

Reference Diagram: 2.8.1.F3

The East Frigg hydraulic system is passivated.

Lille Frigg Supply System

*Reference Diagram:*2.8.1.F4

The surface hydraulic power unit (SHPU - CQ502) is passivated.

PART G NITROGEN

Reference Diagrams: 2.8.1.G1
FF-22-00-16-0077

The purpose of the nitrogen system is to supply TP1 and TCP2 with nitrogen for purging, sweeping, inerting, and pressure testing.

A Linde nitrogen unit is provided on TP1 to produce nitrogen at a rate of 150 m³/h and at purity of about 99%. Outlet pressure is 3 bar. A nitrogen compression unit (also on TP1) is able to pressurize the HP reservoir (the old 8in mudline network) to a max pressure of 172 bar.

The volume of the nitrogen storage line is approx 25m³.

PART H COOLING WATER

General

The cooling water system for the compression area comprises the following:

(a) Process fresh water cooling system;
(b) Utilities fresh water cooling system;
(c) Main sea water cooling system.

The process fresh water cooling system and the utilities fresh water cooling system are supplied with make-up water from the cooling fresh water/TEG drain tank. The fresh water in the systems is mixed with TEG in the proportion of 80/20 per cent water/TEG. The TEG is added as an antifreeze measure. For descriptive purposes the mixture will be referred to as "fresh water".

PART H COOLING WATER (cont.)

Process Fresh Water Cooling System

The system provided the cooling medium for the Frøy main cooling fresh water network.

The fresh water is recirculated round the system by a process fresh water/TEG pump (58P02A). A second pump (58P02B) is maintained at auto standby. Each pump is protected against low flow conditions by a bypass valve fitted downstream. The valve opens at a flow of 250 m³/h.

Four sea water/fresh water heat exchangers (58E01A1 to 4) are connected to the system to reduce the fresh water temperature.

An expansion tank (58T01) is connected to the system downstream of the sea water/fresh water heat exchangers to cater for system surges caused by temperature fluctuations. The tank also provides a datum point from which system level can be monitored.

Fresh water supply and return lines from the utilities fresh water cooling system are located upstream and downstream of the heat exchangers respectively.

Utilities Fresh Water Cooling System

The system provides the cooling medium and supplies water for the following equipment:

(a) Generators and oil coolers.
(b) Air conditioning package condenser.

System flow is maintained by two utilities fresh water/TEG pumps (58P04 A/B) which operate with on duty and the other at auto standby. The pumps take a suction from the process fresh water cooling system.

The pumps are protected against low flow conditions by recirculation, under flow control, back to their suction at a flow of 40 m³/h.

Used water from the utility coolers returns, under pressure control set at 7 barg, to the process fresh water cooling system.

Priming and Make-up

The process and utilities fresh water cooling systems are primed and supplied with make-up water from the cooling fresh water/TEG drain tank (58T02). The tank contains a 80/20 per cent mixture of fresh water/TEG. A corrosion inhibitor is also injected.

Fresh water is supplied to the tank from the desalinated water network as required. TEG is supplied from glycol storage tank CV1B. Glycol is pumped from the tank by one of two TEG make-up pumps (55P02 A/B) located close to the tank.

Water/TEG is pumped from the cooling fresh water/TEG drain tank into the cooling system by one of two fresh water/TEG drain tank pumps (58P05 A/B). The pumps operate with one on duty and the other on standby. The duty pump is started and stopped automatically by level switches located on the expansion tank.

PART H COOLING WATER (cont.)

Main Sea Water Cooling System

The system supplies the following equipment:

(a) Sea water/fresh water heat exchangers 58E01A1 to 4;
(b) Fresh water maker 55X01, (Passivated)
(c) Generator cooling pumps CP653A/B,

Sea water for the system is drawn by three submerged pumps, CP37A/B/C, located in casings externally on Column 1.

The discharges for the pumps are connected to a common header so that the system can be operated with one, two or three pumps on duty. The pumps supply sea water through self-cleaning strainers, which remove suspended solids above 2mm in size, to four sea water/fresh water heat exchangers. The heat exchangers are used to cool fresh water for the process and utilities fresh water cooling systems. Used sea water is discharged overboard via outfalls located in Column 5.

Sea water supply to the fresh water maker is taken from and the generator cooling pumps downstream of the strainers and the supply to the injection water pumps is taken after the four heat exchangers.

Prior to start-up, the system is primed to remove as much air as possible. Priming water is supplied from the washdown system. During start-up, any remaining air is automatically vented from the system through air traps located at high points on the pump discharges and on the heat exchangers.

PART I CHEMICAL INJECTION

Sealine to St. Fergus

The inhibitor is injected to protect the sealine against internal corrosion. The normal flow rate is 3 litres of inhibitor per one million cubic metres of gas.

The system comprises the following main items:

(a) Filling station;
(b) Supply tanks CV65;
(c) Calibration gauge;
(d) Injection pumps CP52 A/B.

The supply tank CV65 is located on Zone 1 Upper Level.

A graded calibration gauge is installed to periodically check the injection rates.

The inhibitor flows into the 32in subsea line to St. Fergus.

PART J HP RELIEF AND LT VENT

Treatment/Compression Area HP Relief

High pressure relief gas from process equipment and gas discharged during operational blowdown of process vessels, is discharged to TP1 LT relief system.

Note: The frøy flare package CQ612 is passivated .

The system comprises the following:

(a) Pressure relief and depressurizing lines from process equipment and associated process lines. The gas is directed into the system by subheaders;
(b) 24in relief header R301;
(c) Several subheaders;
(d) HP relief scrubber CV24 (bypassed);
(e) 24in discharge line R340.

An alarm is activated in the CCR upon high pressure in the line.

High pressure vessels and associated pipework are protected against overpressure by pressure safety valves connected to the HP relief system. The vessels and pipework may also be depressurized by emergency shutdown (ESD) blowdown valves. These valves are opened automatically by a Group "W" or "X" emergency shutdown signal, individually by operating the appropriate hand valve (HSD) or through the PCMS in the CCR.

All ESD valves close on loss of control air/hydraulic. All blowdown valves (BDV) open on loss of control air.

The FWKO separator, and the glycol contactor are fitted with two, parallel mounted pressure safety valves (PSV). (The maximum allowable working pressure of these vessels is higher than the static wellhead pressure.)

Flare gas flows to TP1 flare via the HP flare collection header on TCP2.

Flare gas is monitored for flow and pressure. Flow monitor output is recorded and pressure monitor output transmitted to the QP computer.

Blowdown times are minimised within the capacity constraints of the installed relief system and range from 8 to 75 minutes depending on the item of equipment involved.
Ref. ELF Engineering Report No. 90117R 3 (Sept. '93). Appendix II, Drg. No. 93-038B.DGN

An 8in choke valve is provided which connects each sales gas metering station to the HP relief system so that the gas may be burnt if necessary.

If water is trapped in the flare line a high pressure switch will activate an alarm in the QP Control Room. A pressure transmitter will send a signal to a recorder in the QP Control Room.

PART J HP RELIEF AND LT VENT (cont.)

Treatment Area LT Vent

Low temperature gases from pressure relief valves, pressure safety valves and emergency shutdown blowdown valves are connected and discharged to atmosphere by the LT vent system.

The collected gas, having a minimum temperature of -80°C, is discharged via a vent stack and knockout drum as a cold flare. Any hydrocarbon liquids are collected in the knockout drum and at system drain points and are transferred to the process drain system in the treatment area.

The knockout drum, V47, and vent stack, SP45, are located on TP1.

The HP relief system is connected to the LT vent by a cross-over line including an isolation valve and check valve, preventing cold gas from entering the HP relief system.

Spare connections have been included for the blowdown of other lines.

Any liquid recovered in the drain collection point is taken to the process drain system in the treatment area. This drainage operation is under manual control by visual inspection of level gauge LG V47.7.

Gas collected on TCP2 is discharged on TP1 via line 2022.EAR 16"R.

Provisions are provided for sweeping the system by fuel gas, but the system is normally swept by nitrogen from TP1. A 2in nitrogen connection is provided at the end of the 16in LT vent header on TCP2, which is used for sweeping purposes.

PART K LP VENT

Treatment Area

Waste and relief gas from treatment area equipment operating below 15 barg is discharged to atmosphere by the LP vent system.

The system comprises the following:
(a) 12in vent header;
(b) Two 14in vent headers;
(c) Vent scrubber CV7;
(d) Vent stack CSP24.

The vent piping configuration is such that any entrained condensate drains to the vent scrubber. The vent headers discharge into the LP vent stack, the 12in header direct and the 14in headers via the vent scrubber.

The following equipment vents into the 14in LP vent header V401:

(a) Oil skimmer CV5;
(b) Condensate recycle tank CV33
(c) Fuel gas scrubber CV6 and heater CE3 (passivated)
(d) Glycol surge tanks CV17 A/B;
(e) Condensate separators CV14 A;
(f) LP vent from the extension area; (passivated)
(g) LP vent from East Frigg; (passivated)
(h) methanol storage tank CV17C; (Passivated)
(i) LP vents from Frøy module. (passivated)

The following vessels vent into 8in LP vent header V470:

(a) Glycol regeneration stripping columns CV16A/B;
(b) TEG storage CV1B;
(c) DEG storage CV2C; (Passivated)
(d) Expansion tank CV517; (Passivated)
(e) DEG reboiler CH1C; (Passivated)
(f) methanol storage tank CV17C. Passivated)

PART K LP VENT (cont.)

Where vessels are fitted with parallel pressure safety valves, only one valve is normally in service with its isolating valves car-sealed open (CSO) and the other on standby with its isolating valves car-sealed closed (CSC).

Waste gas is continuously vented from the glycol regeneration streams' stripping columns (CV16 A/B) and glycol surge tanks (CV17 A/B).

Entrained liquid in the gas discharged through 14in vent header V401 is separated in vent scrubber CV7. Liquids are let down, under level control, to process drainage. A high liquid level alarm will indicate in the Control Room.

Entrained liquids in the gas discharged through 8in vent header V470 are separated in LP vent stack CSP24. Liquids are let down, under level control, to oil skimmer CV5.

Waste and relief gas from scrubber CV7 discharges into LP vent stack CSP24 which, together with gas from 8in vent header V470, releases the gases to atmosphere. CSP24 is 22.86m high.

To prevent ingress of air a gas seal is fitted to CSP24. Provision has been made for purging the vent stack via a tapping off the fuel gas system.

Fire protection for the vent stack, CSP24, is provided by two CO_2 fire extinguishing packages, one main and one reserve. Each package contains 13 x 45 kg CO_2 bottles. On activation, all 13 CO_2 bottles are released. Activation of each package is achieved by a local manual release mechanism. The local manual release cabinet is located alongside each package.

Compression Area

Waste and relief gas from low pressure sources in the compression area is collected and discharged to atmosphere by an LP vent system.

The collected gas is discharged via a vent stack as a cold flare. Any liquids collected in the system are passed to the process drain system in the treatment area. A tapping from the fuel gas system enables system purge, but the system is normally swept by nitrogen from TP1.

The system comprises the following:

(a) 8in vent header LV001;
(b) LP vent scrubber 67B01;
(c) Cold vent snuffing package 67X01;
(d) LP vent stack.

PART K LP VENT (cont.)

The following equipment vent into the system:

(a) Generator turbine 52GG01 A/B auxiliary fuel gas system;
(b) Fuel gas package 50X01 A/B low temperature separators;
(g) Module 52 vents.

Any liquid recovered in vent scrubber 67B01, or from the lowest point of the LP vent stack, is let down under level control to the treatment area process drain system.

Purge gas from the fuel gas system is supplied to the vent stack. This gas, together with light gas seal 67X02, ensures that air is excluded from the vent stack.

Fire protection for the cold vent stack 67 X 02 is provided by two CO_2 fire extinguishing packages, one main an one reserve. Each package contains six 45 kg CO_2 bottles and on activation all six bottles are released simultaneously. Activation of each package is achieved by a local manual release mechanism which is contained within a cabinet located alongside the package.
Vent scrubber 67B01, which normally operates at a pressure slightly above atmospheric to maintain a positive pressure in the system, has a design pressure of 3.5 barg, a design temperature of -65° to +100°C and a volume of 31 m³.

CONTENTS

DIAGRAMS

PART A COMPRESSED AIR

Reference Diagrams: FF-85-00-01-5026 Instrument and Utility Air Compressor Package
FF-87-00-19-2052 Instrument and Service Air Systems
FF-87-00-01-5048 Air Dryer CQ21 Air Compressor
FF-22-00-79-1014 Compressed Air Distribution (Frøy)
2.8.2.A1

Three air compressors (Atlas Copco ZR3-58) and ancillary equipment, installed in Zone 5 (previously the Gas Turbine Room) deliver compressed and dry air to the Frigg Central Complex. Since air is only supplied from one location the compressed air system for the compression area is permanently interconnected with the treatment area compressed air system at Pancake 46 and Module 30 for instrument air and utility air systems.

Compressed, oil-free and pulsation-free air is supplied by CQ22 A/B/C which are two-stage water-cooled electric motor-driven screw compressors. Each compressor has a capacity of 1200 m³/h at a discharge pressure of 10.5 barg.

The air compressor package comprises the following:

(a) Air compressors CQ22 A/B/C;
(b) Circulation pumps for cooling water CP36 A/B;
(c) F.W. radiator coolers CE8 A/B/C/D;
(d) Air dryers CQ21 and CQ23;
(e) F.W. expansion tanks CV53 A/B;
(f) Air receiver 57X01T01;
(g) Dried air reservoir for 3 hours (26in lines to TP1 and CDP1 & 4in condensate line TP1 to CDP1).

The three Atlas Copco air compressors each have a dedicated microprocessor control panel. The controllers are programmable which means that all local shutdown levels can be adjusted/modified. Alarms, status and shutdowns are displayed to the operators locally. For each of the controllers, general alarm signals are transmitted to QP Control Room and displayed on annunciators LC12 and LC9. In addition, electric motor on/off information is also displayed on the annunciator in the QP Control Room.

During normal consumption of instrument and plant air, one compressor is running as duty I and the second is running as duty II; the third compressor is set in standby mode. In order to get equal running time on units A, B and C the operator manually re-programs the local controllers with a given frequency.

The compressor duty selection is based on the pressure on the air header outlet as follows:

(a) Duty I compressor - load 9 bar, unload 10.5 bar;
(b) Duty II compressor - load 8.7 bar, unload 10.2 bar;
(c) Standby compressor - load 7 bar, unload 8.5 bar.

Note: The electric motor on the standby compressor is programmed to stop. On duty I and II compressors, each electric motor is running continuously.

PART A COMPRESSED AIR (cont.)

The sealines to CDP1 are tied in to the central complex air network to ensure sufficient air in the reservoir in case of anomalies such as shutdowns, repair, maintenance etc. The reservoir is refreshed with air from the dryers at an acceptable dewpoint. The air receiver 57X01 and the above mentioned reservoir pressure will vary between 10.5 and 9 bar. The air reservoir will last approximately 3 hours in event of shutdown. The service air network will automatically shut down in the event of falling pressure.
Air dryer CQ23 (Deltech MWE 3350) is installed in the Compressor Room on Pancake 08.

Air dryer CQ23 is totally local controlled. However, the dewpoint control unit starts an alarm if the dewpoint temperature exceeds -20°C; this alarm is transmitted to QP.
Air dryer CQ21 is situated on Pancake 42 (compression) and has a local control cabinet mounted in Fire Pump Room A. From the cabinet, one general alarm is transmitted to QP Control Room. Normally air dryer CQ21 is running as duty air dryer. A dewpoint meter is situated in the instrument system and located in the treatment area Instrument Interface Room.

Both air dryers comprise two desiccant vessels, one on drying duty and the other on regeneration; cycling (drying/regeneration) is automatically controlled and initiated. Regeneration is effected by heating the desiccant and the removal of moisture by a small portion of dried air.

The cooling water system consists of four radiator coolers including electric motors and fans, one expansion tank, two circulating pumps and 4in interconnection pipe to the compression area turbine generators (Stal Laval) cooling system. Maximum cooling water inlet pressure is 5.5 bar. Recommended pressure is 3 bar. The radiator cooler and pumps are manually controlled from a panel in the vicinity of CQ22C.

The compressed air system consists of two separate distribution systems supplied from a common header. The two systems are:

(a) An instrument air system serving modules, pancakes, gas compression seal air system, and other specific users.
(b) A plant air system supplying utility stations, pneumatic hoists, and gas turbine washing system, etc.

The two branches from the common compressed air header which supply instrument air and plant air are under the control of their own pressure control valves (PCV). The standard of both instrument and plant air is therefore the same, in terms of humidity and filtration, since the supply is common (only one air receiver for each compressor/dryer set).

The instrument air line PCV is controlled at 7.3 barg to supply the instrument air ring-mains, the plant air line PCV is controlled at 8.0 barg. It should be noted that in the event of the pressure in the air receiver falling below 61.5 bar, the plant air line will be shut-off in order to safeguard instrument air supplies. This modulation of the plant air PCV is carried out by a pressure switch which senses pressure in the instrument air line. In the event of low instrument air, an alarm is transmitted to the QP Control Room.

In order to ensure air to the winches in the columns of TCP2 and TP1 a separate high pressure air system has been installed. The system consists of six air bottles, one three-stage air compressor, air reducing valves and interconnection pipes.

PART A COMPRESSED AIR (cont.)

In order to utilize the emergency air, the winch operators must operate the valves selecting air supply on the relevant winch station. The emergency air system can be supplied with dry air from the CQ22 air compressors.

The TP1 and TCP2 air network is interconnected by two 3in pipes over the bridge - one for instrument air and one for plant air supply.

Automatic shutdown of the duty compressor and the associated equipment is initiated if preset parameters are exceeded. These parameters include:

(a) Loss of room overpressure;
(b) Detection of gas, fire or smoke in room;
(c) Detection of gas in compressor intake;
(d) Detection of gas or fire in workshop;
(e) Detection of gas in common air inlet.

PART B DIESEL FUEL

The diesel fuel system supplies fuel to the day tanks serving the diesel engines driving the firewater pumps, the platform cranes, the emergency generator and the users in the compression area, which includes the generator turbines 52GG01 A/B.

The system comprises the following:

(a) Storage tank CV10;
(b) Pumps CP8 A/B;
(c) Pumps CP33 A/B (for generator turbines 52GG01 A/B);
(d) Filter CV21;
(e) Local control panel.

An interconnection with TP1 allows the system to supply diesel fuel to and accept it from TP1.

Diesel fuel is stored in tank CV10 which has a capacity of 100 m^3 and a maximum working pressure of 1.35 bara at 21°C. Normal tank replenishment is from a service vessel through the unloading stations. CV10 is protected against pressure changes by a pressure/vacuum safety valve.

Level indication of tank CV10 is indicated locally and remotely at the local control panel, and the diesel fuel local control panels of TP1 and QP. The low level alarm of tank CV10 is connected to the FCDA. Level indication of the firewater pump diesel fuel day tanks is also indicated at the local control panel.

PART B DIESEL FUEL (cont.)

Diesel fuel is distributed to consumers by motor-driven pumps CP8 A/B, which are installed in parallel and normally operate one duty, one standby, as determined by a local hand selector switch. Each pump has a capacity of 113.6 litres/min at 4.2 barg.

The duty pump (CP8 A/B) takes suction from tank CV10, and discharges to consumers through filter CV21. Pump operation is controlled by start/stop pushbuttons at the local control panel, and the diesel fuel local control panel of TP1.

Consumer isolating block valves are mounted on a manifold adjacent to the local control panel, enabling system operation by one operator.

Diesel fuel is also distributed to the diesel day tanks for turbines 52GG01 A/B, by motor-driven pumps CP33 A/B. These operate in parallel, but on automatic, only one pump runs depending on which machine has switch to diesel operation. When manual operation is selected, the pumps can be operated from the control panel (Mezzanine Level Control Room) or locally beside the pumps at CV10. Fire in Zone 06 (local area beside CV10) will stop the pumps.

PART C DRAINS

Treatment/Extension/Compression Areas

The drains system comprises open and closed systems. The open drains terminate in a 32in caisson (CV13) located inside Column 1. The caisson has its upper level above sea level, and its lower section open to the sea below sea level. The closed drain from Treat and Comp. terminates in CV55. CP 39 pumps accumulated oil/condensate from CV55 to oil skimmer CV5; if, for any reason CV55 overflows, this is routed to caisson CV13.

Process equipment drains discharge into 4in and 6in closed drain headers, via closed drain subheaders. High and medium pressure vessels are normally not connected to the closed drain system, but are blinded and connected during shutdown periods only.

The 4in and 6in closed drain headers discharge into a drain collector tank, CV55, from which the collected liquid is pumped via CP39 to CV5.

From CV55 there is an overflow line which discharges via a 12in open drain header to the sump caisson, CV13.

To prevent the ingress of hydrocarbon gases into the open drains system a liquid seal loop is installed in the 12in open drain header at the closed drain header connection.
Liquid seals are also fitted to the 2in drain lines of the firewater pump, diesel fuel day tanks (CV11 A/B) upstream of the subheader connection.

Platform deck areas are provided with an open drain system comprising floor gullies leading into deck drain sumps. Each gully has a continuous slope down to the appropriate sump.

PART C DRAINS (cont.)

The open drain dumps discharge into the caisson via seal boxes, drain manifolds, the subheaders and a 12in open header.

In the caisson the oil and water are separated. When the oil/water interface reaches a predetermined level, the oil in the sump is pumped out using waste oil sump pump CP3. CP3 discharges to the condensate slops header serving oil skimmer CV5.

Submersible sump pump CP3 is located inside the caisson. The pump, which is driven by a 3.8 kW electric motor, has a capacity of 95 litres/min at 5.7 bar differential pressure. Pump operation is controlled by remote start/stop pushbuttons located adjacent to oil skimmer CV5. CP3 stops automatically after 20 minutes.

Caisson oil/water interface level indicator LI-CV13-1 incorporates a bubbler system. The differential pressure between the set-point for sea water and the set-point for oil is determined by the bubbler system, using two bubble tubes terminating at different levels in the caisson. LI-CV13-1 is located near CP3 start/stop pushbuttons.

Frøy Module

Hazardous Open Drains

The hazardous open drains system consists of a number of deck located drain boxes and interconnecting pipework for the automatic drainage of surface liquids from each of the four decks in Module 35. In addition to surface drainage, equipment drainage is also provided by the use of liquid drip trays which are similarly piped into the system. The individual drains are connected to deck drain headers each of which is routed separately to a common liquid seal pot (LSP). The LSP has a vent stack to atmosphere which ensures safe removal of explosive gases. The vent stack is positioned at a safe location outside Module 35 and is fitted with a flame arrestor. The stack permits a normal system operating pressure of approximately atmospheric.

All the drainage entering the seal pot leaves through a common 6in line and is connected to the Lille Frigg open drains system liquid seal pot, which is also equipped with a vent stack and has, in addition an overflow line connected to CV13. The drainage from this LSP leaves through the overflow line which is connected direct to sump caisson CV13.. In the event of excessive flow to the seal pot, a 24in deluge dump overboard line has been fitted. The normal operating conditions of the open drains system are atmospheric pressure, ambient temperature and normally no flow.

Closed Drain System

The closed drain system associated with Module 35 is passivated. The Lille Frigg closed drain system is also passivated. The closed drain tank (CV661) is passivated.

PART C DRAINS (cont.)

Seawater Drain System (passivated)

PART D FIREWATER AND DELUGE

Reference Diagrams: FF-22-00-85-1016
FF-22-00-85-1017

General

he firewater system of TCP2 is interconnected with the respective systems on TP1 and QP such that firewater can be supplied from any firewater pump to any one platform. The automatic start system ensures start of all firewater pumps on all three platforms that are set for auto start.

Firewater Pumps

There are three firewater pumps on TCP2, two centrally on Cellar Deck and one on the east side of M30 Compression Main Deck. The three firewater pumps (plus the three on TP1 and QP) will start automatically upon:

(i) activation of fire alarm button (FAB) in any one area;
(ii) fire detection in any one area;
(iii) gas detection (2nd threshold) in process area;
(iv) activation of the deluge valve(s);
(v) initiation of emergency shutdown (ESD).

The two Treatment Area firewater pumps CP6 A/B are passivated.

The two Compression Area firewater pumps 68P01 A/B are hydraulically driven. Both the pumps and diesel drivers are supplied by Frank Mohn. Each diesel engine is provided with a pneumatic start system.

The pumping arrangement consists of two pump stages, one submerged and one within the pump package. The nominal capacity is 7,750 litres/min (465 m^3/h) at a discharge pressure of 10 bar.

The new firewater pump located on the east side of M30 Compression Main Deck, CP 011, is electrically driven and takes firewater at level -19.4 m. The generator is driven by a 16-cylinder MTU diesel engine rated to 1785 kW at 1800 rpm. The engine is provided with a pneumatic start system, and the nominal capacity of the pump is 46,000 litres/min (2760 m^3/h) at a discharge pressure of 10.5 bar.

PART D FIREWATER AND DELUGE (cont.)

The discharge pressure for all pumps is controlled by dedicated pressure control valves (PCVs) routing excess firewater overboard through separate dump lines. Facilities for yearly performance testing of the pumps are available.

The firewater pump CP11 will be routed to the water injection sealine to FWHP, to supply FWHP with firewater.

Firewater Ring Main

The Firewater Ring Main consists of several distribution nets which are interlinked such that all firewater pumps can supply any firewater consumer. The distribution ring consists of several manual isolation valves which ensures that firewater can be supplied from alternative routes should a section of the ring be out of operation.

The Firewater Ring Main are maintained in a pressurised state (5 to 7 bar) by the on/off operation of the brine pumps (P4A/B) on QP. Should these pump fail to maintain the required pressure, then the duty firewater pump will start (low-low pressure).

Fire Fighting Equipment

The various firewater consumers receive firewater from the Ring Main through valved take-offs. The consumers are as follows:

(i) Deluge systems;
(ii) Firewater hose reels;
(iii) Firewater monitors;
(iv) Sprinkler systems

The deluge systems are designed to provide a general area coverage of 10 litres/(m^2*min) plus dedicated equipment coverage. The deluge systems and firewater monitors on Frøy M35 Weather Deck are provided with foam facilities. Similarly, some of the firewater hose reels throughout TCP2 are provided with foam facilities to improve the fire fighting capabilities of hydrocarbon liquid fires.

Details of the equipment and systems served by the valved take-offs listed above are contained in Section 2.11.4.

Fire Areas

The fire areas on TCP2 are segregated horizontally by the deck plating and vertically by the fire walls segregating Frøy M35 from the rest of TCP2 Treatment and Compression. The various fire areas protected by firewater are as follows:

PART D FIREWATER AND DELUGE (cont.)

(i) TCP2 Cellar Deck;
(ii) TCP2 Main Deck (Frøy M35 is a separate area);
(iii) TCP2 Upper Deck (Frøy M35 is a separate area);
(iv) M30 - Compressor Hall A
(v) M31 - Compressor Hall C
(vi) M32 - Compression Weather Deck (Fuel Gas and Hydraulic Oil packages)
(vii) Frøy M35 Main and Intermediate Decks
(viii) Frøy M35 Weather and Metering Decks

Available firewater shall be double the demand of the largest fire area, presently TCP2 Main Deck, item (ii) above.

PART E WASHDOWN

General

The washdown system supplies sea water for general washdown purposes. The system comprises the following:

(a) Washdown pump P33 (on TP1),
(b) Washdown pump 50P02.
(c) Three 4in ring mains,
(d) Washdown hosereels, strategically positioned about the platform.

Valved interconnections with the firewater ring main enable the washdown pump to be used as a backup firewater pump.

Treatment Area

Washdown pump P33 (formally CP7) is now situated on TP1, but operated and hooked-up to the TCP2 treatment wash-down header. The two 4in ring mains (UW1302 and UW1307) encircle the treatment area at Cellar, Main and Upper Deck levels respectively. They are interconnected by two 4in cross-overs UW1305 and UW1306. Valved 2in branch lines off the ring mains serve the washdown hosereels.

Each hosereel comprises 31m of 1.1/2in hose terminating with a spray/jet/shut-off nozzle, rated to deliver 379 litres/min.

The treatment area ring main is interconnected with the treatment area firewater system to provide backup facilities. It is also interconnected with the extension area, Module 51, compression area system, and Frøy Module 35.

PART E WASHDOWN (cont.)

Compression Area

Washdown pump 50P02 is of the vertical centrifugal type, driven by an 89kW electric motor. It has a capacity of 113m³/h at 9.6 barg. Pump operation is controlled by remote start/stop pushbuttons at each compression area hosereel station or from the compression area Control Room.

50P02 is situated in a conductor, has its suction at elevation -10.5m, and discharges into the compression area ring main through a 6in line. A connection from the ring main is made to the Frøy Module 35.

A 4in ring main WW001 (4in) supplies the Cellar, Main and Upper Deck levels of the compression area. WW001 (4in) is interconnected with UW1302 (4in) and UW1307 (4in). Valved 2in branch lines off the ring main serve the washdown hosereels and the water maker. A 6in branch line is used to fill the compression area main sea water network before start-up.

The compression area ring main is interconnected with the compression area firewater system to provide backup facilities.

PART F DESALINATED WATER NETWORK

Reference Diagrams: FF-22-00-77-0078

The desalinated water network is fed from QP and distributes fresh water to the following users:

(a) Fresh water cooling systems;
(b) Turbine compressor water wash systems;
(c) Turbine washing systems;
(d) Fresh water supplies on Upper and Main Decks and various Pancakes.

The desalinated water network is interconnected through a sterilization unit to the potable water system on QP and TP1.

PART G UTILITY SYSTEMS FOR PRIMARY STRUCTURE

Flooding and Dewatering System

Introduction
For necessary maintenance and inspection of the risers and J-tubes, located inside Columns 3 and 5, a flooding and dewatering system for the columns is installed. The columns are normally filled with sea water to sea level.

Flooding System
Flooding is performed by allowing sea water to enter the columns by gravity. Water enters an 18in suction pipe at el. + 13.15m and is allowed into the column under the full rate of flow. If necessary, throttling can be performed by a butterfly valve which is located on the 18in line.

With the valve on each column completely open it takes approximately 53 hours to flood the columns.

Dewatering System

The dewatering system consists of two 16in pipes (one in each column) routed from the bottom of the columns to a level + 13.15m above sea level. Each pipe is equipped with a remote-operated valve at the outlet level. The water is pumped out by two electrically driven dewatering pumps which are installed at the bottom of Column 1.

The emptying time is approximately 55 hours for each column (Nos 3 and 5).

PART G UTILITY SYSTEMS FOR PRIMARY STRUCTURE (cont.)

Recirculation System

The heating of water in Column 3, (Column 5 is unaffected) due to hot gas risers and topside cooling water discharge, is controlled by the recirculation system. The design allows for a maximum temperature gradient across the column wall of 8 deg. C.

A number of valved holes (24) in the column wall between elevations +68m and +78m allow sea water to circulate automatically within the column as dictated by the daily temperature. An externally installed water curtain pump can be manually operated, as required, to flush cold water to the top of the column water.

CONTENTS

DIAGRAMS

FF-00-23-00-0001	**Main Distribution Network, Frigg Field and Frøy**
FF-85-00-46-1011, Sheet 2 to 7	**Safety Plot Plan - PA, Telephone, Stentophone and Indication Lamps**
2.9.4 Fig. 1	**Navigational Aids, Overall System**

2.9.1 POWER GENERATION AND DISTRIBUTION

General

The electrical system on TCP2 conforms to the following design codes of the Institute of Electrical and Electronic Engineers:

- Std 141, 1976, Recommended Practice for Electrical Power Distribution for Industrial Plants;
- Std 142, 1972, Recommended Practice for Grounding of Industrial and Commercial Power Systems:
- Std 446, 1976, Recommended Practice for Emergency and Standby Power Systems.

Purpose

The purpose of the electrical network is to generate and distribute power throughout the platform to support all process, utility, control and communication requirements. In addition, it must maintain emergency and essential supplies to important equipment if the generators should fail, and provide uninterruptible supplies to essential equipment where no momentary breaks in supply can be tolerated.

General Description

Reference Diagram: FF-00-23-00-0001

Introduction
Under normal operating conditions, power for the whole of the Frigg Field is generated at 5.5kV by the two 16MW turbine-driven generators in the compression area of TCP2. Interconnecting cables on the bridges to TP1 and QP carry power to those platforms. DP2, East Frigg and Lille Frigg are served with submarine cables. Small diesel-driven generators in the compression area of TCP2 and also on QP and DP2 provide standby/emergency supplies at 380V.

Main Power Generation
Main power on TCP2 in generated at 5.5kV, 3-phase, 50Hz by two turbine-driven generators (52G01A and B) which deliver 16MW (19.23 MVA) into the network. The turbo-generators are dual-fuelled, running on gas or diesel oil. The generators are capable of being synchronised and operated in parallel.

Inter-platform Connections
Interconnections between TCPC2, TP1 and QP are provided by dual 5.5kV radial feeders which ensure that, in the event of one cable failing, power can be maintained to each switchboard. Supply to DP2 is via a radial feeder from the TCP2 5.5kV busbar. Arrangements are provided for the isolation and earthing of all interconnecting cables between the platforms.

2.9.1 POWER GENERATION AND DISTRIBUTION (cont.)

5.5kV Supplies
New 5.5kV and 380V switchboards have been added as a result of the Frøy tie-in. The new 5.5kV switchboard feeds the existing 5.5kV network, additional HV motors, the 5.5kV/22kV Frøy Wellhead Platform transformer, the 4.4kV start busbars, two capacitor banks and the new 380V switchboard via two new transformers. The existing compression area 2000A main switchboard (S52.32.1.1) consists of circuit-breakers for the incoming and principal outgoing circuits, and contactors high-voltage motors and transformers. Outputs from the switchboard also feed the 800A treatment area switchboard (TCP2.5500). This second 5.5kV switchboard is divided into three sections (A, B and C) by two bus tie breakers.

Transformers
Eight power transformers with ratio 5500/380V are installed on TCP2, which supply the principal 380V switchboards. Transformers T9 and 10, and treatment area transformers T4 and T5 are rated at 1000kVA. Transformers T11 and 12 are rated at 2500kVA. The Frøy tie-in transformers, T25 and T26, are each rated at 1500kVA, are fed from the new M35 5.5kV switchboard and supplies the M35 380V switchboard.

380V Supplies
The 380V low-voltage system comprises a large number of separate switchboards and distribution boards, the main boards being directly supplied through transformers from the 5.5kV system.

Uninterruptible Power Supplies
Fourteen separate battery-supported dc systems are provided on TCP2, six in the compression area and eight in the treatment area. The compression area, treatment area and Frøy Module M35 are all provided with battery-supported ac systems. In addition, a battery-supported ac system is provided for the East Frigg power supply.

Summary of Plant Operation

Main Power Generation
The main power generation gas turbine sets (52G01A and B) are dual fuelled, running on gas or diesel oil. The sets normally run on gas but will automatically change to diesel oil if the pressure of the gas falls below a predetermined level; reversion to gas operation is manual only. The number of generators in service depends on the load.

2.9.1 POWER GENERATION AND DISTRIBUTION (cont.)

The generators are started from a discrete air system comprising three small compressors and two air receivers. One electrically driven compressor and one air receiver is dedicated to each turbine. A third, diesel-driven compressor is available for use in a emergency and can be used to charge either air receiver. Each set is provided with a remote control unit to start and stop the set and to provide the controls and indications necessary for its operation. A cut-out has been installed in the door mechanism to the turbine starting device that will vent the device to atmosphere when the door is opened.

The turbo-generator enclosures and the dual-fuel units are protected against fire by carbon dioxide systems which will operate either automatically or manually. Gas detection facilities are also provided for the enclosures, these facilities provide for the increase in ventilation in the event of gas detection, or will stop the generators if the gas detected is above a predetermined concentration.

Emergency Power Generation
In the event of failure of the main turbo-generating sets, a 380V diesel-driven generator (53G01) is installed to provide emergency low-voltage power to selected consumers in the compression area. The generator feeds into the emergency switchboard (S53.44.2.6) which is normally supplied from the main 380V switchboard (S52.32.2.1). In additon, the emergency switchboard feeds the M35 essential switchboard (LV-DBEM-M35). The treatment area of the platform obtains its supply of emergency power from the diesel generators on QP via DB308.

In the event of failure of the diesel-driven generator, the emergency generator auxiliary switchboard (S53.44.2.7) has a manually back-up supply from the diesel-driven generators on QP. This supply provides the necessary power to the emergency consumers which includes those necessary to start the diesel-driven generator under black-start conditions.

The black-start supply to the emergency generator auxiliary switchboard is controlled from the central electrical control board.

Control
The control of the whole of the Frigg Field electrical system is exercised from the central electrical control board in the MCC Room in the treatment area of the platform.

A mimic panel on the electrical control board represents the layout of the system and discrepancy switches, set in the mimic, this together with an Baily operating station remotely control the various circuit-breakers.

Synchronising of incoming generators is carried out automatically or by manual control. Where synchronising is carried out between different parts of the network (eg, interconnector feeders) a synchronising trolley is used.

The main turbine-driven generator sets are monitored from a local control room located within the generator module. Each of the two main generators may be controlled from remote control boards located in the MCC Room in the treatment area.

2.9.1 POWER GENERTION AND DISTRIBUTION (cont.)

Electrical Generator Drivers

There are two dual-fuelled gas turbine drivers and one diesel engine driver. They are each mounted integrally with their respective main and emergency generators on individually skids; the gas turbines being contained within sound-proofed ventilated enclosures. Each driver is supplied with its own utilities. The diesel engine remains constantly at standby for automatic start in the event of main power failure; it has sufficient day tank capacity for 24 hours continuous operation.
The main characteristics of the electrical generator drivers are as follows:

Gas Turbines

LP Side:
- No of stages: 10
- Speed: 5800 rev/min

HP Side:
- No of stages: 10
- Speed: 7000 rev/min

Diesel Engine

- Power: 1000kW
- Speed: 1500 rev/min
- Oil sump capacity: 150 l
- Min firing speed: 80 rev/min

2.9.2 LIGHTING AND TRACE HEATING

Lighting

General
Three independent lighting systems are provided, one for the treatment area, one for the compression area and one for M-35. Each of the systems is divided into normal and emergency sub-systems. All lighting fittings operate at 220V single-phase derived between phase and neutral of the 380V distribution boards.

It should be noted that all the lighting mentioned below is in use under normal operating conditions. If main power generation fails the emergency lighting will be operative by individual integrated battery packs until the standby generators start and come on-load.

Elf Specification S-10-23-0006 stipulates the following minimum, emergency lighting levels:

- Switchgear rooms: 150 lux
- Ladders and stairways: 50 lux
- Walkways: 25 lux
- Generator rooms: 50 lux
- Generator operation areas: 25 lux

2.9.2 LIGHTING AND TRACE HEATING (cont.)

Treatment Area
The treatment area system, which includes the extension area, the East Frigg module and Module 52, is sub-divided as follows:

- Normal lighting: Supplied from distribution boards DB301, 302, 321 and 351.

- Emergency lighting: Supplied from distribution boards DB308, 322 and 352. DB308 has a standby input from QP.

Distribution boards DB321 and 351 are fed from MCC 'B' in the compression area and provide supplies for the extension area (Module 50) and East Frigg Module 51 respectively.

Compression Area
The compression area lighting system, which also serves Pancake 48, comprises the following:

- Normal lighting: Supplied from distribution boards S52.32.2.4 and 5.

- Emergency lighting: Supplied from distribution board S53.44.2.8 which has an input from emergency generator 53G01.

Module M35
The power supplies for normal lighting in M35 are taken from distribution board DB331, which, in turn if fed from the M35 380V switchboard (LB-DB-M35) located on the Mezzanine Deck of M35. Power supplies for the emergency lighting are taken from distribution board DB332, which is fed from the M35 380V emergency switchboard (LV-DBEM-M35).

Trace Heating

The purpose of trace heating is to minimise heat losses from certain piping, equipment and instruments to ensure their proper operation; it is also used to add heat to process eqipment where there is insufficient heat in the process fluid.

In addition to thermal insulation, instruments and instrument lines in exposed areas, and pipelines and equipment susceptible to hydrate formation and gas condensation, are equipped with self-controlling electrical trace-heating cables. These cables are laid in such a way as to permit the removal of instruments, pipes and equipment without cutting the cables.

Electrical power to the trace-heating cables is supplied through dedicated distribution boards. These boards include earth leakage detection, tripping and alarm circuits. Power is fed from the distribution boards to a junction box in each trace-heating circuit and further distributed via junction boxes to sub-circuits.

2.9.3 COMMUNICATIONS SYSTEMS

Reference Diagrams: FF-85-00-46-1011, Sheets 2 to 7

General

The communications systems on TCP2 conform to the Radio Regulations of the International Telecommunication Union.

Telephone (PABX) System

General
The exchange telephone system is common to all the main platforms comprising the Frigg Field. QP and TP1 form a network having common exchange on QP, the telephones on TP1 being outstations from this exchange.

TCP2 has its own exchange which is connected by four trunk lines to the QP exchange by cable via the bridges to TP1 and to QP.

DP2 has its own exchange, but is connected by three trunk lines to the central QP/TP1/TCP2 system via microwave link.

Exchanges
The principal automatic exchange on QP is a Mitel SX200. The exchange has a maximum of 208 lines available for internal, inter-platform and satellite communication with Norway. A second exchange, Mitel SX10, is provided to be used with the UK tropospheric scatter radio line.

The exchanges on DP2 and TCP2 are Mitel SX100 exchanges. These have a maximum of 104 lines each for internal or inter-platform communication.

Instruments
Two types are provided, an office-type telephone insturment and an x-proof telephone instrument for hazardous areas.

Shore Links
The 208 line main exchange is also used for satellite communication with Norway (Stavanger), for which seven trunk lines are provided between the exchange and the satellite earth station on QP.

Through this satellite link it is possible to speak to subscribers anywhere on the Norwegian public network. Telex, telewriter and facsimile services are also available through this link.

2.9.3 COMMUNICATIONS SYSTEMS (cont.)

Radio communication with the UK (St Fergus) is through the Mitel SX-10 exchange, to which are connected nine additional telephone instruments exclusively for this service. In addition, there are telephones for point-to-point connection to St Fergus (not through the exchange), and also five telephones for direct link with the UK public telephone network (not through the exchange). All are multiplexed with telex, telewriter and telemetry services and are passed to St Fergus by troposcatter.

There are telex and telewriter links between QP and Norway, and between QP and the UK, using the same satellite and troposcatter radio links as the telephone uses. At the Stavanger and St Fergus terminal, the telex links can be extended into the Norwegian and UK public telex network.

Intercommunications

General
A powered intercom system, type Pamex, independent of the network connects all the control rooms and most of the offices and main living rooms of all the platforms comprising the Frigg Field.

A main exchange is installed on QP with a satellite exchange on DP2. This enables all subscribers to call any extension required. The system enables conference groups to be set up and messages to be given via the general call facility. The subsriber can use the system as a loudspeaking voice controlled system or push-to-talk, or as a full duplex private telephone system, except for the ex-proof extension which is voice controlled or push-to-talk.

Description
All control rooms and ex-proof extensions on the complex are directly connected to the QP exchange. The satellite exchange on DP2 is connected to the QP exchange via the multiplex system using microwave radio link.

The main exchange on QP is for a maximum of 80 subscribers and 8 speech channels. The exchange is expandable to 240 subscribers. The satellite exchange located on DP2 is for a maximum of 48 subscribers and 4 speech channels.

The QP exchange is capable of setting up a conference group with the TP1 Interface Room 1, TCP2 Interface Room, Control Room (compression), DP2 Control Room and QP Control Room. Further more, the QP Control Room, Radio, Rig Office and telecom are capable of using the general call facility to give messages.

The satellite exchange are powered so that they will have power cut-off in case of a shutdown. The QP exchange will cut off power to all sets connected to it on the treatment platforms in case of a shutdown on the treatment platforms. Ex-proof sets are not included in this cut-off.

The normal desksets are provided with a built-in loudspeaking mode; in areas with high background noise the push-to-talk button can be used to facilitate normal operation. The set can also be used as a full duplex telephone set by lifting the control unit from the loudspeaker and using it as a handset.

The ex-proof sets are wall-mounted with a built-in microphone and external loudspeaker. The sets can be used as a semi-duplex voice controlled set or, in case of high background, a push-to-talk button can be used to facilitate normal operation.

2.9.3 COMMUNICATIONS SYSTEMS (cont.)

Public Address and Alarm System

General
The Public Address (PA) System is common to three platforms QP, TP1 and TCP2. It also provides the vehicle for the broadcasting of alarms. It is activated from the Central Control Room on QP and alternatively from the PLO Office on TCP2.

The system fitted is a combined public address and general alarm system which can broadcast the following to all parts of the Frigg Field Complex:

- Audio alarm signals to warn personnel of hazardous situations,
- Emergency speech announcements (preceded by a discrete alert tone),
- Routine speech announcements (preceded by a discrete alert tone),
- Pre-recorded emergency speech announcements,
- PABX announcements (paging).

The system comprises the following major parts:

- A four-bay central equipment rack, with a nominal audio power of 8400W (located on QP),
- One 19in rack mounting safe area alarm control panel (located on QP),
- One 19in rack mounting IS (intrinsically safe) alarm control panel (TCP2 PLO Office),
- One desk-mounted IS (intrinsically safe) access unit,
- Three desk-mounted safe area access units,
- Seven simple emergency microphone points (EMPs), on TCP2 (at strategic locations),
- Loudspeakers,
- Flashing lights.

The public address and alarm system is accessed by:

- Seven emergency microphone points (EMPs),
- Access units at the CCR (QP), Radio Room (QP), Rig Office (QP) and the PLO Office (TCP2),
- The PABX,
- The fire and gas panels (for general alarms).

Loudspeakers are distributed throughout the platform at strategic locations. 351 loudspeakers are positioned on TCP2.

The public address and general alarm system interfaces with the following platform systems:

- Fire and gas control panels,
- PABX,
- Flashing lights,
- Intercom system (via the QP alarm control panel in the CCR).

2.9.3 COMMUNICATION SYSTEMS (cont.)

Alarms
There are two types of alarms:

- Muster alarm: Consisting of a continuous tone,
- General platform alarm (GPA): consisting of an intermittent tone of one second duration, with a one second interval between each tone. A GPA will be interrupted (after approximately 8 seconds) by an announcement fiven over the public address system.

The system is capable of broadcasting simultaneously either of the alarms over any one of the three platforms, QP, TP1 and TCP2; ie., a GPA may be given on TCP2 while a muster alarm is being given on QP.

There is an automatic priority ranking of alarms on the platform. The priority of the signals in order of their importance is as follows:

- Priority 1: Muster alarm;
- Priority 2: GPA.

Flashing Lights
Associated with loudspeakers in noisy areas are flashing lights mounted in paris - blue for emergency speech announcements and yellow for alarms. These lights flash automatically during a public address announcement made from an EMP or while an alarm is sounding, to drew the attention of personnel in those areas.

Power Supplies for Communications

Telephone (PABX) System
The power for the TCP2 exchanges comes from a dedicated battery bank which is charged from the common 220V ac net. There is sufficient battery capacity to maintain the operation of the exchange for at least 24 hours after complete loss of ac supply.

Public Address
The 16.8kW of uninterruptible power required for the public address system is obtained from a 40kVA inverter providing 220V, 3ph, 50Hz through the QP emergency switchboard.

Alarms
Power for the alarm lights is derived from distribution board DB25 controlled from the PA rack, and it is distributed through a flashing light distribution board/relay cabinet.

Telemetry

Telemetry is used to transmit metering data for gas and condensate around the Frigg Field and onward to pipeline termini to facilitate pipeline management and product sales. The data passes through up to eight analogue and 16 digital channels from the telemetry master to coding equipment, through a line amplifier to the multiplex unit of the microwave radio link.

2.9.3 COMMUNICATIONS SYSTEMS (cont.)

Miscellaneous Communications

Lifeboat Communications
The only items of radio equipment associated solely with TCP2 are VHF transceivers and radio beacons in the four lifeboats. Refer to Section 2.11.6.

Hand-held Radios
Hand-held radios are used on the platform for the following purposes:

- Marine communications: a VHF radio, tuned to marine channels, is used to communicate between the platform and a surface vessel during such actions as loading/unloading operations.
- Firefighting team communications: a multi-channel UHF radio, tuned to a pre-determined channel, used exclusively for the firefighting team, is used to communicate between members of the firefighting team.
- General communications: a multi-channel UHF radio, tuned to a pre-determined channel, but not the channel reserved for the firefighting team, is used by operators, inspectors, maintenance personnel, etc. to communicate with a colleague during such operations as tests and the checking of actions remote from an initiating device.

Other Radio Communications
All other radio communications are conducted from QP.

2.9.4 NAVIGATION AIDS AND OBSTRUCTION LIGHTS

Reference Diagram: 2.9.4 Fig. 1 *(Safety Case reference Section 2.4.9.10 Fig. 1)*

General

The following navigation aids are installed on TCP2:

- Navigation lights,
- Foghorns,
- Obstruction lights.

The navigation lights and main foghorns on TCP2, TP1 and QP form two single inter-platform systems, each system is separately controlled from QP. The obstruction lights are a self-contained system.

All navigation lights on TCP2, TP1 and QP are synchronised to transmit the letter 'U' in Morse code every 15 seconds.

2.9.4 NAVIGATION AIDS AND OBSTRUCTION LIGHTS (cont.)

Navigation Lights

Main and Secondary White Lights
A set of white lights is installed on the south-east corner of the platform at Cellar Deck level. The set comprises two main and one secondary white light mounted vertically with the secondary light uppermost. Each light is enclosed in a marine lantern fitted with a single-piece fresnel lens.

The main lights are visible in clear weather over a range of 15 nautical miles and through 270°. The two have a combined nominal luminous intensity of 14000 candelas.

The secondary light is visible in clear weather over a range of 10 nautical miles and through 270°. The single secondary light has a nominal luminous intensity of 14000 candelas.
The secondary light lantern is equipped with a rotating lampholder containing four lamps. If a lamp fails, the next is automatically rotated into its place. An alarm will indicate in QP Control Room when the last lamp is used.

Subsidiary Red Lights
Subsidiary red lights are installed on the other three corners of the platform and at the centre of the inter-platform bridge to TP1.

Each light is visible in clear weather over a range of three nautical miles and through 270° (360° for the bridge light). The lights are enclosed in a marine lantern fitted with a single-piece fresnel lens and a red filter.

Each lantern is equipped with a rotating lampholder containing four lamps. If a lamp fails, the next is automatically rotated into its place. An alarm will indicate in QP Control Room when the last lamp is used.

Foghorns

Main and secondary foghorns are separately mounted and installed as a pair at the centre of the east face of the platform at Cellar Deck level.

The main foghorn is a vertical array of eight emitters producing a horizontal acoustic beam through 360° which sounds over a range of two nautical miles in still air.

The secondary foghorn comprises two emitters producing a horizontal acoustic beam through 360° which sounds over a range of half a nautical mile in still air.

Obstruction Lights

Red obstruction lights are installed on all cranes on the platform to warn aircraft of projections. The vertical distance between each light is nominally 10m.

Power Supplies

General
All navigation aids, except obstruction lights and secondary foghorns, receive their power supplies from QP.

2.9.4 NAVIGATION AIDS AND OBSTRUCTION LIGHTS (cont.)

Navigation Lights

The two main white navigation lights each contain one 120V, 500W lamp. The pair are connected in series and fed through a 220/240V auto-transformer in the base of the lantern from the HALS 15 control unit supplied from distribution board DB31 on QP.

The secondary white and subsidiary red navigation lights each contain a 12V lamp at 24W and 6.6W respectively. Power at 120V, 150Hz is fed through a 120/12V transformer in the base of each lantern from the ILS 750 control box supplied from the 24V,100Ah battery-supported navigation aids system on QP.

Foghorns
The main foghorns of TCP2, TP1 and QP operate in parallel at 120V, 250Hz. This supply is provided through control unit SCR 750 on QP and contains a transformer/rectifier and inverter, with the navigation aids 24V battery system floating across the dc link. The rectifier in this unit acts as a charger for the 24V, 1000Ah navigation aids battery. Power to the control unit is supplied from distribution board DB31 on QP.

The secondary foghorn is supplied independently and is dc operated and powered from local 12V, 30Ah transformer/rectifiers and batteries. It is fed from the local emergency distribution board. The batteries float across the transformer/rectifier outputs. A 'float' and 'boost' facility is provided. Float is the normal trickle charge condition and boost is used to recharge the battery. When the battery is fully charged it will revert automatically to float; indication being given at the charger panel.

Obstruction Lights
The obstruction lights are supplied at 220V ac from distribution board DB308 with no battery support.

2.9.5 EARTHING

Protective (Safety) Earthing

All electrical equipment with metal enclosure, to be earth by separate earth conductor or cable armouring depending of the clasifications of the enclosure, and connected to the earth bus bar in supply switchboard.

Non-electrical process equipment is also earthed through bonding straps to the platform deck. This is to prevent dangerous electrostatic charges building-up in vessels and pipework due to the movement of fluids inside them.

Instrument Earthing

General
Three earthing systems are used to provide protection to personnel and equipment, and to prevent mutual interference with data and signalling systems.

Instrument Protective Earth (IPE)
All instrument enclosures, equipment and armoured braiding of instrument cables are connected through systems of busbars in junction boxes and marshalling/equipment racks to the IPE.

2.9.5 EARTHING (cont.)

Instrument Earth (IE)
This is the reference point for all digital and analogue signals except those which are intrinsically safe (IS). All individual screens, and screens for data highway coxial cables, are connected through to the main IE busbar in a way similar to the armoured braiding of cables for the IPE.

Intrinsically Safe Earth (ISE)
This is the reference point for all intrinsically safe instruments, cables and Zener barrier busbars. The individual screens are earthed as for the normal analogue signal cables described above, and the local busbars are connected through to the main ISE busbar. The Zener barrier busbars are contained in the local marshalling/equipment racks, with the Zener barriers mounted directly onto them.

System Earthing

Apart from the safety earthing of equipment enclosures, the electrical conductor of both the high-voltage and the low-voltage networks are tied to earth in order to prevent the system voltages rising too high above earth under conditions of fault.

This done by connecting the neutral points of all transformer low-voltage secondary windings direct to the earth rail of their associated switchboards. The high-voltage system is similarly earthed by connecting the neutral points of each main generator windings to the earthrail of the 5.5kV switchboard, but in this case not direct but through a limiting resistor.

CONTENTS

2.10.1 GENERAL INTRODUCTION

Frigg Control and Data Acquisition System

Reference Diagram: FF-00-16-36-8649 - Block Diagram FCDA Topology.

The Frigg Control and Data Acquisition system (FCDA) constitutes the Frigg Field's instrumentation concept, which includes emergency shutdown (ESD), process shutdown (PSD), surveillance, control and data acquisition.

The FCDA comprises the Instrumented Safety System (ISS) and the Process Control and Monitoring System (PCMS).

The ISS and PCMS systems are based upon autonomous decentralized microprocessor based control systems which automatically perform process and utility plant operation control, safety control, data processing and surveillance.

The FCDA system is organized as follows:

FCDA		
ISS	PCMS	
Emergency Shutdown (ESD)	Process Shutdown (PSD)	Control & Monitoring
Bailey SCU	Bailey PCU	Bailey PCU
Shutdown Cabinets	Shutdown Cabinets	
Allen Bradley PLC	Allen Bradley PLC	
	Local Pneumatic Actions	Local Pneumatic Control

Shutdown System Structure

Reference Diagram: FF-85-16-06-1300 - Frigg Field Shutdown Logic Diagram, Overall View

The safety shutdown system structure is organized in three hierarchical levels, i.e.:

- Emergency shutdown level 1, ESD 1. (Field Shutdown).
- Emergency shutdown level 2, ESD 2.
- Process safety shutdown level 3, PSD 3.

Each of the levels ESD2 and PSD3 are subdivided to allow partial shutdown functions to be specified according to the installation, system or section.

2.10.1 GENERAL INTRODUCTION (cont.)

Definition of the Systems

ISS
The Instrumented Safety System (ISS) is a part of the Instrumentation Concept level 1 and provides the means to allow control of a risk within an acceptable safety level by early detection of a hazardous condition and initiation required to eliminate or reduce consequences of abnormal events.

The applications available within the ISS are related to the control and monitoring functions of the Safety Shutdown system level ESD 1 and ESD 2, e.g.:

- Emergency shutdown
- Fire and gas detection
- Manual push-buttons for shutdown activation
- Measurement of critical safety parameters
- Automatic fire protection activation
- Fire pumps
- Particular protection (leakage detection, OPPS etc.)
- Audible and visual alarms.

The shutdown system upper level functions ESD 1 and ESD 2, serve as the last line of defence in the event of hazardous conditions or major operating disturbances which have failed to be controlled by the Process Control and Monitoring System.

Process Safety System
The process safety is the lower level of the shutdown system (PSD3).

The Process Shutdown is an integral part of the PCMS system.

The process safety system is primarily related to the installation process streams and utility facilities.

PCMS
The Process Control and Monitoring System (PCMS) constitutes the major part of the Instrumentation Concept and includes field equipment, raw data acquisition, processing, monitoring and automation means, allowing execution of main functions, optimization and supervision of the installation.

Functionally the Process Control and Monitoring System comprises two distinct parts:

- Control and monitoring related to installation facilities start-up, normal operation and run-down activities, including process utilities, electrical etc.

- Control and monitoring related to the Process Safety Shutdown PSD 3. Dedicated functions will be established, corrective actions initiated and segregation made in order to reach an acceptable risk level.

2.10.1 GENERAL INTRODUCTION (cont.)

Purpose

Purpose	System	Main Function
Frigg Control and Data Acquisition (FCDA)	Process Control and Monitoring System (PCMS)	Automatic Operation - Control - Process Control - Process Shutdown PSD
	Instrumented Safety System (ISS)	Automatic Safety Control by - Emergency Shutdown (ESD) - Firefighting initiation
	Export Metering System	Metering stations - Data Processing

Implementation

The two systems ISS and PCMS are connected to the FCDA redundant INFINET which provides a duplicated communication path between the different control units on TCP2 and for inter-platform (QP, TP1 and TCP2) communication.

The ISS safety control units are in addition interconnected via redundant dedicated Remote I/O serial links to the ISS Matrix/Mimic located in QP Control Room which provides an alternative communication path.

Central Control Room,on QP, provides operator stations, matrix and mimic panels, for centralized control and surveillance of the platform control and safety system.

2.10.2 FRIGG CONTROL AND DATA ACQUISITION SYSTEM (FCDA)

ISS System

The ISS system is a vital element of the installation safety provisions. In general the ISS executes installation surveillance and control based upon detection of physical conditions normally not present, and operation only in case of abnormal events.

The Instrumented Safety System (ISS) is based upon a decentralized control concept. Data acquisition and control is performed by autonomous and independent Safety Control Units (SCUs).

The main functions of the ISS system are data acquisition, data processing and interfacing the different ESD systems, fire detection, gas detection and firefighting systems.

2.10.2 FRIGG CONTROL AND DATA ACQUISITION SYSTEM (FCDA) (cont.)

The ISS SCUs are connected to relevant field equipment directly or via shutdown cabinets, fire detection cabinets or gas detection cabinets, for measurement and control execution.

The ISS system collects data and processes the signals as follows:

a) Alarms presented on OIS (Operator Interface Station),
b) ESD status and alarms presented on OIS and ISS Matrix/Mimic,
c) Deluge and fire pump activation from OIS and ISS Matrix/Mimic,
d) Initiation of the different shutdown levels from the ISS Matrix,
e) Fire and gas detection status presented on OIS and ISS Mimic,
f) Firefighting equipment status presented on OIS and ISS Mimic.

The shutdown system is fully automatic in operation, but QP Control Room and various strategic locations on TCP2 provide manual control for specific levels of emergency shutdowns of the TCP2 platform.

Each SCU houses two internal sub-units, A and B, with common redundant network interfaces. On each SCU there is installed a maintenance keyswitch for enabling bypass of shutdown outputs for one path at a time which enable function tests of all outputs whilst the plant is live.

Shutdown Levels

The ESD system on TCP2 provides two main levels of equipment and system shutdowns.
These ESD levels, including subdivisions of ESD2, are as follows:

ESD 1	Field Shutdown without decompression	
ESD 2	- ESD 2.0 "T"	Emergency Shutdown (ESD) with decompression of the treatment areas
	- ESD 2.0 "C"	Emergency Shutdown (ESD) with decompression of the compression areas
	- ESD 2.1	Emergency Shutdown (ESD) without decompression of the treatment areas
	- ESD 2.2	Emergency Shutdown (ESD) without decompression of the compression areas
	- ESD 2.3	Emergency Shutdown (ESD) non essemtial users on compression areas

There is no automatic initiation of shutdown levels ESD 1, ESD 2.0"T" and ESD 2.0"C". These ESD levels can be manually initiated from the ISS Matrix located in QP Control Room, in addition ESD 2.0"T" can be initiated manually from Instrument Interface Room (Zone 05) and ESD 2.0"C" from Compression Control Room.

Shutdown level ESD 2.1 can be manually initiated from pushbuttons on the ISS Matrix in QP Control Room, TCP2 Treatment Interface Room and field mounted pneumatic pull handle valves, and automatically from ESD levels ESD 1, ESD 2.0"T" and TCP2 fire and gas detection.

Shutdown level ESD 2.2 can be manually initiated from pushbuttons on the ISS Matrix, Compression Control Room and field mounted pneumatic pull handle valves, and automatically from ESD levels ESD 1 and ESD 2.0"C".

2.10.2 FRIGG CONTROL AND DATA ACQUISITION SYSTEM (FCDA) (cont.)

Shutdown level ESD 2.3 can be manually initiated from pushbuttons in Compression Control Room and field mounted pneumatic pull handle valves, and automatically from ESD levels ESD 1, ESD 2.0"C", ESD2.1, ESD 2.2 and Fire and Gas Detection.

Communication

The ISS communication system is duplicated and interconnected to provide alternative communication paths. These are as follows:

- Via the FCDA redundant INFINET
- Via the ISS serial Remote I/O links to the ISS Matrix/Mimic located in QP Control Room.

The main components in the ISS system on TCP2 are:

System:	Bailey INFI 90
Communication Network:	FCDA Redundant INFINET and ISS Dual I/O Serial Links based on Bailey Remote I/O system
ISS Operator Interface:	Two OIS-44 stations located in QP Control Room, ISS Mimic/ Matrix located in QP Control Room.
Safety Control Units (SCUs):	TCP2T SCU A&B (Node 210&212) - Instrument Interface Room (Zone 05) M35 SCU (Node 220) - M35 Instrument Technical Room TCP2C SCU A&B (Node 230&232/3) - Compression Control Room (Zone 32)

Process Safety

In addition to the Emergency Shutdown level ESD1 and ESD2 controlled by the ISS system there is a lower level of shutdown PSD3 which is an integral part of the Process Control and Monitoring System PCMS.

Shutdown level PSD3 is subdivided to allow partial shutdown functions to be specified according to the installation, system or section.

PSD3 is related specifically to the various process streams and equipment.

Sensors are located within the respective streams/equipment to monitor and detect abnormal situations, such as high-high/low-low pressures/temperatures/levels etc. which can create dangerous situations.

Process shutdown PSD is initiated through local PCUs either directly or via the various shutdown cabinets.

PCMS System

The PCMS system is based on a decentralized control concept. Data acquisition and control is performed by autonomous and independent Process Control Units (PCUs).

The Process Control and Monitoring System (PCMS) is a microprocessor based distributed control system, connected to relevant field devices for measurement and control execution.

2.10.2 FRIGG CONTROL AND DATA ACQUISITION SYSTEM (FCDA) (cont.)

The PCMS system executes the control and surveillance of the installation facilities in accordance with normal operational requirements and equipment operating characteristics.

Certain equipments (main package units) are controlled by their individual control panel. In these cases the PCMS function is limited to data acquisition (status/alarms etc.) and to enable centralized control of commands (start/stop).

The typical applications to be available by the PCMS are related to all installation facilities, also including process safety functions being lower level (PSD3) of the Safety shutdown.

Signalization between all connected PCUs, Operator Stations and external interface devices are transmitted via the FCDA redundant INFINET. The communication function permits transfer of data and signals between each of the units connected on the link.

The main components in the PCMS system on TCP2 are:

System:
- Bailey INFI 90

Communication Network:
- FCDA redundant INFINET Loop 1
- FCDA redundant INFINET Loop 3
- Local Gateway (Node 40)
- TCP2 - TP1 - QP
- TCP2 M35 - Frøy WHP
- Loop 1 - Loop 3

Keep Interface:
Operator Interface is located in Central Control Room on QP

Process Control Units (PCUs):

TCP2T - PCU A (Node 20)	TCP2 Instrument Interface Room
TCP2T - PCU B (Node 21)	TCP2 Instrument Interface Room
TCP2T - PCU C (Node 22)	TCP2 Instrument Interface Room
TCP2T - ELEC PCU (Node 90)	TCP2T MCC Room
EAST FRIGG TIE-IN PCU (Node 03)	TCP2 M51 Interface Room
PCU 6 (Node 06)	TCP2C Compression Control Room
LILLE FRIGG PCU (Node 30)	TCP2C Compression Control Room
TCP2C - PCU A (Node 60)	TCP2C Compression Control Room
TCP2C - PCU B (Node 61)	TCP2C Compression Control Room
M35 - PCU A (Node 44)	TCP2 M35 Instrument Technical Room
M35 - PCU B (Node 45)	TCP2 M35 Instrument Technical Room
M35 - PCU C (Node 46)	TCP2 M35 Instrument Technical Room
M35 - ELEC PCU (Node 91)	TCP2 M35 Instrument Technical Room

Remote I/O Cabinet:

TCP2T - ELEC PCU RIO A1	TCP2T MCC Room
TCP2C - PCU RIO A1	TCP2C Electrical Switchgear Room
TCP2C - PCU RIO B1	TCP2C Electrical Switchgear Room

2.10.3 MANAGEMENT SUPERVISORY SYSTEM (SUPS)

The Management Supervisory System (SUPS) is not implemented on TCP2 platform.

2.10.4 SHUTDOWN SYSTEMS

Purpose

The purpose of the Emergency Shutdown System is to safely shut down the production and utility plants when the control systems have failed to control a process situation and initiate fire fighting actions when a fire or excessive gas concentration is detected.

Description

The shutdown system's higher levels ESD 1 and ESD 2 including subdivisions are integral parts of the ISS system and consist of Safety Control Units (SCUs) and local shutdown cabinets. Shutdown logic necessary to initiate corrective control and shutdown actions is stored in the ISS's SCUs and in the local shutdown cabinets.

The shutdown systems, ESD and PSD for Lille Frigg and Frøy Integration module/areas connect directly to the ISS system's SCUs (ESD 1 and ESD 2) and PCMS system's PCUs (PSD3) and do not have local shutdown cabinets.

Manual Initiation

Electrical push buttons and pneumatic pull handle valves are installed at strategic positions around the platform for manual initiation of specific levels of shutdown.

Shutdown actions are initiated via the shutdown logic and Instrumented Safety System (ISS).

Fire and Gas Detection

Fire and gas detectors located around the platform provide automatic action for specific levels of shutdown.

Upon fire or significant gas detection the following control actions can be initiated via the shutdown logic and ISS, dependant upon the area affected:

a) Start fire pump;
b) Electrical isolation;
c) Shutdown of HVAC, and closure of fire dampers;
d) Initiation of specific ESD level;
e) Fire extinguishant release.

2.10.4 SHUTDOWN SYSTEMS (cont.)

Process Shutdown

Should operating parameters reach a level which can cause subsequent danger to personnel and installation facilities the following control actions can be initiated either automatically or manually dependant upon the stored logic and area affected:

a) Process Isolation (ESDV),
b) Electrical Isolation,
c) Decompression (Blow down),
d) Shut off fuel gas systems.

Shutdown Cabinets

The Shutdown Cabinets are located and serving the different areas as follows:

Shutdown Cabinet No. 1 - Treatment Areas
Shutdown Cabinet No. 1 is located in Zone 05 - Instrument Interface Room. This cabinet is serving the treatment area. The shutdown logic is performed by relays.

Shutdown Cabinet No. 2 - Extension Areas M50
Shutdown Cabinet No. 2 is located in Zone 05 Instrument Interface Room. Signals from the extension area M50, are tied into this cabinet. The shutdown logic is performed by relays.

Cabinet 5B
ESD Cabinet 5B is located in Compression Control Room. This cabinet serves the compression areas. The shutdown logic is performed in an Allen Bradley PLC and associated relays.

Overpressure Protection System (OPPS)

In addition to the 3 levels of shutdown ESD 1, ESD 2 and PSD 3 detailed above, protection exists to protect the export header system, against possible pressure build up exceeding maximum allowable working pressure, called "OPPS" (Over Pressure Protection System).

Protection of the Sales Gas Export System
OPPS is graduated into three levels, where each level is triggered in turn by an eventual pressure build up, or by valve limit switches, to prevent a possible pressure build-up in the sales gas export headers, from TCP2 and TP1, to St. Fergus.

2.10.4 SHUTDOWN SYSTEMS (cont.)

These levels are as follows.

Initiation:

(i) Initial Barrier (precautionary process control action)
Initiated by sealine valve not fully open.

(ii) Primary Protection (process safety)
Initiated on pressure greater than 151 bar sensed in TCP2 export system (or TP1 if dry gas interconnection open).

(iii) Secondary Protection
Initiated on pressure greater than 154 bar sensed in export system of either platform (TCP2 or TP1).

Effects:

(i) Initial Barrier
Trip of closure of FCV's and ESDV's.

(ii) Primary Protection
As initial plus closure of Dry Gas Interconnection Line ESDV and Alwyn inlet if interconnection line open.

(iii) Secondary Protection
Closure of Alwyn inlet at TP1.

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CONTENTS (cont.)

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Area Classification - Upper Deck Intermediate Level	6696	FF 85 23 00 0293 000 002
Area Classification - Main Deck	6698	FF 85 23 00 0294 000 001
Area Classification - Main Deck Intermediate Level	6697	FF 85 23 00 0294 000 002
Area Classification - Cellar Deck	6699	FF 85 23 00 0295 000 001
Area Classification - South Elevation	6700	FF 85 23 00 0296 000 001
Area Classification - East Elevation	6701	FF 85 23 00 0296 000 002
Area Classification - North Elevation	15191	FF 85 23 00 0297 000 001
Area Classification - West Elevation	15192	FF 85 23 00 0297 000 002
Safety Plot Plan - Fire Detection - Cellar Deck	6184	FF 85 00 39 1025 000 002
Safety Plot Plan - Fire Detection - Cellar Deck - Intermediate Level	6185	FF 85 00 39 1025 000 003
Safety Plot Plan - Fire Detection - Main Deck	6186	FF 85 00 39 1025 000 004
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Safety Plot Plan – Communication Facilities - Cellar Deck	6191	FF 85 00 46 1011 000 002
Safety Plot Plan – Communication Facilities - Cellar Deck Intermediate Level	6192	FF 85 00 46 1011 000 003
Safety Plot Plan – Communication Facilities - Main Deck	6193	FF 85 00 46 1011 000 004
Safety Plot Plan – Communication Facilities - Main Deck Intermediate Level	6194	FF 85 00 46 1011 000 005
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2.11.11 Fig. 1 **HVAC - Module 35**
2.11.13 Fig. 1 **Pipeline (Incoming) Communication and Control**

2.11.1 AREA CLASSIFICATION

Reference Diagrams:

Diagram title	DocsOpen No.	Document No.
Area Classification - Upper Deck	6695	FF 85 23 00 0293 000 001
Area Classification - Upper Deck Intermediate Level	6696	FF 85 23 00 0293 000 002
Area Classification – Main Deck	6698	FF 85 23 00 0294 000 001
Area Classification – Main Deck Intermediate Level	6697	FF 85 23 00 0294 000 002
Area Classification - Cellar Deck	6699	FF 85 23 00 0295 000 001
Area Classification - South Elevation	6700	FF 85 23 00 0296 000 001
Area Classification - East Elevation	6701	FF 85 23 00 0296 000 002
Area Classification - North Elevation	15191	FF 85 23 00 0297 000 001
Area Classification – West Elevation	15192	FF 85 23 00 0297 000 002

Purpose

The platform is divided into areas (and zones) which are classified according to the risk of explosion arising from the presence of an explosive atmosphere.
Electrical installations, plant and equipment are designed, installed and maintained, taking into consideration the hazardous area classification, to present the minimum risk of fire and explosion.

Description

Platform areas have been evaluated for risk using the Institute of Petroleum Model Code of Safe Practice, Drilling and Production in Marine Areas (2nd Edition Part 8, 1972 Section 8) and the latest revision of the Institute of Petroleum Electrical Safety Codes as a basis.

East Frigg Tie-In Module M51 areas have been evaluated using Norwegian Petroleum Directorate Guidelines for area classification stipulated 01.11.83.

Lille Frigg Tie-in modules/areas have been classified according to IP Area Classification for Petroleum Installations Part 15 of 1990 and API RP 5008 - 1987.
Frøy Integration modules/areas have been classified according to IP Area Classification for Petroleum Installations Part 15 of 1990.

Danger of an explosion on an offshore installation is particularly prevalent due to the possibility of air mixing with combustible gases, vapours or flammable liquid droplets.

This type of area is called **area category (a)**, and is divided into zone 0, 1 or 2 dependent upon the probability of the presence of an explosive atmosphere, and the likely duration of the hazard.

Zone 0 - Areas in which an explosive atmosphere is present continuously or for long periods.

Zone 1 - Areas in which an explosive atmosphere is expected from time to time during normal operations.

Zone 2 - Areas in which an explosive atmosphere occurs only exceptionally and for short periods of time.

2.11.1 AREA CLASSIFICATION (cont.)

The hazardous area classification drawings have been developed from the various source of release points on the platform.

- A continuous source of release develops into a zone 0, 1 and 2 from the source.
- A primary source of release develops into a zone 1 and 2 from the source.
- A secondary source of release develops into a zone 2 from the source.

Chemical-physical parameters, process parameters and special parameters such as ventilation have been considered in developing the hazardous area boundaries.

Unclassified Areas

These are areas not included in the dangerous category and, on TCP2, are achieved as follows:

(a) Pressurizing an enclosed space with air taken from an unclassified area.
(b) Defining exterior areas which are considered to be an adequate distance from any possible gas or vapour escape, so that the gas or vapour will be dispersed before reaching this area.
(c) Force vented areas which have a high rate of ventilation, with air coming from an unclassified area.

Note: A pressurized or force vented area may be classified as zone 1 when loss of ventilation occurs.

2.11.2 HYDRAULIC SYSTEMS

Purpose

The hydraulic systems provide motive power, with a safe degree of reserve capacity for the operation of:
- Emergency shutdown valves (ESDVs),
- Blowdown valves (ESDVs and BDVs),
- Hand operated isolation valves (HVs),

General Description

There are four (4) different hydraulic systems on the TCP2 platform; the four systems are as follows:
- Treatment (including TCP2 Extension, East Frigg Module 51 and Lille Frigg topside),
- Compression (including Frøy Module M35),Frøy module is passivated.
- East Frigg hydraulic is passivated
- Lille Frigg surface hydraulic power unit, for subsea equipment. (passivated)

The East Frigg wellhead and Lille Frigg surface hydraulic power unit, for subsea equipment are independent of the other two systems, whilst there is an interconnection to supply hydraulic fluid from compression to the treatment system.

For a detailed description of each hydraulic system refer to Section 2.8.1.

2.11.3 FIRE AND GAS DETECTION

Introduction

The platform is divided into areas (safety zones), each area being provided with fire and gas detectors appropriate to the fire and/or gas hazard which it contains.

The gas detection systems are provided to monitor and detect the presence of flammable gases and vapour concentrations, the fire detection systems are provided to detect smoke, heat or flames.

Safety Zones

For the purpose of fire protection the platform is divided into safety zones defined as follows:

- Areas provided with detection and individual or common protection systems,
- Spaces enclosed by fire-rated walls,
- Equipment packages,
- Rooms and other spaces that have been subdivided for ease of identification.

Safety zones are in no way related to "ex-classified" areas, which are graded according to the predicted concentration of gas under normal and abnormal conditions.

Each safety zone is allocated a two-digit reference number:

- **Treatment Area**

Safety Zone	Location	Deck
01	Module 01	Main Deck and Upper Deck
02	Module 02	Main Deck and Upper Deck
03	Module 03	Main Deck and Upper Deck
04	Module 04	Main Deck and Upper Deck
05	Pancake 08, 11, 12, 13 & 14	Cellar Deck
06	Pancake 09	Cellar Deck
07	Inside Column 3	Cellar Deck
09	Central area	Cellar Deck
10	Pancake 07, Column 01	Cellar Deck
11	Pancake 05 & 06	Cellar Deck
12	Pancake 53 & Column 05	Cellar Deck
13	Module 50 (Extension)	Main Deck, Upper Deck & mezz. levels
14	Module 51 (East Frigg)	Main Deck, Upper Deck & mezz. levels
15	Module 52	Main Deck, Upper Deck & mezz. levels

2.11.3 FIRE AND GAS DETECTION (cont.)

- **Treatment Area (cont.)**

Safety Zone	Location	Deck
35B	M35	Main, Mezzanine and Intermediate Deck
35C	M35	Weather Deck, Laydown and Metering Platform
35D	M35	Electrical HV Room - Main Deck
35E	M35	Electrical LV Room - Mezzanine Deck
35F	M35	Electrical Emerg. LV Room - Mezzanine Deck
35G	M35	Instrument Technical Room - Mezzanine Deck
35H	M35	HVAC Container and Air Inlets - Upper Deck

- **Compression Area**

Safety Zone	Location	Deck
30	Module 30	Main Deck and Upper Deck
31	Module 31	Main Deck and Upper Deck
32	Module 32	Main Deck and Upper Deck
33	Module 33	Main Deck and Upper Deck
40	Pancake 40	Cellar Deck
41	Pancake 41	Cellar Deck
42	Pancake 42	Cellar Deck
43	Pancakes 43 and 48	Cellar Deck
44	Pancake 44	Cellar Deck
45	Pancake 45	Cellar Deck
46	Pancake 46	Cellar Deck
63	Column 3	Cellar Deck

Identification of Fire and Gas Detectors

Reference Diagrams:

Diagram Title	DocsOpen No	Document No.
Safety Plot Plan - Fire Detection - Cellar Deck	6184	FF 85 00 39 1025 000 002
Safety Plot Plan - Fire Detection - Cellar Deck – Intermediate Level	6185	FF 85 00 39 1025 000 003
Safety Plot Plan - Fire Detection - Main Deck	6186	FF 85 00 39 1025 000 004
Safety Plot Plan - Fire Detection - Main Deck - Intermediate Level	6187	FF 85 00 39 1025 000 005
Safety Plot Plan - Fire Detection - Upper Deck	6188	FF 85 00 39 1025 000 006
Safety Plot Plan - Fire Detection - Weather Deck	6189	FF 85 00 39 1025 000 007
Safety Plot Plan - Gas Detection - Cellar Deck	6177	FF 85 00 39 1024 000 002
Safety Plot Plan - Gas Detection - Cellar Deck – Intermediate Level	6178	FF 85 00 39 1024 000 003
Safety Plot Plan - Gas Detection - Main Deck	6179	FF 85 00 39 1024 000 004
Safety Plot Plan - Gas Detection - Main Deck - Intermediate Level	6180	FF 85 00 39 1024 000 005
Safety Plot Plan - Gas Detection - Upper Deck	6181	FF 85 00 39 1024 000 006
Safety Plot Plan - Gas Detection - Upper Deck – Intermediate Level	6182	FF 85 00 39 1024 000 007

2.11.3 FIRE AND GAS DETECTION (cont.)

Fire and gas detectors are identified by a tag number constructed as shown in the following examples:
Treatment area: 04-GM-1A

04	**-GM**	**-1A**
Safety zone	detector type	detector number

Where: SD = Smoke Detector
HD = Heat Detector
UV = Ultraviolet Detector
IR = Infrared Detector
GM = Gas Detector Monitor

Fire alarm buttons/switches are similarly identified by the prefix FAB.

Compression area: 63 AUV31-4

64	**-AUV**	**-31**	**-4**
System	detector type	safety zone	detector number

Where: AES = Smoke Detector
AEF = Heat Detector
AUV = Ultraviolet Detector
AEG = Gas Detector Monitor

Fire alarm buttons are similarly identified by the prefix FAB.

General Description

The fire and gas detection system is based upon a decentralized system. Detection is performed by field mounted detectors tied into local fire detection and gas detection panels situated in technical rooms.

Fire detection systems are located in and serve the following areas:

Panel	Location	Make/type	Area
TCP2T SCUB	Instrument Interface Room Zone 05	Autronica BS100	Treatment areas
TCP2T SCUB	Instrument Interface Room Zone 05	Autronica BS100	Treatment, Extension areas & Fire Pump Rooms CP6A/B

2.11.3 FIRE AND GAS DETECTION (cont.)

Fire detection systems are located in and serve the following areas: (cont.)

Panel	Location	Make/type	Area
TCP2T SCUB	Instrument Interface Room Zone 05	Autronica / BS100	Lille Frigg Tie-in area M52
M35 SCU	M35 Instrument Technical Room	Autronica/ BS 100/2 DYFI	Module 35 and Flare
Cabinet 6A	Compr. Contr. Room	Telesystemer	Compression general areas
Panel 9	Compr. Contr. Room	Telesystemer	Gas Compressor A -Module 30
Panel 11	Compr. Contr. Room	Telesystemer	Gas Compressor B -Module 33
Panel 13	Compr. Contr. Room	Telesystemer	Gas Compressor C -Module 31
TCP2C SCUB	Compr. Contr. Room	Autronica/ BS100	Stal Laval Generators A&B
TCP2C SCUB	Compr. Contr. Room	Autronica/ BS100	Lille Frigg Tie-in area Zone 43 Zone 42&46&30&63&C3
East Frigg Fire Detection Panel	M51 Instrument Interface Room	Afa Minerva / T872	East Frigg Tie-in area -Module 51 Zone 14
TCP2T SCUB	Instrument Interface Room, Zone 05	Autronica/ BS 100	Operator Office and Toilet Module

Gas detection systems are located in and serve the following areas:

Panel	Location	Make/type	Area
Gas Detection Panel	Instrument Interface Room Zone 05	Sieger / 1402	Treatment areas
Gas Detection Extension Panel	Instrument Interface Room Zone 05	Sieger / 1402	Treatment areas
Extension Area Gas Detection Panel	Instrument Interface Room Zone 05	Sieger / FS1A	Extension Module 50
TCP2T SCU	Instrument Interface Room Zone 05	Sieger / 7700	Lille Frigg Tie-in area M52
TCP2T SCUB		Bailey SCU slaves	Treatment areas
M35 SCU	M35 Instrument Technical Room	Bailey SCU slaves	Module 35 and Flare
Panel 6B	Compr. Contr. Room	Sieger / FS16	Compression general areas
Panel 9 Passivated	Compr. Contr. Room	Sieger / FS16	Gas Compressor A -Module 30
Panel 11 Passivated	Compr. Contr. Room	Sieger / FS16	Gas Compressor B -Module 33
Panel 13 Passivated	Compr. Contr. Room	Sieger / FS16	Gas Compressor C -Module 31
Cabinet 37	Compr. Contr. Room	Sieger / FS16	Stal Laval Generators A&B
TCP2C SCUA	Compr. Contr. Room	Sieger / 7700	Lille Frigg Tie-in area Zone 43+C3
East Frigg Gas Detection Panel	M51 Instrument Interface Room	Sieger / FS16	East Frigg Tie-in area -Module 51 Zone 14
TCP2C SCUB	Comp. Contr. Room	Bailey SCU slaves	Zone 30 (new f. pump) + Col. 3

Fire and gas detectors are located at strategic positions around the platform, quantities and locations being appropriate to the fire and/or gas hazard which the particular area is subjected.

2.11.3 FIRE AND GAS DETECTION (cont.)

If an abnormal gas concentration or an outbreak of fire is detected, one or more of the following actions may be initiated through the fire and gas logic:

- General Platform Alarm (PA alarm),
- Alarm in QP Control Room, OIS and ISS Mimic/Matrix panel,
- Shutdown level ESD 2.1 and ESD 2.3 (including process shutdown),
- Release of extinguishant (Halon, CO_2, foam),
- Release of deluge,
- Fire pump start,
- Specific electrical isolation,
- Specific shutdown of HVAC, including closure of relevant fire dampers.

Activation of any of the fire alarm buttons (FABs) located around the platform will initiate the following actions:

- General Platform Alarm (PA alarm),
- Alarm in QP Control Room, OIS and ISS Mimic/Matrix panel,
- Fire pump start,
- Shutdown level ESD 2.1 or ESD 2.3 or both.

Field Equipment

The following different types of detectors are used dependent upon the area being protected:

- Heat Detectors,
- Smoke Detectors,
- Infrared (IR) Detectors,
- Ultraviolet (UV) Detectors,
- Fusible Plugs,
- Gas Detectors.

Note: Areas may contain a combination of two or more detector types.

Heat Detectors

Heat detectors are used where, in the event of a fire, a rapid rate of temperature rise is expected, such as small rooms containing diesel engines.

Heat detectors are also used where smoke detectors are unsuitable, for the following reasons:

(i) Outside area with excessive air currents,
(ii) Excessive dirt, dust, vapour or gas,
(iii) High humidity,
(iv) Smoke normally present (eg local to exhaust outlets etc).

2.11.3 FIRE AND GAS DETECTION (cont.)

- Treatment Area
  Heat detectors are installed in instrument and electrical workshop and stores (Module 04), fire pump rooms CP6A & CP6B (Cellar Deck) and Column 01 (top utility shaft, control/engine/ ventilation rooms). Addressable Autronica BE 30/EX.

  Operator Office and Toilet Module (Treatment, Cellar Deck). Type of heat detector used is an addressable Autronica BE 30/EX.

- Compression Area
  Heat detectors are installed in gas compressor filter houses and rooms (Main Deck lower level, Modules 30, 31 & 33) and emergency generator rooms on Cellar Deck. Types of heat detectors used are Fenwal. In generator hoods and firepumps Z42, 46, 30 are used addressable Autronica BE 30/EX.

- East Frigg - Module 51 (M51)
  Heat detectors are installed in the HVAC equipment room and the electrical and instrument interface room. Types of heat detectors used are Fenwal.

- Lille Frigg Tie-in Area (M52 and PC48)
  A heat detector is installed at the fuel gas compressor (PC48 Cellar Deck).

  Type of heat detector used is an addressable Autronica BE 30/EX.

- Frøy Tie-in Areas
  A heat detector is installed in crane CM7 engine room. The detector gives an alarm when reaching 56ºC. The heat detector used is an addressable Autronica type BE-30/EX.

Smoke Detectors

Smoke detectors are installed in clean environmental areas where the emission is probably smoke from smouldering rather than flame content fires.

Smoke detectors of the ionization type are installed in areas containing combustible materials which will produce smoke if ignited.

- Treatment Area
  Optical smoke detectors are installed in technical rooms in Zone 5 and Col. 1. The smoke detectors used are addressable Autronica Type BH-31/EX.

  Operator Office and Toilet Module (Treatment, Cellar Deck). Optical smoke detectors are installed in the office and toilet area. The smoke detectors used are addressable Autronica Type BH-31/EX..

- Compression Area
  Smoke detectors are installed throughout the Cellar Deck, and Modules 30, 31, 32 & 33. The smoke detectors used are Cerebus F6A Ex. A smoke detector is installed in new firepump Power Pack Zone 30 m.d. The smoke detector used is an addressable Autronica Type BH-31/AEX.

2.11.3 FIRE AND GAS DETECTION (cont.)

- East Frigg - Module 51 (M51)
  Smoke detectors are installed in the battery room, HVAC equipment room and the electrical and instrument interface room. The smoke detectors used are AFA Minerva type F35C.

- Frøy Tie-in Areas
  Optical smoke detectors are installed inside the technical room in module M35, the HVAC container and in the M35 crane. The smoke detectors used are Autronica BH-31/EX BH-31/S/EX.

Infrared (IR) Flame Detectors

Infrared (IR) detectors are installed in areas in which combustible materials are expected to burn with a flame.

- Treatment Area
  IR detectors are installed throughout the Main Deck, upper deck, lower level, and Cellar Deck. The infrared (IR) flame detectors used are Dectronics type U7698E .

- Lille Frigg Tie-in Area (M52 and PC48)
  Infrared (IR) detectors are installed throughout the area. The IR detectors used are Detronics type 76988.

- Frøy Tie-in Areas
  Infrared (IR) flame detectors are installed throughout module M35, around the flare knockout drum CV616, in column No. 3, around ESDV CM601.01 & ESDV CM602.01 and the area above column No.3. The IR detectors used are Detronics type U7698E.

- Compression area
  Infrared (IR) flame detectors are installed in Z30 (new firepump) Z63-COL3 Zone 42 + 43. The IR detectors used are Type U7698E.

Ultraviolet (UV) Flame Detectors

UV detectors are used to detect flames in process areas where smoke emission may be light.

- Treatment Area
  One ultraviolet flame detector is installed. The ultraviolet (UV) flame detectors used are Detronics type U7600 Z13 main deck for methanol fire.

- Compression Area
  Ultraviolet detectors are installed in Pancake 40 on Cellar Deck and throughout Modules 30, 31, 32 & 33. The ultraviolet (UV) flame detectors used are Detronics type U7600.

- East Frigg - Module 51 (M51)
  UV detectors are installed in all process areas in Module 51. They are connected in series and there is one loop per deck. The ultraviolet (UV) flame detectors used are Detronics type U7600.

2.11.3 FIRE AND GAS DETECTION (cont.)

Fusible Plugs

Fusible plugs are used where a robust device which will respond to a local heat source is required. Fusible plugs are installed in pneumatic control lines. The fusible plugs will collapse when heated and depressurize the control line, subsequently closing or shutting down equipment appropriately.

Pneumatic fusible plug loops are installed around the following emergency shutdown valves (ESDVs):
- ESDV CM2.1
- ESDV CM3.1
- ESDV CM201.1 (Passivated)
- ESDV CM210.1 (Passivated)
- ESDV CM310.1 (Passivated)

These pneumatic fusible plug loops are only tied into the respective ESDV's local hydraulic control panel. If one of the fusible plugs bursts, the control line will depressurize and the respective ESDV will close.

These system are not tied into the fire detection system.

M35 deluge system is equipped with fusible plug loops tied into the pneumatic control lines for the deluge valves. The fusible plugs will collapse when heated and depressurize the control line, initiating the release of deluge.

Fire Alarm Buttons (FAB)

Manual fire alarm buttons are strategically installed throughout the platform.

Gas Detectors

Gas detectors of the heated filament type are used to monitor and detect the presence of gas vapour concentrations.

They are installed throughout the platform process areas and all ventilation air intakes.

Each sensor head transmits an electrical signal, proportional to the detected level of gas, to its associated control unit. The signal will allow a reading of gas concentration to be made.

- Treatment Area
  The gas sensors used in the Treatment Area are Sieger Model 770 & 910 and general monitors SC110.

- Treatment - Extension Areas - Module 50 (M50)
  The gas sensors used in the Extension area are Sieger Model 926.

- Compression Area
  The gas sensors used in the Compression Area are Sieger Model 910. General monitors SC110 and Sieger Search Point.

2.11.3 FIRE AND GAS DETECTION (cont.)

- East Frigg Module (M51)
  The gas sensors used in East Frigg Module 51 are Sieger Model 910.

- Lille Frigg Tie-in Area
  The gas sensors used are Sieger Model 910. The infrared gas sensors are type Search Line.

- Frøy Tie-in Areas
  General Monitors combustible gas sensors, type SC110 and Sieger infrared searchline 500 and Sieger Search Point Infrared gas detectors are installed in the Frøy Tie-in Areas.

Fire Detection Signal Transmission

Treatment Area - Extension (M50), Fire Pump Rooms CP6A/B, Operator Office and Toilet Module (25)
Addressable smoke detectors, heat detectors and FAB's interface, via zener barriers, with an Autronica Fire Detection unit installed in the TCP2T-SCUB Termination Cabinet. Data from the BSL 100 Fire Alarm Control Panel is transmitted via a dual serial link to the SCU.

Infrared flame detectors provide 4-20 MA signals and are hardwired and interfaced directly via junction boxes and multicore cables to slave modules in TCP2T-SCUB.

Compression Area (System 63)

Fire detection sensors and fire alarm buttons for the compression area transmit signals via field cables through local junction boxes and multicore cables to a 19 inch rack mounted Telesystemer fire detection unit located inside fire detection cabinet 6A. Fire detection cabinet 6A is located inside the compression control room.

For more detailed information see the following Loop diagrams package:
FF-87-16-00-1046 (469 shts.)
Sensors and FAB's for Zones 30, 42, 46, 63 and Col. 3 are interfaced as above for treatment areas but with TCP2C-SCUB in KCCR.

Stal Laval Generators 52G01A and 52G01B Cellar Deck

Manual fire alarm buttons and sensors used to monitor the two Stal Laval turbine generators 52G01A and 52G01B's air intakes, ventilation air duct generator hood and gas fuel unit, transmit signals via field cables through local junction boxes and multicore cables to a BS 100 Autronica fire detection unit. Installed in TCP2C SCUB.

For more detailed information see the following diagrams:
FF-87-23-20-0003, Sheets 392 to 396 - Generator A
FF-87-23-20-0004, Sheets 392 to 396 - Generator B

2.11.3 FIRE AND GAS DETECTION (cont.)

East Frigg Module 51 (M51)

Fire detectors and FABs in East Frigg Module 51 transmit signals via field cables, local junction boxes and multicore cables into East Frigg fire detection panel containing an AFA Minerva Type T872 controller. The East Frigg fire detection panel is located inside M51 instrument interface room.

For more detailed information see the following diagram:
FF-85-16-00-9997

Lille Frigg Tie-in Area

Addressable heat detectors and FABs in M52 (Zone 15) interface, via zener barriers, an Autronica BS 100 fire detection unit installed in the TCP2T-SCUB termination cabinet.

Addressable detectors, heat detectors and FABs in Pancake 48 (Zone 43) interface, via zener barriers, with an Autronica BS 100 fire detection unit installed in the TCP2C-SCUB termination cabinet.

The interface is accomplished by two routed field loops.

Two serial links are utilized for dual communication between each of the Autronica BS 100 fire detection units and their respective SCU.

IR (infrared) flame detectors in M52 interface with a Sieger type 7700 unit installed in the TCP2T-SCU termination cabinet and infrared detectors in Pancake 48 interface with a Sieger type 7700 unit installed in the TCP2C-SCU termination cabinet.

For more detailed information see the following diagram:
FF-85-16-00-2001, Section 40

Frøy Tie-in Areas

Addressable smoke detectors and manual call points (FABs) are, via nine segregated field loops, interfaced to an Autronica BS 100/2 DYFI alarm control unit. The fire alarm control panel scans all detector loops in parallel. Data from the BSL 100 fire alarm control panel is transmitted via a dual serial link to the M35 SCU.

Infrared flame detectors provide 4 to 20mA signals and are hardwired and interfaced directly via junction boxes and multicore cables to the Bailey SCU slaves.

For more detailed information see the following diagram:
FF-85-16-00-2001, Section 40

2.11.3 FIRE AND GAS DETECTION (cont.)

Gas Detection Signal Transmission

Treatment Areas

The gas sensors in the treatment area transmit signals via field cables, local junction boxes and multicore cables to the gas detection panels containing Sieger type 1402 control units.

There are two gas detection panels serving the treatment area, the main panel consisting of three free-standing panels, the second a wall mounted extension panel. Both panels are located inside the instrument interface room, Zone 05 on Cellar Deck.

The General Monitors gas detectors are connected to a transmitter which provides a 4 to 20mA output signal. The sensing element may be incorporated in the transmitter housing or remotely mounted. The output signals are interfaced directly via junction boxes and multicore cables to the Bailey SCU slaves.

Sieger infrared search line type 500 gas and search points detectors provide a 4 to 20mA continuous or stepped output signal. The output signals are interfaced directly via junction boxes and multicore cables to the Bailey SCU slaves.

For more detailed information see the following diagram:
FF-85-16-00-2001, Section 30
FF 85-16-00-9996.

Treatment - Extension Areas (M50)

Gas sensors in the treatment extension areas (Module 50 and Cellar Deck Pancake 53) transmit electric signals via field cables, local junction boxes and multicore cables to the extension gas detection panel containing Sieger type FS1A gas control units. The extension gas detection panel is a free-standing cabinet located inside the instrument interface room on Cellar Deck level.

For more detailed information see the following diagram:
FF-85-16-06-8826

Compression Area (System 63)

The gas detection system for the compression area transmits signals via field cables through local junction boxes and multicore cables to a 19 inch rack mounted Sieger Type FS16 gas alarm control unit located inside gas detection cabinet 6B in the compression control room.

The General Monitors gas detectors are connected to a transmitter which provides a 4 to 20mA output signal. The sensing element may be incorporated in the transmitter housing or remotely mounted. The output signals are interfaced directly via junction boxes and multicore cables to the Bailey SCU slaves.

2.11.3 FIRE AND GAS DETECTION (cont.)

Sieger infrared searchline type 500 gas and search points detectors provide a 4 to 20mA continuous or stepped output signal. The output signals are interfaced directly via junction boxes and multicore cables to the Bailey SCU slaves.

For more detailed information see the following diagram:
FF-85-16-00-2001, Section 30
FF-87-16-00-1046

Stal Laval Turbine Generators 52G01 A/B (System 52)

Gas detectors used to monitor the air intakes, ventilation air duct, generator hood and fuel gas unit of the two Stal Laval generators 52G01A and 52G01B (Pancake 41 Cellar Deck), transmit electric signals via field cables, local junction boxes and multicore cables to 19 inch rack mounted Sieger type FS16 gas alarm control units - one rack for each of the Stal Laval turbine generators. The gas control units are installed as an integral part of cabinet 37 located inside the compression control room.

For more detailed information see the following diagrams:
FF 87-23-20-0003, Sheets 377 to 391 - Generator A
FF-87-23-20-0004, Sheets 377 to 391 - Generator B

East Frigg Module 51 (M51)

Gas sensors in the East Frigg areas (Module 51) transmit electric signals via field cables, local junction boxes and multicore cables to a free-standing gas detection panel containing Sieger type FS16 gas alarm control units. The East Frigg gas detection panel is located inside the instrument interface room in Module 51.

For more detailed information see the following diagrams:
FF-89-16-06-8302 (31 shts.)

Lille Frigg Tie-in Area

Gas detectors in M52 interface, via zener barriers, with a Sieger type 7700 unit installed in the TCP2T-SCU termination cabinet.

Gas detectors in Pancake 48 interface, via zener barriers, with a Sieger type 7700 unit installed in the TCP2C-SCU termination cabinet.

The interface is accomplished by two routed field loops connected to Sieger Highway control cards.

Two serial links are utilized for dual communication between each of the Sieger type 7700 units and their respective SCU.

For more detailed information see the following diagram:
FF-85-16-00-2001, Section 30 (208 shts.)

2.11.3 FIRE AND GAS DETECTION (cont.)

Frøy Tie-in Areas

The General Monitors gas detectors are connected to a transmitter which provides a 4 to 20mA output signal. The sensing element may be incorporated in the transmitter housing or remotely mounted. The output signals are interfaced directly via junction boxes and multicore cables to the Bailey SCU slaves.

Sieger infrared searchline type 500 gas and search points detectors provide a 4 to 20mA continuous or stepped output signal. The output signals are interfaced directly via junction boxes and multicore cables to the Bailey SCU slaves.

For more detailed information see the following diagram:
FF-85-16-00-2001, Section 30 (208 shts.)

Fire Detection Logic

General

The fire detection system is fully automatic in operation with facilities to monitor the platform and initiate corrective firefighting and shutdown actions when a fire is detected.

The logic is performed as follows:

East Frigg (M51) and Compression Area (Telesystemer)

Fire detection control logic is performed by relay logic within the respective fire detection cabinet.

The Instrument Safety System's (ISS) applications are interfaces to the different fire detection systems, data acquisition and exchange of ISS signals from the fire detection cabinets to the central control room on QP.

The actions that each detector can initiate are determined by the logic of the respective fire detection panel and subsequent logic contained within the platform emergency shutdown system.

Treatment, Operator Office and Toilet Module (Zone 5), Extension M50, Compression (Autronica).

The fire detection system for the office and toilet module is installed as an integral part of the ISS system. Programmed logic is performed within the microprocessor based Safety Control Unit (SCU).

The actions the detectors can initiate are determined by the logic stored in the SCU.

The logic for the fire alarm buttons (FABs), smoke detectors and the heat detector are organized in two single loops.

Lille Frigg and Frøy Tie-in Areas
The fire detection system for Lille Frigg Tie-in is implemented as an integral part of the ISS system. Programmed logic is performed within the Safety Control Units (SCUs) which are microprocessor based control units.

2.11.3 FIRE AND GAS DETECTION (cont.)

The actions that each detector can initiate are determined by the logic stored in the SCUs.

The logic for the various areas is organized as follows:

The fire detectors are organized in groups. Each group can contain several detectors and combinations of different types of detectors (heat, smoke, UV or IR detectors).

Fire alarm buttons (FABs) are organized in single loops. Each loop can contain several FABs.

Treatment, Extension M50 and East Frigg M51 Areas

- 1st Level (Single Loop Detection)
  Detection by a single detector will initiate:
  (a) Indication of the fire location on ISS mimic and OIS (Operator Interface Station) in QP control room;
  (b) Indication at the fire control unit (local). M51 Minerva Panel or TCP2T SCUB Autronica Panel.

- Fire Detection 2nd Level (two loops activated simultaneously within the same group/fire zone)
  Will initiate the following alarms and control actions:

  (a) Alarm and indication of the fire location on the ISS mimic and OIS located in QP control room;
  (b) General platform alarm;
  (c) Indication at the fire control unit (local);
  (d) Fire pump start on TCP2, TP1 and QP (process area detectors);
  (e) Shutdown level ESD 2.1;
  (f) Shutdown level ESD 2.3 (only initiated by UV detectors in Zone 11 and IR and smoke detectors around sales gas manifolds Zone 01, 02 and 03 Main Deck);
  (g) Specific electric shutdown;
  (h) Release of Halon where appropriate;
  (i) Release of fire water deluge where appropriate.

- FABs Treatment, extension M50 and East Frigg M51 Areas
  Activation of FABs will result in initiation of the following alarms and control actions:

  (a) Alarm indicated on the ISS mimic and OIS located in the central control room on QP;
  (b) General platform alarm;
  (c) Fire pump start;
  (d) Shutdown level ESD 2.3.
  (e) Shutdown level ESD 2.1

  For more detailed information refer to the following matrix diagrams:
  FF-85-16-00-9997

Treatment, Operator Office and Toilet Module (Zone 5)

- Fire Detection
  Detection by a single detector or activation of a FAB will initiate the following alarms:

2.11.3 FIRE AND GAS DETECTION (cont.)

(a) Common FAB or fire detected alarm indicated on OIS in QP central control room;
(b) Common zone alarm indicated on ISS mimic in QP central control room.

- Fire Detection Shutdown Actions
  Common fire detection will in addition initiate the following alarms and control actions:

(a) Shutdown level ESD 2.1;
(b) General platform alarm;
(c) Fire pump start;
(d) Shutdown of heater battery, DB325, close firedampers.

The office and toilet module is provided with a sprinkler system. The system is equipped with a pressure switch for sprinkler activation and monitoring on the OIS and ISS matrix in QP central control room.

Compression General Areas (System 64)

- 1st Level (Single Loop Detection)
  Detection by a single detector loop will initiate:

(a) Alarm and indication of the fire's location is indicated on the ISS mimic and OIS located in the central control room on QP.
(b) Alarm and indication in compression control room; Telesystemer.
(c) Indication at the fire control unit; Telesystemer.

- Fire Detection 2nd Level (two loops activated simultaneously within the same fire zone) and Fire Alarm Buttons (FABs) will initiate the following alarms and control actions:

(a) Alarm and indication of the fire's location is indicated on the ISS mimic and OIS located in the central control room on QP;
(b) Alarm and indication in compression control room; Telesystemer.
(c) General platform alarm;
(d) Indication at the fire control unit; Telesystemer or Autronica Panel in SCU.
(e) Fire pump start (process area detectors and FABs);
(f) Specific electric shutdown;
(g) Release of Halon where appropriate;
(h) Release of fire water deluge where appropriate;
(i) Initiation of shutdown level ESD 2.3 and ESD 2.1 - Field (process area) mounted detectors and FABs;
(j) Initiation of Group "T" shutdown (compression isolation) - Field (process area) mounted detectors and FABs.

Compression - Stal Laval Turbo-generators (System 52)

- Fire Detection 1st Level (Single Loop) and Fire Alarm Buttons
  Detection by a detector loop or activation of a fire alarm button (FAB) will initiate the following alarms and control actions:

2.11.3 FIRE AND GAS DETECTION (cont.)

(a) Alarm and indication of the fire's location is indicated on the ISS mimic and OIS in the QP central control room;
(b) Indication at the fire control unit (local); Autronica Panel in SCU.
(c) Alarm in Stal Laval control room (Zone 41);
(d) Alarm in compression control room;
(e) Fire pump start on TCP2;
(f) Ventilation system: shutdown of the respective ventilation fans and dampers;
(g) Release of CO_2 (delayed) - turbine hood and fuel gas unit (fire detectors);
(h) Delayed release of CO_2 - turbine hood and fuel gas unit (FABs);
(i) Trip respective turbine generator.

Lille Frigg Tie-in

- Fire Detection 1st Level (heat detectors)
  Detection by a single detector will initiate the following alarms:

  (a) Individual alarm indicated on OIS in QP central control room;
  (b) Common zone alarm indicated on ISS mimic in QP central control room.

- Fire Detection 2nd Level
  Detection by two detectors will in addition initiate the following alarms and control actions:

  (a) Shutdown level ESD 2.1 and ESD 2.3:
  (b) General platform alarm;
  (c) Fire pump start:
  (d) Shutdown signal to Lille Frigg subsea;
  (e) Release of deluge.

- Fire Detection 1st Level (IR detectors)
  Detection by a single detector will initiate the following alarms:

  Instantaneous
  (a) Individual alarm (red) indicated on OIS in QP central control room;
  (b) Common zone alarm indicated on ISS mimic in QP central control room.

  Delayed (5 to 30 sec.)
  (a) Alarm (orange) indicated on OIS in QP central control room;
  (b) Shutdown level ESD 2.1 and ESD 2.3;
  (c) General platform alarm;
  (d) Fire pump start;
  (e) Shutdown signal to Lille Frigg subsea;
  (f) Release of deluge.

2.11.3 FIRE AND GAS DETECTION (cont.)

- Activation of Fire Alarm Buttons will initiate:

  (a) Individual alarm (red) indicated on OIS in QP central control room;
  (b) Common zone alarm indicated on ISS mimic in QP central control room;
  (c) General platform alarm;
  (d) Fire pump start;
  (e) Shutdown signal to Lille Frigg subsea.

Frøy Tie-in Areas

- IR Flame Detectors
  Detection by a single IR flame detector will initiate the following:

  (a) Individual alarm on the OIS, audible and visual,
  (b) Common zone alarm presented on the ISS Mimic panel,
  (c) ESD 2.1 & ESD 2.3,
  (d) General platform alarm,
  (e) Release of deluge and fire monitors,
  (f) Fire pump start,
  (g) Isolate electrical supply

- Optical Smoke Detectors
  Detection by any one of *n* detectors will initiate the following actions:

  (a) Individual alarm on the OIS, audible and visual,
  (b) Common zone alarm presented on the ISS mimic panel.

  Detection by 2 of *n* detectors will in addition initiate the following:

  (a) ESD 2.1 & ESD 2.3,
  (b) General platform alarm,
  (c) Fire pump start,
  (d) Close fire dampers,
  (e) Isolate electrical supply.

- Fire Alarm Buttons
  Activation of fire alarm buttons will initiate:

  (a) Individual alarm on the OIS, audible and visual,
  (b) Common zone alarm presented on the ISS mimic panel,
  (c) ESD 2.1,
  (d) General platform alarm,
  (e) Fire pump start,
  (f) Close fire dampers,
  (g) Isolate electrical supply.

2.11.3 FIRE AND GAS DETECTION (cont.)

Gas Detection Logic

General

The gas detection system is automatic in operation with facilities to monitor the platform and to initiate corrective firefighting and shutdown actions if excessive gas concentration are detected.

The logic is organized according to a matrix prepared for each protected area. The logic for the various areas is performed as follows:

Treatment Area, Extension (M50), East Frigg (M51) and Compression Area

Gas detection control logic is performed by relay logic within the respective gas detection cabinet.

The Instrument Safety System's (ISS) applications are interfaces to the different gas detection systems, data acquisition and exchange of ISS signals from the fire and gas detection cabinets to the central control room on QP.

The actions that each detector can initiate are determined by the logic of the respective fire detection panel and subsequent logic contained within the platform emergency shutdown system. In addition some detectors are implemented as integral part of ISS and logic is performed by SCUS.

Lille Frigg and Frøy Tie-in Areas

The gas detection systems for the Lille Frigg and Frøy Tie-in Areas are implemented as an integral part of the ISS system. The logic is performed within the Safety Control Units (SCUs) which are microprocessor based control units.

The actions that each detector can initiate are determined by the logic stored in the SCUs.

Values of Set Range

Each control unit contains two adjustable alarm set points. The set points are adjustable in the 0 to 100% range of the lower explosion limit (LEL) of gas/air mixture. Control and/or alarm execution is carried out dependent upon detection of the two levels (1st and 2nd levels) and coincident detection.

- 1st Level
  The gas control unit's 1st level is in general adjusted to a level of 15% LEL.

- 2nd Level
  The gas control unit's 2nd level is in general adjusted to a level of 50% LEL.

2.11.3 FIRE AND GAS DETECTION (cont.)

Treatment, Extension M50 and East Frigg M51 Areas

- Single Point Detection
  Detection of gas by a single detector loop will initiate the following action:

  Lower value of the set range - 1st Level
  Detection of gas at the lower value of the set range (20% LEL) will result in the following:

  (a) General platform alarm;
  (b) Alarm on ISS mimic and OIS in QP central control room. (The alarm indicates which level and which zone the initiating detector is located);
  (c) Indication at the gas detection control units (local).

  Higher value of the set range - 2nd Level
  Detection of gas at the higher value of the set range (50% LEL) will result in the following (dependent upon which area is affected):

  (a) Common 2nd. level gas alarm on ISS mimic and OIS in QP central control room;
  (b) Indication at the gas detection control units (local);
  (c) Specific electric shutdown.

- Gas Detectors Configured for Coincidence Operation
  The gas detection logic is, in the majority of cases, organized in groups of two gas detectors. If both detectors in the same group detect a 2nd level, coincidence, the following actions may be initiated (dependent upon which area is affected):

  (a) Fire pump start (process area detectors);
  (b) Indication at the gas detection control units (local);
  (c) Shutdown level ESD 2.1 (directly) and ESD 2.3 (delayed);
  (d) Specific electric shutdown;
  (e) Gas detection in the area around glycol regeneration units CQ1 A/B/C release deluge system XVP6-5.

  For more specific details of the gas detection logic refer to the following matrix diagrams:
  FF 85-16-06-1185 Sheets 105 to 120.

Compression General Areas (System 63)

- Single Point Detection

  Detection of gas by a single detector loop will initiate the following action:

  Lower value of the set range - 1st Level
  Detection of gas at the lower value of the set range (15% LEL) will result in the following:

2.11.3 FIRE AND GAS DETECTION (cont.)

(a) Alarm on ISS mimic and OIS in QP central control room. (The alarm indicates which level and which zone the initiating detector is located);
(b) Alarm in compression control room;
(c) General platform alarm;
(d) Indication at the gas detection control units (local).

Higher value of the set range - 2nd Level
Detection of gas at the higher value of the set range (50% LEL) will result in the following (dependent upon which area is affected):

(a) Common 2nd. level gas alarm on ISS mimic and OIS in QP central control room.
(b) Alarm in compression control room;
(c) Indication at the gas detection control units (local);
(d) Specific electric shutdown.

- Gas Detectors Configured for Coincidence Operation
  The gas detection logic is organized in groups. The logic is arranged in a 2 of 2, 2 of 3 or 2 of 4 voting system. If two detectors in the same group detect a 2nd level, coincidence, the following actions may be initiated (dependent upon which area is affected):

  (a) Fire pump start (process area detectors);
  (b) Indication at the gas detection control units (local);
  (c) Shutdown level ESD 2.3 (directly) and ESD 2.1 (delayed);
  (d) Specific electric shutdown.

Compression - Stal Laval Turbo-generators (System 52)

- Single Point Detection
  Detection of gas by a single detector loop will initiate the following action:

  Lower value of the set range - 1st Level (System 52)
  Detection of gas at the lower value of the set range (15% LEL) will result in the following:

  (a) Alarm on ISS mimic and OIS in QP central control room. (The alarm indicates which level and which zone the initiating detector is located);
  (b) General platform alarm;
  (c) Alarm in compression control room;
  (d) Alarm in Stal Laval control room (Zone 41);
  (e) Indication at the gas detection control units (local).

  Higher value of the set range - 2nd Level
  Detection of gas at the higher value of the set range (50% LEL) will result in the following (dependent upon which area is affected):

2.11.3 FIRE AND GAS DETECTION (cont.)

(a) Common 2nd level gas alarm indicated on ISS mimic and OIS in QP central control room;
(b) Indication at the gas detection control units (local);
(c) Specific electric shutdown.

- Gas Detectors Configured for Coincidence Operation
  The gas detection logic is organized in groups of two gas detectors. If both detectors in the same group detect a 2nd level, coincidence, the following actions will be initiated:

(a) Fire pump start;
(b) Indication at the gas detection control units (local);
(c) Specific electric shutdown;
(d) Trip turbine generators;
(e) Close fuel valves.

Lille Frigg Tie-in Area

- Single Point Detection - 1st Level
  Detection of gas by a single detector within one zone will initiate the following:

(a) Individual 15% LEL alarm indicated on OIS in central control room on QP;
(b) Common zone alarm indicated on ISS mimic in central control room on QP;
(c) Specific electrical shutdown;
(d) General platform alarm.

- Single Point Detection - 2nd Level

(a) Individual 50% LEL alarm indicated on OIS in central control room on QP;
(b) Common 2nd level gas alarm indicated on ISS mimic in central control room on QP;
(c) Specific electrical shutdown:
(d) General platform alarm.

- Coincident detection (by two detectors out of *n* within one zone) 2nd Level
  Will in addition initiate:
  (a) Alarm indicated on OIS in central control room on QP;
  (b) Fire pump start;
  (c) Shutdown level ESD 2.1 and 2.3;
  (d) Shutdown signal to Lille Frigg subsea PCU specific electrical shutdown.

Frøy Tie-in Area

- Single Point Detection - 1st. Level
  Detection of gas by a single detector will initiate the following:
  (a) Individual alarm on the OIS, audible and visual,
  (b) Common zone alarm presented on the ISS mimic panel,
  (c) General platform alarm.

2.11.3 FIRE AND GAS DETECTION (cont.)

- Coincident Detection - 1st. Level
  Detection of gas by 2 of *n* detectors within one zone will in addition initiate the following:

  (a) Closure of fire dampers,
  (b) Isolation of HVAC fans,
  (c) Specific electrical isolation.

- Coincident Detection - 2nd. Level

  (a) ESD 2.1 & ESD 2.3,
  (b) Common 2nd level gas presented on the ISS mimic panel.

See also the following ESD logic diagrams:

FF-85-16-00-9996
FF-85-16-00-9997
FF-22-00-00-1057, Sheet 1

Fire Detection Inhibits

In order to avoid unwanted shutdowns and/or alarms when personnel are performing maintenance tasks, i.e. welding, manual inhibit switches are installed to override outputs from the fire control units.

Fire Detection Cabinet - Treatment Areas, Extension M50
Individual sensor by-pass at the OIS (Operator Interface Station) in Central Control Room on QP.

Fire Detection Panel - East Frigg Module 51
Individual isolation switches are provided on each control unit. An additional overall inhibit keyswitch is also installed.

Fire Detection Panel - Compression Area - Panel 6B
Individual isolation switches are provided on each control unit. An additional overall inhibit keyswitch is also installed. Sensors connected to Autronica System have individual sensor by-pass at the OIS on QP.

Fire Detection Panel - Stal Laval Turbo-generators
Individual sensor by-pass at the OIS (operator interface station) on QP.

Lille Frigg and Frøy Tie-in Areas
Individual sensor by-pass at the OIS (Operator Interface Station) in central control room on QP.

2.11.3 FIRE AND GAS DETECTION (cont.)

Gas Detection Inhibits

In order to avoid unwanted shutdowns and/or alarms when personnel are performing maintenance tasks, manual inhibit switches are installed to override outputs from the gas control units.

Gas Detection Cabinet - Treatment Areas

All control units can individually be overridden by individual inhibit switches. When the inhibit switch is activated all output signals from that particular control unit are overridden. The only indication that remains is a lamp at the gas detection control unit which will indicate if there is an alarm present. In addition an overall inhibit switch is installed + individual sensor bypass at OIS for new gas sensors.

Extension Gas Detection Cabinet - Extension M50 Area

All control units can individually be overridden by individual inhibit switches. When the inhibit switch is activated all output signals from that particular control unit are overridden.

The only remaining indication is a lamp at the gas detection control unit which will indicate if there is an alarm present. Indication lamps highlight which unit is inhibited.

In addition to these individual inhibit switches an overall inhibit switch S31 is installed. When this switch is activated, shutdown actions and fire pump start signals are inhibited, but all alarms remain in service.

Gas Detection Cabinet (Sieger FS16) - East Frigg M51

All control units can individually be overridden by individual inhibit switches. When the inhibit switch is activated all output signals from that particular control unit are overridden except a common 2nd level alarm and fault indication which are initiated from the meter module.

The only remaining alarm is a lamp at the gas detection control unit which will indicate if there is an alarm present.

In addition to these individual inhibit switches an overall inhibit switch is installed. When this switch is activated, shutdown actions and fire pump start signals are inhibited, but all alarms remain in service.

Cabinet 6B (Sieger FS16) - Compression Area

All control units can individually be overridden by individual inhibit switches. When the inhibit switch is activated all output signals from that particular control unit are overridden except a common 2nd level alarm and fault indication (these two alarms have to be separately inhibited at the meter module) which are initiated from the meter module.

The only remaining indication is a lamp at the gas detection control unit which will indicate if there is an alarm present.

2.11.3 FIRE AND GAS DETECTION (cont.)

Gas Detection Cabinets 9, 11 & 13 (Sieger FS16) - Gas Pipeline Compressors 11K01 A/B/C (passivated)

All control units can individually be overridden by individual inhibit switches. When the inhibit switch is activated all output signals from that particular control unit are overridden except a common 2nd level alarm and fault indication (these two alarms have to be separately inhibited at the meter module) which are initiated from the meter module.
The only remaining indication is a lamp at the gas detection control unit which will indicate if there is an alarm or not.

Gas Detection Cabinet 37 (Sieger FS16) - Stal Laval Turbo-generators 52G01 A/B

All control units can individually be overridden by individual inhibit switches. When the inhibit switch is activated all output signals from that particular control unit are overridden except a common 2nd level alarm and fault indication (these two alarms have to be separately inhibited at the meter module) which are initiated from the meter module.

The only remaining indication is a lamp at the gas detection control unit, which will indicate if there is an alarm present.

Lille Frigg and Frøy Tie-in Areas

Individual sensors bypass at the OIS (Operator Interface Station) in central control room on QP.

2.11.4 FIREFIGHTING SYSTEMS

Reference Diagrams:

Diagram Title	DocsOpen No	Document No.
Safety Plot Plan – Fire Fighting Facilities - Cellar Deck	6114	FF 85 00 39 1010 000 002
Safety Plot Plan – Fire Fighting Facilities - Cellar Deck Intermediate Level	6115	FF 85 00 39 1010 000 003
Safety Plot Plan – Fire Fighting Facilities - Main Deck	6116	FF 85 00 39 1010 000 004
Safety Plot Plan – Fire Fighting Facilities - Main Deck Intermediate Level	6117	FF 85 00 39 1010 000 005
Safety Plot Plan – Fire Fighting Facilities - Upper Deck	6118	FF 85 00 39 1010 000 006
Safety Plot Plan – Fire Fighting Facilities - Upper Deck Intermediate Level	6119	FF 85 00 39 1010 000 007

Introduction

The firefighting systems provide protection for personnel, materials and equipment throughout the platform.

General Description

Firefighting Systems

The platform is provided with automatic and manual firefighting facilities in accordance with NPD Regulations for Production Platforms 1980.

Fire fighting systems are provided for protection against particular types of fire which may be expected in any area. There are two basic systems:

- Wet systems, using water or foam (deluge and monitors);
- Dry systems, using Halon, FM200, CO_2 or dry powder.

Wet systems are supplied from the fire water ring main located at Cellar Deck level. Pressure is maintained at a minimum value by a jockey pump. Operation of any part of the fire water system will cause a reduction in ring main pressure and the firewater pumps to provide sea water to the network. **For details of the firewater pumps and fire ring main refer to Section 2.8.2 Part D. The firewater system may be supplemented with water from the washdown system; refer to Section 2.8.2 Part E.**

Foam is provided from mobile units which can be connected to any firewater monitor.
Halon total flood protection is provided for areas/rooms containing a high proportion of electronic/electrical equipment.

Each platform area is provided with one or more of the following:

- Automatic Extinguishing Systems
  (a) Deluge systems;
  (b) Halon systems/FM200;
  (c) CO_2 systems.

- Manual Extinguishing Systems
  (a) Foam/water hosereels;
  (b) Water hosereels;
  (c) Fire monitors;
  (d) Portable fire extinguishers.

In addition to the above-mentioned manual extinguishing equipment, there is a capacity for the manual release of deluge, Halon/FM200 or CO_2 via pushbuttons located in the vicinity of the respective equipment and, in some cases, at strategic exit points from the area concerned.

Fireman's Outfits and Associated Equipment

One fireman's station is provided on the platform. It contains firefighting equipment for the protection of firefighters/rescue teams, and to enable them to effect forced entry.

- Fireman's Station
  - Zone 5 CD (Kongsberg room)

  Fireman's station is equipped as follows:

  Fireman's outfit (12 off)
  Self-contained breathing apparatus (12 off)
  Safety belt harness (2 off)
  Safety line (2 off)
  Signal code plates (2 off)
  Small axe (2 off)

Safety lamp (5 off)
Crowbar (2 off)
Door breaker (2 off)
Sledge hammer
Asbestos blanket (2 off)
Large axe
Electric drill complete with:
- spare 5/8in bit
- 25m extension cable
Hacksaw with spare blades
Loudhailer
Spare key and "O" ring for breathing apparatus
First aid kit

Main Characteristics

Types of Release Systems	
Deluge	- water only
Monitors	- water only - foam/water
Fire water hosereels and hydrant cabinets	
Foam units, mobile (trolley mounted)	
Halon 1301/FM200	
Carbon dioxide	

Portable and mobile (trolley mounted) extinguishers	
Dry powder	- 12kg, portable - 50kg, mobile (trolley mounted)
Carbon Dioxide	- 6kg, portable - 10kg, portable
Water	- 10 litre, portable

Fire Water Supply

The fire water supply network consists of several ring mains routed strategically around the platform at Cellar Deck and Main Deck levels.

Each of the ring mains is utilized to serve a specific area as follows:

Treatment area:
Cellar Deck
Main Deck - Modules 01, 02, 03 and 04
Extension Module 50 (M50)
Lille Frigg Tie-in Module 52

East Frigg M51:	Main Deck - Module 51
Compression area:	Cellar Deck
	Main Deck - Modules 30, 31, 32, 33 and 35
	Lille Frigg Tie-in Cellar Deck PC48

Each of these ring mains is interconnected such that they can be supplied by the five fire water pumps, CP6 A/B and 68P01 A/B and CP11 (new pump with power unit in Zone 30 MD and pump in C3).

It is also possible to distribute fire water to/from QP and TP1 from the TCP2 ring mains through interconnection lines across the bridges QP - TP1 - TCP2.

Automatic Extinguishing Systems

Deluge

- General
  Deluge systems are installed around the platform for protection of personnel and materials.

  Upon initiation of the deluge system, the area protected will be completely covered by a high density spray directed through nozzles strategically located around the respective area/vessel.

- Description
  Dry pipe deluge systems are provided in specific areas. Each system comprises a deluge valve with trim/control equipment, pipework and discharge nozzles.

  Firewater for the deluge systems is supplied from the ring main network through deluge control valves. Operation of a valve will allow water to flow through the system and be discharged simultaneously through all the system nozzles. This will ensure that the area protected will be completely covered by a high density spray.

  The deluge valve is a pneumatic diaphragm-operated, mechanically latched, clack valve. The diaphragm is normally pressurized so that loss of air pressure, or electrical power to a 3-way solenoid valve, will initiate release of the deluge.

  To avoid unwanted release of deluge and maintain operability and control in the event of loss of instrument air, a volume tank and a check valve are installed in each of the deluge systems.

- Automatic Release of Deluge Systems
  Automatic release of the various deluge systems is initiated from coincident operation of the fire detectors within the respective area.

  The stored logic for the function is contained within the respective area fire detection cabinet and the ISS's SCUs. Power to a 3-way solenoid-operated valve, located at the deluge control station, is disconnected thus de-energizing the valve and subsequently depressurizing the control line for the deluge valve.

In addition, certain process area deluge systems are automatically operated upon coincidental gas detection at a level of 60% LEL within a particular area.

For details of the logic required to automatically release a deluge system refer to the respective fire and gas detection matrix diagrams.

- Manual Release of Deluge
  The deluge system may also be manually operated by activation of the locally mounted, pneumatic 3-way valve located adjacent to the deluge valve, or field-sited adjacent to the area being protected.

  Manual release of the different deluge systems can also be initiated remotely by operation of push buttons located on the ISS matrix panel located in the QP central control room.

- Deluge Released Alarm
  Operation of a deluge system will activate a pressure switch PSH which in turn will initiate a deluge released alarm in the central control room on QP.

- Areas Protected by Deluge
  Deluge/water spray systems are installed throughout the platform for protection of equipment and areas as follows:

Treatment Area (Including Extension M50, East Frigg M51 and Lille Frigg Tie-in M52)

Deluge System	Deck	Safety Zone	Areas/Equipment Protected
XV CP6-5	Upper Deck	03 & 04	Glycol regeneration units CQ1 A/B/C
XV CP6-6	Main Deck	03 & 04	General area (Module 03 north-west, Module 04 west) and Vessels CV14 A, C14B, CV17A, CV17C
XV CP6-7	Main Deck	01	General area (Module 01 west) and condensate surge vessel CV3
XV CP6-8	Upper Deck	01	General area (Module 01 east) and pig launcher CM3
XV CP6-9	Cellar Deck	10 & 11	General area (Pancake 06 and 07), Pipe Support Frame 02, Vessels CV33,CV5, CV4A/B,CV6, CP2A/A
XV CP6-10	Cellar Deck	10 & 11	General area (Pancake 05), part of Pipe Support Frame 01, Pipe Support Frame 02, pig receiver CM2 and Hot DEG Pumps CP535 A/B
XV CP6-11	Main Deck Upper Deck	02 & 03 02 & 03	General area (Module 02 west and 03 south-west), FWKO separators CV1 B/C glycol contactors CV2 A/C.
XV CP6-12	Upper Deck	02 & 03	General area (Module 02 & 03 south pipe racks)
XV CP6-14	Main Deck	01, 02, 03 & 04	General area, sales gas headers and manifolds
XV CP6-18	Cellar Deck	09	Central area, pipe track, methanol storage tank CV23 and methanolated water storage tank CV9
XV CP6-19	Cellar Deck	06	General area (Pancake 09), LP Vent Scrubber CV7, diesel storage tank CV10 and Plenty Unit
XV CP6-20 A/B	Main Deck	13	General area (Module 50), Lille Frigg gas scrubber CV211 and Lille Frigg slug catcher CV210.

Treatment Area (Including Extension M50, East Frigg M51 and Lille Frigg Tie-in M52) (cont.)

Deluge System	Deck	Safety Zone	Areas/Equipment Protected
XV CP6-21 A/B	Upper Deck	13	General area (Module 50) and Odin pig receiver CM201.
XV CP6-22 A/B XV CP6.41 XV CP6.43	Cellar Deck	12	General area (Pancake 53), LP relief scrubber CV226. Lille Frigg Tie-in inlet valve. ESDV CM501.01.
XV CP6-22 C	Cellar Deck	12, 43 & 45	Water curtain gas lift ESDV CO501.01, CP609 A/B
XV CP6-23 A/B	Main Deck	14	General area M51 Main & Intermediate Deck, choke and manifold area, EF methanol tank CV350 A/B, EF slug catcher CV310 and EF gas scrubber CV311.
XV CP6-24 A/B	Upper Deck	14	General area M51, EF condensate heater CE311, EF cond. meth. separator CV313, EF meth. water flash drum CV320, EF meth. water flash tank CV360 and EF gas scrubber CV311.
XV CP6.31 XV CP6.33	Cellar Deck & mezz. level	43	General area Pancake 48, General area Pancake 48 mezz. Level, Stab. Crude separator, DV503, Fuel gas compressor K504/5
XV CP6.36 XV CP6.38	Upper Deck	15	High pressure gas lift compressor K506
XV CP6.52 XV CP6.53	Main Deck & mezz. level	15	General area Module 52 General area Module 52 mezz. level Condensate Glycol Separator CV502

EF = East Frigg

Compression Area (Including Frøy M35)

Deluge System	Deck	Safety Zone	Areas/Equipment Protected
68 X 06.1	Main Deck	30	General Area outside compressor hall
68 X 06.2	Main Deck	31	General Area outside compressor hall
68 X 06.3	Main Deck	33	General Area outside compressor hall and LP Vent scrubber 67B01
68 X 06.4	Upper Deck	30	General area
68 X 06.5	Upper Deck	31	General area

2.11.4 FIREFIGHTING SYSTEMS (cont.)

Compression Area (cont.)

Deluge System	Deck	Safety Zone	Areas/Equipment Protected
68 X 06.6	Upper Deck	33	General area
68 X 06.7	Weather Deck	32	Hydraulic package 56 X 01, Fuel gas heater 50 X 07A/B, Fuel gas package 50 X 0A and Fuel gas package 50 X 01B.
68 X 06.8	Main Deck	33	Compressor Room "B"
68 X 06.9	Main Deck	31	Compressor Room "C"
68 X 06.10	Main Deck	30	Compressor Room "A"
68 X 06.11 68 X 06.12	Cellar Deck Cellar Deck	63 63	Column 3, ESDV CM 502.1 ESDV CM3.1 and ESDV CM2.1
68 X 06.13 68 X 06.14	Cellar Deck	42	General Area Pancake 42 and hydraulic power package
68 X06.15 68 X06.16	Main Deck & Mezz. Deck	35B	General area and equipment
68 X06.17 68 X06.18	Intermediate Deck	35B	General area and equipment
68 X06.19* 68 X06.20*	Weather Deck	35C	CV628 and CV629 Frøy Oil Separators (passivated vessels)
68 X06.21 68 X06.22	Metering/ Weather Deck	35C	CV626 and dedicated gas equipment (passivated vessels)
68 X06.25 68 X06.26		44	Flare Knock Out Drum CV616 (passivated vessels)

* Deluge systems equipped with foam liquid unit.

Carbon Dioxide (CO_2) Systems

- General
  Independent carbon dioxide systems are installed to combat fires in platform areas containing electrical equipment.
- Description
  Carbon dioxide is suitable for liquid, fuel and electrical equipment fires, particularly when damage may be caused by water or powder. Once dispersed it gives no protection against re-ignition. Since CO_2 displaces oxygen, there is a risk of asphyxiation if used in a confined space.

  The gas is stored in rechargeable containers in racks close to the protected area.

  Carbon dioxide is distributed within each protected area by a pipework system, fitted with discharge nozzles specially designed to suit the particular application, and strategically located to flood the entire area.

  The operation of the system is either manual or automatic and is initiated by one of the following:

2.11.4 FIREFIGHTING SYSTEMS (cont.)

- Manual Release of Carbon Dioxide Systems

  CO_2 Systems - Stal Laval Turbine Generators 52GG01A/B

  CO_2 can be released manually by operation of a pull handle valve on a nitrogen pilot cylinder located inside a local emergency manual release cabinet. The nitrogen pressure will operate a pneumatic cylinder which will open the valve on the bottle and release CO_2.

  CO_2 System - Crane CM7

  Electrical release buttons are located at each entrance/exit to the protected area and will when operated, initiate CO_2 release, by operation of the solenoid valve, via the ISS system.

  Mechanical manual release of CO_2 is effected by removing a safety pin on the nitrogen pilot cylinder and pushing a release valve lever, the action will operate all CO_2 cylinders.

- Automatic Release of Carbon Dioxide Systems

  Automatic release of carbon dioxide systems is initiated by operation of heat detectors or by a combination of heat and smoke detectors within the affected area. CO_2 is released by operation of a solenoid valve, via logic within the respective fire detection cabinet and/or ISS system.

- CO_2 Pre-release Alarm

  On either automatic or manual operation of a system a local alarm horn will sound prior to release of carbon dioxide. For the two Stal Laval turbine hoods a red flashing light is also activated. The pre-set logic time delay is 17 seconds and allows for evacuation of personnel.

- Areas Protected by Carbon Dioxide

  Five separate carbon dioxide systems are installed on the platform for protection of equipment/areas as follows:

CO_2	Deck	Safety Zone	Room/Area Protected	No of Cylinders
68 X14A	Cellar Deck	41	Turbine hood and fuel gas unit. Stal Laval Turbine Generator - 52GG01A	2 (90Kg)
68 X14B	Cellar Deck	41	Turbine hood and fuel gas unit. Stal Laval Turbine Generator - 52GG01B	2 (90Kg)
XV CM7	Weather Deck	35C Frøy Module	Crane CM7 Engine Room (Molde Crane)	2 + 2 (45Kg)
	Upper Deck	04 33	LP Vent CSP 24 Cold Vent 68x02	13+13(1170 kg) 6+6 (540 kg)

Halon Systems

- General

  Independent Halon systems are installed to combat fires in the areas presenting a special fire hazard or containing electrical equipment.

2.11.4 FIREFIGHTING SYSTEMS (cont.)

Halon Replacement
In accordance with the Norwegian State Pollution Control Authority's (SFT - Statens Forurensingstilsyn) request to cease the use of Halon offshore, the following dates are applicable:

1. From 01.01.1993 it is forbidden to use Halon in all new fire extinguishing systems and portable extinguishers.

2. From 01.01.1995 it is forbidden to refill a fixed extinguishing system with Halon.

3. All fixed Halon systems must be removed before 01.01.2000

Elf has initiated a halon replacement programme to comply with the above milestones. See FOP no 9 for details.

- Description
  Halon 1301 (BTM) is a colourless, odourless, electrically non-conductive gas that extinguishes or prevents ignition by inhibiting the chemical reaction of fuel and oxygen. It is designed to conform with National Fire Protection Association (NFPA) Standard 12A, using a 5 per cent minimum concentration at 20°C, and is the least toxic of the vapour fire extinguishing agents.

  Halon 1301 is normally very safe. However, when a system is activated, the affected area should be vacated as soon as possible. Under extreme conditions the Halon can break down to form and acidic compound.

  The gas is stored in rechargeable containers mounted in racks close to the protected area.

  Halon is distributed within each protected area by a pipework system, fitted with discharge nozzles specially designed to suit the particular application, and strategically located to flood the entire area.

  Operation of a system is automatic or manual and is initiated by one of the following:

- Automatic Release of Halon/FM200 Systems

  Automatic release of each Halon/FM200 system is by operation of the fire detection sensors (smoke detectors) within the area, via logic within the respective fire detection cabinet. The smoke detectors, which are coincidence-interlocked, will operate the Halon/FM200 system for their associated area only.

  Upon automatic release, circuitry within the fire detection system will automatically initiate associated alarm indication, fire pump start and appropriate emergency shutdown action.

- Manual release of Halon/FM200 Systems
  Manual release of each Halon/FM200 system is by operation of a release lever situated at the entrance to the protected area.

- Audible Warning Prior to Release of Halon/FM200

2.11.4 FIREFIGHTING SYSTEMS (cont.)

Immediately after either automatic or manual initiation of Halon/FM200 a warning horn will sound and after a pre-set time delay of between 5 to 30 seconds, the Halon/FM200 will be released. The pre-warning and time delay allows for safe evacuation of personnel within the Halon/FM200 protected area.

- Visual Indication - Halon Status Lights
  Visual indication is provided on Halon control panels at the entrance to a Halon/FM200 protected area showing the system state as follows:
  (a) An illuminated red lamp indicates Halon being released.
  (b) An illuminated amber lamp indicates system in automatic.
  (c) An illuminated green lamp indicates system in manual.

  A key switch located in the Halon/FM200 control panel provides local control of the operating mode, automatic or manual.
- Areas Protected by Halon/FM200
  Halon/FM200 systems are installed throughout the platform for protection of equipment/areas as follows:

Treatment Area (Including Extension M50 and East Frigg M51)

Halon/ FM200 Unit	Deck/Module	Safety Zone	Room Protected	Weight of Halon/ FM200 (kg)	Number of Containers
XC-H4-1	Cellar Deck	05	Emergency and Supply Room	30	1
XC-H5-1	Cellar Deck	05	MCC Room	150	3
XC-H6-1	Cellar Deck	05	Cabling Room	150	3
XC-H7-1	Cellar Deck/ 1st floor	05	Interface Room	250	5
XC-H8-1	Cellar Deck	05	Air Cond Room	200	4
XC-H9-1	Cellar Deck	05	Transformer Room	51	1
XC-H10-1	Cellar Deck	05	Battery Room	50	1
XC-H11-1	Cellar Deck	05	HV Switchgear Room	150	3
FM200	Column 1	10	Control Room	150	2
FM200	Column 1	10	Ventilation Room	150	2
XC-HCP6A-1 FM200	Cellar Deck	09	Fire Pump Room CP6A	166	2
XC-HCP6B-1 FM200	Cellar Deck	10	Fire Pump Room CP6B	100	2
XC-H21-1	Cellar Deck	05	Air Compressor Room	600	12
XC-H22-1 FM200	Main Deck Mezzanine	14	Instr. Interface Room Module 51	50	1

2.11.4 FIREFIGHTING SYSTEMS (cont.)

Treatment Area (Including Extension M50 and East Frigg M51 cont.)

Halon/ FM200 Unit	Deck/Module	Safety Zone	Room Protected	Weight of Halon/ FM200 (kg)	Number of Containers
XC-H23-1 FM200	Main Deck	14	Electrical Interface Room Module 51	50	1
XC-H24-1	Main Deck	14	Battery Room M51	12.5	1
XC-H25-1	Upper Deck	14	HVAC Room M51	47.5	1

Compression Area

Halon/ FM200 Unit	Deck/Module	Safety Zone	Room Protected	Weight of Halon/ FM200 (kg)	Number of Containers
68 X 07.1	Upper Deck *above control room*	32	H&V Fan Room	92	2
68 X 07.2A	Main Deck	32	Transformer Room A	55	2
68 X 07.2B	Main Deck	32	Transformer Room B	100	2
68 X 07.3	Main Deck Intermediate Level	32	Substation	450	6
68 X 07.4	Upper Deck	32	Control Room	600	8
68 X 07.5	Cellar Deck	44	Emergency Generator Room	45	3
68 X 07.6	Cellar Deck	44	Battery Room	30	2
68 X 07.7 FM200	Cellar Deck	44	Emergency Substation	100	2
68 X 07.8	Cellar Deck	41	Turbo Generator Control Room	675	9
68 X 07.9	Cellar Deck	41	Turbo Generator Control Room	45	3
68 X 07.10	Cellar Deck	42	Fire Pump Room 68PD01A	75	1
68 X 07.11	Cellar Deck	46	Fire Pump Room 68PD01B	75	1
68 X 07.12	Main Deck	32	12kV HV Room	165	3

2.11.4 FIREFIGHTING SYSTEMS (cont.)

Manual Extinguishing Systems

Foam/Water Hosereels

Foam/water hosereels are installed on the Cellar Deck, Main Deck and Upper Deck. Foam concentrate is introduced into the water stream through eductors installed upstream of the hosereels.

Water Hosereels

Water hosereels are located throughout the platform. Each reel contains 30 metres of rubber hose with a jet/spray nozzle. A gearing device is fitted for crank winding. Washdown hosereels may also be used for firefighting.

Fire Monitors

Firewater monitors are installed throughout the platform. The monitors are movable through 360° in the horizontal plane and may be locked in any position.

Firewater monitors, with the option of manual remote release, are installed in module M35. The systems comprise a firewater monitor, a monitor control skid, a foam liquid unit and a local monitor release panel.

Manual release of individual firewater monitors can be initiated remotely by operation of pushbuttons on the ISS mimic panel and from the operator interface station, both located in the Central Control Room on QP.

Areas Protected by Remote Released Firewater Monitors

Monitor System	Deck	Safety Zone	Areas/Equipment Protected
68 X 09.4	Laydown Area Weather Deck	35C	General Area
68 X 09.5	Laydown Area Weather Deck	35C	General Area
68 X 09.6	Laydown and Metering Platform	35C	Gas Metering Skid and Fuel Gas Metering Skid

Portable Fire Extinguishers

There are two types of portable fire extinguishers as follows:

(a) Dry powder: these are chemical extinguishers pressurized by a CO_2 bottle attached to the container. They are in sizes of 12kg and 50kg. The 50kg containers are trolley mounted.

(b) CO_2: these are 6kg and 10kg hand-operated extinguishers containing liquefied CO_2

2.11.4 FIREFIGHTING SYSTEMS (cont.)

Portable fire extinguishers are distributed about the platform; the number and type are arranged to suit the potential fire hazard.

2.11.5 PLATFORM ALARM STATIONS AND INDICATION LAMPS

Reference Diagrams:

Diagram Title	DocsOpen No	Document No.
Safety Plot Plan – Communication Facilities - Cellar Deck	6191	FF 85 00 46 1011 000 002
Safety Plot Plan – Communication Facilities - Cellar Deck Intermediate Level	6192	FF 85 00 46 1011 000 003
Safety Plot Plan – Communication Facilities - Main Deck	6193	FF 85 00 46 1011 000 004
Safety Plot Plan – Communication Facilities - Main Deck Intermediate Level	6194	FF 85 00 46 1011 000 005
Safety Plot Plan – Communication Facilities - Upper Deck	6195	FF 85 00 46 1011 000 006
Safety Plot Plan – Communication Facilities - Upper Deck Intermediate Level	6196	FF 85 00 46 1011 000 007

Purpose

The purpose of the alarm system is to warn personnel of incidents requiring a co-ordinated effort by all concerned to preserve life and the safety of the platform and equipment on it. The indication lamps are located in noisy areas to inform personnel of broadcasts/alarms being made over the platform's public address system.

Overall Platform Audible Alarms

There are two types of alarms:

- Muster alarm - continuous tone.
- General platform alarm - intermittent tone of one second duration, with a one second interval between each tone. This will be followed by an announcement over the PA System.

In addition "alert" signals - precede an announcement over the PA system. There is an alert signal for emergency speech announcements and a separate alert signal for routine speech announcements.

The system is capable of simultaneously broadcasting either of the alarms over any one of the three platforms QP, TP1 and TCP2, ie a general platform alarm may be given on TP1 while a muster alarm is being given on QP and TCP2.

There is automatic priority ranking of alarms on each platform. The priority of the signals in order of their importance is as follows:

Priority 1 - Muster Alarm
Priority 2 - General Platform Alarm

For example, if a GPA is being given on a platform and a muster alarm is initiated on the same platform, the muster alarm will override. The public address system is distinct in that an alert signal will override any alarm tone for a period of 10 seconds.

2.11.5 PLATFORM ALARM STATIONS AND INDICATION LAMPS (cont.)

If an alarm (GPA or muster) has been given manually, it can be cancelled by operating the appropriate pushbutton on the alarm control panel in QP. Automatic alarms have to be cleared or bypassed before they can be cancelled.

A general platform alarm (GPA) on TCP2 is initiated either automatically by the fire or gas detection system on TCP2 or by operation of the GPA pushbutton on QP.

Local Audible Alarms

Halon/FM200 and CO_2 protected areas have electrically operated bells installed, activated on system release.

Visual Alarms

Selected platform areas, notably noisy areas, are provided with flashing lamps operated by the Public Address System, as follows:

- Yellow lamps for alarms,
- Blue lamps for emergency speech announcements over the public address.

At each entrance to a Halon protected area, a local lamp panel is installed with the following functions:

- Green lamp illuminated: system in manual
- Amber lamp illuminated: system in automatic
- Red lamp illuminated: Halon released

Red flashing lamps are provided at room entrances to indicate fire condition inside the area, operated by the fire detection system.

2.11.6 LOCATION OF RESCUE AND LIFESAVING EQUIPMENT

Reference Diagram:

Diagram Title	DocsOpen No	Document No.
Safety Plot Plan – Lifesaving Equipment & Escape Routes - Cellar Deck	6198	FF 85 00 51 1012 000 002

Purpose

The purpose of lifesaving and rescue equipment is to quickly evacuate personnel from the platform in an emergency and to provide a means of flotation for persons who are in the sea before they can be picked up. Safety equipment is provided throughout the platform for use in accidents causing injury to personnel.

In the event of platform evacuation, each of the lifeboats is equipped with transceivers to provide 2-way communication on the international marine VHF frequencies.

2.11.6 LOCATION OF RESCUE AND LIFESAVING EQUIPMENT (cont.)

Lifesaving Equipment

Lifesaving equipment providing the primary means of personnel evacuation from the platform comprise the following:

- Three 42-man lifeboats (Watercraft)
- Two 20-man liferafts
- Twenty-two lifebuoys.

Watercraft Lifeboats

Each glass fibre Watercraft lifeboat is powered by a 22kW Lister HRWZ water-cooled diesel engine. The engines are equipped with Bryce Berger hydraulic starting systems and Borg Warner hydraulic transmission.

The lifeboat system is designed to enable the crew to evacuate the platform quickly. The lifeboat itself is totally enclosed and independent of the outside atmosphere, and protected by a water spray system which enables the lifeboat to survive an oil fire for 10 minutes (about 1.6 km width) when proceeding at maximum speed.

The water spray system consists of a 16,000 litre compressed air cylinder charged to 2483 bar, driving a Watercraft CP10 pump which draws sea water through the bottom of the boat and discharges it through a filter to the spray nozzles.

The air exhausted from the water spray system pump is sufficient to supply the engine when running at full throttle, to provide air for personnel, and to maintain a slight pressure in the passenger space for the exclusion of toxic fumes.

The lifeboat carries sufficient fuel for 24 hours, operation and is also provided with the following emergency equipment, stowed in the steering console locker:

- Pyrotechnic signals.
- Portable radio-telephone for emergency frequency only. Battery operated and providing two-way voice communications, plus a two-tone alarm transmission which actuates alarm systems in ships and coastguard stations.
- A flashing beacon with line. Battery operated and normally hung upside down. When inverted, the beacon automatically switches on and will operate while floating in water.
- VHF beacon buoy for air/sea rescue. Release of the flexible antenna switches on the beacon which continues to operate for 48 hours.
- Hand torch, battery operated.
- Portable radar reflector.

The boat has two watertight doors on each side for embarkation, and is attached to the two sets of falls by Mills release gear, operated by the helmsman by means of a handle mounted on the port side of the steering platforms. The gear is designed so that it will not release until the boat is waterborne.
The Schat Type ORD/DHM davits allow the boat to be lowered without power at a controlled speed of 18 to 36m/min.

2.11.6 LOCATION OF RESCUE AND LIFESAVING EQUIPMENT (cont.)

Lowering is controlled by the helmsman, by means of a wire which passes through the canopy at the control position. Lowering ceases at any position on release of the control wire.

Hoisting is normally by electric motor, but may also be carried out by hand crank, which does not revolve when the hoist motor is running or when the boat is being lowered by gravity.

Lifeboat Communications

The three lifeboats are each equipped with Shipmate RS 8000 25W transceivers which provide two-way communication on the international marine VHF frequencies. The sets are powered from the lifeboat engine batteries which are kept charged through flexible connections which in turn are released automatically when the lifeboat is lowered.

In addition, the three lifeboats are each provided with an automatic Jotron Tron 1C radio beacon. The beacon is activated by lowering it overboard, where if floats upright and automatically starts to transmit on 1.21.5 and 243MHz at a power of 250mW.

Liferafts

The two 20-man inflatable liferafts are provided at stations on the north and east sides of the Cellar Deck.

The liferafts are davit launched with a full complement of men on board, plus provisions, search detection equipment, first-aid kit, etc.

Each liferaft comprises two superimposed buoyancy tubes, a double-skin floor and a canopy. The buoyancy tubes are inflated automatically by a CO_2 cylinder located under the raft, which is discharged during the launch sequence. Inflation of the raft also erects the canopy.

Water pockets under the liferaft provide stability, and a drogue may be streamed to limit drift and provide directional stability.

Lifebuoys

Each lifebuoy installation is equipped with a water-activated Aqualite. When a lifebuoy is thrown overboard, the Aqualite is automatically released from its stowage by its lanyard. Once activated the light will illuminate for 45 minutes.

A lightweight throwing line 50m long is attached to each lifebuoy.

Knotted Ropes

In the event that escape to sea level is necessary, knotted ropes are located in strategic positions around the platform Cellar Deck.

2.11.6 LOCATION OF RESCUE AND LIFESAVING EQUIPMENT (cont.)

Life Jackets and Survival Suits

Life jackets and survival suits are stored in containers/lockers at Cellar Deck adjacent to lifeboat stations.

2.11.7 ESCAPE AND ACCESS ROUTES

Reference Diagrams:

Document title	DocsOpen No:	Document No.
Safety Plot Plan – Lifesaving Equipment & Escape Routes - Cellar Deck	6198	FF 85 00 51 1012 000 002
Safety Plot Plan – Lifesaving Equipment & Escape Routes - Cellar Deck Intermediate Level	6199	FF 85 00 51 1012 000 003
Safety Plot Plan – Lifesaving Equipment & Escape Routes - Main Deck	6200	FF 85 00 51 1012 000 004
Safety Plot Plan – Lifesaving Equipment & Escape Routes - Main Deck Intermediate Level	6201	FF 85 00 51 1012 000 005
Safety Plot Plan – Lifesaving Equipment & Escape Routes - Upper Deck	6202	FF 85 00 51 1012 000 006
Safety Plot Plan – Lifesaving Equipment & Escape Routes - Upper Deck Intermediate Level	6203	FF 85 00 51 1012 000 007
Safety Plot Plan – Lifesaving Equipment & Escape Routes - East Elevation	6204	FF 85 00 51 1012 000 008
Safety Plot Plan – Lifesaving Equipment & Escape Routes - South Elevation	6205	FF 85 00 51 1012 000 009
Safety Plot Plan – Lifesaving Equipment & Escape Routes - West Elevation	6206	FF 85 00 51 1012 000 010
Safety Plot Plan – Lifesaving Equipment & Escape Routes - North Elevation	6207	FF 85 00 51 1012 000 011

Purpose

Escape and access routes are provided to enable personnel to gather rapidly and safely at their designated muster stations.

Escape Routes

Escape routes are clear routes leading from the platform production areas to the bridge to TP1 and to the lifeboat stations.

There are exit points from each module or area which lead to an escapeway.

All regularly manned areas are provided with at least two well-defined escape routes, which are indicated by prominently displayed signs. To avoid confusion and/or panic, personnel should, if possible, never move along escape routes against the directional arrows.

Escape route signs are of luminous material, with white lettering and figures on a green background.

Escape routes are painted in non-slip yellow; the full width and length of the route is painted with the exception of stairways.

Access Routes

Access routes are clear routes leading personnel safely from one platform area to another. The routes are painted in a similar fashion to escape routes.

Personnel are allotted a lifeboat station on arrival on the platform, and should familiarize themselves with its position and the escape routes leading to it.

In the event of a main power failure, adequate lighting of the escape routes is provided by the emergency lighting system.

2.11.8 PASSIVE FIRE PROTECTION

Reference Diagrams:

Diagram Title	DocsOpen No	Document No.
Safety Plot Plan – Fire Fighting Facilities - Cellar Deck	6114	FF 85 00 39 1010 000 002
Safety Plot Plan – Fire Fighting Facilities - Cellar Deck Intermediate Level	6115	FF 85 00 39 1010 000 003
Safety Plot Plan – Fire Fighting Facilities - Main Deck	6116	FF 85 00 39 1010 000 004
Safety Plot Plan – Fire Fighting Facilities - Main Deck Intermediate Level	6117	FF 85 00 39 1010 000 005
Safety Plot Plan – Fire Fighting Facilities - Upper Deck	6118	FF 85 00 39 1010 000 006
Safety Plot Plan – Fire Fighting Facilities - Upper Deck Intermediate Level	6119	FF 85 00 39 1010 000 007

Firewalls and gastight walls are installed at various locations throughout the platform to prevent fire/gas to spread and to give maximum protection to personnel. They are constructed of steel plate strengthened as necessary by corrugations or stiffeners. They protect certain areas from fire/gas and prevent fire/gas spreading by containing it within an area. The firewalls, ceiling and roofs are rated to various fire classes (A-60, H-0, H60, H-120) pending on areas and fire loads. Each rating is capable of withstanding certain temperatures for different lengths of time. The locations of the firewalls and gaslight walls are shown on the referenced diagrams.

Firewalls

A dedicated H-0 fire bull has been installed to separate the Frøy M35 module from the rest of TCP2 Treatment and Compression (see referenced drawings). This prevents fires from spreading from one area to another. This to also ensure sufficient fire water quantities are available for the largest area.

In order to improve escape, fire protection panels have been installed on the bridge landing area and for 16m along the bridge towards TP1. The panels comprise 5mm of corrugated stainless steel plate on the outside, 90mm of rockwool insulation and 1mm of stainless steel plate positioned on the inside of the protected area.

2.11.9 BLAST PROTECTION

There are no specific arrangements on TCP2 to protect areas from the effects of blast. Report DocsOpen no. 52307 concluded that no blast protection was necessary on the additional modules/pancakes positioned for the treatment of Lille Frigg and Frøy gas, oil and condensate. However, weather dadding has been removed to reduce such effects (3m height and above).

2.11.10 TEMPORARY REFUGE

QP has been designated as the temporary refuge (TR) for the whole Frigg Central Complex. Within the TR an area on the upper level, consisting of the Garden (U33), Bar (U32), Cinema (U29) and Reading Room (U30), has been designated as the "muster area". This is a large open space with a total floor area of approximately 202m² (gross area). The central control room, also situated on the upper level of QP, is the emergency control centre in the event of a major incident.

In order to improve QP as TR, radiation shields have been erected on the two sides facing TP1 and TCP2. This ensures that QP is safe from radiation heat even for riser fires on TP1 and TCP2.

2.11.11 HEATING, VENTILATION AND AIR CONDITIONING (H.V.A.C.)

Treatment Area

The enclosed spaces of the treatment area are provided with a pressurized system of ventilation. Three levels of pressurization are maintained, namely 12mm WG, 6mm WG, 5mm WG and 4mm WG. Each room has an exhaust system designed to maintain the required pressure within it.

The rooms provided with a ventilation system, the number of air changes per hour and the level of pressurization within each room, are listed as follows:

Room	Pressurization	Air Changes/Hour
Air Conditioning and Air Compressor Rooms	6mm WG	7
Instrument Interface, Cabling, Switchgear and MCC Rooms	6mm WG	12
Battery Room and Air Lock	5mm WG	30
Operator Office and Toilet Module	4mm WG	6
Workshop, Stores, Electrical Workshop and Toilets	12mm WG	23
Fire Pump Houses 1 and 2	6mm WG	18
Transformer Room	6mm WG	37
Emergency Supply Room	12mm WG	19
PLO Office and Toilet Module	4mm WG	6

Compression Area

The enclosed spaces of the compression area are ventilated by separate systems. Compressor Modules 30, 31 and 33, the Diesel Generator Room and the Transformer Rooms are ventilated but not pressurized. The Fan Room and Substation, 12kV HV Room, Turbo-generator Room, Diesel Fire Pump Rooms and the Emergency Substation are ventilated and kept at a positive pressure; each room has an exhaust system designed to maintain the required pressure within it. The Battery Room is ventilated by extraction and kept at a negative pressure by inlet control.

2.11.11 HEATING, VENTILATION AND AIR CONDITIONING (H.V.A.C.) (cont.)

The rooms provided with a ventilation system, the number of air changes per hour and the level of pressurization within each room, are listed below.

Room	Pressurization	Air Changes/Hour
Compressor Modules 30, 31 and 33	-	12
Fan Room and Substation	6mm WG	12
Control Room	6mm WG	12
12kV HV Room	6mm WG	12
Turbo-generator Room	6mm WG	12
Diesel Fire Pump Rooms	6mm WG	12
Battery Room	-10mm WG	12
Emergency Substation	6mm WG	12
Diesel Generator Room	-	12
Transformer Rooms	-	12

East Frigg Module

The enclosed spaces of the East Frigg Module are provided with a pressurized system of ventilation, the air being supplied by a common set of equipment. One pair of exhaust fans extract air from the two Interface Rooms while the Battery Room has its own dedicated pair of exhaust fans.

The rooms provided with a ventilation system, the number of air changes per hour and the level of pressurization within each room, are listed as follows.

Room	Pressurization	Air Changes/Hour
Instrument Interface Room	6mm WG	15 to 30
Electrical Interface Room	8mm WG	13 to 26
Battery Room	6mm WG	30
H.V.A.C. Plant Room	6mm WG	6 to 12

Frøy Module M35

Reference Diagram: 2.11.11 Fig. 1

The HVAC on M35 supplies the following technical rooms:
- Instrument Room,
- Low Voltage Room,
- Low Voltage Emergency Room,
- High Voltage Room.

2.11.11 HEATING, VENTILATION AND AIR CONDITIONING (H.V.A.C.) (cont.)

The system consist of two 100% fans, one in service the other on standby. These fans and their input filters are located in a container. The system has a central water-cooled air cooler/heater, and only one thyristor controlled electrical heating element for the Instrument Room. The heating element is powered by the low voltage distribution board. The emergency switchboard feeds the standby and normal running fans.

Fire or gas detection in the HVAC intake causes the system to shut down. In addition, there are fire dampers in the intake and outlet of each room. These dampers close if a fire or gas is detected in the HVAC container intake. In addition, each damper closes individually according to shut down logic. Sensors are located in each duct and in each room.

The system is not designed to run during an emergency situation such as a fire and an explosion in M35. The walls and doors are designed to contain a gas-free atmosphere inside the technical rooms for a minimum of 30 minutes after an HVAC shut-down (if the doors are not opened). Fire resistant coatings on walls, floors, ceiling and doors will ensure acceptable temperature inside emergency equipment rooms.

2.11.12 EMERGENCY POWER AND LIGHTING

Emergency Power

The platform is provided with a diesel generator which supplies emergency power to the compression area and to emergency switchboard M-35 (LV-DBEM-M35). The diesel generator (53GD01) feeds a 380V emergency switchboard (S53.44.2.6) which provides power for the emergency consumers, including the emergency diesel generator auxiliary switchboard (S53.44.2.7).

In the event of failure of the diesel generator, the emergency generator auxiliary switchboard has a back-up emergency supply from the diesel generators on QP (DA1 and 2), via the 380V MCC extension. This supply provides the necessary power to the emergency consumers which include those necessary to start the diesel generator under black start conditions.

The black start supply, via SW699 on the emergency diesel generator auxiliary switchboard, is controlled from the central electrical control board (ECB 3).

The treatment area of the platform relies on the QP diesel generators for a supply of emergency power.

Details of normal and emergency power generation are given in Section 2.9.1.

Emergency Lighting

Emergency lights are connected to emergency switchboard and in addition each light fitting have its own battery which keep one of the tubes in operation for a limited period when all electrical generations has failed.

2.11.12 EMERGENCY POWER AND LIGHTING (cont.)

During normal operation both tubes are fed from the normal 220V ac output. When power fails, the battery supply power to one tube only. This arrangement provides emergency lighting at half the normal level for about 45 minutes.

Upon reappearance of the normal supply the circuits return to normal and the batteries are recharged. The charge rate is slow as no boost is provided; charging can take up to 24 hours after a heavy discharge.

Details of normal lighting are given in Section 2.9.2.

Elf Specification S-10-23-0006 stipulates the following minimum, emergency lighting levels:

- Switchgear rooms: 150 lux
- Ladders and stairways: 50 lux
- Walkways: 25 lux
- Generator rooms: 50 lux
- General operating areas: 25 lux

2.11.13 PIPELINE (INCOMING) COMMUNICATION AND CONTROL

Reference Diagram: 2.11.13 Fig. 1

The content of 2.11.13 has been repeated from the Safety Case Section 2.4.11.16.

(i) Frigg Gas Pipelines

General

Normal communications are carried out using equipment based in QP. Communications affecting pipeline control is the concern of the four companies that have pipelines connecting with the Frigg Central Complex. Each of the companies have internal telephone networks that are linked to QP. These links are:

- The ELF network which links all Frigg Field platforms, Heimdal, Frøy and onshore offices in Stavanger.

- The TOM network which links the TOM offices in Aberdeen, the St Fergus Terminal, MCP01 (now un-manned) and the Alwyn platforms and which is extended through to QP.

- The Norsk Hydro network which links Oseberg A to Frigg Field (QP).

These telephone networks are established for the sections between the shore and the platforms, with lines carried in the UK tropo-scatter network for the TOM telephone system and in the Norwegian domestic satellite communications system (NORSATA) for the ELF telephone networks. The NORSATA system has, in general, no back-up, but one Aberdeen subscriber number is carried to QP in UK tropo-link.

2.11.13 PIPELINE (INCOMING) COMMUNICATION AND CONTROL (cont.)

Purpose-built links have been installed between QP and the following:

- Other ELF platforms (telecommunication cables and/or microwave links);
- Alwyn (tropo-scatter);

Because of the number of communication systems installed on the Frigg Central Complex it is considered that sufficient back-up capability exists in the event of a failure of the primary system.

Normal Communication

Communications from QP to TOM platforms normally take place via the relevant telephones located in the operational control rooms or field manager's offices. In addition, there is a hotline between QP and the St Fergus Terminal control rooms.

Communications between Frigg and Heimdal are normally via the ELF telephone network.

For personnel working at other places linking with each other and with vessels in the field, communication is available via radio on VHF and UHF channels.

Back-up Communication

The first back-up in the event of failure of the national lines (including failure of the automatic back-up system) is the emergency telephone communication routed through the TOM network.

The last back-up is the marine radio, via the VHF for short distances, or the single-side band (SSB) radio (for communication to shore via coastal stations).

ELF consider that there is no possibility for an emergency occurring on the Frigg Central Complex at such a speed that it would destroy all lines of communication in an instant. Elf have not identified so far, any risk of a total loss of all communication systems. However, in the improbable event of a major incident occurring, the presence of the field standby vessel and the relatively close proximity of DP2 (less than 1km) ensures that assistance can be called for using a combination of the communication systems installed thereon.

(ii) Frostpipe Communications

The purpose of the pipeline control telephone system is to provide the Frigg Central Complex and Oseberg A with the voice communication necessary to operate the Frostpipe.

The dedicated telephone lines link the Frigg QP Central Control Room, the Oseberg A Main Control Room and all other control rooms active in the production and transportation of Frostpipe stabilized condensate.

The carrier route between the Frigg Central Complex and Oseberg A is:

- NORSTATA, between Frigg Central Complex and Eik Ground Station;

2.11.13 PIPELINE (INCOMING) COMMUNICATION CONTROL (cont.)

- Leased landlines between Eik Ground Station and Norsk Hydro Sandsli, Telenor A/S;
- Norsk Hydro Offshore Telecommunication System from Norsk Hydro Sandsli.

The pipeline control telephone system is not interconnected with any other telephone network, public or private. Voice communication between QP and Oseberg A is also possible via marine band radio and via the public telephone network.

2.11.14 STANDBY VESSELS

The standby service for the Frigg Field installations of QP, TP1, TCP2 and DP2 is covered by one vessel.

In addition to fully complying with the regulations of both the UK and Norwegian sectors, vessels used for standby duty are equipped with the following:

- Firefighting monitors, class Fi-Fi 1;
- Grappling hook to connect to drifting vessels;
- Towing hook with a bollard pull of 75 tons;
- Sealift rescue scoop;
- Dacon retrieval net;
- Night vision equipment, ie binoculars on the bridge and goggles for the FRC;
- Bilingual crew;
- Azimuth thruster with a separate power supply;
- Equipment for oil dispersal.

2.11.15 SECURITY

No physical or electronic barriers or detection systems are fitted to the platform for the prevention of unauthorized access.