SKJOLD FIELD
AN UNMANNED WELLHEAD PLATFORM
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by

Kjeld Thomsen. Knud Erik Pedersen
Allan Hansen. Lars Dam Rasmussen
INTERATIONAL STEEL CONSULTING A/S

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1. SUMMARY

This paper presents a brief description of the new Skjold Field Platform which is presently under build up in the Danish North Sea. The Skjold Field platform is connected to the Gorm Field by means of an 11 km long subsea pipeline. Some of the outstanding features in the conceptual design and installation to be emphasized are:

a) Invention of an unmanned remote controlled production platform as the first to be installed in the entire North Sea exploration area.

b) Application of long distance automatic control regarding provisions for adequate process shut-down and fire safety requirements.

c) Onshore preassembly of complete topside installation comprising decks, modules, process, utility and power supply prepared for a single topside load-out.

d) Fabrication and assembly of jacket as well as topside by merely Danish contractors.

1. ZUSAMMENFASSUNG

Diese Schrift gibt eine kurze Beschreibung der neuen Skjold-Field-Plattform, die zur Zeit im dänischen Teil der Nordsee aufgebaut wird.

Das Skjold-Field Plattform ist durch eine Unterwasser-Rohrleitung von 11 km Länge mit dem Gorm-Field verbunden.

Bemerkenswerte Einzelheiten in dem Konzept der Konstruktion und der Installation hervorzuheben sind die folgende:

a) Die Einrichtung als eine unbemannte Plattform mit Fernbedienung ist zum ersten Mal in der ganzen Nordsee benutzt worden.

b) Die Feuerschutzanlage und die Shut-down-Möglichkeit der Prozessanlage werden durch eine automatische Fernbedienung kontrolliert.

c) Die komplette Topside-Installation einschliesslich Decke, Module, Prozessanlage und Kraftversorgung wird auf Land zusammengebaut und als eine Einheit montiert.

d) Die Herstellung und der Zusammenbau des Jackets sowie die Topside-Installationen sind ausschliesslich von dänischen Unternehmern ausgeführt worden.
1. RÉSUMÉ

Cet article présente une brève description de la nouvelle plate-forme Skjold Field étant actuellement en cours de construction dans le secteur danois de la Mer du Nord. Skjold Field est une plate-forme reliée au complexe Gorm Field à travers d'un conduit de 11 km long. Quelques-unes des caractéristiques uniques dans l'étude conceptuel et l'installation à être soulignées sont :

a) Invention d'une plate-forme de production inhabitée télécommandée à longue distance, étant la première à être installée dans toute l'aire d'exploration de la Mer du Nord.

b) Application de contrôle automatique à longue distance envisageant des mesures complètement capables pour fermeture d'opérations et des spécifications de sécurité contre-feux.

c) Pré-assemblage au port de l'installation du pont de production complète, comprénant des plates-formes, modules, proces, service, et l'approvisionnement d'énergie, préparés pour un simple transport maritime.

d) Fabrication et assemblage de la plate-forme à treillis métalliques aussi bien que du pont de production par d'entrepreneurs purement danois.
Figure 1. Overall view of existing and planned offshore installations in a part of the Danish North Sea.
1. INTRODUCTION

The Skjold oilfield is situated in the Danish North Sea approximately 220 km west of Esbjerg between the two producing fields Dan and Gorm.

On behalf of Dansk Undergrunds Consortium, DUC, the operator Dansk Boreselskab A/S decided to proceed with front-end engineering August, 1980. Official government approval of DUC's plans for development of the field was granted February, 1981. The project is at present, end 1981, in the final on-shore fabrication completion phase. Load-out is planned for 1982, and the platform is expected to be on production within the same year.

The development of the field is to take place in different phases. Phase I which has now been implemented includes drilling of two wells only, one for production and one observation well for monitoring of reservoir behaviour during phase I.

The jacket and well head area of the decks are however prepared for future extension to six or nine wells.

The produced crude oil will as two-phase flow be piped to the Gorm Field for separation and processing at the existing facilities here.

As it appears the Skjold phase I development is modest and does not as such compare with other larger oil and gas fields in the North Sea.

The platform concept is however singular in the way that the phase I is designed as an unmanned platform remote controlled from the Gorm Field central control room.

One of the main objectives has been to design systems which would make unmanned production mode possible without continuous operation of power generators and rotating equipment at all and at the same time providing highest degree of assurance against spurious shut-downs.

This has called for development of special concepts and solutions in connection with remote control, process control and shut-down system, fire/gas alarm systems, emergency power and fire pump systems a.o. making a study of the phase I facilities described in the following of interest.
Figure 2. Perspective view of the Skjold Field Platform installation.
2. GENERAL LAY-OUT

The water depth of the Skjold field is approximately 40 m and the platform is designed using a piled four leg jacket structure concept. The topsides consists of three decks. The lower deck is elevated 22 m above sea level. The main deck is situated at level 30.00 m, and the helideck at level 38.00 m. The overall length of the platform complex is approximately 37 m and the overall width is approximately 25 m.

The well-head area and process area are located at the south end of the platform on open platform areas. A fire wall separates the actual well-head area from the rest of the platform. Utility systems and building modules are located at the north end of the platform on deck areas cantilevered north of the jacket legs module line.

The lifeboat area and emergency assembly area has been placed on a suspended platform extended off the north end of the lower deck. The area is screened from fire hazards at process areas by the utility modules and shielded from above by the helideck.

The pedestal mounted crane is situated at the platform east side. In order to obtain clearance to the crane and to be outside the classified zones around the process facilities the helideck has been off-set by locating the deck centre above the platforms north/west leg.

The well conductor pipes are terminated at lower deck at the well head area south of the fire wall. The area contains the X-mas trees, flow lines, production manifold and the pipeline riser to Gorm. Furthermore the sump tank has been located at the lower deck well head area. The well head control panel has been located on the intermediate mezzanine X-mas tree access deck, which is suspended from the main deck 2.5 m above the lower deck.

The main deck area above the wells has been provided with hatches to allow drilling operations and for mounting of wireline equipment, lubricators etc. for well logging and servicing.

Methanol injection pumps and pump for injection of sumptank fluid into flow line are located on lower deck adjacent to the north side of the fire wall.

The methanol tanks which are re-filled on-shore and hoisted on deck from supply boats by the platform crane are located on main deck above the pumps on lower deck.

The pig launcher for launching of pipeline scrapers or linalogs is located on the main deck at the south/west platform corner above the pipeline riser.

Figure 5. Plan of topside installation at level +30.00. 1. Main generator room. 2. Tool room. 3. Logging unit. 4. Diesel oil vessel. 5. Potable water vessel. 6. Methanol movable tanks. 7. Wireline unit. 8. Removable panel above wellheads. 9. Pig launcher. 10. Crane.
Figure 6. Plan of helideck at level +38.00. 1. Landing net panels. 2. Fire fighting platform. 3. Access stairs.

Figure 7. Elevation of topside installation in line 3 facing line 1. 1. Helideck. 2. Main deck. 3. Cellar deck. 4. Tool room. 5. Main generator room. 6. Firepump room/Accomodation. 7. Battery room. 8. Emergency generator room.
The main deck area between the methanol tanks and the utility areas has been provided with large hatches to give access to lower deck for crane hoisting.

The modules and utility systems have been located at the north end of the platform.

Module 1, 2 and 3 are located on lower deck. Module 1 contains fire pump engine room and a radio/control room on ground floor and diningroom, kitchen and sanitary facilities and storeroom as well as bunks for occasional accomodation of personnel on first floor.

Module 2 contains battery systems for fire/gas alarm systems, radio/telecom. systems and for marine navigational aid systems.

Module 3 contains emergency generator unit and emergency power switchboards.

Module 4 and 5 are located on the main deck. Module 4 is the main power unit containing a generatorroom and a main switchboardroom.

Module 5 contains workshop/toolroom.

Roof of module 4 is prepared to accomodate electric logging unit to be used for phase I reservoir monitoring. Utility storage tanks for potable water and diesel oil are situated in the utility area on main deck.

The assembly area is situated on lower deck on a cantilevered platform north of the utility area furthest away from the process area.

The assembly area contains two 15 man survival boats situated one on each side of the platform. The platforms rescue boat, for use in "man over board" situations is likewise located in the assembly area.

The helideck is designed and approved for helicopters with maximum rotor diameter of 15.9 m allowing operation of Bell 212 helicopters currently in use in the Danish North Sea and operation of possible future type Bell 214.

All enclosures are provided with at least two exits. Stairs and ladders are provided so that there are at least two exit possibilities from all platform areas, including normally accessible module roofs.

The helideck is provided with two stairs on opposite deck sides for access to main deck.

There are two stairways between main deck and lower decks likewise on opposite platform sides.

Access to boat landing takes place by ladder from main deck at the platform utility area and by emergency ladder running from main deck/lower deck to the boat landing at the well head area.

3. PLATFORM STRUCTURE

The wellhead platform structure rise to a top level of +38 m above LAT water level and reach a sub sea depth of -39.6 m corresponding to a total structural height of 77.6 m.

The topside structure comprise three decks with the cellar deck at level +22.00 making room for the well head area to one side of a fire shield wall and further space for pump skids and modules enclosing utility systems on the other side. The main deck positioned at level +30.00 m allow space for well head operations and further utility modules. Finally the helideck is placed at level +38.00 m and offset from the centre of the lower decks as shown on figure 2 and 3.

An 200kN tower slewing crane is provided for inter platform lifts and service lifts from supply boats. The crane support shaft is supported on a twin frame structure cantilevered 2 m off the two lower decks. The maximum outreach of the crane boom is 21.2 m with a service load capacity of 70 kN.

The entire topside structure is supported on and rigidly connected to a four leg fully braced conventional type Jacket structure built up in throughout tubular sections. The legs are anchored to the seabed by means of a total of 12 Ø 1200 mm tubular piles driven to a depth of 55 m below mud line.

The cellar deck and the main deck are all welded in plane frame grid structures. The grids are primarily built up by means of rolled H-standard shapes. Both decks are throughout covered with gratings connected to the top flanges of the floor beams with mechanical fasteners. A mezzanine deck is further provided between the cellar deck and the main deck to allow passage to service around wellhead Christmas tree. The mezzanine deck is a fully bolted construction to enable easy dismounting during drilling of the wells. The bolted design has permitted application of hot dip galvanizing of all structural elements in the deck and bracing members and further of all grating, stairs, ladders, walkways and railing.
Figure 10. View of jacket fabrication during built up at site near Alborg.

Figure 11. Tubular welded joint in jacket lattice work.
The helideck rise 8 m above the main deck and is cantilevered over the tubular legs opposite the wellhead area to an outreach of 10.6 m. The helideck design conform to the BL. 3-5 standard issued by the Danish Directorate of Civil Aviation. The deck proper is supported on a main girder frame of rolled H-sections integrated in the cantilevered lattice girder support system of tubular members.

The load out phase of the platform structure requires a sub-division into the jacket structure proper, the helideck and the remaining topside structure. The fabrication of the jacket structure took place at a shop near the city of Alborg and the load out will take place at the waterfront nearby. The subassembly of the topside structural load out sections took place on the quay in Esbjerg harbour.

The design of the jacket structure and the miscellaneous decks comply with American codes such as "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" of AISC, "Structural welding code" of AWS and "Recommended practice for planning, designing and constructing fixed offshore platforms" of API. However, the design also complies with the Danish temporary offshore regulations and specification for the design of steel structures DS 412 issued by the Danish Engineering Society. The more stringent requirements of these codes to govern.

Modules and secondary structures comply with DS 412 and NPD regulations covering the respective structural items.

The jib slewing crane is designed according to DIN 15018 combined with relevant NPD regulations mainly regarding safety requirements in offshore application of cranes.

The characteristic design loads for the cellar deck and the main deck is 20 kN/m², whereas walkways and platforms are designed for a distributed uniform load of 5 kN/m².

The crane is supplied with fully selfcontained diesel/hydraulic power unit, load and movement limiting devices, wave compensation etc.

The crane engine room and cabin is pressurized and the engine has been provided with accessories allowing full crane operation in classified area.

The helideck is designed for an equivalent distributed load of 0.5 kN/m² together with (or) concentrated wheel loads corresponding to 69.7 kN increased with dynamic addition according to specification in SKU guidelines.
Figure 12. General view of topside during built up on site at offshore base in Esbjerg harbour.

Figure 13. View of mezzanine deck suspended from main deck.
The environmental loads due to wind, waves and current are based on statistics for the North Sea area. Whence the jacket shall resist a maximum storm wave height of 23.5 m with period 15.6 seconds and a simultaneous storm tide current of 1.43 m/sec. The fatigue investigations also cover loads induced by current and vortex shedding on bracing members. The wind load specified reach a maximum velocity pressure at helideck level of 1.83 kN/m² distributed and 2.09 kN/m² local pitch load.

All steel applied in the primary structural elements of jacket and deck structures comply with BS 4360 class D steels in killed and normalized condition of strength grades 50 and 40. Specific applications of steel to for instance padeyes, main truss columns, crane pedestal, jacket cans etc. where through plate thickness loading may occur are delivered with proved through thickness properties to prevent lamellar tearing.

Steel applied in modules and secondary structures comply with DIN 17100 class 2 grade 37 in the as killed condition. However improved through thickness properties and normalization are required for specific applications such as padeyes, base plates for modules, life boat supports etc.

All bolts applied in bolted connections are high-strength bolts class 8.8 complying with DIN 267.

4. MODULES AND MISCELLANEOUS STRUCTURAL DETAILS

A total of five containerlike modules are installed to accomodate power supply and other sensitive installations. The following three modules are located on the cellar deck:

1. Two storey module 6.7 x 6.4 x 5.5 m (L x W x H) comprising control room, fire pump room with overhead hoist beam and emergency accommodation room.

2. One storey module 4.2 x 2.4 x 3.1 m (L x W x H) for battery installation with overhead hoist beam.

3. One storey module 3.5 x 3.4 x 3.0 m (L x W x H) for emergency generator with overhead hoist beam.

The remaining two modules located on the main deck are:

4. One storey module 7.1 x 5.9 x 3.0 m (L x W x H) making room for main generator with overhead hoist beam and logging unit placed on roof.

5. One storey module 5.9 x 3.4 x 3.0 m (L x W x H) making room for general maintenance tools.
Figure 14. Typical module built up. a. Elevation of module. b. Vertical section through module. c. Plan and installation of main generator.
A typical arrangement plan of a module is shown on figure 14 comprising main generator unit, halon battery, compressor installation and electrical converter.

The accommodation rooms are not intended for permanent use. If a permanent manning is needed in connection with a possible future extension, a new living quarter module will be located on the cellar deck between the two life boats.

The fire protection requirements to the module surfaces call for a minimum 4 mm thick steel plate cladding. Consequently the structural concept is based on the application of sandwich type panels in walls, floor and roof integrated as rigid load carrying diaphragms. The sandwich walls enclose minimum 100 mm mineral wool insulation. The only exception is the fire pump room where additional 25 mm insulation is required. The modules are further protected by means of overhead sprinkler systems.

The sandwich walls are provided with vertical IPE-shape stiffeners at a distance of approximately 900 mm, whereas stiffening of sandwich slabs in roofs and floors are achieved by means of H-shapes and IPE-shapes with size adopted to span and characteristic floor load. The stiffeners are welded to the exterior cover plate by means of staggered fillet welds to limitate shrinkage and plate distortion. The connection of the interior cover plates to stiffeners is established by means of fillet welds in adequately spaced punched φ 30 mm holes.

The diaphragm panels are welded to RHS-sections placed along the module boundaries and joined to a rigid space frame. Corner joints call in this case for special attention regarding geometry and welding sequence to achieve a rational built up in the workshop. Special framing members are provided to establish a number of holes in the roofs and walls for pipes, ventilating units, cables and doors. The entrance doors are self-closing sliding doors, whereas the emergency exit doors are hinged. All modules are four point supported on footings provided at the corner column bases extending 80 mm below the bottom face of the module floor. The connection to the floor beams is arranged as simple butt plate bolted joints between column base plate and floor beam topflange. The governing load case for the footings appears to be load out phase in which the following accelerations during seaward transportation have to be considered:

Rolling : \[ A_R = 0.25 \times g \]
Pitching : \[ A_P = 0.31 \times g \]
Heaving : \[ A_H = 0.20 \times g \]

where \( g \) stands for the gravity acceleration.
Figure 15. Typical frame and base detail of a module.
1. RHS 120 x 120 x 5.6. 2. RHS 200 x 120 x 6.3. 3. PL.6. 4. PL.4.
5. Grating. 6. M20 class 8.8. 7. Deck beam. 8. PL 30 (RR.St.37-3N)
9. 6 mm chequer plate.

Figure 16. View of module base connection to deck beam.
Figure 17. Module installation during built up of topside structural system.

Figure 18. Padeye detail. a. Perspective view.
b. Padeye gusset plate. 1. Ø 152.4/Ø 92.4 (RR ST 37-3N)
2. FL 20 (RR ST 37-3N).
Figure 20. Crane pedestal structure and framed support cantilevered from the platform decks. 1. Ø 2090 x 20/15. 2. PL 20 x 636. 3. PL 20 x 440. 4. Erection joint. 5. Gangway. 6. Access door. 7. Ventilating opening. 8. PL 32. 9. PL 32 x 520. 10. HEB 700.
The padeyes are inserted in cut outs along the diagonal plane in the top corners of the modules. The padeye gusset plates are connected with merely longitudinal welds loaded in shear to enable a smooth transfer of the hook up load to the rather small plate thickness in the RHS boundary sections applied. The padeyes are designed to resist characteristic loads amplified with a dynamic factor of 1.5 and a safety distribution of the heave up load with 66% to 33% on the diagonal wires. Consequently the maximum sling load reach 390 kN with sling angle 45° for modules 1 and 4, whereas the sling load for modules 2, 3 and 5 reach a maximum of 66 kN.

The jib slewing crane is a standard 350 kN service load crane at outreach 6.0 m or 70 kN at outreach 21.2 m classified to crane group B2 according to DIN 15018. The service load capacity however in the offshore application is downgraded to 200 kN at outreach 6.0 m to allow higher load frequency and adequate fatigue safety corresponding to classification in DIN 15018 group B4.

The crane pedestal design called for special consideration because of the offset in extent of the platform main structure and the limited size of the adjoining deck members available for attachment of the pedestal support structure. The pedestal is at the deck levels supported by cantilevered H-shaped girders which are fully restrained in the cylindrical shell by the provision of full diaphragm stiffeners at the flange levels of the girders. Spatial stability is achieved by adding of horizontal girders to form triangular frames at both support levels. The crane pedestal column is cylindrical with a diameter of 2090 mm and a total length of 15.2 m. A hinged door in the cylinder at main deck level allows access to installations inside the pedestal column and to inspection of the slewing ring from the inside. The pedestal is further equipped with a device allowing jack-up of the crane for a more detailed inspection of the slew ring. According to NPD regulations the pedestal structure is designed to a higher level of safety than the slewing crane proper. The access to the drivers cabin is provided from a platform around the pedestal via ladder to another platform 4.5 m above main deck and finally to a revolving ladder that follows the crane rotation.

The joint between the tubular jacket legs and the primary girders in the decks are all welded rigid connections achieved by throughpassing girders with extended flangewidth and cylindrical shell type stiffeners adapted to fit with the tubular legs as shown on figure 22. All interior joints in the deck frame structure are welded butt type connections.
Figure 21. View of crane pedestal during built up.

Figure 22. Rigid connection between jacket leg and primary deck members. 1. PL 25. 2. PL 35. 3. Ø 1220 x 25. 4. Sector Shell of Ø 1220 x 25. 5. Ø 610 x 12.7. 6. Plate girder H = 900, B = 650 mm. 7. HEB 900.
Figure 23. View of welded joint between jacket leg and primary deck members similar to junction for crane pedestal.

Figure 24. General view of slewing crane at test stand.
Figure 25. Topside padeye.

Figure 26. Fireshield located between cellar deck and main deck.
5. PROCESS SYSTEM

The production is transported to the separation facilities at the existing Gorm platform as two phase fluid/gas flow through a 11 km insulated 6" pipeline.

At Gorm the flow is routed to a distribution manifold for connection to existing high pressure, low pressure or test separators.

The flow lines at Skjold, subsea pipeline, platform risers and flow lines at Gorm upstream of block valves at distribution manifold are all designed for full 210 bar well head shut-in pressure. This has made it possible to avoid installation of pressure relief and blow-off facilities at Skjold and has contributed to simplify process alarm and shut down procedures.

Flow control is achieved by an automatic pressure control valve at Gorm, situated upstream of the separator distribution manifold, in conjunction with fixed orifice chokes in the flow lines to the separators. Controlled flow to the respective separation facilities is maintained by appropriate pressure setting of the pressure control valve corresponding to the desired flow rate. The adjustable chokes down stream of the X-mas tree wing valves at Skjold are manually set corresponding to the precalculated required pipeline flow pressure for the production rate in question.

The sump tank connected to the closed process drain system is 2000 l and sized to contain the flow line and process system fluid volume and intended for manually draining of flow line system. The sump pump is an adjustable stroke piston type pump, capacity 1200 l/h 138 bar pressure, for reinjection of sump tank fluid into the flow line. The system is intended for manual operation only.

The methanol system consists of two 4770 l transportable tanks with flexible connections to permanently piped high and low pressure methanol pumps unit. The low pressure pump, rated at 75 l/min. is used for filling of the well head tubings prior to pressuring up with high pressure pump, rated at 7.5 l/min., in connection with openings of sub surface safety valves.

During normal production the pipeline insulation maintains sufficient flow temperatures to ensure against hydrate formation. After long shut down periods fluid/gas hydrate formation expectancy would impose certain pressure limits when the pipeline fluid is cooled down to ambient sea bed temperature if hydrate prevention measures are not taken.
The high pressure pump is therefore further intended for methanol injection into the flow line prior to planned operational shut-downs of longer duration to enable operation with normal flow line pressures upon start-up without encountering hydrate formation problems.

The high pressure methanol pump can in these situations be started and monitored from the Gorm control room via the telemetry system.

The X-mas tree arrangements are permanently connected to kill-line supply and return manifolds mounted on lower deck in the well area. The kill-line piping is routed to the boat landing and terminated with couplings for boat connections and to the main deck for possible drilling rig connection. The system design pressure is 345 bar corresponding to the pressure rating specified for the X-mas trees.

All process piping is designed in accordance with API 14 E and ANSI B 31.3.

Pipe connection from X-mas trees to production manifold is ASTM A 333 grade a for low temperature service due to low temperature occurances at start-up conditions.

From pig launcher to riser connection API 5LXX52 piping has been utilized to conform inside pipe diameter to pipeline. All other process piping is ASTM A 106 grade B.

6. PROCESS SHUT DOWN SYSTEM

The process shut-down valves at Skjold, i.e. sub surface safety valve, X-mas trees master and wing valves and the riser valve are controlled by the hydraulic well head control panel situated on the mezzanine deck at the well head area. The well head panel again interfaces with a pneumatic control panel in the control room which again interfaces with the fire/gas alarm panel and the Skjold/Gorm line-of-sight telemetry system.

In case of operational shut-down (OSD) or emergency shut-down (ESD) of the Gorm facilities the Skjold Field production is automatically shut-in via the Skjold/Gorm telemetry system.

Automatic shut-down of Skjold likewise takes place upon flow line high/low pressure alarm and riser low pressure alarm as well as for fire/gas alarms. Fire/gas alarms from outside detection loops in process areas, apart from shut-in of x-mas trees master and wing valves and riser valve, also cause shut-in of the sub surface safety valves.

Shut-down alarms and all shut-down valves open/closed status signals are transferred to the Gorm control room via the telemetry system.
7. FIRE SAFETY AND GENERAL UTILITY SYSTEMS

The basic design objective has been to ensure a high degree of unmanned production mode reliability and at the same time maintain a high level of safety.

This has been achieved mainly by employing system concepts allowing unmanned platform production mode without the necessity of continuous operation of rotating equipment and A.C. heavy current electrical systems, and by using pneumatic controls and pneumatic detection systems as widely as possible, reducing battery power consuming apparatus to a minimum.

As a consequence all systems on standby for automatic start such as firepump system and emergency generator system and all systems in operation in unmanned mode are designed for safe operation in hazardous classified areas and under extreme environmental conditions, so that no unmanned mode equipment is dependant on room pressurization, gas monitoring, space heating etc. for safe and reliable operation.

The battery power systems are in full operation both in manned and unmanned platform mode and consist of a 12 V system for navigation lights and fog horns, a 24 V system for radio and telecom systems and a 24 V system for fire/gas detection, alarm and shut-down system. All three systems are designed with double parallel batteries and double battery charger systems providing full system redundancy. Each system is sized for one full week operation on battery power alone at an ambient battery room temperature of \(-5^\circ\text{C}\). In the unmanned mode the emergency generator is further on standby starting automatically powering the battery chargers should anyone of the batteries run low. The batteries, chargers, battery controls, fuses, switchgear etc. are all approved for operation in classified areas.

The main power system for 380/220 V - 50 Hz, A.C. power is put into operation when the platform is manned for supply of power for lighting, heating and ventilation and for general utilities etc. The system includes a conventional radiator cooled 185 kW diesel generator set. Prior to start of engine the generator room and associated switchboard rooms etc. are purged and pressurized powered from the explosion proof emergency generator system. Once the main generator is in operation the emergency generator can be stopped and the flameproof emergency generator switchboard is automatically powered from the main generator system. Should the main power fail in this manned operation mode the emergency generator starts automatically for supply of safety systems, e.g. emergency lighting, helideck lighting etc. The emergency power system which includes a 70 kW diesel generator unit is fully explosion proof. The engine has been explosion secured by provision of special exhaust cooler, exhaust flame-arrestor/spark arrestor, combustion air flamearrestor and overspeed cut-off, high pressure explosion retaining engine manifolds and shaft seals a.o. The engine is provided with dual air starting
Figure 29. Flame proof switchboard for emergency power system.

Figure 30. Fire gas alarm panel.
system and pneumatic NPFA 20 type motor controls. The emergency generator switchboard, controls and all equipment supplied from the generator etc. are all Ex(d) types with Ex(e) termination boxes suitable for zone 1 operation. Apart from automatic start upon power failure as described above the generator is remote controlled via the telecom. system from the Gorm control room.

In the unmanned mode fire detection is accomplished by pneumatic quartzoid bulb detection loops both outside on the open platform area and inside the modules for automatic platform shut-down and start of fire pump upon activation. Outside detectors further trip deluge system for fixed spray protection and inside detectors activate halon release in respective modules upon fire detection. Gas detection in the unmanned mode has been limited to the outside process areas. The detectors are arranged in groups of three, for two out of three voting logics, causing platform shut-down. The fire/gas loops and alarm and shut-down panel section in operation in unmanned platform mode is specially developed and approved for operation in a hazardous area. In the manned mode, when all modules are powered and ventilating, heating and utility systems etc. being in use, a comprehensive fire/gas and alarm system comprising smoke and rate of rise heat detection where appropriate inside buildings, UV detection, gas detection in air intakes and inside rooms classified as safe areas, ventilation and room pressurization monitoring, and full general platform alarm system etc. is put into operation.

The fire pump system comprises a direct diesel driven vertical long shaft pump. The nominal pump capacity is 865 m³/h.

The engine, rated at 490 HP at 1800 RPM, is supplied with heat exchanger for water cooling and is explosion secured and pneumatically controlled as described for the emergency generator engine. The pump system can therefore be maintained operational in any hazardous situation. This concept, securing a high degree of availability and reliability, and in consideration of the unmanned concept provision of one pump system only has been found acceptable and has been approved by the authorities.

The fire fighting system comprises full outside fixed water spray protection of all platform areas, fixed spray exposure protection of tanks and vessels and high rate fixed spray protection of χ-mas trees. The nominal water rates for the deck area is 10 l/m² min. in utility areas and 20 l/m² min. in the well head area. Fire pump engine room is likewise protected by fixed spray de-luge system. The platform is further provided with hosereels and water monitors, foam monitor protection of helideck etc.

Dry powder 500 kg hosereels units are provided at process areas, utility area and helideck. Generator room, switchboard rooms, control room etc. are protected by total flooding Halon 1301 systems.
The line-of-sight telemetry system is in continuous operation both in manned and unmanned mode, transferring approximately 40 differentiated alarm and status signals to the central control room at Gorm and transferring remote control and shut-down signals from Gorm to Skjold. The system has been designed for fail-safe emergency shut-down of Skjold upon signal or system failure.

The L.O.S. and telemetry panel at Skjold has been specially developed for the project and approved for operation in classified area.

The platforms non-directional-aeronautical radio beacon has likewise specially been improved and modified for the Skjold concept. The system is remote controlled via the telemetry system from Gorm for start/stop upon request.

The instrument air system comprises a main and a back-up air bank each with capacity for maintaining pneumatic detection system, pneumatic and well-head control panel in operation for one week without operating of air compressors in unmanned mode. The air bank is charged when the dual 1000 l/min. air compressor system is started in manned platform operation mode.
Figure 31. View of main generator room.

Figure 32. Topside installation mounted and ready for load out.
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DESIGN AND CONSTRUCTION

CLIENT: DANSK BOREELS KAB A/S

OUTLINE SPECIFICATION: DANSK BOREELS KAB A/S

CONSULTING ENGINEERS:
Jacket and Deck Structures C.J.B. - EARL & WRIGHT, LONDON
Topside Facilities, Modules and Secondary Structures INTERNATIONAL STEEL CONSULTING A/S COPENHAGEN
Pipeline Skjold/Gorm CHRISTIANI & NIELSEN A/S, COPENHAGEN BROWN & ROOT LTD., LONDON

CERTIFICATION:
Design and Fabrication DET NORSKE VERITAS A/S
Load out, Sea Transport and Noble Denton & Associates, LONDON
Offshore Lift

CONTRACTORS:
Topside Facilities VØLUND ENERGITEKNIK A/S, COPENHAGEN
Jacket Structure MONBERG & THORSEN A/S, STEEL DIVISION COPENHAGEN
Offshore Installation HEEREMA MARINE CONTRACTORS S.A.
Pipeline Skjold/Gorm BROWN & ROOT, NORGE A/S
REFERENCES


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Price DKr. 40,-.