



# Wireline –

## Highly Technological Equipment for Measurement and Control Intervention on Oil and Gas Wells

by Sandra Wassink



Floating drilling unit for offshore use

### **The production process of oil and gas**

In the production process of oil & gas, several steps have to be taken: Exploration, production, transportation and storage.

## Exploration

The first step in the complete process of producing oil and gas is exploration. The world is explored for potential petroleum reserves. In the exploration process four stages take place: collection of geological knowledge, seismic surveying, drilling and testing.

Based on geological knowledge and the seismic survey the drilling will start. For drilling a drill tower is used. This can also be referred to as a ›drilling mast‹ or ›derrick‹. A ›drill string‹ is attached to the drill tower with a bit. The elevated platform under the drilling tower is called a ›drill floor‹. The drill floor is the heart of the tower, which contains a rotary table that is responsible for the rotation of the drill string, and is where all assembly tools for the drill string are located.

During the drilling process a fluid called mud is used to circulate into and out of the well. A **Blow Out Preventer (BOP)** is used to ensure closing the well under certain conditions in order to prevent the mud from blowing out of the hole. A Blow Out Preventer is a large specialized valve to seal, control and monitor oil and gas wells. They were developed to cope with extreme pressures and uncontrolled flow emanating from a well reservoir during drilling. The Blow Out Preventer is installed on the drill floor. To keep the mud circulating, high pressure pumps – so-called mud pumps – can be used. These are located near the drill floor.

The mud protects the borehole from collapsing. The final collapse protection is provided by the casing; a steel pipe lowered into the hole and firmly set by pumping cement between the casing outside and the formation. This is called a ›cased borehole‹.

Of all exploration phases, drilling is the most visible one. The making of a hole can may take many weeks and in some cases many months. The cost for drilling is high, but if proper data analysis is available, the chance of success is also high. The first well provides valuable geophysical information, and it would be extremely lucky, if it also happened to be placed in the optimum position in the oil or gas containing layers. →



Figure 1: Oil well Christmas tree

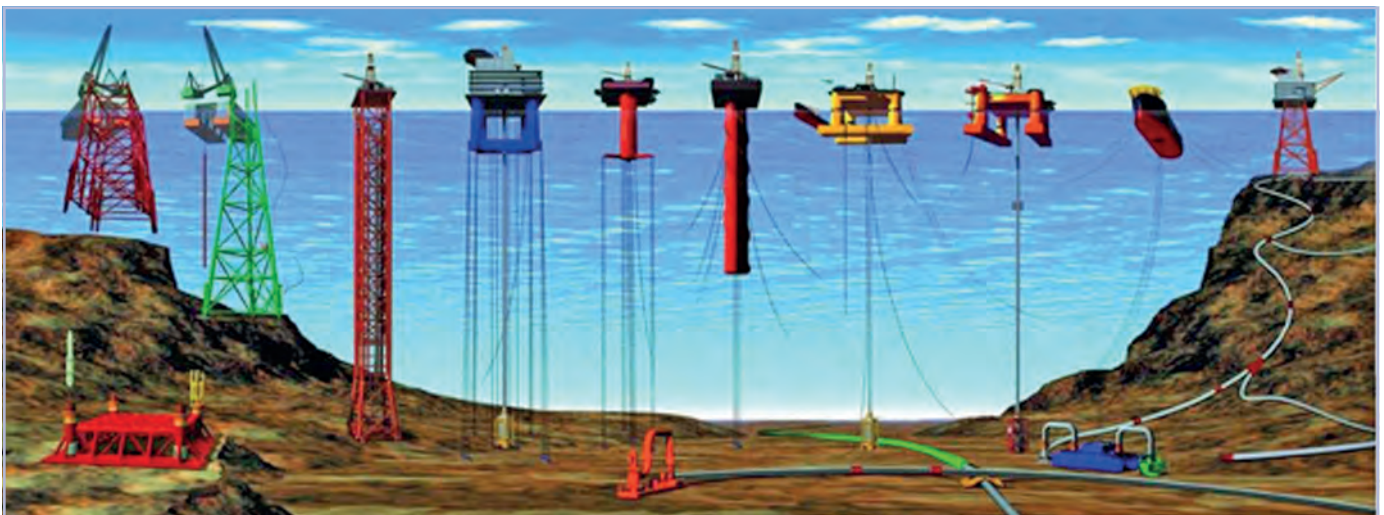


Figure 2: Types of offshore platforms and drilling rigs. From left to right: 1 + 2 conventional fixed platforms, 3 compliant tower, 4 + 5 vertically moored tension leg and mini-tension leg platform, 6 spar, 7 + 8 semi-submersibles, 9 FPSO (floating production storage and offloading facility), 10 sub-sea completion and tie-back to host facility



Figure 3: Pipeline for oil transport from the separators nearly situated at the wells to further processing

Offshore drilling is not much different from onshore drilling. However, drilling an exploration well at sea is almost always done by means of a MODU, **M**obile **D**rilling **U**nit. This may be a drilling ship, but could also be a semi-submersible drilling platform or a self-elevating (jack-up) platform.

During the drilling process, measurements are taken in the borehole, for example to establish the electric conductivity of the soil, the radioactivity or the acoustic properties. A test assembly is placed near the bottom of the hole, to record the downhole pressure. Also oil and gas samples are taken to analyse composition, viscosity, specific and density. All data obtained along with the reservoir volume established by seismic and drilling, and with the gas-oil-water interfaces and the porosity of the rock formation allow an estimation of the quantity of oil in place and the percentage producible.

### Development

When an exploration well indicates interesting quantities of oil and gas, further development starts with the drilling of additional wells to establish the size, the productivity and the contours of the field in more detail; the so-called ›appraisal wells‹ and ›delineation wells‹. The seismic images are extremely important when the sites of the extra wells are determined. From the seismic information plus the data of ›appraisal wells‹ the total amount of producible oil or gas in the reservoir can be estimated.

Drilling a production well is very similar to drilling an exploration well. However, there are some differences. An exploration well is normally drilled vertically, whereas production wells are often drilled from a single site at the surface to different areas of the formation in what is referred to as ›directional drilling‹.

After drilling and casing the well, it must be ›completed‹. Well completion is the process in which the well is enabled to produce oil or gas. Like in exploration wells, casings are placed in the production well. The casing pipes are secured in place with cement (Cased Hole). Finally ›production tubing‹ is let down inside the casing. After closing off the room between tubing and casing, the well is ready for production. The production tubing will carry the well fluids to the surface. Completion includes some work at the surface, to control

the well flow. A number of valves and chokes are placed on top of the wellhead. The assembly of the valves, chokes and piping is called the ›Christmas tree‹ (Figure 1).

### Separation of oil, gas and water

Once the presence of oil or gas has been proven, the most difficult part of the exploration and production process would seem to be finished. However, it is not simply a matter of feeding the mixture of oil, gas and other fluids coming out of the well, into a tank or pipeline; it requires conditioning.

The fluid flowing out of the well is not purely oil; almost always some gas is dissolved in the petroleum. While oil is flowing upward through the production tubing, gas is released. The oil may be contaminated with water, usually salt water, or sand. This needs to be removed before it damages the pipeline. This is done by a production installation, with one or several separators.

After the oil has been separated from the gas, water and sand, the oil will be forwarded to a local production centre via short pipelines, called ›flowlines‹. The centre contains separators and other production equipment, and often storage tanks.

The main difference in offshore production is its location in the middle of the sea, which requires a platform above water for placing the wellheads, Christmas trees, separators, pumps and so on. A platform at sea is always more expensive than a small stretch of real estate on land. The most common platform types are: jacket platform, gravity structures, **Tension Leg Platform (TLP)** and **Spar Platform**, **Semi-submersible (FPSS)**, **Floating Production Storage and Offloading Ships (FPSO)**, (Figure 2).

### Transportation and storage

Transportation of the oil from the well to consumers is done through a network of pipelines, refineries, cargo holds of tank ships, and eventually train and road (Figure 3). Transportation of crude oil from oil fields to refineries mainly takes place through pipelines and the use of large ships.

### Maintenance

Oil and gas wells need occasional maintenance. The tubing may need replacement or the perforations of the rock around the well may have plugged during years of production. If the problems are contained by maintenance, a well may flow for years without problems. Here the importance of wireline service comes in.

### Wireline Technology in the process of oil & gas production

#### Wireline, what is that?

In the oil and gas industry, the term wireline usually refers to a cabling technology used by operators of oil and gas wells to lower equipment or measurement devices into the well for the purposes of well intervention and reservoir evaluation, and additionally it may also be used as a guy rope.

The braided line can contain an inner core of insulated wires which provide power to equipment located at the end of the cable, normally referred to as electric line, and provides a pathway for electrical telemetry for communication between the surface and equipment at the end of the cable.

For oilfield work, the wireline resides on the surface, wound around a large (3 to 10 feet in diameter) spool, called a winch. For onshore applications users may use a portable spool, for example on the back of a special truck, or one set up as a permanent part of the drilling rig. A motor and drive train turn the spool, and raise and lower the equipment into and out of the well. For offshore application the spool can be placed in a container. →



Figure 4: Wireline attached to the top of a Christmas Tree



Figure 5: Wireline truck with drum (inside)

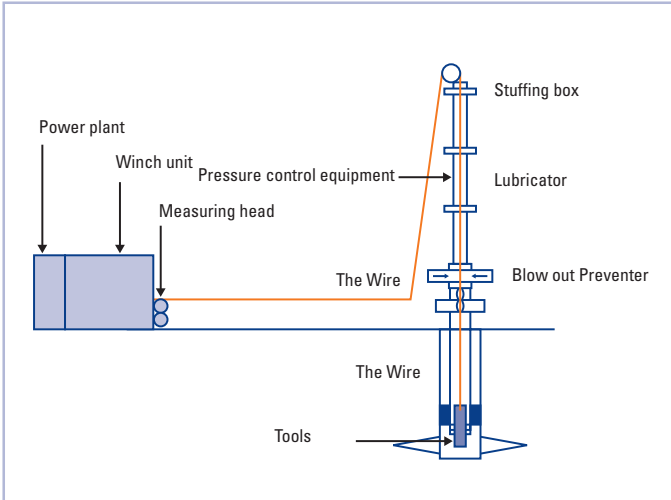


Figure 6: Wireline, cased hole services

The fundamental elements required to perform a wireline service are (Figure 6):

- > Power unit
- > Winch unit
- > Measuring head
- > Pressure control equipment
- > The wire
- > Tools

*Advantages of Wireline*

Wireline tasks can easily be performed when a well is under pressure. This has the obvious advantage that the well does not need to be killed. Production can continue unhindered and there is no time lost. Killing a well is costly and time consuming, and damage can occur. Additionally, it is time consuming and costly getting a well back into production.



Figure 7: A winch in a container for offshore applications.

*Wireline logging*

Wireline logging refers to the practice within the oil and gas industry of lowering a logging device attached to a wireline into a borehole or oil well to measure the properties of the rock and fluids of the formation. The measurements obtained are then interpreted and used to determine the depths and zones where oil and gas can be expected to be found.

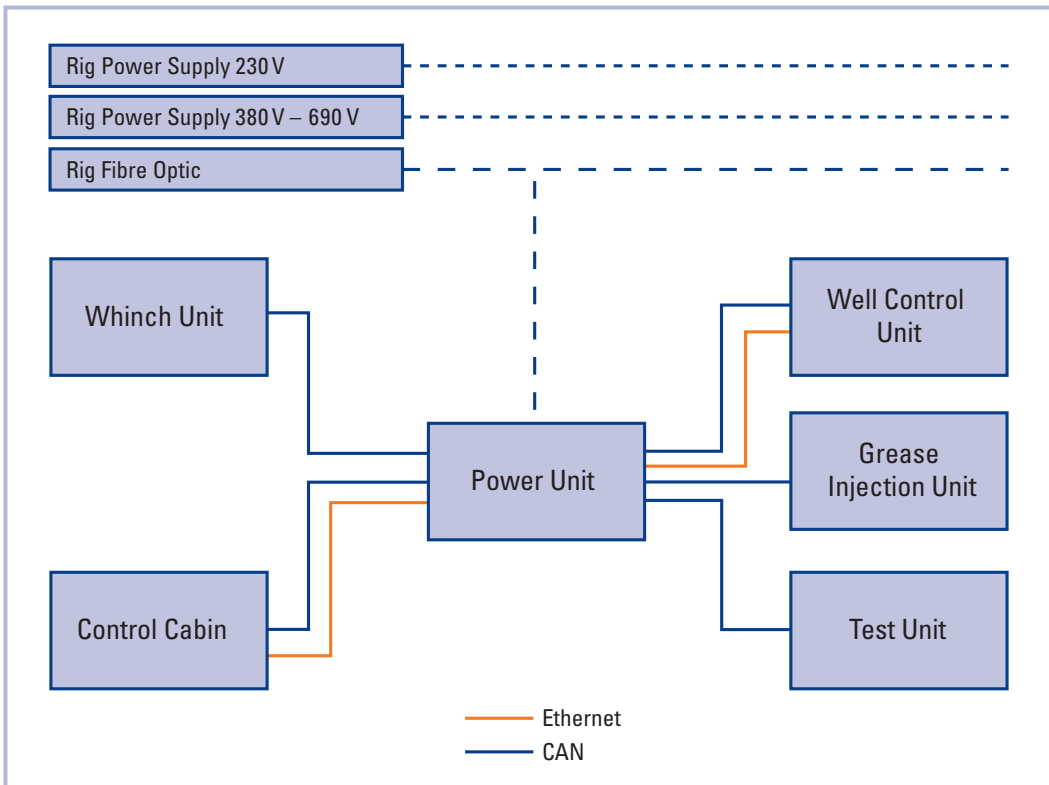


Figure 8: Power Supply and communication system for Wireline



Figure 9 and 10: Smart Monitor with control

### Wireline for Kristin oilfield in Norway

The Norwegian company Statoil is responsible for oil production at ›Kristin Field‹, located in the south-western part of the Halten Bank in the Norwegian Sea. The field was developed with 12 production wells in four subsea templates, tied back to a semi-submersible production platform.

The wire lining has been outsourced to several companies. Wireline units are used at this production site for wireline logging and maintenance, in this case referred to as ›cased hole‹ services.

It is most common to use the wireline unit outside the hazardous areas or in a Zone 2 environment (placed on a truck for onshore applications). However, for this specific application a Zone 1 unit was required.

#### Electromach b.v. / R. STAHL

Already in an early stage the company Electromach B.V. were involved in the discussions how to create a complete zone 1 wireline application. A huge advantage, compared to the competition, was the combination of long-term relationship, workshop, knowledge and experience in explosion protection technology, good contacts with the notify bodies, flexibility in development and last but not least the wide range of products, which makes a one-stop-shopping possible.

Electromach received the order to supply 16 complete wireline units, of which every application contained 6 containers: a winch unit, a control cabin, a power unit, a well control unit, a grease injection unit and a test unit (Figures 7 and 8). →

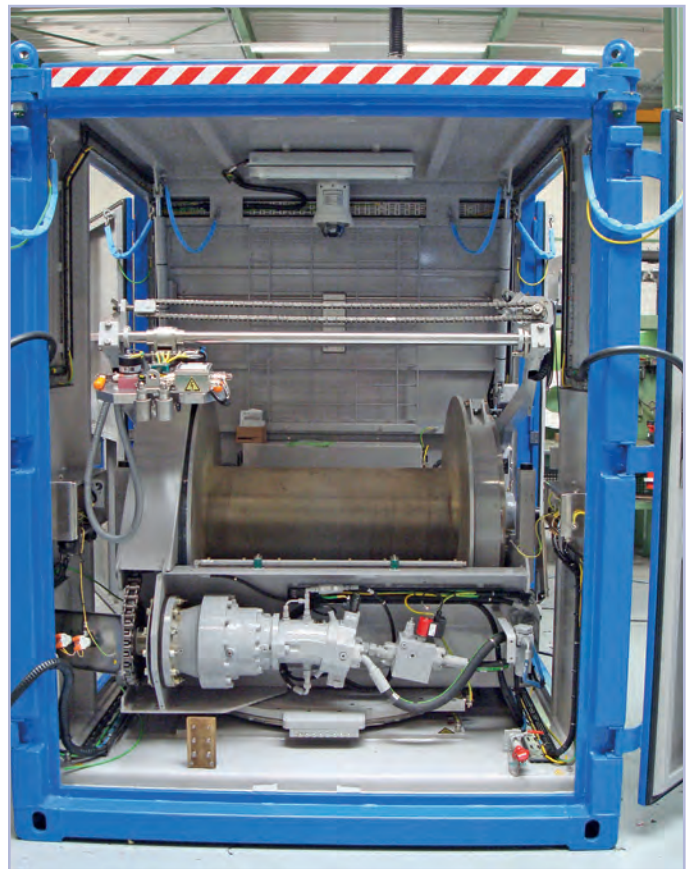


Figure 11: Monitoring winch with cameras



Figure 12: Frequency converter with active cooling system in a flameproof enclosure

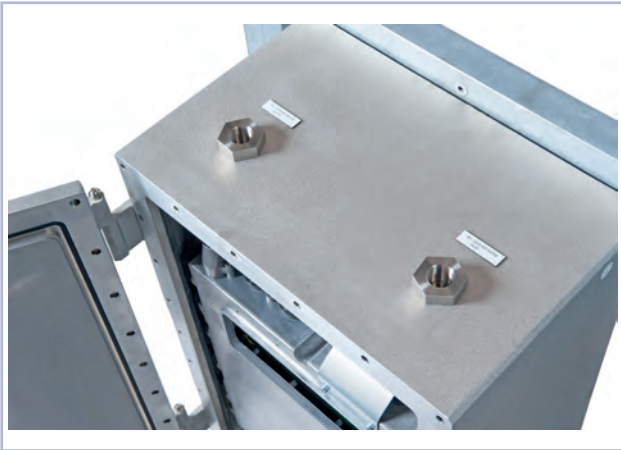


Figure 13: Connection for cooling fluid at CUBEx enclosure

#### *Smart monitor with control for Control Cabin*

For the visualization of the control software of the application a new modern explosion protected PC and a special control was needed in the Control Cabin. The Open-HMI of STAHL-HMI was customized to the demands of the customer. Communication was based on CAN-Bus protocol. The hardware/software combination is called Smart Monitor (Figures 9 and 10).

#### **Winch unit**

For monitoring the winch a »small« explosion protected camera was required. After testing several possibilities, R. STAHL's compact zoom camera (EC-710) and dome camera (EC-750) were selected. The camera images are integrated into the Smart Monitor application (Figure 11).

#### **Power unit**

To provide the applications with the required power, the power pack was equipped with a large transformer (90KVA) and a frequency converter. The converter, equipped with a cooling plate, was built into a flameproof enclosure (CUBEx series). The connection for the cooling fluid was made directly on the CUBEx (Figures 12 and 13).

Space was a critical issue in this project, because of the limited space on the production platforms. The containers had to be built as compact as possible. The use of the modular CUBEx flameproof enclosures contributed to a more compact installation (Figure 14).

#### **Conclusion**

With the early co-operation between user, developer and manufacturer the exceptional and difficult demands on the »Wireline System« in regard to explosion protection and application environment have been optimally solved. The experience Electromach and R. STAHL have with similar tasks for the oil and gas industry had a very positive effect here. So the explosion-protected Wireline-unit for use in Zone 1 that is described here can be qualified as a »top performance« of the two manufacturers. The wireline unit which was designed for »Kristin Field« can be categorized as »top of the line«.



Figure 14: Power pack container (in progress), compact design