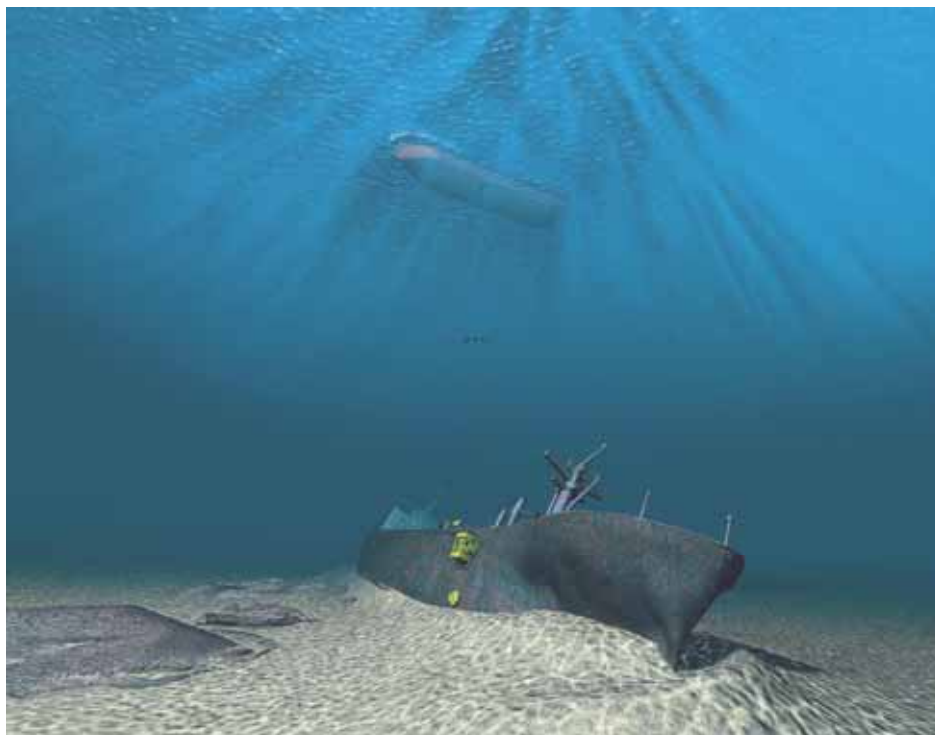


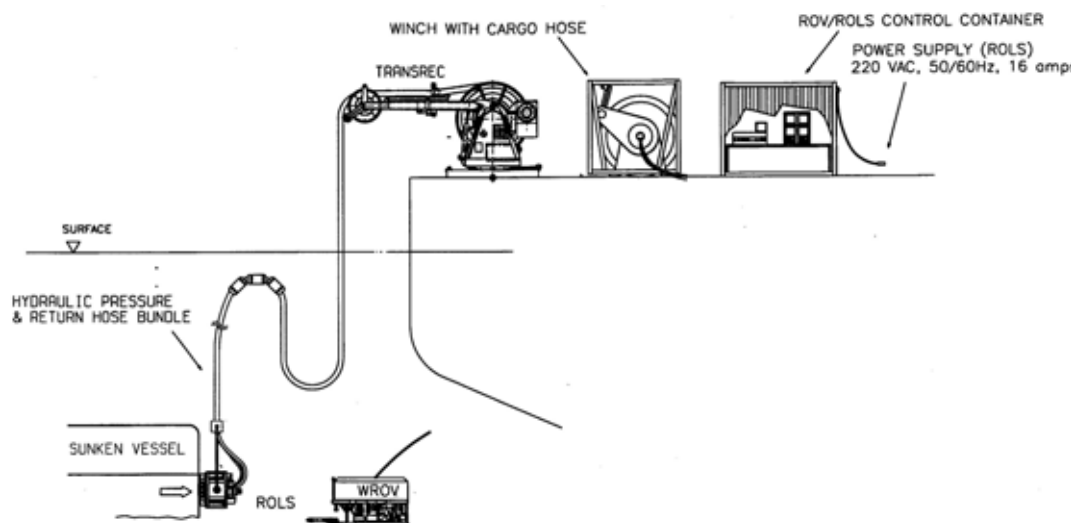
TECHNICAL DESCRIPTION REMOTE OPERATED OFF LOADING SYSTEM ROLS



Frank Mohn Flatøy AS
Oil & Gas Division

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Remote Operated Off Loading System (ROLS)

BACKGROUND

The ROLS project was launched as part of the Norwegian State Pollution Control Authority's program for oil removal from sunken ships.

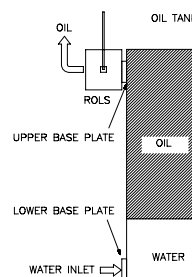
A lot of vessels along the coast of Norway represent a treat to the environment. Most of these ships were sunken during World War II.

The ships are all classified as war graves and during offloading this has to be taken into consideration.

The project early identified the need to develop a driverless tool that could penetrate the tanks of the vessels and recover the fuel oil or cargo located in the tanks. The use of divers is costly, especially in deep waters (100 feet and deeper).

The ROLS system represents a cost effective method for oil recovery of sunken ships/tanks, and the system can be operated from a barge or a vessel.

In addition to be a cost effective method, the system is safe and time saving as no divers are used.



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PATENT

The ROLS unit is a diverless "Hot Tap" system, patented worldwide.

GENERAL DESCRIPTION

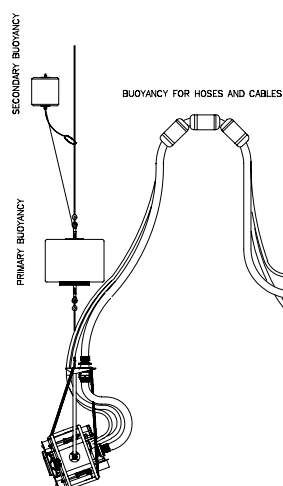
The ROLS operation is carried out from a surface vessel keeping its position by means of DP or four point mooring or alternatively a barge.

The ROLS system is a driverless hot tap and pump system capable of remote recovery of oils and other hazardous liquids from sunken vessels.

It will normally be launched at sea by means of an onboard crane; the ROLS unit is equipped with two thrusters for horizontal positioning of the unit. In addition the ROLS is assisted by a ROV (Remote Operated Vehicle). The ROV should have a thruster capability of approximately 7 HP.

The ROLS system will be powered from a surface hydraulic system via one hydraulic pressure hose and one hydraulic return hose.

The liquid from the wreck will be pumped through a cargo hose up to a surface manifold system and into a tank-vessel.



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All controls of the ROLS functionality will be performed from a surface control system via a sub sea control cable.

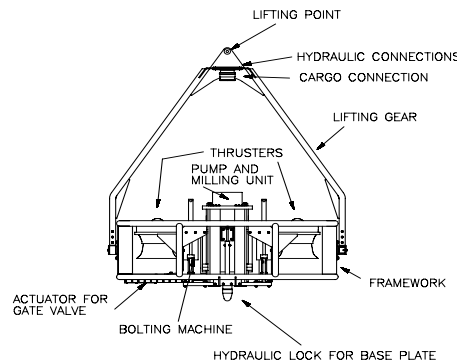
The ROLS unit consists of the following main equipment:

- One pump with milling unit
- Four drilling machines
- One actuator for the gate valve (The gate valve is located in the base plate)
- One hydraulic lock-in device for the base plate
- Two hydraulic thrusters
- One hydraulic control valve unit.
- Four cameras
- Four lights
- Framework, lifting gear, hydraulic connections and protecting screens.
- Materials:

Framework, brackets and other supporting structures are made from sea-water resistant aluminum.

Pump and other moving parts are made from stainless steel (AISI 316L).

Hydraulic motors and hydraulic cylinders are made from carbon steel. For further info see material specifications.



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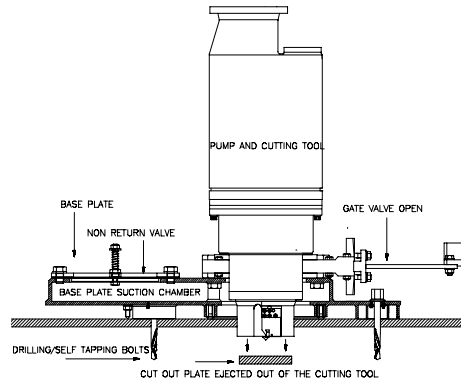
- Cargo hose
- High pressure hydraulic hose
- Low pressure hydraulic hose
- Control cable
- Video cable

Umbilical winch

ROLS operating panel

ROLS landing plates (2 for each tank)

Diesel hydraulic powerpack



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SURVEY

Prior to installation of subsea equipment for penetration of the hull, a survey is performed of the wreck. The survey detects obstacles, and removal of all these will be performed prior to marking of predetermined penetration holes.

The wreck is normally marked with HPR transponders. In addition subsea equipment as the ROV and the ROLS is marked to be able to continuously monitor the location. This to simplify navigation.

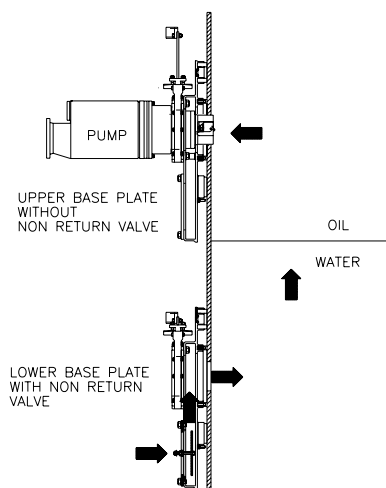


MARKING OF TANKS

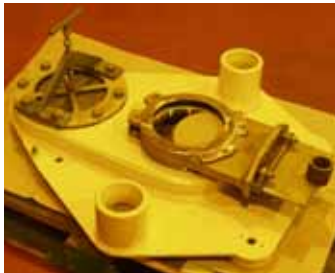
Prior to penetration of the hull, the attachment points are marked by the ROV. Attachment points and co-ordinates are calculated from the as built drawings of the vessel by adequate structural analysis and calculations related to stiffening arrangement. The co-ordinates are based upon known reference points such as welding seams, water inlets etc.

SUBSEA WORK

Each tank will have two penetration points. One at the lower part of the hull, and one at the upper part of the hull. The ROLS concept utilizes the difference in physical and chemical properties between seawater and oil. Since the density of the oil is lower than the density for water, it is important that the upper plate is located as high as possible on the tank, to be able to recover as much as possible. The lower Base Plate is equipped with a non-return valve allowing water to be sucked into the tank when the ROLS is pumping out the oil. This is necessary to maintain the pressure balance between the internal tank and the ambient pressure. Alternatively this balance may be maintained by utilizing the ventilation hoses from the tank to the deck.



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Combined drill and thread making bolt

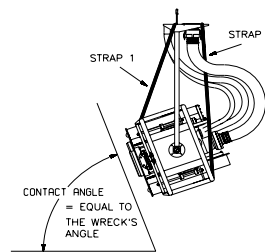
After the ROLS is guided gently down to the lower part of the wrecks' oil tank, and there is physical contact between the base plate and the wreck, the two ROLS thrusters are started and increased to maximum power.

Due to the friction between the Base Plate and the hull, the ROLS unit will remain steady in this position without any external support either from the ROV or from the crane.

The ROV is released from the ROLS and "fly" back to a position where it can observe the ROLS operation.

Adjusting the contact angle

If it is necessary to adjust the angle of the ROLS, this is done by strapping it up to the lifting gear, by means of two straps. This angle is necessary to set in order to hit the angle in which the wreck is laying. This angle will be set finally as the thrusters will force the ROLS into the wreck side.



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ROLS IN OPERATION

Bolting the lower Base Plate to the tank, for seawater inlet.

After the ROLS with lower base plate is in position, the thrusters will push with full power. The bolting machine is started, and one by one the bolts are connecting the base plate to the hull. Each bolting operation will take approximately 3-6 minutes depending on the plate thickness.

When the base plate is bolted to the tank, the thrusters are turned off.

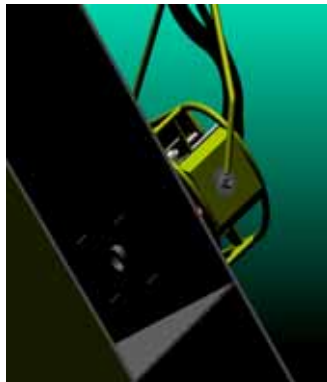
Penetrating the tank

After the lower base plate with check valve is bolted, penetration of the hull can start.

A hydraulic cylinder moves the pump and milling unit in forward position.

Penetration of the oil tank in the wreck is done by that the ROLS is drilling out a circular plate. This plate will be ejected out from the milling tool and into the tank by means of a spring-loaded ejector.

The duration of the penetration will normally vary between 9 and 12 minutes. After penetration, the pump and milling unit will be retracted, and the gate valve is closed.




Releasing the ROLS unit from the base plate.

The hydraulic locks for the base plate will be released, and the ROLS unit will be pushed away from the wreck by running the thrusters backwards. The ROLS is hoisted to the surface and prepared for the next base plate.



Preparing for the second base plate, upper base plate for discharging of oil.

The second base plate will then be made ready for connection. This plate is located at the top of the wreck's oil tank. Launching, guiding, bolting and penetrating will be performed as described above.

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Pumping

When the tank is penetrated, the pump will not be retracted as for lower base plate. The pump remains in the foremost position. In this position the pump will seal against the gate valve, and thus oil will not leak out to the ambient area. It is then ready to start pumping. The pump speed is step-less variable from minimum to maximum speed. Water is flowing through the non-return valve in the lower base plate and into the tank simultaneously as the pump is pumping via the upper base plate.

Note that if the oil is viscous, the pump speed will be reduced in order to avoid that water is creating a vertical "channel" through the oil and up to the pump suction area.

Releasing the ROLS unit from the base plate.

After the pumping has been completed, the pump is retracted and the base plate valve closed. The ROLS is disconnected from the base plate and can return to the surface by means of the ship crane and the ROV.

HYDRAULIC SYSTEM

The hydraulic system consists of proportional-valves stacked together, and an oil-filled pilot block with solenoid valves. Electrical control signals from the topside control panel controls the pilot solenoid valves. The solenoid valves controls the proportional valves.

The proportional valves adjust all hydraulic pressure settings and flow limitations. The hydraulic oil is routed to the hydraulic consumers through hydraulic hoses. All fittings are made of stainless steel.

For further information see hydraulic diagram.

LIFTING GEAR

The ROLS unit is hinged in the lifting gear. Connections for hydraulic pressure and return connection for the cargo outlet are located on the top of the lifting gear.

CAMERA SYSTEM

The ROLS system is furnished with four black and white cameras and four sub sea lights. Signals and power for the cameras and the lights are via hardwired umbilical to the surface. Black and white monitors are connected to the junction box.

The camera system requires 220 VAC 50/60 single-phase power.

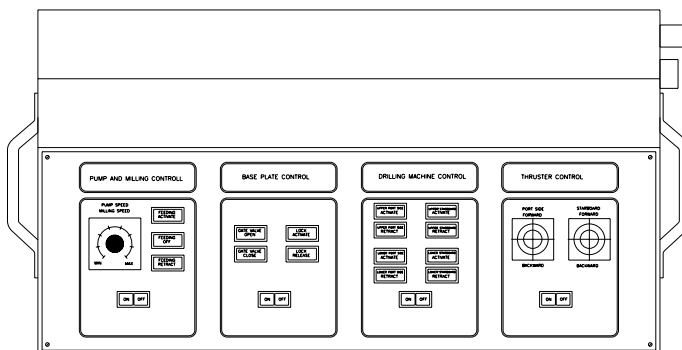
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CONTROL PANEL

The control panel is separated into four main sections:

One section for “ Pump and Milling Control”, one section for “Base Plate Control”, one section for “Bolting Machine Control” and one section for “Thruster Control”.

The required power supply is 220 VAC single phase, 50/60 Hz, 16 amps. The panel is designed for indoor use only, and will normally be placed on a desk. The weight is approximately 40 kg and can be carried by two persons.

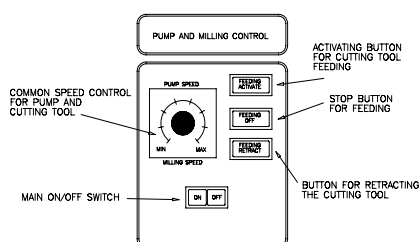


Pump and milling control

This section of the control panel controls the pump and cutting tool functions. The main on/off button must be activated before operating the functions. By means of the potentiometer the pump and cutting tool speed is step less adjustable from min to max.

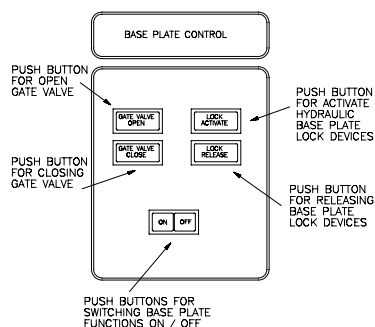
One button activates the forward feeding, one button stops the feeding, and one button retracts the pump.

There are also buttons for switching the control section on and off.



Base Plate control

The two hydraulic lock-in devices, provides that the base plate is locked to the ROLS. After they are guided into the engagement sleeve on the base plate, they will be locked to the sleeve.



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The locks are operated from the “base plate control” section on the control panel.
The base plate control will also operate the gate valve.

Drilling machine control

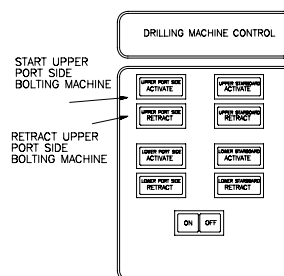
When pushing one of the activating buttons, the hydraulic motor and the hydraulic feeding cylinder will start simultaneously.

When pressing the retract button, the hydraulic motor will stop, and the hydraulic feeding cylinder will retract the drilling machine to the rear position.

The drilling speed and the feeding pressure is pre-set from factory, and should normally not be adjusted.

Pressure setting of the drilling machine must be set directly on the proportional valve on the ROLS unit.

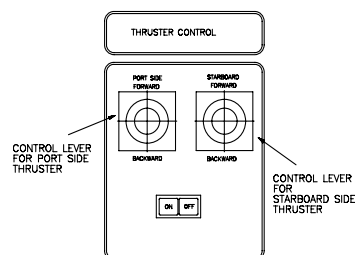
The bolting machines are not reversible in order to screw out the bolts.



Thruster controls

From this section the thrusters are operated.

Each thruster (starboard and port side) are independent adjustable by means of a control lever.



OPTIONAL EQUIPMENT FOR SPECIAL DISCHARGE PROJECTS

In special discharge projects we can utilize the following concepts. These however represent just some few alternatives. For your special projects we will adjust our concept to meet the requirements.

Discharge of vessels with double hull

Installation of Double Bottom Tool for seawater inlet

For these projects we will use the FRAMO Double Bottom Tool (DBT). The Double Bottom Tool is lowered down to the wreck, where the ROV picks her up. The ROV guides the tool into the already installed base




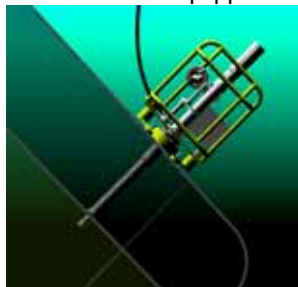
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plate and ensured that it was sealed and locked, before the inner hull is penetrated.

The tool consists of a caisson with a ball joint seal. The caisson is moved/pressed against the inner hull. A sealed contact between the caisson and the pump is established. In addition the double bottom tool consist of a hydraulic driven motor with extended shaft. The shaft is equipped with a cutting bit to penetrate the inner hull. The lower Double Bottom Tool is equipped with a check valve, which allowed



seawater to enter the tank upon discharge from the upper base plate.

The DBT installed at the upper base plate is equipped with a pump.

Once acceptable level of cargo is pumped out, the Double Bottom Tools is released from the base plate and retrieved to the surface. The ROV can then close the gate valves, and leave the tank sealed off.

