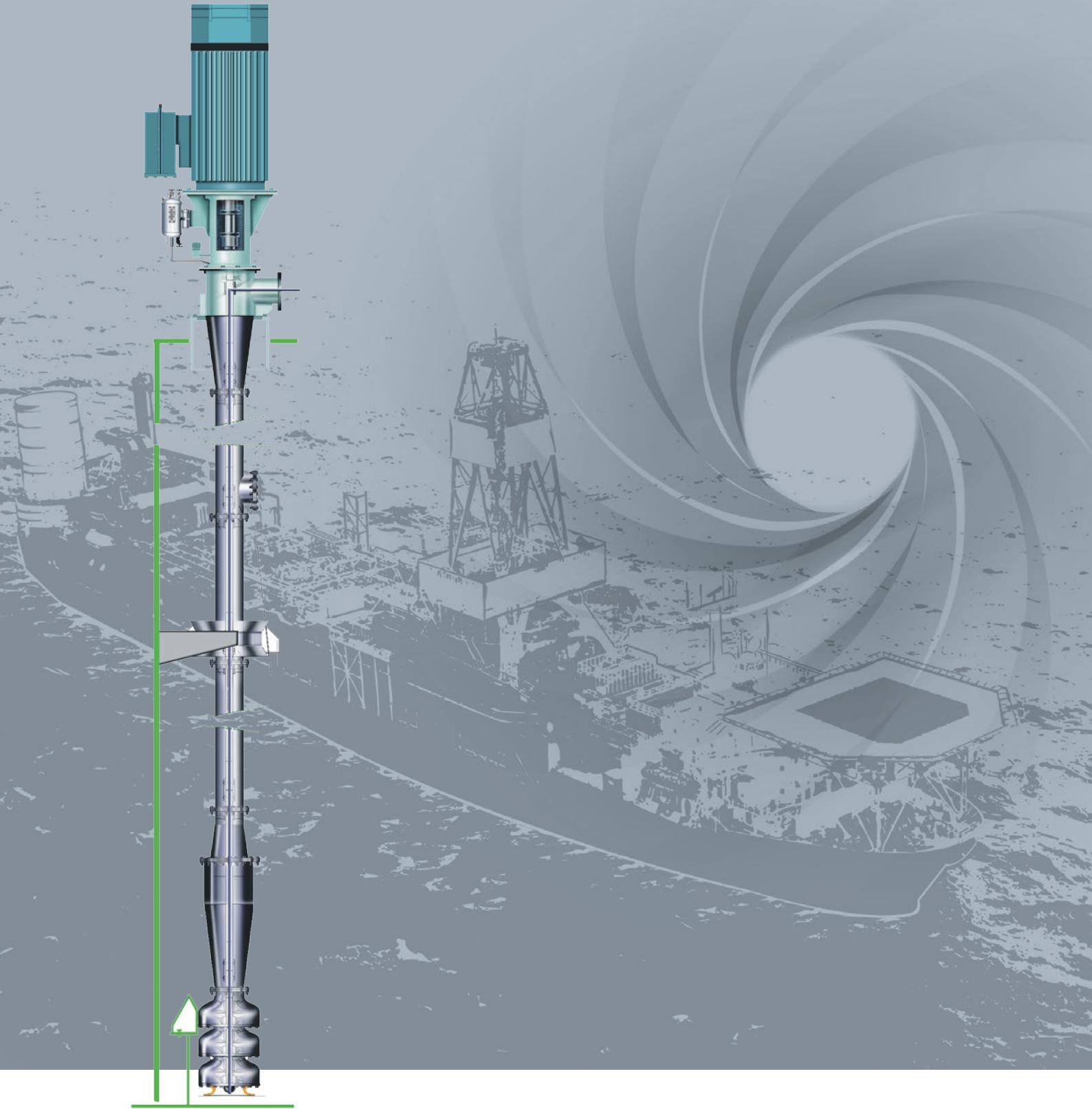


EUREKA CARGO PUMP SYSTEM for FPSO, FSO and Shuttle Tankers



Keep going. Keep safe.

EUREKA

BUILDING TRUST THROUGH **EXPERIENCE** FPSO, FSO, SHUTTLE TANKERS



FPSO PETROJARL 1, PGS



FSU NJORD, NORSK HYDRO



MV FUTURA & NATURA, NESTE SHIPPING



FSO CAKERAWALA, C-TOC



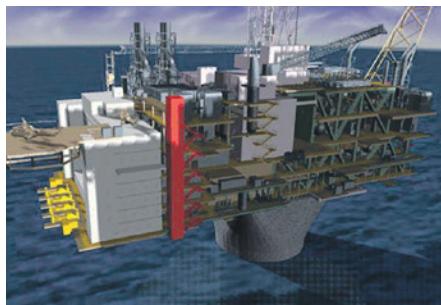
FPSO PETROJARL FOINAVEN, PGS



FSO BAYU UNDAN, CONOCOPHILLIPS



FPSO NORTHERN ENDEAVOUR (LAMINARIA),
WOODSIDE



HEBRON, EXXON

OVER 1000 LINE SHAFT PUMPS
delivered to marine & offshore markets

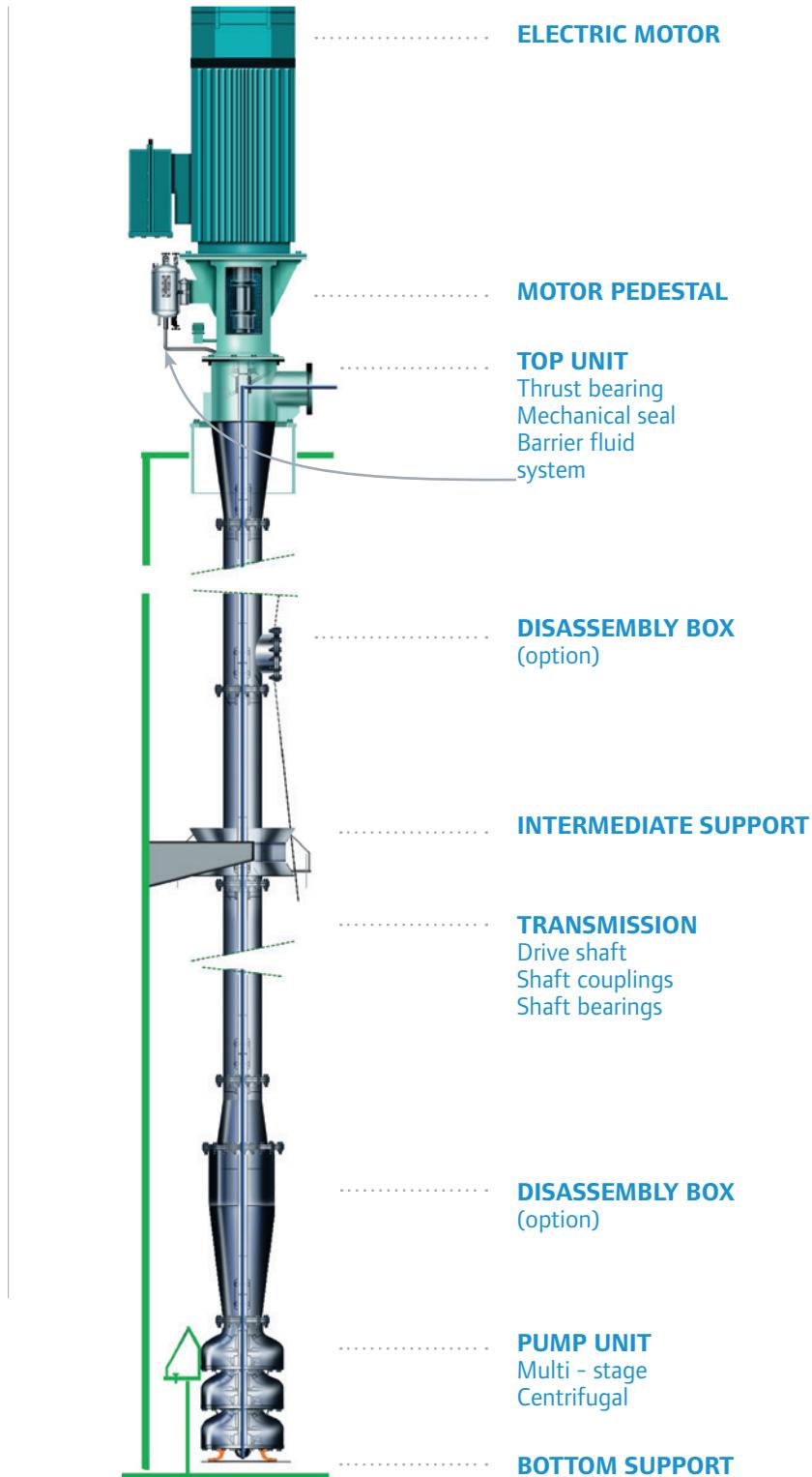
CARGO EXPORT, BALLAST & BOOSTER PUMPS

The electric drivers are vertical explosion proof marine type electric motors of the same type used on product tankers and gas carriers.

The motor pedestal is made of painted carbon steel material.

Line shaft pumps have axial thrust taken by a deck head mounted thrust bearing or by the bearing in the driver. Either an oil or grease lubricated thrust roller/ball bearing is used.

- Several intermediate shafts are connected by sleeve couplings. The standard shaft length is two times the column section length and supported by two journal bearings.
- Journal bearings are of the product lubricated sleeve type. Typical material is carbon/graphite with excellent dry running capabilities.
- Impellers are keyed to prevent rotation and are axially secured between shaft sleeves and shaft lock nut. Thus securing the impellers in the correct axial position, as well as protecting the shaft from wear under the bearings in the pump unit. As an option, the intermediate shafts can also be delivered with protective sleeves under the journal bearings in the riser.
- The impeller is single suction and designed with a large eye area to ensure low NPSH requirements and thus reduce the possibility of cavitations.
- The pump bowls are of the diffuser type. Each diffuser has an outlet flange screwed to the next diffuser or first riser column. Together with the riser columns and discharge bend on deck, they are designed for the required working pressure.



THE ADVANTAGES OF EUREKA ELECTRIC DRIVEN DISTRIBUTED PUMP OFFLOADING SYSTEM



The Eureka electric driven cargo oil export system gives you optimized HSE values like; **high system efficiency, low energy consumption, low noise and safe maintenance.**

The Eureka deepwell pump is a centrifugal, single- or multistage, product lubricated line shaft type.

The Eureka distributed pump arrangement has one deepwell pump in each cargo tank. Each pump can have a differential pressure up to 22 bar (g) and there are no limitation on capacity. The Eureka deepwell pumps are electric driven with explosion proof deck-mounted motors. For higher pressure and other operational scenarios booster pumps are incorporated in the system.

RELIABILITY

Cargo oil offloading is a part of the main stream on stationary installations and requires offshore technology standard. The API 610 standard of the Eureka deepwell pumps secures built in overload capacities and long lifetime of the pumps. Proven technology with over 1000 pumps delivered.



ENERGY EFFICIENCY SOLUTION

Our electric driven deepwell pumps are designed for high output and low energy consumption. This is based on proven technology from the electric power supply industry. Optimized fluid design of the pump units and carefully designed drive shaft arrangements further contribute to low generator power demand.

EASY MAINTENANCE & LOW OPEX

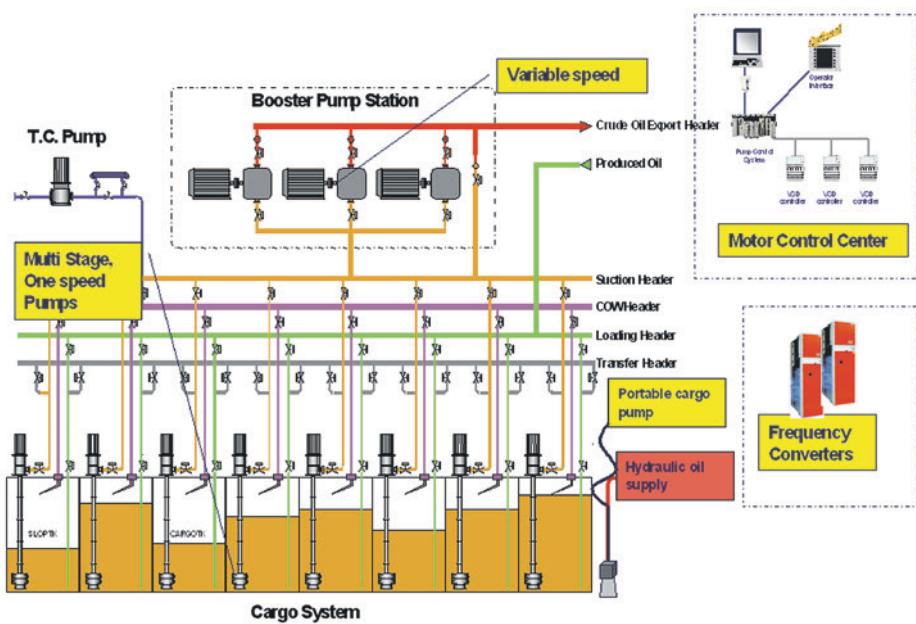
All critical parts are placed and maintained from the top deck side. Pumps are designed for continuous operation with 20 000 hours interval between major inspection. In remote locations the Eureka deepwell pump is easily maintained by the crew.

REDUCED POSSIBLE FAILURE MODES

Eureka distributed pump arrangement ensures that a potential problem with one of the pump units will not affect other parts of the offloading system. The risk for a potential problem is dramatically reduced because of the low system complexity (direct drive) and fewer possible failure modes.

LOW INSTALLATION COST

Eureka electric deepwell pumps are easy to install with the majority of the installation work to be carried out from the main deck. The installation does not require pump suction piping nor power supply piping. The main installation should not become a critical task as it can be carried out as an independent task late in the building process.



TANDEM OR SIDE BY SIDE OFF-LOADING

This crude oil export system is based on off-loading to a shuttle tanker or conventional tanker in either tandem or side by side configuration. The pressure required by the off-loading system is normally below 15 bar

Crude Oil Export Arrangement

Crude oil export is carried out by one multi stage deepwell pump (1) in each cargo tank. The pump pressure is sufficient to pump directly to the shuttle tanker via the off-loading header.

The multi stage deepwell pumps (1) are driven by two-speed explosion proof electric motors. Low speed is used for filling up of pipe line, crude oil transfer, draining of tanks and off-loading at low capacities. High speed is used for high off-loading capacity and crude oil washing.

The system is very flexible and designed to meet all different operational conditions.

Pump Specification

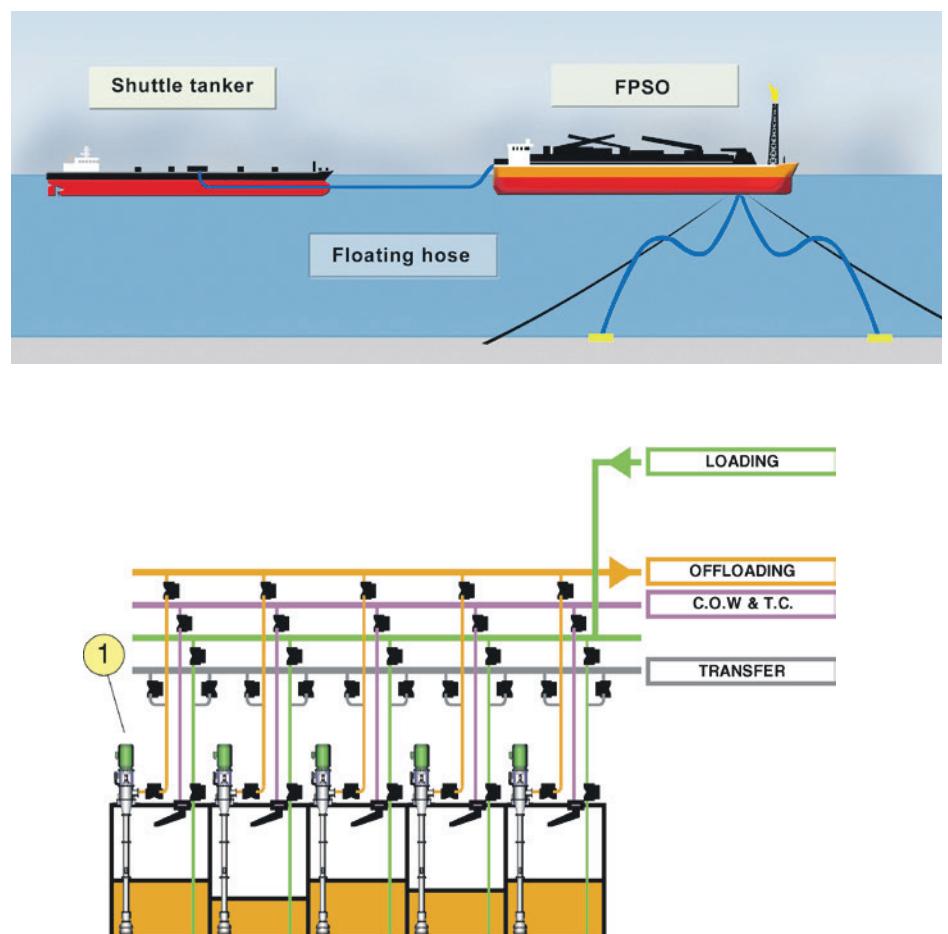
Crude oil export off-loading system based on one crude oil export pump in each cargo tank. The pumps have sufficient head to offload directly to the shuttle tanker. The total rated off-loading capacity is achieved by operating a number of pumps simultaneously. The pump pressure should be sufficient to achieve required off-loading pressure (Considering friction loss and static height in the total system including FPSO, shuttle tanker and off-loading hose).

Tandem configuration

Off-loading is carried out to a tanker via a floating hose. The tanker is moored in tandem with the FPSO. The hose is connected between the stern off-loading station on the FPSO and to the cross over manifold of the tanker.

Side by side configuration

The tanker is moored side by side with the FPSO and off-loading is carried out via a flexible hose between the cross over manifold of the FPSO and the tanker.



CRUDE OIL EXPORT PUMP

Type : Vertical multi stage deepwell centrifugal
Standard : API 610
Total head : 120 - 200 mfc
Shaft seal : Double mechanical w/barrier fluid
Material : AISI 316 (recommended)
Motor Type : Explosion proof, Vertical electric motor
Ex. Classification : Exde IIB T4

PIPELINE & BUOY OFF-LOADING

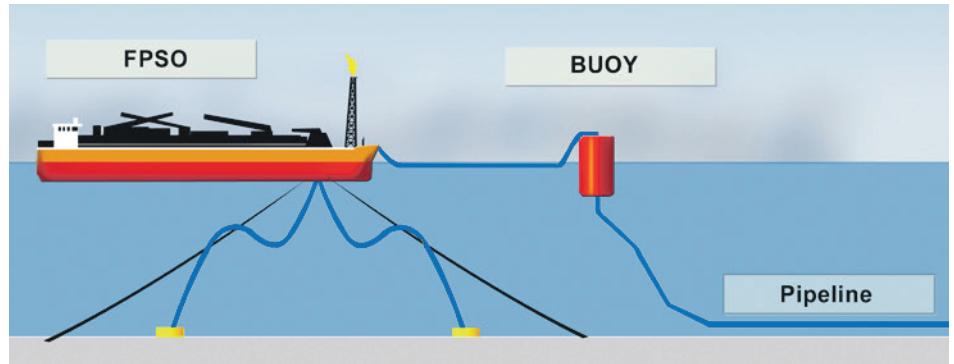
This crude oil export system is based on off-loading to a pipe line where high pressure of up to 50 bar is normally required

CARGO EXPORT LIFT PUMP (1)

Type	: Vertical Single stage deepwell centrifugal
Standard	: API 610
Total head	: 30 – 50 mfc
Shaft seal	: Double mechanical w/barrier fluid
Material	: AISI 316 (recommended)
Motor Type	: Explosion proof, Vertical Single-speed electric motor
Ex. Classification	: Exde IIB T4

CARGO EXPORT BOOSTER PUMP (2)

Type	: Horizontal Single stage centrifugal
Standard	: API 610
Total head	: 200 – 600 mfc
Shaft seal	: Double mechanical w/barrier fluid
Material	: Carbon steel (recommended)
Motor Type	: Explosion proof, Vertical variable-speed electric motor
Ex. Classification	: Exde IIB T4



PUMP SPECIFICATION

Crude oil export off-loading system based on one crude oil export lift pump in each cargo tank. The lift pumps have sufficient head (Tank height + 15 mfc) to supply a suction header on deck which in turn supplies the booster pumps on deck. The total rated off-loading capacity is achieved by operating a number of lift pumps simultaneously. The booster pumps are speed controlled and boosts the pressure to that required for off-loading pressure (Accounting for friction loss and static height in the total system including, FPSO, Pipeline, Buoy and off-loading hose). The total capacity of the booster pumps shall be equal to the rated off-loading capacity.

Buoy configuration

A floating hose connects the FPSO to the buoy. The floating buoy is connected to on shore storage via a pipeline.

Direct pipeline configuration

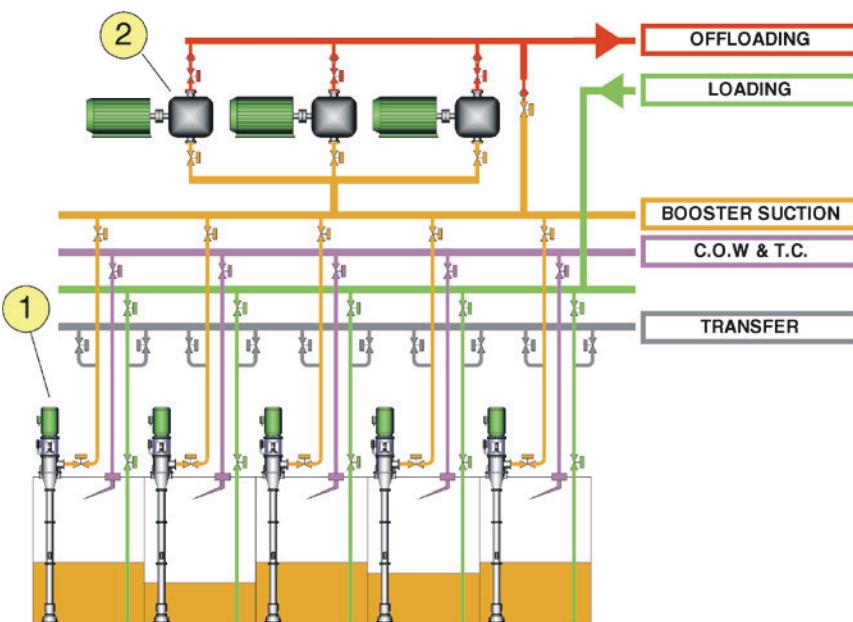
A pipeline connects the FPSO and the on shore storage directly through the turret.

Pipeline Off-loading

Crude oil export is carried out by one single stage deepwell pump (1) in each cargo tank. The pump pressure (up to 5 bar) is sufficient to feed the on deck mounted booster pumps. The booster pumps (2) creates the required pressure (up to 50 bar) for off-loading.

The single stage deepwell pumps (1) are driven by one-speed explosion proof electric motors and the booster pumps (2) are driven by frequency controlled explosion proof electric motors.

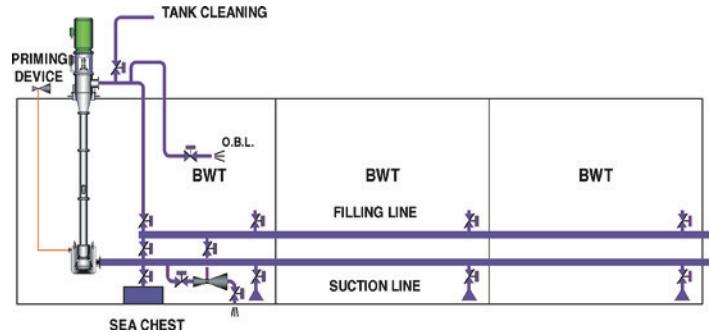
For operation during filling up of pipe line, crude oil transfer, draining of tanks and off-loading at low capacities, only the single stage pumps are used. Booster pump operation is used for high off-loading capacity and crude oil washing.



UTILITY SYSTEMS

Ballast Water System

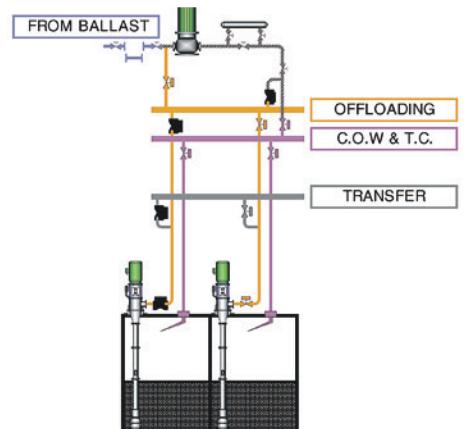
The ballast system is based on single stage deepwell pumps installed in the aft wing ballast tanks on both port & starboard side. The pumps have a suction bucket which can be connected to the piping system in the ballast tanks. A stripping ejector is used for stripping of the ballast tanks. To achieve high flexibility in all operation, the ballast system has a suction line for de-ballasting and a filling line for ballasting. Priming of the pumps is carried out by a priming device installed at deck level. The Port & Starboard side ballast systems are interconnected. For large capacity systems two pumps can be installed in each Port & Starboard side.



TANK CLEANING & CRUDE OIL WASHING SYSTEM

Tank cleaning

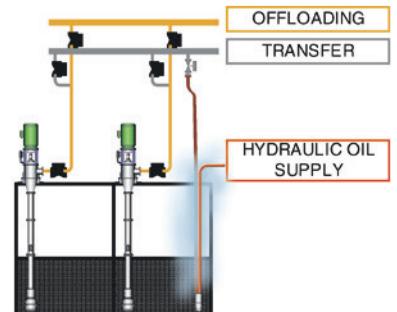
A tank cleaning pump is installed on the main deck. Sea water is supplied to the suction side of the pump by either the Port or Starboard side ballast system via a spool piece. The tank cleaning pump has sufficient pressure to supply the tank cleaning machines via the COW and Tank Cleaning header. If hot water is required, the water can be heated by pumping through a butterworth heater.



PORTABLE UNLOADING SYSTEM

A portable unloading system is used in case of failure of a main cargo pump. The portable pump is used for transfer of crude from one tank to another. The pump can be lowered into a cargo tank through a standard butterworth opening. The pump is hydraulic driven and is supplied by a separate hydraulic power pack or the hydraulic power pack of other utility systems. The crude oil is discharged through a flexible hose which is connected to the transfer header and transferred to the available cargo tank. Off-loading of the crude oil can then be carried out by the deepwell pump in this tank.

The portable pump can also be used for completely draining of a cargo tank in case of maintenance and gas freeing. The pump is supplied together with a portable tripod winch.



ACCESSORIES



VARIABLE SPEED DRIVE

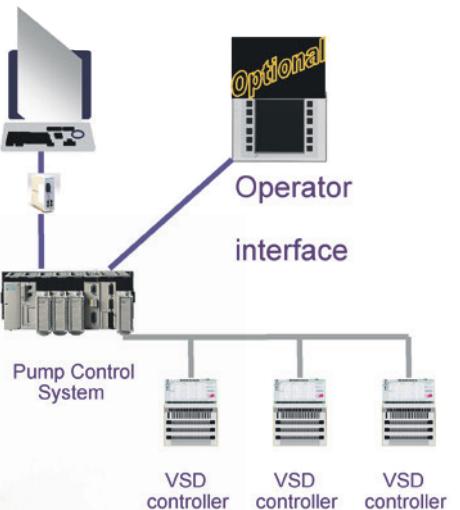
As an option we can offer the latest technology in frequency converter VSD where the frequency converters are used both soft start up and matching pump capacity and pressure to process requirements. The technology in the field enables us to start up pump, bring it to full speed and, when speed control is not needed, phase it into a fixed bus arrangement.

All frequency converters are designed for marine applications, approved by the classification societies.

MOTOR CONTROL CENTER

The electric driven Eureka pump system can easily be connected to the centralised system and the software will be an integrated part of that.

Optional EPS can supply direct online MCC (Motor Control Center) units including motor starters.



CARGO EXPORT, BALLAST & BOOSTER PUMPS

CARGO EXPORT PUMP

Electric driven multi stage deepwell pump. Can be delivered in a wide range of materials suitable for pumping crude oil under all FPSO operating conditions. Electric motor is two speed explosion proof type. This gives high efficiency and reliable operation during all conditions.

MODEL	CAPACITY	HEAD
CD200	500 - 800 M3/H	25 - 200 MLC
CD250	800 - 1600 M3/H	25 - 200 MLC
CD400	1600 - 2000 M3/H	25 - 200 MLC
CD450	2500 - 4000 M3/H	40 - 180 MLC

BALLAST PUMP

Electric driven single stage deepwell pump. Can be delivered in a wide range of materials suitable for pumping sea water under all FPSO operating conditions. The electric motor is of the single speed explosion proof type, giving high efficiency and reliable operation during all conditions.

MODEL	CAPACITY	HEAD
CD200	500 - 800 M3/H	25 - 50 MLC
CD250	800 - 1600 M3/H	25 - 50 MLC
CD400	1600 - 2000 M3/H	25 - 50 MLC
CD450	2500 - 4000 M3/H	40 - 50 MLC

CRUDE OIL BOOSTER PUMPS

Direct electric driven or variable speed, frequency controlled drive API610 vertical or horizontal single stage centrifugal pump, skid mounted. The pump can be delivered in a wide range of capacity and head specification. Normally three units are used to obtain rated offloading capacity.

MODEL	CAPACITY	HEAD
BB2	UP TO 5000 M3/H	UP TO 600 MLC



COMPONENTS OF THE EUREKA DEEPWELL PUMP

The Eureka deepwell pump is a vertical turbine product lubricated line shaft type pump. It is designed according to API 610 for continuous pumping duty under all operating conditions. For crude, condensate, LPG and methanol duty the pump is delivered in SS316 material. For ballast and seawater duty the pump is delivered in Duplex 22Cr, 25Cr, or Ni-Al-Br material. The drive shaft is always delivered in Duplex 25Cr material.



FEATURES

API 610 design - Journal bearing distance is according to API 610. The running speed of the pump is max. 75% of the critical speed. This gives an under-critical tolerance of minimum 25% as specified by API 610.

Easy and safe disassembly and assembly – The pump can be disassembled without entering the tank, or in the tank when equipped with dismantling boxes. In order to pull the pump below the process deck the pump can be delivered with reduced shaft length (option). The in tank components are long lifetime items (min. 20.000 hours). All critical parts are situated on deck in the top unit or electro motor. An inflatable safety seal is used to prevent gas leakage by maintenance operation in the top unit.

Continuous duty under all operation conditions – Line shaft is an efficient way of transferring power. The energy transferred in the Eureka pump is very low and do not cause any damage to the journal bearings. The line shaft pump with a typical length of +/- 30 m can deviate 30 cm from alignment centre without causing any damage. Hence, the pump is not critical to bulkhead deflection or bending of vessel hull.

With FEM analysis the location of the pump supports are predicted to avoid vibrations on the deck head. Typically a pump have one intermediate and one bottom support. Pump axial thrust is taken by deck head mounted thrust bearing.



HIGH VISCOSITY QUALIFICATION OF EUREKA API 610 LINE-SHAFT PUMPS THROUGH EXTENSIVE FULL SCALE TESTING

In 2014 and for the first time Eureka Pumps performed a full scale, high viscosity pump performance test for a 2-stage vertically suspended (VS1) API610 pump. The test scope was part of an ongoing EPC project and exclusively conducted for industrial purposes. The viscosity range for the complete test scope, including the internal test conducted in preparation for the official tests was 480 cP to 3075 cP. The objective, to simulate real field operation with crude oil and qualify the pump for the given field conditions and requirements were successfully achieved. The test stand with its complexity worked satisfactorily throughout the complete viscosity range (480 - 3075 cP).

Furthermore, the reason for conducting this test scope was the uncertainties in published methods of predicting high viscosity fluid pump characteristics, limited available literature, hence reduced field operational risks.

Measured results were then compared to published methods for pump characteristics viscosity correction. The objective for these additional analyses was to evaluate possible alternative approaches in order to improve uncertainties with viscous prediction and ultimately reduce the number of tests/test scope in future projects.

The conclusion was quite interesting. Test results compared with Hydraulic Institute (HI) and GÜLICH's viscosity prediction shows discrepancies for all performance parameters consisting of flow, head and power/efficiency. A major observation is the significant under-prediction of power for both GÜLICH's and Hydraulic Institute (HI) prediction from 1994 and 2010 when compared to actual measured power consumption. The discrepancy increased with increasing viscosity. HI from 1994 gave the most conservative/hence the most accurate power corrections. It should be emphasized that this comparison is simply for discussion

within the industry and not for validation of published methods of viscosity correction for pump characteristics.

The test results provide valuable insight of the effects on high viscosity pumping and by improving the predictions this will allow a more accurate rating and efficient optimization of the process equipment, e.g. electrical motor, valves, cooling system.

In cases where installation cost, maintenance cost and loss of production are critical in financial terms and where the uncertainties regarding performance predictions are high, realistic laboratory testing with real fluids, real operating points and specific design of the pump may be necessary to mitigate the potential risks.

Ref. "High Viscosity Test of a Crude Oil Pump" a scientific paper by Brigitte Le Fur, Cato Knutsen Moe & Fabien Cerru.



EUREKA PUMPS AS is a Norwegian pump supplier with more than 40 years of experience in the oil & gas and marine industry, offering a range of pumps and generator sets that covers a majority of applications. EUREKA PUMPS supplies to new builds and offers services for upgrading, modification, equipment testing, installation and commissioning.

EUREKA PUMPS is a market leader among companies operating on the Norwegian Continental shelf, and it is also present in International markets with selected applications, based on own technology. EUREKA PUMPS main office is in Oslo (Lysaker), Norway, and has offices and advanced service facilities along the Norwegian coast. EUREKA PUMPS also has offices in Houston St. Johns, Busan and Kuala Lumpur.

EUREKA PUMPS is one of five companies in the ALIGN group, a leading supplier of production equipment and safety critical products and solutions. ALIGN offers services ensuring continuous production, a perspective that safeguards optimal operations and lower life-cycle costs. The ALIGN group is owned by Converto Capital and HitecVision.

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