TECHNICAL DESCRIPTION

Framo Cable Free Electric Submersible Pump

Reliable technology for continuous operation

The Framo advantage

At Framo, we're driven by the simple idea that pumps should never be isolated from the task they perform. It's a belief that revolutionized marine cargo handling. And today it's creating new possibilities for faster, safer and more profitable business in the oil and gas industry.

It's also an idea backed up by experience. Framo has proud roots that stretch back to 1938, and marine customers have put their trust in our unique pumping technology for over 50 years.

But even more important is the trust that customers place in us. That's why we see our designs through from start to finish at our own facilities in Norway, where we test each project in full scale before delivery.

Framo customers know they receive full support throughout the service life of their equipment. No matter the problem, our experts can be dispatched 24/7 to any location worldwide, and they stay until the issue is resolved.

With a global organization of 1200 dedicated employees, we are a partner you can rely on.

Achilles JQS empowered by Achilles Qualified

IEC IECEx

DNV NORWEGIAN ACCREDITATION MSYS 002
ISO 9001/ISO 3834-2/ISO 14001 CERTIFIED COMPANY

Think outside the pump room

Pumps are the heart of oil and gas processes. But traditional solutions with a central pump room mean wasted space, added risk and higher operational costs.

Framo pumps are different. Submerged in simple side-mounted caissons, they eliminate both hull penetrations and the need for a massive internal pump room and extensive piping.

Powered with the unique electric Framo cable-free concept, submersible pumps also ensure increased uptime. This is thanks to a short, stiff rotating shaft that avoids excessive wear and tear.

The total result is a pumping solution that reduces risk while saving both space and money. That's what it means to think outside the pump room.

List of contents

Cable-free electric submersible pump

The Framo electric submersible pump comprises three main parts:

- Pump/motor unit with end suction
- Pipe stacks with integral electric power transmission system (riser pipes)
- Top plate arrangement with el. junction box and Condition Monitoring System (CMS)

The Framo electric submersible pump is an electrically driven close-coupled end suction centrifugal pump with one or two stages. The suction inlet of the pump is the lowest point of the pump assembly.

The power transmission system integrated in the pipe stack is a unique feature for the Framo Electric Submersible Pumps. In lieu of a conventional solution with a cable running down the outside of the riser pipe to the motor, the electric conductors are located inside a protective pipe and provide power supply to the motor.

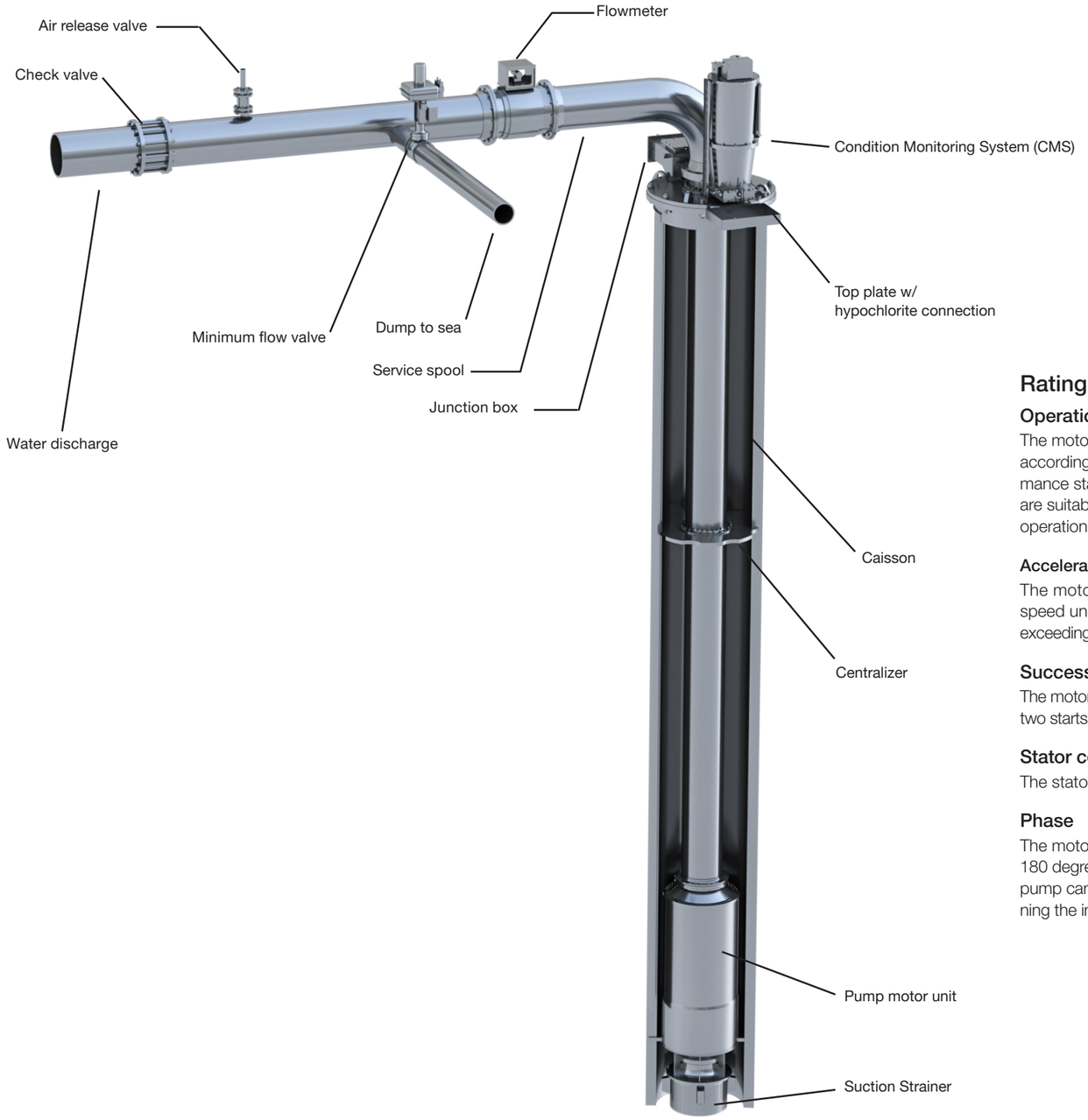
The conductors are mounted inside a protective pipe (cofferdam pipe) by means of insulation pieces. The electric conductors are hollow copper pipes that allow the conductors also to be the return line of the circulated lubricant. The oil pipe assembly is mounted concentric in the water pipe forming a complete section of the pipe stack.

The riser pipe sections are flanged together to make up the required length of the pump. When the pipe stacks are connected, the electric transmission system is connected automatically, i.e. there is no additional handling of cables or separate conductors.

The electric connections are made with male/female sliding band connectors, fitted to each end of the conductor pipes.

A forced oil circulation system is applied for cooling, insulation, lubrication and overpressure protection.

The lubricant is circulated by use of a circulation skid located close to the pump. Overpressure is maintained statically during stand-by and gives seal leakage control by monitoring oil level in the tank.



Rating and performance

Operation

The motors are designed for continuous operation at rated output, according to IEC 60034-1 duty type S1. Other ratings and performance standards can be complied with upon request. The motors are suitable for direct on-line starting or Variable Speed Drive (VSD) operation.

Acceleration

The motors are capable of accelerating the given load to full speed under conditions of 100% to 80% of rated voltage without exceeding the permissible temperature rise for any part of the motor.

Successive starts

The motors are capable of at least three starts from cold condition or two starts from hot condition in quick succession against a full load.

Stator connection

The stator windings are star connected.

Phase

The motors can withstand any re-closure with the internal voltage 180 degrees out of phase with the incoming supply voltage, i.e. the pump can be restarted at any time even if the water column is running the impeller in the opposite direction immediately after a stop.

The solution

Framo electric submersible pumps are close-coupled, end-suction centrifugal pumps with one or two stages, driven by an integrated oil-filled induction motor that is designed for direct on-line starter (DOL) or variable speed drive (VSD) operation.

In operation, the pump is suspended from a riser pipe that contains a built-in electric power transmission system, eliminating the need for hanging electric cables and submerged penetrations, while also providing mechanical protection. The pumped seawater is delivered up through the riser system. Seawater is prevented from entering the motor and conductors by internal overpressure, created by circulating fluid from a small external circulation unit (CMS). The fluid also cools, insulates and lubricates the system.

Integral power transmission

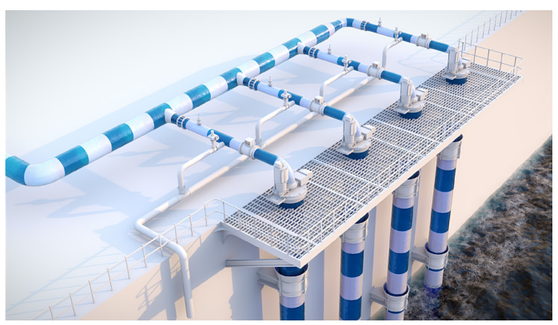
Each section of riser pipe is flanged at both ends and contains the power conductors and cooling system. They consist of a concentrically mounted cofferdam pipe through which pass the copper conductors carrying power to the pump motor. The conductors are spaced at 120 degrees by means of insulation pieces, and spring-loaded sliding connectors on the conductors ensure a safe and reliable electrical connection. The integrated conductor pipe sections are fitted with stab-in connectors. The system is assembled by simply bolting the riser pipe compact flanges together. A top plate supports a junction box for termination of the power transmission system.

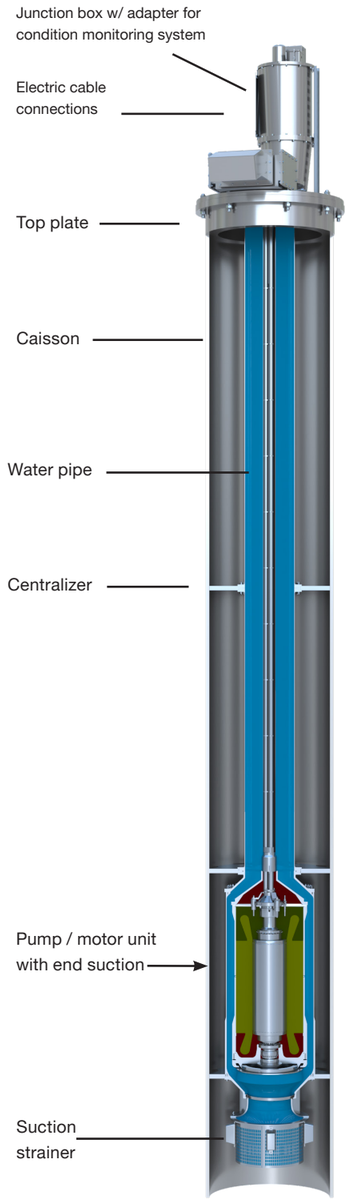
Condition Monitoring System

In addition to circulating lubricant around the system, the circulation unit also provides continuous condition monitoring of the submerged pump and motor unit. Temperature, pressure, cleanliness and seal leakage data are read by sensors and relayed to the monitoring unit. Supply and return connections for the circulation unit are mounted on the top plate.

Compact, low-weight design

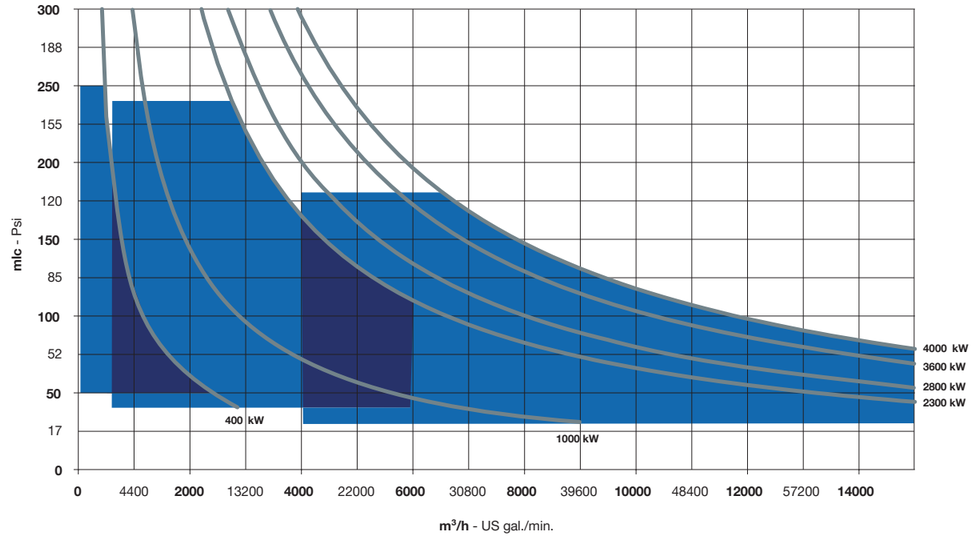
Circulating lubrication combined with the integrated pump and motor configuration makes the unit very compact, with a high power-to-weight ratio.





Technical data

Performance domain



Submerged lift pump

	Small		Medium			Large			
PUMP TYPE	**SE200**	**SE225**	**SE280**	**SE315**	**SE355**	**SE400**	**SE450**	**SE500**	**SE560**
Required caisson diameter	18”	26”	30”	36/38”	40”	46”	52”	58”	62”
Flow range [m³/h] (BEP)	200-500	300-1000	600-2400	700-3200	1400-6200	2800-8500	3000-10000	4000-12000	4000-15000
Pipestack diameter min/max	8/10”	10”/14”	10”/18”	14”/20”	18”/28”	24”/32”	24”/44”	24”/44”	24”/44”
Max power (50/60Hz) [kW]	175/220	400/400	800/1000	1000/1200	2100/2500	2200/2800	2900/3600	3300/4000	3800/4000
Max power (50/60Hz) [kW] 11kV	NA	NA	NA	NA	1400/1750	1800/2150	2200/2700	2600/3150	3800/4500
Voltage min/max [kV]	0.40/0.69	0.40/0.69	0.40/6.6	0.40/6.6	0.40/11	3.3/11	3.3/11	3.3/11	3.3/11
Weight pump/ motor unit max [kg]	900	1500	2700	5000	6600	8500	10200	12000	13500
Weight per 6m pipestack min/max dia [kg]	200/380	380/480	380/560	480/600	560/980	840/1440	840/1810	840/1810	840/1810
Weight top plate arrangement min dia/max dia [kg]	*	380/415	430/500	535/651	670/1050	1200/1250	1380/1500	1600/1700	1750/1850

* Application dependent

Note: The range chart and the data table show the normal operating range. However, for special cases, the pumps can be modified to cover duties outside this range.

Submerged pump/motor unit

The electric motor is a low or high voltage, oil filled, induction motor.

The shaft with the rotor is supported at the top (non-drive end) by a roller bearing for radial support. The drive end is supported by combined radial and thrust bearings. They can be either double angular ball bearings or spherical axial roller bearings combined back-to-back with a conical roller bearing, pending ratings and motor speeds. The bearings are designed to take maximum axial forces and have a design life in compliance with API 610 latest edition.

Both drive end and non-drive end bearings are lubricated and cooled by the forced fluid circulation, which gives optimal working conditions for the bearings.

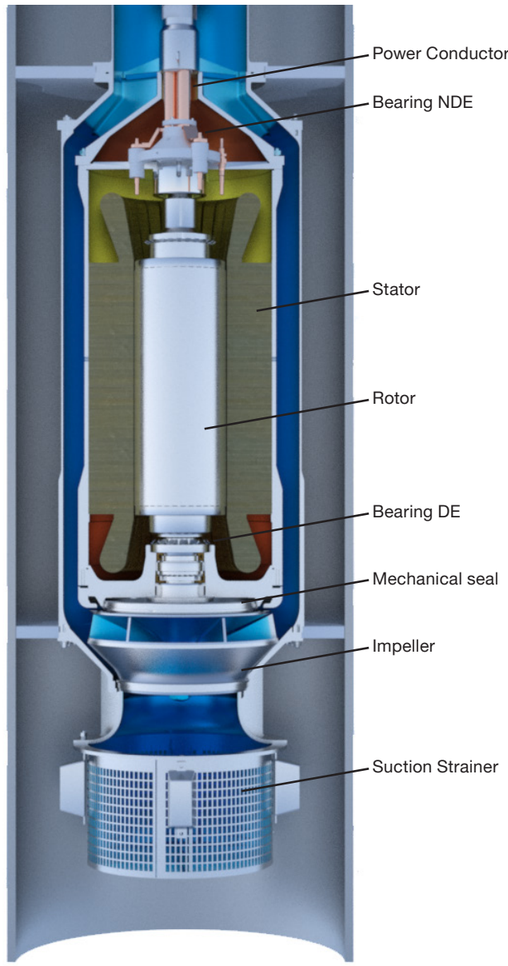
The axial thrust load is limited by the impeller wear ring diameter and by draining the chamber above the impellers.

The seal arrangement consists of a balanced mechanical seal riding on a sleeve. The seal spring is inside the seal, protected by the lubrication fluid. The arrangement is designed such that the seal is continuously lubricated and cooled by the forced fluid circulation system.

The pump impeller discharge into the outer shell of the pump housing, concentric of the motor housing. The diffusor design is with guide vanes, ensuring good radial balance and minimum diameter. The suction is through a strainer, bolted to the end cover of the pump. The impellers are shrink-fitted to the motor shaft and locked with an impeller nut.

The lubricant enters the motor via the outside of the conductor pipes (inside cofferdam pipes) and is directed to the lower part of the motor via a bore in the rotor shaft. A partial flow is branched off to the mechanical seal and through the bearings.

The lubricant returns through the rotor/stator gap before returning via the conductor system. The motor housing and bearing brackets are designed to give a good and even spread of the lubricant flow ensuring optimal cooling and lubrication for all rotating parts.



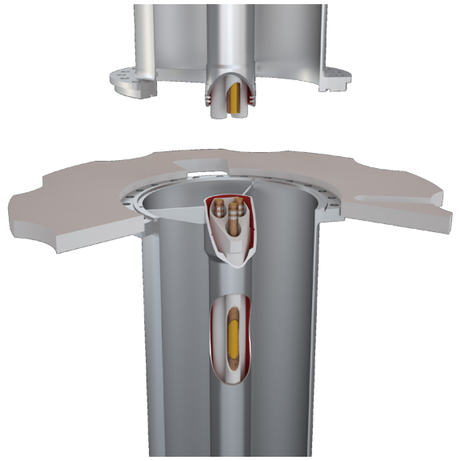
Pipe stack/power transmission

The pipe stack assembly consists of sections with length according to project requirements.

Each section comprises three copper conductor pipes, spaced 120 degrees by means of insulation pieces mounted inside of a protective pipe (cofferdam pipe). The cofferdam pipe assembly is fixed to one end of the pipe stack section and supported radially on the other end so that when the sections are assembled, differences in thermal expansion can be accommodated.
The cofferdam pipe is mounted concentric inside the water pipe. The water pipe and the cofferdam pipe make up a complete pipe stack section.

The water pipe sections are flanged together, while the cofferdam pipe is a male/female sliding connection with double o-ring seals used to separate the lubricant and pumped media. The three copper pipes have spring-loaded sliding connectors (male/female) on each end.

The pressure and return side (outside and inside) of the copper pipes are separated by o-rings on the connectors.



Top plate arrangement

The top plate consists of a discharge flange, condition monitoring system and junction boxes for the instruments and electric power supply. The top plate (mounting plate) will be supplied to meet client caisson flange diameter.

The power conductor system is terminated in a junction box mounted on the discharge bend.

The junction box has IP66 protection and is IEC/Atex Ex e certified for hazardous area (zone 1) operation as standard.

Condition Monitoring system

The condition monitoring system serves the following purposes:

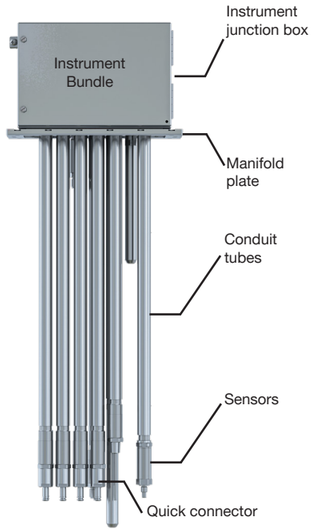
- Lubrication and cooling of pump bearings and mechanical seal
- Overpressure protection of the electric motor and power transmission from outside leakage
- Cooling of the electric motor
- Electrical insulation condition monitoring

The condition monitoring system consists of a reservoir, a pressure amplifier and a statically pressurized closed circuit. A positive displacement pump circulates the lubricant in the closed circuit. The lubricant is filtered on the discharge side, downstream of the fluid circulation pump. The lubricant is further discharged from the top flange arrangement inlet to the pump head through the concentric conductor pipe inside the pipe stack.

The pumped liquid that flows in the water pipe normally cools the lubricant. After passing through the motor in the pump head, the heated lubricant flows back inside the power conductors in the concentric cofferdam pipe.

In cases where there is large installed motor power, a relatively short pipe stack or when warmer liquids are being pumped by the SE pump, the circulated lubricant will be cooled in a separate cooler integrated with the fluid circulation system.

The closed circulation loop is pressurized by a small electrically driven pump, taking suction from an atmospheric tank. This pump maintains the correct pressure in the closed circuit and compensates for the very low leakage of lubricant over the mechanical seal in the SE pump. It is designed to maintain a constant pressure in the fluid circulation loop at all time.



Instrumentation

As shown in figure above, the components of the instrument bundle are assembled on a manifold plate. Sensors are located inside the tank, submerged in lubrication fluid, connected to the tubes via quick connectors. Cables are routed inside the tubes and terminated in the junction box at the top of the tank. The junction box is certified ‘Ex e’ and placed on manifold plate with conduit tubes entering from below. This minimizes the number of junction boxes and the lenght of wiring, meanwhile ensuring a close location to the instruments.

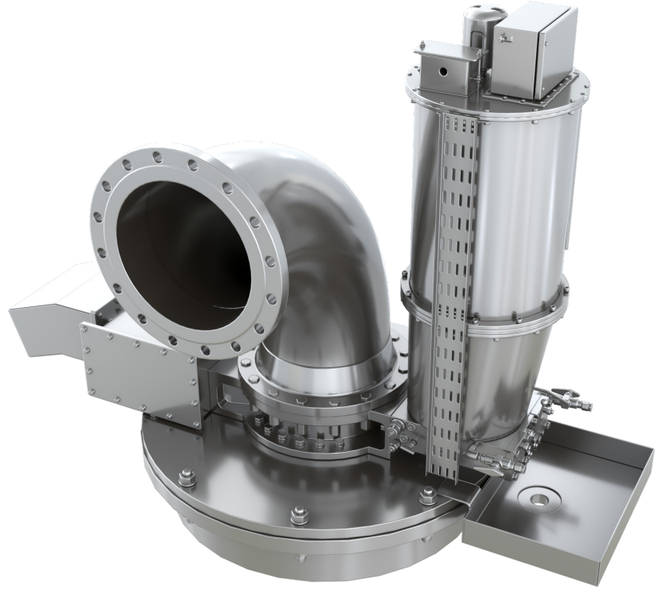
Instrumentation of the condition monitoring system includes the following parameters:

- Pressure for return fluid
- Temperature for return fluid
- Top and bottom differential pressure, indicating level
- Filter differential pressure
- System differential pressure, indicating flow
- Magnetic chip detector in return line from SE pump

The Central Control System of the facility will normally perform the monitoring and control of the SE pump system.

The complete condition monitoring system including tank, pumps, filters, accumulator, valves and instruments are assembled on one common skid, to be installed on the top plate.

The condition monitoring system has a standard Ex rating for operation in hazardous area (Zone 1).



Specifications for three phase induction motors, SE type

Standards and codes

Motor design, materials and performance comply with the following list of codes, standards and regulations, (where applicable for oil submerged motors)

Code/std/Reg.	Designation Title	Reference
IEC*	Rotating electrical machines	IEC 60034
IEC	Dimension and output ratings for rotating electrical machines	IEC 60072
IEC	Recommendations for the classification of materials for the insulation of electrical machines	IEC 60085
IEC	Electrical installations in ships	IEC 60092-101
IEC	Classification of degrees of protection proved by enclosures	IEC 60529
IEC	Mobile and fixed offshore units - Electrical installations	IEC 6189
Norsok	Electrical systems	E-001

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