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## Marine industry

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Coflexip Stena Offshore

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Spherical roller bearings

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Bespoke bearing housings

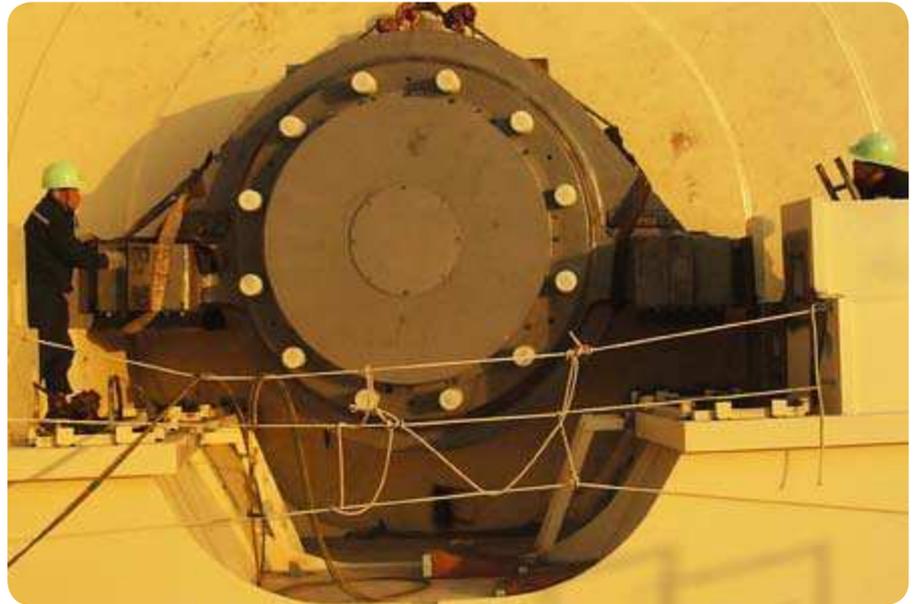
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LGEM 2 bearing grease

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Hydrocam bolt tensioners

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# World's largest bearings for CSO Deep Blue

Deep-sea pipe laying at depths up to 2,500 m is a complex and potentially dangerous task requiring highly specialised skills and equipment. One of the leaders in the field is Coflexip Stena Offshore, which operates a fleet of pipe laying vessels, including one of the world's largest and most sophisticated purpose designed ships, the CSO Deep Blue.

The CSO Deep Blue was designed to lay both rigid and flexible pipes, of various diameters, in a continuous operation, and is unique in its capacity to lay pre-welded rigid steel pipelines from a pair of huge reels, at the hub of which are rolling bearings contained in housings specially developed and manufactured by SKF.

In common with its forerunner, the "CSO Apache", CSO Deep Blue was originally designed to have a single cable reel capable of carrying 5,000 tonnes of pipe and SKF was originally invited to present a solution for the bearings for this system. As the development of new ship evolved, however, it was agreed that an improved pipe laying capability would be provided by adopting two 770 tonne reels.

Each of these are capable of handling up to 2,500 tonnes of rigid steel pipe, up to 400 mm diameter, wound around a hub 20 m in diameter.

The design of the reels enables pipe to be welded onshore and then continuously laid at sea, in lengths ranging from up to 12.5 km of 400 mm diameter pipe to 333 km of 60 mm pipe.

In addition to ensuring the smooth and safe operation of the reels, the bearings and housings also have to allow the reels to rotate under wide fluctuations of heat and cold, in seas with wave heights as great as 4 m, and under extreme static survival load conditions.

The solution developed by SKF consists of one spherical roller bearing weighing 9.5 tonnes and one of 5.5 tonnes, which are among the heaviest spherical roller bearings ever manufactured by the company.

In consultation with Coflexip Stena Offshore's engineers, it was calculated that the potential loads involved would require bearings with bore diameters of 1 320 mm and outer diameters of 2.06 m and 1.85 m respectively.



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The bearings were designed by SKF's Large Size Bearings (LSB) team in Gothenburg, Sweden, and manufactured at the LSB facilities in Gothenburg and Schweinfurt, Germany. In addition, the extensive finite element analysis work required for the project was carried out at the SKF Engineering Research Centre (ERC) in The Netherlands.

While the bearings are based on standard ISO dimensions, there are some exceptional features. The outer ring, for example, is wider than standard to accommodate a greater tolerance for misalignment caused both by the movement of the ship and also difficulties presented by the loads and environmental conditions. The inner ring was also modified by adopting an exaggerated chamfer. This accommodates the significant bending moments on the reel shafts and hence reduces the stress concentration factor where the shafts pass through the bearings.

The bearing housings were designed and supplied by SKF in the UK and consist of one pair weighing 34 tonnes each and another pair each weighing 26 tonnes. The housings use a special cast steel employed for applications in the North Sea, with the particular properties of the material being achieved by cooling the castings in still air, to avoid subjecting it aggressive heat treatment. Tests on the raw steel material revealed that its tensile strength was well above the 300 N/mm<sup>2</sup> required.

The geometry developed for the housings was also substantially different from the accepted norm for large bearing designs. For instance, as a traditional flat foot design would have been subjected to severe bending forces in the swell of the sea and therefore become a potential source of weakness, the mounting feet of the housings were instead manufactured to reach almost to the centre of the casting. The completed housings underwent non-destructive testing using magnetic particle inspection, while key areas of the castings were also tested ultrasonically. Even the steel studs were special in that they are cadmium plated and then coated with a plastic coating called Xylan.

The bearings have a very low rotational speed, which makes it difficult to build a lubricating film. To counter this problem, SKF selected lubricating grease LGEM 2, which is a high viscosity material containing solid lubricants that enable it to function at temperatures ranging from -20 to +150 °C. It is water and rust resistant and is recommended for applications that operate under heavy loads, severe vibration and very low speeds. Over 1,000 kg of LGEM 2 was used in the bearings for Deep Blue!

Lead time for the design and development of the bearings and their housings was relatively quick for this type of project, with the time from order to delivery being just seven months. In addition, a major emphasis was placed on quality control throughout the project and the process was therefore overseen by a dedicated SKF service engineer. Hydrocam bolt tensioners were also used to stretch the high tensile steel fixing studs; the stretch factor, or tensile stress, being set within the Hydrocam unit.



*Large Size Bearing (LSB)*



*CSO Deep Blue vessel*

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