1. Laying of Pipes under Mariager Fjord

In connection with the crossing of Mariager Fjord, account had to be taken of the vulnerable environment in the area.

The preliminary studies included an analysis of the feasibility of performing a controlled directional drilling under the inlet. Soil samples were taken from under the inlet. Results showed that there were too many large rocks to carry out the nine controlled directional drillings which were necessary. Furthermore, the cables would be covered by 8-10 metres of silt with very poor thermal conductivity.

The inlet with underground rocks. Figure 14

An alternative which was considered was to build a tunnel with a diameter of 3 m. This would, however, be a very expensive solution, which also entailed considerable environmental impact in connection with the removal of the drilled-out material on land.

The laying of an armoured submarine cable was also considered. However, such a solution was not suitable: partly on account of the thermal conditions on the floor of the inlet, and partly because of the risk of contaminating the inlet with washed-out organic material during the submerging of the cables.

The conclusion was that the most constructive solution was to lay pipes across the bottom of the inlet.

One high-voltage cable was laid in each pipe. The pipes were laid on top of the floor of the inlet so as to avoid organic material from being churned up during the construction phase. This was a factor to which considerable importance was attached by the environmental authorities in selecting the solution. The thermal conductivity was also greatly improved as the cables have been laid in relatively large water-filled pipes. The pipes act as radiators, carrying off the heat generated in the cables.

Strong plastic pipes were used with a wall thickness of approx. 30 mm. They offer improved mechanical protection compared to armoured cables. The pipes, each 21 metres long, were welded together in the nearby Kongsdal harbour on the southern side of Mariager Fjord.

Internal rough edges around the heat-sealed joints were removed in order to reduce the risk of the cables being damaged when being pulled through the pipes.

A pipe set consists of three pipes. Ballast blocks were mounted on each set of pipes, ensuring a spacing of 1 m between each of them. The concrete ballast blocks were positioned at such a distance that the pipes remained floating on the surface. It was

only when the centre pipe was filled with water that the three pipes and the ballast blocks sunk down onto the bottom of the inlet.

Diagram showing sinking of pipes. Figure 13

When the approx. 700-metre-long pipes were welded together and the ballast blocks mounted they were moored on the water.

Each set of pipes was towed from Kongsdal harbour into the inlet to the crossing point of the 400 kV cable. This took about 3 hours.

The pipes were first pushed in on the southern shore. During this stage of the operation the inlet, by agreement with the maritime authorities, was closed to vessels.

The pipes were directed between the sheet piling which had been driven down into the banks of the inlet. Beforehand, a channel had been excavated between the sheet piling, making it possible to trench the pipes into the shore later. The ends of the pipes are telescopic, which made it possible to extend the pipe if it sank further down into the bottom of the inlet than expected.

During the laying operation the pipes were sealed and filled with air. Once the pipes had been towed into place, the middle pipe was filled with water. The pipes and ballast blocks then sank slowly to the bottom as water entered the middle pipe.

Three pipe systems were laid across the inlet. Furthest to the west is a system for 150 kV cables. The middle system as well as that to the east are for 400 kV cables. The spacing between the systems is 6 m – as on land. After each pipe system was laid, its position was checked and adjusted.

After the pipes were positioned, the two remaining pipes were filled with water. Controls were in place to check the volume of water filling the pipes. Water was pumped out of Mariager Fjord to fill the pipes.

There is a hole in the upper side of the telescopic pipe. The hole is covered by a strong filter cloth through which water can pass unimpeded but which prevents sand and other sediments from entering the pipe. In other words the pipe can “breathe”. Any air in the system will disappear through the hole. The pipe with the “breathing hole” was put in position underwater after the cable was pulled through the pipe.

Drawing showing breathing hole in telescopic pipe. Figure 54

The pipes were pulled up above the surface at the shores of the inlet. This prevented stones and sand from entering the pipes when the cables were being pulled through.

After the cables were pulled through, the filter cloth was attached to the “breathing hole” in the telescopic section of the pipe. The pipes were then sunk down onto the sandy bottom. Out to a water depth of approx. 7 m, the pipes were trenched 1 meter down into the floor of the inlet.

Possibly drawing with ballast blocks, trenched down into the bottom of the inlet. See figure 53