Nord Stream 2
Committed. Reliable. Safe.

Background: Above Water Tie-In in German Waters

Nord Stream 2 AG | Sep-21

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Above Water Tie-In

The Nord Stream 2 Pipeline was built in several phases, with the two lines having been laid by several ships. The various sections thus needed to be welded together in stages. This involved a connecting weld seam carried out above the water surface, also called an above water tie-in (AWTI). Altogether three AWTI's were made In Germany.

1. AWTIs in German Waters

The first AWTI in German waters was carried out on one of the two pipe strings east of the island of Rügen in summer 2019, when the special vessel CASTORO 10 connected the pipeline sections, which had been laid separately there in territorial waters in 2018, to each other above water.

The second and third AWTI were carried out by FORTUNA in July and September 2021 in the German Exclusive Economic Zone (EEZ). For each pipeline string, the two sections that had previously been laid from opposite directions from Danish and German waters were connected. With these AWTIs, the offshore part of each pipeline string was mechanically completed.

2. The AWTI Process

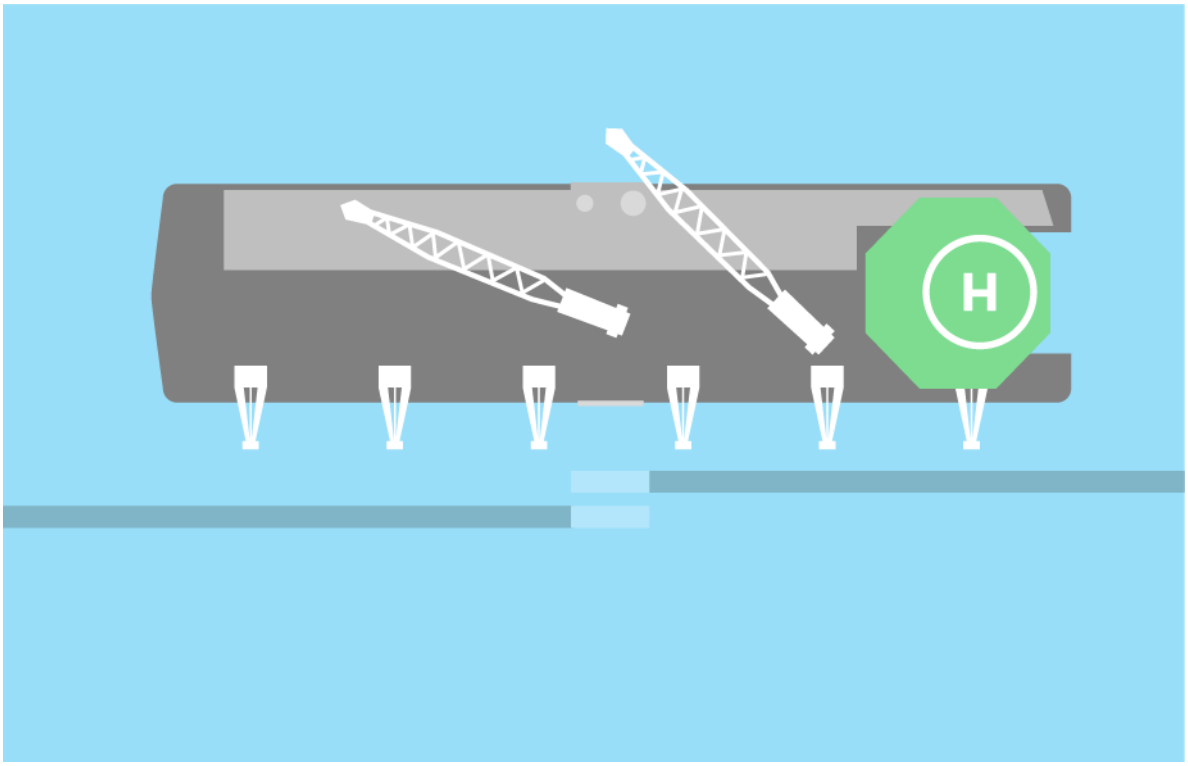
The basic steps of the AWTI process can be summarised as follows:

- Two pipe ends lie parallel and overlapping on the sea floor;
- Divers attach buoyancy tanks to the pipe ends and secure the hoisting cables of six davits located alongside the AWTI barge;
- Both pipe ends are lifted one after the other above the waterline;
- The pipe ends are cut to the appropriate length, aligned, welded, tested and coated;
- The connected pipeline is laid down in an arc upon the seabed;
- Divers remove the buoyancy tanks and unfasten the hoisting gear;
- The exact as-laid position of the line is measured by a survey vessel;
- In a subsequent step, rock placement is carried out where necessary to ensure the lateral stability of the pipeline arc laid onto the seabed.

3. Preliminary Pipelay Works

The clamps required for the AWTI to attach the hoisting gear to the pipe ends had already been installed during the pipelaying process. The last 350 metres of each of the two pipe strings before the AWTI position were produced with a reduced concrete coating thickness of 70 mm in order to reduce the weight of the pipeline for the AWTI lifting operation. The last

pipe section was then installed without concrete coating, as this pipe had to be cut to length in the lifted state to allow for the aligning and welding the two ends.



Initial situation – pipeline sections lie on the seabed next to the AWTI barge (top view; illustration indicative only)

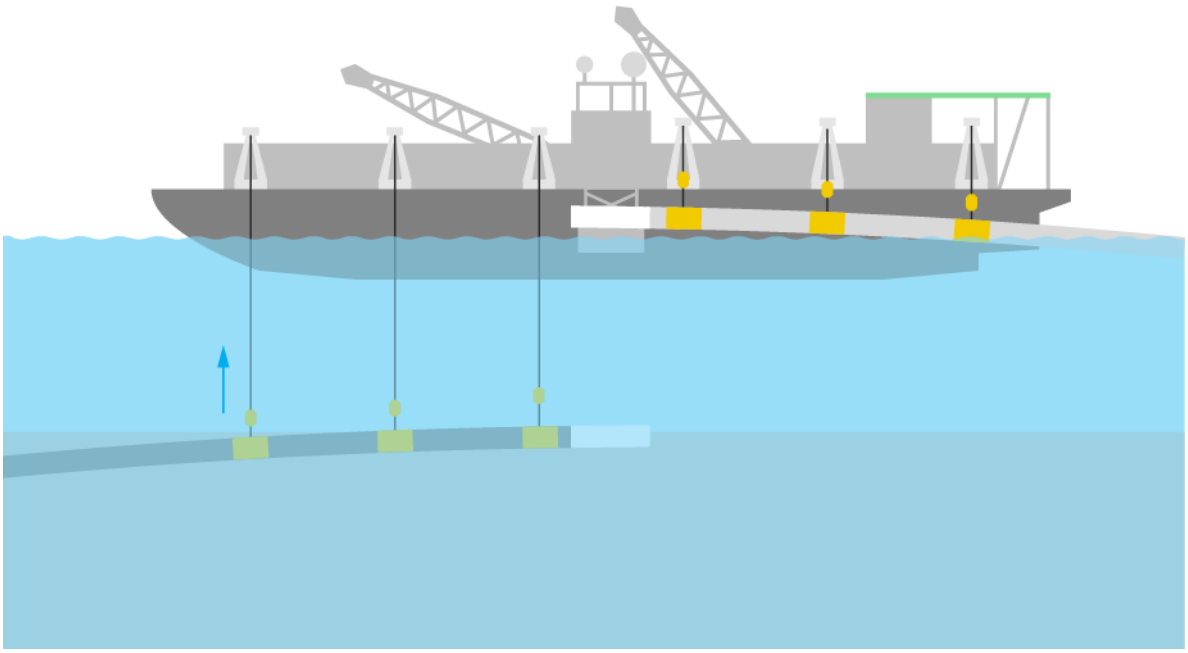
4. Preparatory Diving Works

First, the AWTI barge was positioned and anchored at the AWTI site. Within this anchor pattern, buoyancy tanks were installed along the pipeline at the pre-installed connection points with the help of divers. Each pipe end was provided with up to 8 x 5 tons of buoyancy in order to further reduce the weight of the pipeline and to safely lift and hold the pipe ends in the barge davit cranes. During the first AWTI in territorial waters, the buoyancy tanks were installed with the help of a so-called “depressor frame”. This installation frame provided the necessary downforce to manoeuvre the buoyancy tanks to their installation position on the pipeline in a controlled manner using the deck crane of the AWTI barge. During the AWTI in the German EEZ, divers installed so called airbags that were lowered and connected to the pipeline in empty condition before filled with air subsea.

The diving works were carried out in compliance with the health and safety requirements of the relevant authorities and certification companies. Representatives of Nord Stream 2 AG were also present on board to inspect and follow the diving work. For diving emergencies, a decompression chamber was installed on the AWTI barge as part of the diving equipment.

5. Lifting and Length Adjustment of the Pipe Strings

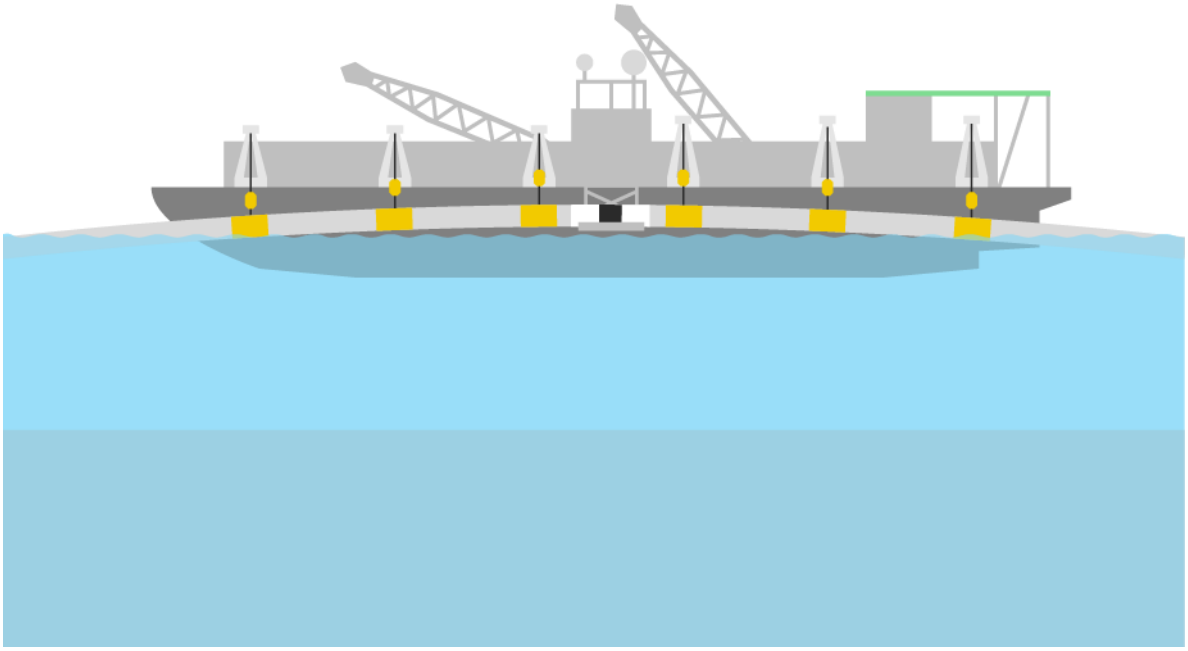
To lift the pipes, the AWTI barge was positioned in its anchor pattern on site. The pre-installed pipe clamps were then attached to the lifting devices of the AWTI barge with the help of divers. For this purpose, the AWTI barge was equipped with six so-called davits (hoists configured as an A- or H-frame) arranged in such a way as to enable lifting work to be carried out next to the side wall of the AWTI barge. Both pipe strings were then lifted so that their ends are horizontal above the waterline. The pipeline heads were then cut off and the pipes were cut to length so that they could be aligned for welding. The alignment was achieved with the help of a large external line-up clamp (ELUC) casually referred to as the bear cage.



Raising the sections (side view; illustration indicative only)

6. Connecting the Pipe Strings

After the ends of the two pipe strings were cut to length, they were aligned with each other by means of the ELUC. Once the correct alignment for welding had been achieved, the connecting girth seam was produced by manual welding and then tested non-destructively.



Connecting the sections – "Above-Water Tie-in" (side view; illustration indicative only)

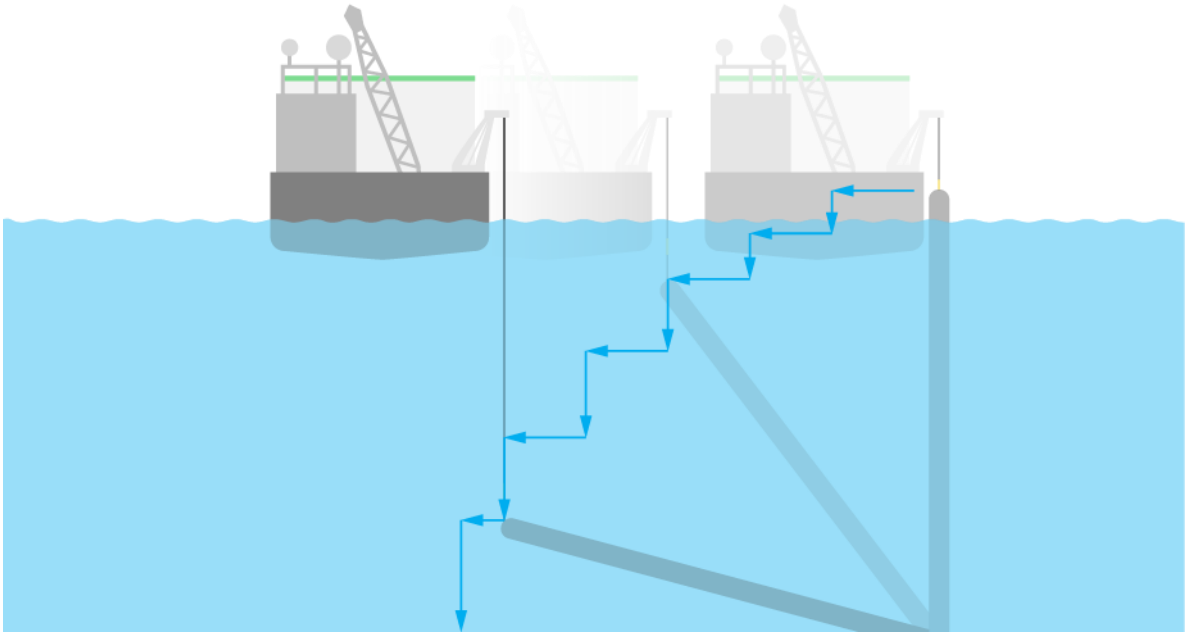
Following the completion of the weld testing through Automated Ultrasonic Testing (AUT) a so-called Heat Shrink Sleeve (HSS) was applied to the area of the weld seam to produce an anti-corrosion coating.

Stone protection mats were then laid around the anti-corrosion coating and fixed with tension straps. These stone protection mats protect the anti-corrosion coating against potential damage during the subsequent rock placement works.

It is not necessary to adjust the outside diameter in the connection area to the outside diameter of the adjacent concrete-coated pipes, as the pipeline was lowered directly onto the seabed without having to go through the firing line on board the pipelay vessel, as it would be the case in the normal pipelay process.

7. Lowering of the Pipeline

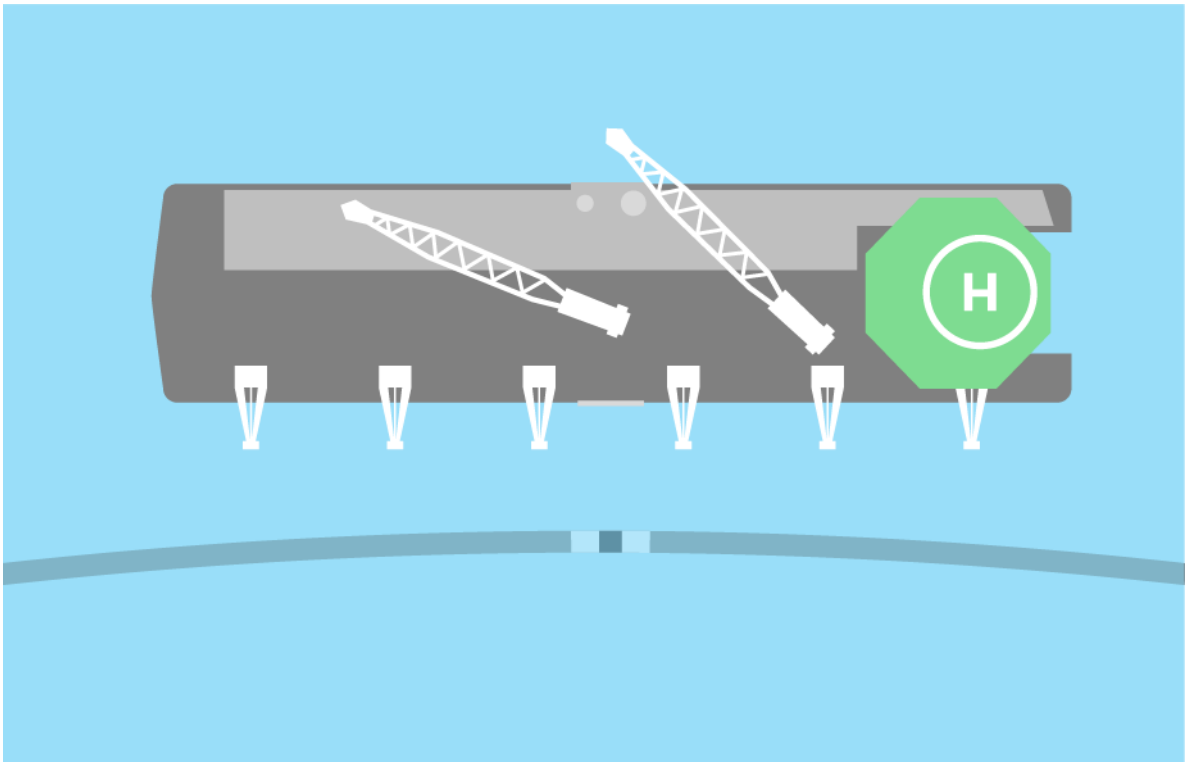
When the necessary coatings had been applied in the welded section, the pipeline was laid on the seabed. This was done by slowly moving the AWTI barge sideways and gradually lowering the pipeline at the same time. Thus, the pipeline lying on the seabed formed a horizontal arc that has a deflection of about 20 to 25 meters at its apex. The size of the horizontal deflection on the seabed is directly related to the lifting height and the depth of the water.



Laying down the connected line (illustration indicative only)

8. Final Diving Works

After the pipes were connected and laid on the seabed, the hoisting cables of the davits were first disconnected from the pipeline. Again, divers released the cables from the lifting clamps attached to the pipes one after the other, as well as detaching the buoyancy tanks/air bags, which were then lifted by crane onto the AWTI barge. Subsequently, the divers released the fixing of the buoyancy tanks and the hoisting ropes from the pipe. These were also removed from the pipeline on the seabed and lifted onto the barge by crane.



Final result – Connected pipeline sections placed on the seabed (top view; illustration indicative only)

As soon as the diving work is completed, the AWTI barge will leave the site and a survey vessel will determine the exact position of the pipeline on the seabed. In a subsequent step, rock placement works are carried out where necessary to secure the position of the pipeline arc on the seabed.

9. Concluding Remarks

A total fleet of six to nine ships were deployed as part of each AWTI process:

- An AWTI barge positioned and anchored on site, which connected the two pipeline strings;
- Two or three anchor handling tugs, positioning the anchors of the 8- or 12-point mooring system of the AWTI barge;
- A tow tug to tow the AWTI barge to the work site, this can also act a supply vessel or anchor handling tug for the AWTI barge;
- A supply vessel that ensures sufficient supplies for the AWTI barge;
- A survey vessel to determine the exact position of the pipe strings;
- A boat to transport the crew of the AWTI barge;
- Two guard vessel were permanently on site and informed the seatraffic of the offshore construction site and safety zone around the AWTI barge.
- Furthermore, a fall pipe vessel that carried out rock placement works after the AWTI completion.

In total, three AWTIs were carried out in German waters to complete the two strings of the Nord Stream 2 Pipeline.

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About Nord Stream 2
Nord Stream 2 is a pipeline through the Baltic Sea, which will transport natural gas over some 1,230 km from the world's largest gas reserves in Russia via the most efficient route to consumers in Europe. Nord Stream 2 will largely follow the route and technical concept of the successful Nord Stream Pipeline. The new pipeline will have the capacity to transport 55 billion cubic metres of gas per year, enough to supply 26 million European households. This secure supply of natural gas with its low CO2 emissions will also contribute to Europe's objective to have a more climate-friendly energy mix with gas substituting for coal in power generation and providing back-up for intermittent renewable sources of energy such as wind and solar power.
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