

Background: Above Water Tie-In in German Waters

Nord Stream 2 AG | Aug-19





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Above Water Tie-In

The Nord Stream 2 Pipeline will be built in several phases, with the two lines being laid by several ships. The various sections thus need to be welded together at a later stage. This involves a connecting weld seam that is carried out above the water surface, also called an above water tie-in (AWTI). The AWTI is essentially a stationary construction site. The process takes about three weeks in total.

1. AWTI in German Waters

The pipelay vessel Castoro 10 (C10) was used during July to November 2018 to lay the two lines of the Nord Stream 2 Pipeline (Line A and Line B) from the landfall in Lubmin to kilometre point (KP) 54.4, east of the island Rügen.

The two pipelines were each laid through a microtunnel near Lubmin and in a previously excavated, approximately 29-kilometres-long trench through the Bay of Greifswald, parallel to Landtief and up to KP 54.4. Only on the last kilometre were the pipelines laid directly on the natural seabed.

In the Pomeranian Bight, Audacia laid the two pipelines from KP 54.4 to KP 16.5 between October and December 2018.

For line B, the sections laid separately by C10 and Audacia need to be connected by an AWTI. This AWTI is planned for summer 2019. The C10 will be deployed as a so-called "AWTI barge".

2. The AWTI Process

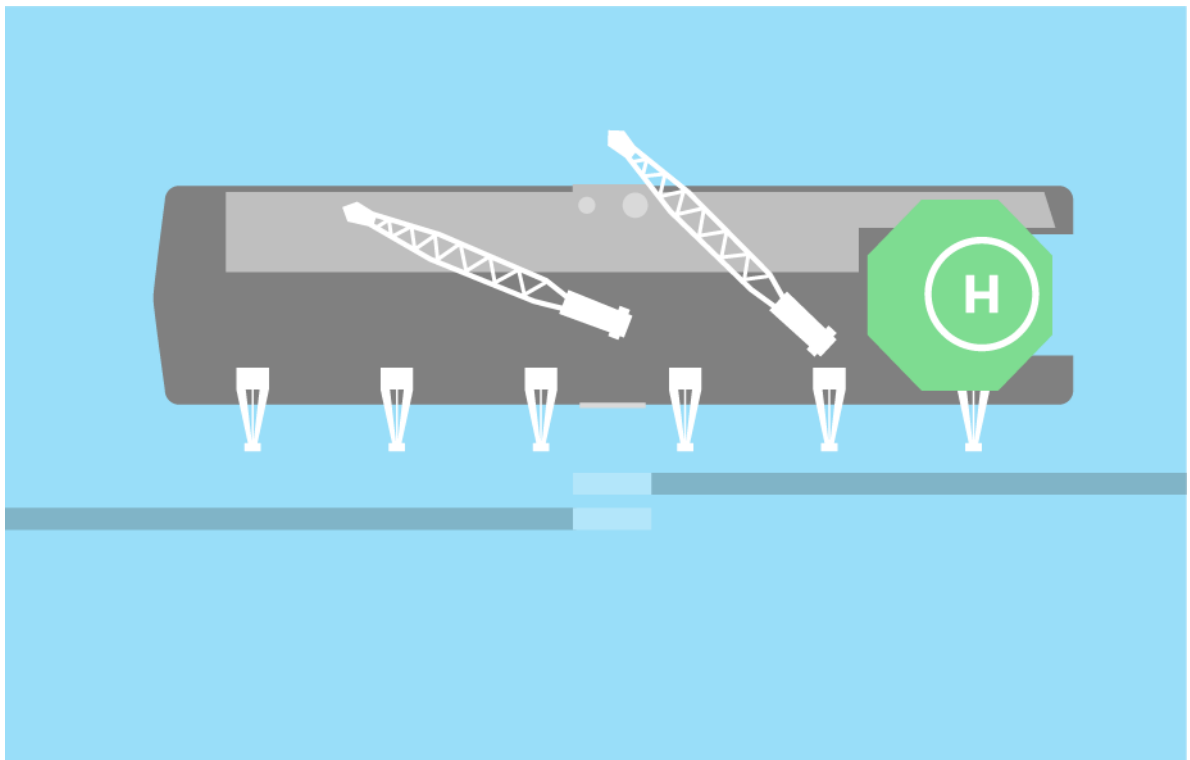
The basic steps of the AWTI process can be summarised as follows:

- > Two pipe ends lie parallel and overlapping on the sea floor;
- > Divers attach buoyancy chambers to the pipe ends and secure the hoisting cables of six A-frames (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, welded, tested and coated;
- > The connected pipeline is laid in an arc upon the seabed;
- > Divers remove the buoyancy chambers and unfasten the hoisting gear;
- > The exact position of the line is measured by a survey vessel;
- > In a subsequent step, rock placement is carried out where necessary to secure the position of the pipeline arc laid on the seabed.



3. Preliminary Pipelay Works

The two separately laid sections of line B are already installed on the seabed at KP 54.4. During the pipelaying process, the clamps required for the AWTI to attach the hoisting gear to the pipe ends have already been installed. The last 350 metres of each of the two pipe strings before the AWTI position are produced with a concrete casing reduced to 70 mm in order to reduce the weight of the pipeline for the AWTI lifting operation. The last pipe section is then completely without concrete sheathing, as this pipe is cut to length in the lifted state to allow for the connecting seam.



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 C10 is positioned and anchored at the AWTI site. Within this anchor pattern, buoyancy chambers are installed along the pipeline at the pre-installed anchor points with the help of divers. Each pipe end is provided with 5 x 5 tons of buoyancy in order to further reduce the weight of the pipeline and to safely lift and hold the pipe ends. The buoyancy chambers are installed with the help of a so-called “depressor frame”. This installation frame provides the necessary downforce to manoeuvre the buoyancy chambers to their installation position on the pipeline in a controlled manner using the deck crane of the C10.

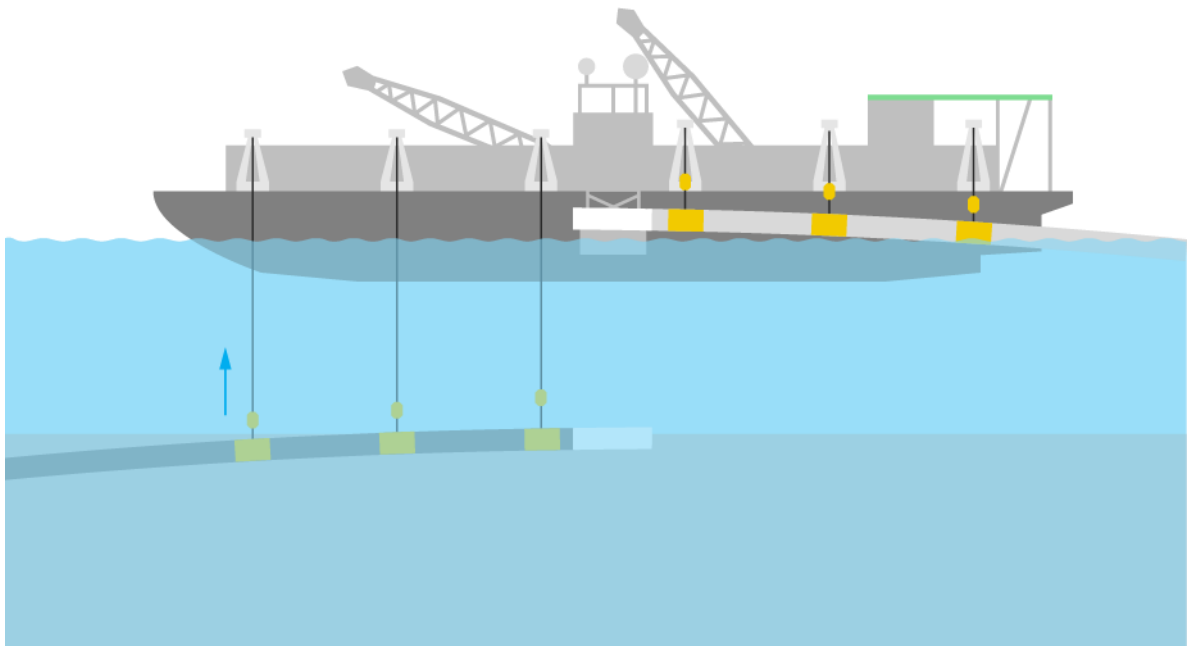


After settling the buoyancy chambers on the pipe, divers attach them to the anchor points and release the “depressor frame”. It can then be loaded with the next buoyancy chamber on deck of the C10. The C10 moves about 25 metres to the position of the next buoyancy chamber in this time.

The diving works are carried out in compliance with the health and safety requirements of the relevant authorities and certification companies. Two representatives of Nord Stream 2 AG are also present on board to inspect the diving work. For diving emergencies, a pressure chamber is installed on the C10 as part of the diving equipment.

5. Lifting and Length Adjustment of the Pipe Strings

To lift the pipes, the C10 is positioned in its anchor pattern on site. The pre-installed pipe clamps are then attached to the lifting devices of the AWTI barge with the help of divers. For this purpose, the AWTI barge is equipped with six so-called davits (hoists configured as an A-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 are then lifted so that their ends are horizontal above the waterline. The pipeline heads are then cut off and the pipes are cut to length so that they can be aligned for welding.

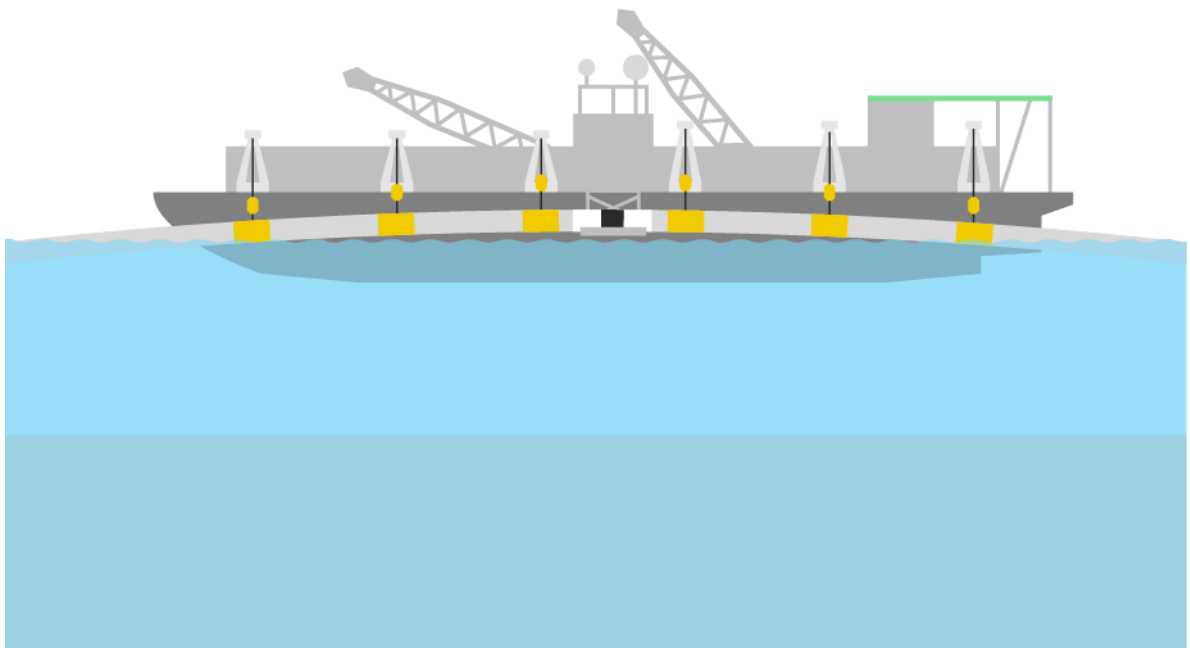


Raising the sections (side view; illustration indicative only)



6. Connecting the Pipe Strings

After the ends of the two pipe strings have been cut to length, they are aligned with each other by means of a hydraulically operated external centring device. Once the alignment has taken place, the connecting seam is produced and then tested non-destructively.



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

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

Stone protection mats are 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.

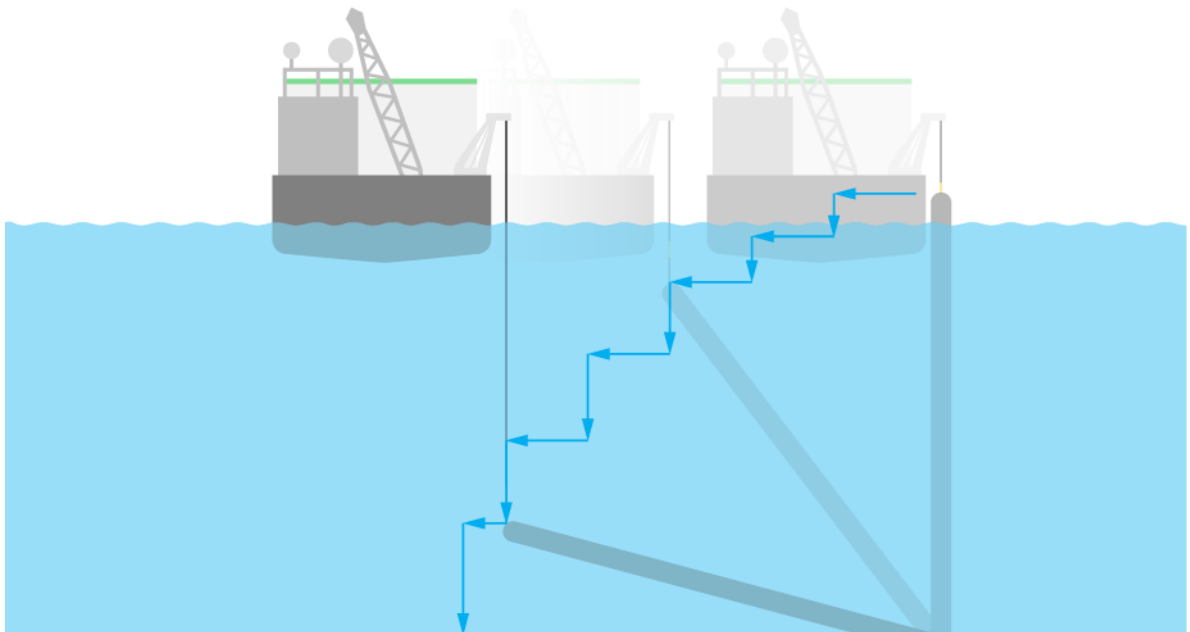
It is not necessary to adjust the outside diameter in the connection area to the outside diameter of the adjacent concrete-coated pipes, as the pipeline is lowered directly onto the seabed without having to go through the firing line on board the pipelay vessel, as would normally be the case.

7. Lowering of the Pipeline

After the necessary coatings have been applied in the welded section, the pipeline is laid on the seabed. This is done by slowly moving the AWTI barge sideways and gradually



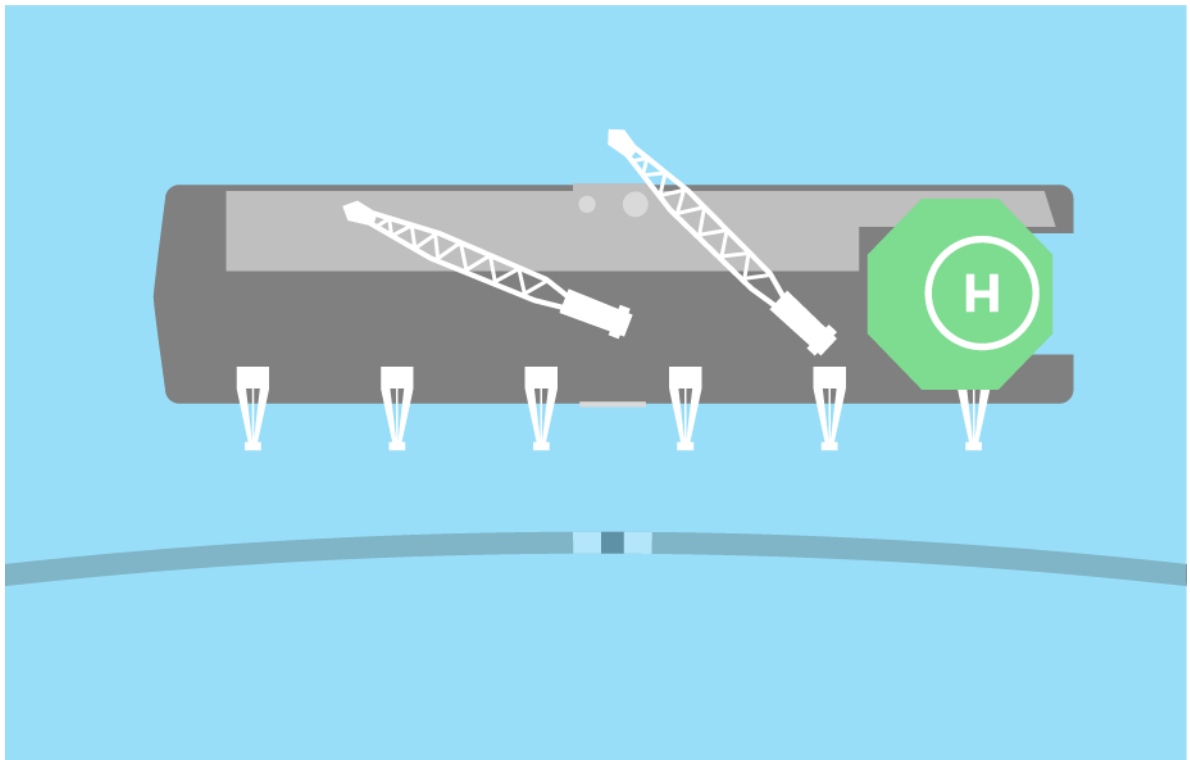
lowering the pipeline at the same time. Thus, the pipeline lying on the seabed forms a horizontal arc that will have a deflection of about 20 meters at its apex. The size of the horizontal deflection non the seabed is directly related to the lifting height and/or the depth of the water.



Laying down the connected line (illustration indicative only)

8. Final Diving Works

After the now connected pipes have been laid on the seabed, the hoisting cables of the davits are first disconnected from the pipeline. Again, divers release the cables from the lifting clamps attached to the pipes one after the other, as well as detaching the ten buoyancy chambers, which are then lifted by crane onto the C10. Subsequently, the divers release the mounting clamps of the buoyancy chambers and the hoisting ropes from the pipe. These are also lifted onto the C10 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 five ships will be deployed as part of the AWTI works:

- > An AWTI barge (Castoro 10 – C10) positioned and anchored on site, which connects the two pipeline segments;
- > An anchor handling vessel that acts as a tug boat for entering the Port of Mukran, as well as serving as a supply vessel for the AWTI barge;
- > An anchor handling vessel, acting as a supporting tug boat for entering the Port of Mukran;
- > A survey vessel to determine the exact position of the pipe strings;
- > A boat to transport the crew of the C10;
- > Furthermore, a boat is permanently on site to secure the offshore construction site.

In addition to the works described in this document, two further AWTI operations will be carried out at KP 16.5 in the German Exclusive Economic Zone. A similar procedure will also take place in Russian waters to connect the Nord Stream 2 Pipeline sections there.



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About Nord Stream 2

Nord Stream 2 is a planned 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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