Nord Stream
The new gas supply route for Europe

BACKGROUND INFORMATION

February 2010

Nord Stream's Logistics Concept

Tailor-made solutions for an efficient pipe-laying process

Content:

A. Summary

Construction of the Nord Stream Pipeline in the Baltic Sea region requires a customised logistics infrastructure comprising new plants for the concrete coating of pipes, additional storage yards in the Baltic Sea area and the development of port facilities and infrastructure. Nord Stream's logistics concept ensures that the natural gas pipeline through the Baltic Sea is constructed as efficiently as possible in terms of costs and timing, while ensuring protection of the environment.

Nord Stream is the largest logistics project in the Baltic Sea region to date. Each of the two almost parallel lines of the approximately 1,220-kilometre-long pipeline system will be made up of about 100,000 steel pipes, each 12.2 metres long and weighing about 12 tonnes. After application of the concrete coating, the weight is roughly doubled.

Delivery, concrete coating, repeated loading and unloading, as well as shipping and storage of the pipes present major logistical challenges. Investments in the logistics centres in port areas will have a long-term positive impact on sustainable development of the Baltic Sea region, boosting employment and bolstering local and regional economies.

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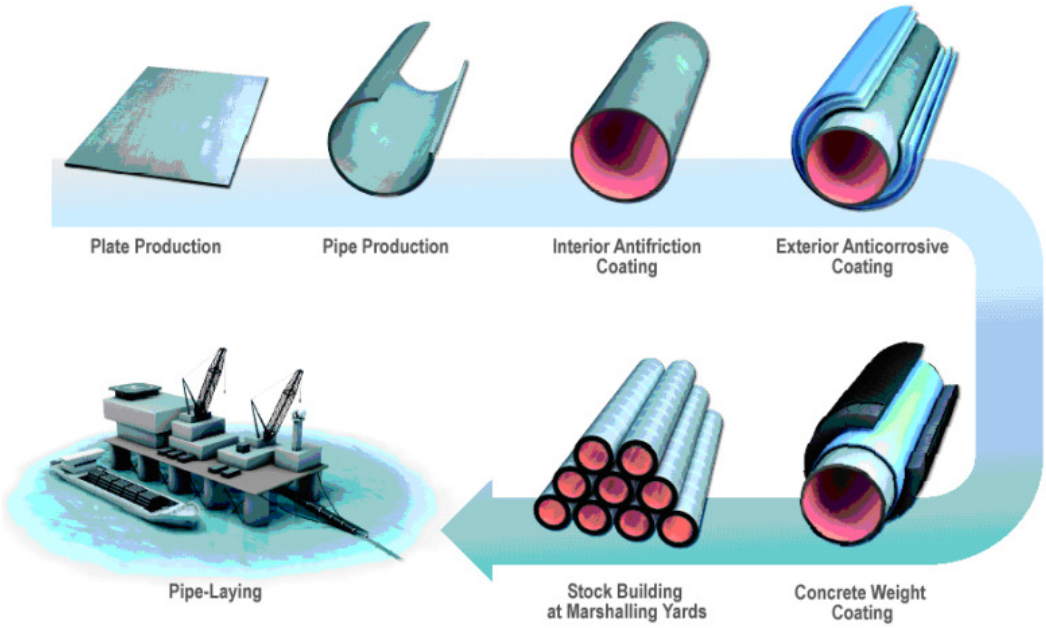
B. Project

Nord Stream will be an approximately 1,220 kilometre offshore natural gas pipeline system consisting of two lines that stretches through the Baltic Sea from Vyborg, Russia, to Lubmin, Germany. It will be built by Nord Stream AG, which is a joint project of OAO Gazprom, BASF/Wintershall AG, E.ON Ruhrgas AG and N.V. Nederlandse Gasunie.

The construction of the first Nord Stream line with a flow capacity of around 27.5 billion cubic metres (bcm) of natural gas per year is due to begin in 2010, and is scheduled for completion in 2011. The second line is due to be constructed immediately after completion of the first line and is scheduled to come into operation in 2012, doubling annual capacity to around 55 bcm. The anticipated total capital cost of the project is 7.4 billion euros.

C. Logistics Chain

The comprehensive logistics chain developed by Nord Stream comprises pipe production, concrete weight coating, storage, trans-shipment and the handling of pipes until pipe laying begins.



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1. Pipe Production

Each of the two parallel Nord Stream pipelines will consist of roughly 12.2-metre-long pipes with an inner diameter of 1,153 millimetres, which will be made of high-tensile steel in accordance with DNV[1] Offshore Standard OS-F 101. Pipe wall thicknesses will range from 41.0 to 26.8 millimetres. A gradual reduction in wall thickness is possible as internal gas pressure along the route decreases over the distance: starting at 220 bar where the gas enters the pipeline in Russia to approximately 100 bar at the end of the line in Germany.

The production steps include plate production, pipe milling, welding, stretching, treatment of pipe ends (chamfering and bevelling) and quality control. Pipes for the first pipeline were produced by the German company EUROPIPE GmbH (EUROPIPE) (75 percent) and ZAO OMK (OMK) from Russia (25 percent). For the supply of steel pipes for the second pipeline Nord Stream commissioned EUROPIPE (65 percent) and OMK (25 percent) again as well as Japanese Sumitomo (10 percent). Delivery of the pipes for the second pipeline is scheduled to start in May 2010.

2. Pipe Pre-Coating (Internal and External)

After the initial quality control, all pipes receive an internal anti-friction coating and an external anti-corrosion coating. The internal coating consists of a two-component epoxy resin flow coat of minimum 90 microns (10^{-6} m) thickness with a very low surface roughness, which increases flow capacity by reducing friction. This internal coating also provides temporary corrosion protection and makes cleaning easier.

A 3-layer polyethylene coating is applied externally to protect the pipeline against corrosion. The first layer is a fusion bonded epoxy coating of at least 150 microns thickness. The second layer of adhesive has a thickness of approximately 0.25 mm. On top is the main layer for corrosion protection, consisting of high-density polyethylene. The total thickness of this 3-layer coating is at least 4.2 millimetres. This coating has been selected for several reasons: It is able to withstand the maximum design temperature of 40°C and the minimum design temperature of -10°C, while also providing for high mechanical and electrical resistance and reducing the requirements for additional, active cathodic corrosion protection.

Both the internal anti-friction and the external anti-corrosion coating are handled by the pipe suppliers immediately after pipe production. From there, the coated pipes are transported to the concrete coating plants on the Baltic Sea coast: Mukran in Germany and Kotka in Finland.

The transport of pipes for the Nord Stream Pipeline from Mülheim to Mukran or – to be precise – to the port of Sassnitz began on 6 May 2008. EUROPIPE commissioned DB Schenker Rail AG to transport the pipes. This “early” start of pipe delivery

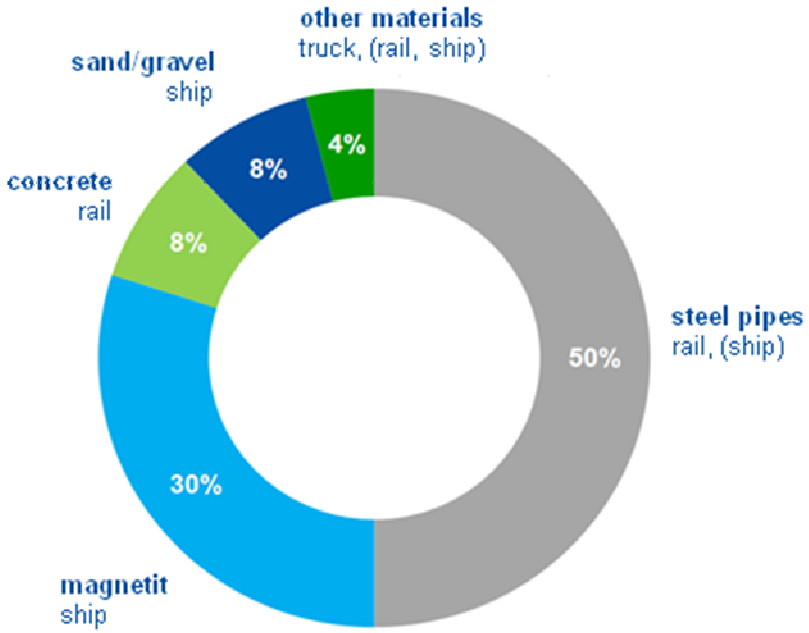
[1] Det Norske Veritas (DNV) is an Oslo-based independent foundation with the objective of safeguarding life, property, and the environment. It identifies, assesses, and advises on the management of risk in the maritime industry, energy and transportation. DNV has a dedicated research department that has enhanced and developed services, rules and industry standards. Many of the technology solutions developed have been so precise that they have helped define internationally recognised standards.

represents an important step in the logistical planning of the Nord Stream project: At least two-thirds of the pipes to be laid, that is roughly 800 kilometres of the total pipeline length, must be coated and available at various logistics sites around the Baltic Sea from April 2010 when laying of the first line is planned to begin. This will ensure the construction schedule can be met.

3. Delivery of further Materials

Transport routes for mineral materials used for the concrete coating are kept short in order to minimise energy consumption and emissions. All materials are sourced from seven European countries. The major part of the material, 1.38 million tonnes of magnetite, is supplied by MINELCO AB from Sweden. The German company Mibau was awarded the contract to transport the magnetite via the Norwegian port of Narvik. The German company Holcim is to deliver 370,000 tonnes of cement, transported by DB Schenker by rail or ship to Kotka. An additional 370,000 tonnes of aggregate will come from Finland and Norway, and be transported by sea. Anodes for active corrosion protection of the pipeline will be delivered from Italy by ship. Trucks will be used only to transport small volumes of materials, such as the steel for the wire cages from Belgium, the Netherlands and France, and pegs[2] for the cages from Britain.

Total weight about 4.3 million tonnes



The transport of the pipes also involves several European companies. German steel pipe manufacturer EUROPIPE is shipping its approximately 140,000 pipes by DB Schenker Rail Deutschland AG. The remaining 50,000 pipes for the Nord Stream Pipeline are produced by the Russian company OMK in Vyksa (350 km east of Moscow), from where they will be delivered to Kotka by the Russian national railway. The

[2] These pegs realize the right distance between pipe and wire cage around the whole pipe.

onward transport of the concrete coated pipes from Mukran and Kotka to the interim stock yards at Karlskrona, Slite and Hanko is being undertaken by Swedish shipping company AtoB@C Shipping AB. Norway's NorSea Group is responsible for pipe handling and storage at the three interim stock yards. Sea Terminal Sassnitz GmbH, part of the Hamburg-based BUSS Group, has taken on all logistics activities in Mukran. At Kotka, this task will be undertaken by Stella Stevedorica Oy Ltd of Kotka.

Ninety-six percent of all transport activities for the first pipeline are handled by rail or ship, the most environmentally friendly methods of conveyance. Transport by truck is limited to local movement within the ports when at all possible.

4. Pipe Concrete Coating

4.1 Technology

At the weight coating plants, the steel pipes are coated externally with concrete that is applied on top of the anti-corrosion coating. The additional weight provided by the concrete coating is needed to counteract buoyancy and ensure stability of the pipeline on the seabed. Approximately one tonne of concrete is applied on every metre of pipe. The final weight per pipe ranges from 19 to 31 tonnes (the average is 23 tonnes). After concrete coating, the pipe sections, a total of 200,000 for the two lines, will weigh about 4.6 million tonnes in total.

For the concrete coating, a special concrete mixture with a certain proportion of magnetite is used. It has a large density of more than 5 kg/dm^3 and is used to ensure that the thickness of the concrete applied is within a range of 60 to 110 millimetres. This variation in thickness depends on water depth, as well as wave and current action in the area where the respective pipe joint will be laid. The concrete coating also protects the pipeline against damage in the water, such as by bottom trawling equipment or backfilling.

There are two concrete weight coating application methods: Compression, whereby the concrete is wrapped around the pipe,[3] and an impingement process,[4] during which the concrete coating is "thrown" on to the pipe at high speed ensuring it achieves high density. Nord Stream has opted for this process which, along with high density, also gives the applied concrete coating good adhesion properties. The quality of the concrete coating is thoroughly tested after curing.

In addition to normal pipe segments, there are also some "special" pipes segments with a greater wall thickness – so-called "buckle arrestors." They are installed at cer-

[3] Wrap application of concrete is also often termed compression coating. During the wrap application process, the corrosion coated pipe travels through the plant on a conveyor in a spiral motion past the concrete application belt. In general, a conveyor belt system feeds pre-mixed concrete from the batch mixing plant to the application belt. At the same time, wire mesh and an outer plastic wrap are fed to the application belt and the concrete wire mesh and outer plastic wrap are simultaneously wrapped around the pipe. Source: http://ppsc.com.my/OA-2008-Paper.html#top, accessed on 10 Nov 2009

[4] During application by the impingement method, the concrete mix is thrown onto the pipe surface by a set of rollers. The throwing unit transfers the concrete at high velocity so that it is compacted onto the pipe surface. End rings are used to perform concrete cutbacks. The concrete is reinforced with a specially manufactured cage that is installed prior to concrete application. Care is taken during application so that damage of the corrosion coating does not occur. The high velocity imparts significant energy to the impinged particles. This force is transferred initially to the corrosion coating so that this has to have the ability to withstand this impact. Once the concrete is applied the pipes are again weighed and end rings removed to form the cut backs. Source as above.

tain intervals as a precautionary measure to protect the pipeline against total collapse in case of a failure: If one section of the pipeline should suffer damage during the laying process, the buckle arrestor protects the pipeline from progressive damage. In addition, so-called sacrificial anodes will be attached to every fifth to twelfth pipe section (depending on marine environmental conditions) which provide additional active corrosion protection.

4.2 Implementation

As Nord Stream is the first offshore pipeline to be installed in the Baltic Sea, an infrastructure for concrete coating had to be developed. Flexible coating plants have been used during construction of other pipelines. The Baltic Sea climate, however, with its volatile and sometimes cold weather, poses specific technical problems for weight coating. Under such conditions, the process requires fixed industrial structures, as concrete coating requires temperatures above the freezing point. Nord Stream had to weigh performing concrete coating in existing plants in Norway, Scotland or France against the construction of new facilities on the Baltic Sea's coast.

After an in-depth analysis, Nord Stream opted for the more environmentally friendly alternative of constructing new plants, which significantly reduces transport volumes particularly in the Baltic Sea region.

Following an international tender process, Nord Stream chose EUPEC to supply concrete coating and all logistics services required in the Baltic Sea region. These services include the acceptance of pipe shipments and the unloading of the pipes in Mukran and Kotka, storage, concrete coating, shipping to additional storage facilities and the transfer of the treated pipes to the company commissioned to lay the pipeline. EUPEC has 40 years' experience in providing comprehensive solutions for the protection of steel pipes – from supply to delivery.

5. Curing, Onward Transportation and Storage

After concrete coating, the pipes undergo a special curing process in a large enclosed "sauna", during which they are steam cured at a temperature of 60 °C. Afterwards, they can be stacked and are ready for onward transportation. They are transshipped by coaster vessels to the interim stock yards. Once there, they are unloaded using specialised equipment (cranes, reach stackers, Mafi trailers), moved on and stored in stacks.

For pipe laying, the pipe segments are removed from storage and prepared for onward shipment at the ports' quaysides. Special pipe carrier vessels take the pipe segments to the pipelay barges.

6. Pipe Laying

For the most part, the two Nord Stream pipelines will run directly on the sea bed. In some areas, the lines will have to be laid in a trench ("trenching") and covered with gravel ("rock dumping") to ensure adequate stability on the sea bottom. This applies above all to the landfall areas. Here, the pipelines will be buried to at least one metre

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below the seabed until water depth is at least 14 metres. The pipelines will also be buried in areas of heavy ship traffic to ensure protection from potential damage from ships' anchors.

The pipe laying itself is carried out by pipelay barges, which are large, purpose built vessels with a crew of about 300. On these vessels, the concrete coated pipe sections are welded into a continuous pipeline. Each weld is tested using ultrasound, and a field joint coating is applied to each joint before the pipeline is finally lowered to the seabed. During this process, every single pipe has to be tracked – with its specific wall thickness depending on its location within the pipeline or with anodes or buckle arrestors.

The pipelay vessel can only operate in ice-free water, at water depths of at least 10 to 20 metres (depending on vessel) and in good weather conditions. Waves of 3.5 metres or more require pipe laying to stop. On average, pipelay vessels are expected to move at an average speed of about 2.5 km per day. In the landfall regions around Greifswald and Vyborg, flat bottom lay barges will be used for shallow water operations.

The Italian company Saipem S.p.A. has been commissioned to undertake offshore pipe laying of the two natural gas pipelines. The construction schedule and detailed technical design of the pipeline are currently being finalised.

D. Logistics Concept

The pipeline route was selected after an integrated evaluation of technical, environmental and economic aspects. The final route was optimised after a consultation process with the Baltic Sea littoral states extending over several years. The pipeline will traverse the Exclusive Economic Zones (EEZ) and territorial waters of Russia (123 km), Denmark (137 km) and Germany (81 km), as well as the EEZs of Finland (375 km) and Sweden (506 km).

The aim of the Nord Stream logistics concept is to minimise impacts on the sensitive ecosystem of the Baltic Sea. This includes choosing low-emission transport by rail and ship, short transport distances on the Baltic Sea and the concentration of logistics activities on selected ports and industrial zones.

The Nord Stream Project could not utilise any existing logistics infrastructure in the Baltic Sea area. To ensure that the pipeline is laid with as efficiently as possible, five ports were chosen on the basis of comprehensive research. Sites close to the landfalls of the pipeline provided optimal solutions for delivery of the pipes by rail from the mills, the dispatch of material by sea, and for the onward shipment of the concrete coated pipes to interim stock yards.

The selected ports fulfil the following conditions:

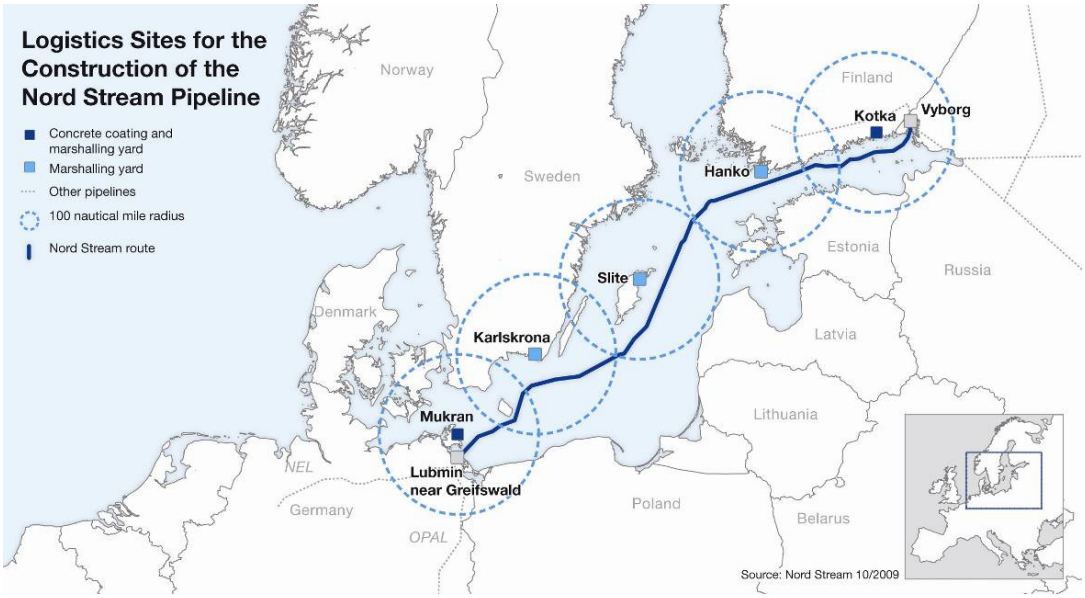
- A minimum area of 300,000 square metres for the construction of a concrete coating plant, and 70,000 square metres each per pipe storage/marshalling yard.
- A minimum water depth of 8 metres
- Quays of 150 metres

- Exclusive use of the port infrastructure for the complete duration of the pipe-laying process.

A further important criterion was distance from the pipeline route. The upper limit is 100 nautical miles (185 km). It was set so that the pipe carrier vessels delivering coated pipes to the lay barges could complete a round trip – including loading and unloading – within one day.

More than 60 ports were examined according to these criteria. The outcome was that Mukran on the German island of Rügen and Kotka on the coast of the Gulf of Finland were chosen as the most suitable sites for the concrete coating plants and interim storage yards. They minimise transportation distances for the steel pipes which, for the first of the two lines, will come from Mülheim in Germany and Vyksa in Russia. In addition, Slite on the Swedish island of Gotland was selected for the main interim stock yard and Karlskrona in southern Sweden was chosen for further interim storage in order to limit final pipe shipment to less than 100 nautical miles. The port of Hanko in the south of Finland will also serve as an interim stock yard.

As Nord Stream's logistics partner, EUPEC has concluded contractual agreements for the sites and is responsible for ongoing organisational co-ordination.



Kotka, Finland:	Concrete Coating Plant + Pipe Storage
Hanko, Finland:	Pipe Storage
Slite, Sweden:	Pipe Storage
Karlskrona, Sweden:	Pipe Storage
Mukran, Germany:	Concrete Coating Plant + Pipe Storage

Sustainable Investment in the Infrastructure of the Baltic Sea Region

Total contract value for concrete coating and logistics for the Nord Stream project amounts to about 650 million euros, of which around 100 million euros are invested

into the required infrastructure in the Baltic Sea region. The balance of the investment total covers costs for raw materials, labour and logistics, including freight charges.

Infrastructure investments for the Nord Stream project have provided substantial support for the development of the five key sites, giving a boost to the regional economy and labour markets. The coating plants and interim stock yards in Mukran and Kotka have created 200 and 190 jobs, respectively, for at least a three year period, with a further ten jobs created at each of the interim stock yards at Slite, Karlskrona and Hanko. This investment will also have indirect benefits for business development and employment in all these locations, as well as long-lasting benefits resulting from improvements to their infrastructures.

E. Logistics Locations

1. Kotka: Concrete Coating Plant and Interim Stock Yard

Kotka in Finland is a publicly-owned port in the Gulf of Finland in the eastern Baltic Sea. With a water depth of 14 metres, quays of sufficient length and an area of 40 hectares, Kotka is the ideal location for a coating plant with marshalling yard. In addition, the Kotka harbour authority is investing in a new quay for loading pipes onto pipe carrier vessels. Approximately 35 percent of the pipes for the first pipeline will be delivered to Kotka, where they will be concrete coated and then delivered either directly to the pipelay barge or to the interim stock yard at Hanko.

2. Hanko: Interim Stock Yard

The port of Hanko in Finland is publicly owned. It has about eight hectares of storage area available. Operations for the Nord Stream project will start in the first quarter of 2010.

3. Slite: Interim Stock Yard and Optimal Location for Middle Section

Nord Stream regards the use of Slite on the island of Gotland as both economically and environmentally beneficial. Its location enables short transport distances to the pipeline route (the alternative would have been a port on the Swedish mainland or in another Baltic state). The advantage of the rather short distance from the pipeline route is the substantial reduction of the volume of shipping and the resulting environmental impact. Moreover, Nord Stream is contributing to upgrading the port at Slite. Gotland will thereby benefit from an alternative port to Visby and will in the future be able to use the new port facilities for ferry connections, in particular to Poland and other Baltic states. The local authorities have already received first enquiries for such routes.
The reconstructed port will have a water depth of eight metres with a new 150 metre long and 30 metre wide quay.

In light of the limited area available at the port, Nord Stream has developed a special, customised pipe-handling concept for Slite. Pipe segments are shipped over the longer distance from Mukran by larger vessels, which will be moored on one side of

the pier. From there, they will be transferred on a "just-in-time" basis across the pier to smaller special ships that will deliver them to the pipelay barge. It is this innovative ship-to-ship handling system that makes it possible to use Slite, whose location is ideal from a logistics point of view.

4. Karlskrona: Interim Stock Yard

The port in Karlskrona provides an interim stock yard of approximately six hectares. The whole area is paved and built on solid rock. With two existing jetties, Karlskrona is an ideal site for an intermediate storage facility. Other advantages include the water basin's depth of nine metres and availability of offices for EUPEC's use right by the quayside.

5. Mukran: Concrete Coating Plant and Interim Stock Yard

Mukran is a publicly owned harbour on the island of Rügen on Germany's Baltic Sea coast. The port's existing infrastructure has been improved so that a total area of 50 hectares is available for the Nord Stream project. EUPEC will concrete coat approximately 65 percent of the pipes for the first line in Mukran and store some of them at the site, as well. Mukran receives all pipe sections by rail from Mülheim an der Ruhr, Germany. Since mid-August 2009, some of the coated pipe sections have been shipped on to the interim stock yard in Karlskrona. Starting in 2010, the remaining pipe segments will be transported directly to the pipelay vessel or shipped on to the interim stock yard in Slite.

F. Conclusion

Nord Stream's logistics concept:

- minimises environmental impact in the Baltic Sea region by using resources carefully and considerately,
- creates benefits for participating ports as these enjoy the long-term upgrading of their infrastructure and
- boosts local economy, which in turn benefits from the creation of jobs.

More information at www.nord-stream.com

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