

## System 800xA Fully automated ESD System for major gas plant increases safety



Danish energy giant DONG Energy trusts ABB's System 800xA High Integrity to protect critical gas treatment plant. Safety is all important at the Nybro Gas Treatment Plant on the west coast of Jutland, Denmark. An impressive 16 to 25 million cubic meters of natural gas is handled every day at the plant, which is situated only a few hundred meters from an important road leading to the summer house areas along the North Sea coast.

When the natural gas arrives from the fields in the North Sea through the several hundred kilometers of pipelines it proceeds directly to Denmark's only natural gas refinery. This is DONG Energy's gas treatment plant in Nybro, which was started up in 1984. The facility has since been continuously expanded in order to keep pace with the increasing amounts of gas that are being extracted from deep below the sea bed.

### All the gas from the Danish sector of the North Sea passes through Nybro

The current capacity at Nybro Gas Treatment Plant is up to 25 million cubic meters per 24 hours. The plant is part of DONG Energy's upstream transportation system for natural gas, and all Danish produced natural gas passes from the North Sea through the Nybro Gas Treatment Plant. It is responsible for reducing the pressure, controlling the quality and measuring the gas. If necessary, Nybro can also process the gas in order to remove liquids, sulphur and other contaminants.

Nybro Gas Treatment Plant also houses DONG Energy's Gas Control Center (GCC). GCC is manned 24 hours a day and is responsible for monitoring both DONG Energy's distribution network and the associated metering- and regulation station, Nybro Gas Treatment Plant itself, Stenlille Gas Storage as well as the crude oil infrastructure from the North Sea to the oil terminal in Fredericia.

### Plant safety is critical

It goes without saying that a plant which handles the Danish and most of the Swedish consumption of natural gas requires a very high level of security. That is also the reason why Nybro Gas Treatment Plant right from the outset was equipped with an ESD (Emergency Shut Down) system, to make it possible to shut off the supply of gas and vacate the gas from the plant in case of an emergency situation. The old system was based on relays, which the operators were supposed to operate via pushbuttons, should an emergency situation occur.

Prior to the decision to install a new and automated ESD system DONG Energy performed a safety analysis of the whole facility. This demonstrated that a number of actions were needed to bring the existing relay based and fully mechanical safety system up to date. In part because there was a need for a new and modern system, in part because they wanted to eliminate "the human factor" which is always a potential source of error, especially in a stressful and chaotic emergency situation.





The Dong Nybro plant receives and handles an impressive 16 to 25 million cubic meters of natural gas every day from the fields in the North Sea. The gas treatment plant contains about 100 kilometers of pipe.





“One of the things we really appreciate in the system is the ability to visualize the relationship between cause and effect”, says Erik Delf.

The operators had to make the difficult decision about what to do in an emergency situation and whether the plant was shut down or not depended on this decision.

“In addition to the huge amounts of gas we handle here, another risk factor is that the plant is very close to a busy road, which serves as a main traffic artery to and from the popular beach and summer house areas along the West coast of Jutland,” says Erik Delf, Technical Coordinator at Nybro Gas Treatment Plant. – “And it is easy to imagine what that could mean, if we were to have a large gas explosion or an uncontrollable fire.”

#### **Reliability is paramount**

Logically, an ESD system is something the user would, hopefully, never want to use. Nevertheless, the surrounding community and employees at the plant must be able to trust that it will in fact work as expected, if one day the need should become reality.

This was a deciding factor for the choice of ABBs solution. ABB could also provide the best price and a reliability and availability as close to 100 percent as possible.

There are four different safety classes, the so-called SIL (Safety Integrity Level) classes, where SIL1 is the lowest level and SIL4 the highest. Nybro Gas Treatment Plant is classified as SIL2 and SIL3. ABB has supplied a System 800xA based on AC 800M HI controllers, which fulfill the requirements of these classifications.

#### **Integration and extended coverage**

“The implementation of the new system also gave us the opportunity to include various sub-systems such as the



The control room of the Dong Nybro gas treatment plant. The status of the ABB ESD system is projected on the wall screen to the right.



One of the eight AC 800M HI controllers with I/O modules used in the Dong Nybro gas treatment plant as part of the ESD system.

All photos from Fotografierne Nibe.

UV detectors we previously used to detect heat, flames, gas and smoke, but which were not integrated into the old ESD system,” explains Jens Wedege Petersen, system operator at DONG Energy’s Gas Control Center.

“Today we employ IR detectors which are far more reliable and also faster, and which have now been integrated into the ESD system.”

“It was a logical requirement from the client that the new ESD system should be able to integrate seamlessly with the existing process control system from Honeywell, to allow it to be monitored from the central control system without any need for separate monitors and user interfaces,” explains Tom Gulbrandsen, Product Specialist, ABB in Denmark. “This facilitates the work for the operators when they, as a part of their daily routines, monitor that valves and other equipment connected to the ESD system are positioned as they should, as well as monitoring the frequent partial tests and the annual full scale test that is performed on the system. “

“In addition we have the option to manually open and close the different valves e.g. in cases where we need to isolate sections in connection with repair work or simply to close down sub-plants or sectors”, explains Erik Delf.

#### **ABB’s offshore experience helps with a smooth transition for the plant**

Thanks to ABB’s vast experience from the offshore industry the project team was able to establish the specifications for the ESD system and set up a detailed day-to-day work plan, which could be kept for reference when work commenced.

It was important for DONG Energy that their clients, private and industrial gas consumers all over Denmark, would not experience any inconveniences or interruption of the gas supply during the implementation of the ESD system. It was initially decided that the exchange of the old system and installation of the new one should be carried out without the need to shut down the plant.

During the implementation phase it became clear, however, that the plant could be shut down during one hour – sufficient time to perform the shift-over itself – without causing any problems for the facility or its customers. The shut down was preceded by an increase of the pressure in the distribution lines so that sufficient amounts of gas were available in the lines and the decentralized gas storage facilities that form part of the natural gas network.

“The implementation of the system went completely smooth and according to schedule and the real shut down was minimized to 45 minutes. The original schedule was respected in spite of the difficult working conditions, caused by the concurrent upgrading of our overall control system,” says Erik Delf.

Jens Wedege Petersen commented: “We were happy with the collaboration with ABB’s experts. They proved to be good at understanding our situation and our frustrations, when at times we didn’t really understand how to tackle all of the challenges of this project.”

#### **From full speed ahead to a complete stop in 45 minutes**

The natural gas that comes in from the North Sea arrives at a pressure of up to 135 bar which is reduced to 80 bars – the pressure used in the Danish onshore transmission system.





“The ESD system may be remotely supported from ABB in Odense, in case we need support. This is a huge advantage because it saves both time and money”, says Jens Wedege Petersen, DONG Energy.

It is easy to understand that a gas leakage or a fire could quickly escalate with devastating consequences. It is therefore very important that the ESD system is capable of ensuring both that faulty sub-sections of the facility can be quickly isolated from the rest of the plant and that the faulty section or the complete plant can be depressurized as quickly as possible.

Specifically, sub-sections of the plant can be depressurized in just 15 minutes while it takes approximately three quarters of an hour to depressurize the complete plant. This is achieved by burning off the gas on the flare and serves as an important safety valve.

#### **Redundant technique protects the process**

ABBs ESD system consists of eight controllers placed in various locations in the facility. All communications are conducted via a double, redundant fiber optic ring. This means that a breach in one place of the ring will have no consequences for communication – the signal will simply find another way around the ring. If just one of the eight stations breaks down, the emergency system is activated, and the whole plant is closed down. The actual brains of the system are the likewise redundant servers, which for security reasons are placed on different locations. Additionally, there are two separate control rooms, in the unlikely event that the main control room should be rendered unusable. Finally, the ESD system is hooked up to a UPS system, so that should the power fail, its functionality will not be interrupted in case of a power failure.

#### **Technical facts – ESD system**

- 3 work stations – HP xw4300 workstation
- 2 Aspect/Connectivity Servers – HP DL360 G4
- 1 Connectivity Server for OPC connection to Honeywell – HP DL360 G4
- 2 Domain Servers – HP DL360 G4
- Redundant fiber optic ring network – Hirschmann RS20
- 5 AC 800M HI with SM810 (SIL2)
- 3 AC 800M HI with SM811 (SIL3)
- Input modules AI880 and DI880
- Output modules DO880
- HIMA relay (SIL2 and SIL3)

#### **Facts – Natural gas**

- Under normal atmospheric pressure natural gas is gaseous.
- The chemical composition is just under 90 percent methane, more than five percent ethane, almost three percent other hydrocarbons, one percent carbon dioxide and less than half a percent nitrogen.
- One cubic meter of natural gas weighs about 850 grams. One cubic meter of air weighs about 1,250 grams.
- The energy in 1,000 cubic meters of natural gas corresponds to the energy in 1,100 liters of heating oil (or six months consumption in a normal household).

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