GE
Grid Solutions

Konti-Skan:
Lindome Converter Station

GE renews Pole 1 of the HVDC link between Sweden and Denmark.

The Lindome HVDC Converter Station of the Konti-Skan interconnection

Imagination at work

HVDC Line positioned between AC transmission lines

Customer Challenges

The Customers

SVENSKA KRAFTNÄT is the owner and operator of Sweden's transmission network responsible for the national electricity grid and the country's 400 and 220 kV power lines. ENERGINET.DK is the Danish counterpart, who owns and operates the 400 kV transmission network for Denmark and is responsible for the overall security of the supply, including connections to neighbouring countries.

Mercury Arc to Innovative Thyristor Valve Upgrade

Originally built in the 1960s, the mercury arc HVDC system of Pole 1 of the Konti-Skan HVDC undersea electricity transmission link was nearing the end of its design lifetime. It was scheduled for replacement and upgrade to match the power rating of Pole 2 in the city of Lindome, built in the 1980s.

GE was selected to deliver a cost effective replacement with its innovative HVDC thyristor valve technology replacing the old mercury arc system. This important re-investment program covered the complete renewal of the pole 1 converter in Vester Hassing, Denmark using state-of-the-art technologies.

In Sweden, a new pole was added at the Lindome converter station with the same specifications as Vester Hassing.

Smoothing reactors and AC Filters

Project Overview

Country:	Sweden
Project:	Konti-Skan - Lindome station
Customer:	SVENSKA KRAFTNÄT
Technology	High Voltage Direct Current (HVDC) Line Commutated Converter (LCC)
Scope:	4 x 157 MW pump turbines 4 x 170 MVA vertical asynchronous motor/generator units Full site delivery, installation, supervision, commissioning and key equipment for the new plant
Rating:	380 MW
Delivery Date:	2006

Innovative Solutions for a Changing Energy World

The scope of the Lindome turnkey substation included:

- Valve hall with H400 series valves
- An auxiliary service building
- Two 3-phase transformers
- AC and DC harmonic filters
- DC reactors
- Cooling systems for the valves and the transformers
- Full control and protection systems, including SCADA

Pole 1 Technical Characteristics

Rated system voltage	AC = 420 kV / DC = 285 kV
Rated power capacity	P = 380 MW
HVDC converter transformers	1 x 203 MVA, 415/111.5 kV, Y-Y 1 x 203 MVA, 415/111.5 kV, -Y
AC filters	1 x 45 MVAr – 11th/13th double-damped 2 x 66 MVAr – 11th damped
DC filter	Triple tuned at 12th/24th/42nd
DC reactor	L = 160 mH

Major Components of the System

Valve Design

GE modernized the liquid-cooled valve design of the H400 series thyristor valves. Following the well-established H300 "banded pair" technology where two thyristors are clamped by fiberglass bands to their heat sinks, the same principles were applied in the H400 technology, up to six thyristors and heat sinks are clamped by Glass-Reinforced Plastic (GRP) tension bands.

These provide the high clamping force necessary for good electrical and thermal contact between thyristors and heat sinks. The straps also maintain adequate dielectric strength to support the voltage stresses experienced during the off-state intervals of the valve. The clamping system facilitates the replacement of a thyristor without opening any power or coolant connections.

Each thyristor is a 125 mm 8.5 kV (forward or reverse repetitive withstand potential) electrically triggered device. Each has its own damping and grading circuits so that all electrical stresses are shared between thyristors as closely as possible. Each thyristor is also protected by an electronic overvoltage protection that fires if the forward voltage or its rate of change (dv/dt) exceeds a protective threshold.

An additional benefit gained by the local electronic protection being integral with each thyristor level is that the protection settings are dynamic. They can be made compatible with the actual operating parameters of the individual level, rather than with a gross approximation for the entire valve.

Cooling System

The thyristor valves are the main heat source in the cooling system, the main pump being the other (much smaller) heat source. Within the thyristor valve, the main heat-dissipating components are:

- Thyristors
- DC grading resistors
- Damping resistors
- di/dt limiting (saturating) reactor

The cooling system uses pure de-ionised water for the coolant. However, because the minimum outdoor ambient temperature is below 0°C, a calculated proportion of ethylene glycol is added to prevent the coolant from freezing.

All materials in contact with the coolant are selected taking into account the need to maintain the high purity and low conductivity of the coolant. These materials include:

- 316 or 316L stainless steel
- Low copper content aluminium
- Ethylene Propylene Diene Rubber (EPDM)
- Cross-linked Polyethylene (PEX)

H400 Valves

DC Smoothing Reactor

Although PEX, EPDM and stainless steel are highly immune to corrosion, the aluminium used in the heatsinks makes controlling the purity of the coolant water of paramount importance. Accordingly, the cooling plant incorporates equipment to filter, de-aerate and de-ionise the coolant water.

Filters

The scheme is rated to offer a reactive power exchange of ±40 Mvar at the converter station busbar. To limit the step change in AC voltage when a filter is switched, the maximum rating of a filter is 65 Mvar. The control system ensures that sufficient filters are in service for the power being transmitted. In addition, there is an automatic AC voltage control or operator controlled exchange of reactive power with the AC system.

Digital Control

The Series V digital control technology delivers system security and reliability, as there is no longer the need for recalibration due to "drift". The architecture of the Series V control system provides the following features:

- Fully digital control and protection
- Modern microprocessor based controllers
- Industry standard bus system and components
- Flexible communications interface with other devices and controllers
- Remote diagnostics and monitoring
- User-friendly graphical operator interface
- Fully upgradeable

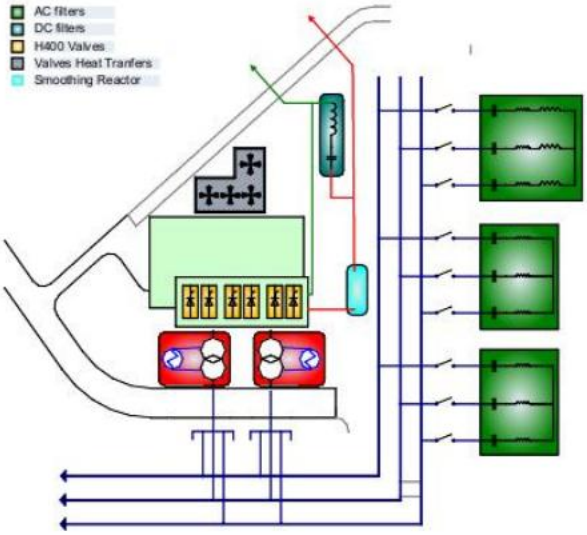
All controls are duplicated for reliability. The redundancy arrangement is designed to maintain full system performance in the event of any failure. Changeover from the active controller lane to the standby controller lane may be effected automatically by activation of the fault detection mechanism, or manually, via the engineer's interface.

Lindome Layout

H400 thyristor valves

Outdoor valve cooling system

Converter transformers



Smoothing reactor

AC filters

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Imagination at work