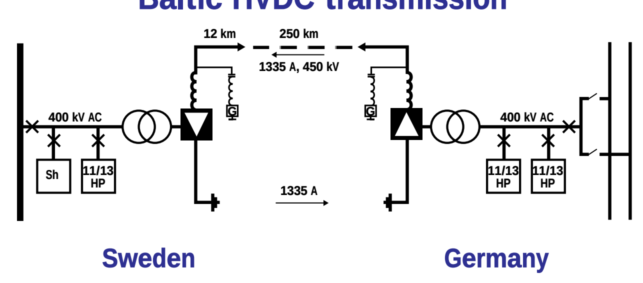
CONVERTER

Stations

The two converter stations that connect the HVDC cable to the AC networks on the Swedish and German sides respectively have basically the same functional design (fig 1). The design itself is based on experience from recently performed projects in Scandinavia, e.g. Fenno-Skan, Konti-Skan 2, Gotland etc. which for instance means that the whole circuit solution is of quite a simple but robust design.

fig. 1



The valves are suspended quadruple valves, air insulated, water cooled and of indoor design. The transformers are of a single-phase three winding design with one common spare transformer located on the German side. An air core reactor of 200 mH is used in each station as a smoothing reactor on the dc side.

Both converter stations are equipped with AC filters. On the German side with two fully redundant filters but on the Swedish side only with one (combined with a shunt capacitor bank). Each of the filters will have an 11th/13th double tuned branch and a high pass broad band branch. The complete filters are connected to the converter station 400 kV AC bus via a power circuit breaker that can trip a faulty filter without affecting the power transmission on the link, provided the redundant filter is available.

On the DC side filter can be avoided in Herrenwyk due to the fact that the HVDC cable is entering the converter station directly. However, in Sweden the 12 km long DC overhead line makes it necessary to filter the DC side harmonics. For Baltic Cable quite a new type of filter solution is used, namely an active filter.

Active DC filter

By use of an active filter one high voltage passive filter branch only can replace several such branches and thus save both space and costs. The active part contains as main parts harmonic measuring devices, signal processors and a harmonic generator. The aim is to let the generator produce and inject harmonics on the DC bus, via the passive branch, with the same amplitude but 180 degrees phase shifted compared with the converter produced harmonics. Thus the sum will be very close to zero.

Control

The operation of the link is planned to be based on remote control from control centres from either Germany or Sweden. The control system will include several control modes in addition to the normal power control and the back-up synchronous control.

The emergency power control will be a feature for fast automatic (manual also possible) power changes, including full power reversals and start-up from stand-by operation, with a maximum rate of 990 MW/s. Activation will be based on e.g. local frequency or AC voltage levels. Regulating parameters, such as power change and power regulation speed will be determined individually for a maximum of 10 entries.

Two different modes of frequency control are included. Normal frequency control may be used e.g. when spinning reserve is to be brought from the other system and the regulation system will then operate with speed droop and deadband. The other frequency control will be used for islanded operation, i.e. one system will be operated as an island and the DC link will serve as a primary frequency controller.

Cable dependent voltage control (simplified)

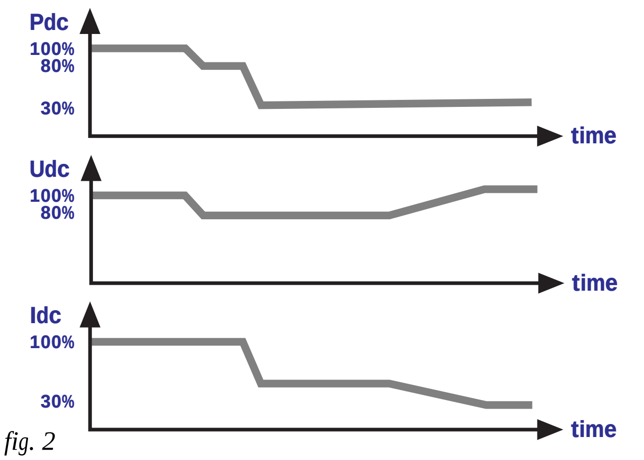


fig. 2

Under normal operating conditions the reactive power unbalance will be controlled by the automatic switching of filter and shunt banks.

Two cable control systems are installed into the converter station in order to optimize the power transmission of the link, also taking into account the dielectric stresses in the insulation and the temperature limitations of the cable. The cable loading prediction system will together with the station loading prediction system form the so called loading capability system which will on a real time basis predict possible 15 minutes and continuous overload for the whole link. The cable dependant voltage control will comprise a model of the cable heat dynamic which will have a time constant of several hours (fig. 2). For more information, see the Cable pamphlet.

Locations and layouts

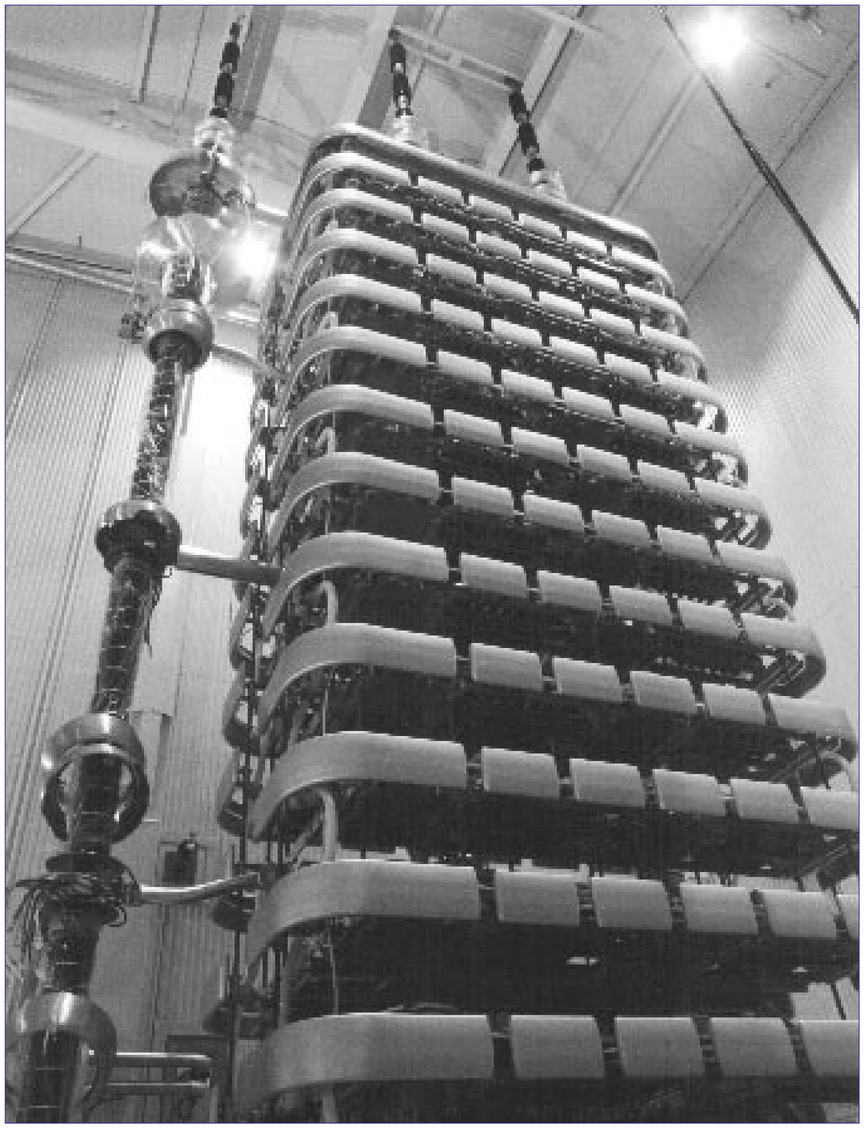
On the Swedish side the height of the valve hall has been discussed due to its location in a flat landscape. Both building construction, architectural designs and a compact thyristor valve design have been scrutinized. The valve hall is placed as low as possible with respect to the ground water level, and the mounting point for the suspended valve has been integrated into the roof construction. The total building height will be 19.5 meters compared to the thyristor valve height of 16.8 meters, and the height above ground will be 17.8 meters. This will result into a converter building which is more than 5 meters lower than expected from the beginning.

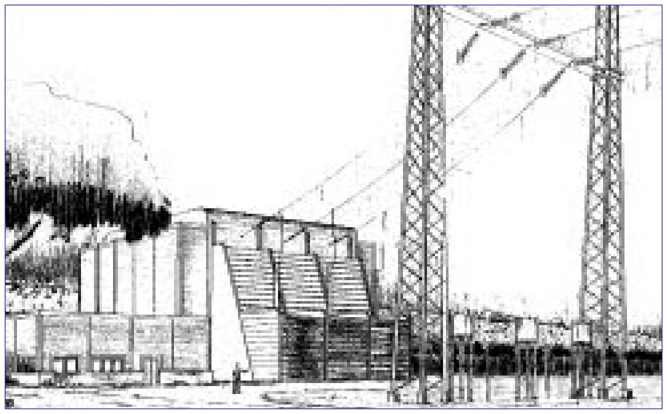
To achieve the valve height of 16.8 meters it was necessary for the contractor of the converter station, ABB Power Systems, to develop some new mechanical design elements and confirm by high voltage testing before it was possible to meet the requirements for compression of the valve.

The station area on the Swedish side will also be surrounded by an approximately 3 meters high earth embankment. Furthermore, a 50 meters wide belt of decidious trees will be planted around the area.

On the German side the height has not been any problem but instead the outlook of the station area itself. The area chosen for the station had up to the summer of 1992 been used for a coal fired power plant and just before the work with the converter station started the demolition of the old plant took place.

As the main and heaviest parts of the station were to be located on the old coal storage place close to river Trave, major piling work had to be performed. Further, the very unsymmetrical outlook of the area has given a different and more complex layout of the station compared to the one on the Swedish side.





Main data

Thyristor valves:	water cooled, air insulated
Converter transformers:	one phase three windings, 235 MVA/unit
Filters:	conventional passive ac filters, active dc filter
Valve hall:	inner height of 20 metres
Normal control mode:	constant power
Additional control modes:	emergency power, frequency control, cable controls
Operation control:	remote

Contractor

ABB Power Systems AB, Sweden

BALTIC CABLE

BALTIC CABLE AB
Nobelvägen 66, 205 09 Malmö
tel 46-(0)40-25 61 30, fax 46-(0)40-25 61 40