

SC B3 Substations & electrical installations
PS 2: Design and technology**Experience in the HVDC equipment development for Vyborg converter complex
upgrade at SS 400 Vyborg PJSC FGC UES**

D. VODENNIKOV¹, E. DAVYDOV^{*2}, A. ANTONOV², M. PESHKOV²
PJSC «FGC of UES»¹, JSC «R&D Center FGC of UES»²

Russian Federation

***Davydov@ntc-power.ru**

Vyborg converter complex (VCC) consists of four thyristor HVDC line-commutated converters connected in parallel. VCC provides asynchronous interconnection of Russian and Finland power systems with 1300 MW transfer capability in both directions.

Operation modes at 400 kV Vyborg substation characterized by idle mode and at the same time ramping has increased and has reached 600 MW since 2013. Such operation conditions gave negative impact on VCC equipment and lead to emergency shutdowns growth.

Complex was put into operation in 1983. Planned lifetime of the installed equipment was 25 years. Thus, the converting equipment of HVDC line has fulfilled its resource and requires replacement with a new one.

In 2016, PJSC FGC UES made a decision to carry out R&D on the development, manufacture and testing of high-voltage VCC with one phase of the converter bridge, control cabinet and autonomous cooling system based on modern components for full scale modernization of the whole VCC in the following years.

The phase of the converter bridge includes two high-voltage thyristor valves combined in a single frame of the supporting type. Each high-voltage thyristor valve (HVTV) includes four high-voltage thyristor modules (HVTM). The design of the HVTV allows quick installation and removal from the frame structure, and also allows for annual maintenance work and most types of repairs directly at height.

HVTV includes a thyristor assembly of series-connected thyristors and coolers, control and protection units, and saturable reactors. PJSC Elektrovypryamitel (Saransk, Russia) class T283-1600 60 device used as a thyristor for the layout of high-voltage valves. Reliability of the devices was confirmed by the life test cycle of T283-1600 thyristors, carried out at the plant upon the request of R&D Center of FGC UES (R&D Center).

The control complex (CC) is a hardware and software system designed for control and protection of high-voltage thyristor gates. CC functional blocks are executed on π -TCA architecture. The architecture was developed by R&D Center specialists (Moscow, Russia). π -TCA architecture characterized by using Micro-TCA architecture implemented in Euromechanics form factor optimized for high-voltage converter devices control tasks.

High reliability of the system is provided by redundancy of all elements and the hot-swapping possibility of any functional modules.

Cooling system of high-voltage thyristor valves is a double-circuit type including deionized water and polypropylene glycol mixture.

Currently, all factory tests of developed equipment has been conducted, which fully confirmed its performance in various operating conditions, the impacts of lightning and switching overvoltage, etc. The tests were carried out at R&D Center specialized stands according to a tests program developed with IEC 60700-1 requirements.

Converter bridge phase with CC and autonomous cooling system will be installed, tested and commissioned at 400kV Vyborg substation till the end of 2019.

Step-by-step replacement of the HVDC equipment will reduce the equipment repair cost, increase the reliability of the converter complex and also increase energy efficiency.

Further the developed equipment can be used for both HVDC transmission and B2B HVDC of the LCC type, resulting the implementation of electricity transport projects from Russia to China, Japan (Asian Energy ring) and other countries.