



Power Stability Expert

| Case Study |

NR Protects China's First 1000kV UHVAC Link

Technical Innovation Based on Customers' Need



Jindongnan–Nanyang–Jingmen power links are the first 1000kV UHVDC transmission project in China. It was constructed by State Grid Corporation of China (SGCC) in 2006 and was put into service in 2009. NR Electric (NR), as one of leading power system solution providers, supplies complete protection, automation and control solution to ensure the safe operation of this power system. So far, the UHVDC links are operating normally, transferring large amount of electricity from West China to Southeast of China.

Overview

The Jindongnan–Nanyang–Jingmen power links interconnect the Central China Power Grid and the Northern China Power Grid with the distance of 654km. Two substations with 1000kV/500kV/110kV transformers were built at Jinmen and Jindongnan respectively, and an interconnecting station was built up at Nanyang.

Table 1. System Parameter of Jindongnan–Nanyang–Jingmen Power Links

Rated Transmission Capacity	5000MW
Transforming Capacity	6000MVA
Rated Voltage Level	1000kV
Highest Operating Voltage Level	1100kV

The Project was approved in August 2006 and started construction by the end of the same year. It was completed in November 2008, put into trial operation on November 30th and was put into operation after 168 hours of trial run at 10 pm, January 6th, 2009. This is the world first 1000kV transmission line in commercial service.

Customer Needs

China's energy distribution is in the unbalanced situation that energy resources are far away from load centers. The majority of the hydropower resources are located in the west, and coal resources are located in the northwest, but huge loads are located in the east and south. To reduce the transmission losses to a manageable level, UHV transmission is a logical choice. Ultra-high-voltage AC (UHVAC) transmission system has been built in China since 2009 to transmit electricity over long distances between China's energy resources and load centers.

As the first 1000kV UHVAC project, the State Grid Corporation of China(SGCC) was expecting to master the core technology and possess the adequate experience on the UHVAC transmission system through the implementation of this project. SGCC required the manufacturers to make a comprehensive study on the new UHVAC system and propose an appropriate solution for the new system. As well, a reliable and stable protection and control solution should be provided to keep the continuous operation of the critical project and to minimize the downtime of this 1000kV UHVAC transmission system.



NR Solution

In the beginning stage of the project, NR set up a dedicated research team to thoroughly study on the system characteristics. Extra functions and mechanical performance of protection and control products were developed to adapt to 1000kV transmission system. All these new features are verified in the Analog Model Simulation Laboratory and the RTDS Digital Model Simulation Laboratory.

Overall Protection & Control Configuration

NR provided the full-scale protection and control solutions for this UHVAC project, including 1000kV transmission line distance protection, 1000kV transmission line current differential protection, 1000kV/500kV/110kV transformer protection, 1000kV circuit breaker protection, 1000kV transmission line voltage and transfer trip protection and the substation automation system for the whole substation in Jinmen. All these products are based on the robust and well-proven hardware and software platform.

System Scheme

For the 1000kV transmission line, a redundant scheme was utilized with two sets of protections, one is the distance relay and the other is current differential protection. Both of the protections integrate the full-scale main and backup protection in one rack. It ensures that there is always a complete set of protection for the 1000kV transmission line in case any one of these two protections is out of service.

Overvoltage Protection

For a long-distance UHVAC transmission line, the large capacitive current may cause the overvoltage situation. So the overvoltage protections are required on both sides of the transmission lines to handle this overvoltage condition. The dedicated overvoltage protections were supplied, which also integrates the initiating of transfer tripping command.

Transformer Protection

The 1000kV/500kV/110kV transformers were composed of a main transformer and a compensating transformer. For this kind of transformer, the redundant scheme was employed for the main transformer protection while a separated protection was used for the compensating transformer to enhance the sensitivity during internal faults.

Circuit Breaker Protection

The 1000kV circuit break protection integrated the failure protection and auto-reclosing functions. An interposing relay set was used in combination to accomplish the tripping and close commands issued by protection and control devices.

Automation System

An advanced substation automation system was applied to the whole substation including 1000kV, 500kV and 110kV voltage levels. This integrated protection and control system made the supervision and maintenance easy and cost-effective. It integrated protection, bay-controller, metering, monitoring and communication together and communicated with the remote control center.



Customer Benefits

Based on NR Electric's innovative and reliable protection and control solution, the Ultra HVAC transmission system in China has achieved a high level of reliability and ensured the continuous power supply for the vital customers in Eastern China. As well, the stability margin of the transmission line is improved due to the fast clearance of short-circuit fault via NR Electric's high speed protection.

The implementation of UHVAC system using modern high efficiency generation leads to less pollution near the energy resources. The old thermal power plants along the coast will be retired. The UHVAC grid will aid China's plan of electrification and de-carbonization, and enable the integration of renewable energy by removing the transmission bottleneck which is currently limiting expansions in wind and solar generation capacity.

Through the implementation of 1000kV UHVAC transmission project, China has established a first-class UHVAC transmission system, mastered the core technology and formed a set of standards on UHV AC power transmission. The Project has also upgraded the manufacture industry of power facilities, trained and nurtured a team of technological and managing experts and validated the technical feasibility, equipment reliability, system safety and environmental friendliness in the UHV AC transmission.

