

**DC transmission (HVDC) and flexible AC transmission systems (FACTS)
RESEARCH OF IMPROVING FORCE RETARD FUNCTION**

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High Voltage DC Transmission (HVDC) has obvious advantage in long distance, large power transmission. Of course, long distance also means high possibility of DC line fault. Only in 2007, HVDC in China Southern Grid (CSG) are blocked 10 times due to DC line or electrode line fault, 5 for TSQ, 3 for GG1 and 2 for GG2 project respectively. HVDC in State Grid are blocked 5 times due to DC line or electrode line fault.

DC arc can be kept even DC voltage across is very low. And the capability for DC breaker open DC arc is limited. So, it is almost impossible to distinguish DC arc if there is no other way for DC current flowing through. However, it is not necessary to block HVDC when DC line or electrode line fault occurs. Force Retard is used in HVDC to distinguish DC line fault and restart HVDC. Parameters of this function are decided by system requirement and the safety of HVDC equipment.

The shortcomings of force retard function in China Southern Grid and State Grid are as followed:

- 1) For GG1 and GG2 project in CSG, only pole 1 enable force retard function, for the reason of system stability.
- 2) The fault range that can cause force retard is small. For electrode line fault and metallic return line fault, energy storage is lower than DC line, and deionization is easier than DC line fault, force retard is the best choice to clear fault.

Based on the experience for several years, measurement of improving force retard function is analyzed.

- 1) Enhance function of control software, avoid limitation of using force retard like GG1 and GG2 project. In new project, force retard of both pole 1 and 2 are enabled and controlled by bi-pole control, that one pole restart after the other with some time delay if DC line fault occurs on both poles within very short time.

- 2) In MR mode, DC Line Transversal Differential Protection (87DCLT) initiates force retard.

- 3) In GR mode, Electrode Unbalance Protection (60EL) initiates force retard. Though electrode line fault almost make no negative influence to HVDC equipment and grid operation, force retard is still the best choice to clear fault, for the safety of person and animal.

Measurements item 1, 2 and 3 will be used in $\pm 800\text{kV}$ YUNGUANG HVDC project. CSG will modify related pole control and DC protection software of GG1 and GG2 project under help of manufacture.

