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2016 Paris Session

C1 PS3

Improvement of mode controllability and short-circuit currents limitation in metropolises power grid by means of electromechanical AC links as an alternative to DC links.

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Concentrated power grid of every metropolis is characterized by considerable power consumption, large size of installed power generating facilities and relatively short 110-500 kV power lines. Russian and international experience shows that power consumption of metropolises increases constantly. As a result, short-circuit currents design level in main power grid of metropolises power system exceeds 63 kA. This value exceeds maximum value of commercially available circuit breakers rated breaking current.

Current limiting devices and reactors can be used for limitation of short-circuit current to necessary level. However, the most popular method is sectioning of power grid up to separation of power system into insolated fragments. For example, Moscow power grid has approximately 30 sectioning points in 220 kV grid and approximately 100 sectioning points in 110 kV grid. Sectioning of power grid allows reducing of short-circuit current however it also reduces redundancy capabilities for power supply of some substations and power districts. This results in reduction of reliability of consumers' power supply.

It is proposed to use DC links in order to interconnect opened sections of grid. This solution ensures set active-power flow, reactive power control, that is become more important with development of cable networks, and also limitation of short-circuit currents. The main disadvantages of this technical solution are high price and considerable dimensions that result in difficulties associated with allocation of land plots for substation in order to place DC link in an urban area.

Electromechanical AC link based on asynchronized machines (double feed machines) is almost complete analogue of DC link. Electromechanical AC link is a unit with two electric machines, installed on its main shaft. Either machine can operate in generator and motor mode. Vector excitation control of every machine ensures independent control over set active-power flow and reactive power control in two of their connection points. Moreover, electromechanical AC link exclude transfer of zero and negative-sequence currents, high current and voltage harmonics from one power grid to another, ensuring in point of fact galvanic isolation of interconnecting grid sections.

Electromechanical AC links have the following advantages before DC links:

- Smaller occupied area;
- Absence of high harmonics;

- Acceptable short-term current overload up to double value;
- Lesser price.

Electromechanical AC links with rated capacity of 100 MW and 200 MW were preliminary investigated and designed. Electromechanical AC link is a vertical unit, consisting of two asynchronous motors-generators. Vertical arrangement of the unit minimizes occupied area. Rated rotor speed is 750 rpm. Cooling is completely air-type. Excitation system of every motor-generator ensures in-feeding of three-phase rotor with variable frequency from 0 to 0.25 Hz. Start-up frequency converter is used in order to start up the unit. Ramping of active power from zero to nominal value is not more than 0.3 sec.

Today the possibility of application of electromechanical AC link in power grid of Moscow city is being considered. Short-circuit current increases up to 77 kA in case of closing the circuit from high-power CHP to 220 kW major tie-substation. In case of installation of electromechanical AC link at this transfer, short-circuit currents will not exceed 49 kA. This allows interconnecting of forcedly opened sections and also provide of active-power flow control and voltage control at the connection point of the unit.

Expert evaluation of technical effect, associated with applying of electromechanical AC links at several facilities of Moscow city is provided. For example, application of electromechanical AC link in 220 kV power grid of Moscow city ensures the following:

- Liquidation of sectioning points in nodes with electromechanical AC link installation;
- Reduction of short-circuit currents in 220 kV power grid, adjacent to the node with of electromechanical AC link installation (approximately to the value of 12 kA in case of installation of one link 200 MW and approximately 30 kA in case of installation of two links and approximately 45 kA in case of installation of four links);
- Possibility for voltage control (within the range from -4 to +8 kV) and reduction of need for required additional sources for reactive power compensation;
- Possibility for active-power flow control;
- Extension of acceptable operation modes of the bulk power grid due to possibility for handle active-power flow control through by-passing 220kW circuits.

In order to reach additional technical and economical effect it is necessary to solve tasks on determination of control principles of electromechanical AC links operation modes on the basis of asynchronized machines, in both meshed and distribution high-voltage power grids of Moscow metropolis.