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Operation experience of asynchronized turbine-generator sets in the Moscow power system

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Five asynchronized turbine-generator sets (ASTG) with a capacity from 110 to 320 MW were put into operation in the Moscow power system from 2003 to 2009:

- one generator T3FA-110-2U3 type with a capacity of 110 MW at CHPP-22 (Moscow)
- three generators T3FAU-160-2U3 type with a capacity of 160 MW (one generator at CHPP-21 and two generators of CHPP-27, Moscow)
- one generator T3FSU-320-2U3 type with a capacity of 320 MW at Kashira`s CHPP (Moscow region)

The ASTGs have two windings on the rotor, which allows vector control of the excitation. The possibility of independent control of the rotor current in two axes makes allows to rotate the resultant vector of the magnetic excitation flux relative to the longitudinal magnetic axis of the rotor d, in contrast to the synchronous generator, where the magnetic field is rigidly connected with the rotor.

As known, limitation of the minimal excitation (LME) is introduced in synchronous turbine-generator (STG) which is associated with an increase in the heating of the stator end zones and a significant decrease of statical and dynamic stability.

ASTGs do not actually have LME. The problem of preventing the heating of the end zones of the stator is solved due to special design and more intensive cooling of this zone. Problems of stability are solved by special vector control of the excitation. As a result, ASTGs, unlike synchronous turbine-generators (STGs), can operate in modes of deep consumption of reactive power, without violating static and dynamic stability.

The technical and economic effect of the ASTG application is as follows:

1. Rejection from the additional reactive power compensation devices (shunt reactors) on the station's buses.
2. Improvement of operating modes for reactive power of synchronous turbine-generator units of the power station due to the elimination of unfavorable regimes for STG with the consumption of reactive power (or near to consumption).
3. Increasing of the reliability of the generating equipment.

The increase in reliability of ASTG, in comparison with STG, is due to the possibility of working with excitation in one of the windings of the rotor or in general without excitation, in the event of failures in the excitation system. Oscillograms of transient processes at work

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without excitation in an asynchronous mode and test results at imitation of various failures in the excitation system are shown in the report.

Variable nature of the load is observed in the Moscow power system. In recent years overhead power lines have been converted to cable lines design, as a result is excessive reactive power during hours of minimum load.

It was decided install the ASTGs at a number of power plants to improve the manageability of the Moscow power system in terms of maintaining the required voltage levels and regulating the flow of reactive power, and to improve the stability and reliability of the power system.

The operational experience of ASTGs has shown their effectiveness in maintaining of requested level of voltage. Most part of the time ASTGs operate in regimes of reactive power consumption. The analysis of operating modes is carried out and the statistical analysis of operational parameters is given for the last five years.

The report analyzes the technical state of asynchronized turbine-generators installed in thermal power plants, based on the results of complex diagnostic tests during repairs with the withdrawal of the rotor.

Inspections included an evaluation of the state of the active steel core and the stator winding, rotor body metal, insulation and copper of the rotor winding. The surveys were carried out on the basis of a set of measures aimed at early detection of defects and assessment of the technical condition of the main turbine-generator units, including the use of technical endoscopes, measurement of the level of PD, ultrasonic flaw detectors, and some others.

Complex carry-out tests of asynchronized turbine-generator units showed high operational reliability in comparison with other air turbine-generator units of the same power class. The detected defects are mainly due to the so-called run-in stage, which is characteristic of the newest types of machines operating with a higher loading level of the active parts. The operating experience is taken into account by the manufacturer in the design and manufacture of new generators of similar types.