OPTIMALIZATION OF CONNECTION THE SECONDARY WINDING OF THE AUXILIARY NORMAL TRANSFORMER IN THE NUCLEAR POWER PLANT

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ABSTRACT

The nuclear power plants use for supply of onsite power system the normal, standby and emergency sources. The subject of my report is the optimalization of winding connection of lower voltage of auxiliary normal and standby transformers. The suppliers use the delta connection or star connection connected to earth through high – ohmic impedance.

KEYWORDS

nuclear power plant, auxiliary normal transformer, auxiliary standby transformer, onsite power system, delta and star connection of winding

1. INTRODUCTION

The power units VVER 1000 (***W****ater-****W****ater* ***E****nergetic* ***R****eactor)*, AP 1000 (***A****dvanced* ***P****assive* *Reactor*) and APWR (***A****dvanced* ***P****ressurized* ***W****ater* ***R****eactor*) use for connection of onsite power system of auxiliary normal transformers. The supply of onsite power system through the network 400 kV is used in the power units EPR (***E****uropean* ***P****ressurized* ***R****eactor*). The onsite power system of power unit is powered from the main generator at normal operation. When the main generator is shutted down with the generator load breaker switch open, auxiliary normal transformers (ANT) are powered through the main transformer from the offsite power sources.

2. DESCRIPTION OF THE AUXILIARY NORMAL AND STANDBY TRANSFORMERS IN THE ETE1,2

During power generation mode, the turbine generator normally supplies electric power to the plant auxiliary loads through the auxiliary normal transformers. Each auxiliary normal transformer supplies power at around 50 percent of the plant loads. The average auxiliary plant loads are at around 50 MW [1]. This transformers have the nominal power 63 MVA on the side of higher voltage and 31,5 MVA on the secondary and tertiary windings. The ratio of transformer is 24±4×4%/6,3/6,3 kV. The voltage control is necessary because of changeable voltage on the primary side of transformer. The second reason is transient compensation of voltage start of the large asynchronous machines. The control of voltage keeps up the voltage on the busbars of substations from 6 kV to 6,3 kV. The transformers have split windings. It means that the coils on the side of higher and lower voltage are divided on two parts. On the side of higher voltage they are parallel interconnected and on the side of lower voltage they operation separated. This conception gives the reduction of short circuit currents on the busbars of lower voltage and it rises the safety of supply of power. The right function of this conception is

contingent approximately on the same load of both windings of lower voltage. If the loads aren't the same, the scattering losses rise. It can mean that some parts of transformer will overheat.
A maintenance source is provided to supply power through an auxiliary standby transformers (AST). This transformers are supplied from the power network 110 kV from the switchyard Kočín or Dasný and at black-out is possible the supply from hydro power plant Lipno. They are performed like triple-wound transformers in connection Y_N/d1/d1 with ratio 110±4×4%/6,3/6,3 kV. The voltage control is necessary because of voltage drop at supply from more distant sources (Dasný – 30 km) at starts of large asynchronous machines and the regulation of transformers 400/110 kV in the switchyard Kočín or Dasný. The transformers have split winding, too. The supply conception of onsite power system of other power units is different in number and construction of auxiliary transformers. The power unit APWR by Mitsubishi [2] uses four two-winding transformers in connection delta – wye. The power unit AP 1000 by Westinghouse [3] uses like the Russian power unit two triple-wound transformers connecting D/yz/yz. The power units EPR [4] use three triple-wound auxiliary transformers connecting in the power network 400 kV. This power unit uses a different number of auxiliary normal and standby transformers. These transformers are connected Y_N/yz/yz.
The primary of the unit auxiliary transformer is connected to the main generator isolated phase bus duct tap. When a monophase defect originate in isolated system, large short circuit currents don't set in. In these electric circuit currents have the values of several hundreds of kA. These large currents mean the destruction of the bus duct. The short circuit power between the main generator, the main transformer and the auxiliary normal transformers can be to 16,2 GVA. Because of possible beginning earth connection is necessary to dimension the insulation of machine windings for the line–to–line voltage.
Four main switchgears indicated like 1 BA, 1 BB, 1 BC a 1 BD [1] are powered from individual windinds of the auxiliary normal transformers. In these individual switchgears are connected one reactor coolant pump (RCP) – 8 MW and one condensate pump (CP) – 2MW. To the switchgears 1 BB and 1 BD are connected the cooling–water pumps (CWP) – 7 MW. The transformers (T1) for supply of networks 400 V are connected to the switchgears 1 BA, 1 BB, 1 BC and 1 BD. The scheme shows the figure 1. This four medium voltage buses are non-class 1E.

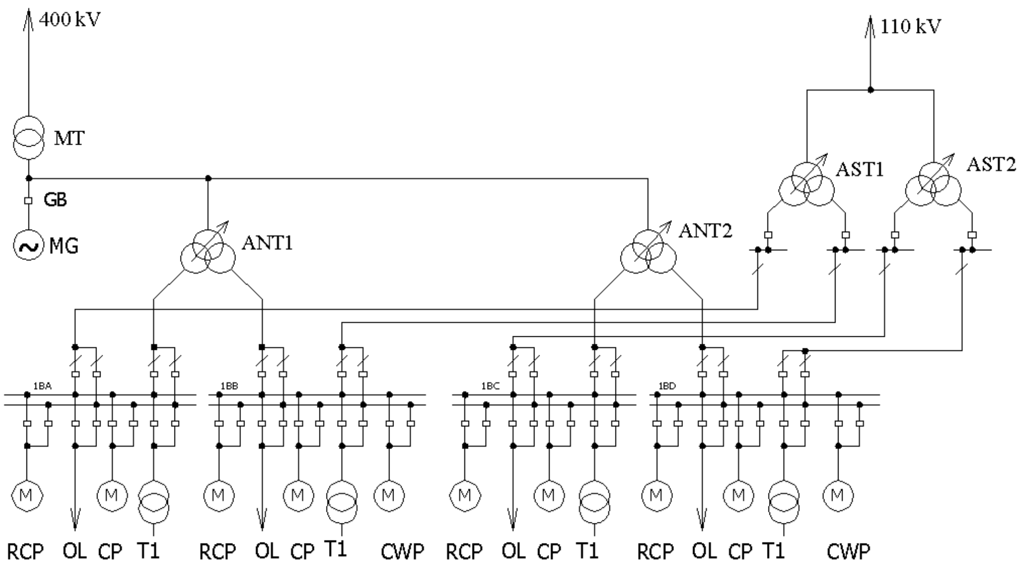

Figure 1 - The part of AC onsite power systém. This figure shown interconected the auxiliary normal transformers (ANT1,2), auxiliary standby transformers (AST1,2), switchgears, main transformer (MT), main generator (MG) and the other auxiliary loads (OL) of the power unit.

The auxiliary transformers have protective devices installed on both the primary and secondary sides. Protective devices may include transformer differential, transformer earth fault, instantaneous overcurrent, overheating, overvoltage and Buchholz relay.

3. THE PROPOSED SOLUTION

For detection of influence of winding connection in transformer to size of overvoltage at earth fault I suppose the making of three-phase model of one part of onsite AC power system. I will model two varieties of connection of secondary and tertiary windings of auxiliary normal transformers – d and y_z. The parameters of cable line, transformers and asynchronous motors of high power will be included in the model. The next subject to discuss is the influence to starting of large asynchronous machines. I need to know the characteristics of electric appliances $M = f_{(\omega)}$ and the moments of inertia of electromotors for model calculation.

The setting up of electric protection of transformers, the busbars in main switchgears and the electromotors relate to the previous items. The influence of right evaluation of earth fault has the influence to the safety of power unit.

4. CONCLUSIONS

The aim of my report is the choice of the most optimum winding connection of auxiliary normal transformers with a view to operation safety, losses and the overvoltage at earth fault.

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