ANALYSIS OF THE MINIMAL PLANE AND MINIMUM CURRENTS OF SHORT LOADING CRITERIA AT THE ELECTION OF TRANSFORMERS WITH THE POSSIBILITY OF RELATED RESERVATION

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Introduction. Power transformers are widely used in transmission lines, switchgears and household appliances. The main role in this case is played by power three-phase oil transformers of general industrial purpose. This main category covers transformers with a capacity of units of up to tens and hundreds of thousands of kVA, with voltages ranging from hundreds to 750 kV.

Transmission of electricity occurs with less losses at high voltage and low current levels, so the power lines are usually high-voltage, while domestic and industrial electromechanical equipment requires high current and low voltage values, therefore, in the immediate vicinity of the place of consumption are equipped with lowering transformers substations, designed for a given load size. One of the modern requirements for transformers working on a joint load is to ensure the possibility of mutual redundancy. To ensure this requirement, transformers are fed from independent sources through independent lines. Since the mutual redundancy of transformers should be equivalent, their power should be the same [1].

The choice of power and number of power transformers according to the criteria of the minimum area for the equipment and the minimum short circuit current on the output bus for the distribution system of the given power at work on a joint load with the possibility of mutual redundancy is one of the urgent tasks of studying the operational capabilities of power three-phase oil transformers.

The aim of the work. The aim of this study is to select the power and number of transformers for a switchgear for a load of 1100 kVA, based on criteria for the minimum area of equipment and minimum short circuit currents on output bus from two possible variants, namely three transformers with a power of 630 kVA and two transformers with a power of 1000 kVA.

Materials of research. In accordance with the stated goal, the main objectives of this study are the following: 1) calculation and comparative analysis of the minimum permissible areas for the placement of three transformers with a power of 630 kVA and two transformers with a power of 1000 kVA; 2) calculation and comparative analysis of short-circuit currents on output bus of transformers with the capacity of 630 and 1000 kVA.

Solving these tasks is carried out on the basis of the results of the analysis of the [1] requirements regarding the provision of permissible areas for power transformers, which are installed in the RU 10 / 0.4 kV and short circuit currents on the output bus.

In accordance with the requirements for transformers located inside the room, the distance in the lumen from the most protruding parts of the transformers must be not less

than: 1) to the back and side walls – 0,6 m; 2) to the canvas of the door or the protruding parts of the wall from the entrance to the room – 0,8 m; 3) the distance between the nearby transformers is 1.25 m.

According to the catalog of power three-phase oil transformers manufactured by domestic manufacturers [2, 3], the nominal dimensions of a transformer with a capacity of 630 kVA are as follows: 1) length – 2,16 m; 2) width – 1.65 m.

The minimum allowable width and length of a room with three transformers with a capacity of 630 kVA is 2.85 m and 10.38 m respectively. The thumbnail of the location of the three transformers is shown in Fig. 1.

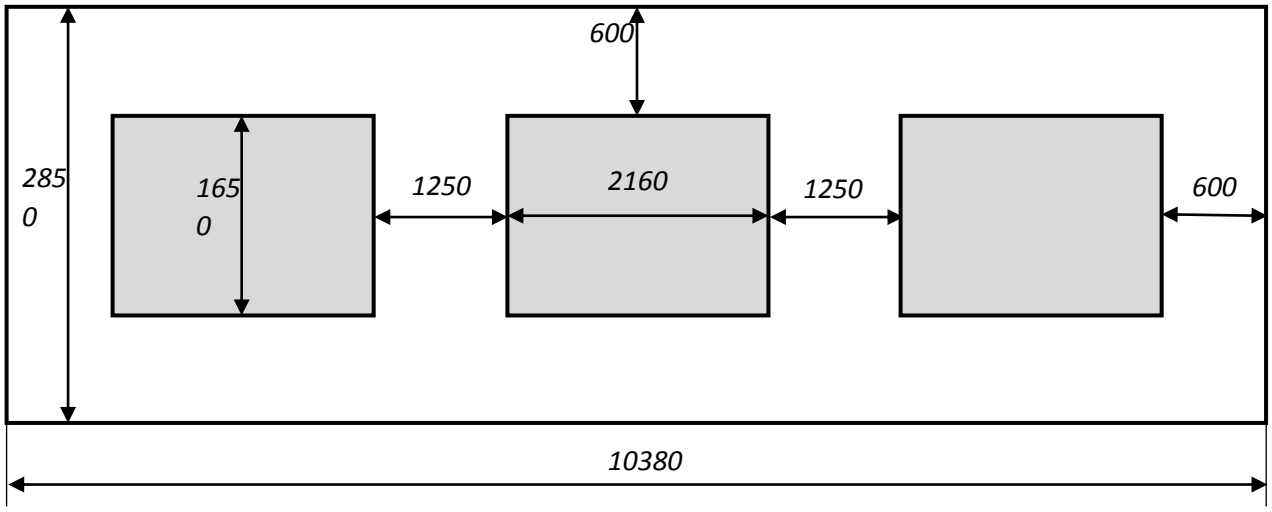

Figure 1 – Thumbnail location of three transformers with a power of 630 kVA; on the darkened background the area under the transformer

The minimum allowable space for placement of three transformers with a capacity of 630 kVA is $2.85 \times 10.38 = 29.583$ m^2.

According to the catalog of power three-phase oil transformers manufactured by domestic manufacturers [2], the nominal dimensions of a transformer with a capacity of 1000 kVA are as follows: 1) length – 2.902 m; 2) width – 1,856 m.

The minimum allowable width and length of a room with two transformers with a capacity of 1000 kVA is 3,056 m and 8.445 m respectively. The sketch of the arrangement of two transformers is shown in Fig. 2.

The minimum allowable space for placement of two transformers with a capacity of 1000 kVA is $3,056 \times 8,454 = 25,836$ m^2.

From the performed calculations it is clear that the placement of two 1000 kVA transformers requires an area of 3.74 m^2 smaller than the placement of three transformers with a power of 6300 kVA.

The calculation of the short-circuit current on the output bus of a transformer with a power of 630 kVA is carried out in the following sequence

$$Z_T = \frac{U_2^2}{P_H} \times \frac{U_{кз}}{100} = \frac{(0,4)^2}{630} \times \frac{5,5}{100} = 0,000014\ Om, \quad (1)$$

where: Z_T – the complete resistance of the transformer on the side of the low voltage winding, U_2 – the voltage on the output bus of the transformer, P_H – the power of the transformer, U_{kz} – the voltage of the short circuit.

$$I_{кз} = \frac{U_2}{\sqrt{3} \times Z_T} = \frac{0,4}{\sqrt{3} \times 0,000014} = 16,3\ kA. \quad (2)$$

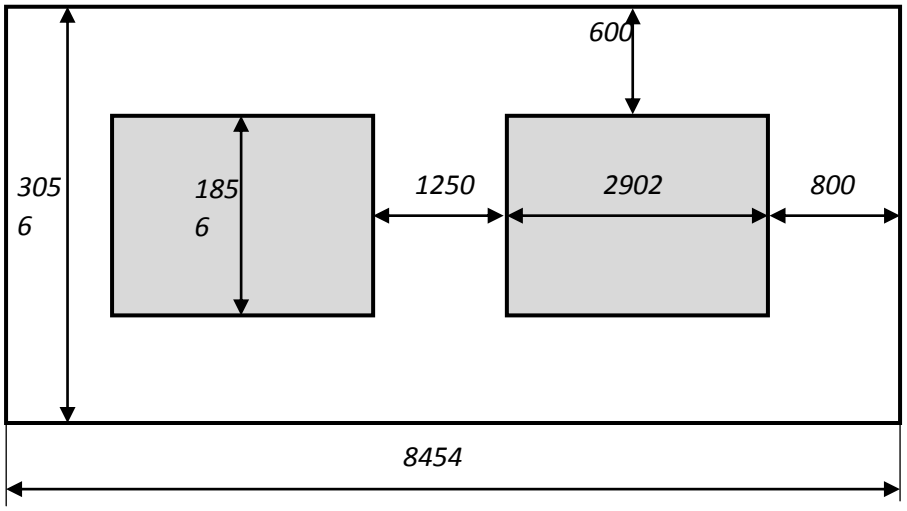

Figure 2 – Sketch of location of two transformers with the power of 1000 kVA; on the darkened background - the area under the transformer

Similarly on the output bus of a transformer with a capacity of 1000 kVA

$$Z_T = \frac{U_2^2}{P_H} \times \frac{U_{кз}}{100} = \frac{(0,4)^2}{1000} \times \frac{5,59}{100} = 0,000009\ Om, \quad (3)$$

$$I_{кз} = \frac{U_2}{\sqrt{3} \times Z_T} = \frac{0,4}{\sqrt{3} \times 0,000009} = 25,8\ kA. \quad (4)$$

It can be seen from formulas (2) and (4) that the short-circuit current on the output bus of a transformer with a power of 630 kVA is 37% less than in a transformer with a power of 1000 kVA.

Conclusions. According to the results of the study, it was found that two 1000 kVA transformers occupy a smaller area, but require more powerful protection devices than three transformers with a capacity of 630 kVA. Thus, according to the criterion of the minimum area of the premises for placing it is recommended to choose two transformers of greater power, and according to the criterion of the minimum short-circuit currents – three transformers of less power.

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