EVALUATION OF VALUABLE CRITERIA OF TRANSFORMER GROUP AT WORK ON GENERAL LOADING

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Introduction. Typically, one or two transformers are installed on the transformer substation, and one-transformer version is chosen in the case of power supply of electric devices, which allows the power supply from only one non-interrupted source (third-generation electronics), and in the case of the power supply of all types of electrical equipment through closed networks, connected to two or more substations, interconnected back-up lines. Two transformers are installed at substations feeding the electricians of II and I categories and have no connection with other substations. For both transformers to be able to reliably backup their power supply from independent sources from independent lines. Given the fact that the reservation should be equivalent, select transformers of the same power [1].

The choice of power and number of power transformers according to the criteria of the minimum value of transformers and their overload estimation in case of an emergency or preventive disconnection of one or more transformers from one group at work on a joint load is one of the urgent tasks of studying the operational capabilities of power three-phase oil transformers.

The aim of the work. The purpose of this study is to select the power and number of transformers for a switchgear for a load of 1100 kVA according to the criteria for the minimum value of transformers and to assess their overload in case of switching off one or more transformers from one group of two possible variants, namely: three transformers with a capacity of 630 kVA and two transformers with capacity 1000 kVA.

Materials of research. In accordance with the stated goal, the main objectives of this study are the following: 1) the definition and comparative analysis of the cost of three transformers with a capacity of 630 kVA and two transformers with a power of 1000 kVA domestic and foreign production; 2) calculation and comparative analysis of overload of transformers in case of an emergency or preventive disconnection of one or more transformers from one group.

The solving of these tasks is carried out on the basis of the results of the analysis of the requirements [1] for ensuring permissible overloads with the mutual redundancy of transformers installed in the switchgear of 10 / 0.4 kV and the cost characteristics of the transformers of the investigated capacities from the directories of manufacturers placed in open access [2, 4].

According to the catalog of power three-phase oil transformers manufactured by domestic [2] and foreign manufacturers [4], the minimum cost of three transformers with a capacity of 630 kVA is 315 thousand UAH. In the case of an order from a domestic producer and 240 thousand UAH + 10% of the specified amount for delivery costs when ordering from a foreign manufacturer, and the minimum cost of two

transformers with a capacity of 1000 kVA is 240 thousand UAH and 165 thousand UAH + 10% of the specified amount for shipping costs, respectively.

According to the requirements [3], the installation of single-shift transformer substations is recommended at full reservation of electrics of the first and second category from the low voltage networks and for power supply of consumers of the third category, as well, when the power and mass can replace the damaged transformer within one day and if there is centralized reserve.

Electrical equipment of the production shop belongs to the second category, so the electricity supply in this case should be provided by two independent power supplies that have a mutual reservation, and a break in their operation in case of violation of the power supply from one power supply may be permissible for the time necessary for the inclusion of backup power by actions regular staff or visiting brigade.

The power of each transformer of the group is selected so that when one of them is disconnected, those remaining in the work (taking into account their permissible overload and reserve on the networks of high and low voltage) provide a full load power supply.

The total installed power of transformers must satisfy the conditions:

- in normal operation mode

$$S_T \geq \frac{P_{max}}{n_T}; \quad (1)$$

- in emergency mode of operation

$$S_T \geq \frac{P_{max}}{k_{ав}(n_T - n_{відкл})}, \quad (2)$$

where: n_T – the number of transformers, S_T –the power of the transformer, P_{max} – the maximum load of transformers in normal mode, $n_{відкл}$ – the number of switched off transformers, $k_{ав}$ – the coefficient of permissible overload transformer in emergency mode.

Options for switching off transformers in groups of three transformers of 630 kVA power and two 1000 kVA transformers are shown in Fig. 1 and Fig. 2 respectively.

In the normal operation of three transformers with a power of 630 kVA (Fig. 1, a), each transformer has 470 kVA load

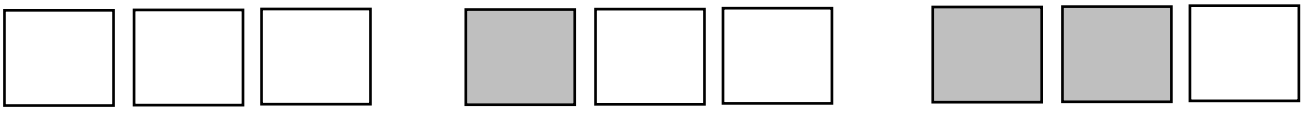
$$630 > \frac{1100}{3} = 470\ kVA,$$

in the extreme case (Fig. 1, b) – 611 kVA, working transformers are not upgraded by 3%

$$630 > \frac{1100}{0{,}9\times(3-1)} = 611\ kVA,$$

and in the emergency case (Fig. 1, c) - 1222 kVA, the working transformer is overloaded by 57%, which is inadmissible

$$630 < \frac{1100}{0{,}9\times(3-2)} = 1222\ kVA.$$



a) *b)* *c)*

Figure 1– Scheme of three transformers with a power of 630 kVA: a) normal mode; b), c) emergency modes; disabled transformers are shown in dark

a) *b)*

Figure 2– Scheme of two transformers with a power of 1000 kVA: a) normal mode; b) emergency mode; disabled transformer is shown in dark

In the normal mode of operation of two transformers with a power of 1000 kVA (Fig. 2, a), each transformer has a load of

$$1000 > \frac{1100}{2} = 550\ kVA,$$

in the emergency case (Fig. 2, b) - 611 kVA, the working transformer is overloaded by 10%, which is permissible

$$1000 < \frac{1100}{0{,}9\times(2-1)} = 1222\ kVA.$$

Conclusions. According to the results of the study, it has been established that two 1000 kVA transformers provide the possibility of mutual redundancy in an emergency with an allowable overload, and three transformers with a capacity of 630 kVA provide the specified requirements only if one of them is disconnected. By the criterion of the minimum cost, the group of two transformers is also optimal.

References

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