Short-circuit currents in distribution and transmission networks in Serbia and "transportation" problem

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Summary:

The paper depicts directional distribution of symmetrical three-phase short-circuit currents in distribution network models. It should be emphasized that these estimates should forego the estimates of power and voltage distribution in specific networks, for instance by "transportation" method.

The paper may be useful to young planning and electrical engineering staff in distribution companies in determining supplying limits for smaller or larger groups of consumers in the networks.

1. Introduction

Belgrade distribution network intensively developed over the second half of the XX century. The following voltage levels have remained up to the present days: 400 kV, 220 kV, 110 kV, 35 kV, 10 kV and 0.4 kV. In accordance with the concept documentation, further construction of 35 kV cable network is suspended but not the construction of 35 kV overhead lines network. This voltage level supplies rural areas.

In the aforementioned period of development, many of the lines were enormously long, which is nowdays adjusted by construction of supplying TSs. As for the rural areas, such supplying TSs are 110/35/10 kV TSs that reduce, in an exceptionally effective manner, enormously long 35 kV overhead lines network.

In technical-economic evaluation of variants for construction of new network, "EDB", Ltd. is using PRAO programme package in order to optimize all costs for further construction and exploitation of all networks. This computer programme calculates power distribution in networks with appropriate losses and reliability costs. The programme actualizes these costs together with investment costs, as they are of different characters and have different appearance dynamics. Total costs related to each variant for construction of the network are calculated in that way. Calculation of power distribution is known in literature as transportation problem, with various methods to solve it.

2. Distribution of symmetrical three-phase short-circuit currents in distribution and transmission network models

Figures 1 and 2 bellow show distribution of symmetrical three-phase short-circuit currents and powers in the network models based on 35 kV network. Network model 4 is based on 110 kV, 35 kV and 10 kV cable networks, and network model 7 is based on 110 kV, 35 kV and 10 kV overhead networks. It is obvious that long 110 kV and 35 kV lines significantly depreciate symmetrical three-phase currents and powers in the networks. As the protection in 35 kV network is set at 1600 A, it is obvious that 35 kV overhead lines

should not be longer than 10 – 12 km. In that way, a secure detection of fault currents is enabled as early as in the first degree of operation of protection devices.

Protection devices connected to the longer lines protect network in the second degree of operation with a certain time delay. In this case, however, destruction of the network elements in the fault is notably larger.

Fig. 1. Distribution of currents of symmetrical three-phase short-circuits through all voltage levels in network models 4 and 7

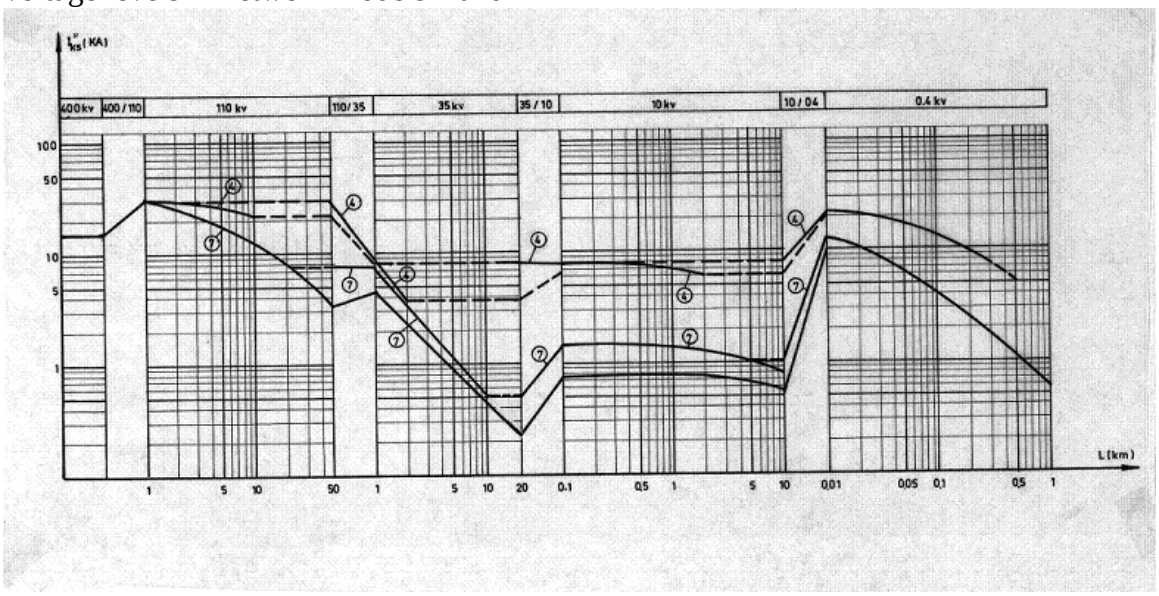
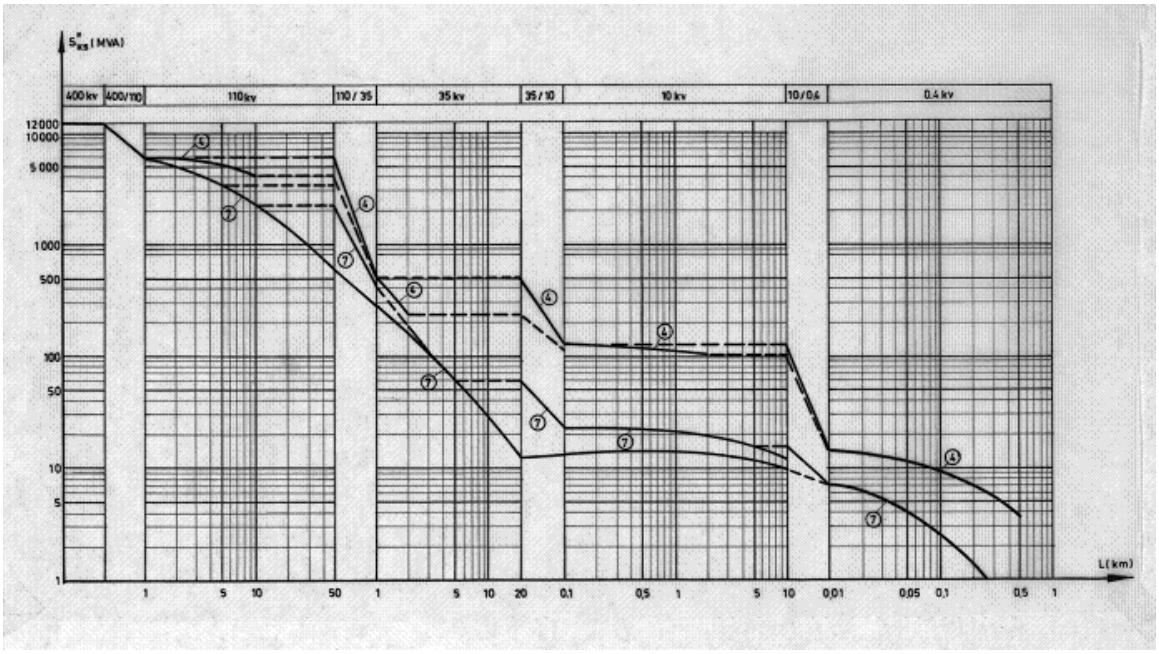


Fig. 2. Distribution of powers of symmetrical three-phase overhead short-circuits through all voltage levels in network models 4 and 7



Unsymmetrical single-phase and double-phase short-circuit currents are limited by resistance in neutral points of supplying transformers and are not much dependent on the length of 35 kV and 10 kV networks.

3. Characteristics of computer programmes from this point of view

"EDB", Ltd. is using several computer programmes for network quality rating. Yet, none of the said programmes calculates symmetrical and unsymmetrical short-circuit currents and powers in distribution networks. The aforesaid represents the main reason why these computer programmes allow enormous lengths of 35 kV and 10 kV overhead lines. If this were a case of need in new sources, they would have been actual in 35 kV and 10 kV networks much before in the long-term plan programmes for construction of networks.

An actual issue in "EDB", Ltd. is a construction of 110/35/10 kV TS Grocka supplied through 35 kV lines more than 20 km long. Symmetrical three-phase short-circuit currents are around 1000 A. Accordingly, 110/35/10 TS Grocka is to be constructed without delay – which doesn't imply PRAO programme package.

4. Conclusion

"EDB", Ltd. is using a few computer programmes for network quality analysis as well as for calculation of actualised costs for construction and exploitation of various variants for network construction.

However, these computer programmes do not analyse network operation in the regime of short-circuit currents – which implies that even the exploitation of enormously long 110 kV, 35 kV and 10 kV overhead lines is allowed.

Therefore, it would be necessary that the computer programmes for network quality analysis contain, in addition to the module for transport problem, a part relating to the calculation of short-circuit currents in the networks, as well.

This would enable analysis of network operation quality to be carried out in a way that would really provide higher quality, not only in local conditions but also at a wider level.

5. Literature

- Short-circuit current in distribution networks in Belgrade, Study, Belgrade, 2000, Tomislav Milanov, B.Sc.El.Eng.