PROTECTION OF 35-750 KV SWITCHGEARS FROM LIGHTNING OVERVOLTAGES

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Introduction

During operation the insulation of switchgear equipment is exposed to normal operating voltage as well as various types of overvoltages, among which lightning overvoltages occupy an important place.

Lightning overvoltages pose a real danger to the equipment of networks of almost all classes of rated voltage and, therefore, require the development and implementation of effective protective decisions, one of which is the use of special protective devices – gapped surge arresters and nonlinear metal-oxide surge arresters (MOA).

The protective properties of gapped arresters and MOA are based on the nonlinearity of voltampere characteristics of their working elements, which provides a noticeable decrease in resistance at elevated voltages and a return to the initial state after voltage reduction to normal operating. The low nonlinearity of the voltampere characteristics of the working elements in the gapped surge arresters did not allow for both a sufficiently deep limitation of overvoltages and a small leakage current when exposed to the operating voltage, from which it was possible to rebuild due to the introduction of spark gaps in series with the nonlinear element. The significantly greater nonlinearity of the metal-oxide resistances (varistors) of the MOA made it possible to abandon the use of spark gaps in their design, i.e. the nonlinear elements of the MOA are gapless connected to the network during its entire service life.

Currently, gapped arresters are practically discontinued and, in most cases, have served their standard service life. The construction of insulation protection schemes for equipment, both new and upgraded switchgear, from lightning and switching overvoltages is now possible only with the use of MOA.

The identity of the functional purpose of gapped arresters and MOA and the apparent simplicity of the design of the latter often lead to the fact that the replacement of old gapped arresters with new metal-oxide surge arresters is carried out without checking the admissibility and effectiveness of the use of the installed MOA at the considered point of the network. At the same time, the standard schemes for protecting equipment insulation from overvoltages developed several decades ago focused only on the use of gapped arresters and were obtained

in simplified computational models, since the capabilities of computer technology were very limited. In addition, these old schemes used so far do not take into account the significant operational experience accumulated during their existence in power systems.

In particular, the issues of switchgear equipment protection from lightning overvoltages with the help of gapped arresters are considered in the Russia rules of electrical installations (REI), where for various schemes of open switchgear are given, depending on the number and type of gapped arresters, also on the maximum distances to the equipment. For the first time, the requirements of the REI regarding the distances from the gapped arresters to the protected equipment were formulated in 1961 with the help of so-called lightning protection analyzers and have not been revised since then.

In the latest (7th) edition of the REI, for the first time, in addition to gapped arresters, an MOA is also considered as a new protective device against lightning overvoltages on the equipment of the switchgear. In this last edition of the REI, it is proposed to determine the permissible distances from the switchgear's equipment to the MOA in accordance with the protective characteristics of the MOA based on the requirements for distances to gapped arresters given in previous editions of the REI. Consequently, all the same requirements of 1961, obtained in a very simplified formulation on lightning protection analyzers and not taking into account half a century of operational experience accumulated in power systems, were adopted as the basis for the construction of protection of the equipment of the switchgear from lightning overvoltages in the latest edition of the REI.

The development of computer technology and specialized software make it possible to carry out calculations of transients in electrical networks at a new level to optimize the circuits for protecting equipment insulation from overvoltage and a reasonable choice of the main characteristics of protective devices. However, despite the possibilities of modeling and calculating transients, the old developments of many years ago are still widely used in Russia, which is caused by the lack of easy-to-use and sufficiently justified modern methods for calculating various types of overvoltages.

The lack of Russian regulatory documents and calculation methods in the field of power equipment insulation protection from lightning overvoltages, which would take into account the accumulated operational experience, is aggravated by the mass introduction of protective MOA-type devices into the country's energy sector, when are often incorrectly solved the tasks

of choosing the number of MOA, their installation locations and main characteristics. As a result networks have increased accident rate of protected equipment and the MOA themselves.

Below in the Book, taking into account the current level of knowledge and modeling capabilities, the main problems that need to be solved when constructing insulation protection schemes for switchgear equipment from lightning overvoltages using protective devices of the MOA type are considered.