Energetic, 2002, № 4

G.I. Volovich, Doctor of Technical Science, professor

Discussing the issue of measuring contact resistance of high voltage breakers

The article by V.P. Golubev et al. “Measuring contact resistances to direct current in electric equipment” [1] was published in the journal “Energetic” № 6 (2001). Intensity of electric current, used for measuring contact resistances, is of great importance, because general switch to the currents recommended in the article will cost Energy industry of Russia several dozens of millions of rubles.

It is known [2, p.75], that transient resistance of an electrical connection is determined by the current flow lines constriction resistance in places of connection Rs and the resistance, caused by the presence of different oxide coatings and contamination on the surface of contacts Rp:

$$R_k = Rs + R_p.$$

Resistance R_s is mainly defined by the form and the number of contact surfaces. With the growth of the current, passing through the contacts, electromechanic forces, striving to draw the contacts apart, increase, therefore resistance R_s rises a little alongside the current growth. Resistance R_p, conditioned by oxide semiconducting coatings, on the contrary, decreases with the current growth as a result of thermal break-down, diffusion and ionic conductivity growth. It is this factor that some decline in transient resistance alongside current growth is connected with. However, to eliminate resistance R_p in electrical apparatus construction, reciprocal displacements of contacting elements is anticipated at the moment of switching on, as a result these elements clean themselves. That is why GOST 8024-90 « Alternating current apparatus and devices for voltages above 1000 V. Temperature rise at continuous duty. Norms and test methods.» cl.2.6 in RD (controlling documents) 34.450-51.300-97 «Scope and standards of electrical apparatus testing» cl.9.5.1 has no instructions about the value of the current needed

to determine R_k, the only requirement is that it shouldn't exceed reference values for this device (apparatus).

Based on the mentioned above, let's consider the results, presented in the article [1] and in its fuller version [3], allocated in the Internet at: *http://www.prompribors.ru/catalog/mki-200.htm*. Great difference in the results of measuring R_k of oil circuit breakers U-220-10 (1000A) (year of manufacture 1966) and MKP-110M (600A) (oil, cubicle, substation circuit-breaker) (year of manufacture 1962) of microohmmeters F-415 and MKI-600, can be explained by the fact that these devices exhausted their life span long time ago, their mechanical parts are badly worn-out and contacts do not clean themselves when short circuit occurs. The authors of the article failed to mention if they had switched on and off the circuit breakers 5-7 times before conducting measurements, as it is recommended, for instance, in [4, p.19]. It is these operations that make it possible to eliminate oxide coverings and contamination and get reliable measurements, when current values are low and the breakers' mechanisms are in working order. The authors of the article [3] point out that transient resistance measurements of the new circuit breakers manufactured at the plant «Uralelectrotyazhmash» produced less differences when measured for high and low currents by the devices. The authors do not mention whether the devices were checked before conducting measurements. The fact is that microohmmeters F-415, F-4104 and some others, developed 25 or even more years ago, were constructed on the basis of obsolete components and fail to measure low resistance accurately. The author of these words measured resistance of the shut for 750 A with the device F-415 at Isakovskaya substation OAO Chelyabenergo once. Indoors this microohmmeter showed 80 microohm (whereas reference value is 100 microohm), and outside at ambient temperature of 5˚C, it showed 150 microohm!

Thus, when measurements are conducted at low currents, presence of high resistances in the main circuit of high voltage breakers indicates that the mechanisms of the breakers are worn out and need to be repaired. Proposition that in this condition the breakers can continue operating, because measurements of R_k

at high currents give reasonable value, shouldn’t be taken into consideration. In principle rusty light weapons can efficiently shoot, because weapons undergo even more severe tests before being brought into military service; however, military officials carefully observe cleanness of the weapon and it's no accident. Microohmmeters with high current values are needed for measuring transient resistance of contacts without reciprocal displacements of contacting elements, for instance, of busbar assembly on bolted connection in powerful current leads at the moment of switching on.

OOO (limited liability company) «Chelenergopribor» manufactures compact microohmmeter IKS-5 with current value of 2 A. It allows measuring transient resistances from 1…10000 microohm in one range, with real absolute error of resistance measurements below 1000 microohm not exceeding 1 microohm. The device passed official tests and is registered in State Register of measuring instruments (Gosstandart certificate RF № 8681). Operation of 60 microohmmeters of this type for more than two years at the enterprises of «Chelyabenergo» detected no unreasonable increase of transient resistances of oil circuit breakers. To learn more about this device, see [5].

References

1. Golubev V.P., Krylov A.D., Komarov V.I. et al. Measuring contact resistances to direct current in electric equipment// Energetic. – 2001, №6. – p. 34.

2. Theory of electrical apparatuses / Aleksandrov G.N., Borisov V.V., Ivanov V.L. et al.; edited by G.N. Aleksandrov. – M.: Vysshaya shkola, 1985. – 312 p.

3. Measuring resistance to direct current in electrical power equipment www.prompribors.ru/catalog/mki-200.htm.

4. Shtern V.I., Tests of oil circuit breakers of 6–35 kV. – M.: Energy. – 1975. – 112 p.

5. Microohmmeter IKS-5 www.limi.ru/x5/x5.htm .