

Surge arrester MO resistor testing

ABB philosophy to quality assurance

The key component of the gapless metal-oxide surge arrester is of course the metal-oxide resistor. Without a detailed knowledge of the MO resistor characteristics it is not possible to design or produce a reliable high-performance arrester. Tests on metal-oxide surge arresters are thoroughly specified in the applicable IEC standard 60099-4. However, in addition to fulfilling the well-detailed type test requirements it is even more important how the manufacturer chooses to perform routine tests and quality control of the MO resistor production. Since many MO resistor properties are statistical parameters, for example energy capability, the applicability of type test results after several years to current production may be in doubt. Type tests cannot realistically be repeated more than about every 5 – 10 years, for both economic and practical reasons. It is thus vital and necessary to have extensive routine and sample tests and other quality control measures that ensure the on-going validity of the type tests in daily production.

ABB Routine and Sample testing of MO resistors for HVAC AIS applications

Routine residual voltage (protection level) test and classification

The most important role of the arrester is to protect under all circumstances. Low protection levels mean extra safety margins to equipment insulation withstand levels and extended protection distances. It is extremely important that the protection level is as accurately known as possible. ABB measures the protection level at 10 kA, 8/20 μ s on every manufactured MO resistor. Normally the measuring accuracy is higher when measuring on individual MO resistors than on complete arresters or arrester units, which is why ABB prefers this method. In addition to regular calibrations of measuring equipment, frequently-tested reference MO resistors are used to check the measuring system on a daily basis to assure desired accuracy.

All ABB MO resistors are classified according to their 10 kA (8/20 μ s) residual voltage and thereafter sorted into voltage-classes. All MO resistors in a class are considered to have a residual voltage equal to the upper limit of that class; thereby assuring guaranteed protection levels with margin. Additionally, the low current characteristic at 1 mA (dc) is measured and all details are then printed on each MO resistor together with batch identification. Finally all MO resistors are visually inspected. MO resistor production and testing details are logged and stored electronically, giving full traceability for each individual MO resistor.

Routine energy withstand test

Energy capability of MO resistors is to some extent a statistical factor. It is therefore necessary to perform routine tests at higher energy than claimed as "rated energy" to ensure a sufficiently high probability that all manufactured MO resistors could withstand rated data. It is important to note that it is not the best MO resistor which will determine the capability of the complete arrester but the MO resistor with lowest energy strength since normally there is no redundancy in an arrester. If one MO resistor fails during an overvoltage event the arrester will either fail instantaneously or its longevity will be jeopardized.

All ABB MO resistors must pass three energy test cycles with cooling in-between. In each cycle, the injected energy is much higher than set as the single impulse energy capability for the specific MO resistor type. MO resistors with insufficient energy capability are automatically rejected.

Sample energy capability test

This includes the following tests on samples taken from each individual batch of manufactured MO resistors. If the samples do not pass the defined criteria, then the entire batch is rejected.

- Validation of repetitive charge transfer rating (Qrs), based on the same sampling and test procedure and criteria as the IEC 60099-4 type test for station class. The samples are representative of the highest residual voltage of MO resistors from the individual batch in order to verify the statistical quality of each produced batch of all sizes of MO resistors.
- High current test with two 100 kA 4/10 μ s impulses at spaced interval.

Sample accelerated life tests

MO resistors are processed in batches consisting of some several thousands. It is a well-known fact that small variations in process parameters may influence the long-term stability of the MO resistors. ABB verifies the stability of every batch by performing accelerated ageing test on a number of randomly selected MO resistors from the batch. In order to approve the batch for use, all of these MO resistors have to show lower power losses after 1,000 hours of accelerated ageing (extrapolated from a shorter duration) than at the start. In addition, the 1,000-hours-value must not be greater than 1.1 times the minimum value. Possible signs of increasing power losses would normally be indicated before 300 hours but, in cases of doubt, the ageing test will be extended up to the full 1,000 hours. Batches in which unapproved MO resistors appear are rejected. The rejection rate is nevertheless extremely low.

An important parameter in the accelerated ageing test is the voltage stress on the metal-oxide material: It must be verified that this stress represents, with margin, the highest continuous stress in service as defined by the continuous operating voltage U_c for the arrester. The ABB ageing test is hence made at an elevated temperature of 115 °C at the equivalent of 1.05 times U_c thereby verifying full control over maximum possible stress seen in service.

Other sample tests

In addition to the above, the following measurements are made on sample blocks from each batch to check inherent MO resistor parameters:

- Power frequency reference voltage
- Power losses
- Low current protection characteristic
- Capacitance

Conclusion

When evaluating surge arresters from different manufacturers, in addition to comparing catalogue data, the user must weigh up the reliability of the product based on once-off test data as well as the

procedures and processes used during regular production which give added-value and security to guaranteed performance.

ABB manufactures its own MO resistors with full control of the process from the raw material to the finished electrically characterized block. In contrast, an increasing number of arrester manufacturers buy their MO resistors from an external supplier; and potentially different suppliers from time to time. Type tests must be performed for every make of MO resistor used in a particular arrester, otherwise published type test reports are worthless. Unless the MO resistor source is known and specified, this means that “type tests” for the arresters, if they do exist, could be questionable in many respects: depending on the design. eg residual voltage, operating duty, short-circuit, moisture ingress, mechanical withstand, etc. The situation is even more critical if the arrester manufacturer does not perform their own extensive routine tests on the externally bought MO resistors before they are used in their arresters.

To this end, ABB has the testing philosophy that our customers shall feel confident that an ABB arrester fulfils guaranteed and type test data and that any MO resistor or arrester taken from ABB production are likely able to pass type test requirements.

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