Guide for Application of Power Apparatus Bushings

C57.19.100-1995 (Reaff 1997)

10.2 Routine and special tests

10.2.1 Power/dissipation factor and capacitance

Bushing power or dissipation factor and capacitance should be measured when a bushing is first installed and also one year after installation. After these initial measurements, bushing power or dissipation factor and capacitance should be measured at regular intervals (3 to 5 years typical). The measured values should be compared with previous tests and nameplate values. ~~Since power/dissipation factor varies with temperature, all measurements should be made at or corrected to 20 °C. Appropriate correction factors should be selected based on the manufacturer's recommendation and the user's experience.~~

Since the power/dissipation factor can vary with temperature, test results should be converted to a common temperature base {usually 20 degree C} using temperature-correction data that is available from manufactures and various industry sources. The following procedure should be used:

1. Measure the bushing's power/dissipation factor.
2. Determine the bushing's temperature.
3. Obtain the appropriate correction factor corresponding to the bushing's temperature.
4. Multiply (1) and (3) – see example below:

Example

Ohio Brass Company bushing Class GK, 115 kV
(1) Calculated power factor = 0.42%
(2) Bushing temperature = 30°C
(3) Multiplier from the Temperature-Correction Table at 30°C = 1.11
(4) Corrected to 20°C power factor = 0.42% x 1.11 = 0.47%

These correction factors are average values at best, and therefore, subject to some error. The magnitude of error is minimized if tests are performed at temperatures near the reference temperature of 20°C (68°F). If questionable power/dissipation factors are recorded at relatively high temperatures, the bushings should not be condemned until it has been allowed to cool down to near 20°C and repeat tests have been performed. This also applies to bushings tested near freezing where a large (greater than 1.00) correction may cause the result to be unacceptably high; in this case the equipment should be retested at a higher temperature. Bushing should not be tested when their temperatures are much below freezing because moisture may have changed to ice, which has a significantly higher volumetric resistivity any therefore be undetected.
In the case of bushings mounted in transformers, the bushing temperature is approximated by taking the average between the ambient and transformer top-oil temperatures.

~~Consult the manufacturer for temperature correction factors for cast insulation bushings. They normally require much higher correction factors than oil-impregnated paper-insulated bushings. This also means that extra care is required when making power or dissipation factor measurements on cast insulation bushings.~~

Any bushing that exhibits a history of continued power/dissipation factor increase should be scheduled for removal from service and further investigation. The bushing manufacturer should be consulted for guidance. If any bushing exhibits an increase in power or dissipation factor over a period of time, the rate of change of this increase should be monitored by more frequent tests. If the power or dissipation factor measurement of a bushing doubles from its initial reading, then the test frequency should be increased or the bushing should be removed from service. If the power or dissipation factor measurement triples the initial test reading, then the bushing should be removed from service.

Bushing capacitance should be measured with each power or dissipation factor test and compared carefully with both nameplate and previous tests in assessing bushing condition. This is especially important for capacitance-graded bushings where an increase in capacitance of 5% F more over the initial/nameplate value is cause to investigate the suitability of the bushing for continued service. The manufacturer should be consulted for guidance on specific bushings.

It is usually impossible to make absolute UST measurements of the bushing core capacitance and power factor of resistance-graded bushings because of the influence of the resistive glaze on the surface of the bushing porcelain. Differences in the glaze can cause significant variations in measurements between different bushings of the same voltage class and type. In some instances, the measured UST power factor may even be negative.

Standard practice during diagnostic testing of resistance-graded bushings is to record the measured UST values of capacitance and power factor for comparison with other measurements made on the same bushing. When there is evidence of a permanent increasing or decreasing trend in the measured values, the bushing manufacturer should be consulted for assistance in evaluation of the condition of the bushing.

Most modern high-voltage bushings are equipped with voltage or test taps. Voltage (or capacitance) taps, are used generally on bushings rated above 69 kV, and test (or power factor) taps, used generally on bushings rated 69 kV and below. Routine bushing field tests should include power/dissipation factor tests on the tap insulation. These measurements are effective for detecting problems such as deteriorated or contaminated oil, defective tap compartment seals, mechanical damage to the tap insulators, and the failure of the top terminal gaskets. Abnormal readings can alert the user to a potential failure hazard before the C1 insulation measurement is effected. While the test tap (C2) insulation is not controlled during the manufacturing process, significant changes in either the C2 capacitance and/or power/dissipation factor from an initial value are indicative of a problem.