Application guide for power factor testing of surge (lighting) arresters

Introduction
The purpose of a surge (lighting) arrester is to limit the overvoltages that may occur across transformers and other electrical apparatus due either to lightning or switching surges. The upper end of the arrester is connected to the line or terminal that has to be protected, while the lower end is solidly connected to ground.

The arrester is composed of an external porcelain tube containing an ingenious arrangement of stacked discs (or valve blocks) that are composed of a silicon carbide material known by trade names such as thyrite, autovalve, etc. This material has a resistance that decreases dramatically with increasing voltage.

Arresters are effectively switching devices that serve as an insulator under normal conditions and as a conductor under overvoltage conditions. After an overvoltage condition is cleared the arrester must return to its normal insulating condition. The measurement of power loss is an effective method of evaluating the integrity of an arrester and isolating potential failure hazards. This test reveals conditions which could affect the protective functions of the arrester, such as: the presence of moisture, salt deposits, corrosion, cracked porcelain, open shunt resistors, defective pre-ionizing elements, and defective gaps.

Test connections
It is recommended that tests be made on individual arrester units rather than on a complete multi-unit arrester stack. A single arrester unit can be tested by the normal ungrounded specimen test (UST) in the shop; however, it can only be tested by the grounded specimen test (GST) when mounted on a support structure in the field. Refer to Page 44 in Section 3 of the Delta-2000 instruction manual for test connections and test sequence on multi-unit arrester stacks.

- When testing in the field, disconnect the related high-voltage bus from the arrester.
- Connect a ground wire from the test set to the steel support structure of the arrester stack.
- When connecting the high voltage lead, ensure that the cable extends out away from the arrester and does not rest on the porcelain.

Test procedure
Always observe safety rules when conducting tests. Power factor testing is extremely sensitive to weather conditions. Tests should be conducted in favorable conditions whenever possible. Measurements on surge arresters should always be performed at the same or recommended test voltage since nonlinear elements may be built into an arrester. Except for the specific purpose of investigation surface leakage, the exposed insulation surface of an arrester should be clean and dry to prevent leakage from influencing the measurements.

Warning: Exercise extreme care when handling arresters suspected of being damaged, since dangerously high gas pressures can build up within a sealed unit.

- Follow the tests sequence per Exhibit A. The test mode and the number of tests performed will depend on the number of arresters in the stack.
- Record test results on a test form. (Appendix C, Miscellaneous Equipment)

Test results
For all power factor testing, the more information recorded at the time of testing will ensure the best
comparison of results at the next routine test. Test data should be compared to factory or nameplate data if
available. If no data is available, compare the test results to prior tests on the same arrester and results of
similar tests on similar arresters. The following additional information should be recorded on the test form:

- Record all the nameplate information of the arrester.
- Identify each set of readings with the arrester serial number.
- Note any special or unusual test connections or conditions.
- Record actual test voltage, current, watts, power factor and capacitance. Correct the current and watts
to a standard test voltage 2.5kV or 10kV.
- Surge arresters are often rated on the basis of watts loss. To obtain the equivalent 10 kV watts loss
  from a measurement of capacitance and power factor, perform the following calculations if the test set
does not display the results.

  \[
  \text{Watts loss} = C_{\mu\text{F}} \times \%DF \times 377 \times 10^{-6} \quad \text{(for 60 Hz)}
  \]

  \[
  \text{Watts loss} = C_{\mu\text{F}} \times \%DF \times 314 \times 10^{-6} \quad \text{(for 50 Hz)}
  \]

  Where: \(C_{\mu\text{F}}\) = capacitance in picofarads
  \%DF = percent dissipation (power factor)

- Record ambient temperature and relative humidity and a general indication of weather conditions at
  the time of the test.

On multi-unit arrester stacks the UST loss readings may be less than the arresters tested in the GST mode
because stray currents do not affect the UST test results.

Higher than normal losses could be the results of dirt or moisture both on the inside and outside surface of
the porcelain, cracked or broken porcelain, salt deposits and contamination in general. Lower than expected
test results could be the result of open shunt resistors or defective pre-ionizing elements. Loss results will
differ between manufacturers and style of arresters.

References
Theodore Wildi, Electrical Machines, Drives, and Power Systems