Recent Changes to the IEEE High-Voltage Circuit Breaker Rating Standard, Part 1

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This is the first of a two-part Technical Brief that will describe the changes made to the 2018 Edition of IEEE C37.04, IEEE Standard for Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V.

IEEE C37.04, IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers, has undergone the first full revision since 1999. C37.04 – 2018, was approved by the IEEE Standards Association Standards Board on December 5, 2018 and published May 31of 2019. The document has changed significantly. The revision incorporated C37.04a – 2003 Amendment 1: Capacitance Current Switching, C37.04b-2008 Amendment 2: To Change the Description of Transient Recovery Voltage for Harmonization with IEC 62271-100 and the preferred ratings values from IEEE Std C37.06-2009 which will now be withdrawn. The document has grown from 29 pages to 120 pages and now contains 31 tables of ratings in the normative body of the standard. A nice addition to this edition is Clause 6.1.1 which contains a summary of the tables for required values and preferred ratings. It is very helpful when navigating the revised document.

Harmonization with the IEC circuit breaker standards has driven many changes to C37.04. Most references to “indoor” and “outdoor” circuit breakers have been changed to class S1 for breakers rated over 100kV and class S2 for rated voltages less than 100kV. Class S1 circuit breakers are intended to be used in a cable system. The definition of a cable system is a system in which the supply side of the circuit breaker is connected with 100 m or more of cables, or the capacitance equivalent to 100 m of cable. Class S2 circuit breakers are intended to be used in a line system. Line systems are defined as systems in which the supply side of the circuit breaker is connected to overhead lines with less than 100 m of cables. However, the actual difference between the two classes is only the required transient recovery voltage (TRV) parameters. A Class S1 circuit breaker can be used on a line system if the TRV of that system is within the capabilities of a class S1 circuit breaker.

The term “definite purpose”, which historically was used to describe a circuit breaker with back-to-back capacitance current switching capability, has been changed to describe any circuit breaker that has been designed and tested in accordance with general purpose circuit breaker requirements and meets more specific performance requirements, such as higher transient recovery voltages.

Usual service conditions have changed. Indoor and outdoor service conditions have been segregated. The most notable changes are the operating temperature ranges. Unlike the previous edition that stated the ambient temperature is not above 40° C or below -30° C for either indoor or outdoor circuit breakers, the upper temperature limit for both indoor and outdoor is now 40° C with a 24 h average not exceeding 35° C. For indoor circuit breakers the ambient low temperature limit has been changed from -30° C to -5° C and the conditions of humidity have been expanded. Although all Powell circuit breakers are designated indoor, they will continue to be rated for a minimum temperature of -30° C. A pollution severity class of “very light” has been added to both indoor and outdoor types and is further described in Annex C. This can be equated to normal indoor applications which are not directly exposed to outdoor weather conditions.

Although several “new” ratings have been added to the ratings tables, there are no significant changes to the rating structure from the previous edition. In the spirit of harmonization, not only with the IEC but with other related documents, the organization of the document has been changed and IEC abbreviations for ratings values have been added, such as U_r for the rated maximum voltage V. To help familiarize users with these changes a list of acronyms and abbreviations has been added as clause 3.2.

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Another example of a change due to harmonization with the IEC is the rated dielectric withstand capability (i.e. hipot and BIL) is now called rated insulation capability. The actual requirements of both terms are mostly the same as the previous edition.

The table containing the limits temperature rise has been revised. The 1999 version of the table contained temperature rise limits for contacts and connections that were for bare copper, silver or nickel coated and tin coated for operation in air, in sulferhexaflouride (SF_6) and in oil. The terms "air" and "SF_6" have been changed to "reactive gasses (RG)" and "non-reactive gasses (NRG)" respectively. This change has no impact on Powell's breakers since all of the designs are for use in air (i.e. "RG") and the temperature limits did not change.

Powell has historically not allowed customer requested tin-plating of the primary disconnects on the breakers and switchgear due to questionable short-circuit performance. Now the temperature limit of tin-plated contacts in "RG" (air) has been lowered from 65° to 50° C which would require a significant de-rating of the continuous current rating. This is now another reason to not allow tin-plating of those contacts when requested.

The close and latch rating has been expanded to include circuit breakers applied on systems with X/R ratios greater than 17. The peak close and latch current for those circuits must be equal to or less than 2.7 times the rated short circuit current for all time constants greater than 45 ms up to 133 ms.

Part 2 of this Technical Brief will address the remainder of the pertinent changes to C37.04 – 2018, beginning with the service capability requirement.

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