Powell Technical Brief #46

Significance of K factor in Circuit Breaker Ratings

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The most basic interrupting ratings of a high voltage circuit breaker are a rated short-circuit current, I, and a rated maximum voltage, V, at which the breaker must interrupt I. This is a simple concept, widely understood. However, these breakers also have a rated voltage range factor, K, which is not so widely understood. (Note: This K factor has absolutely nothing to do with the K factor used to determining the suitability of a transformer for use in a circuit with high harmonic levels.)

In many types of circuit breakers the physics of arc interruption are such that a given circuit breaker can interrupt a higher current at a lower voltage. In order to take advantage of this capability in the application of circuit breakers, the K factor was introduced into the ANSI standards for circuit breakers. The K factor is a dimensionless number which defines the range of voltage over which the interrupting current increases. The rated maximum voltage divided by the K factor, or V/K, gives a voltage below which no increase in interrupting current is required.

The K factor also defines the magnitude of the increased interrupting requirement. The current which must be interrupted as voltage V/K is KI. Between V and V/K, the current increase is proportional to the voltage decrease, and may be calculated by the formula:

Required symmetrical current interrupting capability = rated short circuit current x (rated maximum voltage/operating voltage)

This formula yields a constant MVA interrupting rating, equal to the square root of three times VI, between V and V/K, and a constant current interrupting rating, equal to KI, at voltages below V/K.

Two things need to be said about the K factor. First, the concept agrees with the physical reality of oil-blast and air-magnetic circuit breakers. Breakers using these technologies really do have higher interrupting ability at lower voltages, and assigning a K factor other than one allows a wider application of a given circuit breaker. However, circuit breakers using vacuum or SF_6 puffer interrupters are essentially constant current interrupters up to a limiting maximum voltage, so a K factor other than one does not match the physical attributes of circuit breakers using these technologies. In the latest (1987) edition of ANSI C37.06, K has been set to 1.0 for all circuit breakers except indoor oilless circuit breakers, which are the breakers used in metal-clad switchgear.

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Second, for a known system voltage, the K factor is unimportant. On any given system, if the voltage decreases, the available short circuit current will also decrease, not increase. If a circuit breaker is properly applied at the maximum system voltage, it will have the necessary short circuit capability for any lower voltage on that system.

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