TechTopics No. 61

Circuit breaker "standard duty cycle"

Recently, we have fielded many questions about the "standard duty cycle" from specifiers and users of medium-voltage circuit breakers in reclosing applications. The standard duty cycle for medium-voltage circuit breakers is specified in the ANSI/IEEE standards, and the specification of the standard duty cycle changed with the approval of the 1999 edition of the standards.

The standard duty cycle has always been intended as the benchmark for circuit breaker application, and the uniform operating cycle for use during the design (type) tests of the circuit breaker in the short-circuit laboratory. The standard duty cycle given in the two generations of standards is as follows:

1979–generation standards

- C37.04, clause 5.6: "Rated Standard Operating Duty (Standard Duty Cycle). The standard operating duty of a circuit breaker shall be two unit operations with 15 s interval between operations (CO – 15 s – CO)."

- C37.09 specified the standard interrupting test (TD4) with a 15 s interval between opening operations, and included reclosing duty tests (TD9 and TD10) with the interval between operations equal to the minimum reclosing time in C37.06, 30 cycles for medium-voltage circuit breakers (see table 10 of C37.06-1987).

- C37.04 did not require the standard duty cycle on the circuit breaker rating label.

- The application guide, C37.010, gave derating factors and formulas for interrupting capacity on reclosing cycles that differed from the standard duty cycle.

1999–generation standards

- C37.04, clause 5.6: "Rated standard operating duty (standard duty cycle). The standard operating duty of a circuit breaker is:

$$O – t – CO – t' – CO$$

Where

O	= Open
CO	= Close – Open
t'	= 3 minutes
t	= 15 seconds for circuit breakers not rated for rapid reclosing, and
t	= 0.3 seconds for circuit breakers rated for rapid reclosing."

- C37.09 requires that the standard operating duty test (TD4) be conducted with the duty cycle as defined in C37.04, either non-reclosing or reclosing. Hence, the 1999 edition simplifies testing. It also specifies three interruptions in a sequence.

- C37.04 requires that the standard duty cycle be stated on the circuit breaker rating label.

- The application guide, C37.010, no longer indicates derating factors for vacuum circuit breakers for reclosing duty cycles that differ from the standard duty cycle.

Answers for infrastructure.

In essence, the basis of rating for the circuit breakers, and the basis of the design (type) tests, has not changed from the 1979 to the 1999 standards. Both generations include a test duty cycle with a reclosing interval of a minimum time (0.3 seconds in the 1999 edition, 30 cycles or 0.5 seconds in the 1979 edition). The 1999 standard adds a requirement for a second CO operation (e.g., a third interruption) after the time interval t' (three minutes), which was not in the 1979 standards, and therefore, the testing performed in accordance with the 1999 standards is more severe than that required under the 1979 (and earlier) versions of the standards.

Siemens feels that the questions from users about the "standard duty cycle" arise from confusion between the reclosing duty cycle used in a particular application and the "standard duty cycle," which is the basis of circuit breaker design, application and design testing. The standard duty cycle establishes a uniform basis for the performance of circuit breakers. Also, it establishes a uniform basis for the short-circuit design tests conducted in the power laboratory.

The short-circuit laboratories have limitations on the number of interruptions that they can perform in a single operating cycle. Most short-circuit laboratories use a short-circuit generator that is disconnected from the power system during an actual test, and the generator output is maintained by the inertia of the rotating machine during the test. Under this arrangement, the machine slows down during each short-circuit episode, and in turn, the recovery voltage imposed on the circuit breaker following interruption decreases. The short-circuit energy available for a subsequent short-circuit episode is also reduced, and may not meet the current levels required during an interrupting test. Most laboratories cannot perform duty cycles in which there are more than two interruptions in a small space of time, as they need time to increase the speed of the machine after the second short-circuit. For this reason, the new standard duty cycle has a three-minute interval between the second interruption and the third interruption, to allow the laboratory to connect the short-circuit generator to the power system for a sufficient time to bring its frequency back up to the 60 Hz area, and hence, to assure that recovery voltage and short-circuit current will meet the conditions required for a valid test.

Thus, users need have no concern that the 1999 revision of the "standard duty cycle" somehow masks poorer product performance. The reverse is really true, as the 1999 standards add a third interruption to the standard duty cycle test.

Users can apply circuit breakers tested to the new "standard duty cycle" in the 1999 standards without derating factors for reclosing duty cycles, in accordance with the guidelines in the C37.010 application guide.