PRODUCTION TESTING - LOW-VOLTAGE POWER CIRCUIT BREAKERS

APPLICABLE TO K-LINE AC, K-LINE DC, K-DON AND KSP

All low voltage circuit breakers shipped from the factor undergo a series of testing and inspection procedures to insure high quality of workmanship and of circuit breaker performance in the field. Since circuit breakers are basically designed to protect human life and to prevent damage to electrical equipment, it is essential that each circuit breaker be rigidly inspected and tested for correct performance.

Production tests are performed on each circuit breaker before shipment. Modern, up-to-date testing equipment is utilized for accuracy and reliable measurements in the inspection, calibration and testing. Qualified testers with many years of testing experience insure that each individual circuit breaker will perform as it is designed to perform. In addition, each breaker is inspected to verify that it complies with the specific order for which it was manufactured.

Production tests shall include the following:
(1) Control and secondary wiring check test
(2) Dielectric withstand test
(3) Mechanical operation test
(4) Calibration test (not applicable to KSP)

CONTROL AND SECONDARY WIRING CHECK TEST

Control and secondary wiring are checked to make sure that all connections have been made correctly. Devices and relays, if used, are checked by actual operation where feasible. Those circuits for which operation is not feasible are checked for continuity.

DIELECTRIC WITHSTAND TEST

Dielectric tests are made on each circuit breaker after final assembly has been completed.

The dielectric test is applied as follows:
(1) With circuit breaker in the open position, apply 2,200 volts (1,000 volts plus twice 600 volts):
  (a) Between live parts, including both line and load terminals, and metal parts that are normally grounded.
  (b) Between line terminals and load terminals.
(2) With circuit breaker in the closed position, apply 2,200 volts:
  (a) Between live parts and metal parts that are normally grounded.
  (b) Between terminals of different phases.
(3) With circuit breaker in either open or closed position, apply 1,500 volts:
  (a) Between control circuit and metal parts that are normally grounded. If the circuit breaker control circuit includes a motor, the motor may be disconnected during the dielectric test on the concircuit and subsequently tested, in place, at its specified dielectric withstand voltage, but at no less than 900 volts.

Dielectric failure is indicated when the leakage current resulting from the failure is sufficient to trip open the small breaker in the test equipment.

MECHANICAL OPERATION TEST

Electrically operated circuit breakers are given the following no-load operational tests:
(1) Five closing and five opening operations at minimum control voltage.
(2) Five closing, five opening, and five trip-free operations at maximum control voltage.
(3) Two operations to check antipumping, which is performed in the following manner.
  (a) Apply uninterrupted control power to the closing circuit.
  (b) Trip the circuit breaker. The circuit breaker is to remain open until closing circuit power has been interrupted and then restored.
(4) If other devices, electrical or mechanical, are used, they are checked for proper functioning. Such devices are to include key interlocks, mechanical interlocks, electrical interlocks, padlocking, racking mechanisms, etc.

Manually operated circuit breakers -
(1) Manually operated circuit breakers are given five closing and five opening operations
(2) When shunt trip is used, the circuit breaker is opened by means of the shunt trip a minimum of five times at the minimum control voltage specified for the coil.
(3) The circuit breaker is given five trip-free operations.
(4) If other devices, electrical or mechanical, are used, they are checked for proper functioning. Such devices include key interlocks, mechanical interlocks, electrical interlocks, padlocking, racking mechanism, etc.

CALIBRATION TEST

The most important calibration test is that of adjusting and setting of the direct acting trip device so as to afford reliable overcurrent protection of the electrical equipment connected

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to the circuit breaker terminals. These calibration tests may include the following steps where applicable:

(1) Calibrate and set the pickup of the long-time delay element.
(2) Calibrate the delay of the long-time element.
(3) Calibrate and set the pickup of the instantaneous trip element.
(4) Calibrate and set the pickup of the short-time delay element.
(5) Calibrate and set the delay of the short-time trip element.

DESIGN TESTING - LOW-VOLTAGE POWER CIRCUIT BREAKERS (Cont.)
APPLICABLE TO K-LINE AC, K-LINE DC, K-DON AND KSP

Design tests are made to determine the adequacy of the design of a particular type, style, or model of a circuit breaker to meet its assigned ratings and to operate satisfactorily under normal service conditions or under unusual conditions if specified. Design tests are made only on representative circuit breakers to substantiate the ratings assigned to all circuit breakers of a particular design. Where circuit breakers are to be used in enclosures, the design test is made with the breaker in its enclosure.

Design tests on low voltage power circuit breakers include the following:
(1) Dielectric withstand test
(2) Continuous current test
(3) Short-time current test (applicable to K-line AC only)
(4) Short-circuit current interrupting test
(5) Making current test (applicable to K-line AC only)
(6) Latching current test (applicable to K-line AC only)
(7) Endurance performance test
(8) Switching current test (applicable to KSP only)

DIELECTRIC WITHSTAND TEST

Dielectric withstand tests on circuit breakers are made to determine the ability of the insulation to withstand overvoltages.

A 60-cps alternating sinusoidal voltage whose rms value is equal to the specified voltage is used.

The dielectric test is applied as follows:
(1) With circuit breaker in the open position, apply 2,200 volts (1,000 volts plus twice 600 volts):
  (a) Between live parts, including both line and load terminals, and metal parts that are normally grounded.
  (b) Between line terminals and load terminals.
(2) With circuit breaker in the closed position, apply 2,200 volts:
  (a) Between live parts and metal parts that are normally grounded.
  (b) Between terminals of different phases.
(3) With circuit breaker in either open or closed position, apply 1,500 volts:
  (a) Between control circuit and metal parts that are normally grounded. If the circuit-breaker control circuit includes a motor, the motor is disconnected during the dielectric test on the control circuit and subsequently tested, in place, at 900 volts.

CONTINUOUS CURRENT TESTS

The continuous current test is made to insure that the circuit breaker can carry its rated continuous current without exceeding the allowable temperature rise. A circuit breaker equipped with a direct-acting trip device is tested with a coil having a current rating equal to the continuous current rating of the circuit breaker frame size.

Three-pole circuit breakers are tested using a three-phase circuit.

SHORT-TIME CURRENT TEST

The short-time current test is made to verify the ability of the circuit breaker to carry fault currents for a short time period, when applied without direct-acting trip devices.

With the circuit breaker in the closed position, the short-time current is applied and maintained for two periods of one-half second each with a fifteen-second interval of zero current between the one-half second periods.

SHORT-CIRCUIT CURRENT INTERRUPTING TEST

The interrupting tests are made on circuit breakers to determine their ability to close, carry, and interrupt currents within their assigned ratings.

Types of tests:
(1) A single-phase test with line-to-line voltage equal to rated maximum voltage applied across one pole and with the current equal to or greater than 87 percent of the short-circuit current rating.
(2) Three-phase tests with line-to-line voltage equal to rated maximum voltage and the average of the three-phase current equal to or greater than the applicable short-circuit current rating.

K-don only:
(3) A three-phase test with line-to-line voltage equal to rated maximum voltage and the average of the three-phase current equal to the rated short-circuit current of the circuit breaker element frame size.

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Each test consists of an open operation followed after a 15-second* interval by a close-open operation. If time-delay tripping devices are used, the tripping on each opening shall be delayed by the associated tripping devices.

After performance of an interrupting duty cycle at its short-circuit rating, the circuit breaker will be in the following condition:

(1) Mechanical - It will be substantially in the same mechanical condition as before the test.

(2) Electrical - It will be capable of withstanding a dielectric test of 60 percent of the standard test voltage. The circuit breaker will be capable of carrying rated continuous current, but not necessarily without exceeding rated temperature rises and will be capable of operating automatically within specified time limit at the 300 percent calibration point.

MAKING CURRENT

The circuit-breaker making current capability is demonstrated by the ability of the circuit breaker to pass the short-circuit current duty cycle (open - 15 second interval - close-open) test.

LATCHING CURRENT

The ability of a circuit breaker that is not equipped with a direct-acting instantaneous trip element to meet its latching current capability is demonstrated by the ability of the circuit breaker to pass the short-circuit current duty cycle (open - 15 second interval - close-open) test.

SWITCHING CURRENT TEST - KSP ONLY

The power service protector is to be capable of switching current equal to 1200 percent of its rated continuous current.

This test is made with the fuses replaced by links. It will be run under the same conditions as the short circuit current interruption tests but at the lesser value of current.

The power service protector will be capable of performing three 3-phase closing and opening operations without maintenance.

ENDURANCE PERFORMANCE TEST

Endurance performance tests are made on circuit breakers to determine their ability to operate satisfactorily in usual service without excessive servicing or maintenance.

The electrical endurance test is made with rated continuous current, rated maximum design voltage, and rated control voltage, and will not necessitate the repair or replacement of any functional parts prior to completion.

The mechanical endurance test is made at no load and with rated control voltage, and will not necessitate the repair or replacement of any functional parts prior to completion.

At the end of the test, the circuit breaker will be capable of meeting all its continuous current and voltage ratings, and one opening test at rated short-circuit current.

APPLICABLE STANDARDS

The K-Line of circuit breakers and the many variations are designed and tested in accordance with the following standards.

	ANSI	NEMA Standard
Basic K-Line AC	C37.13-1973 C37.16-1973 C37.17-1972	SG3-1971, Part 13
K-Line DC (gen. purpose)	C37.14-1969	SG3-1971, Part 14
K-Don	C37.28-1969	SG3-1971, Part 28
KSP	C37.29-1974	SG3-1971, Part 29

*For K-DON and KSP the time interval is the time that it takes to replace fuses and reset anti-single-phase device.