

## TESTING OF CIRCUIT BREAKERS

Equipments when designed to certain specification and is fabricated needs testing for its performance. The general design is tried and the results of such tests conducted on one selected breaker and are thus applicable to all others of identical construction. These tests are called the type tests. These tests are classified as follows:

### (i) Short circuit tests:

- Making capacity test.
- Breaking capacity test.
- Short time current test.
- Operating duty test

### 2. Dielectric tests:

Power frequency test:

- One minute dry withstand test.
- One minute wet withstand test.
- Impulse voltage dry withstand test.

### 3. Thermal test.

### 4. Mechanical test

Once a particular design is found satisfactory, a large number of similar C.Bs. are manufactured for marketing. Every piece of C.B is then tested before putting into service. These tests are known as routine tests. With these tests it is possible to find out if incorrect assembly or inferior quality material has been used for proven design equipment. These tests are classified as

(i) operation tests (ii) mill volt drop tests, (iii) power frequency voltage tests at manufacturer's premises, and (iv) power frequency voltage tests after erection on site.

We will discuss first the type tests. In that also we will discuss the short circuit tests after the other three tests. Dielectric Tests The general dielectric characteristics of any circuit breaker

or switchgear unit depend upon the basic design i.e. clearances, bushing materials, etc. upon correctness and accuracy in assembly and upon the quality of materials used. For a C.B. these factors are checked from the viewpoint of their ability to withstand over voltages at the normal service voltage and abnormal voltages during lightning or other phenomenon.

The test voltage is applied for a period of one minute between (i) phases with the breaker closed, (ii) Phases and earth with C.B. open, and (iii) across the terminals with breaker open. With this the breaker must not flash over or puncture.

These tests are normally made on indoor switchgear. For such C.Bs the impulse tests generally are unnecessary because it is not exposed to impulse voltage of a very high order. The high frequency switching surges do occur but the effect of these in cable systems used for indoor switchgear are found to be safely withstood by the switchgear if it has withstood the normal frequency test. Since the outdoor switchgear is electrically exposed, they will be subjected to over voltages caused by lightning. The effect of these voltages is much more serious than the power frequency voltages in service. Therefore, this class of switchgear is subjected in addition to power frequency tests, the impulse voltage tests. The test voltage should be a standard  $1/50 \mu\text{sec}$  wave, the peak value of which is specified according to the rated voltage of the breaker. A higher impulse voltage is specified for non-effectively grounded system than those for solidly grounded system. The test voltages are applied between (i) each pole and earth in turn with the breaker closed and remaining phases earthed, and (ii) between all terminals on one side of the breaker and all the other terminals earthed, with the breaker open. The specified voltages are withstanding values i.e. the breaker should not flash over for 10 applications of the wave. Normally this test is carried out with waves of both the polarities. The wet dielectric test is used for outdoor switchgear. In this, the external insulation is sprayed for two minutes while the rated service voltage is applied, the test overvoltage is then maintained for 30 seconds during which no flash over should occur. The effect of rain on external insulation is partly beneficial, insofar as the surface is thereby cleaned, but is also harmful if the rain contains impurities.

### **Thermal Tests**

These tests are made to check the thermal behavior of the breakers. In this test the rated current through all three phases of the switchgear is passed continuously for a period long enough to achieve steady state conditions. Temperature readings are obtained by means of thermocouples whose hot junctions are placed in appropriate positions. The temperature rise above ambient, of conductors, must normally not exceed  $40^{\circ}\text{C}$  when the rated normal current is less than 800 amps and  $50^{\circ}\text{C}$  if it is 800amps and above.

An additional requirement in the type test is the measurement of the contact resistances between the isolating contacts and between the moving and fixed contacts. These points are generally the main sources of excessive heat generation. The voltage drop across the breaker pole is measured for different values of d.c current which is a measure of the resistance of current carrying parts and hence that of contacts.

### **Mechanical Tests**

A C.B. must open and close at the correct speed and perform such operations without mechanical failure. The breaker mechanism is, therefore, subjected to a mechanical endurance type test involving repeated opening and closing of the breaker. B.S. 116: 1952 requires 500 such operations without failure and with no adjustment of the mechanism. Some manufacture feel that as many as 20,000operations may be reached before any useful information regarding the possible causes of failure maybe obtained. A resulting change in the material or dimensions of a particular component may considerably improve the life and efficiency of the mechanism.

### **Short Circuit Tests**

These tests are carried out in short circuit testing stations to prove the ratings of the C.Bs. Before discussing the tests it is proper to discuss about the short circuit testing stations.

There are two types of testing stations; (i) field type, and (ii) laboratory type. In case of field type stations the power required for testing is directly taken from a large power system. The breaker to be tested is connected to the system. Whereas this method of testing is economical for high voltage C.Bs. it suffers from the following drawbacks:

- The tests cannot be repeatedly carried out for research and development as it disturbs the

whole network.

- The power available depends upon the location of the testing stations, loading conditions, Installed capacity, etc.
- Test conditions like the desired recovery voltage, the RRRV etc. cannot be achieved conveniently. In case of laboratory testing the power required for testing is provided by specially designed generators.

This method has the following advantages:

1. Test conditions such as current, voltage, power factor, restricting voltages can be controlled accurately.
2. Several indirect testing methods can be used.
3. Tests can be repeated and hence research and development over the design is possible.

The limitations of this method are the cost and the limited power availability for testing the breakers.

