



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 11024.4-2019

**Shunt capacitors for a.c. power systems having a rated voltage
above 1 000 V -- Part 4: Internal fuses**

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1 Scope

This Part of GB/T 11024 specifies the requirements for power capacitor testing and provides guidelines for fuse protection.

This Part applies to internal fuses (referred to as fuses) that disconnect the faulty capacitor component, so as to allow the remainder of the capacitor unit and the capacitor bank to which the capacitor unit is connected to continue to operate. Such fuses are not intended as replacements for switching devices such as circuit breakers or as replacements for external protection of capacitor banks or any portion thereof.

2 Normative references

The following documents are indispensable for the application of this document.

For dated references, only the dated version applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB/T 11024.1-2019, Shunt capacitors for a.c. power systems having a rated voltage above 1000V. Part 1: General (IEC 60871-1:2014,MOD)

3 Terms and definitions

Terms and definitions determined by GB/T 11024.1-2019 and the following ones are applicable to this document.

3.1 Rated voltage of a capacitor element

UNE The root-mean-square value of the AC voltage that is specified when designing capacitor components.

4.1 Overview

short-term instantaneous overvoltage that the capacitor typically experiences during its life.

During the life of the capacitor, the fuse shall be able to continuously withstand a current equal to or greater than the maximum allowable current of the unit divided by the current of number of parallel fuses.

The fuse shall be able to withstand the inrush currents that may occur during the life of the capacitor due to the switching operation.

The fuse that is attached to the undamaged component shall be able to withstand the discharge current due to component breakdown.

The fuse shall be able to withstand the current that is caused by a short-circuit fault on the outside of the capacitor bank at a peak voltage of 2.5 UN (2.2 UN for AC filter capacitors).

5.1.1 Overview

The fuse shall be able to withstand all routine tests of the capacitor unit in accordance with the provisions of GB/T 11024.1-2019.

5.1.2 Discharge test of internal fuse

Capacitors that have internal fuses shall be capable of withstanding a short-circuit discharge test; pass a 1.7 UN DC voltage through a gap that closes to the capacitor as far as possible and does not contain any applied impedance for a test.

The capacitance shall be measured before and after the discharge test. The difference between the two measured values shall be less than the amount of change that is caused by the internal fuse failures.

The discharge test can be performed before or after the voltage test between the terminals (see Chapter 9 of GB/T 11024.1-2019). However, if it is performed after the voltage test between the terminals, the capacitance shall be measured at the rated voltage, so as to check if the fuse is operating.

If the purchaser agrees to accept a capacitor with fuse failures, the voltage test between the terminals (see Chapter 9 of GB/T 11024.1-2019) shall be performed after the discharge test.

If the test is performed with AC, it is not necessary to use the peak voltage to trigger component damage for the test at the lower limit voltage.

Some test methods are given in Appendix A.

5.3.2 Capacitance measurement

The capacitance shall be measured after the test, so as to prove that the fuse has been disconnected. The used measurement method shall be sufficiently sensitive to detect changes in capacitance that is caused by the disconnection of a fuse.

5.3.3 Inspection of the unit

The casing shall be free of significant deformation before opening.

The casing shall be inspected after opening, so as to ensure that:

- a) the intact fuse is not significantly deformed;
- b) no more fuse damage than more than one (or one tenth of the directly connected components with fuses) (see Note to A.1 in Appendix A). If method b) in Appendix A is used, an additional fuse that is connected to the intact component (or one-tenth of the directly connected components with fuses) is allowed to be damaged at the upper limit voltage.

Note: A small amount of blackening impregnating agent does not affect the quality of the capacitor.

It shall be noted that dangerous residual charges may be present on components that are broken due to fuse action or due to damage to their connecting wires. All components shall be carefully discharged.

5.3.4 Voltage test after the casing is opened

The voltage test shall be performed by applying a DC voltage of $3.5 \times U_{Ne}$ (U_{Ne} is the component voltage) between the breakdown component and the fuse gap after fusing, for 10 s. Components and fuses shall not be removed from the test unit. During the test, the gap shall be in the impregnating agent; no breakdown is allowed between the fuse gap or any part of the fuse and the rest of the unit.

Note: For units, of which all components are connected in parallel, and for all units that use the methods b), c), d) or e) in Appendix A for testing, this test may be replaced by an AC test before the unit is opened. The test voltage between the terminals is calculated as the capacitance ratio, such that the voltage between the breakdown component and its blown fuse gap is $3.5 \times U_{Ne}/2$.

Appendix A (Normative) Internal fuse isolation test method

A.1 Overview It shall use one of the test methods a), b), c), d), e) or other methods.

The voltage and current of the capacitor shall be recorded during the test, so as to verify that the fuse has been disconnected.

In order to verify the current limiting performance of the fuse at the upper limit voltage test,

the voltage drop across the fuse after fusing, except for the transition process, shall not exceed 30% of the upper limit voltage.

If the voltage drop exceeds 30%, measures shall be taken, such that the parallel stored energy and power frequency fault currents that are obtained from the test system are comparable to the operating conditions. Then, perform tests under these conditions to verify whether the fuse action is satisfactory.

In doing this test, measures should be taken to prevent the capacitor unit from exploding and the nail from explosive ejecting.

Note: an additional fuse that is connected to the intact component (or one-tenth of the directly connected components with fuses) is allowed to be damaged at the upper limit voltage.

A.2 Test method The test method is as follows:

a) preheating of the capacitor Place the capacitor unit in an oven for preheating before the lower limit AC test voltage is applied. The preheating temperature ($100^{\circ}\text{C} \sim 150^{\circ}\text{C}$)

is chosen by the manufacturer, in order to obtain the first breakdown in a practically short time (minutes to hours).

In order to prevent the internal hydraulic pressure from being too high due to high temperature, an overflow pipe with a valve can be installed on the unit to close the valve at the moment when the test voltage is applied.

A lower preheating temperature can be used when applying the upper limit test voltage, so as to avoid breakdown if the test voltage has not been reached.