PD IEC/TS 60871-2:2014

BSI Standards Publication

# Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V

Part 2: Endurance testing

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The UK participation in its preparation was entrusted to Technical Committee PEL/33, Power capacitors.

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# SPECIFICATION TECHNIQUE

## Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V – Part 2: Endurance testing

## Condensateurs shunt pour réseaux à courant alternatif de tension assignée supérieure à 1 000 V – Partie 2: Essais d'endurance

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# CONTENTS

FOREWORD ..... 3
1 Scope ..... 5
2 Normative references ..... 5
3 Terms and definitions ..... 5
4 Quality requirements and tests ..... 6
4.1 Test requirements – General purpose ..... 6
4.2 Test procedure ..... 6
4.2.1 General ..... 6
4.2.2 Routine test ..... 6
4.2.3 Conditioning of the units before the test ..... 6
4.3 Ageing test ..... 6
4.3.1 Initial capacitance and dielectric loss measurements ..... 6
4.3.2 Final capacitance and dielectric loss measurements ..... 7
4.3.3 Acceptance criteria ..... 7
4.4 Validity of test ..... 7
Annex A (normative) Requirements regarding comparable element design and test unit design ..... 8
A.1 Test element design criteria ..... 8
A.2 Test unit design ..... 8
Annex B (informative) Definition of element and capacitor container dimensions ..... 10
B.1 Flattened pressed element ..... 10
B.2 Capacitor container ..... 10

Figure B.1 – Flattened pressed element ..... 10
Figure B.2 – Capacitor container ..... 10

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# SHUNT CAPACITORS FOR AC POWER SYSTEMS HAVING A RATED VOLTAGE ABOVE 1 000 V –

## Part 2: Endurance testing

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC/TS 60871-2, which is a technical specification, has been prepared by IEC technical committee 33: Power capacitors and their applications.

This third edition cancels and replaces the second edition published in 1999. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) The overvoltage cycling test has been moved to IEC 60871-1:2014.

The text of this technical specification is based on the following documents:

| Enquiry draft | Report on voting |
|---|---|
| 33/536/DTS | 33/565/RVC |

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60871 series, published under the general title *Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

# SHUNT CAPACITORS FOR AC POWER SYSTEMS HAVING A RATED VOLTAGE ABOVE 1 000 V –

## Part 2: Endurance testing

## 1 Scope

This part of IEC 60871, which is a technical specification, applies to capacitors according to IEC 60871-1 and gives the requirements for ageing tests of these capacitors.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60871-1:2014, *Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V – Part 1: General*

IEC TR 60996, *Method for verifying accuracy of tan delta measurements applicable to capacitors*

## 3 Terms and definitions

For the purpose of this technical specification, the following terms and definitions apply in addition to those given in IEC 60871-1:

**3.1**
**test unit**
one of the units to be manufactured or a special unit which, with respect to the properties to be checked by the ageing test, is equivalent to the units to be manufactured

Note 1 to entry: The restrictions on test unit design are detailed in Annex A.

**3.2**
**comparable element design**
range of construction elements that will be comparable in performance, under the test procedure, with elements of the units to be manufactured

Note 1 to entry: See Annex A for detailed design limits.

**3.3**
**inter-element insulation**
insulation between two series-connected elements, consisting of:

– the outer turns of the insulation layers around the electrodes in an element, or
– a separate insulation layer placed between the two elements

Note 1 to entry: This separate insulation layer may protrude outside the width and (or) length dimension(s) of the flattened element (see Annex B).

# 4 Quality requirements and tests

## 4.1 Test requirements – General purpose

The ageing test is a special test carried out in order to ascertain that the progression of deterioration resulting from increased voltage stress at elevated temperature does not cause untimely failure of the dielectric. It is a mean to ensure that basic material selection is properly made and that any rapid deterioration does not take place. The test should not be seen as a tool for any exact assessment of life characteristics of a dielectric. For that purpose various research and development activities are to be taken care of by the manufacturers.

The ageing test shall be carried out as special tests by the manufacturer for a particular dielectric system, i.e. not for each particular capacitor rating. The test results are applicable to a wide range of capacitor ratings within the limits defined in Annex A. The purchaser shall, on request, be supplied with a certificate detailing the results of such tests.

## 4.2 Test procedure

### 4.2.1 General

The ageing test shall be carried out in the sequence given below. The applied test voltage shall have a frequency of 50 Hz or 60 Hz, except for the test according to 4.2.2 where a d.c. voltage can be used according to 9.3 of IEC 60871-1:2014.

### 4.2.2 Routine test

The test unit shall be subjected to the routine voltage test between the terminals (see IEC 60871-1) with an amplitude such that the correct test voltage is obtained across each element.

### 4.2.3 Conditioning of the units before the test

The test unit shall be subjected to a voltage of not less than 1,1 $U_N$ at an ambient temperature of not less than +10 °C for not less than 16 h.

NOTE The conditioning is carried out to stabilize the dielectric properties of the test units.

## 4.3 Ageing test

### 4.3.1 Initial capacitance and dielectric loss measurements

The capacitor unit shall be measured at 0,9 to 1,1 times the rated voltage. The choice of temperature is left to the manufacturer.

#### 4.3.1.1 Test method

The ambient temperature during the ageing test shall be not less than 55 °C.

It is anticipated, given the limits for the test object specified in Annex A, that more than 60 °C average dielectric temperature is achieved. If requested by the purchaser further details about the relation between external and internal (dielectric) temperatures should be given by the manufacturer. The dielectric temperature may be measured with thermocouples on specially prepared test units or estimated from previously established relationships between internal and external temperatures such as by use of resistive dummy capacitors described in IEC 60996.

The ambient temperature shall be held constant with a tolerance of –2 °C to +5 °C. Prior to energization, the test units shall be stabilized in this ambient for 12 h. Due to the length of this test, voltage interruptions are allowed. During these interruptions, the units shall remain in the

controlled ambient. If power is lost to the chamber, the ambient temperature shall be reattained for 12 h prior to re-energization of the units.

The testing time shall depend on the test voltage. Either one of the following test conditions shall be used:

| Test voltage | Duration<br>h |
|---|---|
| 1,25 $U_N$ | 3 000 |
| 1,40 $U_N$ | 1 000 |

#### 4.3.2 Final capacitance and dielectric loss measurements

The measurement shall be repeated under the same conditions as for the initial measurement, within a temperature tolerance of ±5°C. The measurements shall be made within two days after completing the tests in 4.1.3.2.

#### 4.3.3 Acceptance criteria

No breakdown shall occur when two units have been tested, or alternatively one breakdown is accepted when three units have been tested.

To verify no breakdown the capacitance measurements performed in 4.3.1 and 4.3.2 shall differ by less than an amount corresponding to breakdown of an element.

### 4.4 Validity of test

The ageing test is a test on the elements (their dielectric design and composition), and on their processing (element winding, drying and impregnation) when assembled in a capacitor unit. Each ageing test will also cover other capacitor designs, which are allowed to differ from the tested design within the limits stated in Annex A.

A test performed at 50 Hz is also applicable for 60 Hz (and lower frequency) units and vice versa.

# Annex A
(normative)

# Requirements regarding comparable element design and test unit design

## A.1 Test element design criteria

A tested element design is considered to be comparable with respect to the elements in the units to be manufactured if the following requirements are fulfilled:

a) the tested element shall have the same or an inferior number of layers of solid materials in the dielectric and be impregnated with the same liquid.

   the dielectric shall be within 70°% to 130°% of the thickness and be rated at equal or higher electrical stress.

   when a dielectric contains both film and paper, the stress value to be used in this comparison is the stress across each of the solid materials, calculated using the thickness of only the solid materials and their respective permittivity.

   for the ageing test, using resistors and/or internal fuses is irrelevant for the test. It is up to the manufacturer to choose.

b) the dielectric composition of the solid materials shall be the same, for example all-film or all-paper or film-paper-film, etc.;

c) solid and liquid dielectric materials shall satisfy the same manufacturer's specifications;

d) the aluminium-foil design shall be the same:
   - same manufacturer's specification;
   - thickness within ±20 %;
   - extended or non-extended foil edges;
   - folded foil at the edges and (or) cut ends if it is a feature of the design;
   - less or equal free margin;

e) element connections shall be of the same type, for example tabs, soldering, etc.;

f) the element width (active foil width) is allowed to vary within 50°% to 400°% and the element length (active foil length) is allowed to vary within 30°% to 300°% (see Annex B).

## A.2 Test unit design

A test unit is considered to be comparable to the units to be manufactured if the following requirements are satisfied:

a) elements meeting the requirements of Clause A.1 shall be similarly assembled, have equal or thinner inter-element insulation, be equally pressed within the manufacturing tolerance, etc., as compared with the units to be manufactured;

b) a suitable number of elements shall be connected to give not less than 100 kvar output at rated voltage (50 Hz). All connected elements shall be placed adjacent to each other.

   NOTE The connected elements may be series and parallel-connected in any way to match the test equipment.

c) the connections outside the tested elements may be enlarged in order to handle the increased currents due, for example, to a number of elements in parallel;

d) the insulation to the container shall be of the same thickness or thicker;

   NOTE This requirement is intended to ensure that the drying and impregnation conditions are equal to those of the units to be produced. The electrical withstand requirements of the insulation to container are taken care of by the tests according to Clauses 10 and 15 of IEC 60871-1:2014.

e) a container shall be used, the height of which is not less than 20% of the height of the unit to be manufactured. The depth and width of the container shall not be less than 50%.

NOTE These ranges in container dimensions are necessary to allow for the variation in element sizes.

The container material shall be of equal type (metal, polymer etc.), but the painting can be omitted or may be different.

The bushing design and number of bushings may be adjusted in order to match the test voltage and/or test currents;

f) the drying and impregnation process shall be identical with the normal production process.

# Annex B
(informative)

## Definition of element and capacitor container dimensions

### B.1 Flattened pressed element

As shown in Figure B.1, the element has been pressed flat in the height direction.

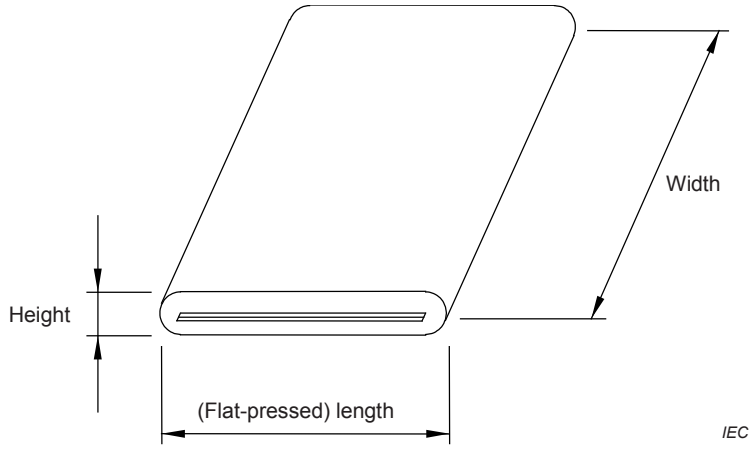


**Figure B.1 – Flattened pressed element**

Element or (active) foil length is obtained by unwinding the element in the length direction.

### B.2 Capacitor container

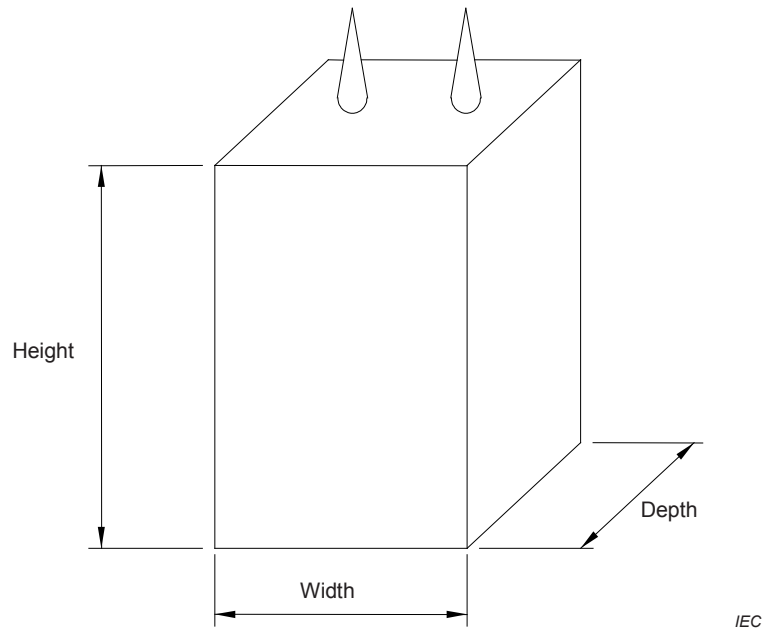


**Figure B.2 – Capacitor container**

Height is always determined from the side on which the bushings are fitted to the opposite side. Normally the length dimension of the flattened element corresponds to the container depth dimension. Depending on the design, the element width direction may correspond to either the container height or the container width dimension (see Figure B.2).

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