# AMENDMENT NO. 1 SEPTEMBER 2011

# TO

# IS 15086 (Part 1) : 2001/IEC 60099-1 (1991) SURGE ARRESTORS

## PART 1 NON-LINEAR RESISTOR TYPE GAPPED SURGE ARRESTORS FOR a.c. SYSTEMS

(The Amendment was originally published by IEC in 1999.)

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**3.1 Arrester identification**

*Replace the 5th dash* "pressure-relief class (for arresters fitted with pressure-relief devices)" *by the following new text:*

– the rated short-circuit withstand current in kiloamperes shall be stated on the nameplate of the surge arrester. Arresters without a claimed short-circuit withstand capability shall have this indicated on the nameplate, see 8.7.

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**5.4 Switching impulse sparkover voltage**

*Replace the second sentence of this clause by the following new text:*

There are limits only for heavy-duty arresters with rated voltages above 200 kV. For these arresters the limits are given in table 8 (column 7).

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**5.8 Long-duration current withstand**

*Replace the second sentence of this clause by the following new text:*

For both types the lightning residual voltage (8.4.1) recorded before and after this test shall not have changed by more than ±10 %. For heavy surge arresters, the dry power frequency sparkover voltage (8.2) recorded before and after the test shall not have changed by more than ±10 %.

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**Table 2 – Parameters for wet tests**

*Replace characteristics 4 and 5 including the note, as follows:*

**Price Group 5**

| | | |
|---|---|---|
| 4. Type of nozzle | See figures 2a, 2b, 2c* | See figure 2d* |
| 5. Water pressure | See figures 2a, 2b, 2c* | See figure 2d* |
| * Figures refer to IEC 60060-1. | | |

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**8.3.5 Switching impulse sparkover-voltage/time curve test**

*Replace the second sentence in the subclause by the following new text:*

There are limits only for heavy-duty arresters with rated voltages above 200 kV. For these arresters the limits are given in table 8 (column 7).

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**8.7 Pressure-relief tests**

*Replace the existing title and text of this clause by the following:*

**8.7 Short-circuit tests**

**8.7.1 General**

Arresters, for which a short-circuit withstand is claimed by the manufacturer, shall be tested in accordance with this subclause. The test is made to show that an arrester failure is not likely to cause an explosive failure. Each arrester type is tested at three different values of short-circuit currents; the rated short-circuit current and two reduced short-circuit currents. Another test is used to verify the capability of the pressure-relief device or of the surge arrester withstanding, for a low magnitude fault current. If the arrester is equipped with some other arrangement, as a substitute for a conventional pressure-relief device, this arrangement shall be included in the test.

The frequency of the short-circuit test current supply shall be no less than 48 Hz and no more than 62 Hz.

In addition, some re-closing cycles can be performed after agreement between the manufacturer and the purchaser. For this special test, the procedure and the acceptance criteria shall be agreed between the manufacturer and the purchaser.

**8.7.2 Preparation of the test samples**

For the high-current tests the test samples shall be the longest arrester unit, with the highest rated voltage of each different design of arrester. For the low current test the test sample may be an arrester unit of any length of each different design. The test sample shall be of the highest rated voltage used for the tested length. The samples shall be prepared with a fuse wire for conducting the required short-circuit current.

The external fuse wire shall be placed along the surface of the active part (non-linear resistor and gaps) inside the arrester housing, such that the entire active part is short-circuited. If the space between the active part and the arrester housing is filled with a combination of solid material and a channel of gas or liquid, the fuse wire shall be located as far as possible from this gas or liquid channel. Figure 2 shows some examples of such cases. The actual location of the fuse wire in the test shall be reported.

The fuse wire material and size shall be selected so that the wire will melt within the first 30 electrical degrees after the initiation of the test current.

According to table 9 a total of four test samples is required for the rated short-circuit current test, one for the high-current test, one for each of the two reduced short-circuit current tests and one for the low current test.

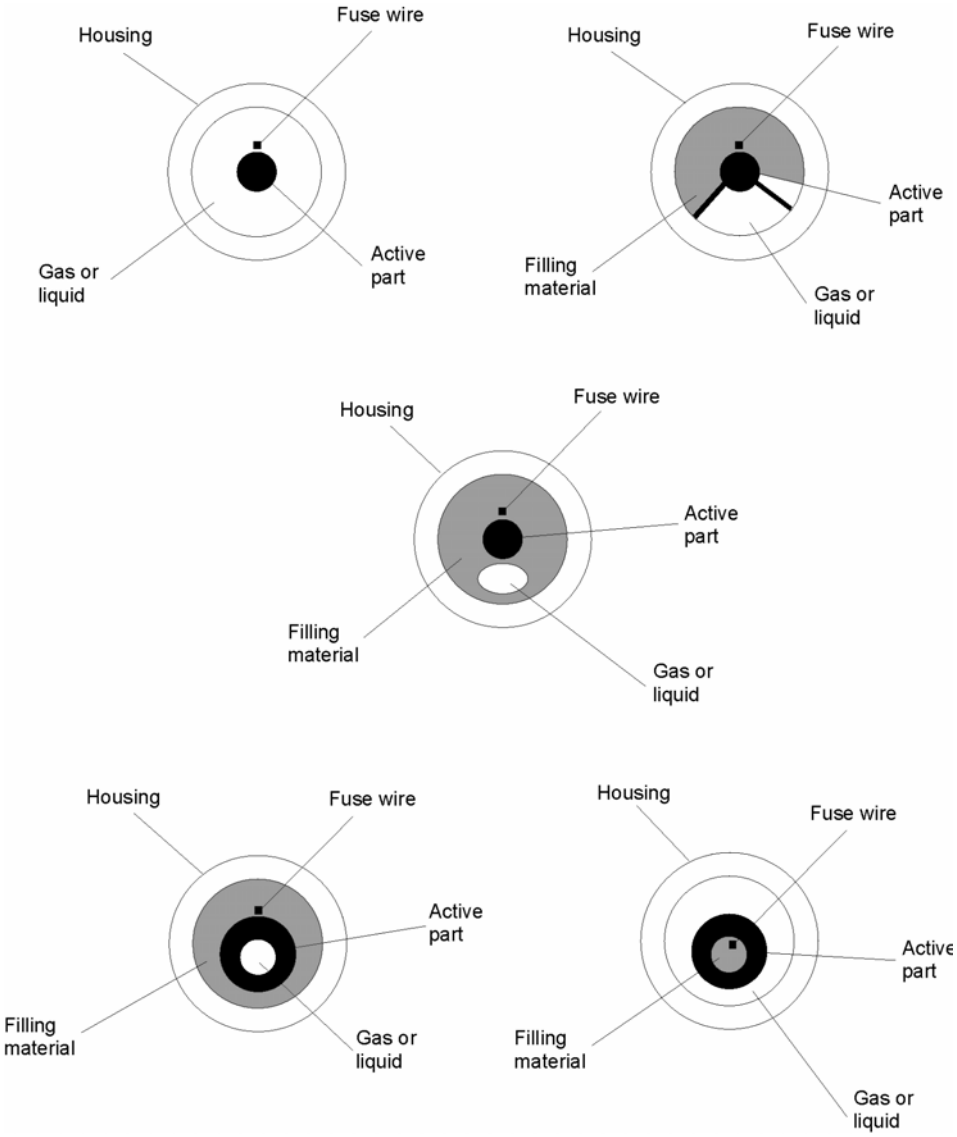


**Figure 2 – Position of the fuse wire in different cases**

**Table 9 – Required currents for short-circuit tests**

| Arrester class = nominal discharge current | Rated short-circuit current | Reduced short-circuit currents | | Low short-circuit current with a duration of 1 s* |
|---|---|---|---|---|
| A | A | A | | A |
| 20 000 or 10 000 | 80 000 | 50 000 | 25 000 | 600 ± 200 |
| 20 000 or 10 000 | 63 000 | 25 000 | 12 000 | 600 ± 200 |
| 20 000 or 10 000 | 50 000 | 25 000 | 12 000 | 600 ± 200 |
| 20 000 or 10 000 | 40 000 | 25 000 | 12 000 | 600 ± 200 |
| 20 000 or 10 000 | 31 500 | 12 000 | 6 000 | 600 ± 200 |
| 20 000, 10 000 or 5 000 | 20 000 | 12 000 | 6 000 | 600 ± 200 |
| 10 000 or 5 000 | 16 000 | 6 000 | 3 000 | 600 ± 200 |
| 10 000, 5 000, 2 500 or 1 500 | 10 000 | 6 000 | 3 000 | 600 ± 200 |
| 10 000, 5 000, 2 500 or 1 500 | 5 000 | 3 000 | 1 500 | 600 ± 200 |

* For surge arresters to be installed in resonant earthed or unearthed neutral systems, the increase of the test duration to longer than 1 s, up to 30 min, may be permitted after agreement between the manufacturer and the purchaser. Then the low short-circuit current shall be reduced to 50 A ± 20 A. For this special test, the test sample and acceptance criteria shall be agreed between the manufacturer and the purchaser.

NOTE 1 If an existing type of an arrester, already qualified for one of the nominal currents in table 9, is being qualified for a higher nominal current value than available in this table, it shall be tested only at the new nominal value. Any extrapolation can only be extended by two steps of rated short-circuit current.

NOTE 2 If a new arrester type is to be qualified for a higher nominal current value than available in this table it shall be tested at the proposed nominal current, at 50 % and at 25 % of this nominal current.

NOTE 3 If an existing arrester is qualified for one of the rated short-circuit currents in this table, it is deemed to have passed the test for any value of rated current lower than this one.

### 8.7.3 Mounting of the test sample

Test samples shall be mounted to simulate installation conditions. For a base-mounted arrester, a mounting arrangement is shown in figures 3a and 3b. The distance to the ground of the insulating platform and the conductors shall be as indicated in figures 3a and 3b.

For non-base mounted arresters (e.g. pole mounted arresters), the test sample shall be mounted to a non-metallic pole using mounting brackets and hardware typically used for service installation. For the purpose of this test, the mounting bracket shall be considered as a part of the arrester base. In cases where the foregoing is in variance with the manufacturer's instructions, the arrester shall be mounted in accordance with the installation recommendations of the manufacturer. The entire lead between the base and the current sensor shall be insulated for at least 1 000 V. The top end of the test sample shall be fitted with the base assembly of the same design as that of an arrester or with the top cap.

For base-mounted arresters, the bottom end fitting of the test sample shall be mounted on an insulating support that is the same height as a surrounding circular or square enclosure. The insulating support and the enclosure shall be placed on top of an insulating platform, as shown in figures 3a and 3b. For non-base mounted arresters, the same requirements apply to the bottom of the arrester. The arcing distance between the top end cap and any other metallic

object (floating or grounded), except for the base of the arrester, shall be at least 1,6 times the height of the sample arrester, but not less than 0,9 m. The enclosure shall be made of non-metallic material and be positioned symmetrically with respect to the axis of the test sample. The height of the enclosure shall be 40 cm ± 10 cm, and its diameter (or side, in case of a square enclosure) shall be equal to the greater of 1,8 m or the diameter of the test sample plus twice the test sample height. The enclosure shall not be permitted to open or move during the test.

For practical reasons an alternative enclosure is a square enclosure made of wood for example, having a side equal to the diameter of the circular enclosure.

Test samples shall be mounted vertically, unless otherwise agreed upon between the manufacturer and the purchaser.

NOTE The mounting of the arrester during the short-circuit test and, more specifically, the routing of the conductors must represent the most unfavourable condition in the field. The routing shown in figure 3a is the most unfavourable to use during the initial phase of the test before venting occurs (especially in the case of a surge arrester fitted with a pressure-relief device).

However, during the remaining arcing time, this routing forces the arc to move away from the arrester, thus reducing the risk of the arrester catching fire. For arresters without a pressure-relief device, it is proposed that, as an alternative, the direction of the venting ports (if any) remains as in figure 3a, but the ground conductor should be directed to the right, as described in figure 3b. In this way, the arc will stay close to the arrester during the entire duration of the short-circuit current, thus creating the most unfavourable conditions with regard to the fire hazard.

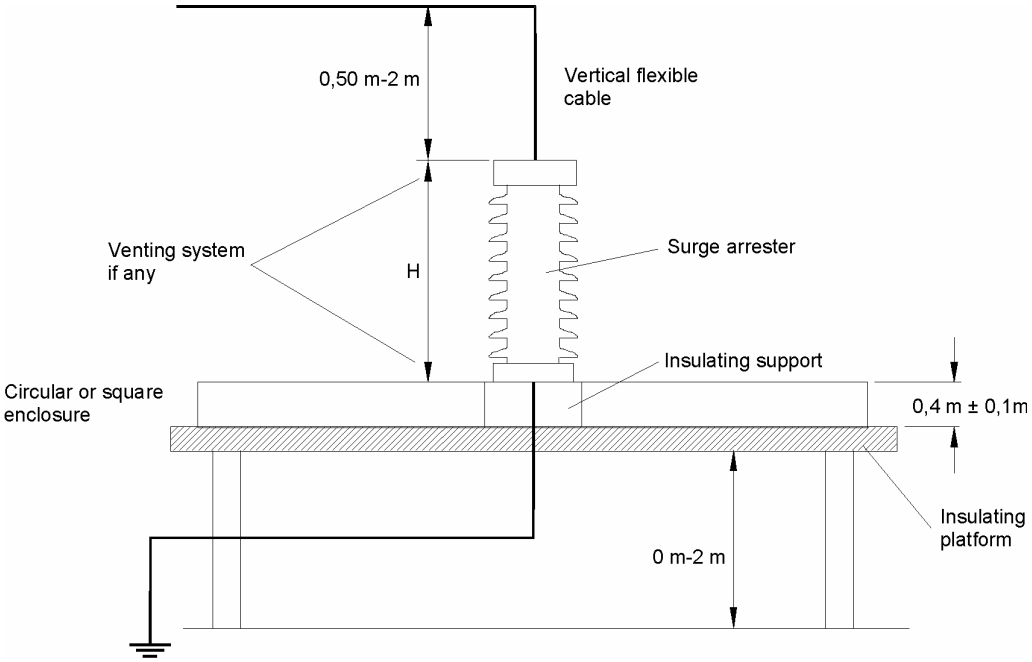


**Figure 3a – Circuit layout for surge arresters with a pressure-relief device**

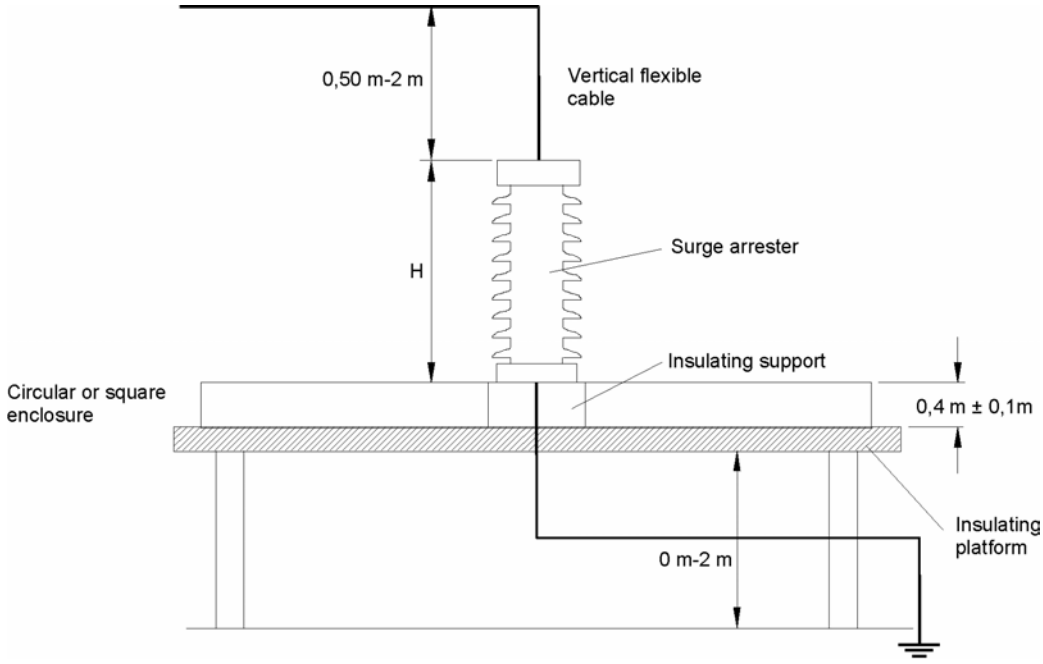


**Figure 3b – Circuit layout for surge arresters without a pressure-relief device**

**Figure 3 – Short-circuit tests**

### 8.7.4 Evaluation of test results

Structural failure of the sample is permitted as long as there is no violent shattering ; except as permitted below, no fragment of the test sample shall fall outside the enclosure.

- The following types of fragments are accepted to fall out of the enclosure:
  - fragments, less than 10 g each, of ceramic material such as non-linear resistors or porcelain;
  - pressure-relief vents, covers and diaphragms consisting of thin and lightweight pieces of metal or plastic.
- During the test the arrester shall be able to self-extinguish open flames within 2 min following the end of the test. Any ejected part (in or out of the enclosure) shall also self-extinguish open flames within 2 min or a shorter duration based on agreement between the purchaser and the manufacturer.

For arresters to be used in applications where mechanical integrity and a strength is required after failure, different test procedures and evaluations may be established between the manufacturer and the user (as an example, it may be required that after the tests the arrester shall still be able to be lifted and removed by its top end).

NOTE 1 Positioning the sample as shown in figure 3a, with the vent ports facing the direction of the test source, may cause the external arc, which is created during the venting operation, to form and be swept in close proximity to the arrester housing. As a result, the thermal shock effect may cause excessive chipping and shattering of the weather sheds, as compared to the other possible orientations of the venting ports.

NOTE 2 If the arrester has not visibly vented at the end of the test, caution should be exercised, as the housing may remain pressurised after the test. This note is applicable to all levels of test current, but is of particular relevance to the low-current pressure-relief tests.

### 8.7.5 High current short-circuit tests

One sample shall be tested at a rated short-circuit current selected from table 9. A second and third sample shall be tested, respectively, at the higher and lower reduced short-circuit currents corresponding to the selected rated current. All three samples shall be prepared according to 8.7.2 and mounted according to 8.7.3.

Tests shall be made in a single phase test circuit, with an open circuit test voltage of 107 % to 77 % of the rated voltage of the test sample arrester, as outlined in 8.7.5.1. However, it is expected that tests on high voltage arresters will have to be made at a testing station which might not have the sufficient short-circuit power capability to carry out these tests at 77 % or more of the test sample rated voltage. Accordingly, an alternate procedure for making the high current short-circuit tests at a reduced voltage is given in 8.7.5.2. The measured total duration of test current flowing through the circuit, as detected by the current sensor whose installation is described in 8.7.1, shall be equal to or greater than 0,2 s.

NOTE Experience has shown that tests at the rated current do not necessarily demonstrate acceptable behaviour at lower currents.

#### 8.7.5.1 High current tests at full voltage (107 % to 77 % of rating)

The prospective current shall first be measured by making a test with the arrester shorted or replaced by a solid link of negligible impedance.

The duration of such a test may be limited to the minimum time required to measure the peak and symmetrical components of prospective current waveform.

For the rated short-circuit current, the peak value of the first half-cycle of the prospective current shall be at least 2,5 times the r.m.s. value of the symmetrical component of the prospective current. The following r.m.s. value of the symmetrical component shall be equal to the rated short-circuit current or higher. The actual r.m.s. value of the prospective current shall be quoted as the test current for the arrester. For the reduced short-circuit currents the r.m.s. value shall be ±10 % of the required current levels according to table 9. There is no asymmetrical requirement on the first peak.

The X/R ratio of the test circuit impedance, without the arrester connected, shall preferably be at least 15. In cases where the test circuit impedance X/R ratio is less than 15, the test voltage may be increased, or the impedance may be reduced, such that:

– for the rated short-circuit current, the peak value of the first half-cycle of the prospective current is equal to or greater than 2,5 times the required test current level;

– for the reduced current level tests, the tolerances above are met.

The actual peak value of the prospective current, divided by 2,5, shall be quoted as the test current, even though the r.m.s. value of the symmetrical component of the prospective current may be higher. Because of the higher prospective current, the sample arrester may be subjected to more severe duty, and therefore, tests at X/R ratio lower than 15 shall only be carried out with the manufacturer's consent.

The solid shorting link shall then be removed and the arrester sample(s) shall be tested with the same circuit parameters.

NOTE The resistance of the restricted arc inside the arrester may reduce the r.m.s. symmetrical component and the peak value of the measured current. This does not invalidate the test, since the test is made with at least normal service voltage and the effect on the test current is the same as would be experienced during a fault in service.

#### 8.7.5.2 High current test at less than 77 % of rated voltage

When tests are made with a test circuit voltage less than 77 % of the rated voltage of the test samples, the test circuit parameters shall be adjusted such that the r.m.s. value of the symmetrical component of the actual arrester test current shall equal or exceed the required test current level of 8.7.5. For the rated short-circuit current, the peak value of the actual arrester test current in the first half-cycle shall be at least 2,5 times the required test current level. For the reduced short-circuit currents the r.m.s. value shall be ±10 % of the required current levels according to table 9. There is no asymmetrical requirement on the first peak.

The X/R ratio of the test circuit impedance, without the arrester connected, shall preferably be at least 15. In cases where the test circuit impedance X/R ratio is less than 15, the test voltage may be increased or the impedance may be reduced such that, for the rated short circuit current, the peak value of the first half-cycle of the prospective current is equal to or greater than 2,5 times the required test current level.

The actual peak value of the test current, divided by 2,5, shall be quoted as the test current, even though the r.m.s. value of the symmetrical component of the test current may be higher. Because of the higher test current, the sample arrester may be subjected to more severe duty, and therefore, tests at X/R ratio lower than 15 shall only be carried out with the manufacturer’s consent.

NOTE If the circuit that produces the required asymmetrical current results in higher symmetrical value than required, current may be reduced, not less than 2,5 cycles after initiation, to the required symmetrical value.

### 8.7.6 Low current short-circuit test

The test shall be made with any test circuit that will produce a current through the test sample arrester of 600 A ± 200 A r.m.s., measured at approximately 0,1 s after the start of the current flow. The current shall flow for 1 s. In the case of a surge arrester fitted with a pressure-relief device, the arrester design shall be considered to have failed this test if venting does not occur during the test.

Refer to note 2 of 8.7.4 with regard to handling an arrester that fails to vent.