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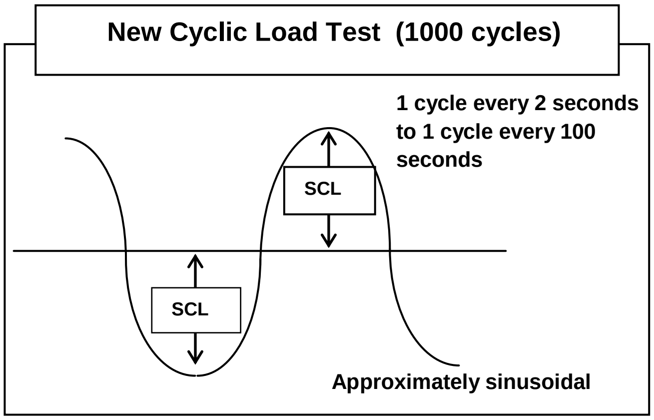
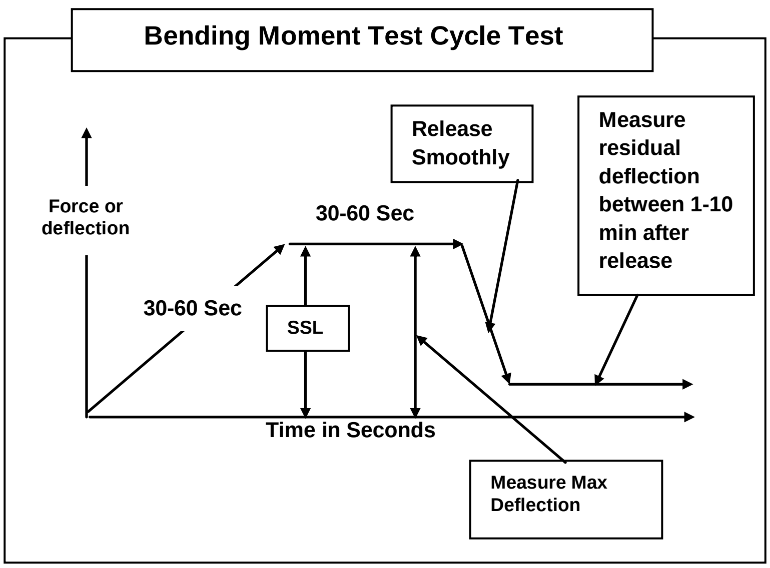
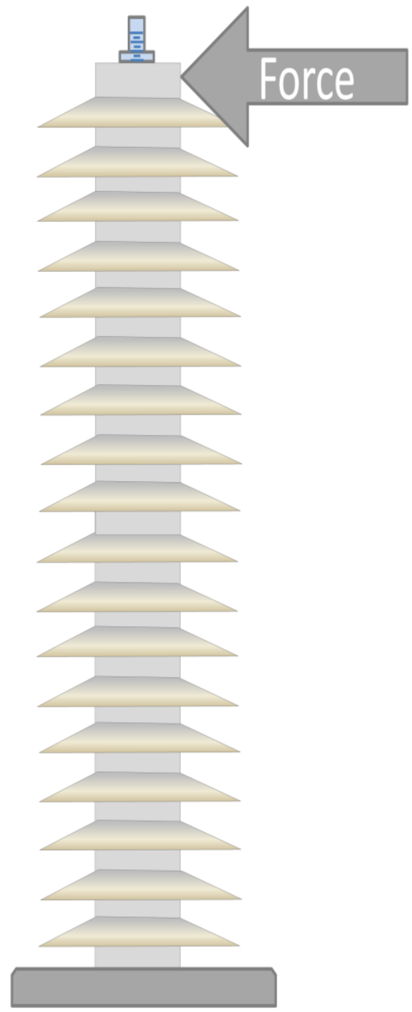
Understanding New IEC Mechanical Test Requirements of Arresters







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Understanding New IEC Mechanical Test Requirements of Arresters

Introduction

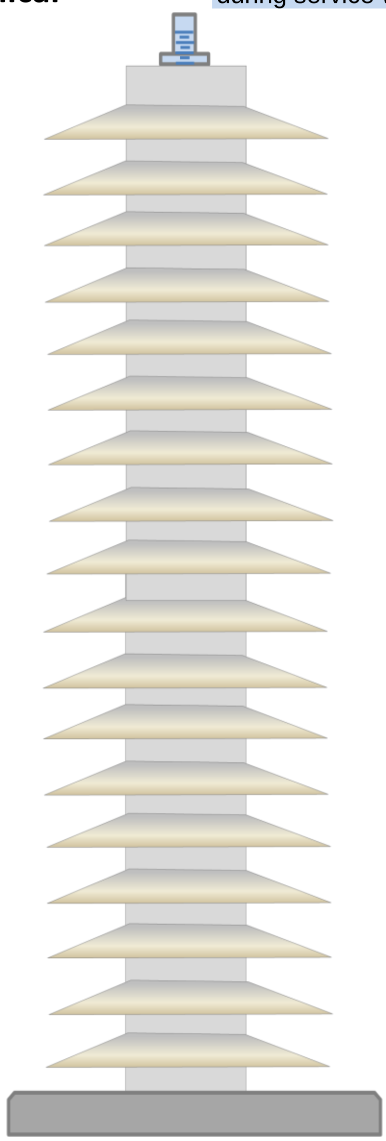
This document is not intended to be a replacement for the upcoming standard, but clarification of what is coming soon. When the new procedure is adopted as a standard in 2009, this document will assist all stakeholders in understanding the new requirements.

Rationale for New Mechanical Tests

In 60099-4 Ed. 2.1 of 2006-07, mechanical tests are specified in Clause 8.9 for porcelain housed arresters and in Clause 10.8.9 for polymer-housed arresters. Environmental tests for porcelain, cast resin and polymer-housed arresters are given in Clause 8.10.

The main reason for improving this test series in 60099-4 is that the test procedures and acceptance criteria for polymer-housed arresters have been criticized as not being relevant and not taking into account the different features of polymer-housed arresters on the market today. For example, strain conditions currently specified in 60099-4 could not be used as evaluation criteria for most polymer arrester designs. In addition the environmental tests under Clause 8.10 have been questioned as being too complicated, time consuming and not necessarily ensuring the reliability of polymer surge arresters.

More details of the rationale are found in Annex A of this Document.



Mechanically Related Definitions

Per 60099-4 after addition of New Mechanical Tests

New Names to existing Definitions

Specified Continuous Load ***SCL***

Force perpendicular to the longitudinal axis of an arrester, allowed to be continuously applied during service without causing any mechanical damage to the arrester.

Previously referred to as "Maximum permissible service load" (MPSL)

Specified short-term load ***SSL***

Greatest force perpendicular to the longitudinal axis of an arrester, allowed to be applied during service for short periods and for relatively rare events (for example, short-circuit current loads, wind gusts) without causing any mechanical damage to the arrester.

Replaces Maximum permissible dynamic service load" (MPDSL)

Mean breaking load ***MBL***

The average breaking load for porcelain or cast resin-housed arresters determined from tests of at least 3 samples. MBL must be greater than or equal to 1,2*SSL

Note, this refers to Porcelain and Cast Resin Housed Arresters only

The following definitions are currently in the standard and appear here for reference only

Bending moment
Horizontal force acting on the arrester housing multiplied by the vertical distance between the mounting base (lower level of the flange) of the arrester housing and the point of application of the force

Terminal line force
Force perpendicular to the longitudinal axis of the arrester measured at the centre line of the arrester

Torsional loading
Each horizontal force at the top of a vertical mounted arrester housing which is not applied to the longitudinal axis of the arrester

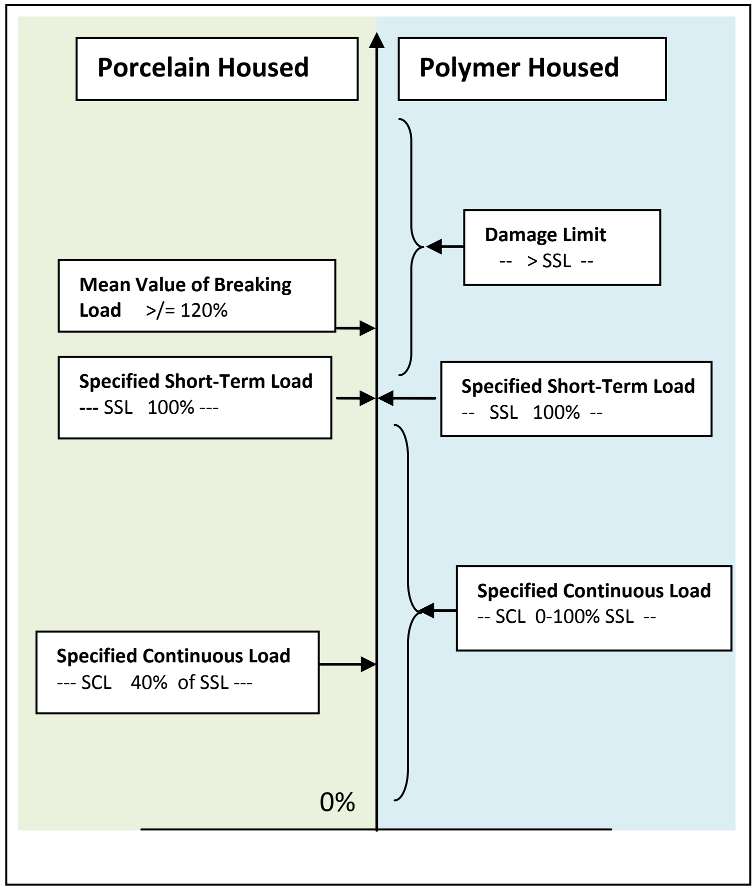
Breaking load
Force perpendicular to the longitudinal axis of a porcelain-housed arrester leading to mechanical failure of the arrester housing

Note, this refers to Porcelain and Cast Resin Housed Arresters only

Damage limit
Lowest value of a force perpendicular to the longitudinal axis of a polymer-housed arrester leading to mechanical failure of the arrester housing

Note, this refers to Polymer Housed Arresters only

Diagram of Loads and Values



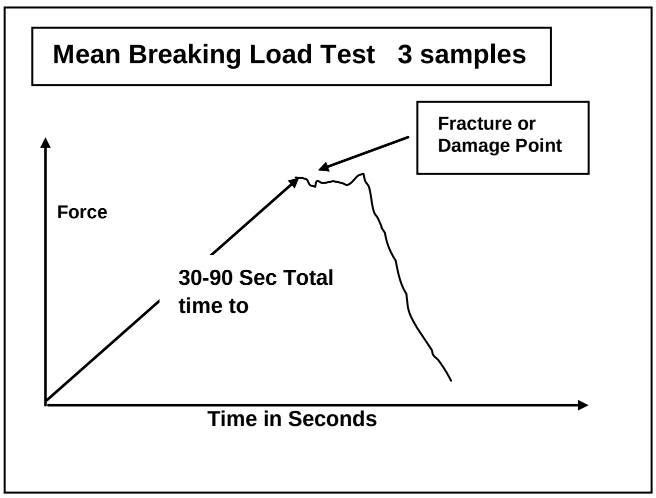
What's New and What's Gone

The only requirement eliminated from the current standard is the requirement known as the Sulphur-dioxide test of metal parts on polymer housed arresters.

Porcelain Housed Arrester
Mean Breaking Load Test

This is a new test, though not a new concept. It was defined in the past, but there was as definition of breaking load. This test and value pertains only to brittle arresters such as porcelain housed and cast resin housed arresters.

The test needs to be watched closely for the first sign of damage, it may not be obvious.



Porcelain Housed Arrester
Bending Moment Test (SSL)

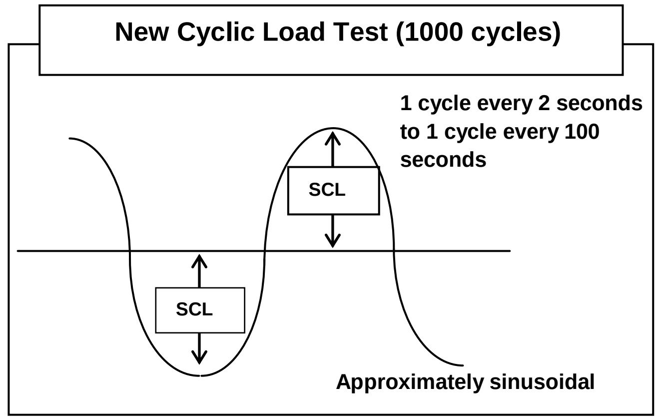
This is not a new test, but the name of the resulting value has changed to Specified Short-Term Load (SSL) from maximum permissible dynamic service load (MPDSL),
There is a minor change in the maximum test time for the post bending moment test.

Porcelain Housed Arrester
Specified Continuous Load Test (SCL)

This value has been 40% of the MPDSL and is now 40% of SSL. This value is derived from practical service history of porcelain housed arresters.

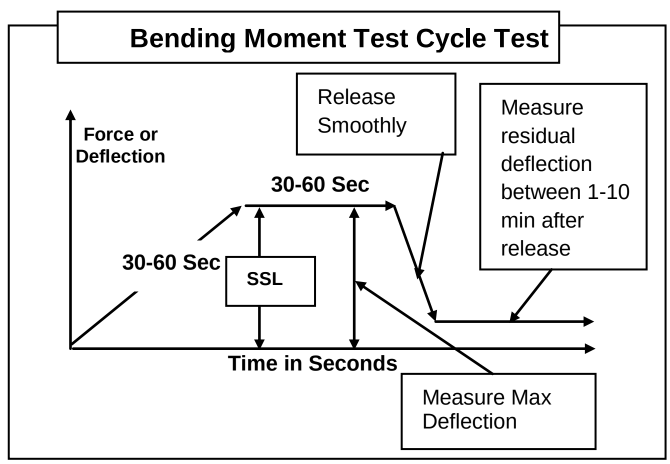
Polymer Housed Arrester
1000 Cycle Bending Moment Test

There is not actually a name for this test, it is just part of the polymer housed bending moment test series. This is a new test in concept and in practice. This test is specified to verify that the samples can withstand the Specified Continuous Load. It is required only for polymer housed arresters above 52kV.



The Bending Moment Test

Though this test is not new, there are some parts that have been modified. This diagram shows the test procedure in simple graphic form.



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Flow Diagram of New IEC Mechanical Testing

Porcelain and Cast Resin Housed Arresters

8.9 Bending Moment of Porcelain Housed Arresters

- **8.9.1 General**
- **8.9.2 Sample Preparation**
- **8.9.3.1 Test for MBL**
- **8.9.3.2 Test of SSL**
- **8.9.4 MBL and SSL Evaluation**

8.10 Environmental Tests of Porcelain Housed Arresters

- 8.10.1 **General**
- 8.10.2 **Sample Preparation**
- 8.10.3.1 **Temperature cycling test**
- 8.10.3.2 **Salt Mist test**
- 8.10.4 **Evaluation**

Annex M Bending Moment Test Details
- **M1 Method of bending**
- **M3 Chart of types of Bending Moments**

Polymer Housed Arresters

10.8.9 Bending Moment and Moisture Ingress Tests of Polymer Housed Arresters

- **10.8.9.1 General**
- **10.8.9.2 Sample Preparation**
- **10.8.9.3 Sample Procedures as show below**

Arresters Rated for (Um) >52kV

- **10.8.9.3 a) Step 1** All three Samples subjected to 1000 cvcle test
- → **10.8.9.3 a) Step 2.1** Two samples receive bending moment test
- → **10.8.9.3.1** One sample receives thermal and mechanical tests
- → **10.8.9.3.2** All three samples receive 42hr boiling water test
- → **10.8.9.4 a) Evaluation**

Arresters Rated for (Um) ≤ 52kV

- **10.8.9.3 b) Step 2.1** Two samples receive bending moment test
- **10.8.9.3.1** One sample receives thermal and mechanical tests
- → **10.8.9.3.2** All three samples receive 42hr boiling water test
- → **10.8.9.4 b) Evaluation**

IEEE vs. IEC Differences

In C62.11, the IEEE arrester test standard, there are two definitions relevant to mechanical characteristics of arresters.

3.50 Maximum design cantilever load-static (MDCL-static): The maximum cantilever load the surge arrester is designed to continuously carry.

3.84 Ultimate mechanical strength-static (UMS-static): The load at which any part of the surge arrester fails to perform its mechanical function.

MDLC vs. SCL
Continuous Load Characteristics (Polymer Housed Arresters only)

These two characteristics are very similar if not the same. Each is the long term maximum continuous force specified by the manufacturer and verified by test. Both tests require thermal and mechanical cycling at the declared continuous load. The tests both consist of boiling water tests after the different force tests to determine if the unit seals have been compromised. The IEEE test does not include the new 1000 cycle test.

UMS vs. MBL
Breaking Load Characteristics of Porcelain Arresters

These two characteristics are identical in all ways. The merely have different names. Both require three samples to be stress in the same way until they break. The mean value of the three is considered the force at which they break. The continuous working load of the porcelain housed arrester is considered to be 40% of this value by both standards.

Impact on Arrester Characteristics

It is clearly the intention of MT4 to assure that all arrester designs introduced to the market meet minimum capabilities. The addition of the 1000 cycle bending moment test is to better characterize and quantify the long term continuous load on an arrester. It is believed by most on the maintenance team that this new test will result in higher quality products with fewer premature failures in the field.

Specifying Mechanical Characteristics

All arresters are designed to support themselves at a minimum. The Specified Continuous Load (SCL) characteristic is specifically for arresters that will carry loads above and beyond their own weight. If an arrester is not stressed above its own weight while in service, there is no reason to specify an SCL. If it is used to support long spans of cable or buss work then specifying SCL should be considered.

Issues Delayed Until Future Editions

One oversight that surfaced near the end of this standard development cycle was the need for a test of Aeolian vibration aging of an arrester. This is of course an issue only for arresters mounted on transmission lines where aeolian vibration can take place.

Fortunately this issue will be addressed in the upcoming externally gapped line arrester standard 60099-8 for externally gapped arresters only. In that standard the Aeolian vibration test will likely be as follows

Test procedure in upcoming 60099-8
Acceleration of arrester's free end: 1.0 • g
Number of oscillations: 1•10^6
Frequency: resonance frequency of the installation
Direction of oscillations: intended most critical direction relative to the sample axis
Test sample installation condition: intended most critical way of mounting
Load: actual electrode or loaded by max. specified weight

It was agreed by the MT that for ungapped line arresters that can be subjected to Aeolian vibration, a test will be developed in the next review of this portion of the standard.

End

Annex A

Rationale of this change to the standard per the CDV Introduction

This section was the introduction to the CDV circulated in 2008. Unfortunately it will not appear in the final standard and this valuable rationale will be lost to future standards' writers and readers.

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As a result, MT 4 undertook the task of developing an improved and more relevant procedure for mechanical and environmental tests. Since the existing mechanical test requirements were added to 60099-4, many new types of polymer-housed arrester designs were introduced. It was the consensus of MT4 and many arrester users that it was difficult to find common acceptance criteria based purely on mechanical loading tests, except when obvious breaking occurred. It was recognized that moisture ingress has been one of the more prevalent causes of polymer-housed arrester failures in the past, and it was therefore considered appropriate to use a moisture ingress test as a means of evaluating the arrester after application of mechanical loading.

MT4 did not wish to create new definitions for mechanical loads, but to use those already established in IEC 61462 for hollow-core insulators. However, 61462 definitions were not directly applicable to polymer-housed surge arresters. With regard to arresters, there are many different designs of polymer-housed arresters on the market. Designs utilizing hollow insulators are only one type of available designs. For many arrester designs the metal-oxide resistors form an integrated part of the mechanical strength of the complete arrester. IEC 61462, on the other hand, does not consider the components inside the composite hollow insulator.

IEC 60099-4 is an apparatus standard and thus must consider the complete design, not only the insulating housing. A cyclic test for taller arresters (arresters for system voltages > 52 kV) considering the features of most arrester designs has been seen as more representative for real service stresses than a static bending test.

The rationale for the proposed cyclic tests was that surge arresters are subjected to a number of different mechanical loads in service. The direction and amplitude of the loads vary. A static bending test, therefore, is not representative for all realistic loads in service. If a manufacturer declares a maximum continuous load rating for an arrester, then it is expected that the arrester can withstand this load even if it varies dynamically due to environmental or other effects. In addition many arrester designs with polymeric housings are more or less flexible.

Subjecting the arrester, in a cyclic way, to maximum continuous load specified by the manufacturer may result in significant deflection which in turn may affect the moisture ingress probability and/or jeopardize the mechanical integrity of the metal oxide blocks. Furthermore, the maximum short-term load that can be applied without breaking may be significantly reduced after the arrester has been subjected to a continuous load in a cyclic manner. A specified short-term load verified on new arresters not previously subjected to any tests, therefore, may give a too optimistic value. In addition there is no simple way in general to check that a continuous load has damaged the arrester or not.

MT4, therefore, decided to introduce a cyclic load test. If the arrester passes 1000 cycles at the specified continuous load (SCL) and subsequent water immersion and evaluation tests, it is considered likely that the arrester can continuously be subjected to the SCL. Furthermore, the short term load (SSL) must be a load which the arrester could be subjected to even after many years in service. Thus MT4 has considered it necessary to specify that verification of SSL shall be performed after the cyclic test in order to take into account some mechanical “ageing” of the arrester. For short arresters, i.e. arresters for system voltages not exceeding 52 kV, a cyclic load test was considered unnecessary.

Regarding porcelain-housed arresters, considering the long experience of this type of arresters, the introduction of a new cyclic test for this arrester design was considered as not necessary.

Changes to the environmental tests were also made. For porcelain-housed arresters, it was considered that, based on the long experience of this type of arrester, all tests of the existing standard are neither necessary nor relevant to determining field performance. For polymer-housed arresters, it was considered that the existing weather ageing test imposes sufficient environmental stress, and that additional tests are not necessary.

End

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