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Edition 2.0 2020-03
REDLINE VERSION

INTERNATIONAL STANDARD

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Overhead lines – Requirements and tests for ~~stockbridge type~~ aeolian vibration dampers

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Overhead lines – Requirements and tests for ~~stockbridge type~~ aeolian vibration dampers

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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OVERHEAD LINES –
REQUIREMENTS AND TESTS FOR AEOLIAN VIBRATION DAMPERS

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 61897 has been prepared by Technical Committee 11: Overhead lines.

This second edition cancels and replaces the first edition published in 1998. This edition constitutes a technical revision.

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

a) Consider, in addition to Stockbridge type aeolian vibration dampers, also spiral aeolian vibration dampers and elastomeric aeolian vibration dampers.
b) Consider the application of dampers on high temperature conductors, specifying additional high temperature tests in clamp slip tests.
c) Simplify the procedure of the damper effectiveness evaluation.
d) Introduce test at low temperature on fastener components such as break away bolts and conical spring washers.
e) Include figures showing the test arrangements for the main mechanical tests.

The text of this standard is based on the following documents:

FDIS	Report on voting
11/266/FDIS	11/273/RVD

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

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended

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OVERHEAD LINES – REQUIREMENTS AND TESTS FOR ~~STOCKBRIDGE TYPE~~ AEOLIAN VIBRATION DAMPERS

1 Scope

This document applies to ~~Stockbridge type~~ aeolian vibration dampers intended for single conductors or earth wires or conductor bundles where dampers are directly attached to each subconductor.

The purchaser may adopt part(s) of this document when specifying requirements for ~~other types of aeolian vibration dampers or for Stockbridge dampers used on conductors or~~ cables different from those mentioned above (e.g. optical ground wires (OPGW), all dielectric self-supporting optical cables (ADSS)).

In ~~many~~ some cases, test procedures and test values are left to agreement between the purchaser and the supplier and are stated in the procurement contract.

Annex A lists the minimum technical details to be agreed between purchaser and supplier.

Throughout this document, the word “conductor” is used when the test applies to ~~Stockbridge~~ dampers for conductors or earth wires.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(466):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 466: Overhead lines*

IEC 60888:1987, *Zinc-coated steel wires for stranded conductors*

IEC 61284:1997, *Overhead lines – Requirements and tests for fittings*

IEC 61854, *Overhead lines – Requirements and tests for spacers*

IEC 62567:2013, *Overhead lines – Methods for testing self-damping characteristics of conductors*

ISO 1461:2009, *Hot dip galvanized coatings on fabricated ~~ferrous products~~ iron and steel articles – Specifications and test methods* ~~1)~~

ISO 2859-1:~~1989~~1999/AMD1:2011, *Sampling ~~plans~~ schemes indexed by acceptable quality ~~level~~ limit (AQL) for lot-by-lot inspection*

~~1) To be published.~~

ISO 2859-2:1985, *Sampling procedures for inspection by attributes – Part 2: Sampling plans indexed by limiting quality level (LQ) for isolated lot inspection*

~~ISO 3951:1989, *Sampling procedures and charts for inspection by variables for percent nonconforming*~~

ISO 3951-1:2013, *Sampling procedures for inspection by variables – Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL*

ISO 3951-2:2013, *Sampling procedures for inspection by variables – Part 2: General specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection of independent quality characteristics*

ISO 9001:2015, *Quality management systems – Requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-466 apply, as well as the following.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
stockbridge-type aeolian vibration damper
device comprising a ~~messenger~~ steel cable with a weight at each end and one bolted clamp or a helical rod attachment, attachable to a conductor, for the purpose of damping aeolian vibration

3.2
spiral aeolian vibration damper
SVD
device made of helical plastic which wraps around the conductor for purposes of damping aeolian vibration (these are commonly used on earth wires, OPGW and ADSS cables)

3.3
elastomeric aeolian vibration damper
device comprising suspended weights connected to elastomeric articulations and one bolted clamp or a helical rod attachment, attachable to a conductor for the purpose of damping aeolian vibration

3.4
high temperature conductors
HTC
conductors which are designed to have a maximum continuous operating temperature over 95 °C

3.5
maximum continuous operating temperature
conductor temperature specified by the manufacturer and measured at the outer wire layers

4 General requirements

4.1 Design

The damper shall be designed so as to

- damp aeolian vibration;
- withstand mechanical loads imposed during installation, maintenance and specified service conditions;
- avoid damage to the conductor under specified service conditions;
- be capable of being removed and re-installed without damage to the conductor;
- be free from unacceptable levels of corona and radio interference under all service conditions, when installed on phase conductors;
- be suitable for safe and easy installation. The clamp design shall retain all parts when opened for attachment to conductor. Furthermore, the clamp design shall be such that the damper, during installation, can be suspended on the conductor before tightening the clamp;
- ensure that individual components will not become loose in service;
- maintain its function over the entire service temperature range;
- avoid audible noise;
- prevent water collection.

NOTE Other desirable characteristics which are not essential to the basic functions of the damper but which may be advantageous include:

- verification of proper installation from the ground;
- easy installation and removal from energized lines.

In the case of vibration dampers for conductors or earth wires containing integral fibre optic elements (or an externally applied optical cable wrapped around the earth wire) account should be made of the possible effects of the damper on these fibre optic elements should be accounted for.

4.2 Materials

The materials shall conform to the requirements of IEC 61284.

4.3 Mass, dimensions and tolerances

Damper mass and significant dimensions, including appropriate tolerances, shall be shown on contract drawings.

4.4 Protection against corrosion

In addition to the applicable requirements of IEC 61284, the messenger cable (including cut ends if applicable when exposed) shall be protected against corrosion, e.g. in accordance with IEC 60888 for hot dip galvanized steel wire.

4.5 Manufacturing appearance and finish

The dampers shall be free of defects and irregularities; they shall have all outside surfaces smooth and all edges and corners well-rounded.

4.6 Marking

The fitting marking requirements of IEC 61284 shall be applied to all clamp assemblies including those using breakaway bolts. On spiral dampers, the markings should be on the plastic rod.

4.7 Installation instructions

The supplier shall provide a clear and complete description of the recommended installation procedure including in-span positions.

5 Quality assurance

A quality assurance programme taking into account the requirements of this document can be used by agreement between the purchaser and the supplier to verify the quality of the vibration dampers during the manufacturing process.

Detailed information on the use of quality assurance is given in ~~ISO 9000-1 [1], ISO 9001 [2], ISO 9002 [3], ISO 9003 [4] and ISO 9004-1 [5]~~ a system as per ISO 9001 or similar.

It is recommended that test equipment used to verify compliance to this document is routinely maintained and calibrated in accordance with a relevant quality standard.

6 Classification of tests

6.1 Type tests

6.1.1 General

Type tests are intended to establish design characteristics. They are normally made once and repeated only when the design or the material of the damper components is changed. The results of type tests are recorded as evidence of compliance with design requirements.

6.1.2 Application

Dampers shall be subjected to type tests as per Table 1.

Unless otherwise specified, each type test shall be performed on three test samples which are identical in all essential respects with dampers to be supplied under contract to the purchaser.

All units shall pass the tests.

The dampers used for tests during which no damage occurs to the units or their components may be used in subsequent tests.

6.2 Sample tests

6.2.1 General

Sample tests are required to verify that the dampers meet the performance specifications of the type test samples. In addition, they are intended to verify the quality of material and workmanship.

6.2.2 Application

Dampers shall be subjected to sample tests as per Table 1.

The samples to be tested shall be selected at random from the lot offered for acceptance. The purchaser has the right to make the selection.

The dampers used for tests during which no damage occurs to the units or their components may be used in subsequent tests.

6.2.3 Sampling, acceptance criteria

The sampling plan procedures according to ISO 2859-1 and ISO 2859-2 (inspection by attributes) and ISO 3951 (inspection by variables) and the detailed procedures (inspection level, AQL, single, double or multiple sampling, etc.) shall be agreed between the purchaser and the supplier for each different attribute or variable.

NOTE Sampling inspection by variables is an acceptance sampling procedure to be used in place of inspection by attributes when it is appropriate to measure on some continuous scale the characteristic(s) under consideration. In the case of failure load tests and similar expensive tests, better distinction between acceptable quality and objective quality is available with acceptance sampling by variables than by attributes for the same sample size.

The purpose of the sampling process may also be important in the choice between a variables or attributes plan. For example, a purchaser may choose to use an attributes acceptance sampling plan to assure that parts in a shipment lot are within a required dimensional tolerance; the manufacturer may make measurements under a variables sampling plan of the same dimensions because he is concerned with gradual trends or changes which may affect his ability to provide shipment lots which meet the AQL.

6.3 Routine tests

6.3.1 General

Routine tests are intended to prove conformance of vibration dampers to specific requirements and are made on every damper. The tests shall not damage the dampers.

6.3.2 Application and acceptance criteria

Whole lots of dampers may be subjected to routine tests. Any damper which does not conform to the requirements shall be discarded.

6.4 Table of tests to be applied

The following Table 1 indicates the tests which shall be performed. These are marked with an "X" in the table.

However, the purchaser may specify additional tests which are included in the table and marked with an "O".

Units or components damaged during the test shall be excluded from the delivery to the customer.

Table 1 – Tests on dampers

Subclause	Test	Type test	Sample test	Routine test
7.1	Visual examination	X	X	O
7.2	Verification of dimensions, materials and mass	X	X	
7.3	Corrosion protection tests	X	X	
7.4	Non-destructive tests	O	O	O
7.5	Clamp slip test	X	O	
7.6	Breakaway bolt test ~~1)~~	X	X	
7.7	Clamp bolt tightening test	X	X	
7.8	Attachment of weights to messenger cable	X	X	
7.9	Attachment of clamp to messenger cable test	X	X	
7.10	Corona and radio interference voltage (RIV) tests[1)]	X ~~1)~~		
7.11 7.11.2 7.11.3	Damper performance tests – Damper characteristic test – Damper effectiveness evaluation	 X X	 O 	
7.12	Damper fatigue test	X		
1) Not applicable for earth wire dampers.				

~~NOTE~~

- The supplier should state in the tender quality plan, or other tender documentation, which testing is already complete (i.e. which type tests) and which tests (sample or routine) are included in the tender, subject to the approval or change required by the purchaser.
- If conical washers are used on bolted clamps, embrittlement tests shall be performed in accordance with clause 7.5.2.2 of IEC 61854:2019.

7 Test methods

7.1 Visual examination

Type tests shall include visual examination to ascertain conformity of the dampers in all essential respects, with the manufacturing or contract drawings. Deviations from the drawings shall be subject to the approval of the purchaser and shall be appropriately documented as an agreed concession.

Sample tests and, if required, routine tests shall include visual examination to ensure conformity of manufacturing process, shape, coating and surface finish of the damper with the contract drawings. Particular attention shall be given to markings required and to the finish of surfaces which come into contact with the conductor. The sample test procedure and acceptance criteria shall be agreed between the purchaser and the supplier.

For dampers subjected to corona type test, the sample test shall include a comparison of shape and surface finish with one of the corona type test samples when specified by the purchaser.

7.2 Verification of dimensions, materials and mass

Type and sample tests shall include verification of dimensions to ensure that dampers are within the dimensional tolerances stated on contract drawings. The purchaser may choose to witness the measurement of selected dimensions or may inspect the supplier's documentation when this is available.

Type and sample tests shall also include verification of materials to ensure that they are in accordance with contract drawings and documents. This verification shall normally be carried out by the purchaser inspecting the supplier's documentation relating to material specifications, certificates of conformity or other quality documentation.

The total mass of the damper complete with all its components shall comply with the mass shown on the contract drawing (within given tolerances).

7.3 Corrosion protection tests

7.3.1 Hot dip galvanized components (other than messenger cable wires)

Hot dip galvanized components other than messenger cable wires shall be tested in accordance with the requirements specified in ISO 1461.

The coating thicknesses shall conform to Tables ~~2~~3 and ~~3~~4 of ISO 1461:2009, unless otherwise agreed between purchaser and supplier. However, for the purpose of this document, Tables ~~2~~3 and ~~3~~4 in ISO 1461:2009 shall apply to the following categories of items (and not to the categories specified in ISO 1461).

Table ~~2~~3: Coating thickness on all samples except

- washers;
- threaded components;
- small parts which are centrifuged (significant surface area <1 000 mm^2).

Table ~~3~~4: Coating thickness on

- washers;
- threaded components;
- small parts which are centrifuged (significant surface area <1 000 mm^2).

7.3.2 Ferrous components protected from corrosion by methods other than hot dip galvanizing

Ferrous components protected from corrosion by methods other than hot dip galvanizing shall be tested in accordance with the requirements of relevant IEC/ISO standards agreed between purchaser and supplier.

7.3.3 Hot dip galvanized messenger cable wires

Hot dip galvanized messenger cable wires shall be tested in accordance with the requirements specified in IEC 60888.

7.4 Non-destructive tests

The purchaser shall specify or agree to relevant test methods (ISO or other) and acceptance criteria. Examples of non-destructive tests are as follows:

- magnetic test;
- eddy current test;
- radiographic test;
- ultrasonic test;
- proof load test;
- dye penetrant test;
- hardness test.

7.5 Clamp slip test

The test shall be performed using the conductor for which the clamp is intended. The conductor shall be "as new", i.e. free of any deterioration or damage. The minimum free length of test conductor between its terminating fittings shall be 2 4 m. The conductor shall be tensioned to 20 % of its rated tensile strength. Precautions shall be taken to avoid birdcaging of the conductor.

The clamp shall be installed in accordance with the supplier's instructions on a different portion of conductor for each test. In the case of breakaway bolts, the installation torque shall be the design value nominal breakaway torque minus the specified tolerance agreed between the purchaser and the supplier (see 7.76).

NOTE The use of other conductors, or conductor lengths or tensions may be agreed between purchaser and supplier.

By means of a suitable device a load coaxial to the conductor shall be applied to the damper clamp, as indicated in Figure 1. The load shall be gradually increased (not faster than 100 N/s) until it reaches 2,5 kN (specified minimum slip load) the load given in Table 2 or the load agreed between purchaser and supplier. This load shall be kept constant for 60 s. Then the load value shall be gradually increased until slippage of the clamp occurs. The value of slip load shall be recorded.

For the slip test conducted on High Temperature Conductors (HTC) using Stockbridge and elastomeric dampers only, the parameters are the same as for standard conductors. After installing the clamp at ambient temperature, the conductor shall be electrically heated up to the maximum continuous operating temperature as specified by the conductor manufacturer and kept constant at this temperature for 0,5 h. The conductor tension load shall be kept constant at 20 % RTS. Then the slip test shall be performed at maximum continuous operating temperature as described above.

For the type test, an additional thermal process of the conductor shall be performed.

A new clamp shall be fixed at ambient temperature on the conductor which is tensioned to 20 % of RTS. It is permitted to fix several clamps on the same setup to reduce expenditure of time. The distance between the clamps shall be at least 300 mm.

Then the conductor shall be electrically heated up to the maximum continuous operating temperature as specified by the conductor manufacturer and kept constant at this temperature for 1h.

Afterwards the temperature shall decrease to at least ambient temperature plus 5 °C. These cycles shall be carried out four times. At the end of the fourth cycle, after decreasing the temperature to ambient values the slip load test shall be performed. For the complete test run the tension shall be kept constant at 20 % of rated tensile strength.

Clamp slip shall be considered as having occurred when a slip distance of 1 mm for bolted clamps and 2,5 mm for helical attachments is measured.

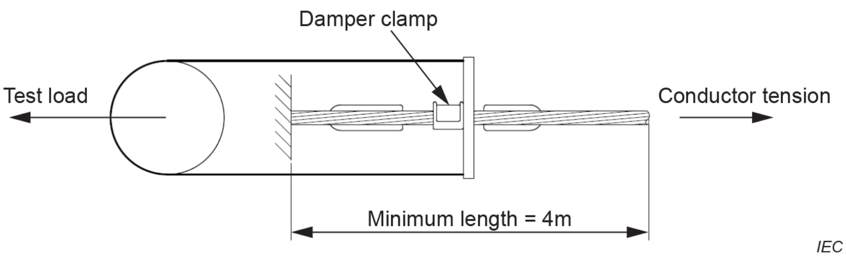


Figure 1 – Test arrangement for longitudinal slip tests

Table 2 – Load criteria (for standard and high temperature conductors)

Damper	Conductor diameter	Attachment	Specified minimum load/~~Maximum slip~~	
			Load kN	Movement mm
Stockbridge or Elastomeric	< 19 mm	Bolted	1,25	1,0
Stockbridge or Elastomeric	≥ 19 mm	Bolted	2,5	1,0
Stockbridge or Elastomeric	All	Helical	1,0	2,5
Spiral damper[1]	All	Helical	0,1	2,5
[1] Only for standard conductors.				

Acceptance criteria

No movement of the clamp relative to the conductor greater than ~~1 mm~~ shown in Table 2 shall occur at or before the end of ~~application of 2,5 kN~~ the specified minimum load for 60 s. ~~If both a minimum and a maximum slip load are stated, the slip shall occur between those values.~~ Surface flattening of the outer strands of the conductor is acceptable. If armor rods are used under the clamp, slippage of the armor rods relative to the conductor is considered as clamp slippage.

7.6 Breakaway bolt test

The breakaway bolt~~s~~ or breakaway cap, if used, shall be tested by applying increasing torque to the breakaway portion of the bolt or the cap until it breaks away. The test shall be carried out at ambient temperature.

Precaution shall be taken on a constant continuous circular motion of the torque wrench and a perpendicular angle between torque wrench and bolt head.

The breakaway torque shall be recorded.

- Acceptance criteria:

The breakaway torque shall be within the tolerance ~~agreed between the purchaser and~~ specified by the supplier.

If no tolerance is specified, the range shall be nominal installation torque plus/minus 10 %.

For countries where ambient temperature below 0 °C can be expected, it is recommended to repeat the tests on breakaway bolts and breakaway caps at the temperature corresponding to the average temperature of the coldest month.

The specimens shall be kept for at least 1 h in an appropriate cooling device prior the test. During the break away test the temperature should be measured and recorded. The temperature during the test shall not increase more than 10 °C from initial cooling temperature.

7.7 Clamp bolt tightening test

The test shall be performed by installing the clamp on a length of the conductor for which the damper is intended. In case not available, an equivalent conductor or a tube of same diameter can be used. If the damper is to be used for two or more sizes or types of conductor, then the clamp shall be tested on each conductor unless the purchaser agrees to test on one conductor only.

The bolts or nuts shall be tightened to a torque 10 % above the specified installation torque with a calibrated torque wrench. Clamps with breakaway bolts or breakaway caps shall have the breakaway portion of the head removed prior to the test and shall be tightened ~~with~~ 10 % above the specified installation torque~~ value plus the agreed tolerance~~. ~~The threaded connection shall remain serviceable for any number of subsequent installations or removals and all components of the clamp shall be undamaged. No unacceptable damage shall occur to the conductor inside the clamp. Unacceptable damage shall be agreed between the purchaser and the supplier.~~

- Acceptance criteria

The threaded connection shall remain serviceable (by hand) for three subsequent installations and removals and all components of the clamp shall be without any mechanical deformation or cracks. No plastic deformation shall occur to the conductor inside the clamp.

Lastly, the torque shall be increased to either twice the specified installation value or the maximum torque value recommended by the bolt supplier, whichever is lower. This increase shall not result in any breakage of threaded parts or other components of the clamp or any cracks. The bolt shall be able to be removed from the clamp without any failure.

Plastic deformation is permitted.

7.8 Attachment of weights to messenger cable test

On an assembled damper a tensile load shall be applied between the weights coaxial with the messenger cable, as indicated in Figure 2. The load shall be gradually increased (100 N/s maximum) until it reaches 5 kN (specified minimum slip load). This load shall be kept constant for 60 s.

The load shall then be increased slowly until one weight has been pulled free of the messenger cable. The maximum load obtained during this process shall be recorded, for information purposes only.

- Acceptance criteria

No relative movement greater than 1 mm between each weight and the messenger cable shall occur at or before the end of the application of 5 kN for 60 s.

~~NOTE~~ It may be necessary to remove the load before measuring the distance between the weights, i.e. when the elastic stretch of the messenger cable results in an apparent movement of the weights along the messenger cable.

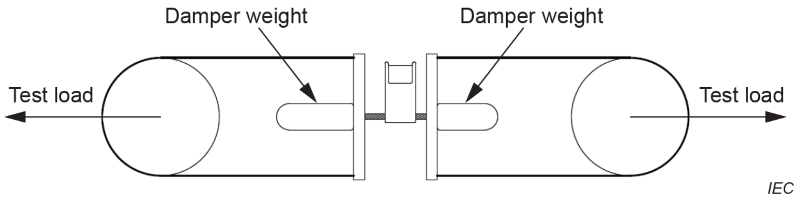


Figure 2 – Test arrangement for attachment of weights to messenger cable test

7.9 Attachment of clamp to messenger cable test

A tensile load shall be applied between the messenger cable and the clamp body, coaxial with the messenger cable, as indicated in Figure 3. The load shall be gradually increased (100 N/s maximum) until it reaches 1,5 kN (specified minimum slip load). This load shall be kept constant for 60 s.

The load shall then be increased slowly until the clamp has been pulled free of the messenger cable. The maximum load obtained during this process shall be recorded, for information purposes only.

- Acceptance criteria

No movement of the clamp relative to the messenger cable greater than 1 mm shall occur at or before the end of the application of 1,5 kN for 60 s.

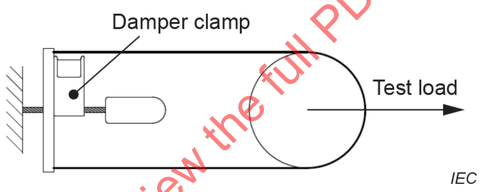


Figure 3 – Test arrangement for attachment of clamp to messenger cable test

7.10 Corona and radio interference voltage (RIV) tests

The tests shall be performed in accordance with Clause 14 of IEC 61284:1997.

7.11 Damper performance tests

7.11.1 Performance test variants

Two performance test variants are specified in conjunction with their respective acceptance criteria. The purchaser shall specify or agree to the variant to be applied.

a) Variant A

During type and sample tests, the damper characteristic test (see 7.11.2) is executed and the results are compared with the acceptance criteria and limits established by the purchaser.

~~NOTE~~ This variant does not require the damping effectiveness evaluation (see 7.11.3) because this was taken into account when establishing the lower and upper limits.

b) Variant B

During type tests the damper characteristic test (see 7.11.2) is performed on three samples.

The damper effectiveness of the type test samples is then checked by one of the three methods described in 7.11.3 (damper effectiveness evaluation). If these three samples meet the acceptance criteria as per 7.11.3, their characteristics may be used as a reference for the future checking of the characteristics of the same damper type, e.g. in sample tests.

For sample testing, the damper characteristic test (see 7.11.2) shall be performed and the results compared with the characteristics obtained during "type tests" (see Table ~~2~~3 ~~— Acceptance criteria in 7.11.2~~).

7.11.2 Damper characteristic test

7.11.2.1 Stockbridge or elastomeric dampers only

The damper shall be attached via its clamp to a shaker controlled by a sinusoidal oscillator, as shown in Figure 4, the output signal of which is variable in frequency and amplitude. A frequency range of 0,18/*d* to 1,4/*d* – where *d* is the conductor diameter in metres – shall be covered unless a narrower frequency range is agreed between the purchaser and the supplier. Any automatic sweep rate not exceeding 0,2 decade/min in the case of logarithmic sweep, and 0,5 Hz/s in the case of linear sweep, may be used. Alternatively, the frequency range may be covered step by step (maximum step intervals of 0,5 Hz below 10 Hz, 1 Hz between 10 Hz and 100 Hz and 2 Hz above 100 Hz) with stability of result being checked at each frequency. The clamp velocity shall be held constant at 0,1 m/s (~~single peak~~ 0-p).

NOTE Some difficulties may arise during the test for frequencies below 5 Hz because the oscillations of the shaker may not be truly sinusoidal.

A logarithmic sweep rate of 0,2 decade/min means that after 1 min the frequency is $10^{0,2}$ times the initial frequency and 10 times the initial frequency after 5 min.

The results of the test shall be graphs of

- Damper impedance Z_v (ratio between force F and velocity V at the damper clamp);
- Phase angle φ_v between force F and velocity V ~~signal~~ at the damper clamp;
- Damper power dissipation ~~P_v~~ $P_v = \frac{1}{2} F\, V \cos\varphi_v$;

against frequency.

OR

- Damper dynamic stiffness $\frac{F}{u}$ (ratio between force F and displacement u at the damper clamp);
- Phase angle φ_u between force F and displacement u at the damper clamp;
- Damper power dissipation $P_v = \pi f \frac{F}{u} u^2 \sin\varphi_u$ *where* f is frequency, F is the peak force, u is peak displacement;

against frequency.

Examples of graphs are illustrated in Annex B.

If specified by the purchaser, the test results can be presented in a different manner, provided that the above-mentioned characteristics can be derived from these results.

When variant B is used, from the last of the above graphs the frequencies f_i and power dissipation values P_i corresponding to the resonances of the damper shall be recorded. The following designations are used for convenience of reference in this standard:

f_i i[th] resonant frequency;

P_i power dissipated by the damper at f_i.

During type tests the following values shall be determined from the results from the tested dampers:

$f_{i\min}$ the lowest f_i value obtained for the dampers tested;

$f_{i\max}$ the highest f_i value obtained for the dampers tested;

$P_{i\min}$ the lowest P_i obtained for the dampers tested;

$P_{i\max}$ the highest P_i obtained for the dampers tested;

for all resonant frequencies of the dampers.

- Acceptance criteria

Table ~~2~~3 – Acceptance criteria

	Variant A	Variant B
Type test	For all frequencies the phase angle φ_v and the damper power dissipation P_v shall stay between the lower and the upper limits required by the purchaser	No criterion since test results are only used as reference for sample tests
Sample test	For all frequencies the phase angle φ_v and the damper power dissipation P_v shall stay between the lower and the upper limits established by the purchaser	In sample tests the resonant frequencies f_i and the corresponding power values P_i shall be determined and compared with the values $f_{i\ \min}$, $f_{i\ \max}$, $P_{i\ \min}$ and $P_{i\ \max}$ obtained from the damper characteristic type test (see above). The damper shall meet the sample test requirement if, for each damper, the following applies: $0{,}8 f_{i\min} < f < 1{,}2 f_{i\max}$ $0{,}8 P_{i\min} < P < 1{,}2 P_{i\max}$ For all resonant frequencies

NOTE Guidance on the measurement of power dissipation of aeolian vibration dampers in laboratory tests is given in IEEE Std 664 [1][2] which refers to the damper characteristic test as "forced response method" (see Clause 4 of IEEE Std 664:1993). ~~It is recommended that the detailed procedures for instrumenting and for controlling this test are developed with reference to these recommendations.~~

7.11.2.2 High Temperature Conductors (HTC) – Elastomeric dampers only

The damper shall be attached via its clamp to a piece of conductor or tube. After installing the damper at ambient temperature, the conductor/tube shall be electrically heated up to the maximum continuous operating temperature as specified by the conductor manufacturer and kept constant at this temperature for 0,5 h. Then the temperature shall decrease to ambient temperature. This cooling and heating shall be carried out for four cycles. Then the damper characteristic test shall be performed as described in 7.11.2.1. There shall be no change in damper performance more than 10 % between standard conductor test and the high temperature conductor test.

2 Numbers in square brackets refer to the Bibliography.

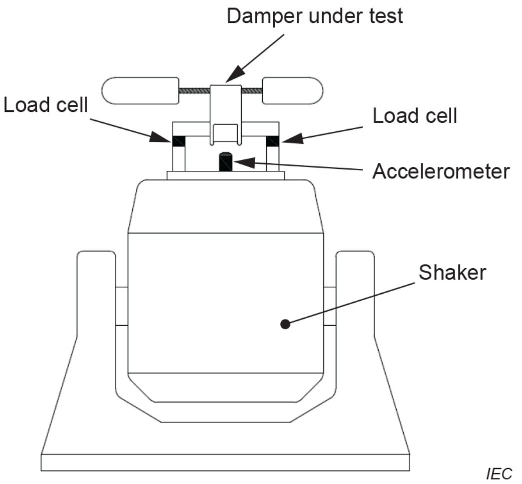


Figure 4 – Test arrangement for damper characteristic test

7.11.3 Damper effectiveness evaluation

7.11.3.1 Methods of evaluation

The evaluation of the effectiveness of dampers shall be carried out by means of one or more of the following methods:

- laboratory test;
- field test;
- analytical method.

The method(s) to be applied shall be agreed between the purchaser and the supplier.

7.11.3.2 Laboratory test

The test shall be performed using conductor(s) and tension(s) specified by the purchaser. Alternatively, the supplier may propose conductor(s) and tension(s) for the test, subject to acceptance by the purchaser. The minimum free span length shall be 30 m. The span shall be maintained at the specified tension for at least 24 h before starting the test.

A rigid clamp shall be installed to support rigidly (but not to tension) the conductor at both ends of the span and the damper and shaker shall be positioned as indicated in Figure ~~4~~5. The shaker shall be installed in such a way that its connection to the conductor is located in the first loop for all frequencies to be employed.

An example of laboratory test span construction is shown in Figure 5.

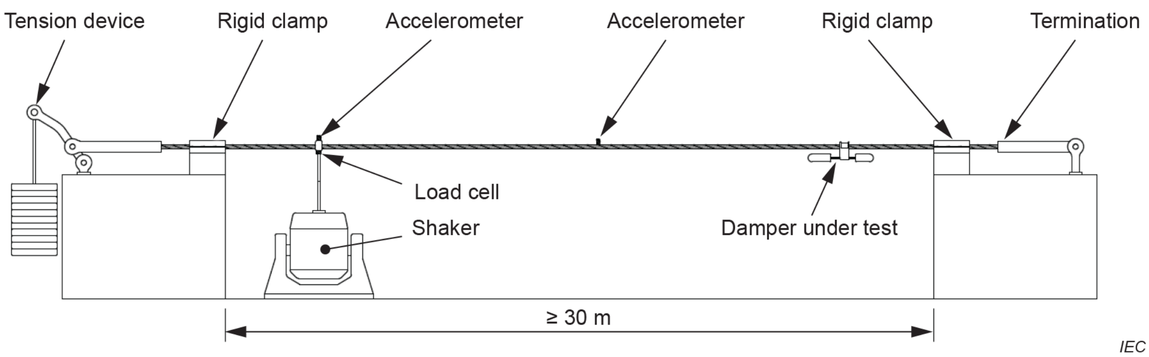


Figure 5 – Example of test rig for laboratory test of damper effectiveness

Although armor rods may be fitted around the conductor at suspension points in service, these ~~shall be~~ are normally omitted in this test to determine the performance of the damper alone. If the purchaser wishes to include armor rods to simulate their actual line this is acceptable.

The damper or dampers shall be installed in accordance with the supplier's recommendations, unless specified otherwise by the purchaser. ~~Conductor bending strain shall be monitored adjacent to the rigid clamp at the span end with the damper(s) and to both sides of the clamp of each damper. Two strain gauges shall be attached to the conductor at each of the three positions (or five in the case of two dampers); one each on the two uppermost strands and as close as practicable to, but not more than 2 mm from the last point of contact of the rigid clamp with strands and 5 mm from the last point of contact of the damper clamp with strands.~~ This test is not intended for spiral aeolian vibration dampers.

The test span shall be excited to achieve stable conductor motion at the frequencies for which resonance occurs within the range 0,18/*d* to 1,4/*d*, where *d* is the conductor diameter in meters, unless a narrower frequency range is agreed between the purchaser and the supplier. A ~~maximum of 20 tuneable~~ minimum of 15 tunable span resonances shall be tested; they shall be reasonably spaced over the frequency range indicated above. In frequency ranges at which the energy dissipation is the lowest, each tunable harmonic should be tested.

~~NOTE 1~~ Guidance on the measurement of power dissipation of aeolian vibration dampers in laboratory tests is given in IEEE Std 664 [1]. It is recommended that the detailed procedures for setting up, for monitoring and for controlling the tests are developed with reference to ~~these recommendations~~ this document.

~~The excitation shall be adjusted at each tuneable frequency f_j until the highest of the strain readings corresponds to 150 microstrain (single peak).~~

~~NOTE 2 – The value of 150 microstrains (single peak) is only for test purposes and it is not directly related to life expectancy.~~

~~At each of these test frequencies the following shall be recorded:~~

~~a) frequency f_j;~~

~~b) conductor bending strains;~~

~~c) power input P_j from the shaker determined either from the exciting force F (peak value) and conductor velocity V (peak value) at the point of the application of the force: ($P_j = 0,5 \times F \times V \times \cos\varnothing$, where $\varnothing$ is the phase angle between F and V) or from the standing wave node and antinode amplitudes in accordance with IEEE 664;~~

~~d) the conductor antinode peak-to-peak amplitude Y_j in one of the loops near the damper.~~

The excitation shall be adjusted at each tunable frequency f_j to achieve:

0,2 m/s (0-p) antinode loop velocity V

At each of these test frequencies the following shall be recorded:

- Frequency f_j;
- Power dissipated by the damper P_j shall be determined by either:

  a) from the shaker determined either from the exciting force F (0-p) and conductor velocity V (0-p) at the point of the application of the force ($P_j = \frac{1}{2} F\, V \cos\varphi_v$, where φ_v is the phase angle between F and V). If Power method is used a correction for end losses and conductor self-damping should be made in accordance with IEEE Std 664 [1] and IEC 62567;

b) or from the standing wave node and antinode amplitudes in accordance with IEEE 664 [1]

– The conductor antinode peak-to-peak amplitude Y_j in one of the loops near the damper.

– Conductor self-damping may be added into the calculation, for span protected by the damper, by the following formulae:

$$P_t = P_j + P_c$$

where

P_t is the power dissipated by the damper and conductor;

P_j is the power dissipated by the damper;

P_c is the power dissipated by the conductor at the maximum protectable conductor span length. Refer to IEC 62567.

- Acceptance criteria

For each test frequency the power ~~input P_j~~ dissipated P_t during the test shall exceed the assumed wind power input $P_{w,j}$ which shall be calculated from the formula:

$$P_{w,j} = L\, d^4 f_j^3 fnc\left(\frac{Y_j}{d}\right)$$

where

L is the maximum protectable conductor span length for the damper arrangement under test as agreed between the purchaser and the supplier (m);

d is the conductor diameter (m);

f_j is the frequency (Hz);

Y_j is the conductor antinode peak-to-peak amplitude (m);

$fnc\left(\frac{Y_j}{d}\right)$ is the wind power input function as given in Annex C, unless otherwise agreed between the purchaser and the supplier.

The measured power dissipation values, if agreed between purchaser and supplier, shall then be corrected by adding the amount of conductor self-damping corresponding to the difference in length between the in-service span and the test span. Correction for the conductor self-damping and the power dissipation at the span termination should be evaluated with reference to IEC 62567.

NOTE ~~3~~ The total power dissipation measured in this test represents the sum of the power dissipation of the damper, the mechanical self-damping of the length of conductor under test and the power dissipation at the span termination. The in-service span lengths will typically be much higher than the length of conductor under test. Therefore, the measured dissipation will be smaller than the dissipation in the in-service spans vibrating with the same antinode amplitude as the test span. For high frequencies, the conductor self-damping in the in-service span will contribute significantly to the total dissipation. ~~The measured power dissipation values, if agreed between purchaser and supplier, shall then be corrected by adding the amount of conductor self-damping corresponding to the difference in length between the in-service and the test span. Correction for the conductor self-damping and the power dissipation at the span termination should be evaluated as reported in IEEE 563 [6].~~

7.11.3.3 Field test

The field test shall be carried out on at least two spans of different lengths. The test spans shall be selected between supports with suspension sets and shall be approximately level. The purchaser shall specify or agree upon: the test duration, the measurements to be made (bending amplitude or strain at the suspension clamp, wind velocity and direction, turbulence, etc.), the instrumentation and transducers to be used and the way to follow for processing and presenting the experimental data.

The specified field tests duration shall be extended if, during the test period, the occurrence of wind perpendicular to the test spans with velocities in the range 0,5 m/s to 10 m/s, is deemed to have been insufficient.

- Acceptance criteria:

The acceptance criteria shall take into consideration the measured bending amplitudes or strains on the conductor. They shall be agreed between the purchaser and the supplier making reference to IEEE WPM, 31TP 65-156 [2], CIGRE, SC22 WG04 [3] , CIGRE, SC22 WG11-TF2 [4] , IEEE Std 1368 [5] or to equivalent publications.

7.11.3.4 Analytical method

The damper effectiveness shall be determined by means of computer programs based on mathematical modelling.

~~NOTE~~ Sufficient evidence should be provided to demonstrate that the analytical method being used has been validated against laboratory results or field test results.

The purchaser shall provide the following information where available:

– the length(s) of the span(s) to be considered;

– the characteristics of the conductor: type, stranding, mass per unit length, RTS;

– the tensile load of the conductors, the relevant temperature and ruling span;

– the conductor self-damping;

– the type of suspension clamp (conventional, AGS, etc.);

– the characteristics of armor rods, if applied;

– the terrain characteristics (flat, coastal area, suburban area, etc.);

– the yearly distribution of the average wind velocity (average value for 10 min);

– the characteristics of devices (for example warning spheres) attached to the conductor and their in-span distribution.

- Acceptance criteria:

~~See 7.11.3.3.~~

The acceptance criteria shall take into consideration the calculated bending amplitudes or strain on the conductor. They shall be agreed between the purchaser and the supplier making reference to IEEE WPM, 31TP 65-156 [2], CIGRE, SC22 WG04 [3], CIGRE, SC22 WG11-TF2 [4], IEEE Std 1368 [5] or to equivalent publications.

7.12 Damper fatigue test

7.12.1 Test methods

Two alternative methods can be applied for the fatigue test:

– Swept frequency method

– Resonant frequency method

Whereas the first method requires sweeping frequency and 100 million (10^8) cycles, the second method excites vibration at ~~a~~ each resonant frequency of the damper and accumulates 10 million (10^7) cycles. The method to be applied shall be agreed between the purchaser and the supplier.

The agreed method shall be carried out on each of three dampers which have first been subjected to the damper characteristic test (7.11.2). Each damper shall be attached via its clamp to a shaker controlled by a sinusoidal oscillator the output of which is variable in frequency and amplitude. The attachment shall be by means of a bar or tube having practically the same diameter as the conductor for which the damper is being installed. The clamp fastener shall be tightened on the bar or tube to the specified installation torque.

7.12.2 Swept frequency method

A frequency range of at least 0,18/*d* to 1,4/*d* – where *d* is conductor diameter in metres – shall be covered unless a narrower frequency range is agreed between the purchaser and the supplier. Any automatic sweep rate not exceeding 0,2 decade/min in the case of logarithmic sweep and 0,5 Hz/s in the case of linear sweep may be used. The clamp velocity shall be held constant at 0,1 m/s (~~single peak~~ 0-p). The damper shall be vibrated for 100 million (10^8) cycles unless otherwise agreed between the purchaser and the supplier.

NOTE Some difficulties may arise during the test for frequencies below 5 Hz because the oscillations of the shaker may not be truly sinusoidal.

7.12.3 Resonant frequency method

~~The test frequency shall be controlled so that it continuously corresponds to within ±0,5 Hz of the highest resonant frequency of the damper (which may change during the test). The vibration amplitude of the shaker (single peak) shall be 0,5 mm and the damper shall be driven for 10 million (10^7) cycles unless a different amplitude and number of cycles are agreed between the purchaser and the supplier.~~

~~NOTE For this test it is of special significance to carry out the long-term vibration loading at the point of resonance. If required by the purchaser, the test frequency may be recorded in a diagram as a function of the load cycles.~~

Conduct fatigue tests at 0,075 m/s (0-p) clamp velocity, at each resonant frequency of the damper, for a duration of 5 million cycles if a 2-response damper, and 2,5 million cycles if a 4-response damper, shall be performed.

7.12.4 Acceptance criteria

The tests specified in 7.11.2.1, 7.8 and 7.9 shall be repeated after the termination of the fatigue test.

The dampers ~~shall~~ will pass the test if

– for each individual damper the corresponding resonant frequencies before and after the test do not differ from each other by more than ±20 %;
– values of damping power before and after test at the individual resonant frequencies do not differ by more than ±20 %;
– examination of the dampers shows that all strands of the messenger cable are unbroken;
– the acceptance criteria of 7.8 and 7.9 are met;
– the residual tightening torque of the clamp fastener is not less than 50 % of the original value (i.e. half of the specified installation torque).

NOTE The residual tightening torque (RTT) should be measured by means of a torque wrench which is applied to the bolt and operated in the tightening direction. The RTT value is read on the torque meter when the bolt begins to move.

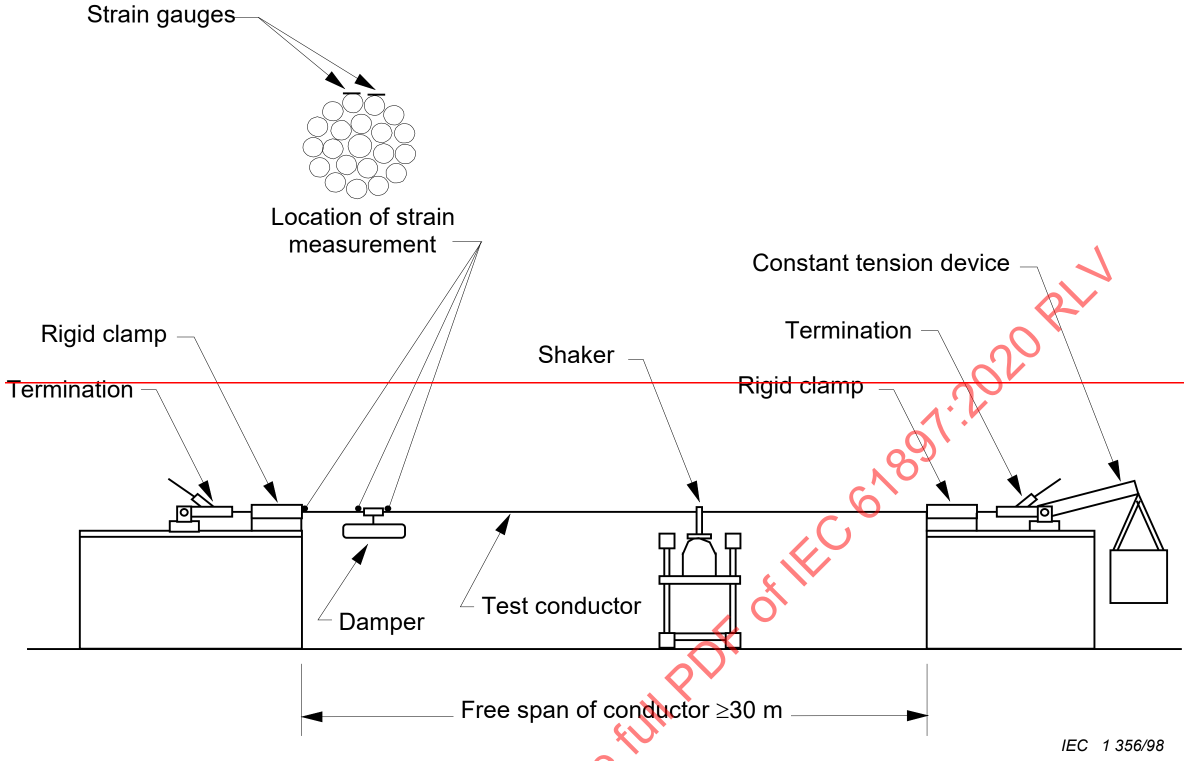


Figure 1 – Test rig for laboratory test of damper effectiveness (see 7.11.3.2)

7.12.5 Fatigue test method – for spiral aeolian vibration dampers (SVD)

Fatigue test for spiral damper shall be conducted on a test span. For this test, one damper should be installed, according to the supplier's recommendation, on the appropriate conductor. The test span length should be a minimum of 20 m at a tension of 20 % RTS. The end terminations can be standard fittings such as compression, bolted or helical fittings. The termination is allowed to articulate. After the installation of the damper, the conductor is vibrated at a resonant frequency between 0,4/*d* and 1,4/*d* where *d* is the conductor diameter in metres. The excitation velocity should be 0,075 m/s (0-p) antinode loop velocity for 10 million (10^7) cycles.

- Acceptance criteria

No failure of the damper at the completion of the test. Minor wear up to 15 % material thickness of the damper is acceptable. No damage of the conductor is acceptable.

Annex A
(normative)

Minimum technical details to be agreed between purchaser and supplier

Reference subclause		Test option		Details to be agreed
6.2.3	Sampling, acceptance criteria	☐ Inspection by variables		Inspection level, AQL, sampling instruction
		☐ Inspection by attributes		Inspection level, AQL, sampling instruction
7.5	Clamp slip test			Tolerance if breakaway bolts are used
7.6	Breakaway bolt test			Tolerance
7.7	Clamp bolt tightening test			Tolerance if breakaway bolts are used
7.10	Corona and radio interference voltage (RIV) tests	☐ Voltage method		Specified corona extinction voltage
	NOTE Not applicable for earth wire dampers	☐ Voltage gradient method		Specified corona extinction test voltage gradient
7.11	Damper performance tests	☐ Variant A		Limits of damper characteristics
		☐ Variant B	☐ Laboratory test	Conductor tension + others (see 7.11.3.2)
			☐ Field test	Conductor tension + others (see 7.11.3.3)
			☐ Analytical meth.	Conductor tension + others (see 7.11.3.4)
7.12	Damper fatigue test	☐ Swept frequency method ☐ Resonant frequency method		

Annex B
(informative)

Examples of graphs relevant to damper characteristic test

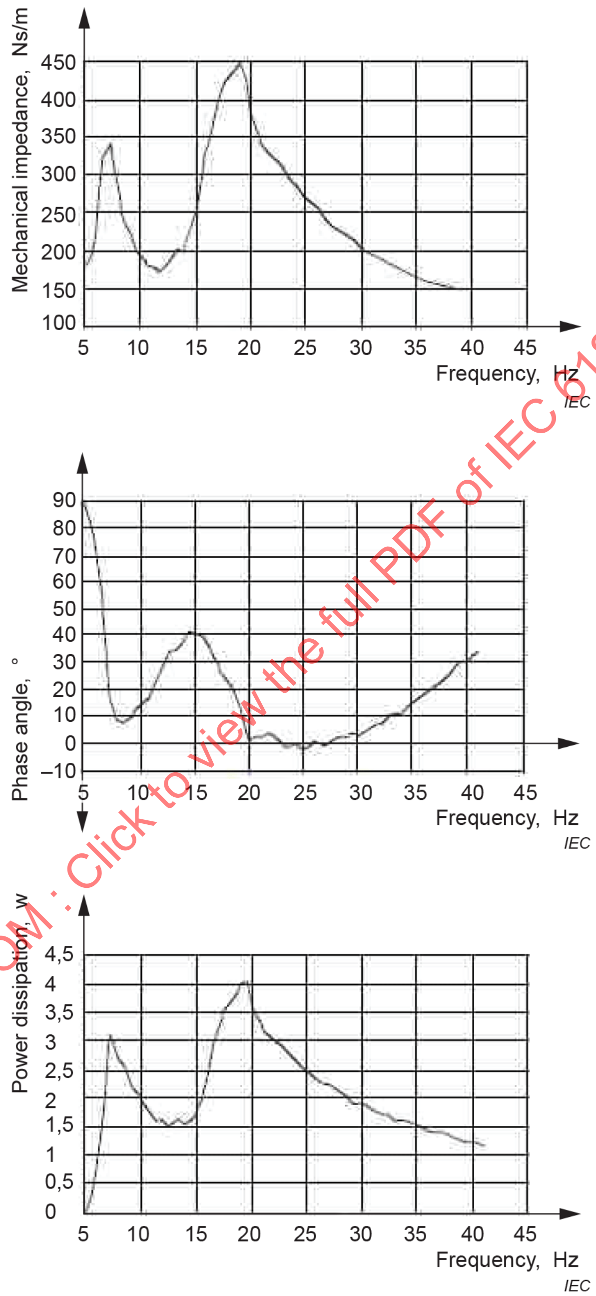
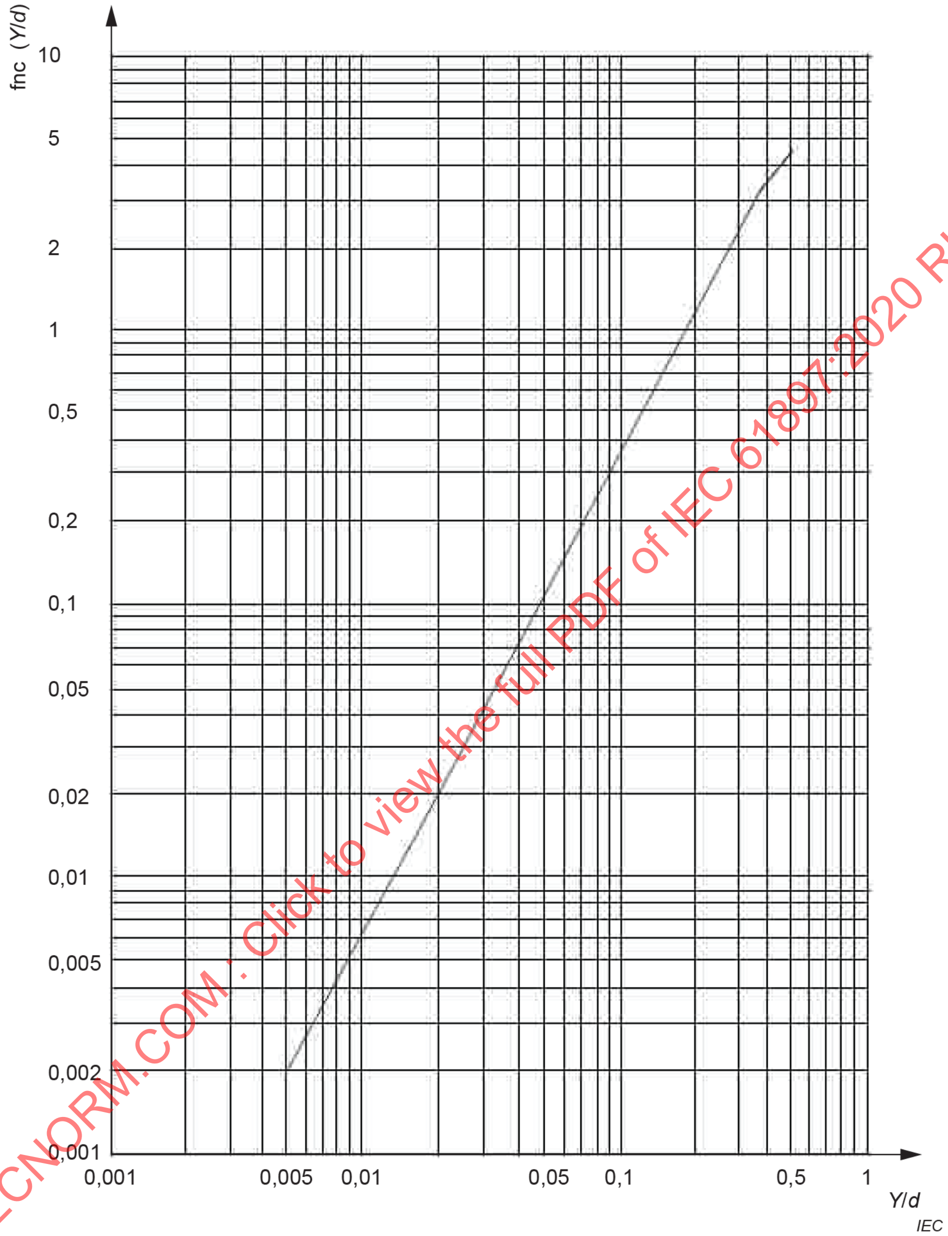


Figure B.1 – Examples of graphs relevant to damper characteristic test (damper with two resonant frequencies)

Annex C
(normative)

Wind power input curve



Key

Y is the conductor antinode amplitude peak-to-peak (m)

d is the conductor diameter (m)

Figure C.1 – Wind power input curve

In order to minimize errors in reading off values of $fnc\left(\frac{Y_j}{d}\right)$ from Figure C.1 the following formula shall be used:

$$fnc\left(\frac{Y_j}{d}\right) = 10^z$$

where

$$z = \sum_{n=0}^{8} a_n X^n$$

and

$$X = \lg\left(\frac{Y}{d}\right)$$

a_0 = – 0,491949

a_1 = – 11,8029

a_2 = – 43,5532

a_3 = – 78,5876

a_4 = – 86,1199

a_5 = – 58,1808

a_6 = – 23,6082

a_7 = – 5,26705

a_8 = – 0,495885

Annex D
(informative)

Description of HT conductors as given in CIGRE TB 695-2017 [6]

Type 0

Conductors designed for a maximum continuous operating temperature of 95 °C.

Type 1

Conductors consisting of a strength member made of steel, coated steel, or steel alloy, and an envelope for which the high temperature effects are mitigated by means of thermal-resistant aluminium alloys.

Type 2

Conductors consisting of a strength member made of steel, coated steel, or steel alloy, and an envelope for which the high temperature effects are mitigated by means of annealed aluminium.

Type 3

Conductors consisting of a metal-matrix composite (MMC) strength member, and an envelope for which the high temperature effects are mitigated by means of thermal-resistant aluminium alloys.

Type 4

Conductors consisting of a polymer-matrix composite (PMC) strength member, and an envelope for which the high temperature effects are mitigated by means of annealed aluminium or thermal-resistant aluminium alloys for HTLS applications.

Bibliography

~~[1] ISO 9000-1:1994, *Quality management and quality assurance standards – Part 1: Guidelines for selection and use*~~

~~[2] ISO 9001:1994, *Quality systems – Model for quality assurance in design, development, production, installation and servicing*~~

~~[3] ISO 9002:1994, *Quality systems – Model for quality assurance in production, installation and servicing*~~

~~[4] ISO 9003:1994, *Quality systems – Model for quality assurance in final inspection and test*~~

~~[5] ISO 9004-1:1994, *Quality management and quality system elements – Part 1: Guidelines*~~

~~[6] IEEE Std 563:1978, *IEEE Guide on Conductor Self-Damping Measurements*~~

[1] IEEE Std 664:1993, *IEEE Guide for Laboratory Measurement of the Power Dissipation Characteristics of Aeolian Vibration Dampers for Single Conductors*

[2] IEEE Committee report, *Standardization of conductor vibration measurements*; IEEE WPM 1965; 31 TP 65-156

[3] CIGRE SC22 WG04, *Recommendations for the evaluation of the lifetime of transmission line conductors; Electra 63, March 1979*

[4] CIGRE SC22 WG11-TF2, *Guide to vibration measurements on overhead lines; Electra 163, Dec 1995*

[5] IEEE Std 1368:2007, *IEEE Guide for Aeolian Vibration Field Measurements of Overhead Conductors*

[6] CIGRE SCB2 WG 48, *Experience with the mechanical performance of non-conventional conductors – Technical Brochure 695, August 2017*

IEC 61897

Edition 2.0 2020-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Overhead lines – Requirements and tests for aeolian vibration dampers

Lignes aériennes – Exigences et essais applicables aux amortisseurs de vibrations éoliennes

IEC 61897:2020-03(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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OVERHEAD LINES –
REQUIREMENTS AND TESTS FOR AEOLIAN VIBRATION DAMPERS

FOREWORD

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International Standard IEC 61897 has been prepared by Technical Committee 11: Overhead lines.

This second edition cancels and replaces the first edition published in 1998. This edition constitutes a technical revision.

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

a) Consider, in addition to Stockbridge type aeolian vibration dampers, also spiral aeolian vibration dampers and elastomeric aeolian vibration dampers.
b) Consider the application of dampers on high temperature conductors, specifying additional high temperature tests in clamp slip tests.
c) Simplify the procedure of the damper effectiveness evaluation.
d) Introduce test at low temperature on fastener components such as break away bolts and conical spring washers.
e) Include figures showing the test arrangements for the main mechanical tests.

The text of this standard is based on the following documents:

FDIS	Report on voting
11/266/FDIS	11/273/RVD

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

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended

OVERHEAD LINES –
REQUIREMENTS AND TESTS FOR AEOLIAN VIBRATION DAMPERS

1 Scope

This document applies to aeolian vibration dampers intended for single conductors or earth wires or conductor bundles where dampers are directly attached to each subconductor.

The purchaser may adopt part(s) of this document when specifying requirements for cables different from those mentioned above (e.g. optical ground wires (OPGW), all dielectric self-supporting optical cables (ADSS)).

In some cases, test procedures and test values are left to agreement between the purchaser and the supplier and are stated in the procurement contract.

Annex A lists the minimum technical details to be agreed between purchaser and supplier.

Throughout this document, the word "conductor" is used when the test applies to dampers for conductors or earth wires.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(466):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 466: Overhead lines*

IEC 60888:1987, *Zinc-coated steel wires for stranded conductors*

IEC 61284:1997, *Overhead lines – Requirements and tests for fittings*

IEC 61854, *Overhead lines – Requirements and tests for spacers*

IEC 62567:2013, *Overhead lines – Methods for testing self-damping characteristics of conductors*

ISO 1461:2009, *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

ISO 2859-1:1999/AMD1:2011, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptable quality limit (AQL) for lot-by-lot inspection*

ISO 2859-2:1985, *Sampling procedures for inspection by attributes – Part 2: Sampling plans indexed by limiting quality level (LQ) for isolated lot inspection*

ISO 3951-1:2013, *Sampling procedures for inspection by variables – Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL*

ISO 3951-2:2013, *Sampling procedures for inspection by variables – Part 2: General specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection of independent quality characteristics*

ISO 9001:2015, *Quality management systems – Requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-466 apply, as well as the following.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
stockbridge-type aeolian vibration damper
device comprising a steel cable with a weight at each end and one bolted clamp or a helical rod attachment, attachable to a conductor, for the purpose of damping aeolian vibration

3.2
spiral aeolian vibration damper
SVD
device made of helical plastic which wraps around the conductor for purposes of damping aeolian vibration (these are commonly used on earth wires, OPGW and ADSS cables)

3.3
elastomeric aeolian vibration damper
device comprising suspended weights connected to elastomeric articulations and one bolted clamp or a helical rod attachment, attachable to a conductor for the purpose of damping aeolian vibration

3.4
high temperature conductors
HTC
conductors which are designed to have a maximum continuous operating temperature over 95 °C

3.5
maximum continuous operating temperature
conductor temperature specified by the manufacturer and measured at the outer wire layers

4 General requirements

4.1 Design

The damper shall be designed so as to

– damp aeolian vibration;
– withstand mechanical loads imposed during installation, maintenance and specified service conditions;
– avoid damage to the conductor under specified service conditions;
– be capable of being removed and re-installed without damage to the conductor;

– be free from unacceptable levels of corona and radio interference under all service conditions, when installed on phase conductors;
– be suitable for safe and easy installation. The clamp design shall retain all parts when opened for attachment to conductor. Furthermore, the clamp design shall be such that the damper, during installation, can be suspended on the conductor before tightening the clamp;
– ensure that individual components will not become loose in service;
– maintain its function over the entire service temperature range;
– avoid audible noise;
– prevent water collection.

Other desirable characteristics which are not essential to the basic functions of the damper but which may be advantageous include:

– verification of proper installation from the ground;
– easy installation and removal from energized lines.

In the case of vibration dampers for conductors or earth wires containing integral fibre optic elements (or an externally applied optical cable wrapped around the earth wire) the possible effects of the damper on these fibre optic elements should be accounted for.

4.2 Materials

The materials shall conform to the requirements of IEC 61284.

4.3 Mass, dimensions and tolerances

Damper mass and significant dimensions, including appropriate tolerances, shall be shown on contract drawings.

4.4 Protection against corrosion

In addition to the applicable requirements of IEC 61284, the messenger cable (including cut ends when exposed) shall be protected against corrosion, e.g. in accordance with IEC 60888 for hot dip galvanized steel wire.

4.5 Manufacturing appearance and finish

The dampers shall be free of defects and irregularities; they shall have all outside surfaces smooth and all edges and corners well-rounded.

4.6 Marking

The fitting marking requirements of IEC 61284 shall be applied to all clamp assemblies including those using breakaway bolts. On spiral dampers, the markings should be on the plastic rod.

4.7 Installation instructions

The supplier shall provide a clear and complete description of the recommended installation procedure including in-span positions.

5 Quality assurance

A quality assurance programme taking into account the requirements of this document can be used by agreement between the purchaser and the supplier to verify the quality of the vibration dampers during the manufacturing process.

Detailed information on the use of quality assurance is given in a system as per ISO 9001 or similar.

It is recommended that test equipment used to verify compliance to this document is routinely maintained and calibrated in accordance with a relevant quality standard.

6 Classification of tests

6.1 Type tests

6.1.1 General

Type tests are intended to establish design characteristics. They are normally made once and repeated only when the design or the material of the damper components is changed. The results of type tests are recorded as evidence of compliance with design requirements.

6.1.2 Application

Dampers shall be subjected to type tests as per Table 1.

Unless otherwise specified, each type test shall be performed on three test samples which are identical in all essential respects with dampers to be supplied under contract to the purchaser.

All units shall pass the tests.

The dampers used for tests during which no damage occurs to the units or their components may be used in subsequent tests.

6.2 Sample tests

6.2.1 General

Sample tests are required to verify that the dampers meet the performance specifications of the type test samples. In addition, they are intended to verify the quality of material and workmanship.

6.2.2 Application

Dampers shall be subjected to sample tests as per Table 1.

The samples to be tested shall be selected at random from the lot offered for acceptance. The purchaser has the right to make the selection.

The dampers used for tests during which no damage occurs to the units or their components may be used in subsequent tests.

6.2.3 Sampling, acceptance criteria

The sampling plan procedures according to ISO 2859-1 and ISO 2859-2 (inspection by attributes) and ISO 3951 (inspection by variables) and the detailed procedures (inspection level, AQL, single, double or multiple sampling, etc.) shall be agreed between the purchaser and the supplier for each different attribute or variable.

NOTE Sampling inspection by variables is an acceptance sampling procedure to be used in place of inspection by attributes when it is appropriate to measure on some continuous scale the characteristic(s) under consideration. In the case of failure load tests and similar expensive tests, better distinction between acceptable quality and objective quality is available with acceptance sampling by variables than by attributes for the same sample size.

The purpose of the sampling process may also be important in the choice between a variables or attributes plan. For example, a purchaser may choose to use an attributes acceptance sampling plan to assure that parts in a shipment lot are within a required dimensional tolerance; the manufacturer may make measurements under a variables sampling plan of the same dimensions because he is concerned with gradual trends or changes which may affect his ability to provide shipment lots which meet the AQL.

6.3 Routine tests

6.3.1 General

Routine tests are intended to prove conformance of vibration dampers to specific requirements and are made on every damper. The tests shall not damage the dampers.

6.3.2 Application and acceptance criteria

Whole lots of dampers may be subjected to routine tests. Any damper which does not conform to the requirements shall be discarded.

6.4 Table of tests to be applied

The following Table 1 indicates the tests which shall be performed. These are marked with an "X" in the table.

However, the purchaser may specify additional tests which are included in the table and marked with an "O".

Units or components damaged during the test shall be excluded from the delivery to the customer.

Table 1 – Tests on dampers

Subclause	Test	Type test	Sample test	Routine test
7.1	Visual examination	X	X	O
7.2	Verification of dimensions, materials and mass	X	X	
7.3	Corrosion protection tests	X	X	
7.4	Non-destructive tests	O	O	O
7.5	Clamp slip test	X	O	
7.6	Breakaway bolt test	X	X	
7.7	Clamp bolt tightening test	X	X	
7.8	Attachment of weights to messenger cable	X	X	
7.9	Attachment of clamp to messenger cable test	X	X	
7.10	Corona and radio interference voltage (RIV) tests[1)]	X		
7.11	Damper performance tests			
7.11.2	– Damper characteristic test	X	O	
7.11.3	– Damper effectiveness evaluation	X		
7.12	Damper fatigue test	X		

[1)] Not applicable for earth wire dampers.

- The supplier should state in the tender quality plan, or other tender documentation, which testing is already complete (i.e. which type tests) and which tests (sample or routine) are included in the tender, subject to the approval or change required by the purchaser.
- If conical washers are used on bolted clamps, embrittlement tests shall be performed in accordance with clause 7.5.2.2 of IEC 61854:2019.

7 Test methods

7.1 Visual examination

Type tests shall include visual examination to ascertain conformity of the dampers in all essential respects, with the manufacturing or contract drawings. Deviations from the drawings shall be subject to the approval of the purchaser and shall be appropriately documented as an agreed concession.

Sample tests and, if required, routine tests shall include visual examination to ensure conformity of manufacturing process, shape, coating and surface finish of the damper with the contract drawings. Particular attention shall be given to markings required and to the finish of surfaces which come into contact with the conductor. The sample test procedure and acceptance criteria shall be agreed between the purchaser and the supplier.

For dampers subjected to corona type test, the sample test shall include a comparison of shape and surface finish with one of the corona type test samples when specified by the purchaser.

7.2 Verification of dimensions, materials and mass

Type and sample tests shall include verification of dimensions to ensure that dampers are within the dimensional tolerances stated on contract drawings. The purchaser may choose to witness the measurement of selected dimensions or may inspect the supplier's documentation when this is available.

Type and sample tests shall also include verification of materials to ensure that they are in accordance with contract drawings and documents. This verification shall normally be carried out by the purchaser inspecting the supplier's documentation relating to material specifications, certificates of conformity or other quality documentation.

The total mass of the damper complete with all its components shall comply with the mass shown on the contract drawing (within given tolerances).

7.3 Corrosion protection tests

7.3.1 Hot dip galvanized components (other than messenger cable wires)

Hot dip galvanized components other than messenger cable wires shall be tested in accordance with the requirements specified in ISO 1461.

The coating thicknesses shall conform to Tables 3 and 4 of ISO 1461:2009, unless otherwise agreed between purchaser and supplier. However, for the purpose of this document, Tables 3 and 4 in ISO 1461:2009 shall apply to the following categories of items (and not to the categories specified in ISO 1461).

Table 3: Coating thickness on all samples except

- washers;
- threaded components;
- small parts which are centrifuged (significant surface area <1 000 mm^2).

Table 4: Coating thickness on

- washers;
- threaded components;
- small parts which are centrifuged (significant surface area <1 000 mm^2).

7.3.2 Ferrous components protected from corrosion by methods other than hot dip galvanizing

Ferrous components protected from corrosion by methods other than hot dip galvanizing shall be tested in accordance with the requirements of relevant IEC/ISO standards agreed between purchaser and supplier.

7.3.3 Hot dip galvanized messenger cable wires

Hot dip galvanized messenger cable wires shall be tested in accordance with the requirements specified in IEC 60888.

7.4 Non-destructive tests

The purchaser shall specify or agree to relevant test methods (ISO or other) and acceptance criteria. Examples of non-destructive tests are as follows:

– magnetic test;
– eddy current test;
– radiographic test;
– ultrasonic test;
– proof load test;
– dye penetrant test;
– hardness test.

7.5 Clamp slip test

The test shall be performed using the conductor for which the clamp is intended. The conductor shall be "as new", i.e. free of any deterioration or damage. The minimum free length of test conductor between its terminating fittings shall be 4 m. The conductor shall be tensioned to 20 % of its rated tensile strength. Precautions shall be taken to avoid birdcaging of the conductor.

The clamp shall be installed in accordance with the supplier's instructions on a different portion of conductor for each test. In the case of breakaway bolts, the installation torque shall be the nominal breakaway torque minus the specified tolerance (see 7.6).

The use of other conductors, or conductor lengths or tensions may be agreed between purchaser and supplier.

By means of a suitable device a load coaxial to the conductor shall be applied to the damper clamp, as indicated in Figure 1. The load shall be gradually increased (not faster than 100 N/s) until it reaches the load given in Table 2 or the load agreed between purchaser and supplier. This load shall be kept constant for 60 s. Then the load shall be gradually increased until slippage of the clamp occurs. The value of slip load shall be recorded.

For the slip test conducted on High Temperature Conductors (HTC) using Stockbridge and elastomeric dampers only, the parameters are the same as for standard conductors. After installing the clamp at ambient temperature, the conductor shall be electrically heated up to the maximum continuous operating temperature as specified by the conductor manufacturer and kept constant at this temperature for 0,5 h. The conductor tension load shall be kept constant at 20 % RTS. Then the slip test shall be performed at maximum continuous operating temperature as described above.

For the type test, an additional thermal process of the conductor shall be performed.

A new clamp shall be fixed at ambient temperature on the conductor which is tensioned to 20 % of RTS. It is permitted to fix several clamps on the same setup to reduce expenditure of time. The distance between the clamps shall be at least 300 mm.

Then the conductor shall be electrically heated up to the maximum continuous operating temperature as specified by the conductor manufacturer and kept constant at this temperature for 1h.

Afterwards the temperature shall decrease to at least ambient temperature plus 5 °C. These cycles shall be carried out four times. At the end of the fourth cycle, after decreasing the temperature to ambient values the slip load test shall be performed. For the complete test run the tension shall be kept constant at 20 % of rated tensile strength.

Clamp slip shall be considered as having occurred when a slip distance of 1 mm for bolted clamps and 2,5 mm for helical attachments is measured.

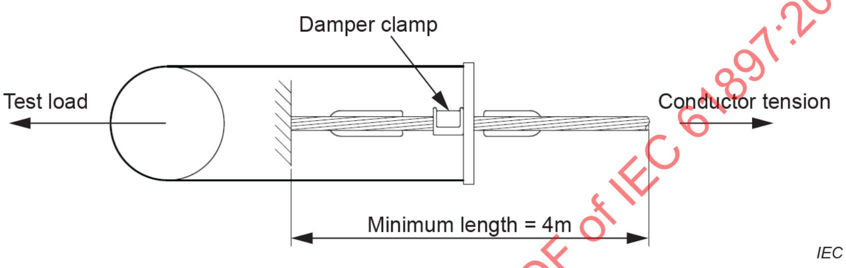


Figure 1 – Test arrangement for longitudinal slip tests

Table 2 – Load criteria (for standard and high temperature conductors)

Damper	Conductor diameter	Attachment	Specified minimum load/Maximum slip	
			Load kN	Movement mm
Stockbridge or Elastomeric	< 19 mm	Bolted	1,25	1,0
Stockbridge or Elastomeric	≥ 19 mm	Bolted	2,5	1,0
Stockbridge or Elastomeric	All	Helical	1,0	2,5
Spiral damper[1]	All	Helical	0,1	2,5

[1] Only for standard conductors.

Acceptance criteria

No movement of the clamp relative to the conductor greater than shown in Table 2 shall occur at or before the end of the specified minimum load for 60 s. Surface flattening of the outer strands of the conductor is acceptable. If armor rods are used under the clamp, slippage of the armor rods relative to the conductor is considered as clamp slippage.

7.6 Breakaway bolt test

The breakaway bolt or breakaway cap, if used, shall be tested by applying increasing torque to the breakaway portion of the bolt or the cap until it breaks away. The test shall be carried out at ambient temperature.

Precaution shall be taken on a constant continuous circular motion of the torque wrench and a perpendicular angle between torque wrench and bolt head.

The breakaway torque shall be recorded.

- Acceptance criteria:

The breakaway torque shall be within the tolerance specified by the supplier.

If no tolerance is specified, the range shall be nominal installation torque plus/minus 10 %.

For countries where ambient temperature below 0 °C can be expected, it is recommended to repeat the tests on breakaway bolts and breakaway caps at the temperature corresponding to the average temperature of the coldest month.

The specimens shall be kept for at least 1 h in an appropriate cooling device prior the test. During the break away test the temperature should be measured and recorded. The temperature during the test shall not increase more than 10 °C from initial cooling temperature.

7.7 Clamp bolt tightening test

The test shall be performed by installing the clamp on a length of the conductor for which the damper is intended. In case not available, an equivalent conductor or a tube of same diameter can be used. If the damper is to be used for two or more sizes or types of conductor, then the clamp shall be tested on each conductor unless the purchaser agrees to test on one conductor only.

The bolts or nuts shall be tightened to a torque 10 % above the specified installation torque with a calibrated torque wrench. Clamps with breakaway bolts or breakaway caps shall have the breakaway portion of the head removed prior to the test and shall be tightened 10 % above the specified installation torque.

- Acceptance criteria

The threaded connection shall remain serviceable (by hand) for three subsequent installations and removals and all components of the clamp shall be without any mechanical deformation or cracks. No plastic deformation shall occur to the conductor inside the clamp.

Lastly, the torque shall be increased to either twice the specified installation value or the maximum torque value recommended by the bolt supplier, whichever is lower. This increase shall not result in any breakage of threaded parts or other components of the clamp or any cracks. The bolt shall be able to be removed from the clamp without any failure.

Plastic deformation is permitted.

7.8 Attachment of weights to messenger cable test

On an assembled damper a tensile load shall be applied between the weights coaxial with the messenger cable, as indicated in Figure 2. The load shall be gradually increased (100 N/s maximum) until it reaches 5 kN (specified minimum slip load). This load shall be kept constant for 60 s.

The load shall then be increased slowly until one weight has been pulled free of the messenger cable. The maximum load obtained during this process shall be recorded, for information purposes only.

- Acceptance criteria

No relative movement greater than 1 mm between each weight and the messenger cable shall occur at or before the end of the application of 5 kN for 60 s.

It may be necessary to remove the load before measuring the distance between the weights, i.e. when the elastic stretch of the messenger cable results in an apparent movement of the weights along the messenger cable.

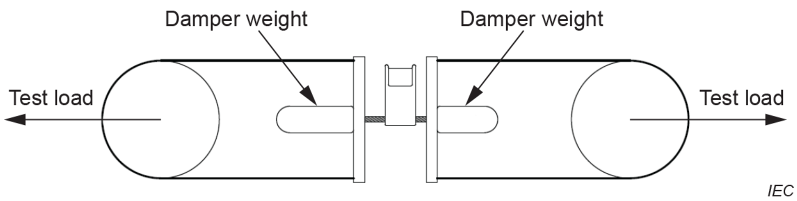


Figure 2 – Test arrangement for attachment of weights to messenger cable test

7.9 Attachment of clamp to messenger cable test

A tensile load shall be applied between the messenger cable and the clamp body, coaxial with the messenger cable, as indicated in Figure 3. The load shall be gradually increased (100 N/s maximum) until it reaches 1,5 kN (specified minimum slip load). This load shall be kept constant for 60 s.

The load shall then be increased slowly until the clamp has been pulled free of the messenger cable. The maximum load obtained during this process shall be recorded, for information purposes only.

- Acceptance criteria

No movement of the clamp relative to the messenger cable greater than 1 mm shall occur at or before the end of the application of 1,5 kN for 60 s.

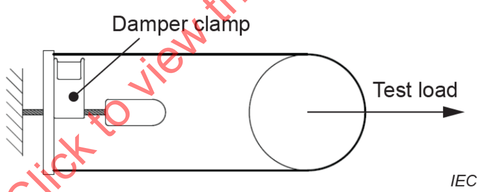


Figure 3 – Test arrangement for attachment of clamp to messenger cable test

7.10 Corona and radio interference voltage (RIV) tests

The tests shall be performed in accordance with Clause 14 of IEC 61284:1997.

7.11 Damper performance tests

7.11.1 Performance test variants

Two performance test variants are specified in conjunction with their respective acceptance criteria. The purchaser shall specify or agree to the variant to be applied.

a) Variant A

During type and sample tests, the damper characteristic test (see 7.11.2) is executed and the results are compared with the acceptance criteria and limits established by the purchaser.

This variant does not require the damping effectiveness evaluation (see 7.11.3) because this was taken into account when establishing the lower and upper limits.

b) Variant B

During type tests the damper characteristic test (see 7.11.2) is performed on three samples.

The damper effectiveness of the type test samples is then checked by one of the three methods described in 7.11.3 (damper effectiveness evaluation). If these three samples meet the acceptance criteria as per 7.11.3, their characteristics may be used as a reference for the future checking of the characteristics of the same damper type, e.g. in sample tests.

For sample testing, the damper characteristic test (see 7.11.2) shall be performed and the results compared with the characteristics obtained during "type tests" (see Table 3).

7.11.2 Damper characteristic test

7.11.2.1 Stockbridge or elastomeric dampers only

The damper shall be attached via its clamp to a shaker controlled by a sinusoidal oscillator, as shown in Figure 4, the output signal of which is variable in frequency and amplitude. A frequency range of 0,18/*d* to 1,4/*d* – where *d* is the conductor diameter in metres – shall be covered unless a narrower frequency range is agreed between the purchaser and the supplier. Any automatic sweep rate not exceeding 0,2 decade/min in the case of logarithmic sweep, and 0,5 Hz/s in the case of linear sweep, may be used. Alternatively, the frequency range may be covered step by step (maximum step intervals of 0,5 Hz below 10 Hz, 1 Hz between 10 Hz and 100 Hz and 2 Hz above 100 Hz) with stability of result being checked at each frequency. The clamp velocity shall be held constant at 0,1 m/s (0-p).

NOTE Some difficulties may arise during the test for frequencies below 5 Hz because the oscillations of the shaker may not be truly sinusoidal.

A logarithmic sweep rate of 0,2 decade/min means that after 1 min the frequency is $10^{0,2}$ times the initial frequency and 10 times the initial frequency after 5 min.

The results of the test shall be graphs of

- Damper impedance Z_v (ratio between force F and velocity V at the damper clamp);
- Phase angle φ_v between force F and velocity V at the damper clamp;
- Damper power dissipation $P_v = \frac{1}{2} F\, V \cos\varphi_v$;

against frequency.

OR

- Damper dynamic stiffness $\frac{F}{u}$ (ratio between force F and displacement u at the damper clamp);
- Phase angle φ_u between force F and displacement u at the damper clamp;
- Damper power dissipation $P_v = \pi f \frac{F}{u} u^2 \sin\varphi_u$ *where* f is frequency, F is the peak force, u is peak displacement;

against frequency.

Examples of graphs are illustrated in Annex B.

If specified by the purchaser, the test results can be presented in a different manner, provided that the above-mentioned characteristics can be derived from these results.

When variant B is used, from the last of the above graphs the frequencies f_i and power dissipation values P_i corresponding to the resonances of the damper shall be recorded. The following designations are used for convenience of reference in this standard:

f_i i[th] resonant frequency;

P_i power dissipated by the damper at f_i.

During type tests the following values shall be determined from the results from the tested dampers:

$f_{i\min}$ the lowest f_i value obtained for the dampers tested;

$f_{i\max}$ the highest f_i value obtained for the dampers tested;

$P_{i\min}$ the lowest P_i obtained for the dampers tested;

$P_{i\max}$ the highest P_i obtained for the dampers tested;

for all resonant frequencies of the dampers.

- Acceptance criteria

Table 3 – Acceptance criteria

	Variant A	Variant B
Type test	For all frequencies the phase angle φ_v and the damper power dissipation P_v shall stay between the lower and the upper limits required by the purchaser	No criterion since test results are only used as reference for sample tests
Sample test	For all frequencies the phase angle φ_v and the damper power dissipation P_v shall stay between the lower and the upper limits established by the purchaser	In sample tests the resonant frequencies f_i and the corresponding power values P_i shall be determined and compared with the values $f_{i\ \min}$, $f_{i\ \max}$, $P_{i\ \min}$ and $P_{i\ \max}$ obtained from the damper characteristic type test (see above). The damper shall meet the sample test requirement if, for each damper, the following applies: $0,8 f_{i\min} < f < 1,2 f_{i\max}$ $0,8 P_{i\min} < P < 1,2 P_{i\max}$ For all resonant frequencies

NOTE Guidance on the measurement of power dissipation of aeolian vibration dampers in laboratory tests is given in IEEE Std 664 [1] [1] which refers to the damper characteristic test as "forced response method" (see Clause 4 of IEEE Std 664:1993).

7.11.2.2 High Temperature Conductors (HTC) – Elastomeric dampers only

The damper shall be attached via its clamp to a piece of conductor or tube. After installing the damper at ambient temperature, the conductor/tube shall be electrically heated up to the maximum continuous operating temperature as specified by the conductor manufacturer and kept constant at this temperature for 0,5 h. Then the temperature shall decrease to ambient temperature. This cooling and heating shall be carried out for four cycles. Then the damper characteristic test shall be performed as described in 7.11.2.1. There shall be no change in damper performance more than 10 % between standard conductor test and the high temperature conductor test.

1 Numbers in square brackets refer to the Bibliography.

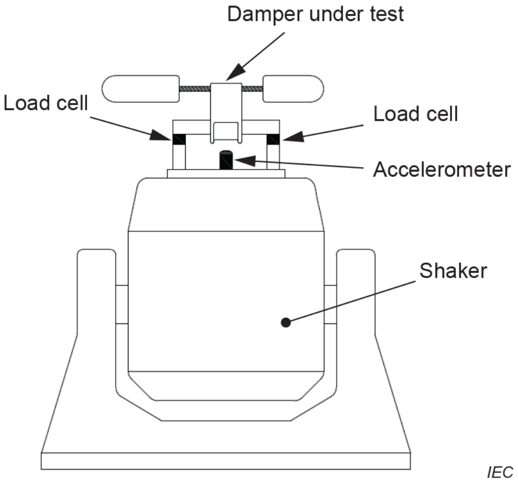


Figure 4 – Test arrangement for damper characteristic test

7.11.3 Damper effectiveness evaluation

7.11.3.1 Methods of evaluation

The evaluation of the effectiveness of dampers shall be carried out by means of one or more of the following methods:

– laboratory test;
– field test;
– analytical method.

The method(s) to be applied shall be agreed between the purchaser and the supplier.

7.11.3.2 Laboratory test

The test shall be performed using conductor(s) and tension(s) specified by the purchaser. Alternatively, the supplier may propose conductor(s) and tension(s) for the test, subject to acceptance by the purchaser. The minimum free span length shall be 30 m. The span shall be maintained at the specified tension for at least 24 h before starting the test.

A rigid clamp shall be installed to support rigidly (but not to tension) the conductor at both ends of the span and the damper and shaker shall be positioned as indicated in Figure 5. The shaker shall be installed in such a way that its connection to the conductor is located in the first loop for all frequencies to be employed.

An example of laboratory test span construction is shown in Figure 5.

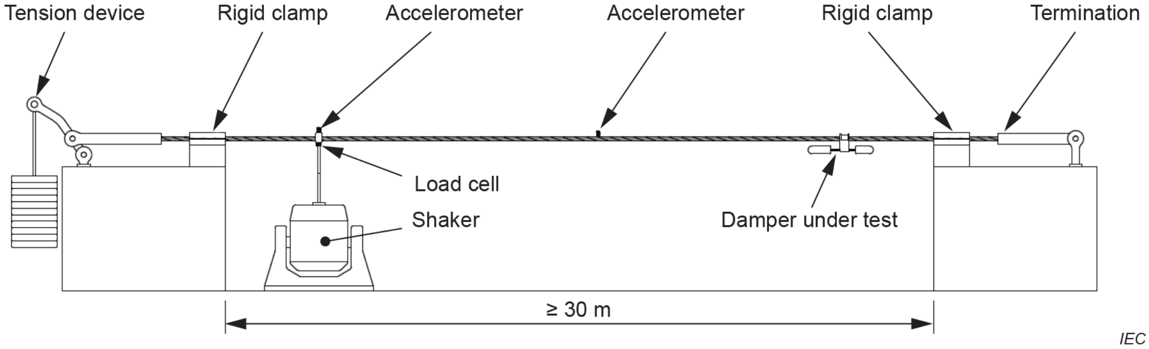


Figure 5 – Example of test rig for laboratory test of damper effectiveness

Although armor rods may be fitted around the conductor at suspension points in service, these are normally omitted in this test to determine the performance of the damper alone. If the purchaser wishes to include armor rods to simulate their actual line this is acceptable.

The damper or dampers shall be installed in accordance with the supplier's recommendations, unless specified otherwise by the purchaser. This test is not intended for spiral aeolian vibration dampers

The test span shall be excited to achieve stable conductor motion at the frequencies for which resonance occurs within the range 0,18/*d* to 1,4/*d*, where *d* is the conductor diameter in meters, unless a narrower frequency range is agreed between the purchaser and the supplier. A minimum of 15 tunable span resonances shall be tested; they shall be reasonably spaced over the frequency range indicated above. In frequency ranges at which the energy dissipation is the lowest, each tunable harmonic should be tested.

Guidance on the measurement of power dissipation of aeolian vibration dampers in laboratory tests is given in IEEE Std 664 [1]. It is recommended that the detailed procedures for setting up, for monitoring and for controlling the tests are developed with reference to this document.

The excitation shall be adjusted at each tunable frequency f_j to achieve:

0,2 m/s (0-p) antinode loop velocity V

At each of these test frequencies the following shall be recorded:

- Frequency f_j;
- Power dissipated by the damper P_j shall be determined by either:

  a) from the shaker determined either from the exciting force F (0-p) and conductor velocity V (0-p) at the point of the application of the force ($P_j = \frac{1}{2} F\, V \cos\varphi_v$, where φ_v is the phase angle between F and V). If Power method is used a correction for end losses and conductor self-damping should be made in accordance with IEEE Std 664 [1] and IEC 62567;

  b) or from the standing wave node and antinode amplitudes in accordance with IEEE 664 [1]

     – The conductor antinode peak-to-peak amplitude Y_j in one of the loops near the damper.

     – Conductor self-damping may be added into the calculation, for span protected by the damper, by the following formulae:

$$P_t = P_j + P_c$$

where

P_t is the power dissipated by the damper and conductor;

P_j is the power dissipated by the damper;

P_c is the power dissipated by the conductor at the maximum protectable conductor span length. Refer to IEC 62567.

- Acceptance criteria

For each test frequency the power dissipated P_t during the test shall exceed the assumed wind power input $P_{w,j}$ which shall be calculated from the formula:

$$P_{w,j} = L\,d^4 f_j^3\, fnc\left(\frac{Y_j}{d}\right)$$

where

L	is the maximum protectable conductor span length for the damper arrangement under test as agreed between the purchaser and the supplier (m);
d	is the conductor diameter (m);
f_j	is the frequency (Hz);
Y_j	is the conductor antinode peak-to-peak amplitude (m);
$fnc\left(\frac{Y_j}{d}\right)$	is the wind power input function as given in Annex C, unless otherwise agreed between the purchaser and the supplier.

The measured power dissipation values, if agreed between purchaser and supplier, shall then be corrected by adding the amount of conductor self-damping corresponding to the difference in length between the in-service span and the test span. Correction for the conductor self-damping and the power dissipation at the span termination should be evaluated with reference to IEC 62567.

NOTE The total power dissipation measured in this test represents the sum of the power dissipation of the damper, the mechanical self-damping of the length of conductor under test and the power dissipation at the span termination. The in-service span lengths will typically be much higher than the length of conductor under test. Therefore, the measured dissipation will be smaller than the dissipation in the in-service spans vibrating with the same antinode amplitude as the test span. For high frequencies, the conductor self-damping in the in-service span will contribute significantly to the total dissipation.

7.11.3.3 Field test

The field test shall be carried out on at least two spans of different lengths. The test spans shall be selected between supports with suspension sets and shall be approximately level. The purchaser shall specify or agree upon: the test duration, the measurements to be made (bending amplitude or strain at the suspension clamp, wind velocity and direction, turbulence, etc.), the instrumentation and transducers to be used and the way to follow for processing and presenting the experimental data.

The specified field tests duration shall be extended if, during the test period, the occurrence of wind perpendicular to the test spans with velocities in the range 0,5 m/s to 10 m/s, is deemed to have been insufficient.

- Acceptance criteria:

The acceptance criteria shall take into consideration the measured bending amplitudes or strains on the conductor. They shall be agreed between the purchaser and the supplier making reference to IEEE WPM, 31TP 65-156 [2], CIGRE, SC22 WG04 [3] , CIGRE, SC22 WG11-TF2 [4], IEEE Std 1368 [5] or to equivalent publications.

7.11.3.4 Analytical method

The damper effectiveness shall be determined by means of computer programs based on mathematical modelling.

Sufficient evidence should be provided to demonstrate that the analytical method being used has been validated against laboratory results or field test results.

The purchaser shall provide the following information where available:

– the length(s) of the span(s) to be considered;
– the characteristics of the conductor: type, stranding, mass per unit length, RTS;
– the tensile load of the conductors, the relevant temperature and ruling span;
– the conductor self-damping;
– the type of suspension clamp (conventional, AGS, etc.);
– the characteristics of armor rods, if applied;
– the terrain characteristics (flat, coastal area, suburban area, etc.);
– the yearly distribution of the average wind velocity (average value for 10 min);
– the characteristics of devices (for example warning spheres) attached to the conductor and their in-span distribution.

• Acceptance criteria:

The acceptance criteria shall take into consideration the calculated bending amplitudes or strain on the conductor. They shall be agreed between the purchaser and the supplier making reference to IEEE WPM, 31TP 65-156 [2], CIGRE, SC22 WG04 [3], CIGRE, SC22 WG11-TF2 [4], IEEE Std 1368 [5] or to equivalent publications.

7.12 Damper fatigue test

7.12.1 Test methods

Two alternative methods can be applied for the fatigue test:

– Swept frequency method
– Resonant frequency method

Whereas the first method requires sweeping frequency and 100 million (10^8) cycles, the second method excites vibration at each resonant frequency of the damper and accumulates 10 million (10^7) cycles. The method to be applied shall be agreed between the purchaser and the supplier.

The agreed method shall be carried out on each of three dampers which have first been subjected to the damper characteristic test (7.11.2). Each damper shall be attached via its clamp to a shaker controlled by a sinusoidal oscillator the output of which is variable in frequency and amplitude. The attachment shall be by means of a bar or tube having practically the same diameter as the conductor for which the damper is being installed. The clamp fastener shall be tightened on the bar or tube to the specified installation torque.

7.12.2 Swept frequency method

A frequency range of at least 0,18/d to 1,4/d – where d is conductor diameter in metres – shall be covered unless a narrower frequency range is agreed between the purchaser and the supplier. Any automatic sweep rate not exceeding 0,2 decade/min in the case of logarithmic sweep and 0,5 Hz/s in the case of linear sweep may be used. The clamp velocity shall be held constant at 0,1 m/s (0-p). The damper shall be vibrated for 100 million (10^8) cycles unless otherwise agreed between the purchaser and the supplier.

NOTE Some difficulties may arise during the test for frequencies below 5 Hz because the oscillations of the shaker may not be truly sinusoidal.

7.12.3 Resonant frequency method

Conduct fatigue tests at 0,075 m/s (0-p) clamp velocity, at each resonant frequency of the damper, for a duration of 5 million cycles if a 2-response damper, and 2,5 million cycles if a 4-response damper, shall be performed.

7.12.4 Acceptance criteria

The tests specified in 7.11.2.1, 7.8 and 7.9 shall be repeated after the termination of the fatigue test.

The dampers will pass the test if

- for each individual damper the corresponding resonant frequencies before and after the test do not differ from each other by more than ±20 %;
- values of damping power before and after test at the individual resonant frequencies do not differ by more than ±20 %;
- examination of the dampers shows that all strands of the messenger cable are unbroken;
- the acceptance criteria of 7.8 and 7.9 are met;
- the residual tightening torque of the clamp fastener is not less than 50 % of the original value (i.e. half of the specified installation torque).

The residual tightening torque (RTT) should be measured by means of a torque wrench which is applied to the bolt and operated in the tightening direction. The RTT value is read on the torque meter when the bolt begins to move.

7.12.5 Fatigue test method – for spiral aeolian vibration dampers (SVD)

Fatigue test for spiral damper shall be conducted on a test span. For this test, one damper should be installed, according to the supplier's recommendation, on the appropriate conductor. The test span length should be a minimum of 20 m at a tension of 20 % RTS. The end terminations can be standard fittings such as compression, bolted or helical fittings. The termination is allowed to articulate. After the installation of the damper, the conductor is vibrated at a resonant frequency between 0,4/*d* and 1,4/*d* where *d* is the conductor diameter in metres. The excitation velocity should be 0,075 m/s (0-p) antinode loop velocity for 10 million (10^7) cycles.

- Acceptance criteria

No failure of the damper at the completion of the test. Minor wear up to 15 % material thickness of the damper is acceptable. No damage of the conductor is acceptable.

Annex A
(normative)

Minimum technical details to be agreed between purchaser and supplier

Reference subclause	Test option	Details to be agreed
6.2.3 Sampling, acceptance criteria	☐ Inspection by variables	Inspection level, AQL, sampling instruction
	☐ Inspection by attributes	Inspection level, AQL, sampling instruction
7.5 Clamp slip test		Tolerance if breakaway bolts are used
7.6 Breakaway bolt test		Tolerance
7.7 Clamp bolt tightening test		Tolerance if breakaway bolts are used
7.10 Corona and radio interference voltage (RIV) tests	☐ Voltage method	Specified corona extinction voltage
NOTE Not applicable for earth wire dampers	☐ Voltage gradient method	Specified corona extinction test voltage gradient
7.11 Damper performance tests	☐ Variant A	Limits of damper characteristics
	☐ Variant B – ☐ Laboratory test	Conductor tension + others (see 7.11.3.2)
	☐ Variant B – ☐ Field test	Conductor tension + others (see 7.11.3.3)
	☐ Variant B – ☐ Analytical meth.	Conductor tension + others (see 7.11.3.4)
7.12 Damper fatigue test	☐ Swept frequency method ☐ Resonant frequency method	

Annex B
(informative)

Examples of graphs relevant to damper characteristic test

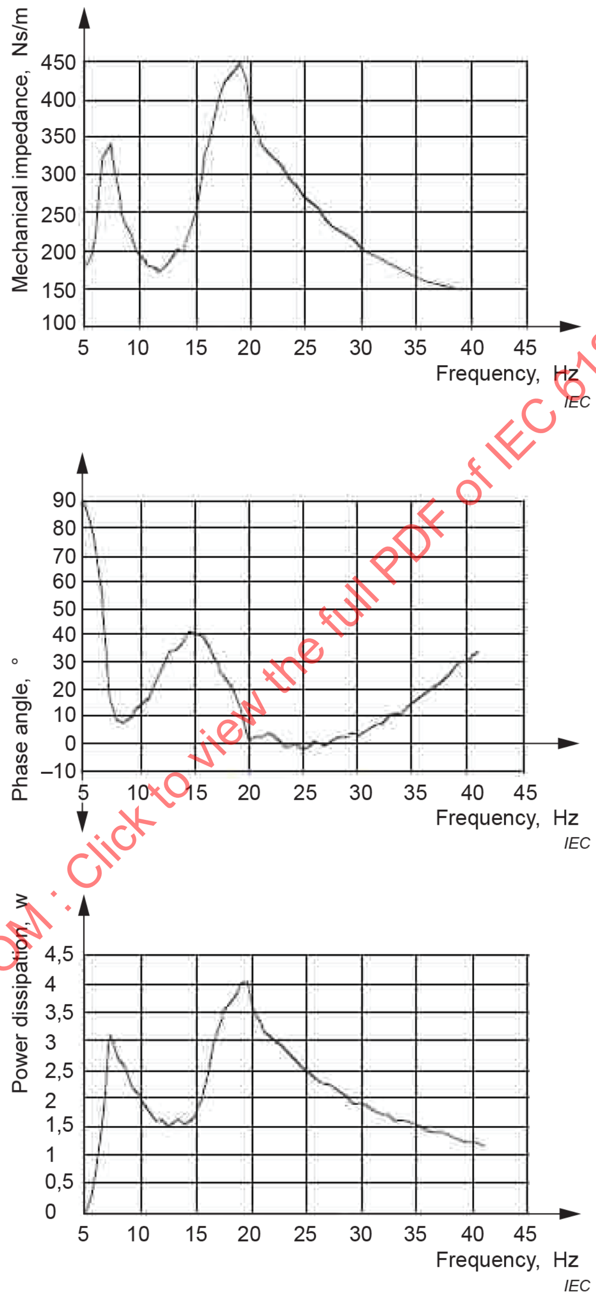
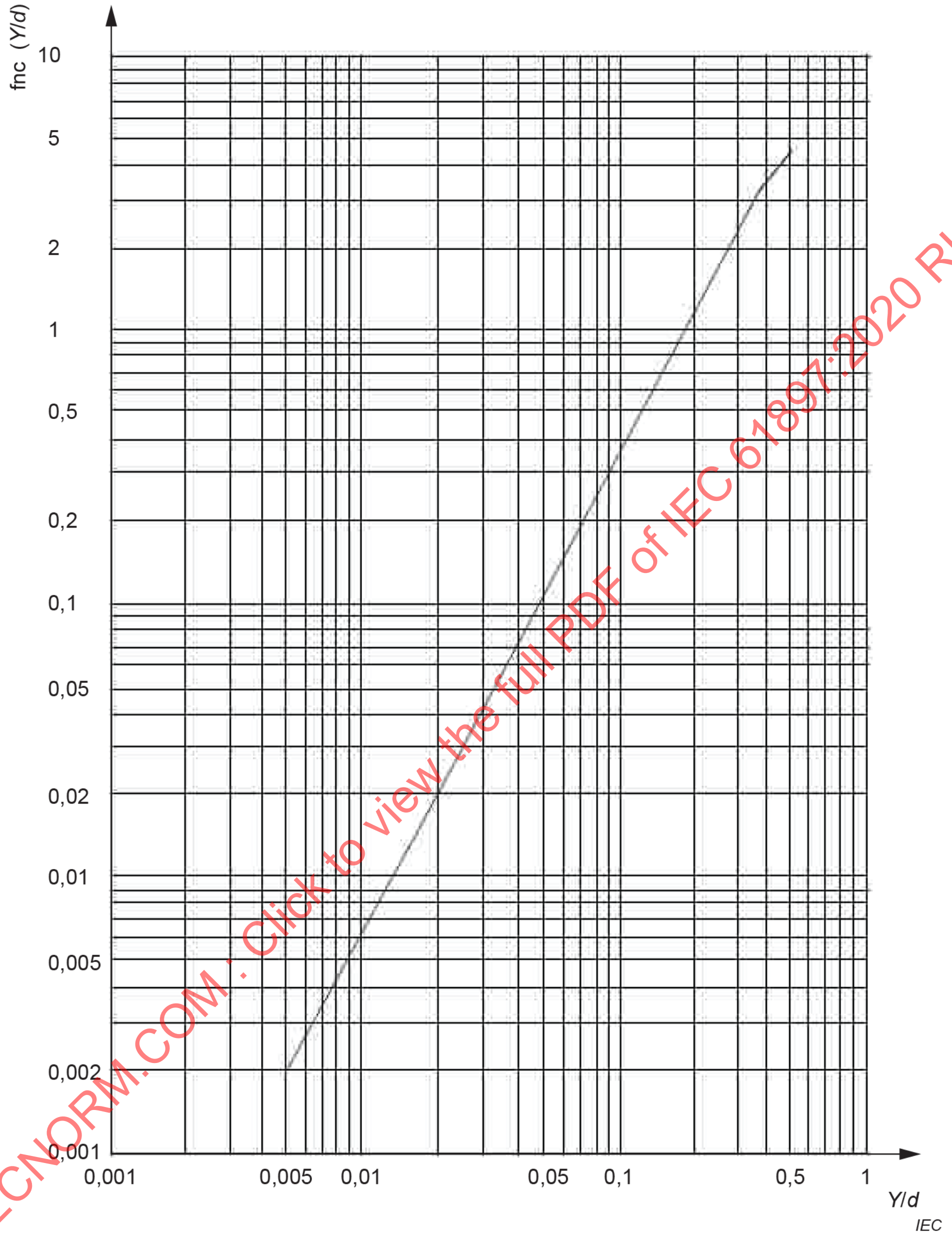


Figure B.1 – Examples of graphs relevant to damper characteristic test (damper with two resonant frequencies)

Annex C
(normative)

Wind power input curve



Key

Y is the conductor antinode amplitude peak-to-peak (m)

d is the conductor diameter (m)

Figure C.1 – Wind power input curve

In order to minimize errors in reading off values of $fnc\left(\frac{Y_j}{d}\right)$ from Figure C.1 the following formula shall be used:

$$fnc\left(\frac{Y_j}{d}\right) = 10^z$$

where

$$z = \sum_{n=0}^{8} a_n X^n$$

and

$$X = \lg\left(\frac{Y}{d}\right)$$

a_0 = – 0,491949

a_1 = – 11,8029

a_2 = – 43,5532

a_3 = – 78,5876

a_4 = – 86,1199

a_5 = – 58,1808

a_6 = – 23,6082

a_7 = – 5,26705

a_8 = – 0,495885

Annex D
(informative)

Description of HT conductors as given in CIGRE TB 695-2017 [6]

Type 0

Conductors designed for a maximum continuous operating temperature of 95 °C.

Type 1

Conductors consisting of a strength member made of steel, coated steel, or steel alloy, and an envelope for which the high temperature effects are mitigated by means of thermal-resistant aluminium alloys.

Type 2

Conductors consisting of a strength member made of steel, coated steel, or steel alloy, and an envelope for which the high temperature effects are mitigated by means of annealed aluminium.

Type 3

Conductors consisting of a metal-matrix composite (MMC) strength member, and an envelope for which the high temperature effects are mitigated by means of thermal-resistant aluminium alloys.

Type 4

Conductors consisting of a polymer-matrix composite (PMC) strength member, and an envelope for which the high temperature effects are mitigated by means of annealed aluminium or thermal-resistant aluminium alloys for HTLS applications.

Bibliography

[1] IEEE Std 664:1993, *IEEE Guide for Laboratory Measurement of the Power Dissipation Characteristics of Aeolian Vibration Dampers for Single Conductors*

[2] IEEE Committee report, *Standardization of conductor vibration measurements*; IEEE WPM 1965; 31 TP 65-156

[3] CIGRE SC22 WG04, *Recommendations for the evaluation of the lifetime of transmission line conductors; Electra 63, March 1979*

[4] CIGRE SC22 WG11-TF2, *Guide to vibration measurements on overhead lines; Electra 163, Dec 1995*

[5] IEEE Std 1368:2007, *IEEE Guide for Aeolian Vibration Field Measurements of Overhead Conductors*

[6] CIGRE SCB2 WG 48, *Experience with the mechanical performance of non-conventional conductors – Technical Brochure 695, August 2017*

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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LIGNES AÉRIENNES – EXIGENCES ET ESSAIS APPLICABLES AUX AMORTISSEURS DE VIBRATIONS ÉOLIENNES

AVANT-PROPOS

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Cette deuxième édition annule et remplace la première édition parue en 1998. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) intégration des amortisseurs de vibrations éoliennes en spirale et des amortisseurs de vibrations éoliennes en élastomère, en plus des amortisseurs de vibrations éoliennes de type Stockbridge;
b) prise en compte de l'application des amortisseurs sur des conducteurs haute température, avec la spécification d'essais à haute température supplémentaires dans le cadre des essais de glissement des pinces;

c) simplification de la procédure d'évaluation de l'efficacité des amortisseurs;

d) introduction d'un essai à basse température sur les composants de fixation tels que les boulons fusibles et les rondelles élastiques coniques;

e) ajout de figures représentant les montages d'essai des principaux essais mécaniques.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
11/266/FDIS	11/273/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

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LIGNES AÉRIENNES – EXIGENCES ET ESSAIS APPLICABLES AUX AMORTISSEURS DE VIBRATIONS ÉOLIENNES

1 Domaine d'application

Le présent document s'applique aux amortisseurs de vibrations éoliennes pour conducteurs uniques ou câbles de garde, ou aux faisceaux de conducteurs lorsque les amortisseurs sont directement reliés à chaque sous-conducteur.

L'acheteur peut adopter un ou plusieurs fragments du présent document lors de la spécification d'exigences concernant des câbles différents de ceux mentionnés ci-dessus, par exemple les câbles de garde optiques (OPGW, Optical Ground Wire) ou les câbles optiques autoporteurs entièrement diélectriques (ADSS, All Dielectric Self-Supporting).

Dans certains cas, les procédures et valeurs d'essai sont convenues entre l'acheteur et le fournisseur et sont indiquées dans le contrat d'approvisionnement.

L'Annexe A contient les informations techniques minimales à convenir entre l'acheteur et le fournisseur.

Dans le cadre du présent document, le mot "conducteur" est utilisé lorsque l'essai s'applique aux amortisseurs pour conducteurs ou câbles de garde.

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l’édition citée s’applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60050(466):1990, *Vocabulaire Electrotechnique International (IEV) – Chapitre 466: Lignes électriques*

IEC 60888:1987, *Fils en acier zingué pour conducteurs câblés*

IEC 61284:1997, *Lignes aériennes – Exigences et essais pour le matériel d'équipement*

IEC 61854, *Lignes aériennes – Exigences et essais applicables aux entretoises*

IEC 62567:2013, *Lignes électriques aériennes – Méthodes d'essai des caractéristiques d'auto-amortissement des conducteurs*

ISO 1461:2009, *Revêtements par galvanisation à chaud sur produits finis en fonte et en acier – Spécifications et méthodes d'essai*

ISO 2859-1:1999/AMD1:2011, *Règles d'échantillonnage pour les contrôles par attributs – Partie 1: Procédures d'échantillonnage pour les contrôles lot par lot, indexés d'après le niveau de qualité acceptable (NQA)*

ISO 2859-2:1985, *Règles d'échantillonnage pour les contrôles par attributs – Partie 2: Plans d'échantillonnage pour les contrôles de lots isolés, indexés d'après la qualité limite (QL)*

ISO 3951-1:2013, *Règles d'échantillonnage pour les contrôles par mesures – Partie 1: Spécification pour les plans d'échantillonnage simples indexés d'après une limite de qualité acceptable (LQA) pour un contrôle lot par lot pour une caractéristique qualité unique et une LQA unique*

ISO 3951-2:2013, *Règles d'échantillonnage pour les contrôles par mesures – Partie 2: Spécification générale pour les plans d'échantillonnage simples indexés d'après une limite de qualité acceptable (LQA) pour le contrôle lot par lot de caractéristiques qualité indépendantes*

ISO 9001:2015, *Systèmes de management de la qualité – Exigences*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions donnés dans l'IEC 60050-466 ainsi que les suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
amortisseur de vibrations éoliennes de type Stockbridge
dispositif constitué d'un câble en acier équipé d'un poids à chaque extrémité et d'une pince boulonnée ou d'une garniture en hélice, pouvant être fixé à un conducteur et destiné à amortir les vibrations éoliennes

3.2
amortisseur de vibrations éoliennes en spirale
SVD
dispositif constitué d'un élément plastique en hélice qui s'enroule autour du conducteur et dont la fonction est d'amortir les vibrations éoliennes (dispositif couramment utilisé sur les câbles de garde, les câbles OPGW et ADSS)

Note 1 à l'article: L'abréviation "SVD" est dérivée du terme anglais développé correspondant "spiral aeolian vibration damper".

3.3
amortisseur de vibrations éoliennes en élastomère
dispositif constitué de poids suspendus reliés à des articulations en élastomère et d'une pince boulonnée ou d'une garniture en hélice, pouvant être fixé à un conducteur et destiné à amortir les vibrations éoliennes

3.4
conducteurs haute température
HTC
conducteurs conçus pour avoir une température maximale en service continu supérieure à 95 °C

Note 1 à l'article: L'abréviation "HTC" est dérivée du terme anglais développé correspondant "high temperature conductors".

3.5
température maximale en service continu
température du conducteur spécifiée par le fabricant et mesurée au niveau des couches de fils extérieures

4 Exigences générales

4.1 Conception

L'amortisseur doit être conçu de manière à:

– amortir les vibrations éoliennes;
– supporter les charges mécaniques imposées pendant l'installation, la maintenance et les conditions de service spécifiées;
– éviter une détérioration du conducteur dans les conditions de service spécifiées;
– pouvoir être déposé et réinstallé sans endommagement du conducteur;
– ne présenter aucun niveau inacceptable d'effets couronne et de perturbations radioélectriques dans l'ensemble des conditions de service spécifiées, en cas d'installation sur des conducteurs de phase;
– être adapté à une installation simple et sécurisée. La conception de la pince doit maintenir l'ensemble des pièces en place lorsque la pince est ouverte pour fixation au conducteur. En outre, la conception de la pince doit être telle que, pendant l'installation, l'amortisseur puisse être suspendu sur le conducteur avant serrage de la pince;
– assurer que les différents composants ne se desserrent pas en service;
– assurer sa fonction sur l'ensemble de la plage de températures de service;
– prévenir tout bruit audible;
– empêcher toute accumulation d'eau.

La liste suivante répertorie d'autres caractéristiques souhaitables qui ne sont pas indispensables aux fonctions élémentaires de l'amortisseur, mais qui peuvent être intéressantes:

– vérification de l'installation correcte depuis le sol;
– facilité d'installation et de dépose sur les lignes sous tension.

Dans le cas des amortisseurs de vibrations destinés aux conducteurs ou câbles de garde contenant des éléments à fibre optique intégrés (ou un câble optique appliqué à l'extérieur et enroulé autour du câble de garde), il convient de prendre en compte les éventuels effets de l'amortisseur sur ces éléments à fibre optique.

4.2 Matériaux

Les matériaux doivent être conformes aux exigences de l'IEC 61284.

4.3 Masse, dimensions et tolérances

La masse et les dimensions importantes de l'amortisseur, y compris les tolérances appropriées, doivent apparaître sur les plans contractuels.

4.4 Protection contre la corrosion

Outre les exigences applicables de l'IEC 61284, le câble porteur (y compris les extrémités coupées lorsqu'elles sont exposées) doit être protégé contre la corrosion, par exemple conformément à l'IEC 60888 pour les fils en acier revêtus par galvanisation à chaud.

4.5 Aspect et finition de fabrication

Les amortisseurs ne doivent présenter aucun défaut ni irrégularité; toutes les surfaces extérieures doivent être lisses, et les arêtes et coins doivent être arrondis.

4.6 Marquage

Les exigences de l'IEC 61284 concernant le marquage des raccords doivent être appliquées à l'ensemble des pinces équipées, y compris celles qui utilisent des boulons fusibles. Sur les amortisseurs en spirale, il convient de placer les marquages sur la tige en plastique.

4.7 Instructions d'installation

Le fournisseur doit fournir une description claire et complète de la procédure d'installation recommandée en indiquant la répartition des amortisseurs dans la portée.

5 Assurance qualité

Un programme d'assurance qualité prenant en compte les exigences du présent document peut être utilisé par accord entre l'acheteur et le fournisseur afin de vérifier la qualité des amortisseurs de vibrations pendant le processus de fabrication.

Les informations précises concernant l'usage de l'assurance qualité sont fournies dans un système conforme à l'ISO 9001 ou à une norme analogue.

Il est recommandé d'assurer la maintenance et l'étalonnage des appareils d'essai utilisés pour vérifier la conformité au présent document en se référant à une norme qualité pertinente.

6 Classification des essais

6.1 Essais de type

6.1.1 Généralités

L'objet des essais de type est d'établir les caractéristiques de conception. Ils sont généralement effectués une seule fois et répétés uniquement en cas de changement de matériau ou d'évolution de la conception des composants de l'amortisseur. Les résultats des essais de type sont consignés afin de démontrer la conformité aux exigences de conception.

6.1.2 Application

Les amortisseurs doivent être soumis aux essais de type indiqués dans le Tableau 1.

Sauf spécification contraire, chaque essai de type doit être effectué sur trois échantillons d'essai identiques, en ce qui concerne toutes les caractéristiques importantes, aux amortisseurs qui doivent être fournis à l'acheteur au titre du contrat.

Toutes les unités doivent satisfaire aux essais.

Les amortisseurs utilisés lors d'essais, où aucune détérioration des unités ou de leurs composants n'a été constatée, peuvent être réutilisés pour les essais ultérieurs.

6.2 Essais sur échantillon

6.2.1 Généralités

Les essais sur échantillon sont exigés pour vérifier que les amortisseurs satisfont aux spécifications de performances des échantillons d'essai de type. En outre, ils ont pour objet de vérifier la qualité des matériaux et de l'exécution.

6.2.2 Application

Les amortisseurs doivent être soumis aux essais sur échantillon indiqués dans le Tableau 1.

Les échantillons à soumettre aux essais doivent être choisis au hasard parmi le lot présenté pour réception. L'acheteur est habilité à procéder lui-même à ce choix.

Les amortisseurs utilisés lors d'essais, où aucune détérioration des unités ou de leurs composants n'a été constatée, peuvent être réutilisés pour les essais ultérieurs.

6.2.3 Echantillonnage, critères de réception

Les procédures du plan d'échantillonnage selon l'ISO 2859-1 et l'ISO 2859-2 (contrôles par attributs) et l'ISO 3951 (contrôles par variables) ainsi que les procédures précises (niveau de contrôle, NQA, échantillonnage simple, double ou multiple, etc.) doivent faire l'objet d'un accord entre l'acheteur et le fournisseur pour chacun des attributs ou variables.

NOTE Le contrôle d'échantillonnage par variables est une procédure d'échantillonnage de réception à utiliser en lieu et place du contrôle par attributs lorsqu'il est approprié de mesurer la ou les caractéristiques concernées sur une échelle continue. Dans le cas des essais de charge de rupture et autres essais coûteux analogues, l'échantillonnage de réception par variables permet de mieux distinguer la qualité acceptable de la qualité objective que l'échantillonnage de réception par attributs, pour la même taille d'échantillon.

L'objet du processus d'échantillonnage peut également être important pour le choix entre un plan par variables et par attributs. Par exemple, un acheteur peut décider d'utiliser un plan d'échantillonnage de réception par attributs afin de vérifier que les pièces d'un lot d'expédition respectent les tolérances dimensionnelles exigées; le fabricant peut mesurer les mêmes dimensions selon un plan d'échantillonnage par variables s'il craint que des tendances ou changements progressifs puissent affecter sa capacité à livrer des lots conformes au NQA.

6.3 Essais individuels de série

6.3.1 Généralités

L'objet des essais individuels de série est de démontrer la conformité des amortisseurs de vibrations aux exigences spécifiques; ils sont effectués sur chaque amortisseur. Les essais ne doivent pas détériorer les amortisseurs.

6.3.2 Application et critères de réception

Des lots complets d'amortisseurs peuvent être soumis aux essais individuels de série. Tout amortisseur non conforme aux exigences doit être mis au rebut.

6.4 Tableau des essais à effectuer

Le Tableau 1 suivant répertorie les essais qui doivent être effectués. Les essais marqués d'un "X" sont obligatoires.

Toutefois, l'acheteur peut spécifier des essais supplémentaires (marqués d'un "O").

Les unités ou composants détériorés lors de l'essai doivent être retirés de la livraison au client.

Tableau 1 – Essais sur les amortisseurs

Paragraphe	Essai	Essai de type	Essai sur échantillon	Essai individuel de série
7.1	Examen visuel	X	X	O
7.2	Vérification des dimensions, des matériaux et de la masse	X	X	
7.3	Essais de protection contre la corrosion	X	X	
7.4	Essais non destructifs	O	O	O
7.5	Essai de glissement des pinces	X	O	
7.6	Essai des boulons fusibles	X	X	
7.7	Essai de serrage des boulons de pince	X	X	
7.8	Fixation des poids au câble porteur	X	X	
7.9	Essai de fixation de la pince au câble porteur	X	X	
7.10	Essais d'effet couronne et de tension perturbatrice radioélectrique (RIV)[1)]	X		
7.11	Essais de performance de l'amortisseur			
7.11.2	– Essai des caractéristiques de l'amortisseur	X	O	
7.11.3	– Evaluation de l'efficacité de l'amortisseur	X		
7.12	Essai de fatigue de l'amortisseur	X		

[1)] Non applicable pour les amortisseurs de câbles de garde.

- Il convient que le fournisseur précise dans le plan qualité de son offre, ou dans la documentation d'offre, les essais qui sont déjà terminés (essais de type) ainsi que les essais (essais sur échantillon ou essais individuels de série) qui sont compris dans l'offre sous réserve de l'accord ou d'une demande de modification de la part de l'acheteur.
- Si des rondelles coniques sont utilisées sur les pinces boulonnées, les essais de fragilisation doivent être effectués conformément au 7.5.2.2 de l'IEC 61854:2019.

7 Méthodes d'essai

7.1 Examen visuel

Les essais de type doivent comprendre un examen visuel afin de vérifier la conformité des amortisseurs, en ce qui concerne toutes les caractéristiques importantes, aux plans de fabrication ou contractuels. Les écarts par rapport aux plans doivent être soumis à l'accord de l'acheteur et doivent être documentés de manière adéquate sur la base d'une dérogation mutuelle.

Les essais sur échantillon et, si exigés, les essais individuels de série doivent comprendre un examen visuel afin de vérifier la conformité du processus de fabrication, de la forme, du revêtement et de l'état de surface de l'amortisseur aux plans contractuels. Une attention particulière doit être portée aux marquages exigés et à l'état des surfaces qui entrent en contact avec le conducteur. Les procédures d'essai sur échantillon et les critères de réception doivent faire l'objet d'un accord entre l'acheteur et le fournisseur.

Pour les amortisseurs soumis à l'essai de type de détection de l'effet couronne, l'essai sur échantillon doit comprendre une comparaison de la forme et de l'état de surface avec l'un des échantillons d'essai de type de détection de l'effet couronne, lorsque cela est spécifié par l'acheteur.

7.2 Vérification des dimensions, des matériaux et de la masse

Les essais de type et sur échantillon doivent comprendre un contrôle des dimensions afin de vérifier que les amortisseurs respectent les tolérances dimensionnelles indiquées sur les plans contractuels. L'acheteur peut décider d'assister au mesurage des dimensions choisies ou peut contrôler la documentation du fournisseur dès que celle-ci est disponible.

Les essais de type et sur échantillon doivent également comprendre un contrôle des matériaux afin de vérifier qu'ils sont conformes aux plans et documents contractuels. Cette vérification doit normalement être effectuée par l'acheteur qui contrôle la documentation du fournisseur relative aux spécifications des matériaux, les certificats de conformité ou toute autre documentation qualité.

La masse totale de l'amortisseur avec l'ensemble de ses composants doit être conforme à la masse indiquée sur le plan contractuel (dans les tolérances indiquées).

7.3 Essais de protection contre la corrosion

7.3.1 Composants revêtus par galvanisation à chaud (autres que les fils du câble porteur)

Les composants revêtus par galvanisation à chaud autres que les fils du câble porteur doivent être soumis à l'essai conformément aux exigences spécifiées dans l'ISO 1461.

L'épaisseur du revêtement doit être conforme aux Tableaux 3 et 4 de l'ISO 1461:2009, sauf accord contraire entre l'acheteur et le fournisseur. Toutefois, pour les besoins du présent document, les Tableaux 3 et 4 de l'ISO 1461:2009 doivent s'appliquer aux catégories d'articles suivantes (et non aux catégories spécifiées dans l'ISO 1461).

Tableau 3: Epaisseur du revêtement sur l'ensemble des échantillons sauf sur les:

- rondelles;
- composants filetés;
- petites pièces centrifugées (surface utile < 1 000 mm^2).

Tableau 4: Epaisseur du revêtement sur les:

- rondelles;
- composants filetés;
- petites pièces centrifugées (surface utile < 1 000 mm^2).

7.3.2 Produits ferreux protégés contre la corrosion par des méthodes autres que la galvanisation à chaud

Les produits en fer protégés contre la corrosion par des méthodes autres que la galvanisation à chaud doivent être soumis à l'essai conformément aux exigences des normes IEC/ISO pertinentes, convenues entre l'acheteur et le fournisseur.

7.3.3 Fils du câble porteur revêtus par galvanisation à chaud

Les fils du câble porteur revêtus par galvanisation à chaud doivent être soumis à l'essai conformément aux exigences spécifiées dans l'IEC 60888.

7.4 Essais non destructifs

L'acheteur doit spécifier et autoriser les méthodes d'essai pertinentes (ISO ou autres) et les critères de réception associés. Exemples d'essais non destructifs:

- essai magnétique;
- essai par courants de Foucault;

– essai radiographique;
– essai par ultrasons;
– essai de charge d'essai;
– essai de ressuage;
– essai de dureté.

7.5 Essai de glissement des pinces

L'essai doit être effectué sur le conducteur auquel la pince est destinée. Le conducteur doit être à l'état neuf, c'est-à-dire exempt de toute détérioration ou de tout dommage. La longueur libre minimale du conducteur à l'essai entre ses raccords de connexion doit être de 4 m. Le conducteur doit être tendu à 20 % de sa résistance assignée à la traction. Des précautions doivent être prises afin d'éviter la formation de cages d'oiseau sur le conducteur.

La pince doit être installée conformément aux instructions du fournisseur sur une partie différente du conducteur à chaque essai. Dans le cas de boulons fusibles, le couple d'installation doit correspondre au couple de rupture nominal moins la tolérance spécifiée (voir 7.6).

L'acheteur et le fournisseur peuvent convenir de l'utilisation d'autres conducteurs, longueurs de conducteurs et tensions de conducteurs.

Une charge coaxiale au conducteur doit être appliquée à la pince de l'amortisseur au moyen d'un dispositif adéquat (voir Figure 1). La charge doit être augmentée progressivement (à une vitesse n'excédant pas 100 N/s) jusqu'à ce qu'elle atteigne la charge indiquée dans le Tableau 2 ou la charge convenue entre l'acheteur et le fournisseur. Cette charge doit être maintenue constante pendant 60 s. La charge doit ensuite être augmentée progressivement jusqu'à ce que le glissement de la pince se produise. La valeur de la charge de glissement doit être consignée.

Pour l'essai de glissement réalisé sur des conducteurs haute température (HTC) avec des amortisseurs Stockbridge et en élastomère uniquement, les paramètres sont les mêmes que ceux utilisés pour les conducteurs normalisés. Après installation de la pince à température ambiante, le conducteur doit être électriquement chauffé jusqu'à la température maximale en service continu spécifiée par le fabricant du conducteur et maintenu à cette température pendant 0,5 h. La force de traction exercée sur le conducteur doit être maintenue constante à 20 % de la résistance assignée à la traction. L'essai de glissement doit alors être effectué à la température maximale en service continu, comme décrit ci-dessus.

Pour l'essai de type, le conducteur doit être soumis à un autre processus thermique.

Une nouvelle pince doit être fixée à température ambiante sur le conducteur qui est mis en tension à 20 % de la résistance assignée à la traction. Il est admis de fixer plusieurs pinces sur le même montage afin de réduire la durée des essais. La distance entre les pinces doit être d'au moins 300 mm.

Le conducteur doit alors être électriquement chauffé jusqu'à la température maximale en service continu spécifiée par le fabricant du conducteur et maintenu à cette température pendant 1 h.

La température doit ensuite diminuer jusqu'à au moins la température ambiante plus 5 °C. Ce cycle doit être répété quatre fois. A la fin du quatrième cycle, après retour de la température à des valeurs ambiantes, l'essai de glissement de la charge doit être effectué. Pour l'ensemble de la session d'essai, la traction doit être maintenue constante à 20 % de la résistance assignée à la traction.