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Lignes aériennes –

Exigences et essais applicables aux amortisseurs de vibrations éoliennes Stockbridge

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

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61897 has been prepared by IEC technical committee 11: Overhead lines.

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

FDIS	Report on voting
11/140/FDIS	11/142/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.

Annexes A and C form an integral part of this standard.

Annex B is for information only.

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

1 Scope

This International Standard 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 standard 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, all dielectric self-supporting optical cables).

In many 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 standard, the word "conductor" is used when the test applies to Stockbridge dampers for conductors or earth wires.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

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

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

ISO 1461, — *Hot dip galvanized coatings on fabricated ferrous products – Specifications* [1)]

ISO 2859-1:1989, *Sampling procedures for inspection by attributes – Part 1: Sampling plans indexed by acceptable quality level (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*

3 Definitions

For the purpose of this International Standard, the definitions of the International Electrotechnical Vocabulary (IEV) apply, in particular IEC 60050(466). Those which differ or do not appear in the IEV are given below.

Stockbridge-type aeolian vibration damper
device comprising a messenger cable with a weight at each end and one bolted clamp, attachable to a conductor for the purpose of damping aeolian vibration

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;
- 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;
- ease of 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.

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) 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.

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 standard 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]*.

It is recommended that test equipment used to verify compliance to this standard 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.

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* Figures in square brackets refer to the bibliography.

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	X [1]		
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.

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.

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 and 3 unless otherwise agreed between purchaser and supplier. However, for the purpose of this standard, tables 2 and 3 in ISO 1461 shall apply to the following categories of items (and not to the categories specified in ISO 1461).

Table 2: Coating thickness on all samples except

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

Table 3: 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 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 minus the tolerance agreed between the purchaser and the supplier (see 7.7).

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 clamp. The load shall be gradually increased (not faster than 100 N/s) until it reaches 2,5 kN (specified minimum slip load). 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.

Clamp slip shall be considered as having occurred when a slip distance of 1 mm is measured.

- Acceptance criteria

No movement of the clamp relative to the conductor greater than 1 mm shall occur at or before the end of application of 2,5 kN 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.

7.6 Breakaway bolt test

The breakaway bolts, if used, shall be tested by applying increasing torque to the breakaway portion until it breaks away. The breakaway torque shall be recorded. The breakaway torque shall be within the tolerance agreed between the purchaser and the supplier.

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. 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. Clamps with breakaway bolts shall have the breakaway portion of the head removed prior to the test and shall be tightened with the specified 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.

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.

7.8 Attachment of weights to messenger cable

On an assembled damper a tensile load shall be applied between the weights coaxial with the messenger cable. 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.

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. 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.

7.10 Corona and radio interference voltage (RIV) tests

The tests shall be performed in accordance with clause 14 of IEC 61284.

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.

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 – Acceptance criteria in 7.11.2).

7.11.2 Damper characteristic test

The damper shall be attached via its clamp to a shaker controlled by a sinusoidal oscillator, 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).

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 and velocity at the damper clamp);
- phase angle φ_V between force and velocity signal at the damper clamp;
- damper power dissipation P_V,

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

for all resonant frequencies of the dampers.

- Acceptance criteria

Table 2 – 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 $f_{i\,min}$, $f_{i\,max}$ and $P_{i\,min}$ obtained from the damper characteristic type test (see above). The dampers shall meet the sample test requirement if, for each damper, the following applies: $(0{,}8\ f_{i,min}) < f_i < (1{,}2\ f_{i,max})$ $P_i > (0{,}8\ P_{i\,min})$ for all resonant frequencies

NOTE – Guidance on the measurement of power dissipation of aeolian vibration dampers in laboratory tests is given in IEEE 664 [7] which refers to the damper characteristic test as "forced response method" (see clause 4 of IEEE 664). It is recommended that the detailed procedures for instrumenting and for controlling this test are developed with reference to these recommendations.

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 of the following methods:

– laboratory test;

– field test;

– analytical method.

The method 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.

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 1. 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.

Although armour rods may be fitted around the conductor at suspension points in service, these shall be omitted in this test.

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.

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 metres, unless a narrower frequency range is agreed between the purchaser and the supplier. A maximum of 20 tuneable span resonances shall be tested; they shall be reasonably spaced over the frequency range indicated above.

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

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.

- Acceptance criterion

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

$$P_{w,j} = L \times d^4 \times f_j^3 \times \text{fnc}\ (Y_j/d)$$

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(Y_j/d) is the wind power input function as given in annex C, unless otherwise agreed between the purchaser and the supplier.

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 **[8]**, CIGRE, SC22 WG04 **[9]**, CIGRE, SC22 WG11-TF2 **[10]** 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 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, ...);
- the characteristics of armor rods, if applied;
- the terrain (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.

7.12 Damper fatigue test

7.12.1 Test methods

Two alternative methods can be applied for the fatigue test. Whereas the first method requires sweeping frequency and 100 million (10^8) cycles, the second method excites vibration at a 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). 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.

7.12.4 Acceptance criteria

The tests specified in 7.11.2, 7.8 and 7.9 shall be repeated after the termination of the fatigue test.

The dampers shall 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.

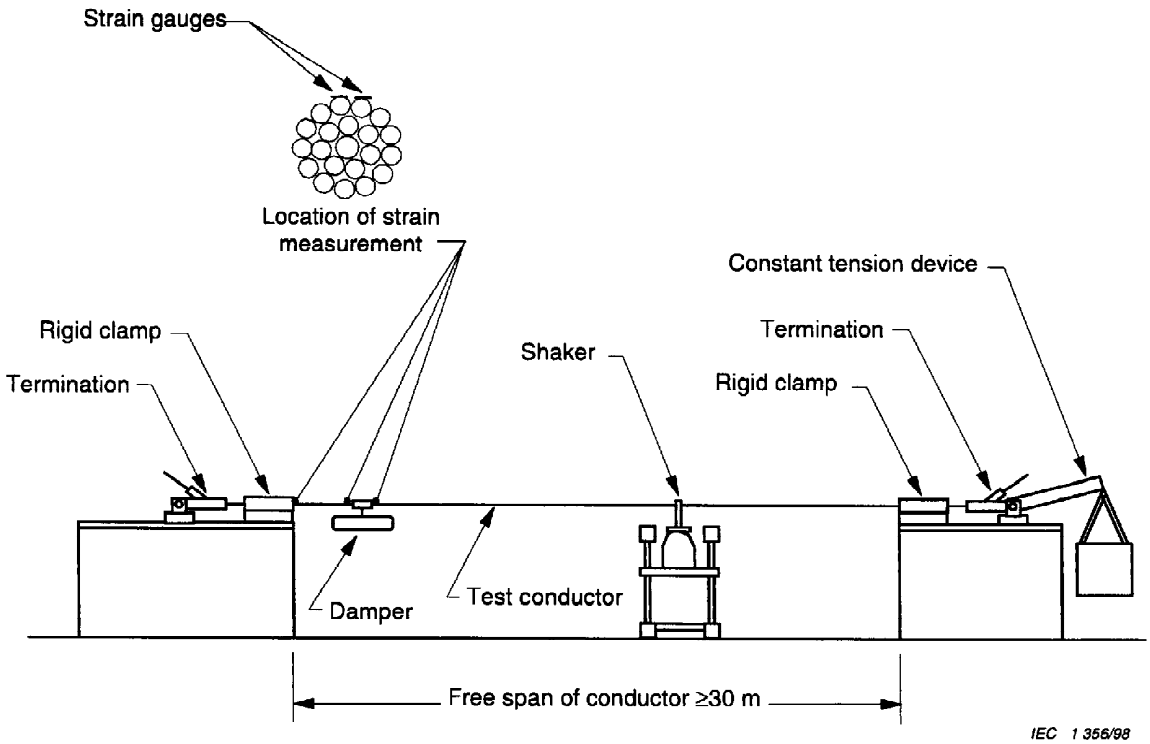


Figure 1 – Test rig for laboratory test of damper effectiveness (see 7.11.3.2)

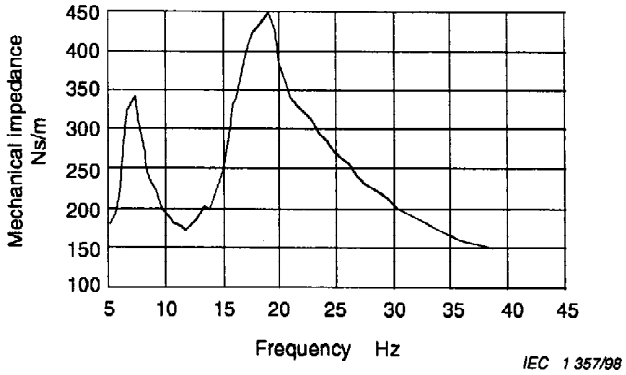
Annex A
(normative)

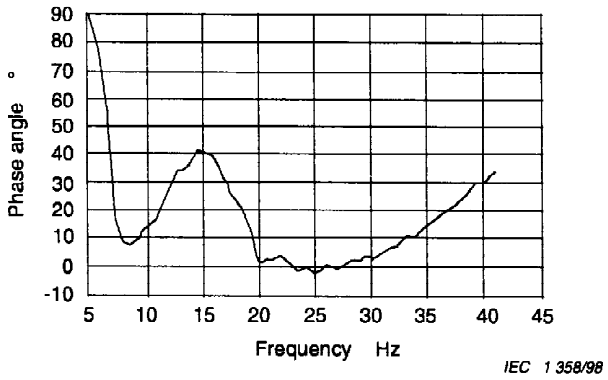
Minimum technical details to be agreed between purchaser and supplier

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





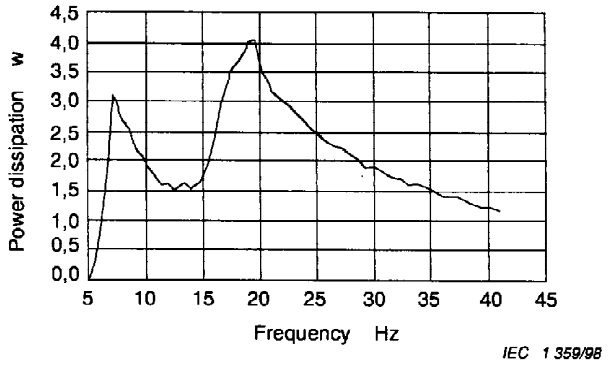
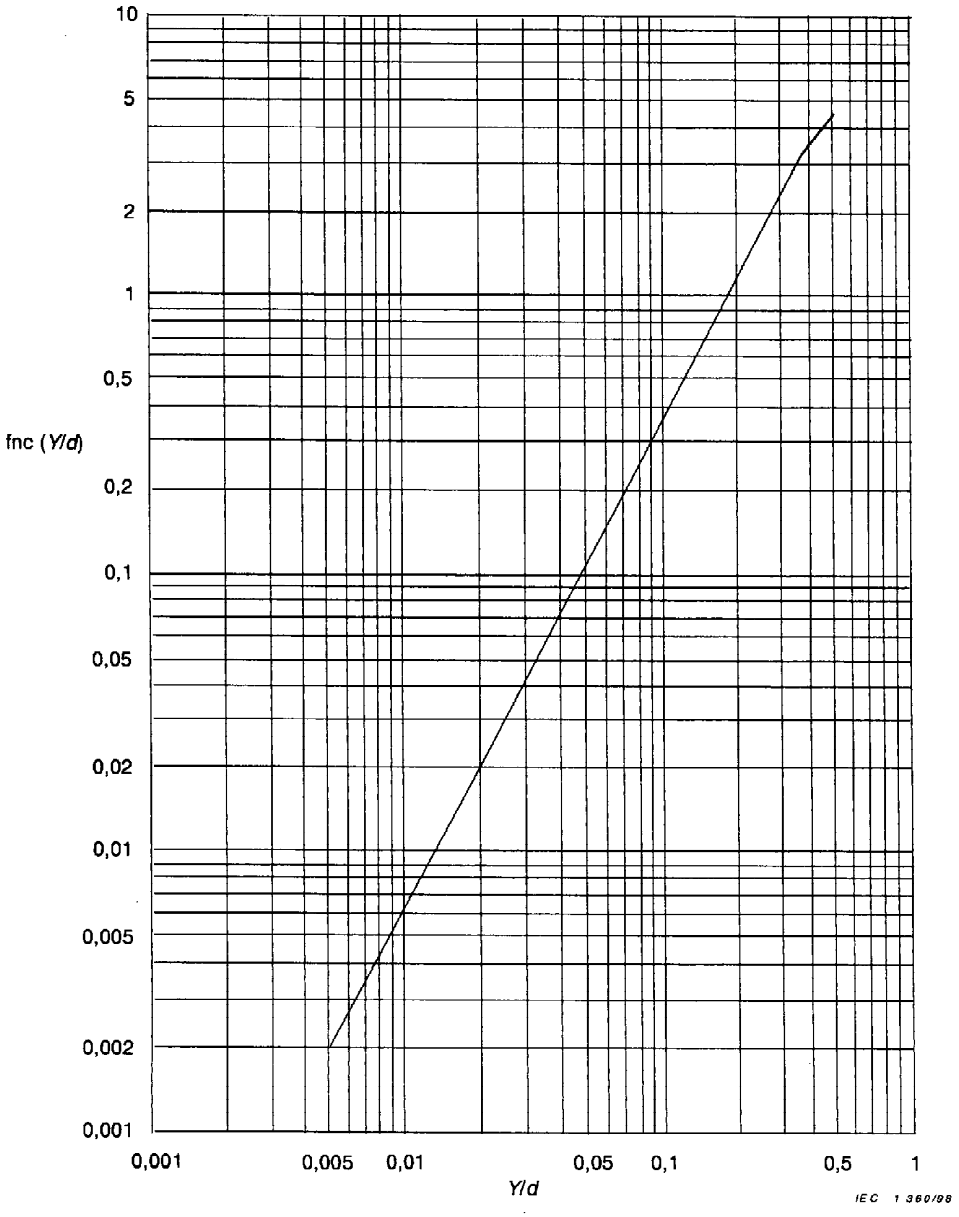


Figure B.1 – Examples of graphs relevant to damper characteristic test (damper with two resonant frequencies)

Annex C
(normative)

Wind power input curve



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

d conductor diameter (m)

Figure C.1 – Wind power input curve

In order to minimize errors in reading off values of fnc(*Y/d*) from figure C.1 the following equation shall be used:

$$\text{fnc}(Y/d) = 10^{z}$$

where

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

and

$X = \lg(Y/d)$

$a_0 = -0{,}491949$

$a_2 = -43{,}5532$

$a_3 = -78{,}5876$

$a_4 = -86{,}1199$

$a_1 = 11{,}8029$

$a_5 = -58{,}1808$

$a_6 = -23{,}6082$

$a_7 = -5{,}26705$

$a_8 = -0{,}495885$

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*

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

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

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

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

Q1 Please report on **ONE STANDARD** and **ONE STANDARD ONLY**. Enter the exact number of the standard: *(e.g. 60601-1-1)*

.....

Q2 Please tell us in what capacity(ies) you bought the standard *(tick all that apply)*. I am the/a:

- purchasing agent ❑
- librarian ❑
- researcher ❑
- design engineer ❑
- safety engineer ❑
- testing engineer ❑
- marketing specialist ❑
- other.....

Q3 I work for/in/as a: *(tick all that apply)*

- manufacturing ❑
- consultant ❑
- government ❑
- test/certification facility ❑
- public utility ❑
- education ❑
- military ❑
- other.....

Q4 This standard will be used for: *(tick all that apply)*

- general reference ❑
- product research ❑
- product design/development ❑
- specifications ❑
- tenders ❑
- quality assessment ❑
- certification ❑
- technical documentation ❑
- thesis ❑
- manufacturing ❑
- other.....

Q5 This standard meets my needs: *(tick one)*

- not at all ❑
- nearly ❑
- fairly well ❑
- exactly ❑

Q6 If you ticked NOT AT ALL in Question 5 the reason is: *(tick all that apply)*

- standard is out of date ❑
- standard is incomplete ❑
- standard is too academic ❑
- standard is too superficial ❑
- title is misleading ❑
- I made the wrong choice ❑
- other .....

Q7 Please assess the standard in the following categories, using the numbers:
(1) unacceptable,
(2) below average,
(3) average,
(4) above average,
(5) exceptional,
(6) not applicable

- timeliness.....
- quality of writing.....
- technical contents.....
- logic of arrangement of contents .....
- tables, charts, graphs, figures.....
- other .....

Q8 I read/use the: *(tick one)*

- French text only ❑
- English text only ❑
- both English and French texts ❑

Q9 Please share any comment on any aspect of the IEC that you would like us to know:

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Q1 Veuillez ne mentionner qu'**UNE SEULE NORME** et indiquer son numéro exact: *(ex. 60601-1-1)*

.....

Q2 En tant qu'acheteur de cette norme, quelle est votre fonction? *(cochez tout ce qui convient)*
Je suis le/un:

- agent d'un service d'achat ❑
- bibliothécaire ❑
- chercheur ❑
- ingénieur concepteur ❑
- ingénieur sécurité ❑
- ingénieur d'essais ❑
- spécialiste en marketing ❑

autre(s).....

Q3 Je travaille: *(cochez tout ce qui convient)*

- dans l'industrie ❑
- comme consultant ❑
- pour un gouvernement ❑
- pour un organisme d'essais/ certification ❑
- dans un service public ❑
- dans l'enseignement ❑
- comme militaire ❑

autre(s).....

Q4 Cette norme sera utilisée pour/comme *(cochez tout ce qui convient)*

- ouvrage de référence ❑
- une recherche de produit ❑
- une étude/développement de produit ❑
- des spécifications ❑
- des soumissions ❑
- une évaluation de la qualité ❑
- une certification ❑
- une documentation technique ❑
- une thèse ❑
- la fabrication ❑

autre(s).....

Q5 Cette norme répond-elle à vos besoins: *(une seule réponse)*

- pas du tout ❑
- à peu près ❑
- assez bien ❑
- parfaitement ❑

Q6 Si vous avez répondu PAS DU TOUT à Q5, c'est pour la/les raison(s) suivantes: *(cochez tout ce qui convient)*

- la norme a besoin d'être révisée ❑
- la norme est incomplète ❑
- la norme est trop théorique ❑
- la norme est trop superficielle ❑
- le titre est équivoque ❑
- je n'ai pas fait le bon choix ❑

autre(s) .....

Q7 Veuillez évaluer chacun des critères ci-dessous en utilisant les chiffres
(1) inacceptable,
(2) au-dessous de la moyenne,
(3) moyen,
(4) au-dessus de la moyenne,
(5) exceptionnel,
(6) sans objet

publication en temps opportun .....
qualité de la rédaction.....
contenu technique .....
disposition logique du contenu .....
tableaux, diagrammes, graphiques, figures.....
autre(s) .....

Q8 Je lis/utilise: *(une seule réponse)*

- uniquement le texte français ❑
- uniquement le texte anglais ❑
- les textes anglais et français ❑

Q9 Veuillez nous faire part de vos observations éventuelles sur la CEI:

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