BS EN IEC 61897:2020



BSI Standards Publication

Overhead lines — Requirements and tests for Aeolian vibration dampers

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

bsi.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

National foreword

This British Standard is the UK implementation of EN IEC 61897:2020. It is identical to IEC 61897:2020. It supersedes BS EN 61897:1999, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/11, Overhead Lines.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2020
Published by BSI Standards Limited 2020

ISBN 978 0 580 92625 9

ICS 29.240.20

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2020.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 61897

April 2020

ICS 29.240.20

Supersedes EN 61897:1998 and all of its amendments and corrigenda (if any)

English Version

Overhead lines - Requirements and tests for Aeolian vibration dampers (IEC 61897:2020)

Lignes aériennes - Exigences et essais applicables aux amortisseurs de vibrations éoliennes (IEC 61897:2020)

Freileitungen - Anforderungen und Prüfungen für Schwingungsdämpfer (IEC 61897:2020)

This European Standard was approved by CENELEC on 2020-04-07. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

© 2020 CENELEC All rights of exploitation in any form and by any means reserved worldwide for CENELEC Members.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

European foreword

The text of document 11/266/FDIS, future edition 2 of IEC 61897, prepared by IEC/TC 11 "Overhead lines" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61897:2020.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2021-01-07
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2023-04-07

This document supersedes EN 61897:1998 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61897:2020 was approved by CENELEC as a European Standard without any modification.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60050-466	1990	International Electrotechnical Vocabulary. Chapter 466: Overhead lines	-	-
IEC 60888	1987	Zinc-coated steel wires for stranded conductors	-	-
IEC 61284	1997	Overhead lines - Requirements and tests for fittings	EN 61284	1997
IEC 61854	-	Overhead lines - Requirements and tests for spacers	-	-
IEC 62567	2013	Overhead lines - Methods for testing self-damping characteristics of conductors	EN 62567	2013
ISO 1461	2009	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods	EN ISO 1461	2009
ISO 2859-1	1999	Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection	-	-
+ A1	2011		-	-
ISO 2859-2	1985	Sampling procedures for inspection by attributes - Part 2: Sampling plans indexed by limiting quality (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	EN ISO 9001	2015

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

CONTENTS

FOREWORD 4
1 Scope 6
2 Normative references 6
3 Terms and definitions 7
4 General requirements 7
4.1 Design 7
4.2 Materials 8
4.3 Mass, dimensions and tolerances 8
4.4 Protection against corrosion 8
4.5 Manufacturing appearance and finish 8
4.6 Marking 8
4.7 Installation instructions 8
5 Quality assurance 8
6 Classification of tests 9
6.1 Type tests 9
6.1.1 General 9
6.1.2 Application 9
6.2 Sample tests 9
6.2.1 General 9
6.2.2 Application 9
6.2.3 Sampling, acceptance criteria 9
6.3 Routine tests 10
6.3.1 General 10
6.3.2 Application and acceptance criteria 10
6.4 Table of tests to be applied 10
7 Test methods 11
7.1 Visual examination 11
7.2 Verification of dimensions, materials and mass 11
7.3 Corrosion protection tests 11
7.3.1 Hot dip galvanized components (other than messenger cable wires) 11
7.3.2 Ferrous components protected from corrosion by methods other than hot dip galvanizing 12
7.3.3 Hot dip galvanized messenger cable wires 12
7.4 Non-destructive tests 12
7.5 Clamp slip test 12
7.6 Breakaway bolt test 13
7.7 Clamp bolt tightening test 14
7.8 Attachment of weights to messenger cable test 14
7.9 Attachment of clamp to messenger cable test 15
7.10 Corona and radio interference voltage (RIV) tests 15
7.11 Damper performance tests 15
7.11.1 Performance test variants 15
7.11.2 Damper characteristic test 16
7.11.3 Damper effectiveness evaluation 18
7.12 Damper fatigue test 21
7.12.1 Test methods 21

7.12.2 Swept frequency method 21
7.12.3 Resonant frequency method 21
7.12.4 Acceptance criteria 22
7.12.5 Fatigue test method – for spiral aeolian vibration dampers (SVD) 22
Annex A (normative) Minimum technical details to be agreed between purchaser and supplier 23
Annex B (informative) Examples of graphs relevant to damper characteristic test 24
Annex C (normative) Wind power input curve 25
Annex D (informative) Description of HT conductors as given in CIGRE TB 695-2017 [6] 27
Bibliography 28

Figure 1 – Test arrangement for longitudinal slip tests 13
Figure 2 – Test arrangement for attachment of weights to messenger cable test 15
Figure 3 – Test arrangement for attachment of clamp to messenger cable test 15
Figure 4 – Test arrangement for damper characteristic test 18
Figure 5 – Example of test rig for laboratory test of damper effectiveness 18
Figure B.1 – Examples of graphs relevant to damper characteristic test (damper with two resonant frequencies) 24
Figure C.1 – Wind power input curve 25

Table 1 – Tests on dampers 10
Table 2 – Load criteria (for standard and high temperature conductors) 13
Table 3 – Acceptance criteria 17

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

OVERHEAD LINES – REQUIREMENTS AND TESTS FOR AEOLIAN VIBRATION DAMPERS

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. 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 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 IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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*

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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;

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

- 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.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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).

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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.

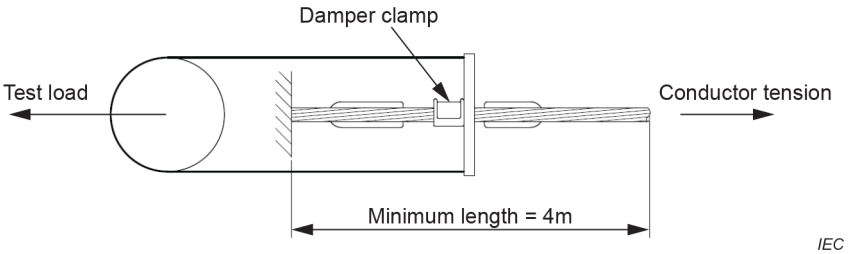


Figure 1 – Test arrangement for longitudinal slip tests

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.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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.

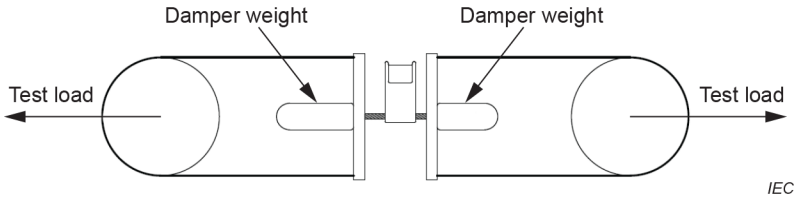


Figure 2 – Test arrangement for attachment of weights to messenger cable test

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.

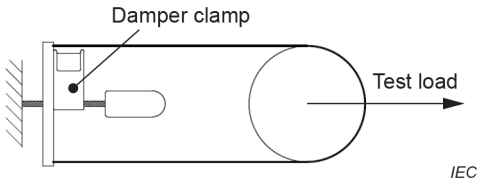


Figure 3 – Test arrangement for attachment of clamp to messenger cable test

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.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

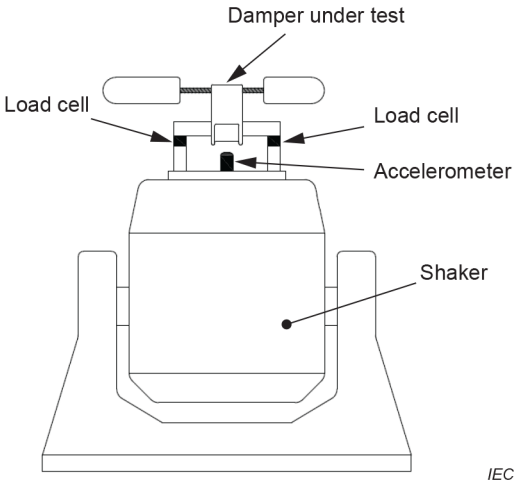


Figure 4 – Test arrangement for damper characteristic test

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.

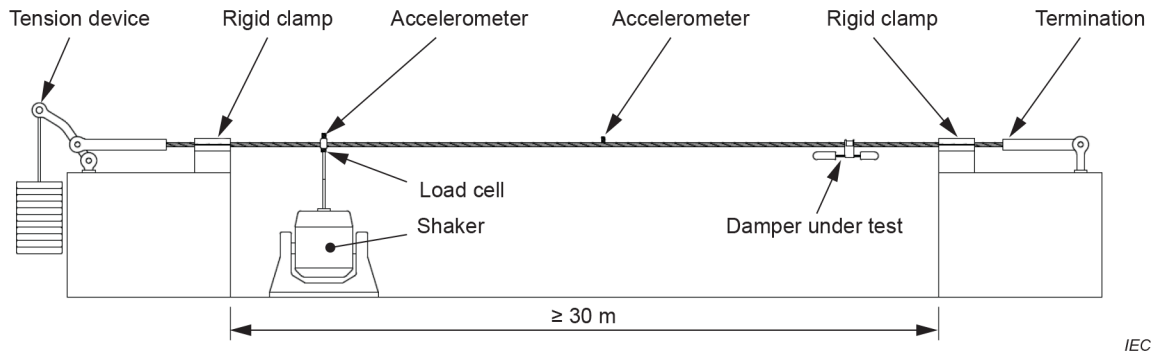


Figure 5 – Example of test rig for laboratory test of damper effectiveness

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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:

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

– 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.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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)
		☐ 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		

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

Annex B
(informative)

Examples of graphs relevant to damper characteristic test

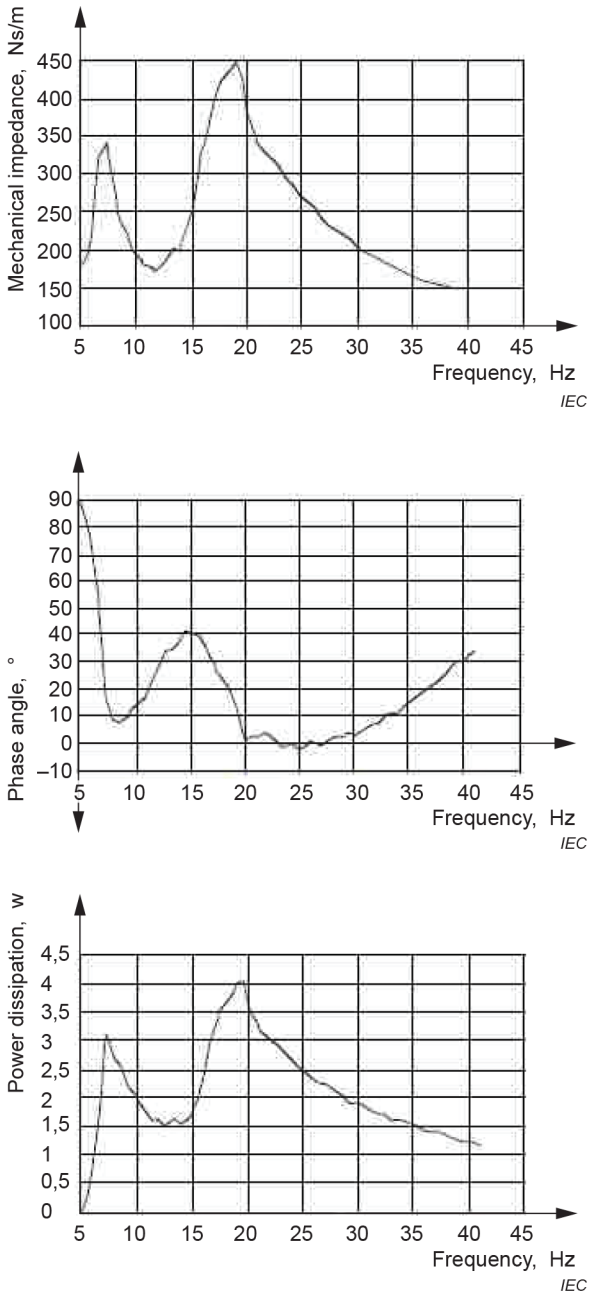
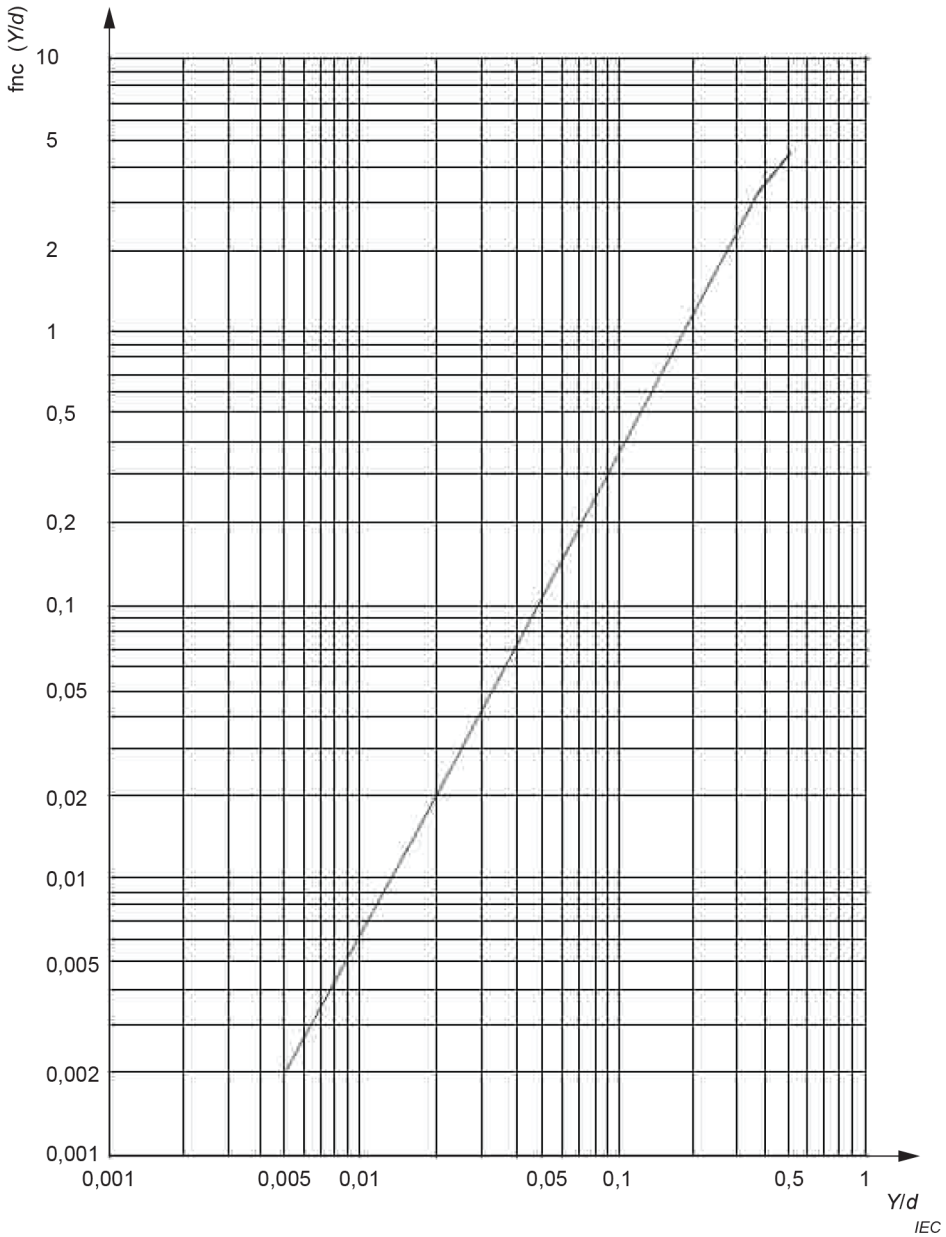


Figure B.1 – Examples of graphs relevant to damper characteristic test (damper with two resonant frequencies)

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

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

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*

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

Licensed copy: Sukanya Arayangkoon, The Electricity Generating Authority of, Version correct as of 01/12/2020

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

Storing and using standards

Standards purchased in soft copy format:

- A British Standard purchased in soft copy format is licensed to a sole named user for personal or internal company use only.
- The standard may be stored on more than one device provided that it is accessible by the sole named user only and that only one copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.

Standards purchased in hard copy format:

- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than one copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright and Licensing team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member.**

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email cservices@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Useful Contacts

Customer Services
Tel: +44 345 086 9001
Email: cservices@bsigroup.com

Subscriptions
Tel: +44 345 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK