NPS/001/022 - Technical Specification for Aeolian Vibration Dampers

1. Purpose

This specification details the Northern Powergrid requirements for the supply of Aeolian vibration dampers for use on the Northern Powergrid Distribution System.

This document supersedes the following documents, all copies of which should be destroyed.

Document Reference	Document Title	Version	Published Date
NPS/001/022	Technical specification for Aeolian Vibration Dampers	2.2	March 2019

2. Scope

This Specification covers the design, manufacture, installation and testing of Aeolian Vibration dampers and spacers dampers for use on single and twin conductor overhead lines located within Northern Powergrid.

2.1. Table of Contents

3. Technical Specification

3.1. General

All Aeolian Vibration dampers shall be so designed ENA TS 43-125 Design guide and technical specification for overhead lines above 45 kV, Part 3 Vibration dampers and spacers - with the following features:

a) Damp Aeolian Vibration and avoid damage or corrosion to the conductor or individual strands during installation or during service;

b) Maintain within specified limits the sub-conductor spacing (at spacer locations), under all service conditions excluding short circuits

c) Prevent in sub-spans between spacers, physical contact between sub-conductors, except during the passage of short-circuit currents when the possibility of contact is accepted provided the specified spacing is immediately restored following fault clearance.

d) Withstand the mechanical loads during installation, maintenance and specified service conditions including conductor temperature variations, ultraviolet radiation, ozone and atmospheric pollutants applicable to the site;

e) Be free from unacceptable levels of corona and radio interference under all service conditions;

f) Avoid audible noise under all weather conditions;

g) Maintain its function over the entire service temperature range from -20°C to 90°C

h) Be capable of being removed and reinstalled without damaging the conductor;

i) Be suitable for safe and easy installation. The clamp design shall retain all parts when opened for attachment to the conductor and shall be designed to ensure the damper, during installation, can be suspended from the conductor before tightening the clamp;

j) Ensure individual components will not come loose in service.

3.1.1. Conductor Range

Appendix 1 & 1b provides details on the type and range of Aeolian Vibration dampers required for us on the company's network.

3.2. Specific Requirements for Vibration Dampers

3.2.1. Project Details

The specific requirements for Aeolian Vibration dampers will depend on the following factors: the geographical orientation of the line with respect to large bodies of water, the frequency of laminar winds (0.5 m/s to 10 m/s), the ground terrain, the nature of the ground cover and the 'everyday' conductor tension.

The use of conventional one response Stockbridge type Aeolian vibration dampers, i.e. with symmetrical damper weights and a 7-strand messenger cable is normally satisfactory in areas with a ground roughness category IV ref BS 8100-1 or higher and an EDT of approximately 20 % of the conductor's rated strength. However, consideration should be given to the use of multi-response Aeolian vibration dampers, i.e. with asymmetrical damper weights and/or spacing and 19-strand messenger cable in areas with a ground roughness category type III or lower, or where a higher EDT is used.

3.2.2. Aeolian Vibration Limits

When installed in accordance with the supplier's recommendations the vibration damper(s) shall limit the Aeolian vibration levels so that the dynamic bending strain on the surface of the outer wires of the

conductor shall not exceed 300 micro-strains (peak to peak) at the vibration damper clamp and at the adjacent suspension clamp or dead-end tension joint / tension clamp. This requirement shall be met for all frequencies up to and including

$$f = \frac{1\,480}{d}$$ Hz (where d is the conductor diameter in mm).

The supplier shall provide either suitable laboratory test results, field test results or calculations to demonstrate to the company's satisfaction that this requirement is met for each Aeolian vibration damper - conductor combination.

3.2.3. Conductor Clamp

Stockbridge type Aeolian vibration damper clamps shall be designed to ensure that after the bolt has been correctly tightened, no slackening of the clamp can occur in service. The design of the clamp shall take account that all Stockbridge type Aeolian vibration dampers will be installed with grease filling the interfaces between the clamp and the conductor to prevent the ingress of moisture. Wherever possible shear head clamp bolts shall be used.

3.2.4. Messenger Cable

The messenger cable for Stockbridge type Aeolian vibration dampers shall comprise stranded fatigue resistant high tensile steel wires. The cable shall be protected against corrosion either by sleeving over the complete length of the cable, or by alternative means that have shown to have proven fatigue and corrosion resistance in the UK or similar environmental areas for a minimum of 20 years' service life. Details of the alternative corrosion protection shall be submitted to the company.

3.2.5. Damper Weights

The design of the Stockbridge type Aeolian vibration damper shall ensure that no contact occurs between damper weights and the messenger cable under service conditions.

3.3. Specific Requirements for Vibration Dampers

3.3.1. Project Details

The specific requirements for Spacer dampers will depend on the following factors: the geographical orientation of the line with respect to large bodies of water, the frequency of laminar winds (5 m/s to 25 m/s), the ground terrain, the nature of the ground cover and the sub-conductor spacing : conductor diameter, (S/D) ratio.

The use of semi-flexible spacers (including those incorporating flexible wire) with asymmetrical sub-span spacing, in conjunction with aeolian vibration dampers may be satisfactory in areas with a ground roughness category IV [ref BS 8100-1] or higher, with an S/D ratio of 15 or higher for twin AL1 / ST1A conductors. If any of these conditions are not fulfilled, it is recommended that spacer dampers are installed.

If it is proposed to use semi-flexible spacers or spacer dampers in conjunction with aeolian vibration dampers as an integral system, this should be clearly stated in the Project Specification.

3.3.2. Overall Flexibility

All spacers excluding rigid spacers, shall permit the following minimum relative movements between sub-conductors without damage to the spacer or the conductor:

a) Longitudinal movement of ± 25 mm;

b) Vertical movement of ± 50 mm;

c) Conical movement of 20°(conical angle);

d) For spacer dampers only a horizontal movement perpendicular to the conductors of ± D, where D is the conductors' diameter.

3.3.3. Spacer Dampers

When installed in accordance with the suppliers instructions the spacer dampers shall achieve the following performance criteria such as to adequately damp both aeolian vibration and sub-span modes of oscillation, to prevent sub-conductor clashing, fretting or fatigue under all applicable frequencies:

1) Aeolian vibration limits

The spacer damper(s) shall limit the aeolian vibration levels so that the dynamic bending strain on the surface of the outer wires of the conductor shall not exceed 300 micro-strains (peak to peak) at the spacer damper clamp and at the adjacent suspension clamp or dead-end tension joint / tension clamp.

This requirement shall be met for all frequencies up to and including $f = \frac{1\,480}{d}$ Hz (where d is the conductors' diameter in mm).

2) System damping performance

The system damping performance as measured by the logarithmic decrement of the fundamental wind induced anti-phase modes of the conductor shall not be less than 0.5. Where the log decrement, (d):

$$d = \frac{1}{n} \cdot \ln\left[\frac{A_0}{A_n}\right]$$

where A_0 = peak to peak amplitude

A_n = peak to peak amplitude at the n^{th} cycle

The manufacturer shall provide either suitable laboratory test results, field test results or calculations to demonstrate to the Engineer's satisfaction that this requirement is met for each spacer damper - conductor combination.

3.3.4. Conductor Clamp

Spacer clamps shall be designed to ensure that after the fastener has been correctly tightened, no slackening of the clamp can occur in service. The design of the clamp shall take account that all spacers, except those with elastomeric clamp liners, will be installed with grease filling the interfaces between the clamp and the conductor to prevent the ingress of moisture. Wherever possible shear head clamp bolts shall be used.

3.3.5. Electrical Resistance

For all spacers with elastomeric components the electrical resistance between the spacer arm and the central frame shall be greater than 1 MΩ to avoid galvanic corrosion of the conductor unless satisfactory endurance from a corrosion test or appropriate service experience is provided. The maximum resistance shall not exceed 20 MΩ to avoid problems caused by capacitive charging of the spacer components in service.

For spacers with elastomeric clamp liners the electrical resistance between the conductor and spacer arm shall be between 1 MΩ and 20 MΩ.

3.4. Materials

Materials used in the manufacture of Aeolian Vibration dampers shall have the following properties as appropriate:

a) Adequate strength for the intended application and service life requirements (including mechanical loads, vibrations, electrical currents and environmental effects) and free from defects that would affect the performance of the Aeolian Vibration damper;

b) Not be liable to intergranular or stress corrosion;

c) Compatible with the conductors' material such that there can be no deterious effects on the conductor or Aeolian vibration dampers from their use;

d) Shall not be adversely affected in the long term by a coating applied for the corrosion protection;

e) Non-metallic materials shall have good resistance to ageing and be capable of withstanding service conditions without a detrimental change in their properties. The materials used shall have adequate resistance to the effects of nitrogen oxides, ozone, ultraviolet radiation and air pollution over the whole range of service temperatures from -20°C to 90°C. They shall not induce corrosion in materials in contact with them.

3.5. Workmanship

Contract drawings for Aeolian vibration dampers shall in addition to the dimensions, show material types and grades, protective treatment and any other pertinent information.

The Aeolian vibration dampers shall be free from defects and irregularities. Aeolian vibration damper weights and conductor clamps shall have all outside surfaces smooth and all edges and corners well rounded.

Contract drawings shall be submitted to the company.

3.6. Corrosion Protection

All materials used in the manufacture of Aeolian vibration dampers shall be inherently resistant to atmospheric corrosion which could affect their performance.

All ferrous materials shall either be inherently resistant to atmospheric corrosion, or be suitably protected against corrosion that can occur during transportation, storage or service. All ferrous parts which will be exposed to the atmosphere in service, except those made of the appropriate grade of stainless steel, shall be protected by hot dip galvanizing in accordance with the requirements of BS EN ISO 1461.

Where zinc coated steel messenger wires are used they shall be hot dip galvanized in accordance with the requirements of BS EN 50189.

All external threads shall be cut or rolled before hot-dipped galvanizing. Nuts to be galvanized shall be subsequently tapped 0.4 mm oversize and the threads oiled.

Drain holes (minimum 6 mm diameter) shall be provided where applicable to ensure that any water entering the damper weights can escape.

3.7. Installation of Vibration Dampers or Spacer Dampers

3.7.1. Vibration Dampers

The supplier shall provide comprehensive instructions in a suitable format covering the selection and installation of the Aeolian vibration damper, including the number of Aeolian vibration dampers per span, distance from the suspension clamp or mouth of dead-end tension joint / tension clamp taking into account the possibility of armour rods being fitted and the clamp bolt installation torque.

In the case of spacer dampers the supplier shall provide instructions on the selection and installation of the spacers, including the sub-span spacing taking into account the possibility of an additional spacer being fitted adjacent to the tension dead-end joint / tension clamp and the clamp bolt installation torque.

3.8. Quality Assurance

3.8.1. General

Type, sample and routine tests shall be undertaken as appropriate on the Aeolian vibration dampers and spacer dampers in accordance with the requirements on this Specification, BS EN IEC 61897 and BS EN IEC 61854

3.8.2. Identification and Marking

All Stockbridge type Aeolian vibration dampers shall be marked to ensure a system of traceability. Corona free markings shall be in accordance with the requirements of BS EN 61284. In addition, the range of conductor sizes for which the Aeolian vibration damper or spacer damper is intended to be used, together with type of conductor shall be clearly shown.

Installation torque values shall be stated in newton-metres (N m) and shall be marked adjacent to the appropriate fasteners tightened during installation.

Details of the proposed marking system shall be submitted to the Company.

3.9. Type Tests

3.9.1. General

Three samples of each Aeolian vibration dampers and spacer dampers for each conductor size shall be subjected to the type tests. One sample of each Aeolian vibration damper and spacer damper subjected to the visual examination, dimensional, materials and finish and corona type tests, shall be retained by the manufacturer for comparison with the production dampers.

3.9.2. Visual Examination, Dimensional, Materials and Finish

Visual examination, dimensional, materials and finish including that of any coating, e.g. galvanizing type tests shall be undertaken in accordance with the requirements of Sections 7.1, 7.2 and 7.3 of BS EN IEC 61897 or BS EN IEC 61854

3.9.3. Clamp Slip

Clamp slip tests on Stockbridge type Aeolian vibration dampers shall be undertaken in accordance with the requirements of Section 7.5 of BS EN IEC 61897 or BS EN IEC 61854, except that the clamp shall be installed on a portion of greased conductor.

3.9.4. Clamp Bolt Tightening

Clamp bolt tightening tests on Stockbridge type Aeolian vibration dampers shall be undertaken in accordance with the requirements of Section 7.7 of BS EN IEC 61897, or 7.5.2.4 of BS EN IEC 61854 except that an initial test to 100 % of the specified installation torque shall be undertaken. After the 100 % load has been applied, the clamp shall be removed from the conductor and the conductor inspected. The clamp shall be then reapplied and the test continued in accordance with the requirements of Section 7.7 of BS EN IEC 61897 or clause 7.5.2.4 of BS EN 61854

3.9.5. Damper Weight Attachment

Damper weight attachment tests on Stockbridge type Aeolian vibration dampers shall be undertaken in accordance with the requirements of Section 7.8 of BS EN IEC 61897.

3.9.6. Clamp Attachment

Clamp attachment tests on Stockbridge type Aeolian vibration dampers shall be undertaken in accordance with the requirements of Section 7.9 of BS EN IEC 61897.

3.9.7. Corona

Visible corona type tests shall be undertaken on phase conductor Aeolian vibration dampers in accordance with the requirements of Section 14 of BS EN 61284.

The Contractor / Manufacturer shall submit details of his proposed spacing between sub-conductors and the electrical clearance between the Aeolian vibration dampers and the earthed metal work. Clearances to other objects, whether earthed or at high voltage, shall be sufficient to ensure insignificant electrical field effects on the test fitting(s).

3.9.8. Damper Characteristics

Aeolian vibration damper performance tests shall be undertaken in accordance with variant B of Section 7.11.1 of BS EN IEC 61897. To establish the characteristics of the Aeolian vibration dampers used in the damping effectiveness evaluation and the damping fatigue tests, damper characteristics tests shall be undertaken in accordance with the recommendations of Section 7.11.2 of BS EN IEC 61897.

3.9.9. Damping Effectiveness Evaluation

The determination of Aeolian vibration damper damping effectiveness shall be undertaken by laboratory test. The laboratory test shall be undertaken in accordance with the recommendations of Section 7.11.3.2 of BS EN IEC 61897. Prior to installation on the laboratory test span the test Aeolian vibration damper shall have been previously subjected to the 'Characteristic' test specified in the preceding clause.

3.9.10. Damper Fatigue Test

The Aeolian vibration damper fatigue test may be undertaken either using the swept frequency method or the resonant frequency method. The test shall be undertaken in accordance with the recommendations of Section 7.12.2 or Section 7.12.3 of BS EN IEC 61897.

3.9.11. Sample Tests

Visual examination, dimensional, materials and finish including that of any coating, e.g. galvanizing and mechanical sample tests on Aeolian vibration dampers shall be undertaken in accordance with the requirements of this Specification and BS EN IEC 61897.

Visual examination shall also include comparison with archived type test sample.

Where specified, similar test procedures to those used for type tests shall be repeated for sample tests.

The acceptance criteria for the sample damper effectiveness evaluation test shall be in accordance with the requirements of Table 3 variant B of BS EN IEC 61897.

4. References

4.1. External Documentation

The products described within this specification shall comply with the latest versions of the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENATS) current at the time of supply

Reference	Title
BS 8100-1 1986 (Withdrawn but definition remains valid)	Lattice towers and masts. Code of practice for loading Code of practice for loading
BS EN 50189	Conductors for overhead lines – Zinc coated steel wires.
BS EN 61284	Overhead lines – Requirements and tests for fittings.
BS EN IEC 61854	Overhead lines – Requirements and tests for spacers.
BS EN IEC 61897	Overhead lines – Requirements and tests for Stockbridge type Aeolian vibration dampers.
BS EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.
ENA TS 43-125, Part 3	Design guide and technical specification for overhead lines above 45 kV, Part 3 Vibration dampers and spacers

4.2. Internal Documentation

Reference	Title
1091010188	Aeolian Vibration Dampers

4.3. Amendments from Previous Version

Reference	Amendments
3.1 General	ENA TS 43-125, Part 3 reference added
4.1 External Documentation	Reference documents updated

5. Definitions

Term	Definition
Spacer Damper	A flexible spacer comprising clamps having arms in the vertical plane connected to a rigid frame by means of semi-conducting elastomeric components, but having defined stiffness properties and suitable for “in-span” application
Stockbridge type Aeolian vibration damper	A device comprising a messenger cable with a weight at each end and one bolted clamp, attached to a conductor for the purpose of damping Aeolian vibration.

6. Authority for Issue

6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		Date
Liz Beat	Governance Administrator	23/01/2024

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

Review Period - This document should be reviewed within the following time period.

Standard CDS review of 3 years?	Non Standard Review Period & Reason	
Yes	Period: n/a	Reason: n/a
Should this document be displayed on the Northern Powergrid external website?		Yes
		Date
Steven Salkeld	Policy and Standards Engineer	23/01/2024

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		Date
Ged Hammel	Senior Policy and Standards Engineer	23/01/2024

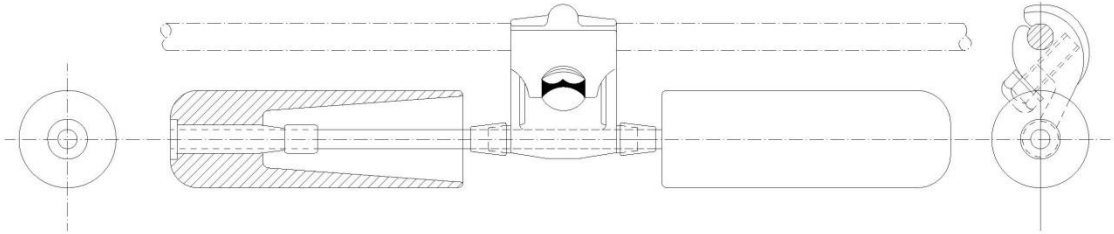
6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Paul Black	Head of System Engineering	22/02/2024

Appendix 1 – Schedule of requirements - Aeolian Vibration dampers

CAT. No.	
ITEM 1	241924
ITEM 2	241943
ITEM 3	241962
ITEM 4	250800
ITEM 5	241982



CONDUCTOR		NAME	DIA. mm / in		SPACING
60mm² ACSR	12/7/2.59mm	SKUNK	12.95 (.510)	ITEM 1	760mm
70mm² ACSR	12/7/2.79mm	HORSE	13.95 (.550)	ITEM 1	840mm
100mm² ACSR	6/4.72 & 7/1.57mm	DOG	14.15 (.557)	ITEM 1	840mm
150mm² ACSR	18/1/3.35mm	DINGO	16.75 (.660)	ITEM 2	990mm
150mm² ACSR	30/7/2.59mm	WOLF	18.13 (.714)	ITEM 3	1070mm
175mm² ACSR	18/1/3.61mm	BURGS	16.4 (.646)	ITEM 2	990mm
			COMPACTED		
175mm² ACSR	30/7/2.79mm	LYNX	19.53 (.770)	ITEM 3	1140mm
175mm² ACSR	18/1/3.61mm	CARACAL	18.05 (.711)	ITEM 3	1070mm
100mm² AL. ALLOY	7/4.65mm	OAK	13.95 (.550)	ITEM 1	840mm
175mm² AL. ALLOY	19/3.76mm	ELM	18.8 (.740)	ITEM 3	1070mm
200mm² AL ALLOY	33/2.87mm	POPLAR	20.1	ITEM 5	800mm
300mm AL. ALLOY	37/3.53mm	UPAS	24.71 (.973)	ITEM 4	1300mm

NOTE
1. SPACING DIMENSION TO BE TAKEN FROM END OF COMPRESSION TERMINATOR AT SECTION POINT OR FROM TONGUE ENDED SUSPENSION CLAMP.

NORTHERN POWERGRID
Manufacturer Details

Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF

VIBRATION DAMPER

Sheet No. 1 | Scale N.T.S.
Prepared By
Type OVERHEAD LINES
Revised 23/11/11 | Grid Reference
Date Issued 08/08/07 | Checked By G HAMMEL
Ref No. C951106 | Historic Drg.No. 1091010188
Revision E Notes

Appendix 1a – Schedule of requirements – spacer dampers

Commodity Code	Description	Drawing Number
241924	Item 1 – see drawing for conductor sizes	1091010188 sht1
241943	Item 2 – see drawing for conductor sizes	1091010188 sht1
241962	Item 3 – see drawing for conductor sizes	1091010188 sht1
250800	Item 4 – see drawing for conductor sizes	1091010188 sht1
241982	Item 5 – see drawing for conductor sizes	1091010188 sht1

APPENDIX 2 -SELF CERTIFICATION CONFORMANCE DECLARATION

Aeolian vibration dampers covered by BS EN 61897 shall comply with the latest issues of the relevant international and British Standards.

This check sheet identifies the clauses within those documents. The manufacturer shall declare conformance or otherwise, clause by clause, using the following levels of conformance declaration codes.

Conformance declaration codes
N/A = Clause is not applicable/ appropriate to the product
Cs1 = The product conforms fully with the requirements of this clause
Cs2 = The product conforms partially with the requirements of this clause
Cs3 = The product does not conform to the requirements of this clause
Cs4 = The product does not currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to conform.

Instructions for completion
- When Cs1 code is entered no remark is necessary
- When any other code is entered the reason for non-conformance shall be entered
- Prefix each remark with the relevant 'BS EN' or 'ENATS' as appropriate

Manufacturer:
Product Reference:

Name: **Signature:** **Date:**

Aeolian vibration dampers

Table 1

	BS EN IEC 61897		
Clause / Sub-clause	Type Test Requirements	Conformance Code	Remarks
4.2	Materials		
4.6	Marking		
4.7	Installation Instructions		
7.1	Visual examination		
7.2	Verification of dimensions, materials and mass		
7.3	Corrosion protection tests		
7.4	Non-destructive tests		
7.5	Clamp slip test		
7.6	Breakaway bolt tests		
7.7	Clamp bolt tightening test		
7.8	Attachment of weights to messenger cable tests		
7.9	Attachment of clamp to messenger cable test		
7.10	Corona and radio interference tests		
7.11	Damper performance tests - Damper characteristic tests - Damper effectiveness evaluation		
7.12	Damper fatigue tests		

Spacer dampers

Table 2

	BS EN 61854		
Clause / Sub-clause	Type Test Requirements	Conformance Code	Remarks
4.2	Materials		
4.6	Marking		
4.7	Installation Instructions		
7.1	Visual examination		
7.2	Verification of dimensions, materials and mass		
7.3	Corrosion protection tests		
7.4	Non-destructive tests		
7.5.1	Clamp slip test		
7.5.2	Breakaway bolt tests		
7.5.2.4	Clamp bolt tightening test		
7.5.3	Simulated Short Circuit Current test		
7.5.4	Characteristics of elastic and damping properties		
7.5.5	Flexibility tests		
7.5.6	Fatigue Tests		
7.6	Tests to characterise Elastomers		
7.7	Electrical tests		
7.7.1	Corona and radio interference tests		
7.7.2	Electrical resistance tests		