Overhead transmission lines
Vibration dampers

Introduction
This document in English shall be regarded as a translation of the corresponding guidelines in Swedish. The aim of the translation is to provide support to foreign manufacturers. The wording in Swedish and the interpretation thereof shall govern contract and legal relations between the parties of the purchasing process.

This technical guideline deals with the requirements for dampers for use on steel reinforced aluminium and aluminium alloy conductors according to SvK TR 05-04E for overhead lines and comprise design, testing and installation. The purpose of the guideline is to guarantee satisfactory performance of the vibration dampers during the lifetime of the overhead transmission line and shall be used for the purchase of vibration dampers.

Technical guideline for vibration dampers with preformed helical rods for overhead earth wire, see TR 05-09-2E.
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1 References

Note that standards, regulations etc. which are referred to in these guidelines are subject to continuous change and can be withdrawn, revised or replaced. The contractor shall immediately inform the client of such changes.

SS 2173  Diameters of spot facings, counter-bores and countersinks - Screws and nuts with ISO metric screw threads and tapping screws

SS-EN 20898-2  Mechanical properties of fasteners - Part 2: Nuts with specified proof load values - Coarse thread

SS-EN 61284  Overhead lines – Requirements and tests for fittings

SS-EN 61897  Overhead lines - Requirements and tests for Stockbridge type aeolian vibration dampers

SS-EN ISO 1461  Hot dip galvanized coatings on fabricated iron and steel articles -- Specifications and test methods

SS-EN ISO 3506-1  Mechanical properties of corrosion-resistant stainless-steel fasteners - Part 1: Bolts, screws and studs

SS-EN ISO 3506-2  Mechanical properties of corrosion-resistant stainless-steel fasteners - Part 2: Nuts

SS-EN ISO 9001  Quality management systems - Requirements

SS-ISO 272  Fasteners -- Hexagon products -- Widths across flats

SS-ISO 898-1  Mechanical properties of fasteners made of carbon steel and alloy steel -- Part 1: Bolts, screws and studs

SS-ISO 2178  Non-magnetic coatings on magnetic substrates - Measurement of coating thickness - Magnetic method

SS-ISO 5455  Technical drawings - Scales

SS-ISO 7091  Plain washers - Normal series - Product grade C

SvK TR 05-04E  Technical guidelines- Conductors
2 Scope

These guidelines are applicable to Stockbridge type vibration dampers which will be used on steel reinforced aluminium and aluminium alloy conductors according to SvK TR 05-04E for overhead lines and comprise design, testing and installation.

The intention of the specification is to guarantee satisfactory performance of the vibration dampers during the lifetime of the overhead line.

The vibration dampers function is to minimise the effect of wind-induced vibrations.

To guarantee the suitability of the dampers a series of three tests has been compiled. The tests shall be performed on the same specimen of damper.

The intention of the first test is to establish the dynamic characteristics of the damper.

The intention of the second test is to establish the damper effectiveness and is performed on a conductor in a test-span.

The intention of the third test is to guarantee sufficient effectiveness of the damper during its entire lifetime. The damper is first exposed to fatigue corresponding to the conductors calculated lifetime. Then it is verified that the dynamic characteristics have not deteriorated significantly.
3 Definitions

Technical terms and definitions used in these regulations:

**Messenger cable**
That part of the damper which attaches the damper weights to the clamp.

**Damper weight**
That part of the damper which is attached to each end of the messenger cable.

**Clamp**
That part of the damper which attaches the damper to the conductor.

**Highest voltage for equipment**
The highest phase-to-phase voltage for which the equipment is designed. Highest voltage for equipment is designated $U_m$ in this document.

**Corona extinction voltage**
The voltage where no corona is visible when the voltage is reduced from a level with visible corona.

4 Description

Vibration dampers shall be of the Stockbridge type and be able to be used on phase conductors and shield wires. Dampers comprise a clamp and a messenger cable with a weight attached to each end. These weights can have equal or different masses and be symmetrical or asymmetrical in shape. In addition they can be symmetrically or asymmetrically placed on the messenger cable relative to the clamp.

5 Requirements

5.1 General
Dampers shall be able to withstand the mechanical stresses which can occur during transport, handling and installation at temperatures as low as −40 °C, in addition to the mechanical stresses which can occur during the lifetime of the overhead line at temperatures from −50 °C to +100 °C.
5.2 Material

5.2.1 Included parts
All parts of the damper shall be manufactured of metal. Parts which are not of stainless steel shall be hot-dip galvanised according to SS-EN ISO 1461. The thickness of the zinc layer shall fulfil the requirements of SS-EN ISO 1461, Table 2 and 3.

5.2.2 Clamp
The clamp shall be manufactured of aluminium alloy containing a maximum of 0.10 % Cu. The alloy shall be resistant to intercrystalline, layer and stress corrosion.

5.2.3 Bolts and nuts
Bolts and nuts shall be made of stainless steel which shall fulfil the requirements of quality A2-80 according to SS-EN ISO 3506. The mechanical properties shall conform to SS ISO 898-1 respectively SS-EN 20898-2.

5.2.4 Washers
To provide sufficient resistance to corrosion washers shall be made of stainless steel with a minimum quality equivalent to A2 of SS-EN ISO 3506. Washers shall have a minimum hardness of 240 HB

5.2.5 Threaded inserts
To provide sufficient resistance to corrosion threaded inserts shall be made of stainless steel with a minimum quality equivalent to A2 of SS-EN ISO 3506. The required mechanical properties shall be equivalent to those given for bolts and nuts in Clause 5.2.3

5.3 Design

5.3.1 Damper
Dampers shall be so designed that it is possible, with hot line tools, to install and remove them from live conductors without completely dismantling the parts of the damper. It shall be possible to hang the damper on the conductor without tightening the bolt of the clamp.

Dampers shall be designed to avoid water accumulation. Holes for drainage, if any, shall have a minimum diameter of 6 mm.

5.3.2 Clamp
The clamp shall fit to the conductors listed in SvK TR 05-04E.

5.3.3 Conductor groove
The conductor groove of the clamp shall fit the conductor diameter and be free from irregularities and sharp edges. The conductor groove may not contain non-metallic materials.
5.3.4 Damper weights
Damper weights may not, under any circumstances, clash with the conductor when installed.

5.3.5 Bolts and nuts
Bolts and nuts shall have M12 metric threads with 18 mm width across flats according to SS-ISO 272. For conductors with a diameter of less than 17 mm bolts and nuts with M10 metric threads and 16 mm width across flats are acceptable.

Bolts shall be long enough to protrude outside the thread of the nut. Counter-bores and countersinks shall be made in accordance with SS 2173.

5.3.6 Washers
Washers shall be manufactured in accordance with SS-ISO 7091.

Clamps shall be provided with a washer under the bolt head and/or under the nut. The washer shall be designed so as to avoid damage to the clamp under the washer.

5.3.7 Hot-dip galvanising
Hot-dip galvanising shall be performed after all fabrication has been completed with the exception of the cutting of the messenger cable. The cut ends of the messenger cable shall be protected from corrosion by an agreed means.

5.3.8 Welding
Welding is not permitted.

5.3.9 Marking
The clamp shall be marked with raised or indented / stamped characters with a minimum height of 3 mm as follows:

- Trademark of the manufacturer
- Type or catalogue number
- Conductor diameter
- Bolts and nuts to be marked in accordance with SS-EN ISO 3506
- Year of manufacture.

5.4 Mechanical requirements

5.4.1 Damper
Dampers shall be able to withstand the mechanical stresses which can occur during their lifetime.
5.4.2 Clamp
It shall be possible to tightening the clamp sufficiently to secure the dampers position without damaging or cause premature fatigue damage to the conductor under the clamp. The clamp shall be able to withstand a torque of 110 Nm without causing breakage of any parts.

5.5 Electrical requirements

5.5.1 Corona
Dampers for phase conductors shall have no visible corona at the test voltage defined by:

\[
\text{Test voltage} = \frac{U_m}{\sqrt{3}} * 1,1
\]

Where \( U_m \) is 245 kV or 420 kV respectively.

5.5.2 Radio interference
The dampers shall be conductive to avoid radio interference.

5.6 Damping requirement

5.6.1 Damper
Dampers shall, during the calculated technical lifetime, give effective damping within the temperature range of -50 °C to +100 °C.

5.6.2 Damping effectiveness
When testing damping effectiveness the measured power input from the shaker shall exceed the theoretical calculated wind power input within the frequency range 185/D Hz to 1295/D Hz, where D is the conductor diameter in mm. The minimum frequency should however be 8 Hz. An example of graphs for damping effectiveness is given in figure 2.

5.6.3 Dynamic characteristics
The dampers dynamic characteristics after fatigue shall not show any significant differences to that before fatigue.
6 Type test

6.1 General
Unless otherwise agreed type tests shall be performed in accordance with Clauses 6.2 to 6.12 on three (3) test samples. Tests in accordance with Clauses 6.2 to 6.6 shall be performed on the same damper.

Type tests shall be performed in such a way that neither the method nor the equipment affects the result.

6.2 Dimensions
The intention of this test is to check that the damper fulfils the requirements in accordance with Clause 5.3 and also is in accordance with the manufacturers drawing regarding measurements.

6.3 Thickness of zinc coating
This test shall be performed in accordance with SS ISO 2178. Each sample shall be subject to, depending on size, 3 to 10 measurements. The points of measurement shall be evenly and randomly distributed over the entire sample surface.

The minimum and average layer thickness requirements in accordance with 5.2.1 shall be fulfilled.

6.4 Dynamic characteristics
The intention of this test is to verify the dynamic characteristics for each type of damper.

The damper shall be mounted on a shake table capable of being vibrated with constant velocities of 0.05 m/s and 0.1 m/s within the frequency range 165/D to 1480/D Hz, where D is the conductor diameter in mm. The frequency shall be varied either continuously with a maximum of 0.2 decades/minute or stepwise with a maximum interval of 1 Hz. The vibration shall be stable at each step when using stepwise measurement.

The following values shall be measured and shown on graphs as a function of the frequency within the given frequency range:

- \( F_\nu \) (Reaction force) (N)
- \( \phi \) (Phase angle, between reaction force and velocity)
- \( P_w \) (Damper power dissipation) (W)
where

\[ P_w = 0.5 \times F_0 \times v \times \cos \phi \] (W)

- \( F_0 \) = reaction force, r.m.s. value (N)
- \( v \) = velocity, r.m.s. value (m/s)
- \( \phi \) = phase angle, between reaction force and velocity (degrees)

### 6.5 Damping efficiency

The intention of this test is to verify that the damping system, i.e. with the damper installed on the conductor, is efficient enough to protect the conductor from fatigue damage.

Tests with alternative measurements are also acceptable. These alternative tests are specified by substituting the paragraphs in **bold** with the paragraphs in *italics* marked *Alt.*

The same damper which has been tested in accordance with Clause 6.2 shall be used.

The test shall be conducted on a laboratory span with a minimum length of 30 m. This test span shall be arranged in accordance with the guidelines of Cigré, Ref. 1 and Ref. 2 and figure 3.

Conductor type and tension shall be selected from Table 1. With agreement between the supplier and the purchaser, conductors not specified in Table 1 may be used. This alternative conductor shall be equal or less in diameter, have the same basic design, i.e. equal number of strands and the same characteristic impedance as the conductor specified in Table 1.

\[ Z = \sqrt{T \times m} \] (characteristic impedance) (kg/s)

where

- \( T \) = conductor tension (N)
- \( m \) = weight per metre of conductor (kg/m)

All particulars stated in Table 1 shall be given for the alternative conductor.

After the conductor has been tensioned a square-faced clamp shall be installed to support the conductor at the end where the damper is to be installed. The radius at the end of the square-faced clamp shall be a maximum of 2 mm. The conductor groove of
the square-faced clamp shall be exactly suited to the conductor diameter. The clamp shall not be used for maintaining the conductor tension.

The damper shall be installed at the distance from the square-faced clamp which is given in Table 1.

**Strain gauges shall be attached to the conductor at three positions in the span, adjacent to the square-faced clamp and on each side of the damper clamp.** The strain gauges, there being a minimum of two at each position, shall be installed on the two uppermost strands of the conductor to monitor the highest tension at each position. For this reason the strain gauges shall be installed a maximum of 2 mm from the end of each clamp.

*Alt* The conductor bending amplitude shall be monitored at three positions in the span, adjacent to the square-faced clamp and on each side of the damper clamp.

The test span shall be vibrated in steady waves within the frequency range 185/D Hz to 1295/D Hz where D is the conductor diameter in mm according to Table 1. The minimum frequency should however be 8 Hz.

**The power input shall be adjusted at each tuneable frequency until the highest strain reading corresponds to 150 µm/m (peak-to-peak).**

*Alt* The power input shall be adjusted at each tuneable frequency until the highest bending amplitude reading corresponds to a strain of 150 µm/m (peak-to-peak).

The bending amplitude at a distance of 89 mm from the square-faced clamp is to be calculated in accordance with the EPRI formula. Ref. 3.

- At each tuneable frequency the following shall be recorded:
  - Power input from the shaker.
  - The conductor antinode peak-to-peak amplitude in one of the first four loops near the damper.
  - The strain at the three points of measurement in the test span.

*Alt* The bending amplitude at the three points of measurement in the test span.

The wind power input shall be calculated in accordance with:

\[ P = F(Y/D) \times D^4 \times F^3 \times L \ (W) \]

where
\[ P = \text{calculated wind power input in Watts}\]
\[ D = \text{conductor diameter in metres in accordance with SvK TR 05-04E}\]
\[ F = \text{tuneable frequency in Hertz}\]
\[ Y = \text{the conductors antinode amplitude peak-to-peak in metres}\]
\[ f(Y/D) = \text{function of the conductors antinode amplitude peak-to-peak, expressed as the conductor diameter in accordance with Figure 1.}\]
\[ L = \text{span length in metres. The calculation shall be made for } L=370\text{ m.}\]

The recorded energy input from the shaker and the calculated wind power input shall fulfil the requirements of Clause 5.6.2

**For each tuneable frequency graphs shall be presented with the following data plotted against the frequency within the given frequency range:**

- strain at all three points of measurement
- the conductor antinode amplitude peak to peak
- power input from the vibrating unit
- calculated wind power input

**Alt**

For each tuneable frequency graphs shall be presented with the following data plotted against the frequency within the given frequency range:

- strain at all three points of measurement
- the conductor antinode amplitude peak to peak
- power input from the shaker
- calculated wind power input

### 6.6 Dynamic characteristics after fatigue

#### 6.6.1 Fatigue

The same damper which has been subjected to testing in accordance with Clauses 6.2 and 6.3 shall be used.
The damper shall be installed on a shake table capable of being vibrated vertically 1x10⁷ cycles at the tuneable frequency which is closest to the frequency 555/D Hz, where D is the conductor diameter in mm.

The minimum peak-to-peak amplitude at the damper clamp shall be equal to the conductor amplitude peak-to-peak recorded at the equivalent tuneable frequency.

6.6.2 Dynamic characteristics after fatigue
After that the fatigue test has been performed in accordance with Clause 6.6.1 the same damper shall be subjected to a repeated dynamic characteristic test to verify that the dynamic characteristics are sustained.

This repeated test shall be performed and the results presented in accordance with Clause 6.4. The graph shall have the same scale as for dynamic characteristics before fatigue.

The dynamic characteristics of the damper shall fulfil the requirements of Clause 5.6.3.

6.7 Attachment of weight to messenger cable
Test shall be performed in accordance with SS-EN 61897 Clause 7.8.

6.8 Attachment of clamp to messenger cable
Test shall be performed in accordance with SS-EN 61897 Clause 7.9.

6.9 Clamp slip test
The intention of this test is to verify that slippage does not occur between the clamp and the conductor.

The damper shall be installed on the same type of conductor as when testing is performed in accordance with Clauses 6.1 – 6.10 inclusive. The installation torque shall be 60 Nm and a load in line with the conductor shall be applied to the clamp.

No slippage may occur at a minimum applied load of 4 kN.

6.10 Conductor damage
The intention of this test is to verify that no damage is caused to the conductor by the clamp.

The damper shall be installed on the same type of conductor as when testing is performed in accordance with Clauses 6.1 to 6.10. The installation torque shall be 80 Nm.

The clamp shall then be removed and the conductor visually examined to verify that it has not been damaged or deformed in such a way that fatigue damage could occur prematurely.
6.11 Tightening
The intention of this test is to verify that the strength of the clamp is sufficient.

The clamp shall be installed on a steel- or aluminium-rod with the same diameter as the conductor for which the clamp is designed. The tightening torque shall be in accordance with Clause 5.4.2.

Rupture shall not occur in any of the parts of the clamp and the bolt shall be easily turned by hand when slackened.

6.12 Corona
The intention of this test is to establish the corona extinction voltage and shall be performed in a fully-darkened room. During the corona test the use of either binocular with a minimum optical performance of 7x50 or an image intensifier with light amplification greater than 40000 in accordance with SS-EN 61284 is recommended.

Dampers shall be arranged and installed on conductors or rods in accordance with Table 1. The rods shall have a diameter within +0.25 mm of the conductor diameter in accordance with Table 1. The dampers shall be subjected to 50 Hz of alternating current. The corona extinction voltage shall be recorded by colour photographs one with visible corona and another at the corona extinction voltage level, with the voltage levels being indicated on the photographs. It is only necessary to test one damper arrangement for each size. This can be performed on either a twin or triple conductor bundle in the case of conductor bundles.

The corona extinction voltage shall exceed that specified in Table 1.

7 Sample test

7.1 General
Sample tests shall be carried out by the manufacturer on dampers selected at random from the lot to be supplied.

Test samples shall be supplied by the manufacturer free of charge to the client and shall not be included in the lot to be supplied.

Results of the sample tests shall comply with the manufacturer’s documentation on which the type test approval was based in accordance with Clause 8.

The sizes of the test sample are indicated in the table below.
The samples shall be subject to testing in accordance with Clauses 7.2-7.9. Dampers which have been submitted to test shall be discarded.

The manufacturer shall inform the client when sample tests will be executed.

Records from the sample tests shall be filed by the manufacturer and be shown to the client on request. In the case where any component does not comply with the requirements, re-testing shall be performed as below.

If only one damper or part thereof, fails to comply with the sample test requirement, a new sample equal to twice the quantity originally submitted for that test shall be subject to re-testing. The re-testing shall comprise the test or tests in which failure occurred.

If two or more dampers, or parts thereof, fail to comply with any of the sample tests, or if any failure occurs during re-testing, the complete lot shall be considered not to comply with the requirements.

Provided that the cause of the failure can be clearly identified, the manufacturer may sort the lot to eliminate all the dampers with this defect. The sorted lot shall then be resubmitted for sample testing. The number then selected shall be three times the first quantity chosen for the test. The re-testing shall comprise the test or tests in which failure occurred in the original test.

If any damper, or part thereof of the sorted lot, fails during this re-testing, the complete lot shall be considered as not complying with the requirements.

7.2 Dimensions
This test shall be performed in accordance with Clause 6.2

7.3 Thickness of zinc coating
This test shall be performed in accordance with Clause 6.3
7.4 Dynamic characteristics
This test shall be performed in accordance with Clause 6.4

The reaction force and phase angle between the reaction force and velocity shall be measured and plotted against the frequency within the given frequency range. The corresponding graphs from the type test shall be plotted on the same chart.

7.5 Attachment of weight to messenger cable
Test shall be performed in accordance with SS-EN 61897 Clause 7.8.

7.6 Attachment of clamp to messenger cable
Test shall be performed in accordance with SS-EN 61897 Clause 7.9.

7.7 Clamp slip test
This test shall be performed in accordance with Clause 6.9.

7.8 Conductor damage
This test shall be performed in accordance with Clause 6.10

7.9 Tightening
This test shall be performed in accordance with Clause 6.11.

8 Delivery

8.1 General
The client shall, according to these guidelines, approve the vibration dampers before delivery. For approval the manufacturer shall demonstrate that the dampers conform to these guidelines.

The manufacturer shall provide documentation in accordance with Clauses 8.2.1-8.2.6 for approval.

The approval of drawings by the client does not release the manufacturer from his obligations regarding the vibration dampers complying with these guidelines.

All documentation shall be written in Swedish or English.

8.2 Documentation
General requirements for documentation see SvK TR 08.
8.2.1 Assembly drawing
The assembly drawing shall have a minimum of two views at an appropriate scale in accordance with SS ISO 5455. On the drawing shall be given:

- Type and/or Catalogue number
- Principal dimensions
- The dimensions of the conductor groove with tolerances
- Maximum and minimum conductor diameter for the vibration damper clamp
- The width across flats of the bolts and nuts
- Installation torque
- All marking
- Weight
- List of materials

8.2.2 List of material
Description of material in included parts.

8.2.3 Manufacturing process
Description of the manufacturing process

8.2.4 Quality system
Quality system in accordance with SS-EN ISO 9001.

8.2.5 Installation instructions
Installation instructions in Swedish or English with the required drawings

8.2.6 Reports
Reports in accordance with Clause 6 and 7.

8.3 Transport and storing
The vibration dampers shall be packed up in that way that they will not be damaged or fouled at transport, construction and storing.
9 Installation

9.1 General
Installation on the conductor shall be performed in accordance with the installation instructions. The distance between the centre of the suspension clamp, or the mouth of the tension clamp, and the first damper shall be in accordance with Table 1. When the jumper is attached in the span by the means of a bolted connector outside the dead end clamp the distance to the damper in accordance with Table 1 shall be measured from the bolted connector. Where two or more dampers are specified the distance between subsequent dampers shall be 1.0 metres. See Figures 4 and 5.

Vibration dampers according to these guidelines shall be used for all new line construction and for lines to be reinforced or reconstructed.

The number of dampers as specified in Table 2 is based on the use of suspension clamps in accordance with SvK TR 05-05E.

On lines with twin or triple bundle conductors all spans shall be fitted with a minimum of one damper per conductor.

9.2 Installation

9.2.1 Suspension insulator string on intermediate structures
The number of dampers per span in accordance with Table 2 is valid for phase conductors and shield wires fitted to suspension clamps on intermediate and angle structures with a line deviation angle of <10°. When the phase conductor or the shield wire is located below the top of trees the number of dampers shall be chosen according to code A2 or B2. For conductors located above the top of trees the number of dampers should be chosen according to code A2 or B2.

When it is anticipated that felling of trees adjacent to the servitude may take place due consideration of this fact should be taken when determining the number of dampers to be installed.

9.2.2 Suspension insulator string on angle structures
A minimum of one damper per conductor shall be fitted on each side of the suspension clamp at angle structures with line deviations ≥ 10° where

- the spans exceed 100 m
- the phase conductor size is greater than 474 mm²
- the shield wire size is greater or equal to 142mm²
For other cases the number of dampers per span in accordance with Table 2 is valid. When the phase conductor or the shield wire is located below the top of trees the number of dampers should be chosen according to code A1 or B1. For conductors located above top of trees the number of dampers should be chosen according to code A2 or B2.

9.2.3 Tension insulator strings
At tension and transposition insulator sets a minimum of one damper shall be fitted per conductor when the span length exceeds 100 m and a minimum of two dampers when the span length exceeds 200 m. This applies when the phase conductor is greater than 474 mm² and the shield wire is greater or equal to 142 mm². For other cases the number of dampers per span in accordance with Table 2 is valid. When the phase conductor or the shield wire is located below the top of trees the number of dampers should be chosen according to code A2 or B2. For conductors located above the top of trees the numbers of dampers should be chosen according to code A2 or B2.
10 Tables

Table 1 Conductor, Damper and corona (also for Al-59 and AlMgSi conductors)

<table>
<thead>
<tr>
<th>Conductor</th>
<th>Damper</th>
<th>Corona test</th>
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<tbody>
<tr>
<td></td>
<td>Type</td>
<td>Distance  1)</td>
</tr>
<tr>
<td></td>
<td>Tension 1)</td>
<td>Type</td>
</tr>
<tr>
<td>142 FeAl</td>
<td>11000</td>
<td>A</td>
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<tr>
<td>241 FeAl</td>
<td>19300</td>
<td>B</td>
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<td>319 FeAl</td>
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<td>F</td>
</tr>
<tr>
<td>910/102 FeAl</td>
<td>46900</td>
<td>G</td>
</tr>
</tbody>
</table>

Notes.

1) Conductor tensions to be used for damping efficiency test.

2) Distance from the centre of the suspension clamp, or the distance from the mouth of the tension clamp, to the centre of the damper clamp. When performing the damping efficiency tests this is the distance between the extreme end of the square-faced clamp and the centre of the damper clamp.

3) Test voltage = \[ \frac{U_m}{\sqrt{3}} \times 1,1 \]

4) Single conductor.

5) Twin conductor bundle: Conductors spaced horizontally at 450 mm centres for conductor diameter up to 32 mm and 600 mm for conductor diameter over 32 mm.

Triple conductor bundle: Conductors spaced in an equilateral triangle with the apex downwards at 450 mm centres for conductor diameter up to 32 mm and 600 mm centres for conductor over 32 mm.
<table>
<thead>
<tr>
<th>Terrain</th>
<th>Vegetation</th>
<th>Code-designation</th>
<th>Terrain-factor</th>
<th>Span length (m)</th>
<th>Number of dampers per conductor and span</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hilly or valleys parallel with the line</td>
<td>Other type of vegetation from dense forest on one side to flat terrain with no obstacles</td>
<td>A2</td>
<td>0,8</td>
<td>&lt;150</td>
<td>0 1 2 2</td>
</tr>
<tr>
<td>Flat or valleys perpendicular to the line</td>
<td>Other type of vegetation from dense forest on one side to flat terrain with no obstacles</td>
<td>B2</td>
<td>1,0</td>
<td>150 - 350</td>
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<tr>
<td>Lakes or watercourses</td>
<td></td>
<td>C</td>
<td>1,3</td>
<td>≥350 - 550</td>
<td></td>
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<td>&gt; 550</td>
<td></td>
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11 Figures

Figure 1  Calculated power input

Y = the conductors antinode amplitude peak-to-peak [m]

D = conductor diameter [m]
Figure 2  Curves of damping efficiency (example)

Figure 3  Test span
Figure 4  Installation at suspension insulator set

Figure 5  Installation at tension insulator set