Overhead transmission lines
Tension clamp

Introduction
These guidelines describe the requirements on tension clamps for use on steel reinforced aluminium conductors and aluminium alloy conductors in accordance with TR05-04E for overhead transmission lines and cover design and inspection. The guidelines intend to guarantee satisfactory performance of tension clamps during the lifetime of the overhead line and shall be used at purchasing of tension clamps.

This English text is to be regarded as a translation of the Swedish guideline. The Swedish text and the interpretation thereof shall govern the contract and the legal relations between parties.
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<td>2</td>
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9.1 General
## 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 which are referred to in these guidelines are subject to continuous change and can be withdrawn, revised or replaced.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.

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2 Scope

These regulations are applicable to tension clamps for steel reinforced aluminium and aluminium alloy conductors according to SvK TR 05-04 for overhead lines and comprise design and testing.

The intention of the specification is to guarantee satisfactory performance of the tension clamp during the lifetime of the overhead line.

3 Definitions

Technical terms and definitions used in these regulations:

**Corona extinction voltage**

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

4 Description

4.1 Tension clamp

Device, comprising one or several parts, for the termination of conductors according to SvK TR 05-04, providing a mechanical and electrical connection to an insulator string.

5 Requirements

5.1 General

Tension clamps 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 Wedge and clamp body
The wedge and the clamp body shall be manufactured from aluminium alloy containing a maximum of 0.10 % Cu. The alloy shall be resistant to inter-crystalline, layer and stress corrosion. Further properties of the alloy shall be:

- Hardness min. 75 HBW
- Resistivity max. 60 n \( \Omega \text{m} \) at 20 °C

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

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

5.2.4 Threaded inserts
Threaded inserts shall be made from stainless steel with a minimum quality equivalent to A2 of EN ISO 3506. The required mechanical properties shall be equivalent to those given for bolts and nuts in clause 5.2.2.

5.2.5 Clamp connecting straps
Clamp connecting straps shall be made of hot dip galvanised steel. The thickness of the zinc coating shall conform to EN ISO 1461.

5.3 Design

5.3.1 Tension clamp
It shall be possible to install the tension clamp on a continuous length of conductor. The trunnion of the tension clamp shall be an integral part of the clamp.

5.3.2 Conductor groove
The conductor groove shall suit conductors according to SvK TR 05-04 and be free from irregularities and sharp edges.

5.3.3 Fatigue damages
The tension clamp may not cause fatigue damage on the conductor.
5.3.4 Clamp connecting straps
The hole in the clamp connecting straps for attaching to the tension clamp trunnion shall be of suitable size and shape in relation to its size.

5.3.5 Bolts and nuts
Bolts and nuts shall have M10 or M12 metric threads with 16 mm or 18 mm width across flats respectively according to ISO 272. Bolts and nuts shall be attached to the tension clamp in such a way that they are impossible to drop accidentally. It shall also be possible to tighten them from the upper side of the clamp.

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

5.3.6 Washers
Washers shall be manufactured in accordance with EN ISO 7091.

5.3.7 Attachment
Tension clamps shall, for the attachment to other details, have a clevis type coupling in accordance with SvK TR 05-12

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

- Manufacturer’s trademark
- Type or catalogue number
- Conductor diameter
- Bolts and nuts to be marked in accordance with EN ISO 3506.
- Year of manufacture.

5.5 Mechanical requirements

5.5.1 Tension clamp
Tension clamps shall comply with the mechanical strength requirements of

SS 424 12 53 and SS-EN 50341

5.5.2 Tightening torque
Bolts and nuts shall be tightened to a torque of 44 Nm and 75 Nm for M10 and M12 respectively.
5.5.3 Bolts and threads
Bolts and threads in tension clamps shall, without failure, be able to be tightened to a torque 50% higher than that stated in clause 5.5.2.

5.6 Electrical requirements

5.6.1 Short circuit current
Tension clamps shall withstand the short circuit current given in SvK TR 05-04 maximum of 40 kA. The peak value of the short circuit current shall be 2.3 times its effective value.

5.6.2 Corona
Tension clamps which are to be used for the termination of phase conductors shall, when fitted to an insulator string, conform to the requirements of SvK TR 05-10 clause 5.4.4.

5.6.3 Hysteresis losses
Tension clamps which are to be used for the termination of phase conductors shall cause no hysteresis losses.

6 Type test

6.1 General
Unless otherwise agreed type test shall be performed in accordance with clauses 6.2-6.6 on three test samples. The tests shall be performed in such a way that the method and equipment do not affect the result.

6.2 Dimensions
This test intends to check that the tension clamp fulfils the requirements in accordance with clause 5.3 and also that it is in accordance with the manufacturer's drawing regarding measurements.

6.3 Thickness of zinc coating
This test is to 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 5.2.5 shall be fulfilled.
6.4  Hardness
Hardness tests on aluminium are to be performed in accordance with EN ISO 6506-1.

Measured hardness values shall conform to the requirements of clause 5.2.1.

6.5  Tightening torque
This test intends to verify that the bolts and threads conform to the requirements of clause 5.5.

The test is to be performed in accordance with SS 424 12 53 clause 5.3.

6.6  Mechanical strength
This test intends to verify that the tension clamp complies with the requirements of clause 5.5.1.

The test is to be performed in accordance with clause 5.3 of SS 424 12 53

6.7  Corona
This test intends to verify the corona extinction voltage in a fully assembled insulator string.

The test is to be performed in accordance with SvK TR 05-10 clause 6.5.

7  Sample test

7.1  General
Sample tests are to be carried out by the manufacturer on tension clamps 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.

The size of the test samples are indicated in the table below.

<table>
<thead>
<tr>
<th>Lot size</th>
<th>Sample size</th>
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<tbody>
<tr>
<td>N ≤ 300</td>
<td>1-3 subject to agreement</td>
</tr>
<tr>
<td>300 &lt; N ≤ 2000</td>
<td>4</td>
</tr>
<tr>
<td>2000 &lt; N ≤ 5000</td>
<td>8</td>
</tr>
<tr>
<td>5000 &lt; N ≤ 10000</td>
<td>12</td>
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</tbody>
</table>
The samples shall be subject to testing in accordance with clauses 7.2-7.5. Tension clamps which have been submitted for test shall be discarded.

The manufacturer shall inform the client when sample tests are to be performed.

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 tension clamp, 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 tension clamps, 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 tension clamps 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 tension clamp, 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
The test is to be performed in accordance with clause 6.2.

7.3 Thickness of zinc coating
The test is to be performed in accordance with clause 6.3.

7.4 Hardness
The test is to be performed in accordance with clause 6.4.

7.5 Tightening torque
The test is to be performed in accordance with clause 6.5.
8 Delivery

8.1 General
The client shall, according to these guidelines, approve the tension clamp before delivery. For approval the manufacturer shall show that the tension clamp conforms to the guidelines.

The manufacturer shall provide documentation in accordance with clauses 8.2.1-8.2.7 inclusive for approval.

The approval of drawings by the client does not release the manufacturer from his obligations regarding the tension clamp complying with the guidelines.

All documentation shall be written in Swedish or English.

8.2 Documentation
A summary of documentation requirements in SvK TR 08E.

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
- 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 EN ISO 9001.
8.2.5 Installation instructions
Installation instructions shall be written in Swedish or English with the required figures.

8.2.6 Short circuit current
Test report verifying the compliance of the tension clamp regarding the short circuit current requirement as given in clause 5.6.1.

8.2.7 Reports
Reports in accordance with clause 6 Type test report and 7 Sample test report.

8.3 Transport and storing
The tension clamps 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 manufacturer installation instructions.

The conductor shall be free from dirt and not be damaged when the tension clamp is installed. Conductor adjacent to the tension clamp shall not have protruding wires.