Overhead transmission lines
Joints for conductors

Introduction
These guidelines describe the requirements on joints for steel reinforced aluminium conductors and aluminium alloy conductors in accordance with TR 05-04E for overhead transmission lines and cover design and inspection. The guidelines intend to guarantee satisfactory performance of joints during the lifetime of the overhead line and shall be used at purchasing of joints.

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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<tr>
<th>Notes</th>
<th>Change notes</th>
<th>Date</th>
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<td>1 (A)</td>
<td>Change of template</td>
<td>09 / 07 / 2008</td>
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<td>2</td>
<td>Change of template. Clause 7.8.2.7 and 7.9.1 revised.Clause 7.8.3 added.</td>
<td>02 / 04 / 2012</td>
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<td>3</td>
<td>Clause 7.1 quantity of samples revised. Clause 9.1 installation of joints in crossings revised.</td>
<td>07 / 06 / 2016</td>
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TEKNISK RIKTLINJE 2016-06-07 TR05-07E
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 which are referred to in these guidelines are subject to continuous change and can be withdrawn, revised or replaced. It is the obligation that the contractor immediately will inform the client of such changes.

SS 424 12 41 Overhead line material – Mid-span joints
SS-EN 50341 Overhead electrical lines exceeding AC 45 kV
SS-EN 50326 Conductors for overhead lines - Characteristics of greases
SS-EN 61284 Overhead lines – Requirements and test for fittings
SS-EN ISO 9001 Quality management systems - Requirements
SS-ISO 2178 Non-magnetic coatings on magnetic substrates - Measurement of coating thickness - Magnetic method
SS-ISO 5455 Technical drawings - Scales
SvK TR 05-04E Technical guidelines – Conductors
SvK TR 08E Technical guidelines - Documentation
EBR Maintenance overhead lines 0.4 – 420 kV

2 Scope

These guidelines are applicable to joints for 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 joints during the lifetime of the overhead line.
3 Definition

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 Joint

Device, comprising one or several parts, for joining two lengths of conductor to provide mechanical and electrical continuity. In joints, contrary to clamps, the conductor lengths have a common line of symmetry.

5 Requirements

5.1 General

Joints shall be able to withstand the mechanical stresses which can occur during transport, handling and installation at temperatures as low as \(-40 \, ^\circ\text{C}\), in addition to the mechanical stresses which can occur during the technical lifetime of the overhead line at temperatures from \(-50 \, ^\circ\text{C}\) to \(+100 \, ^\circ\text{C}\).

5.2 Material

Joints shall be made of material in accordance with SS 424 12 41.

5.3 Design

Joints shall have additional corrosion protection and be designed in accordance with SS 424 12 41.

Extended joint, for replacement of existing joint with increased resistance, shall be equipped with a filler rod or with the possibility to fill up the cavity with grease in order to minimize the risk of frost burst.
Grease shall conform to the requirements of SS-EN 50326.

5.4 Marking
The joints 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
- Year of manufacture

5.5 Mechanical requirements
The mechanical strength of joints shall conform to the requirements of SS 424 12 41 and SS-EN 50341.

5.6 Electrical requirements

5.6.1 Resistance
The resistance (R₀, R₄) for joints for phase conductors and shield wires shall be at maximum of 3.5 % of the resistance of a conductor with a length of one (1) metre. The resistance shall be measured from a point on the conductor immediately outside the joint, to a point immediately inside the end of the joint. See Figure 1.

The resistance (R₁) for joints for phase conductors and shield wires shall be a maximum of 55 % of the resistance of a conductor with the equivalent length. The resistance shall be measured from the conductor immediately outside one end of the joint to the conductor immediately outside the opposite end of the joint. See Figure 1.

5.6.2 Corona
The level of the corona extinction voltage for joints for phase conductors shall be equal to that for the conductor.

5.6.3 Fault current
Joints shall withstand the fault current given in SvK TR 05-04E. The peak value of the fault current shall be 2.3 times its effective value.
6 Type test

6.1 General
Unless otherwise agreed the 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 joints fulfil the requirements in accordance with clause 5.3-5.4 and also are in accordance with the manufacturer drawings 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 shall be fulfilled.

6.4 Mechanical strength
This test intends to verify that the joints comply with the requirements of clause 5.5.

The test shall be performed in accordance with clause 5.3 of SS 424 12 41

6.5 Resistance
This test intends to verify that the joints comply with the requirements of clause 5.6.1 and to give reference values for tests after installation.

The joints shall be installed on the conductor in accordance with the installation instructions. The direct current resistances $R_0$, $R_1$, $R_2$, $R_3$, and $R_4$ according to Figure 1, shall be measured. The conductor tension shall be limited to a maximum of 40 N/mm$^2$ during the measurement of all resistances.

6.6 Corona
This test intends to establish the corona extinction voltage and shall be performed in a fully darkened room.
The joint and the conductor shall be installed such that a clearance of 3 metres from live to earth is obtained. The joint shall be exposed 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. The voltage levels should be indicated on the photos.

The test shall be performed in accordance with SS-EN 61284 where applicable.

7 Sample test

7.1 General
Sample tests shall be carried out by the manufacturer on joints and 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 table below.

<table>
<thead>
<tr>
<th>Lot size</th>
<th>Sample size</th>
</tr>
</thead>
<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>
</tr>
</tbody>
</table>

The samples shall be subject to testing in accordance with clauses 7.2-7.3.

The manufacturer shall inform the client when sample tests shall 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 joint 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 joints, 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 joints with this defect. The sorted lot shall then be re-submitted 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 joint, 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 shall be performed in accordance with clause 6.2.

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

8 Delivery

8.1 General
The client shall, according to these guidelines, approve the joint before delivery. For approval the manufacturer shall show that the joint 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 joint/clamp complying with the guidelines.

All documentation shall be written in Swedish or English.

8.2 Documentation
General requirements for documentation see 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 after installation
• All marking.
• Weight.
• List of materials.
• Required compression tools

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 instruction
Installation instructions in Swedish or English with the required figures.

8.2.6 Fault current
Test report verifying the compliance of the joint regarding the short circuit current requirement as given in clause 5.6.3.

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

8.3 Transport and storing
The joints 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
At construction of new lines and reconstruction of old lines, shall joints not be installed in the crossings or spans adjacent to the crossing spans with Svenska kraftnät’s lines, public roads, electrical railways and frequent used non electrical railways.

Installation on the conductor shall be performed in accordance with the manufacturer’s installation instructions.
The conductors ends shall be free from dirt and not be damaged when the joint is installed. Conductor adjacent to the joint shall not have protruding strands.

The jointing installation location shall be so arranged that the joint and the conductor will not be in contact with the ground during preparation and jointing.

The distance from joints, after conductor sagging, to adjacent fittings shall be a minimum of:

- Other joints 50 metres.
- Tension clamps 50 metres.
- Suspension clamps 20 metres.
- Spacers 2 metres.

### 9.2 Measurement of resistance

The resistance of the joint shall be measured after installation. Resistances $R_1$, $R_2$ and $R_3$ in accordance with Figure 2 shall be measured. Resistance $R_1$ shall be equivalent to the entire length of the joint and the measurement shall be performed from the conductor immediately outside one end of the joint to the conductor immediately outside the opposite end of the joint. Resistances $R_2$ and $R_3$ shall be equivalent to the lengths of each joint half and the measurements shall be performed from the conductor immediately outside each end of the joint to the middle of the joint.

Recommended procedures for measurements can be found in the handbook of EBR “Maintenance of transmission lines 0.4 – 420 kV Chapter 303K, measuring of joints”.

Measured resistances, final span number and in which conductor each joint is located shall be documented in records in accordance with Figure 2 and on computer diskette.

If the measured joint resistance exceeds 10% of the resistance of the type test, the joint in question shall be discarded and be replaced by a new joint.
10 Figures

Figure 1  Measurement of resistance, Type test

Figure 1a  Joint for ACSR conductor

Figure 1b  Joint for AAAC conductor

Figure 1c  Extended joint
Figure 2  Measurement of resistance, Installation records

Conductor numbering

<table>
<thead>
<tr>
<th>Phase</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tbody>
<tr>
<td>Triplex</td>
<td>a</td>
<td>b</td>
<td>c</td>
</tr>
<tr>
<td>Duplex</td>
<td>a</td>
<td>b</td>
<td>c</td>
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Towards greater structure number

<table>
<thead>
<tr>
<th>Span No.</th>
<th>Conductor No.</th>
<th>Measured resistance</th>
<th>Installation</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>R1 µΩ</td>
<td>R2 µΩ</td>
</tr>
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<td></td>
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