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Technical specification for fittings of +/-800 kV DC overhead transmission line

+/-800kV 直流输电线路金具技术规范

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1 Scope

This document specifies the general requirements, the technical requirements, the criteria for judgement, the requirements for marking and accompanying documents and the packaging requirements for the fittings of +/-800 kV direct current overhead transmission lines, and describes the corresponding test methods.

This document applies to the design, manufacture, testing and acceptance of the fittings of +/-800 kV direct current overhead transmission lines.

4 General requirements

4.1 Appearance and dimensions. 4.1.1 The appearance quality and the dimensional tolerances of the fittings shall comply with GB/T 2314. 4.1.2 The nominal failing load and the connection type and dimensions of the connecting fittings shall comply with GB/T 2315.

4.2 Materials. 4.2.1 The material of the fittings shall reduce the hysteresis and eddy current losses of the product. 4.2.2 For steel and iron parts with a nominal failing load of 160 kN and above, the tensile strength of the material shall be not lower than 500 MPa. Apart from Q550, 35CrMo and 40Cr, the yield-to-tensile ratio shall be not greater than 0.8. 4.2.3 The material of compression fittings shall be able to withstand cold deformation. 4.2.4 The non-metallic materials used in the parts of the fittings shall resist ageing, shall have sufficient resistance to ozone, to ultraviolet radiation and to atmospheric pollution at the operating temperature, and shall not induce corrosion in the materials they touch.

4.3 Manufacturing process and quality control. 4.3.1 Forged parts of the fittings shall comply with DL/T 768.2. 4.3.2 Pressed parts shall comply with DL/T 768.3. 4.3.3 Aluminium

parts shall comply with DL/T 768.5. 4.3.4 Welded and thermally cut parts shall comply with DL/T 768.6. 4.3.5 Hot dip galvanized parts shall comply with DL/T 768.7.

4.4 Other requirements. 4.4.1 The model designation of the fittings shall comply with DL/T 683. 4.4.2 At 1.1 times the highest operating voltage of the conductor, the fittings shall show no visible corona, the radio interference voltage shall be not greater than 1 000 μV, and the requirements of Annex A shall be met. 4.4.3 The current density over the electrical contact area of the fittings shall be not greater than 0.15 A/mm2.

5 Technical requirements

5.1 Spacers. 5.1.1 Spacers shall comply with DL/T 1098. 5.1.2 Spacers shall be easy to install and remove, shall not damage the conductor under normal operating conditions and shall keep the sub-conductor spacing at the position where they are installed. 5.1.3 The spacer clamp shall be able to take up the slack caused by creep of the conductor and shall grip it firmly without damaging it. 5.1.4 The surface of the spacer clamp shall be free from obvious sharp edges, burrs and similar defects, the transition from arc to arc shall be natural and smooth, and shot blasting may be applied. 5.1.5 Spacers shall withstand the mechanical loads arising under installation, operation (including short circuit) and maintenance conditions. 5.1.6 The longitudinal grip of the spacer clamp shall be not less than 2.5 kN, the failing load of the clamp body shall be not less than 6 kN, the torsional grip torque of the clamp shall meet Table 1 and the tensile and compressive forces of the clamp shall meet Table 2.

5.1.6 Table 1, torsional grip torque of the spacer clamp, in newton metres, against the outside diameter D of the conductor in millimetres, for the hinged clamp and bolted cap clamp on one hand and the preformed clamp on the other: for D not greater than 34.3, 40 and 40; for D greater than 34.3 and not greater than 36.3, 50 and 50; for D greater than 36.3 and not greater than 38.4, 60 and 60; for D greater than 38.4 and not greater than 40.6, 70 and 63; for D greater than 40.6 and not greater than 42.8, 90 and 72; for D greater than 42.8 and not greater than 48.0, 120 and 96. Table 2, tensile and compressive force between the spacer clamps, in kilonewtons, in heavy ice areas and in areas that are not heavy ice areas: for D not greater than 28.0, 6 and 4; for D greater than 28.0, 8 and 6.

5.1.7 A spacer used within the span shall be of flexible construction and shall have damping properties. The joint of the clamp shall be free to move: the clamp shall move not less than +/- 12.5 mm forwards and backwards in the direction of the conductor, not less than +/- 25 mm in the direction perpendicular to the conductor and not less than +/- 12.5 mm in the horizontal direction, and not less than 10 degrees in the conical direction. 5.1.8 The centripetal force of a spacer under short-circuit current may be calculated in accordance with DL/T 1098, and its overall mechanical strength shall meet the requirement of that centripetal force. 5.1.9 The fatigue performance of spacers shall meet DL/T 1098. 5.1.10 The logarithmic decrement of a damping spacer system on a bundled conductor shall be

not less than 0.04. 5.1.11 The clamp joints of a rubber-damped spacer shall all be filled with rubber, the clamp shall be lined with a rubber pad, and DL/T 1098 shall be met. 5.1.12 The body frame and the clamps of the spacer should be produced by solid die forging, pressure casting or low pressure casting, and shall be heat treated and surface finished as required. 5.1.13 Measures shall be taken to prevent the bolts joining the assembled frame and the clamps from working loose.

5.2 Suspension clamps. 5.2.1 Suspension clamps shall comply with DL/T 756 and DL/T 763. 5.2.2 Suspension clamps should be designed to reduce the effect of aeolian vibration on the conductor; the clamp shall have good dynamic characteristics so that its body can rotate freely and easily. 5.2.3 The radius of curvature of the groove in the body of the suspension clamp shall be not less than eight times the diameter of the conductor. 5.2.4 The groove of the suspension clamp, the keeper and the other surfaces in contact with the conductor shall be even and smooth and free from burrs, projections and any other defect that could wear the conductor. 5.2.5 Measures shall be taken to prevent the bolts of the keeper assembly of a conductor suspension clamp from working loose. 5.2.6 The clevis of the suspension clamp shall have adequate wear resistance. 5.2.7 Where armour rods are used when the conductor is installed in the suspension clamp, the ends of the armour rods shall be of the duck-bill form and shall comply with DL/T 763. 5.2.8 The ratio of the grip of the suspension clamp to the rated tensile strength of the conductor shall comply with Table 3.

5.2.8 Table 3, ratio of the grip of the suspension clamp to the rated tensile strength of the conductor, in per cent, against the ratio of the aluminium area to the steel area for aluminium conductor steel reinforced, aluminium alloy conductor steel reinforced, aluminium conductor aluminium-clad steel reinforced and aluminium alloy conductor aluminium-clad steel reinforced: for a ratio not greater than 2.3, 14; for a ratio greater than 2.3 and not greater than 3.9, 16; for a ratio greater than 3.9 and not greater than 4.9, 18; for a ratio greater than 4.9 and not greater than 6.9, 20; for a ratio greater than 6.9 and not greater than 11.0, 22; and for a ratio greater than 11.0, 24. For all-aluminium alloy stranded conductor and aluminium conductor alloy reinforced no area ratio applies and the value is 24.

5.2.9 At the mouth of the suspension clamp (including inside the clamp), the bending stress and the crushing stress should also be considered; the exit angle on one side is generally between 0 degrees and 25 degrees, and may be increased suitably to meet a particular requirement. 5.2.10 The clevis and the other fittings of the suspension clamp shall be made of steel with a tensile strength not lower than 500 MPa, and all the fittings and fasteners made of steel shall be protected against corrosion by hot dip galvanizing. 5.2.11 The body and the keeper of the suspension clamp shall be made of aluminium alloy, and the clamp body should be produced by solid die forging or by casting.

5.3 Tension clamps and joints. 5.3.1 Tension clamps and joints shall comply with DL/T 757

and DL/T 758. 5.3.2 The surface of the aluminium tube of tension clamps and joints shall be smooth and even and free from cracks, delamination and similar defects. 5.3.3 The tapered length of the compression tube of tension clamps and joints shall be not less than one times the diameter of the conductor. 5.3.4 The flat end of the tension clamp and of the jumper clamp should make contact on both faces; the assembly gap shall be not greater than 0.8 mm, the flatness of the contact face shall be not greater than 30 μm, the surface roughness Ra shall be not greater than 3.2 μm, and the outer face shall be even, free from scoring and smooth around its edges. 5.3.5 The coaxiality tolerance between the centre of the steel anchor of the tension clamp and the centre of the steel tube of the joint sleeve shall be not greater than 0.5 mm, and the mouth of the steel tube shall be deburred and radiused. 5.3.6 The grip of tension clamps and joints on the conductor or earth wire shall be not less than 95 % of the rated tensile strength of that conductor or earth wire. 5.3.7 The bodies of tension clamps and joints follow GB/T 3190. The aluminium tube may be a hot extruded or drawn aluminium tube of aluminium purity not lower than 99.5 %, with a tensile strength of not less than 80 MPa, an elongation after fracture of not less than 12 % and a Brinell hardness of not more than 25. 5.3.8 The body material of the tension clamps and joints used with aluminium alloy conductors follows GB/T 3190, with a tensile strength in the range 130 MPa to 150 MPa, an elongation after fracture of not less than 12 %. 5.3.9 The assembly of the aluminium tube of the tension clamp with the sleeve of the jumper plate shall use an effective process to give a tight fit and shall be firmly welded. The material of the jumper plate follows GB/T 3880 (all parts), machined from section. 5.3.10 The steel anchor of the tension clamp and the steel tube of the joint shall comply with GB/T 699 or GB/T 700, with a Brinell hardness of not more than 156. 5.3.11 The steel anchor of the tension clamp shall be machined by a forging process; the steel anchor of the tension clamp and the steel tube of the joint shall not be machined from tube and shall be free from cracks, delamination and scale. The steel anchor is protected against corrosion by hot dip galvanizing, and the bore of the steel tube shall be cleared of zinc after galvanizing.

5.4 Grading rings and shielding rings. 5.4.1 Grading rings and shielding rings shall comply with DL/T 760.3. 5.4.2 The connection of the grading ring and the shielding ring to the fittings of the insulator string shall be convenient to install and reliable in service. 5.4.3 Measures shall be taken to prevent the bolts of the grading ring and shielding ring assembly from working loose. 5.4.4 Grading rings and shielding rings shall have sufficient mechanical strength to withstand a static mechanical load of not less than 2 000 N. Under normal operating conditions the ring body, the connecting bracket and the fasteners shall be free from fatigue damage, loosening and similar defects. 5.4.5 Grading rings and shielding rings should be made of aluminium tube. 5.4.6 During manufacture the ring body shall be free from splitting of the tube, severe distortion and similar defects; the radial deformation of the tube diameter shall be kept within +/- 3 % of the diameter of the aluminium tube, and the tolerance on the bending radius of the ring body shall not exceed +/- 1 % of the radius of the ring.