Eskom	Standard	Technology

Title: **COMPRESSION FITTINGS AND CLAMPS FOR OVERHEAD SUB-TRANSMISSION SYSTEMS**

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1. Introduction

This specification has been prepared on behalf of the Technical Steering Committee for use by Eskom Distribution as a performance specification for purchasing current-carrying compression fittings and clamps for sub-transmission overhead power lines using bare conductors.

2. Supporting clauses

2.1 Scope

This specification covers Distribution Group's requirements for the design, manufacture, testing and supply of current-carrying compression fittings and clamps for Sub-transmission overhead powerlines. It is applicable to clamps for bare ACSR, AAAC and AAC phase conductors and bare galvanised steel wire earth conductors, for use on Alternating Current (AC) system voltages from 44 kV up to and including 132 kV.

2.1.1 Purpose

This document gives the minimum requirements for the design, manufacture, testing, supply, and delivery of sub-transmission overhead powerlines clamps for stranded conductors that will ensure adequate performance and operation within the Eskom system.

2.1.2 Applicability

This document shall apply throughout Eskom Distribution Sub-Transmission Powerlines.

2.2 Normative/Informative Reference

2.2.1 Normative

Parties using this specification shall apply the most recent edition of the documents listed below:

[1] ASTM A370-03a:2003, Standard methods and definitions for mechanical testing of steel products.

[2] ASTM E709:2001, Standard guide for magnetic particle examination.

[3] IEC 60050-466:1990, International Electrotechnical Vocabulary — Chapter 466: Overhead lines.

[4] IEC 60518:1975, Dimensional standardization of terminals for high-voltage switchgear and control-gear.

[5] SANS 61089:1991, Round wire concentric lay overhead electrical stranded conductors.

[6] SANS 61284:1997, Overhead lines - Requirements and tests for fittings.

[7] SANS 121:2000, Hot-dip galvanized coatings on fabricated iron and steel articles – specifications and test methods.

[8] ISO 2859-1:1999, Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection.

[9] ISO 2859-2:1985, Sampling procedures for inspection by attributes — Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection

[10] ISO 3951:1989, Sampling procedures and charts for inspection by variables for percent nonconforming

[11] SANS 7253:1996, Paints and varnishes - Determination of resistance to neutral salt spray.

[12] SANS 9001:2008, Quality management systems — Requirements

[13] BS 3288-1:1997, Insulator and conductor fittings for overhead power lines — Part 1: Performance and general requirements.

[14] SANS 182-2 :2001, Conductors for overhead transmission lines. Stranded aluminium conductors.

[15] SANS 182-3 :2003, Conductors for overhead transmission lines. Aluminium conductors, steel reinforced.

[16] SANS 182-5 :2001, Conductors for overhead transmission lines. Zinc-coated steel wires for conductors and stays.

[17] SANS 1700-9-1:1997, Part 9 Hexagon socket head screws Section 1 Hexagon socket head screws

[18] 32-1034, Eskom procurement and supply chain management.

[19] 240-53113927, Specification for Substation Clamps for Stranded Aluminium Conductors

[20] 240-53113923, Specification for Substation Clamps for Tube Aluminium Conductors.

[21] 240-147806256: Determination of conductor ratings in Eskom

[22] SANS 61897:2020, Overhead lines - Requirements and tests for Aeolian Vibration Dampers

[23] SANS 813:2008, Clamps for Wire ropes

[24] 240-171000175: Technical Evaluation Criteria for Dx HV Overhead Powerlines Compression Fittings and Clamps

[25] 240-152844641: Phase Conductor Standard for Eskom Overhead Lines

[26] SANS 61089: Round wire concentric lay overhead electrical stranded conductors

[27] IEC 60060-1, High-Voltage test techniques – Part 1: General definitions and test requirements.

[28] IEC 61854: Overhead Lines – Requirements and Tests for Spacers.

[29] CISPR 16-1: Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus.

[30] CISPR 18-2: Radio interference characteristics of overhead power lines and high-voltage equipment – Methods of measurement and procedure for determining limits.

[31] ANSI/NEMA CC 1: Electric power connection for substations.

[32] ANSI C119.4: Electric connectors – Connectors to use between aluminium-to-aluminium or aluminium-to-copper conductors.

2.2.2 Informative

[33] 32-9: Definition of Eskom documents.

[34] 32-644: Eskom documentation management standard.

[35] 474-65: Operating manual of the Steering Committee of Technologies (SCOT).

2.3 Definitions

2.3.1 General

Definition	Description
Aluminium conductor Steel reinforced (ACSR)	A reinforced conductor with one or more layers of aluminium wire stranded around a core of galvanised steel wires.
Breaking force	The tensile load being applied when the test specimen breaks or becomes permanently deformed beyond a specified limit.
Compression fitting	A conductor fitting designed to ensure electrical and/or mechanical continuity of the overhead line conductor, in which the force necessary to grip the conductor is provided by permanent plastic deformation of the fitting and all layers of the conductor by an appropriate compression tool.

Definition	Description
Dead-end tension joint	A joint inserted at the end of a conductor for attachment to an insulator tension set, designed to carry the full current and to provide mechanical termination of the conductor.
International Annealed Copper Standard (IACS)	Internationally accepted value for the resistivity of annealed copper, (1,7241 × 10^{-8} Ωm at 20 °C), referred to as 100 % conductivity (see 3.12).
Jumper flag/lug	A fitting that permits electrical continuity from a pad type terminal or by connection to a threaded stud.
Jumper terminal	The pad provided on a dead-end joint that permits electrical continuity with a jumper flag/lug using bolts.
Mid-span tension joint	A fitting inserted between two lengths of a conductor to provide electrical and mechanical continuity of the conductor under working load.
Percent conductivity	The conductivity of a specimen as a percentage of the conductivity of IACS.
Repair sleeve	A special fitting composed of two interlocking parts, that connect to each other to form a tubular sleeve. The sleeve can be installed over a damaged conductor to restore its mechanical and electrical properties.
Specified minimum failure load (SMFL)	The minimum load specified by the purchaser or declared by the supplier at which mechanical failure shall not take place.
Suspension Clamp	Is a fitting for suspending or hanging cables or conductors from a structure. Since the cable is directly connected to the conductor, its specifications need to match with that of the cable to create a perfect connection.
Tension fitting	A fitting designed to ensure electrical and mechanical continuity of the conductor under line tension.
Termination lug	The termination of a conductor that permits electrical connection to other equipment.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
AAAC	All Aluminium Alloy Conductor
AAC	All Aluminium Conductor
ACSR	Aluminium Conductor Steel Reinforced
AQL	Acceptable Quality Level
IACS	International Annealed Copper Standard
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
M-value	Marking Load (in tension test)
SMFL	Specified Minimum Failure Load

2.5 Roles and responsibilities

It is the responsibility of the engineers, end user and manufacturers to completely abide by the criteria set out in this standard together with the requirements mentioned in the referenced documentation.

2.6 Process for monitoring

The Distribution High Voltage Overhead Powerlines Study Committee must ensure that this document is updated, always renewed and current.

2.7 Related/supporting documents

Not applicable.

3. Requirements

3.1 General

Nothing in this specification shall lessen the obligations of the supplier. The supplier shall be fully responsible for the fitting design and its satisfactory performance in service. Approval or acceptance by Eskom shall not relieve the supplier of the responsibility for the adequacy of the design.

3.1.1 Workmanship

All fittings shall have a smooth finish that is free of defects and shall generally be of high-quality workmanship. All fittings shall be made to design dimensions and tolerances given on the manufacturer design drawings.

3.1.2 Drawings

a) Manufacturing drawings, of all fittings, shall be submitted to Distribution Technology for approval at the time of tendering. Eskom shall only use drawings for its own use and will respect confidentiality associated to proprietary information.

b) All drawings shall clearly indicate all critical dimensions and tolerances

c) The material grade and the heat treatment required for individual items shall be clearly indicated on all drawings.

d) Any revision to drawings of fittings being manufactured for and supplied to Eskom shall clearly indicate the revision number and date.

3.1.3 Tolerances

Tolerances shall be ± 0,5 % of a dimension but not less than 0,7 mm. All tolerances shall be subject to Eskom's approval. Fittings found to be outside of the specified tolerance will be rejected.

3.1.4 Scope of fittings

The compression fittings and clamps are required for making connections between various arrangements of stranded conductor and terminal stems. The standard dimensions adopted by Eskom for these items including conductor current ratings as per 240-147806256 are provided on the Technical Evaluation Criteria for Dx Overhead Powerlines Compression Fittings and clamps with document number 240-171000175.:

3.1.5 General principle of the design

The fittings shall be manufactured for compression by hydraulic compression tools using the "ALCAN" die range.

Compression accessories shall be designed with a tapered end such that the pressure will be gradually reduced to zero on that part of the conductor leaving the accessory.

The dies and fittings shall be designed for hydraulic tools with a minimum output force of 890 kN. The tool type shall be approved by Eskom.

The compression fittings shall be designed to allow their application using live line techniques.

Surfaces of compression fittings in contact with the conductor or earth wire shall be protected from contamination before installation by placing plugs in both ends of the fittings or by placing each individual fitting in a sealed transparent plastic bag. The thickness of the plastic material shall be not less than 100 μm.

The compression fittings, when applied to the appropriate conductor, shall comply with the electrical and mechanical requirements (given in 3.1.6 and 3.1.7) of this specification and retain these characteristics during the normal life of the fitting, whilst in an outdoor environment.

3.1.6 Electrical criteria

The compression fittings and clamps shall:

a) provide satisfactory distribution of current in the jointed conductors,

b) sustain the passage of service current and short-circuit current such that the heating produced in the joint is less than that produced in an equivalent length of the conductor it is to joint,

c) not increase the resistance of the elements of the circuit in which they are incorporated relative to the resistance of the reference conductor,

d) provide the lowest possible emission of radio interference voltage, and

e) not contribute to corona levels.

f) have a current carrying capacity greater than the conductor range for which it is intended.

3.1.7 Mechanical criteria

The mounted compression fittings and clamps shall:

a) be unaffected by conductor motion and vibrations, as well as changes of tension, temperature and any other environmental conditions experienced while in service,

b) be resistant to inter-granular and stress corrosion,

c) cause no damage to or have any deteriorating effect on, the conductor outside the joint, because of the method of application,

d) include systems that prevent the loosening of contact during the serviceable life of bolted connections,

e) withstand loads related to installation, maintenance, and service; and

f) withstand a tensile force equal to but not less than the values indicated in Table 1.

Table 1: Mechanical tension load of compression fittings

1	2
Type of fitting	**SMFL as a percentage of the rated tensile strength of the conductor on which the fitting is applied**
Tension	95 %
Non-tension	25 %
Jumper terminal of the dead-end	25 %

3.1.8 Classification of fittings

The fittings shall be characterised by their mechanical role, the function they perform and the principle of design. The fittings covered by this specification are classified in Table 2.

Table 2: Classification of fittings

		Type of fitting				
Item no.	**Criteria**	**Insulator set fittings and earth wire fittings**	**Suspension Clamps**	**Tension Joints and Tension clamps**	**Partial tension fittings**	**Repair sleeve**
1	Principle of shape	Various	Tubular with armour rods	Various	Various	Two inter-locking parts forming tube
2	Principle of application	Permanent with detachable	Detachable	Permanent with detachable	Permanent with detachable	Permanent

Dead end assemblies shall terminate in an oval, steel eye. The steel end fitting, and where applicable the steel tension tube, shall be drop forged in one piece, or machined from a single piece of material. Jumper flags shall be located directly in front of the end fittings and shall be joined to the aluminium body by welding a complete continuous ring around the tube circumference on both sides of the flag. The manufacturer shall ensure that contact surfaces between bolted components are free from oxide formations, moisture or any other contaminants. The contact surfaces should be greased before bolting.

The pad and the tubular portion of the jumper terminal shall not be joined by welding.

3.1.9 Materials and fabrication

The conductive aluminium part of joints shall be made of at least 99 % pure aluminium (aluminium must comply with BS1490) with a conductivity of not less than 50 % IACS at 20°C. Joints made of galvanised steel need to be made of materials that maintain the strength and electrical properties of the steel being jointed.

The particular materials selected shall be subject to Eskom's approval. The yield strength of ferrous materials shall exceed 280 MPa. The flow stress of the chosen ferrous materials shall be less than 1000 MPa. (Flow stress is equal to half of the sum of yield and UTS). All ferrous material represented in the final product shall have a minimum Charpy V-notch impact energy of 8 J at –10 °C. Charpy V- notch testing shall be conducted in accordance with ASTM A-370. Ductility of ferrous materials at room temperature shall be sufficient to provide a minimum elongation in a 50 mm gauge length, including the fracture, of 18 %. Ferrous joints shall be hot dip galvanised and passivated in accordance with SANS 121 for type B1 articles. Galvanising shall be done after final machining.

All stainless steel components shall be of a grade condition and design that will not enhance stress corrosion cracking and shall be subject to Eskom approval.

If line boring or drilling techniques are used in the manufacture of the sleeves, the tolerance on the wall thickness shall not be exceeded. Every length of tube used in the manufacture of sleeves shall be drift tested (see 4.8).

Welding aluminium alloys shall be done using either a tungsten inert-gas-shielded arc or metal inert-gas-shielded arc process. Welding jigs shall be used to ensure the correct alignment of sleeves. Welds shall be clean, sound, smooth, uniform, without overlaps, properly fused and completely sealed. There shall be no cracks, voids, incomplete penetration, incomplete fusion, undercutting or inclusions. Porosity shall be minimised so as not to affect the mechanical properties of the aluminium alloys. Welds shall be performed by accredited welding personnel and the welding procedure shall be subject to Eskom's approval.

All components shall be free from sharp edges, burrs and shall be finished with etching. There shall be no brittleness of fittings.

A centre stop/stake in plug shall be provided on all sleeve barrels used as a core sleeve in a two-part fitting or in any one-part joint (except for repair sleeves which do not require a centre stop).

The bore of the tubular portions shall be concentric with the outer walls to the extent that any cross section of a tube shall not deviate from the design thickness by more than the following limits: – 0 % + 10 %.

Materials which age harden or have an expiry date may not be used for the manufacture of compression fittings and clamps.

3.2 Specific requirements

3.2.1 Bolts and nuts

Bolts or studs shall be provided on the jumper terminal to connect the jumper flag. If a bolt is provided it must be mechanically fixed into the flag bolt holes such that they need not be held when fastening the assembly.

Bolt heads and nuts shall be M12 hexagon shaped in accordance with SANS 1700-9-1. The diameter of the holes shall be 14 mm. Bolts, studs and nuts shall be made of the approved material for the area in which it will be used. Threads shall be of a quality that enables the desired torque levels to be achieved without compromising clamp contact surface 'contact' pressure.

Table 3: Classification of nut and bolt materials

BOLT TYPE	GRADE	AREAS OF USE
Hot dip galvanised high tensile steel	8.8	At least 15 km inland from the coast
Molybdenum Disulphide (MoS_2) coated, mechanically galvanised high tensile steel	8.8	In areas less than 15 km from the coast
Stainless steel	316 (A4)	At least 15 km inland from the coast
Aluminium – anodised and lanolin treated	7075.T73	In areas less than 15 km from the coast

A flat washer shall be provided under the bolt head. A flat washer, together with a spring washer, shall be provided under the nut. Bolt/stud threads shall be lubricated before assembly. The use of captive or self-locking nuts is preferred to loose nuts. The maximum tightening torque on any size of bolt shall be in accordance with the following:-

a) shall not exceed 75 Nm

b) shall not exceed 75 % of the value at which fracture of permanent distortion of the threads, or fracture of the clamp, occurs. Bolt/stud fracture shall occur before the threads strip.

c) the maximum specific surface pressure under flat washers shall not exceed 120 N/mm^2,

Whichever of the above that results shall be the limiting case. The maximum tightening torque must be quoted in Technical schedule B available on document 240-171000175.

3.2.2 Electrical jointing compound

Jointing compound shall provide low initial contact resistance and prevent deterioration of the contact due to oxidation or corrosion, by excluding air and moisture from the contact surface. Joints filled with the compound shall retain their rated tensions.

The jointing compound shall be:

a) non-toxic and non-inflammable,

b) stable over a wide temperature range (the melting point shall be not less than 100 °C), and

c) neutral, relative to the metals being crimped.

Grease shall comply with that specified in Eskom drawing D-DT-3178.

Jointing compound for the aluminium tube in the two-piece joints must be provided in a separate sealed container and packed as part of the kit. All other compression fittings shall be pre-filled with an adequate amount of the jointing compound. The type of compound and chemical breakdown shall be stated in schedule B of an enquiry document. A recommendation regarding cleaning treatment shall be submitted by the supplier.

3.3 Tools and the application of fittings

3.3.1 The compression tools

The preferred design of the compression head to work with the hydraulic compression shall be such that:

a) it is driven by a motor operated hydraulic compressor

b) the nominal compression force developed is equal to but not less than 890 kN,

c) rapid ram advance is preferred,

d) positive indication is given when the required compression has been achieved, and

The compression head for the die system shall be designed to use dies consisting of two identical parts. Connectivity to dies shall be made through the block or H to H system (Annex B).

The tools adapted for work on live lines shall be made available to Eskom on request.

Only tools that are approved by Eskom (approval based on identical operation to existing Eskom equipment and technological improvements) shall be used.

3.3.2 Dies – general requirements

Dies shall be made of non-corrosive material with a Rockwell hardness of 40 to 45. The dies shall produce hexagonal shaped compressions on fittings.

Dies shall be manufactured as two identical parts with the external dimensions suitable to fit the Eskom approved compression head. Each half of the two parts shall be marked with the die index identification number, and optionally, with the conductor code name. The block or H to H system shall be used to connect dies to the compression tool (Annex B).

Where one die serves two sizes of conductor fitting, it shall be marked with both conductor code names.

The die identification shall be embossed on the fitting by the die, after compression.

3.3.3 Maintenance of tools

Each set of tools shall be supplied with a manual, describing the method of operation and detailing maintenance requirements.

3.4 Installation of compression fittings

Compression Fittings shall be installed using a motor operated hydraulic compression tool approved by Eskom. The manufacturer of the fittings shall submit an installation instruction document to Eskom, with the recommendations regarding the cleaning treatment to be adopted and the method of crimping to be used.

The methodology shall be based on the following practice adopted by Eskom as a standard practice regarding the application of compression fittings – successive crimps shall overlap adjacent crimps by one third. Crimping shall always commence from the joint side and be crimped towards the conductor.

3.5 Documents

The document describing the detailed installation instructions for the supplied fittings shall be provided by the manufacturer for acceptance to Distribution Technology and thereafter on request.

A manual describing the method of operation and detailing maintenance requirements shall be supplied with each tool purchased.

3.6 Quality Assurance

A quality management system shall be operated and maintained in compliance with requirements of ISO 9001:2000. The quality management system shall be approved by Quality Assurance. The details shall be subject to agreement between the purchaser and supplier.

3.7 Technical schedules A and B

Schedule A gives Distribution Group's requirements.

Schedule B shall be completed in full by the supplier.

Model schedules A and B are provided as part of this specification.

Deviations/modifications/alterations from the requirements specified in schedule A shall be well documented in the deviation schedule.

Technical schedules A and B are available on the Technical Evaluation Criteria for compression fittings and clamps - 240-171000175.

4. Tests

4.1 General

The tests shall be performed to establish the design characteristics of the compression fittings and clamps when installed on the applicable conductor and to assure compliance with all requirements specified.

Conductors used for the tests shall be new clean conductors that are compliant with SANS 61089.

The conductor used in the test shall be tested mechanically, to ascertain that the breaking strength is within the limits.

The tests shall be conducted on new fittings in the same state as they are normally supplied.

Unless otherwise specified, tests shall be conducted at ambient temperatures between 15 °C and 30 °C.

Tests shall be conducted by an independent accredited **organization,** or an **organization approved** by **Eskom**.

Eskom reserves the right to witness any or all of these tests. The supplier or manufacturer shall demonstrate an ability to provide means to enable Eskom to witness such test.

If the fittings offered have been tested for compliance with an alternative internationally accepted standard to IEC 61284, those test reports may be accepted by Eskom in place of the tests covered by this specification. Suppliers are requested to indicate compliance with the alternative specification before the tender stage and shall submit these test certificates before the tender for Eskom's consideration.

The qualifying type tests need only to be performed once, provided that the manufacturing method, design and material have not been changed or modified in any way. The type test certificates of completed successful type tests shall be submitted on every tender unless the product is published on an accepted product list. Any change in design shall be indicated at the time of tender.

The fittings shall be mounted on the conductors in accordance with the technical specification of the manufacturer.

The transfer of test certificates between manufacturers will not be allowed.

All compression fittings and clamps shall be stamped with the part number that is unique to each fitting type and manufacturer. Each part number shall have a corresponding test certificate.

4.2 Qualifying tests

Tests to be performed on fittings are divided into three groups; type tests, sample tests and routine tests. The testing procedures and conformance criteria, for most of the tests required, are set out in SANS 61284. The qualifying tests are given in Table 4.

Table 4: Qualifying tests

Item no.	Qualifying Test	Insulator set fittings and earth wire fittings	Suspension Clamps	Tension Joints and Tension clamps	Partial tension fittings	Repair sleeve
1	**Visual Examination**	xxx	xxx	xxx	xxx	xxx
2	**Dimensional and material verification**	xxx	xxx	xxx	xxx	xxx
3	**Hot dip galvanizing**	xx	xx	xx	xx	x
4	**Non-destructive testing**	xxx	xxx	xxx	xx	
5	**Mechanical tests**					
5.1	- Damage and failure load test	xxx	xxx	xx		
5.2	- Slip test		xx			
5.3	- Clamp bolt tightening test		xx	xx		
5.4	- Tensile test			xx	x	xx
6	**Heat cycle tests**			x	x	
7	**Corrosion test**	x	x	x	x	x
8	**Drift test**	xxx	xxx	xxx	xxx	xxx
9	**Torque Test**		xx	xx		
10	**Magnetic losses test**		x	x		
11	**Corona and RIV test**	x	x	x	x	x
12	**Short-Circuit Test**	x	x	x	x	x
xxx =		Type tests, sample tests and routine tests				
xx =		Type tests and sample tests only				
x =		Type tests only				

4.2.1 Type tests

Type tests are intended to establish design characteristics. They are normally only made once and repeated only when the design, manufacturing process or the material of the fitting is changed. The results of type tests are recorded as evidence of compliance with design requirements.

4.2.2 Sample tests

Sample tests are intended to verify the quality of materials and workmanship.

Unless otherwise agreed between the purchaser and the supplier, the sampling plan procedures according to ISO 2859-1 and ISO 2859-2(inspection and attributes) and to ISO 3951 (inspection by variables) shall be applied.

For each sample test, the type of inspection (by attributes or by variables and detailed procedures inspection level, acceptable quality level, single, double or multiple sampling, etc.) shall be agreed between the purchaser and the supplier. Every effort must be made such that a representative from Eskom's Quality assurance department can be present to witness sample testing.

Note: Sampling inspection by variables is an acceptance sampling procedure to be used in place of inspection by attributes when it is more appropriate to measure characteristic(s) under consideration on some continuous scale. In the case of failure load test and similar expensive tests, better discrimination between acceptance quality and objective quality is available with acceptance sampling by variables than by attributes for the same sample size. The purpose of the sampling process may also be important in the choice between a variables or attributes plan. For example, a purchaser may choose to use an attributes acceptance sampling plan to ensure that parts in a shipment lot are within a required dimensional tolerance; the manufacturer may make measurements under a variable sampling plan of the same dimensions because he is concerned with gradual trends or changes which may affect his ability to provide shipment lots which meet the AQL.

4.2.3 Routine tests

Routine tests are intended to prove conformance of fittings to specific requirements and are made on every fitting. The tests shall not damage the compression fitting. Every effort must be made such that a representative from Eskom's Quality assurance department can be present to witness a routine test when fittings are being evaluated.

4.2.4 Quantity tested

Unless otherwise specified, a minimum of 4 (four) samples of each size and type of compression fitting shall be tested. Each test sample shall comply with all the acceptance criteria applicable to the fitting.

4.3 Visual inspection and verification of dimensions

Visual inspections confirm that fitting dimensions conform to the approved drawings. The relevant drawings indicating all critical dimensions of the fittings shall be supplied by the manufacturer. The testing authority shall inspect and verify the dimensions and certify the drawings for compliance with the type tested samples.

4.4 Material verification tests

The analysis of the materials shall be conducted in an official laboratory of the supplier of the raw materials or in a laboratory mutually acceptable to manufacturers of fittings and Eskom.

The composition and properties of the metals and alloys shall correspond to the demands of the approved materials as stipulated in 3.1.9.

The amount of impurities in cast and welded fittings shall not exceed the maximum allowable for accepted materials.

4.5 Mechanical tests

4.5.1 Damage and failure load test

This test shall be done in accordance with SANS 61284 with the relevant acceptance criteria.

4.5.2 Tension test

Tensile tests shall be done in accordance with SANS 61284 and the following:

a) The M-value referred to in the SANS 61284 tensile tests, shall be 20 % of the SMFL given in **Error! Reference source not found.** (section 3.1.7 of this specification).

b) The section of the test where 60 % of SMFL is held, shall be for 15 min.

c) For the remainder of the test, Option a) (as in SANS 61284) shall be used.

All the relevant acceptance criteria in SANS 61284 shall be satisfied, to ensure that a specimen complies.

4.5.3 Slip test

The conductor used in the test shall be the one for which the clamp is intended. The test shall be carried out in accordance with the applicable IEC 61824 procedure.

4.5.4 Clamp bolt tightening test.

The test shall be performed by installing the clamp on a conductor with a diameter equal to that for which the clamp is intended to be used, the bolts and/or nuts being tightened with the installation torque specified by the supplier.

This torque is then increased to the specified installation value times a factor of 1,1. The threaded connection shall remain serviceable for any number of subsequent installations or removals, and all components comprising the clamp shall be undamaged. No unacceptable damage shall occur to the conductor inside the clamp.

Lastly, the torque shall be increased up to either twice the specified installation value or the maximum torque value recommended by the bolt supplier, whichever is lower.

4.6 Heat cycle tests

If Class B joints (non-tension joints as defined by SANS 61284) from a specific manufacturer, are heat cycle tested with short-time over-current pulses, then the manufacturer's Class A joints (tension joints) need not be tested with short-time over-current pulses in the heat cycle test. This shall only apply if the tubular material used for Class A joints are the same as that used for Class B joints. However, if Class B joints from the manufacturer are not tested with the short-time over-current pulses or the material of the classes of joints differ, the Class A joints shall be tested with short-time over-current pulses. The conditions of the heat cycle test (in accordance with Table 3, SANS 61284) can be chosen by the supplier, based on lowest cost or the availability of current to produce the temperature. However, where possible, the longest (high number of cycles) test should be used. If the sample is not needed for corrosion tests, it shall be cut open to check if there is no burning, fusing or local heating of the fitting.

All other aspects of the heat cycle test shall be performed as described in SANS 61284.

4.7 Corrosion tests

Test four fittings that have completed and passed the heat cycle test in 4.6.

Test procedure:

a) Record the initial resistance of the test loop.

b) Place the four fittings in an airtight salt spray cabinet for 1000 h in accordance with SANS 7253.

c) The four connectors shall be subjected to 200 heating and cooling cycles during the 1000 h salt spray testing. For each heating cycle, current shall be circulated such that a temperature of the conductor is, on average, 60 °C for one hour.

Note: If no testing facilities are available that can complete the 200 heating and cooling cycles during the salt spray test, then a provisional acceptance can be negotiated with distribution technology using only part a) of this procedure for testing.

d) Record the final resistance of the test loop.

4.7.1 Acceptance criteria

After corrosion testing:

a) all four fittings shall be free of any traces of detrimental corrosion,

b) the markings specified shall be legible under normal viewing.

c) there shall be no significant change in the resistance of the clamps from the original product resistance.

d) joints shall be cut open. There shall be no indication of burning, fusing, or local heating of the fittings. Joint grease shall still be present in the joint and shall not be degraded.

4.8 Drift tests

Each length of aluminium tubing used to make compression fittings shall be drift tested to determine the soundness of the extruded seam welds. A sample shall be removed from each length of tube. Suitable marking shall identify the samples with the respective tube. The maximum length of tubing from which test samples are removed shall be 6 m.

The drift test shall consist of expanding each sample, using a drift cone, until the initial outside diameter of the tube is increased by 25 % (– 0 %, + 10 % tolerance).

4.8.1 Acceptance criteria

A length of tube shall be considered acceptable if the outside diameter of each test sample is increased by 25 % and no defects or seam splitting occurs. If any test sample splits or appears defective the corresponding tube shall be marked and discarded.

4.9 Torque tests

Torque shall be applied to each of the nuts and bolts of a jumper terminal to flag assembly.

The nuts and bolts shall withstand the forces produced by a torque of 150 % of the stated design torque without failure.

4.10 Magnetic particle tests

All steel end fittings and steel mid-span joints shall be tested before galvanising by the magnetic particle inspection process specified in ASTM E709. Defective components shall be permanently marked and discarded.

4.11 Corona and RIV Test

Corona tests shall be performed according to the test procedure and requirements of section 14 of IEC 61284.

RIV tests shall be performed according to the test and requirements of CISPR 16-1 and CISPR 18-2.

The test voltage for radio influence voltage shall be 1,1Um/√3, where Um is the maximum system voltage.

Correction factors shall be applied in accordance with IEC 60060-1.

4.12 Short-Circuit Withstand Test

Clamps shall be capable of withstanding short-circuit currents without any mechanical damage or overheating. The short-circuit current withstand ratings are given in the respective clamp Technical Schedule A in the Technical Evaluation Criteria for Dx HV Overhead Powerlines Compression Fittings and Clamps -240-171000175.

Under short-circuit conditions the clamp temperature shall not exceed 200°C.

The clamps are specified for service at altitudes of up to 1800 m. If a clamp is tested at an altitude below 1800 m, the limits of operating temperature under normal and short-circuit conditions should be reduced by 2,5 % for each 500 m that the altitude specified exceeds 1000 m.

All clamps shall be able to withstand 31.5kA for 1 second.

4.13 Hot dip galvanizing Test

The test shall be carried out in accordance with the applicable IEC 61824 procedure.

4.14 Non-destructive test

The purchaser shall specify or agree to relevant test methods, classification (type, sample, routine tests) and acceptance criteria.

Examples of non-destructive tests are as follows:

- magnetic test
- eddy current test
- radiograph test
- ultrasonic test
- proof load test
- dye penetrant test
- hardness test.

4.15 Test certificates and samples

4.15.1 Qualifying type tests

Copies of all type-test reports for compression fittings offered shall be supplied to Eskom for approval at tender stage. Certificates supplied for previous tenders shall be re-submitted.

4.15.2 Production sample tests

Copies of sample test certificates are not required by Eskom, but the manufacturer shall retain these certificates for a period of at least 2 years.

4.15.3 Traceability

The test certificates for each fitting shall be traceable by reference to the manufacturer's joint reference number marked on the joint.

4.15.4 Samples

One sample of each item specified, shall be submitted for approval before general manufacture commences. If identical items have previously been supplied to and have been approved by Eskom, further samples may not be required.

5. Marking, labelling and packaging

5.1 Identification and markings

All fittings shall be clearly and permanently marked with the following:

a) the manufacturer's name or identification mark.

b) the manufacturer's item batch number.

c) the joint reference numbers.

d) the code name/s of the conductor for which they are intended.

e) the installation die "ALCAN" reference code.

f) knurl marks to indicate the lines beyond which no crimping should take place.

g) the numbers indicating the sequence of crimps if applicable; and

h) Jumper flags and lugs making up each compression dead end shall be marked with the design installation torque for the nuts and bolts. Markings shall be on the surface opposite to the contact surface.

Example of marking within the marking area of the fitting:

Manufacturer	ZZZZZZ
Batch No.	0450360
Joint reference No.	MJ200Al/Fe
Conductor size (optional)	WOLF
Die	DA8/DS8
Tightening Torque	75 Nm

5.2 Packaging requirements

Single part compression fittings and steel core joints of two-piece compression fittings shall be pre-greased, capped and individually packed. The appropriate amount of jointing compound for the outer sleeve of the two-piece joint shall be separately packed in a container and included in a kit with both the core and outer sleeves.

Detachable fittings shall be supplied as a set in one bag with all necessary bolts, nuts and washers attached to the fitting equipped with the jumper flag.

Identical fittings shall be packed together in sealed transparent plastic bags. The thickness of the plastic material shall be not less than 100 μm.

Each package shall bear the manufacturer's identification mark and the quantity of fittings in the package.

The fittings supplied in large quantities shall be bulk packed in suitable containers. The net weight in each container shall not exceed 30 kg. On the outside of each container the following information shall be provided:

a) the destination address.

b) the gross weight.

c) the manufacturer.

d) the number of fittings of each type and size in the container.

e) the date of manufacture; and

f) the purchaser's order number.

6. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Azwimbavhi Mamanyuha	General Manager: Technology and Engineering
Mfundi Songo	Senior Manager: Technology and Engineering
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Fannie Masango	Senior Engineer: NED Gemma Cluster

This specification shall apply throughout Eskom Holdings Limited, its divisions, subsidiaries and entities wherein Eskom has a controlling interest.

7. Revisions

Date	Rev	Compiler	Remarks
Dec 2023	2	L. Sangweni	- Suspension clamps, insulator set fittings and earth wire fittings and partial tension fittings were added. - Added the following testing requirements: Corona and RIV Test, Short-Circuit Withstand Test, Hot Dip galvanising Test, Non- Destructive Test, Slip Test and Clamp Bolt tightening Test - Technical Schedule A&B (Annexure C) removed and added to 240-171000175
March 2017	1	N.Henderson	Document reformatted on to new template, with new document number. No content change. This document supersedes document DSP_34-1659
Oct 2011	0	None	Compiled By: S Mashaba Reformatted to a new template. Updated normative references. DISSCAAU5 replaced by DSP 34-1659 4.1.4 Table 1 changed to be in line with DST 32-319 Annex C New technical schedule A & B plus deviation schedule added
Jan 2005	0	None	Compiled By: G Stanford Include Mink in the scope of the document as well as all dimensional criteria. Table 1 Corrected the die size across flat for Kingbird from 16.1 to 12.7 for the DS8 die. Reference No changed from SCS… to DIS…
Jan 1999	2	None	Document issued

8. Development team

- Lucy Sangweni

9. Acknowledgements

Not applicable.

Annex A – Impact Assessment

(Normative)

Impact assessment form to be completed for all documents.

1) Guidelines

- All comments must be completed.
- Motivate why items are N/A (not applicable)
- Indicate actions to be taken, persons or organisations responsible for actions and deadline for action.
- Change control committees to discuss the impact assessment, and if necessary give feedback to the compiler of any omissions or errors.

2) Critical points

2.1 Importance of this document. E.g. is implementation required due to safety deficiencies, statutory requirements, technology changes, document revisions, improved service quality, improved service performance, optimised costs.

Comment:

2.2 If the document to be released impacts on statutory or legal compliance - this need to be very clearly stated and so highlighted.

Comment:

2.3 Impact on stock holding and depletion of existing stock prior to switch over.

2.4 Comment:

When will new stock be available?

Comment:

2.5 Has the interchangeability of the product or item been verified - i.e. when it fails is a straight swop possible with a competitor's product?

Comment:

2.6 Identify and provide details of other critical (items required for the successful implementation of this document) points to be considered in the implementation of this document.

Comment:

2.7 Provide details of any comments made by the Regions regarding the implementation of this document.

Comment: (N/A during commenting phase)

3) Implementation timeframe

3.1 Time period for implementation of requirements.

Comment: N/A

3.2 Deadline for changeover to new item and personnel to be informed of DX wide change-over.

Comment: N/A

4) Buyers Guide and Power Office

4.1 Does the Buyers Guide or Buyers List need updating?

Comment: No

4.2 What Buyer's Guides or items have been created?

Comment: N/A

4.3 List all assembly drawing changes that have been revised in conjunction with this document.

Comment: N/A

4.4 If the implementation of this document requires assessment by CAP, provide details under 5

4.5 Which Power Office packages have been created, modified or removed?

Comment: N/A

5) CAP / LAP Pre-Qualification Process related impacts

5.1 Is an ad-hoc re-evaluation of all currently accepted suppliers required as a result of implementation of this document?

Comment: N/A

5.2 If NO, provide motivation for issuing this specification before Acceptance Cycle Expiry date.

Comment: N/A

5.3 Are ALL suppliers (currently accepted per LAP), aware of the nature of changes contained in this document?

Comment: N/A

5.4 Is implementation of the provisions of this document required during the current supplier qualification period?

Comment: N/A

5.5 If Yes to 5.4, what date has been set for all currently accepted suppliers to comply fully?

Comment: N/A

5.6 If Yes to 5.4, have all currently accepted suppliers been sent a prior formal notification informing them of Eskom's expectations, including the implementation date deadline?

Comment: N/A

5.7 Can the changes made, potentially impact upon the purchase price of the material/equipment?

Comment: N/A

5.8 Material group(s) affected by specification: (Refer to Pre-Qualification invitation schedule for list of material groups)

Comment: N/A

6) Training or communication

6.1 Is training required?

Comment: (If NO then 6.2 – 6.6 will be N/A) N/A

6.2 State the level of training required to implement this document. (E.g. awareness training, practical / on job, module, etc.)

Comment: N/A

6.3 State designations of personnel that will require training.

Comment: N/A

6.4 Is the training material available? Identify person responsible for the development of training material.

Comment: N/A

6.5 If applicable, provide details of training that will take place. (E.G. sponsor, costs, trainer, schedule of training, course material availability, training in erection / use of new equipment, maintenance training, etc).

Comment: N/A

6.6 Was Technical Training Section consulted w.r.t module development process?

Comment: Yes

6.7 State communications channels to be used to inform target audience.

Comment: N/A

7) Special tools, equipment, software

7.1 What special tools, equipment, software, etc will need to be purchased by the Region to effectively implement?

Comment: N/A

7.2 Are there stock numbers available for the new equipment?

Comment: N/A

7.3 What will be the costs of these special tools, equipment, software?

8) Finances

8.1 What total costs would the Regions be required to incur in implementing this document? Identify all cost activities associated with implementation, e.g. labour, training, tooling, stock, obsolescence

Comment: N/A

……

……

……

Impact assessment completed by:

Name: S Mashaba

Designation: Engineer

Annex B – Purchasing requirements for hydraulic compression tools

(informative)

Purpose of this Annex is to provide the principal guiding requirements to assist in purchasing of new compression equipment for Eskom crews involved in jointing of overhead conductors and earth wires on sub-transmission lines. In order to standardise on compression system, the 100-ton equipment using hexagonal dies, already in use by Eskom, shall be the standard. The compression tool set should consist of the compression head, motorised hydraulic power pump, interconnecting hoses and dies. This set with the exception of the dies should be purchased as a unit. Alcan die range shall be the standard for sub-transmission line conductors and earth wires.

The Compression Tool Set

Compression Head

Compression head shall be designed to use dies consisting of two identical parts. The compression head shaped to accommodate the “H-to-H” die will be preferred (see figure 1).

Dies should be secured into the head in such way that any movement of the die during crimping operation would be prevented.

Head should be designed for the nominal output force equal but not less than 890 kN (100 t) at a pressure of 70 MPa (700 bar).

Head should be a two speed (double acting) unit with the High Pressure (HP) and Low Pressure (LP) fittings permitting direct connection of both hoses.

Piston should be of such design as to enable the head to be operated without the dies being inserted. Piston stroke should be not less than 20 mm.

Weight of the head should not exceed 35 kg.

Hydraulic Hose pipes

One High Pressure (HP) and one Low Pressure (LP) hosepipes should be supplied as a standard. The HP hose must be capable of withstanding a working pressure of 70 MPa (700 bar). The hose bursting pressure should be not less than 180 MPa (1800 bar).

The connectors on the hoses shall be so designed that the HP and LP hoses cannot be interchanged or connected incorrectly.

Hydraulic Power Pump

Hydraulic power pump should be a portable, completely self-contained unit of robust construction with the weight not exceeding 60 kg (including hydraulic fluid).

Hydraulic compressor pump should be driven by the 4-stroke petrol or diesel engine, air-cooled, with power output of not less than 2.2 kW (3 HP).

Pump should be a two speed (double acting) unit, having an automatic by-pass safety release valve set at 70 MPa (700 bar) for a self-returning piston action.

The High Pressure (HP) and Low Pressure (LP) fittings permitting direct connection of both hoses should be provided. The reservoir capacity should be not less than 10 litres. The type of the hydraulic fluid to be used with the unit should be advised by the supplier.

Remote control operation with the manual control lever for emergency use is preferred. The self-generated 12 V DC power must power such control unit.

Dies

Dies shall be made of non-corrosive material with Rockwell hardness of 40 to 45.

Dies shall be manufactured as two identical parts . The “H-type” die will be preferred. Each half of the two parts shall be marked with the die index identification number and nominal dimension Across Flats in millimetres. The die identification shall be embossed on the fitting after compression.

Following is the standard ALCAN die range for the sub-transmission lines:

DIES FOR ALUMINIUM TUBULAR FITTINGS

1	2
Die Reference	**Dimension Across Flats (mm)**
DA-6	22.0
DA-7	25.4
DA-8	28.2
DA-9	32.3
DA-10	36.2
DA-11	40.2
DA-12	45.7
DA-13	49.7

DIES FOR STEEL TUBULAR FITTINGS

1	2
Die Reference	**Dimension Across Flats (mm)**
DS-6	7.6
DS-7	10.1
DS-8	12.7
DS-9	15.1
DS-10	16.1
DS-11	17.5
DS-12	20.2

For the conductor and respective die sizes refer to 4.1.4 table 1.

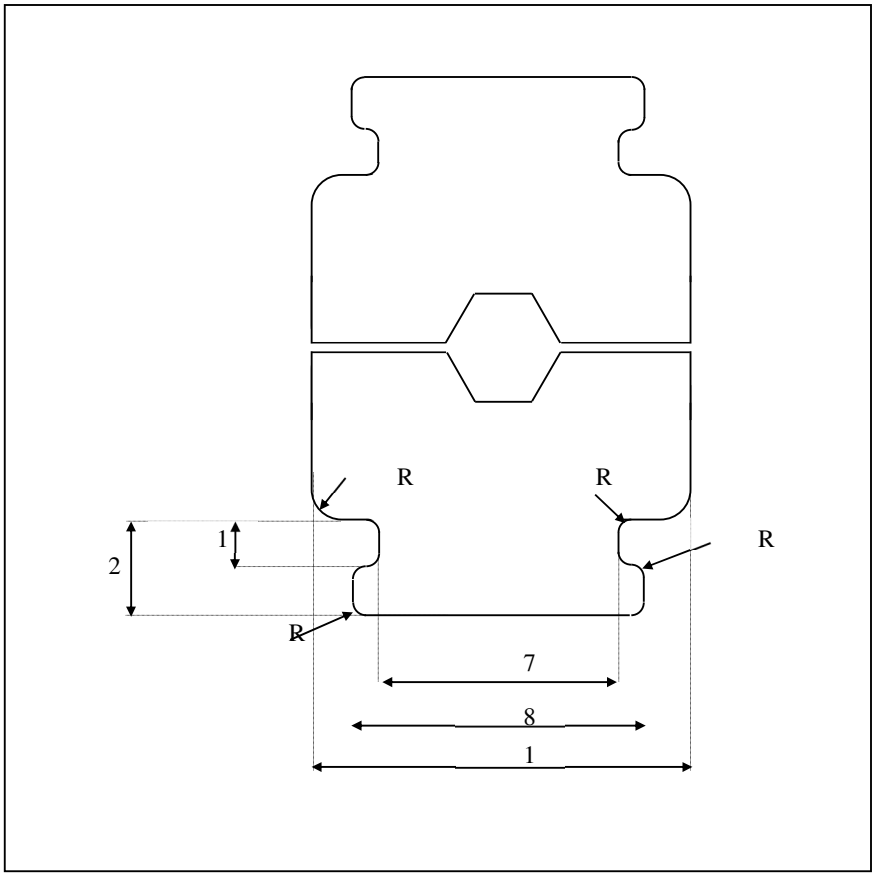

Figure B.1: Block type die end connection

Maintenance of tools

Each set of tools shall be supplied with a manual, describing the method of operation and detailing maintenance requirements.