

CONDUCTORS AND CONDUCTOR SYSTEMS FOR OVERHEAD LINES

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PURPOSE AND SCOPE

This specification forms part of a suite of documents which define National Grid's functional and performance requirements for new plant and equipment associated with electricity transmission.

The Specification defines the technical and general characteristics and performance requirements of a Conductor, Conductor and/or Earthwire System utilising all round and trapezoidal wire concentric lay ACSR, ACAR, AACR, AACSR, Gap-type GZTACSR and ACC (Note 1) overhead line conductors, including their lubrication, procured for and use on overhead lines owned by or directly connected to the National Grid transmission system operating at 132kV, 275kV & 400kV.

In the case of earthwire conductors this specification details the requirements for standard earthwire and Optical Ground Wire (OPGW) conductors which are intended as a direct replacement for conventional earthwires on National Grid overhead lines where optical communications are required.

This specification defines the technical and general requirements applicable for designing a Conductor, Conductor and/or Earthwire System suitable for operational use on National Grid overhead lines operating at 132kV, 275kV and 400kV. In the case of earthwire conductors this specification details the requirements for standard earthwire & optical ground wire (OPGW). OPGW conductors are intended as a direct replacement for conventional earthwires on National Grid overhead lines where optical communications are required.

PART 1 – PROCEDURAL

1 GENERAL REQUIREMENTS

Conductors for overhead lines shall be type registered in accordance with UKBP/TP183 'Type Registered Equipment Procedural Requirements'. Additionally TGN(E) 259 'Type Registration of Overhead Lines' provides guidance on type registration of overhead line systems.

All conductors and conductor systems shall meet the requirements of the relevant standards and the additional requirements stated in this specification.

As part of the Type Registration process for conductors the conductor supplier shall wherever possible recommend suitable suppliers of conductor fittings such as but not limited to Dead End Assemblies, Helical Suspension Units, Suspension Clamps, Spacers and Vibration Dampers.

The following abbreviations and conductor designations according to BS EN 50182 and National Grid are used throughout this specification; in the case of composite core conductors for the purposes of clarification abbreviations as used by manufacturers have been adopted:

ACSR – Aluminium Conductor Steel Reinforced	AL1/ST1A
ACAR – Aluminium Conductor Alloy Reinforced	AL1/AL3
AAAC – All Aluminium Alloy Conductor	AL5 (Note 2)
AACSR – Aluminium Alloy Conductor Steel Reinforced	AL5/ST1A (Note 2)
AACSR - Aluminium Alloy Conductor Steel Reinforced (OPGW)	A20SA/AL3
GZTACSR – “Gap” type ZT Aluminium Conductor Steel Reinforced	AT3 & (Note 3)
ACC - Aluminium and Composite Conductor	(Note 1 & 3)

Note 1:- Conductors that incorporate composite sub components are for the purpose of this specification referred to as Aluminium & Composite Conductor (ACC).

Note 2:- The mean resistivity of AL5 is $31.2\text{n}\Omega/\text{m}$. However, National Grid specify a lower resistivity alloy for phase conductors, see 1.2.2 below, for which an equivalent type is not specified in BS EN 50183.

Note 3:- The material requirements for GZTACSR & ACC conductors are not currently defined in accordance with the nomenclature used for other conductor designs, for further information on these conductors refer to cl. 1.2.2 of this specification.

Earthwires shall normally be Keziah or Keziah Equivalent OPGW; if tower strength determines that a smaller earthwire be used then this shall be a Horse or Horse equivalent OPGW.

This specification does not include detailed requirements for conductor fittings and sub components; the requirements for these are detailed in TS 3.4.35.

1.1 Dimensions

For all new build, refurbishment and repair activity only phase conductors detailed in Appendix A, Table 1A & 1B and earthwires detailed in Table 2 of this specification shall be used. All conductors shall be identified by their National Grid code name, and shall have the nominal aluminium area (mm^2) specified.

For all ACSR, ACAR, AAAC and AACSR constructions the number and diameter of wires comprising each conductor shall conform to the tolerances specified in BS EN 50182, for reference they are detailed in Appendix A, Table 1A of this specification. For GZTACSR & ACC conductors the number and of wires are detailed in Appendix A, Table 1B of this specification, the tolerances for ACC conductors shall be in accordance with those stated on the conductor drawing or datasheet. GZTACSR conductor tolerances are as detailed in section 1.2.2.2 of this specification. Keziah and Horse equivalent OPGW earthwires are specified in Appendix A, Table 2.

National Grid specifies standard conductors and bundle configurations which vary with line construction but still satisfy the requirements of rating and noise performance at the specified voltage, only bundle configurations detailed in PS (T) 046 and Appendix A Table 4 of this specification shall be used.

The optical earthwire shall perform all the duties of standard earthwire according to TS 2.4 'Generic Design Principles for Overhead Lines' and shall be produced in continuous lengths up to but not exceeding 6km.

1.2 Conductor Design and Manufacture

1.2.1 General Conductor Requirements

Conductors shall comply with the requirements of BS EN 50182, BS EN 50183, BS EN 50189, BS EN 60889, BS EN 62004 & BS EN 62420, as appropriate, except where modified in this specification.

Steel, aluminium and aluminium alloy wires shall be pre-formed and/or post-formed so that they remain inert and do not move relative to each other when the conductor is cut. The method of pre-forming and/or post-forming used shall not cause damage to the wires or the galvanising of steel wires. The surface of the conductor shall be free of nicks, cuts or imperfections that could generate audible noise due to corona generation at service voltages. Smooth compression ellipses of up to 3mm in length in the aluminium or aluminium alloy of round wire conductor strands on inner layers of conductors shall be acceptable.

Precautions shall be taken during the manufacture, storage and delivery of conductors to prevent contamination by any other materials which may adversely affect the aluminium or aluminium alloy strands by embrittlement or corrosion, in particular copper. In the event of any machinery used for conductor manufacture being used for materials other than aluminium, aluminium alloy or galvanised steel strands, the manufacturer shall provide a certificate stating that the machinery has been thoroughly cleaned before use and that the conductor is free from contamination. This certificate shall be available for inspection by a National Grid appointed inspector upon request.

The maximum rated continuous operating temperatures for National Grid's phase conductors are as follows;

ACSR & ACAR - 75°C

AAAC - 90°C

ACC – Up to 210°C

GZTACSR - 170°C

It should be noted that under post fault conditions ACSR & AAAC conductors may experience increases in temperature of up to 35°C above their rated operating temperature whilst ACC conductors may achieve temperatures 40°C above their rated temperature, GZTACSR conductors may achieve temperatures of up to 40°C above their rated operating temperature.

For Gap type conductors the minimum conductivity of the aluminium alloy wires shall not be less than 60% of the International Annealed Copper Standard (IACS).

If joints in aluminium or aluminium alloy wires are required, the method of jointing single wires shall be by cold pressure welding, the maximum number of and strength of joints per drum shall be as specified in BS EN 50182.

The minimum tensile strength of any steel, aluminium, aluminium alloy wire or composite component shall be in accordance with Appendix A, Table 5 of this specification and the maximum resistance of the complete conductor shall be in accordance with the requirements of Appendix A, Tables 1A, 1B & 2 of this specification.

All GZTACSR & ACC conductors shall if requested by National Grid have the outer surface of the conductor treated by a process which produces a minimum surface emissivity of 0.6.

1.2.2 Additional Information Specific to Conductor Type

1.2.2.1 All Aluminium Alloy Conductor (AAAC), Aluminium Alloy Conductor Steel Reinforced (AACSR) & Aluminium Conductor Alloy Reinforced (ACAR) Conductors

The maximum resistivity of the aluminium alloy wires of AAAC, AACSR, and ACAR (averaged, in each case, over all the alloy wires) shall be $30.5\text{n}\Omega\text{m}$ at 20°C , with a maximum resistivity of individual strands of $31.5\text{n}\Omega\text{m}$. This is designated as Extra High Conductivity (EHC) alloy conductor.

1.2.2.2 GZTACSR Conductors

GZTACSR conductor used on National Grid's Transmission network is restricted to a single design given the National Grid name 'Matthew' and the details contained in this section only relate to this conductor.

The steel core shall be made from 7 round wires of high tensile steel of diameter 3.2 ± 0.05 mm. The aluminium alloy shall be in the form of 3 layers of trapezoidal-shaped strands. The innermost layer shall comprise 12 strands shaped to form a tube having an internal diameter in the range 11.0mm – 11.8mm and an external diameter of 16.5 mm – 17.5 mm. The lay ratio of the innermost layer shall be between 10 and 16. The middle and outer layers of trapezoidal aluminium alloy strands shall be sufficient to meet the conductor strength and resistance defined in Appendix A, Table 1B of this specification. The overall diameter of the conductor shall be $31.5 +0.5/-0\text{mm}$ when measured under tension. The lay of the outer layer of the conductor shall be right-handed.

1.2.2.3 ACC Conductors

ACC conductors incorporate aluminium and composite sub components and due to the specific nature of how composite conductors are designed and manufactured each one may be slightly different in appearance and performance.

The composite element of an ACC conductor shall weigh less than half of an equivalent segment of steel with a greater strength to weight ratio of steel which will reduce sag profile of the span and the requirement to carry out tower strengthening works prior to installation of the conductor.

Where the core and conducting materials differ the core shall be separated from the conducting element by a barrier to prevent oxidation between the two materials.

1.2.2.5 Optical Earthwire (OPGW) Conductors

Unless specified Optical Earthwire (OPGW) shall be based upon the construction of Keziah conductor (See Note 4) unless the design loadings of this conductor impose unacceptable stress upon the structures (See Note 4). The OPGW conductor shall consist of aluminium alloy and steel wires with one or more optical sub-units (Buffer Tubes) containing optical fibres. The conductor shall meet the design, electrical, mechanical and optical requirements detailed in IEC 60794-1-24, TS 2.04 and Appendix A, Table 2 of this specification as applicable with the exception that any steel wires in contact with stainless steel shall be clad with aluminium according to IEC 61232. The design of the conductor shall be such that it

can be installed and operated without placing the optical fibres under mechanical stress or undue loading under all environmental conditions.

The use of galvanising in direct contact with stainless steel is not permitted. Aluminium clad optical sub units must not be positioned in the outer layer of the conductor.

Optical cable sub units shall contain a minimum of twenty four (24) optical fibres and construction of the conductor shall be designed such that strain is not directly imparted to the optical fibres in service. For Keziah equivalent OPGW one or more buffer tubes may be used, the tubes shall be loosely buffered to minimise transfer of strain into the fibre.

Unless otherwise stated by National Grid fibres within the OPGW shall be arranged as units of six (6) fibre colours using the following colour sequence; Blue, Orange, Green, Brown, Grey & Yellow. Because multiples of the same colour fibres are used permanent identification markers shall be applied to each fibre to aid identification for splicing purposes. The conductor manufacturer shall recommend a suitable cleaning fluid for cleaning fibres in order that splicing activities may be undertaken, this shall be stated on the conductor datasheet.

The buffer tube housing the optical fibres shall be coded at either end for ready identification. Where more than one tube is used and tubes are arranged in a circular configuration it is acceptable to mark the tubes to indicate the start and stop of the circle. The buffer tube(s) shall be filled with a compound to provide resistance to water penetration, vibration damping and for shock absorption. The manufacturer shall also take into account that the sheathing used to separate the fibres will also need to protect the fibres from burs when the buffer tubes are removed for jointing.

The optical sub-unit shall withstand any temperature rise associated with fault current flow in the earthwire without damage; short circuit current ratings are specified in TS 1 'Ratings and Generic Requirements for Plant, Equipment and Apparatus for the National Grid system'.

In order to aid installation the conductor shall be capable of a bend radius of 300mm.

During the final stages of manufacture all open conductor ends shall be capped to prevent the ingress of water into the optical sub-unit and shall be marked or coloured to distinguish between directions of rotation of the colour coding.

Note 4:- There may be some circumstances when a Keziah equivalent earthwire may not be acceptable on some structures, in cases such as this National Grid may specify a smaller OPGW equivalent earthwire. Smaller earthwires shall be limited to one buffer tube.

1.3 Conductor System Design

The minimum composition which constitutes a conductor system shall include Conductor, Anchor Clamps (Compression, Helical or Wedge Clamp), Mid Span Tension Joint, Non-Tension Joints, Jumper and Line Termination Palms, Vibration Dampers, Spacers, Suspension Clamps and a range of conductor repair fittings, such as helical and compression repairs. For earthwire systems these shall include the conductor and all fittings required to adequately support and protect the conductor such as anchor clamps (Compression and Helical), Suspension Clamps, Supporting Links, Vibration Dampers, Earth Bonds and other ancillary items such as tower attachment clamps. OPGW systems shall only make use of helical type anchor clamps and will also make provision for optical joint enclosures. For non OPGW earthwires the system shall also include mid-span joints and repair sleeves.

All bundled conductors with the exception of offset de-spacered bundles shall be fitted with spacer dampers to maintain bundle separation and reduce sub-conductor oscillation and shall be installed in accordance with the placement charts in Appendix A Tables 3A & 3B of this specification and the manufacturer's installation instructions. National Grid has a

minimum requirement that one spacer shall always be fitted 300mm from the end of a tension set to maintain the insulator string configuration. On legacy quad bundles with suspension insulator sets spaced at 300mm two twin rigid spacers fitted with elastomer lined clamps shall be installed to separate the vertical pairs of conductors five metres from the suspension set. Appendix A, Table 4 of this specification details the bundle spacing to be adopted for legacy quad bundles.

Should the requirement for an offset bundled conductor system be identified during the design element of a scheme the designer shall take into account any requirement for spacers to prevent conductor bundle collapse also known as 'zipping' caused by the passage of sustained high currents which draw the sub conductors in the bundle together. Offset bundle configuration shall be 400mm horizontal and 300mm vertical with the exception of Araucaria conductor which shall have 500mm horizontal and 300mm vertical spacing and Redwood conductor which shall have 550mm horizontal and 300mm vertical spacing.

Jumpers on bundled conductor systems shall be fitted with not less than three 200mm twin, triple or quad rigid bolted spacers spaced symmetrically and shall prevent contact between jumper legs, between the jumper and the in-span conductors or between the jumper and the download conductors. On AAAC systems wherever wedge clamps are installed, jumpers shall be connected using either a non-tension joint, or a non-tension joint bonding spacer for bundled conductors, in cases such as this the bonding spacer may replace one of the rigid bolted spacers.

Downleads and Down Droppers shall as a minimum have at least one spacer installed.

Vibration Dampers shall be '4 Response' in design and shall be fitted to all conductors to minimise the effects of aeolian vibration. Manufacturers shall advise installation instructions, quantity and placements of vibration dampers subject to a minimum requirement of one vibration damper per sub-conductor at each end of the span. Due to the nature of how vibration dampers perform selection of dampers and damping systems shall be limited to a single supplier unless clear distinction can be made between sections of an overhead line. Damper placements shall be specified with reference to the centre of suspension clamp, the nose of the anchor clamp or the thimble attachment point of the helical dead end assembly. Any distance specified for placement adjacent to a suspension assembly shall take into account the possibility of armour or helical attachment rods being fitted.

Midspan joints shall only be used for repairs or where a section length is longer than the maximum standard drum length, the number of midspan joints shall be kept to an absolute minimum and this shall be reflected when issuing a drum schedule for installation works.

Midspan joints should not be used within three metres of the conductor suspension clamp or anchor clamp fitting or in spans post installation access may prove difficult such as railways, navigable rivers, motorways and buildings or spans covered by special wayleave conditions, in cases such as this prior agreement with National Grid shall be sought during the design element of any scheme. A line shall be deemed as being over a building when at the conductors maximum rated temperature with an assumed swing of 45 degrees from the vertical any part of the building is directly beneath any conductor.

Wherever midspan joints or compression repair sleeves are installed on ACSR conductors either during refurbishment or during a repair a line splice shunt shall be installed over the compression fitting in order to reduce the probability of the joint increasing in resistance post installation. Midspan Joints shall have a spacer of the correct bundle size and configuration installed between two and five metres distant from the location of the joint(s).

Tension arc horns should be installed on the right hand insulator string of bundle conductors, where an earth end arc horn requires a crank this should be from right to left on standard horns, the only exception to this is on rotated sets where rotated arc horns will be required and the orientation will be reversed. Rotated arc horns shall be installed on the upper insulator string. For all circuits operating at a lower voltage than that of the installed insulation then extension arc horns shall be installed on all towers defined as being

'Approach' towers in accordance with TS1. Arc horn extensions shall be attached on the earth end only.

The conductor system shall include a range of fittings such as to ensure capability of achieving the minimum clearances from live jumpers to tower steelwork as specified in TS 2.4 'Generic Design Principles for Overhead Lines'.

The following conductor types shall be terminated accordingly

ACSR, AACSR (Non OPGW) & ACC – Compression Anchor Clamp

AAAC – Wedge Clamp & Compression Anchor Clamp (Note 5)

OPGW & ACC 'Curlew' – Helical Anchor Clamp (Note 5)

Note 5:- At Junction towers, Terminal towers or Angle towers with deviation angles of 60° or greater, compression anchor clamps shall be used on phase conductors.

Where conductor and conductor system design permits a reduction in the quantity of compression tension components may be achieved by the use of helical anchor or wedge clamp assemblies to terminate the conductor.

In accordance with National Grid policy the earthwire conductor shall be Keziah or Keziah equivalent OPGW unless tower strength determines that a smaller Horse equivalent conductor is required. In general a Keziah or Keziah equivalent OPGW shall be used on all lines operating at 275kV and 400kV with the exception of L34; it may also be used on 132kV lines where routes are L2, L3, L4 or L7 in design. L34 and other tower designs shall make use of a smaller earthwire.

The arrangement of earthwire fittings at suspension towers shall permit lateral swing of the conductor to avoid excessive bending forces in any component of the suspension arrangement whilst ensuring that the conductor is sufficiently clear of tower bracings.

When installing fibre optic wrap cable onto existing ACSR earthwire all suspension towers shall have either a Cushion Grip Suspension (CGS) assembly or a Helical Suspension Unit (HSU) assembly installed. OPGW earthwires shall be suspended from a Helical Suspension Unit (HSU) at suspension towers.

In accordance with National Grid policy the earthwire shall be bonded at each tower or structure utilising a bonding arrangement as described in TS 3.04.35 and detailed on the National Grid Generic Type Registration drawings.

The stringing basis for each conductor is detailed in TS 2.04.

1.4 Grease & Surface Treatments

1.4.1 General Requirements for Grease

All of the grease in a single length of conductor shall be of the same type and shall conform to the performance and test requirements of BS EN 50326 and any additional performance and test requirements of this specification.

Each layer of wire shall have an even and continuous coating of grease applied both lengthways and peripherally and shall not be visible on the exterior of the conductor. No accretion of grease or any pollutant is to be permitted on any equipment of the manufacturer if there is a risk that some of the accretion might come into contact with the exterior of the conductor.

There shall be no drawing oil on the surface of the finished conductor.

Only Category 'A' Cold Applied Grease shall be used and designated as follows:

- a) 80°C (20A80) for grease used in conductors for use as earthwires only
- b) 150°C (20A150) for all standard phase conductors
- c) 210°C (20A210) for high temperature phase conductors (Where Applicable)

Grease shall be stored as per the manufacturer's recommendations.

1.4.2 Grease Application

For conductors designated as earthwires only all layers up to and including the penultimate layer shall be protected with grease suitable for the particular application as shown in the previous section of this specification and shall then be wiped. For standard greased conductors intended for use as phase conductors grease shall not be applied to the interstices between the penultimate and outer layers. The mass of the grease shall be between the minimum and maximum specified in Appendix A, Tables 1A, 1B & 2 of this specification.

For GZTACSR conductor the mass of the grease shall be demonstrated to represent a 60 - 80% fill of the available void encompassed by the internal diameter of the trapezoidal strands. The supplier shall provide details of the mass values required based on a 70% fill of the maximum and minimum void for the purpose of sample testing.

During manufacture of the conductor, drop point tests and oil separation tests shall be carried out in accordance BS EN 50326 Cl. 6.6.2 & 6.6.3 respectively at least once per week on a sample of grease taken from each application point on the manufacturing line, these records shall be retained for inspection should they be required.

1.4.3 Conductor Surface Treatments

Standard temperature conductors shall be supplied with an untreated surface unless specifically requested by National Grid. All conductors designated by National Grid for High Temperature Low Sag (HTLS) operation may have a requirement for a treated surface as detailed below;

GZTACSR & ACC conductors shall have a minimum surface emissivity coefficient of 0.6 to maximise the thermal rating of the conductor when new. This surface emissivity shall be achieved by a treatment of the conductor surface by a method which meets the functional and performance requirements specified in this document.

The colour of the treated surface shall be non-reflective and drab grey. The surface treatment shall be applied uniformly to the outer surface of the conductor only. The conductor manufacturer shall provide evidence to demonstrate that the following requirements are met:

- a) The value of the surface emissivity of the treated conductor is 0.6 or greater, at a surface temperature equal to the maximum operating temperature for the conductor under test.
- b) The surface treatment can be readily abraded with a wire brush or pad for the purpose of making compression connections and repairing the conductor but shall be resilient enough to survive normal handling & installation techniques so as not to increase the audible noise from the energised line over the conductors design life.
- c) The treatment will not provide a sticky surface capable of retaining airborne particles leading to audible noise generation, nor will it become sticky in service at

temperatures up to 150°C (for standard conductors) and 210°C (for High Temperature Conductors) over the design life of the conductor.

1.5 Conductor Drums

The conductor shall be supplied on wooden or metal drums suitable for the required length and conditions of storage and shall also be suitable for use on the installation equipment. The conductor shall be protected on the drums from corrosion, abrasion or the risk of damage due to transport and handling on site. Drums shall be marked to show conductor type, name, length, batch number, date of manufacture and type of grease in the conductor. In addition the drum shall be marked to demonstrate the correct direction of drum rotation during removal of the conductor.

Note 6:- If the grease type limits the application of the conductor to earthwire systems only (20A80), then this shall be clearly marked on the drum.

2 PERFORMANCE REQUIREMENTS

The overall design of the conductor bundle shall be such that radio noise field strengths measured with all circuits in service shall not exceed the recommended levels in BS 5049-2.

Note 7:- National Grid standard conductor bundles at the voltages specified in Appendix A, Table 4 of this specification can be assumed to comply.

National Grid seeks to procure a system having optimised life cycle costs over a service life that is determined by the conductor with a minimum life of 40 years, optical earthwires including the optical sub-unit shall have a minimum life of 40 years.

The minimum engineered design life of individual components used as part of the conductor or earthwire system shall be as stated in TS 3.04.35 'Components for Overhead Lines'.

The maximum resistance of the finished conductor shall be stated in $\mu\Omega/\text{m}$ and shall be no higher than the figure stated in Appendix A, Tables 1A, 1B & 2 of this specification.

Conductor grease where applied shall protect the conductors from environmental conditions and shall not cause corrosion to galvanised steel, aluminium or aluminium alloy wires or any combination of these wires individually or when these materials are in contact with each other. The grease shall be compatible with any wire drawing lubricant used during manufacture of the conductor. The grease or any component of, shall not flow within, nor exude from, the conductor during storage, transport, and erection or during service at the specified temperatures.

All grease selected for conductors shall not be degraded and shall remain resistant to oxidation during manufacture, storage, the conductor manufacturing process and whilst in service and shall be flexible and retaining its properties at all operating temperatures without cracking or flaking.

The grease shall conform to all current health and safety legislation and be issued with a Material Safety Data Sheet (MSDS).

3 TYPE TEST REQUIREMENTS

Type tests are intended to verify the main characteristics of the conductor, which depend mainly on its design and the manufacturing process. Type tests shall be completed at each place of manufacture and shall be repeated when the design, manufacturing process or manufacturing location is changed.

All conductors must be subjected to the type tests detailed in the relevant BS EN's or IEC's referenced in this document and the additional requirements of this specification. Each test along with the acceptance criteria is detailed in the following clauses and a cross check to determine which tests apply to a particular conductor or conductor material are shown in Appendix A, Table 7 of this specification.

The technical parameters of the conductor and materials used shall be provided on the Conductor Datasheet, General Technical Parameters (GTP) or Cross Sectional Drawing submitted as part of the type registration process.

3.1 Tests on Finished Conductor

Type testing shall be in accordance with BS EN 50182 for the finished conductor. The conductor sample offered by the manufacturer for type test shall be of sufficient length to enable all the required tests to be completed.

3.1.1 Surface Condition

The surface condition of the conductor shall be subjected to a visual inspection.

Acceptance criteria - The surface of the conductor shall be free from all imperfections visible to the unaided eye, such as nicks, scratches and indentations. If an additional coating to manage a given emissivity value has been applied to the conductor then this shall also be smooth and uniformly applied to the conductor surface. On greased conductors there shall be no evidence of grease on the exterior of the conductor.

3.1.2 a) Conductor Diameter

The conductor diameter shall be measured on samples prepared for conductor type test.

Acceptance criteria - The diameter of the conductor shall not vary from the nominal value shown in Appendix A, Tables 1A, 1B & 2 by more than +/- 1%.

b) Internal Gap Measurement (GZTACSR Conductors Only)

GZTACSR conductors shall have the internal diameter of the inner layer of aluminium/zirconium measured and shall comply with the values stated on the manufacturers conductor datasheet, GTP or drawing.

Acceptance criteria - The internal diameter of the inner layer of aluminium/zirconium shall be between 11.0 – 11.8mm and not vary from the nominal value shown on the datasheet, GTP or drawing by more than +/- 3%.

3.1.3 D.C Resistance

The resistance of the full conductor shall be measured and wherever required corrected for a 1m sample.

Acceptance Criteria – The measured value shall not exceed the maximum D.C.Resistance identified in Appendix A Tables 1A, 1B & 2 of this specification.

3.1.4 Inertness

The aluminium / aluminium alloy layers of the conductor shall be unwound for approximately 0.5m and re-layered. It is acceptable to complete this test on samples whilst still on the drum or immediately prior to strip down of a sample with a minimum length of 1m taken for strand testing.

Acceptance criteria - All wires shall lie in their natural position and at the point the conductor is cut the wire ends shall remain in position. The wires shall be readily replaced by hand and then remain in their approximate position.

3.1.5 Lay Ratio and Direction of Lay

The lay ratio of a given layer of conductor shall be obtained by dividing the measured lay length by the diameter of the layer.

Acceptance criteria - The following values shall be applied;

Steel wires & Composite strands, 16 – 26.

Aluminium & Aluminium Alloy wires, 10 – 16 for the inner layers and 10 – 14 for the outer layer.

The outer layer of wires shall be right hand lay.

3.1.6 Number and Type of Wires

The conductor shall be examined and the number and type of wires shall be checked.

Acceptance criteria - The number and type of wires shall be confirmed as being in accordance with the conductor stated on the relevant datasheet, GTP or cross sectional drawing.

3.1.7 Mass per Unit Length of Conductor and Grease

The mass of grease per unit length of conductor shall be determined from a sample of conductor taken from the end of the drum. The weight and length of the conductor sample shall be measured and recorded and the sample inspected to confirm that no grease is visible on the exterior. The wires in each layer shall be separated progressively layer by layer whilst being inspected to verify that the coating and wiping requirements are met. The grease may be removed by any convenient method such as de-greasing and the weight of the cleaned conductor sample determined and confirmed as being in accordance with Appendix A, Tables 1A, 1B & 2 of this specification.

Acceptance criteria - The mass per unit length shall be determined by use of apparatus having an accuracy of $\pm 0.1\%$ and the result of the conductor shall not vary by more than $\pm 2\%$ of its nominal value detailed in Appendix A Tables 1A, 1B & 2 of this specification. The mass of grease in the sample (corrected for a 1m length) shall fall within the minimum and maximum values stated in Appendix A Tables 1A, 1B & 2 of this specification.

Note 8:- During confirmation of grease mass in the conductor it is acceptable to obtain sufficient grease for drop point and oil separation tests; if this method of grease collection is employed then the grease shall be removed without heating the conductor and prior to any de-greasing or cleaning activity taking place.

3.1.8 Stress-Strain Curve Test

The stress-strain curve shall be performed in accordance with BS EN 50182 Appendix C. Where a range of sizes of the same conductor design, i.e. AAAC or ACSR, are manufactured only the largest conductor size is required to be tested.

Acceptance criteria - There are no specific pass/fail criteria for a stress/strain test; data gathered from the test shall represent the best knowledge of the behaviour of the conductor under load.