

COMPONENTS FOR OVERHEAD LINES

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PURPOSE AND SCOPE

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

This Specification defines the characteristics and performance requirements for all insulator and conductor components, spacers and vibration dampers procured for use on overhead lines owned by or directly connected to the National Grid transmission system operating at 132, 275 & 400kV.

PART 1 – PROCEDURAL

1. GENERAL REQUIREMENTS

1.1. General

Components 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.

For the purpose of this specification it may be assumed that Keziah (160mm² AACSR) and Fibre Optic conductors (OPGW) are exclusively for use on earthwire applications. All other conductors may be used for 400 kV phase wire applications except Lynx (175mm² ACSR) and Upas (300mm² AAAC) which may only be used for 275kV applications.

Sub components identified as part of an overhead line solution shall be selected to permit interchangeability between components where multiple product sources are registered. **It is acceptable to submit designs that are suitable for a range of conductor sizes.**

Prior to the type registration of components that interface directly with conductors the component manufacturer or supplier shall wherever possible be endorsed by the conductor

suppliers for the design and manufacture of components for installation onto their conductor(s).

All components shall meet the requirements of the relevant legislation and any additional requirements detailed within this specification. The following requirements apply to each component type;

1.1.1 Insulator Fittings

Drawings of a range of insulator components are detailed in BS 3288: Part 2 and the National Grid '68 series' drawings.

1.1.2 Conductor Fittings

All conductor components shall meet the requirements of BS EN 61284 & National Grid '68 Series' drawings and will only be **type** registered for use on conductor designs on which they have been tested.

1.1.3 Vibration Dampers

All vibration dampers shall meet the requirements of BS EN 61284 and BS EN 61897.

The manufacturer shall submit designs for 4 response dampers only and for each design shall provide a procedure for installation and recommend the quantity and placement of vibration dampers in accordance with the requirements of TS 3.04.37.

1.1.4 Spacers

All spacers shall meet the requirements of BS EN 61284 and IEC 61854.

The manufacturer shall provide a procedure for installation.

1.2 Materials

Where different materials are used in a component then the design shall ensure that electro chemical action or other adverse effects associated with dissimilar materials cannot occur.

All component materials, with the exception of elastomer lined components, shall be in accordance with BS EN 754 & 755 and shall only have aluminium or aluminium alloy in contact with the conductor.

All steel bolt assemblies shall unless specified otherwise in this document be hot dip galvanised high tensile steel to BS 4190 (grade 8.8 for bolts and grade 8 for nuts).

All stainless steel bolts shall be A2 or A4 grade as per BS EN ISO 3506.

Where components designed for use on high temperature conductors utilise elastomeric elements (e.g. conductor liners & damping elements etc.) the thermal performance of the elastomer shall be capable of meeting the maximum operating temperature of the conductor it is intended for use on.

1.3 Assemblies

The design of assemblies shall be such as to minimise the number of parts and the possibility of incorrect assembly and installation. As far as possible small components (e.g. fasteners) should be captive. Split pins shall be Austenitic Stainless Steel.

The need for special tools for installation or removal of components shall be avoided if possible but where required they shall be submitted to National Grid for assessment during type registration.

All threaded fasteners shall be locked to ensure that slackening does not occur due to vibration in service, where fasteners are required to be torqued this should be clearly identified and the relevant torque setting clearly marked.

Where a component is available with a bolt or clevis pin, a bolt shall be used unless otherwise agreed by National Grid. For BS 3288 components this shall be indicated in the part reference number by the suffix "A" in accordance with BS 3288: Part 2.

1.4 Conductors

This Specification shall apply to components designed for installation on the conductors detailed in Appendix A Tables A1.1 and A1.2 of this specification.

The following abbreviations are used throughout this Specification:

Standard Conductor Types

ACSR	Aluminium Conductor Steel Reinforced
AACSR	Aluminium Alloy Conductor Steel Reinforced
ACAR	Aluminium Conductor Alloy Reinforced
AAAC	All Aluminium Alloy Conductor
GZTACSR	"Gap" type ZT Aluminium Conductor Steel Reinforced (See Note 1)
OPGW	Optical Ground Wire

Composite Core Conductors

ACC	Aluminium & Composite Conductor (See Note 1)
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Note 1: Designated as High Temperature Low Sag conductors

1.5 Galvanising

All ferrous components shall be hot dip galvanised in accordance with BS EN ISO 1461.

Renovation of un-coated areas, or areas damaged in handling is permitted in accordance with BS EN ISO 1461. Components having any areas of rust will not be accepted.

Tubular components, such as arc horns, shall be vented such that galvanising of the inner surface complies with the above requirement, and vent holes sealed using zinc plugs. The method of venting and plugging shall avoid damage to the galvanising, weakening of the component and shall not give rise to corona in service.

1.6 Component Finish

All components shall have burrs & sharp edges removed and corners radiused, where applicable this must be completed prior to galvanising. The ends of all conductor grooves shall be suitably radiused, i.e. suspension clamps and the surface finish shall be sufficiently smooth to prevent corona in service.

1.7 Marking

1.7.1 General

All components shall be marked legibly and indelibly in accordance with BS EN 61284. All marking should be completed using suitable lettering and positioned to ensure the lettering does not generate corona discharge. Any additional marking to the above shall be allowed provided that it does not result in any ambiguity in identification of the component.

Where the same component is suitable for use on more than one conductor then the conductor **range** shall be clearly marked on both the component and associated drawing.

Identification of components shall include the suppliers unique identifier, conductor size and type **or conductor range**, e.g. '400 ACSR' or '31.5mm – 40mm', date of manufacture and traceability mark. The manufacturers stated installation torque(s) in Newton metres (e.g. "50 Nm") shall be marked adjacent to screwed fasteners tightened during installation.

The following details the additional requirements for the particular component types;

1.7.2 Insulator Fittings

The recognised BS 3288 reference or in the case of National Grid specific components the relevant National Grid '68' series drawing.

Components designed in accordance with a National Grid '68' series drawing shall have the Specified Minimum Failing Load (SMFL) of the component marked separately.

1.7.3 Conductor Fittings

All components shall be marked and identified outside of any compression areas where possible to allow easier identification of the component post compression.

The following additional marking shall be provided on conductor components;

- a) In the case of helical components the information shall be provided on tear-off labels; in addition the components shall be marked with paint to an agreed colour code (See Note 2) according to Appendix A Table A2 of this specification.
- b) Compression fittings - direction of compression and limits of compression shall be marked on any separate compression sleeves supplied with the component.
- c) Suspension clamps - the straps of suspension clamps shall be marked with the reference number as per the relevant National Grid component drawing.

Note 2: In the case of helical repair sleeves the paint shall be applied at the centre of the component.

1.7.4 Spacers

The following additional marking shall be provided on spacers;

- a) Correct orientation of spacer (using vertical arrows marked 'up' or using 'top' or other agreed marking to indicate this).
- b) For non-tension bonding joint spacers the longitudinal limits and direction of compression.

1.8 Packaging

Components shall be packaged in accordance with the National Grid Packaging Specification to provide adequate mechanical and corrosion protection in transit and for reasonable storage periods.

The gross weight of the package/components shall be clearly identified on the outside of the packaging and any specific requirements, (i.e. 2 Person Lift, Mechanical Lift Only, shall be detailed).

Conductor compression assemblies shall be supplied in sealed packaging containing the correct amount of grease required to assemble the joint. The aluminium tube shall be supplied dry and separately vacuum packed within the main packaging to prevent age hardening during extended storage periods.

Installation instructions where applicable shall be supplied with each batch of components.

1.9 Drawings

1.9.1 General

Only information relevant to National Grid registered conductors shall be included on component drawings.

The following general information shall be shown on the relevant component drawing;

- a) The supplier drawing number and revision.
- b) The markings to be applied to the component.
- c) The relevant specification to which the component is manufactured and tested.

- d) The technical data for components shall include all critical dimensions and applicable tolerances; in addition any other dimensions which significantly affect the functional and performance characteristics of the component shall also be included;
- e) All sub components that form part of an assembly shall be identified.
- f) All sub suppliers of a component shall be identified.
- g) Nominal weight in kilograms (Kg) and stated installation torque(s) in Newton metres (e.g. "50 Nm") shall be shown.
- h) All materials shall be specified and referenced to the applicable specification, grade and any relevant heat treatment condition.
- i) Where applicable compliance with the relevant galvanising and welding specification requirements shall be stated in a note.

In addition to the general requirements detailed above the following specific information shall be included on the relevant drawing.

1.9.2 Insulator Fittings

- a) BS 3288 or National Grid '68' drawing series reference.
- b) Specified Minimum Failing Load (SMFL).
- c) Other test loads as appropriate e.g. for erection and/or maintenance activities.

1.9.3 Conductor Fittings

- a) The conductor(s) the component is designed for **and tested on**.
- b) The tube and bore dimensions of all compression fittings.
- c) The across flats dimensions of the relevant compression dies for each conductor(s) shall be detailed (e.g. 40.21) and the die reference (e.g. S11, A11). Only the compression heads used during **testing** shall be detailed.
- d) The direction of compression and the required conductor cut back dimensions.
- e) The surface preparation (e.g. scratch brushing) and protection of all external electrical contact areas shall be noted.
- f) The grease requirements for tubular components.
- g) The equivalent conductor length to enable calculation of the 'e' value shall be shown on the drawing and measured resistance readings obtained during testing.

1.9.4 Vibration Dampers

- a) Overall dimensions to include mass and length of damper, mass, length and diameter of weights, attachment clamps and messenger cable stranding.
- b) Maximum attachment clamp opening.
- c) Distance between attachment clamp centre and messenger cable centre.
- d) **Conductor range the component has been tested on and is registered for if applicable.**

1.9.5 Spacers

- a) Overall frame dimensions, conductor clamp width and range of angular movement.
- b) Bolt lengths and maximum clamp opening.
- c) Confirmation that any conductor spacing is to the specified tolerance.
- d) **Conductor range the component has been tested on and is registered for if applicable.**

1.10 Corona

Conductor components as specified in Appendix B Table B3, vibration dampers (apart from those used exclusively on earthwires) and spacers with the exception of Non Tension Joint Bonding spacers, shall satisfy the requirements of section 4.1.23 of this specification.

1.11 Grease, Jointing and Line Grip Compounds

All grease, jointing and line grip compounds applied to components which interface with the conductor in service shall have an operating temperature that matches or exceeds the post fault temperature of the conductor for which it is designed in accordance with TS 3.04.37. Only Category 'A' cold applied greases shall be used.

All components that have a metal to metal interface with the conductor shall be designed for installation with grease between the component and the conductor.

All compression components shall be supplied dry with the correct amount of grease or jointing compound required to assemble the joint. The grease or jointing compound shall be supplied in a separate sealed package as part of the joint assembly.

Line grip compounds may be used with helical repair sleeves and line splice shunts, the compound shall not corrode the conductor.

2. GENERAL DESIGN REQUIREMENTS

2.1 Insulator Fittings

All insulator fittings shall conform to the designs detailed in BS 3288 Part 2 and the tolerances defined. Where no design is contained within BS 3288 then National Grid will produce a '68' series drawing which shall detail the requirements of the fitting.

2.1.1 Arc Horns & Stress Devices

2.1.1.1 General

The design of arc horns shall be in accordance with the National Grid '68' series drawings.

The design and application of arc horns shall ensure that the resulting arc gaps across an insulator set meet the values specified in TS 1, a $\pm 3\%$ tolerance shall be applied.

Arc horns shall comply with the mechanical test requirements of Section 4.1.7 of this document.

The minimum specification of steel tubing shall be 'medium steel tube', in accordance with BS EN 10255.

Arc horns and stress devices shall be galvanised both inside and outside, the ends shall be formed into smooth hemispheres and shall be sealed.

The surface finish of arc horns and stress devices shall be sufficiently smooth to prevent corona in service with particular attention given to the plugging of vent holes. The approximate position of vent holes shall be marked on manufacturer's drawings submitted to National Grid for type registration.

Arc horn and stress device fixing bolts shall be M16 and fitted with a washer, nut and lock nut. The correct length and quantity of arc horn bolts shall be determined from the National Grid generic string drawings. The thread length of bolts shall conform to Table 3 of BS 4190 and all washers shall conform to BS 4320.

2.1.1.2 Identification Codes

For all new designs of arc horns the following identification codes shall be adopted;

LS – Line End Suspension Set Arc Horn

LT – Line End Tension Set Arc Horn

ES – Earth End Suspension Set Arc Horn

ET – Earth End Tension Set Arc Horn

X – Extension Arc Horn

C – Corona Shield

Each of the above will be issued with a suffix number and all component drawings will have the relevant National Grid identification marked on them.

Arc horns which have an additional 'R' suffix are designed to be installed on rotated insulator sets and shall be manufactured in the opposite orientation to the standard arc horn.

2.2 Conductor Fittings

The relevant National Grid '68 Series' component drawings detail the critical dimensions. Tolerances as specified in BS 3288-1 apply except where indicated otherwise. Where a maximum dimension is specified, the tolerance shall be +0 and -10%. Where a minimum dimension is specified the tolerance shall be -0 and +10%. Where approximate dimensions are specified, the tolerance shall be $\pm 10\%$.

Designs which do not comply with the generic National Grid '68' Series drawings may be accepted following review. All non-conformances from this specification must be agreed and fully documented in accordance with UKBP/TP 183.

All conductor fittings shall have an operating temperature that exceeds the post fault temperature of the conductor for which it is designed.

2.2.1 Compression Components

Compression components shall be suitable for installation using hydraulic compression head and die sizes detailed in Appendix A Tables A1.1 and A1.2 of this specification. Following compression the components shall not permit relative movement between the individual layers of the conductor. The direction and longitudinal limits of the compression shall be clearly identified.

Note 3: Three components shall be type tested, where more than one compression head size is to be used to complete the compressions the test samples may be compressed using a combination of compression heads, i.e. 2 x 60t and 1 x 36t.

2.2.1.1 Compression Dead Ends

Compression dead ends shall be supplied with a 2 hole flag up to and including 570mm² AAAC and a four hole flag for all other conductor sizes. Where compression dead ends are installed on low duty sets and substation connections the quantity of jumper flags and their orientation may be adjusted. All compression dead ends shall utilise a single clevis or tongue design.

2.2.1.2 Midspan Joints

Midspan Joints for ACSR shall include a longitudinal centering key. Joints for ACAR and AAAC shall include a central barrier or stop.

2.2.1.3 Jumper and Line Termination Palms

Jumper and line termination palms shall be supplied with a 2 hole flag up to and including 570mm² AAAC and a four hole flag for all other conductor sizes. The contact surfaces shall be scratch brushed or rough machined and shall be protected with a removable dry weatherproof coating.

Bolts (M16) and nuts shall be made from high tensile steel, equivalent to Grade 8.8 (BS 4190). Load spreading washers of 44 mm nominal diameter, 9.5mm thick with 18mm diameter hole. Bolts nuts and washers shall be galvanised to BS EN ISO 1461 and shall be supplied greased or lightly oiled.

2.2.1.4 Compression Repair Sleeves

Compression repair sleeves suitable for the repair of conductor damage are shown in Appendix A Table A3 of this specification and the criteria for the number of broken strands and length of damage is detailed. All compression repair sleeves shall be a split interlocking tube design and have a maximum compressed length of 400mm.

2.2.1.5 Tee Connectors

Tee connectors shall be manufactured from split interlocking tube.

2.2.1.6 Non Tension Joint Non Disconnectable

Non tension joints are suitable for jointing jumper legs and down droppers only. They shall be manufactured from full tube with the centre point being identified on the exterior.

2.2.2 Wedge Clamps

Wedge Clamp assemblies shall have bodies and wedges manufactured from forged aluminium alloy and galvanised steel straps. The design shall consider the installation / removal of the clamp and shall consist of the minimum number of components within the sub assembly. The type registration submission shall include the details of the recommended extractor tool.

2.2.3 Helical Components

All helical components shall be designed for installation on conductors that are right hand lay and the individual rods or sub-sets of rods making up each component shall be taped or tied together and shall be marked with the relevant colour code in accordance with Appendix A Table A2 of this specification. Ball ended rods shall be used on earthwire installations, repair sleeves and line splice shunts only and parrot billed rods shall be used on all other phase wire installations.

2.2.3.1 Helical Suspension Unit (HSU) Assemblies

The clamp shall be completely inter-changeable with a standard conductor clamp design in respect of drop and interface fitting.

The clamp shall have the capability of an unobstructed lateral swing through a 60° inclusive angle.

A cast clamp body may be acceptable; where it is used a load bearing strap shall support the load.

A continuous aluminium stiffener shall run throughout the length of the elastomeric element to provide added strength. The elastomeric element shall not trap moisture between the conductor and itself and shall not cause any corrosion to the conductor.

2.2.3.2 Helical Dead End Assemblies

Helical dead ends shall be supplied as an assembly complete with thimble and reinforcing rods where required.

2.2.3.3 Armour Rods

Armour rod sets shall comprise individual aluminium alloy rods and shall completely enclose the conductor. Armour rods for application under Keziah equivalent OPGW earthwire with tower cleats applied over the top shall be 5.4mm ±0.05mm in diameter and 1200mm long.

2.2.3.4 Helical Repair Sleeves

Helical sleeves suitable for the repair of conductor damage are shown in Appendix A Table A2 of this specification and the criteria for the number of broken strands and length of damage is detailed. The sleeves shall be supplied in sub-sets, each having the centre marked with the identified colour code and the conductor contact surfaces coated with permanently bonded conductive grit.

2.2.3.5 Line Splice Shunts

The central portion of the line splice shunt shall accommodate the maximum length of compression sleeve or midspan joint for each conductor type in accordance with the National Grid component drawings. The diameter shall be suitable to accommodate the across flats die size as given in Appendix A Tables A1.1 and A1.2 of this specification.

2.2.3.6 Bird Flight Diverters

Bird flight diverters shall only be applied to earthwire conductors and shall either be of a helical or sphere design and may be manufactured from aluminium alloy or coloured high impact PVC.

2.2.4 Earth Bond Assemblies

All earth bond assemblies shall be capable of safely withstanding a load of 50kA for 200ms. The maximum electrical resistance of the bond shall be 0.260Ω/km at 20°C.

2.2.5 Bolted Suspension Clamps

The clamp body and keeper shall be forged and shall have either aluminium or aluminium alloy in contact with the conductors. Clamp bolt/screws shall be high tensile steel which has been galvanised by the hot-dipped process and shall remain captive in one part of the clamp at all times.

The threads of the bolts/screws shall be greased or lightly oiled to ensure that they are free running when the component is installed, even after a lengthy period in storage. Nuts shall be high tensile steel and shall be hot-dipped galvanised prior to thread cutting.

The clamp design shall incorporate a locking device (i.e. spring washer or lock nut) that will ensure that no slackening of the clamp shall occur in service.

Clamping bolts shall be capable of being tightened to 120Nm or twice the stated installation torque (whichever is the smaller) without failure.

Suspension clamps for GTZACSR conductors shall compress the aluminium layers of the conductor onto the steel core sufficiently to withstand a 5kN force applied axially to the core without movement.

2.2.6 Elastomer Lined Suspension Clamps

The clamp shall be completely inter-changeable with a standard conductor clamp design in respect of drop and interface fitting.

The clamp shall have the capability of an unobstructed lateral swing through a 60° inclusive angle.

The clamp body and keeper shall be forged and shall have either aluminium or aluminium alloy in contact with the conductors. Clamp bolt/screws shall be high tensile steel which has been galvanised by the hot-dipped process and shall remain captive in one part of the clamp at all times.

The threads of the bolts/screws shall be greased or lightly oiled to ensure that they are free running when the component is installed, even after a lengthy period in storage. Nuts shall be high tensile steel and shall be hot-dipped galvanised prior to thread cutting.

The clamp design shall incorporate a locking device (i.e. spring washer or lock nut) that will ensure that no slackening of the clamp shall occur in service.

Clamping bolts shall be capable of being tightened to 120Nm or twice the stated installation torque (whichever is the smaller) without failure.

2.2.7 Parallel Groove (PG) Clamps

PG Clamps shall be suitable for conductor sizes identified in Appendix A, Tables A1.1 and A1.2 of this specification and in the case of earthwire bonds suitable for installation onto HSU

rods. The clamps shall be manufactured from aluminium in accordance with BS EN 573 & BS EN 515. All fastenings shall be stainless steel in accordance with BS EN ISO 3506 and shall be held captive in assembly.

Parallel groove clamps are restricted to earthwire bonding and temporary hot joint by pass applications.

2.2.8 Pilot Set, Jumper and Suspension Set Weights

Weights shall be galvanised in accordance with section 1.5 of this specification and shall be designed such that they can be installed without detaching the keepers.

Galvanised steel bolt assemblies which form part of the weight(s) that are not load bearing may be grade 4.8 or equivalent.

Pilot set weights shall be 80Kg +/- 5Kg. Jumper weights shall be 50Kg +/- 2.5Kg with the exception of Lynx and Upas conductors which shall be 23Kg +/- 2Kg. **Suspension set weight assemblies shall have a maximum weight of 257Kg for triple configuration and 175Kg for a twin configuration and shall have a tolerance of +/- 5%.**

2.3 Vibration Dampers

Vibration dampers **shall be '4 Response' in design** and comprise of two weights attached via a length of messenger cable to a bolted or helically attached clamp for installation on the conductor for which the damper is designed. The self-damping effect of the **conductor and the damping provided by spacer dampers** shall not be taken into consideration when designing the vibration damper.

A damping system for each conductor type shall be produced with installation instructions and placement charts issued as part of Type Registration.

2.3.1 Damper Weights

The design of the vibration damper weights shall ensure that no dynamic impact occurs between the messenger cable and weights or conductor and weights during service. Where the design of weights permits collection of water, drain holes shall be provided to ensure that any water entering the weights can escape when the vibration dampers are either in storage or service. If the weights are manufactured from ferrous metal they shall be galvanised in accordance with section 1.5 of this specification.

2.3.2 Messenger Cable

The messenger cable shall be straight and sufficiently stiff to support the weights without deflection when the vibration damper is suspended by its clamp. It shall be made from stranded high tensile fatigue resistant steel wires. Ferrous wires other than stainless steel wires shall be galvanised to BS EN 50189 with a minimum zinc thickness of 35 microns. There shall be no relative movement between messenger cable and conductor clamp during service.

If stainless steel wires are used, the grade of steel shall be resistant to stress corrosion and this shall be demonstrated by a suitable test.

2.3.3 Conductor Clamps

Vibration damper clamps shall have only aluminium, aluminium alloy, or an elastomer in contact with the conductors and shall be designed so as to admit the sub-conductors without the need to remove any of the keeper fasteners. The clamp design shall ensure that, after the bolt/screw or attachment rods have been applied in accordance with the supplier's instructions no slackening of the clamp can occur in service.

All bolts shall be a minimum grade of 8.8, shear or breakaway bolts shall not be used.

Clamp bolts/screws shall be hot-dipped galvanised in accordance with section 1.5 of this specification and shall preferably be peened at the end or otherwise modified to prevent them being completely unscrewed inadvertently. However, this will not be considered essential if the length of bolt or screw is sufficient to allow the clamp opening to be at least 1.25 times that

of the conductor diameter without completely unscrewing the bolt or screw. Any nuts shall be galvanised (prior to cutting of thread) high tensile steel and shall be captive.

The threads of bolts or screws shall be greased or lightly oiled to ensure they are free running when the vibration damper is installed, even after a lengthy period in storage.

2.4 Spacers

2.4.1 Spacer Types

Spacers are designed to maintain bundle separation, and are required for conductors detailed in TS 3.04.37. Various spacer types are required by National Grid for this purpose. These include:

a) Rigid Spacer:-

Comprising bolted aluminium or elastomer lined clamps which are solidly connected to each other, both electrically and mechanically, and which are suitable for jumpers, downleads, down-droppers and cross jumpers. Rigid spacers with elastomer lined clamps may also be installed on rotated phase conductor bundles in order to prevent conductor-conductor contact during bundle collapse under high electrical loads.

b) Non-Tension Joint Bonding Spacer:-

Comprising two or more non-tension joints connected to form a combined joint and spacer for jumpers.

c) Spacer Dampers:-

Comprising of bolted aluminium or elastomer lined conductor clamps having arms angled in the vertical plane and connected to a rigid frame via semi-conducting bushes which have defined stiffness and damping properties suitable for in span application on all bundle configurations.

2.4.2 Spacer Sizes

Spacers suitable for the following applications are required:

- a) 200mm twin, triple and quad rigid spacers for jumpers on all conductors.
- b) 200mm non-tension joint bonding spacers for **ACSR**, AAAC and ACC conductors.
- c) 300mm twin rigid spacers with elastomer lined clamps for installation 5m from a quad duplex suspension set.
- d) 300mm twin, triple and quad rigid spacers for downleads on all conductors.
- e) 300, 400 and 500mm twin spacer dampers (as required) for all conductors and in addition 550mm twin spacer dampers for 850 AAAC.
- f) 400x400mm and 500x500mm quad spacer dampers for 400 ACSR.
- g) 500mm equilateral triangle with apex down for triple 700 AAAC.
- h) **500 & 640mm twin rigid spacers with elastomer lined clamps for rotated bundles.**

Note 4: The permissible tolerance on conductor spacing shall be $\pm 3\%$.

2.4.3 Mechanical Strength

All spacers shall have sufficient mechanical strength to withstand, without permanent deformation, the forces they may be subjected to in service on unbroken conductors, including wind-induced conductor movement and electromagnetic forces induced by load or fault currents.

2.4.4 Flexibility

All spacer dampers shall permit the relative movements between sub-conductors without damage to the spacer or to the conductors.

2.4.5 Resistance of Elastomeric Elements and Clamp Liners

To avoid galvanic corrosion of the conductor or frame in contact with the elastomeric element the test in clause 4.1.11 shall be performed and the resistance shall be more than 1MΩ. To avoid problems caused by capacitive charging of the spacer components in service the resistance shall be less than 20MΩ.

2.4.6 Clamps

Spacer clamps shall have only aluminium, aluminium alloy, or an elastomer in contact with the conductors and shall be designed so as to admit the sub-conductors without the need to remove any of the keeper fasteners. The clamp design shall ensure that, after the fasteners have been applied in accordance with the supplier's instructions no slackening of the clamp can occur in service.

Clamp bolts/screws shall be hot-dipped galvanized high tensile steel to BS EN 61854 (or subjected to a process to achieve equivalent corrosion protection that is acceptable to National Grid) and shall preferably be peened at the end or otherwise modified to prevent them being completely unscrewed inadvertently; however this will not be considered essential if the length of bolt or screw is sufficient to allow the clamp opening to be at least 1.25 times that of the conductor diameter without completely unscrewing the bolt or screw. All bolts shall be manufactured to grade 8.8.

The threads of bolts or screws shall be greased to ensure they are free running when the spacer is installed, even after a lengthy period in storage. Nuts, where used, shall be made of high tensile steel and shall be hot-dipped galvanized prior to the cutting of the thread. All nuts shall be captive. Shear or breakaway bolts shall not be used.

National Grid considers unlined spacer clamps suitable for twin non rotated conductor bundles only. Clamps for all other bundles shall be elastomer lined.

3. PERFORMANCE REQUIREMENTS

Insulator and conductor components shall be designed and manufactured for a service life of at least 40 years, vibration dampers and spacers shall be designed and manufactured for a service life of at least 20 years. All service life shall take full account of environmental factors, including conductor temperature variations between -20°C and 210°C, ultra-violet radiation, ozone and atmospheric pollutants.

The design and manufacture of components that interact with the conductor shall ensure that the conductor (which may be more than 40 years old) is unaffected by installation of the component, either immediately, or in service. To this end the component shall not cause opening or damage to the strands when first installed and shall not cause fretting, fatigue or corrosion of the strands in service.

No component shall cause corona discharge or audible noise due to the effect of the wind whilst in service as far as is practicable.

Where disc spring washers are used they shall not completely flatten when the clamp bolt or screw is tightened to the stated installation torque.

Spacer dampers shall be designed such as to adequately damp both aeolian and sub span oscillation to prevent sub-conductor clashing, fretting or fatigue.

4. TYPE TEST REQUIREMENTS

Type tests are intended to verify the main characteristics of the components, which depend mainly on its design and the manufacturing process. They shall, at the discretion of National Grid, be repeated when the design, manufacturing process or manufacturing location is changed.

All components must be subjected to the type tests detailed in the relevant BS EN's, IEC's and this specification. The details of the tests required for each component type are detailed in

the relevant table in Appendix B of this specification. Each test along with acceptance criteria is detailed in the following clauses.

Except where National Grid agree to waive tests on components which are part of a family of common design three components from a representative manufacturing batch shall be tested. In the case of range taking components compliance shall be demonstrated on each conductor the component is to be registered for.

Drawings for registration of the components, subject to satisfactory test results, shall be available at the time that type tests are undertaken.

All components designed for an OPGW conductor shall be type tested on the specific design of OPGW it is to be type registered with, i.e. 24 or 36 fibres, there is no requirement to test on each manufacturer of a standard design of conductor manufactured to TS 3.04.37. It is also accepted that testing completed on a 36 fibre conductor design may also, at the discretion of the National Grid engineer, be accepted in lieu of testing on a 24 fibre conductor design.

4.1 Type Tests

4.1.1 Material Verification

Material verification shall be carried out by the supplier. This can be in the form of a certificate of conformation from the manufacturer or other quality documentation or tests on the material.

Acceptance criteria - The material verification documentation shall be included in the type test report.

4.1.2 Visual Examination

All components shall be inspected to ensure conformity of manufacturing process, shape, coating and surface finish.

Acceptance criteria – component conforms in all essential respects to the relevant drawing.

4.1.3 Verification of Dimensions

All components shall be inspected for conformance with the relevant drawing. All dimensions stated shall be checked in accordance with the stated tolerances.

Acceptance criteria – all dimensions must be in accordance with the relevant drawing and must be within the identified tolerances.

4.1.4 Verification of Marking

All components shall be inspected to verify marking is in accordance with clause 1.7 of this specification and the relevant drawing.

Acceptance criteria – markings are compliant, permanent and are clear and legible.

4.1.5 Galvanising

a) Ferrous Metal Parts

All ferrous metal parts shall have a galvanic coating applied which shall be in accordance with BS EN ISO 1461.

Acceptance criteria - for items that are not centrifuged Table 3 of BS EN ISO 1461 shall be adhered to, for those items that are centrifuged then Table 4 is applicable.

b) Ferrous Steel Wires

Ferrous wires other than stainless steel wires shall be galvanized to BS EN 60888.

Acceptance criteria - a minimum zinc thickness of 35 microns is required.

4.1.6 Mechanical (Insulator Fittings)

Unless otherwise indicated on the drawing, the specified minimum damage load shall be 70% of the SMFL of the component. The minimum damage load test may be waived if no significant deformation is observed after application of the SMFL.