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# NPS/002/017 – Technical Specification for 66kV and 132kV Cable Accessories

## 1. Purpose

The purpose of this document is to detail the technical requirements of 66kV and 132kV cable accessories for use on the Northern Powergrid (the Company) distribution network.

This document supersedes the following document, all copies of which should be destroyed:

Reference	Version	Date	Title
NPS/002/017	4.0	Oct 2016	Technical Specification for 66kV and 132kV Cable Accessories

## 2. Scope

This specification details the technical requirements for 66kV and 132kV cable accessories. This includes XLPE to XLPE straight joints, transition joints and terminations for use on the Company's distribution network.

Any technical documents referenced in this specification refer to the latest versions of the relevant International Standards, British Standards (BS) and Energy Networks Association (ENA) Standards current at the time of supply.

Service failures have been experienced on terminations due to longitudinal shrinkage of cable oversheath material and disturbance to the lead sheath, moisture seals and earth connections. All accessories shall, as far as is reasonably practicable, accommodate or prevent movement of cable components occurring as a result of cable sheath retraction.

The following appendices form part of this technical specification:

- Appendix 1 – Typical cable types and sizes,
- Appendix 2 – Additional tests for terminations,
- Appendix 3 – Logistical requirements,
- Appendix 4 – Self certification conformance declaration,
- Appendix 5 – Addendum to supplier requirements,
- Appendix 6 – Pre-commission testing, routine inspection and maintenance requirements, and,
- Appendix 7 – Technical information checklist.

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### 3. Technical Requirements

#### 3.1. Conditions of Operation

Cable accessories purchased in accordance with this specification are required to operate under conditions stipulated in:

- IMP/001/913 - Code of Practice for the Economic Development of the EHV System.
- IMP/001/914 - Code of Practice for the Economic Development of the 132kV System.
- IMP/001/909 - Code of Practice for Distribution System Parameters.

The following are general conditions of operation.

- Nominal system voltages 66kV and 132kV.
- The working voltage of any part of the system does not normally exceed the normal system voltage by more than 6% at 66kV and 10% at 132kV.
- Nominal system frequency 50 Hz.
- The system operates with the neutral point earthed either directly or through a resistance or reactance at one or more points.
- 66kV accessories shall be rated at a minimum of 72.5kV and be suitable for 3-phase symmetrical short circuit currents of 20 kA for 2 seconds and phase to earth fault currents of 3 kA for 2 seconds (note: at 66 kV phase to earth currents are less than 3-phase currents) where the system has been designed with an earth fault factor of 1.73.
- 132kV accessories shall be rated at a minimum of 145kV and be suitable for 3-phase symmetrical short circuit currents of 25 kA for 1 second and phase to earth fault currents of 31.5 kA for 1 second where the system has been designed with an earth fault factor of 1.40.

Typical cable types and sizes that may require jointing are listed in Appendix 1.

#### 3.2. Joints

##### 3.2.1. General

Joints are required to make connections between cables of various sizes and types. Existing cables typically are:

- Single-core or 3-core paper insulated with copper or aluminium conductor, fluid filled, gas filled with either lead or aluminium sheath, and PVC or PE oversheath;
- Single-core with extruded XLPE insulation, bonded screen, copper, or aluminium conductor, lead, corrugated Aluminium or welded aluminium sheath and PE oversheath meeting the requirements of IEC 60840 and BS 7912. XLPE cables may contain water swellable tapes or powders.

##### 3.2.2. Single-Core XLPE to XLPE Straight Joints

XLPE straight joints shall be tested to meet the requirements of IEC 60840 and BS 7912.

New installations on 132kV XLPE cable shall be cable systems as defined in IEC 60840, clause 12. This is also the preferred arrangement for 66kV installations.

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### **3.2.3. Transition Joints (single-core XLPE to single-core and 3-core fluid filled, or gas filled cables)**

Joints shall be tested to meet the requirements of IEC 60840 and BS 7912. Additionally this shall include the hydraulic, lightning impulse voltage and dielectric security tests specified in IEC 60141.

### **3.2.4. Oil Filled Joints (single-core and 3-core fluid filled)**

Joints shall be tested to meet the requirements of ENA TS 09-4 (The routine, sample and routine on site tests are specified within section 11) and BS 7912. Additionally this shall include the hydraulic, lightning impulse voltage and dielectric security tests specified in IEC 60141.

### **3.2.5. Gas Filled Joints (single-core and 3-core gas filled)**

Joints shall be tested to meet the requirements of ENA TS 09-4 (The routine, sample and routine on site tests are specified within clause 11), and BS 7912. Additionally this shall include the hydraulic, lightning impulse voltage and dielectric security tests specified in IEC 60141.

## **3.3. Terminations**

### **3.3.1. General**

Terminations for 66kV or 132kV XLPE cables shall be tested to meet the requirements of IEC 60840 and BS 7912. New installations on 132kV XLPE cables shall be cable systems as defined in IEC 60840, clause 12. This is also the preferred arrangement for 66kV installations.

### **3.3.2. Indoor and Outdoor Terminations**

Terminations shall conform to the requirements of relevant clauses of IEC 60840, BS 7912 and the additional tests for outdoor terminations specified in Appendix 2.

Outdoor terminations at 132kV shall be self-supporting by a plumbed or clamped baseplate. Outdoor terminations at 66kV may be self-supporting, or if not must be of a design that allows “settling” of the cable on the cable support without altering the performance of the termination.

### **3.3.3. Gas Insulated Switchgear (GIS) Terminations**

GIS terminations shall conform to the requirements of relevant clauses of IEC 60840, BS 7912 and the specific requirement of BS 7912, clause 16.10. They shall also conform to the requirements of the additional tests specified in Appendix 2.

### **3.3.4. Pollution Level and Creepage Requirements**

Unless otherwise specified, the minimum specific creepage distance (SCD) shall be 25mm/kV as detailed in IEC 60815, Table J.1.

### **3.3.5. Gas and Oil Filled Indoor and Outdoor Terminations**

Terminations shall conform to the requirements of relevant clauses of ENA TS 09—4 1991, BS 7912 and the additional tests for outdoor terminations specified in Appendix 2. The routine, sample and routine on site tests are specified within ENA TS 09-4, clause 11.

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### **3.4. Earthing – Auxiliary Equipment**

#### **3.4.1. Bonding Arrangements**

New cable systems will normally be “solidly bonded”, with special bonding arrangements applicable to existing installations. Auxiliary equipment required for earthing and earth connections shall conform to the requirements of IEC 60840 and BS 7912, clause 17.

#### **3.4.2. Bonding Leads**

Earth bonding leads shall be appropriate for the required fault level of the cable system to which they are connected and will normally be 120mm<sup>2</sup> copper for 66kV and 240mm<sup>2</sup> copper for 132kV cable systems. Bonding leads shall conform to the requirements of BS 7912 Clause 17.

#### **3.4.3. Cable Sheath Link Boxes**

Cable sheath link boxes shall meet the requirements of NPS/002/026 - Technical Specification for Cable Sheath Link Boxes.

#### **3.4.4. Sheath Voltage Limiters (SVLs)**

Where the cable earthing and bonding arrangement dictates the use of SVLs, these shall be installed in an earthed metal-housed cable sheath link box as detailed in clause 3.4.3, and may be supplied as single-phase or as a 3-phase unit. Where they are supplied as single-phase units they must be a “matched set” with identical characteristics. SVLs shall meet the requirements of BS 7912 clause 17.

### **3.5. Control System (accessories) for Oil filled and Gas Pressure Systems**

The general requirements for control systems are specified with ENATS 09-4 1991 Section 6 covers oil filled cable systems, and section 7 covers gas filled cable systems. The routine, sample and routine on site tests are specified within section 11.

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## 4. References

### 4.1. External Documentation

The products described in this specification shall conform to the latest versions of relevant International Standards, British Standards and ENA Standards current at the time of tendering. The following documents are particularly relevant.

Reference	Version/Date	Title
IEC 60840	2020	Power cables with extruded insulation and their accessories for rated voltages above 30kV ( $U_m = 36\text{kV}$ ) up to 150kV ( $U_m = 17\text{ kV}$ ) – Test methods and requirements
BS 7912	2012	Power cables with XLPE insulation and metal sheath, and their accessories, for rated voltages from 66 kV ( $U_m = 72.5\text{kV}$ ) to 132kV ( $U_m = 145\text{kV}$ )
IEC 60141-1	1998	Oil filled paper insulated, metal sheathed cables and accessories for alternating voltages up to 400kV
ENA TS 09-4	3.0/1991	66kV and 132kV impregnated paper insulated oil filled and gas pressure type cable systems
IEC 60815-1	2008	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles
BS EN 62155	2003	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V
BS EN 60507	2014	Artificial pollution tests on high voltage ceramic and glass insulators to be used on a.c. systems
ENA TS 09-10	2.0/1999	Porcelain insulators for 33, 66, 132 and 400kV cable outdoor sealing ends

Although not referenced within this document the following documents are relevant with regard to 66kV and 132kV underground cables and terminations.

Reference	Version/Date	Title
ENA TS 09-2	6.0/2016	Specification for the supply, delivery and installation of power cables with operating voltages in the range 33kV to 400kV and associated auxiliary cables
BS EN 62271 - 209	2007	High-voltage switchgear and controlgear. Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52kV. Fluid-filled and extruded insulation cables. Fluid-filled and dry-type cable-terminations

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#### 4.2. Internal Documentation

Reference	Title
IMP/001/909	Code of Practice for Distribution System Parameters
IMP/001/913	Code of Practice for the Economic Development of the EHV System
IMP/001/914	Code of Practice for the Economic Development of the 132kV System
NPS/002/026	Technical Specification for Cable Sheath Link Boxes

#### 4.3. Amendments from Previous Version

Reference	Summary of Amendments
<b>4. References</b> 4.1 External Documentation	* Update specification versions to latest
<b>5. Definitions</b>	* Additional items added

### 5. Definitions

Term	Definition
GIS	Gas Insulated Switchgear
MDPE	Medium Density Polyethylene
PE	Polyethylene
PVC	Polyvinyl chloride
SVL	Sheath Voltage Limiter
The Company	Northern Powergrid
XLPE	Cross-Linked Polyethylene

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## 6. Authority for Issue

### 6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		<b>Date</b>
Liz Beat	Governance Administrator	17/11/2022

### 6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

**Review Period** – This document should be reviewed within the following time period.

<b>Standard CDS review of 3 years</b>	<b>Non-standard review period and reason</b>	
No	Period: 5 Years	Reason: Update will be dictated by contract renewal date or any significant changes in the specification or documents referenced.
<b>Should this document be displayed on the Northern Powergrid external website?</b>		Yes
		<b>Date</b>
Paul Hanrahan	Engineer – Asset Management	17/11/2022

### 6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		<b>Date</b>
Steve Salkeld	Policy & Standards Engineer	17/11/2022
Joe Helm	Policy & Standards Manager	18/11/2022

### 6.4. Authorisation

Authorisation is granted for publication of this document

		<b>Date</b>
Paul Black	System Engineering Manager	21/12/2022



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## Appendix 1 - Typical Cable Types and Sizes

### A1.1 Cables

Typical 66kV and 132kV cables on the Company's network are as follows:

- 3-core 0.25in<sup>2</sup> to 1.0in<sup>2</sup> (or metric equivalent), copper or aluminium conductor, fluid filled, or gas filled screened, lead or aluminium sheath and PVC oversheath.
- Single-core 0.25in<sup>2</sup> to 1.0in<sup>2</sup> (or metric equivalent), copper or aluminium conductor, fluid filled, screened, lead or aluminium sheath and PVC oversheath.
- Single core 185mm<sup>2</sup> to 1400mm<sup>2</sup> stranded copper conductor or aluminium, XLPE insulation, lead or welded aluminium sheath and MDPE oversheath.

### A1.2 Accessory Capabilities

The supplier shall provide details in Appendix 4 - Self Certification Conformance Declaration of the cable types for which each joint or termination is suitable. This shall include the size, build up, material types, manufacturer's reference and place of manufacture.

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## Appendix 2 - Additional tests for cable terminations

### A2.1 Outdoor Terminations

#### A2.1.1 Salt Fog Test

The method and conditions shall be as specified in BS EN 60507. The salt solution shall have a salinity to be agreed between the Company and supplier. The test voltages shall be 42kV for 66kV terminations and 84kV for 132kV terminations.

#### A2.1.2 Heavy Wetting Test

The termination shall be subjected to artificial rain at a rate of 2mm/min at an angle of 45° to the vertical and with a conductivity of 1000 µS/cm. The test voltages shall be as specified in A2.1.1. The requirements shall be as specified in BS EN 60507.

#### A2.1.3 Hydraulic Test

This test applies only to fluid-filled terminations.

The completed insulator component shall be sealed with blanking plates and subjected to internal pressure. The test pressure shall be 12 bar for insulators with maximum static design pressure up to 5.25 bar and 34 bar for insulators with design pressure over 5.25 bar up to 15 bar. The insulator shall withstand the test pressure without leakage for a period not less than 15 minutes.

#### A2.1.4 Cantilever Load Test

This test applies only to self-supporting terminations.

The method and requirement shall be as specified in BS EN 62155. The termination shall withstand a bending moment not less than the declared available value.

### A2.2 GIS Terminations

#### A2.2.1 Cantilever Load Test

The termination shall be subjected to a bending moment of 4,500 Nm at its base for not less than one minute at ambient temperature. No damage shall be sustained.

#### A2.2.1 Mechanical Endurance Test

The termination shall be jointed to cable of minimum length 10mtrs. The termination shall be mounted vertically and subjected to vibration of frequency 100 Hz ± 5% and acceleration not less than 5 g (where g is approximately 10 m/s/s) in all three perpendicular axes. Where each axis is tested individually the test period shall be 30 minutes and where two axes are tested together the test duration shall be 45 minutes.

The rigid insulator component of the termination shall be examined by ultrasonic equipment to detect any damage.

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## Appendix 3 – Logistical requirements

### A3.1 Storage

To enable the Company to store the product(s) in accordance with the manufacturer's recommendations, the tenderer should provide details of the recommended storage environment and maximum stacking height with respect to each tendered product.

Details should be provided, where relevant, of the minimum and maximum exposure levels, frequency of exposure and duration of exposure of the packaged item with respect to:

- Ambient temperature
- Humidity
- Water
- Dust
- Atmospheric corrosion
- Impact
- Vibration
- Solar radiation

### A3.2 Packaging and labelling

The tenderer shall ensure that each item is suitably packaged and protected to maintain the product and packaging as "fit for service" prior to installation, taking account of the potential for an outdoor storage environment. All packaging shall be sufficiently durable giving regard to the function, reasonable use and contents of the packaging. Where product packages tendered are made up of sub-packages, all the sub-packages shall, unless varied by this specification, be supplied securely packaged together. Where items are provided in bagged form the material from which the bags are made shall be capable of sustaining the package weight and resisting puncture by the materials within. The tenderer shall submit at the time of tendering the details of the proposed packaging (i.e. materials composition and structure) to be used for each product. Where the tenderer is unable to provide packaging suitable for outdoor storage this should be stated at the time of tender.

In order to maximise storage space all palletised goods shall be supplied in standard returnable box pallets with the following specification. Where applicable, suppliers shall also indicate the maximum number of units of each product that are storable per box pallet.

- Size – 1200mm (w) x 1000mm (d) x 750mm (h)
- Weight (empty) – Up to 33 kg
- Load capacity – Up to 450 kg
- Maximum stacking capacity – 10 high

Suppliers shall also include details of the type of material used to manufacture the box pallets.

The Company will give consideration to innovative alternatives to this packaging specification.

Clearly legible, easily identifiable, durable and unambiguous labelling shall be applied to each individual package and, where relevant, multiple packing of like products. Where product packages tendered are made up of sub-packages each sub-packages shall be marked.

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As a minimum requirement the following information shall be included on packaging:

- Manufacturer's trademark or name
- Supplier's trademark or name
- Description of item
- Date of packaging and/or batch number
- Northern Powergrid product code
- Weight
- Shelf life
- Pack quantity

The tenderer shall submit at the time of tendering a sample of the proposed labelling for each product package.

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## Appendix 4 – Self certification conformance declaration

Power cable accessories for rated voltages 66kV to 132kV shall conform to the latest issues of the relevant Standards. The following tables are intended to amplify and/or clarify the requirements of those Standards. This check sheet identifies the relevant clauses of the Standards.

The manufacturer shall declare conformance or otherwise, clause by clause, using the following levels of conformance declaration codes.

### Conformance declaration codes

N/A = Clause is not applicable or appropriate to the product

Cs1 = The product conforms fully with the requirements of this clause

Cs2 = The product conforms partially with the requirements of this clause

Cs3 = The product does not conform to the requirements of this clause

Cs4 = The product does not currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to conform.

### Instructions for completion

- When Cs1 code is entered the supplier shall provide evidence to confirm conformance.
- When any other code is entered the reason and supporting evidence for non - conformance shall be entered.
- Prefix each remark with the relevant 'BS EN' 'IEC' or 'ENA TS' as appropriate.
- Provide technical data sheets and associated drawings for each product.

**Manufacturer / Supplier:**

**Manufacturer / Supplier Product Reference:**

**Northern Powergrid Product Reference (Commodity Code):**

**Details of the Product Type: (e.g. Voltage, Conductor Type and Size)**

**Name:**

**Signature:**

**Date:**

**NOTE:** One sheet shall be completed for each item or variant submitted.

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#### Appendix 4 – Self certification conformance declaration (continued)

IEC 60840 (Cable systems)				
Clause	Requirement	Conformance Code	Evidence Reference	Remarks / Comments
12.2	Range of type approval			
12.4.1	Test voltage values			
12.4.3	Bending test			
12.4.5	Tan $\delta$ measurement			
12.4.6	Heating cycle voltage test			
12.4.4	Partial discharge test (ambient and high temp)			
12.4.7	Lightning impulse voltage test followed by power frequency voltage test			
Annex G	Test of outer protection of buried joints			
12.4.8	Examination			

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IEC 60840 (Accessories)				
Clause	Requirement	Conformance Code	Evidence Reference	Remarks / Comments
12.2	Range of type approval			
12.4.1	Test voltage values			
12.4.4	Partial discharge test at high temperature			
12.4.6	Heating cycle voltage test			
12.4.4	Partial discharge test (ambient and high temp.)			
12.4.7	Lightning impulse voltage test followed by power frequency voltage test			
Annex G	Test of outer protection of buried cables			
12.4.8	Examination			

IEC 60141-1				
Clause	Requirement	Conformance Code	Evidence Reference	Remarks / Comments
5.2	Routine pressure test			
7.3	Lightning impulse voltage test			
7.4	Dielectric security test			

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IEC 60815				
Clause	Requirement	Conformance Code	Evidence Reference	Remarks / Comments
Table J1	Specific creepage distance (SCD) 25kV/mm			

BS 7912				
Clause	Requirement	Conformance Code	Evidence Reference	Remarks / Comments
16.2.1.	Test and requirements – General			
16.3	Partial discharge test			
16.4	Load cycle voltage test			
16.3	Partial discharge test			
16.5	Lightning impulse voltage test			
16.6	Power frequency voltage test			
16.7	Examination			
16.8	Tests on buried joints			
16.8.2	Mechanical tests			
16.8.3	Water immersion and heat cycling			
16.8.4	DC voltage withstand test			
16.8.5	Lightning impulse voltage tests			



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#### Appendix 4 – Self certification conformance declaration (continued)

Additional Tests for Terminations				
Clause	Requirement	Conformance Code	Evidence Reference	Remarks / Comments
	<b>Tests on outdoor terminations:</b>			
A2.1.1	Salt fog test			
A2.1.2	Heavy wetting test			
A2.1.3	Hydraulic test			
A2.1.4	Cantilever load test			
	<b>Tests for GIS terminations:</b>			
A2.2.1	Cantilever load test			
A2.2.2	Mechanical endurance test			

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#### Appendix 4 – Self certification conformance declaration (continued)

09-04 (66kV and 132kV Impregnated Paper Insulated Oil Filled and Gas Pressure Type Power Cable systems)				
Schedule D to be completed by the manufacturer	Requirement	Conformance Code	Evidence Reference	Remarks / Comments
	<b>Manufacturers Tests reference</b>			
9.2	External Insulation			
9.2	External Insulation in ER C65 if glass fibre protection box used			
9.3	Outdoor sealing Ends in accordance with ENA TS 09-10 if porcelain			
<b>11.1 Routine tests</b>				
11.1.2	Oil filled accessories Pressure tests			
11.1.3	Gas filled accessories Pressure tests			
<b>11.2 Sample tests</b>				
11.2.2	Test for water tightness			

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## Appendix 5 – Addendum to supplier requirements

### A5.1 Work Instructions

Approved work instructions shall be agreed and provided by the supplier.

### A5.2 Kitting

All joints and terminations shall be supplied in kit form. All necessary components including connectors, lugs and work instructions shall be supplied in the kit.

### A5.3 Tooling

The tooling costs associated with the handling, installation, inspection, maintenance, repair and decommissioning of the product(s) is crucial to the Company's assessment of the product viability.

To enable the Company to understand and assess the cost of required tooling the tenderer should provide full details of the tooling recommended for use by the manufacturer for the purpose of handling, installation, commissioning, inspection, maintenance, repair and decommissioning of each tendered product. The tenderer should provide, where available, indicative prices applicable to the recommended tooling.

Supplier requirements			
Clause	Requirement	Conformance Code	Remarks
Tooling	Are any additional tools required to construct the joint or termination	Y/N	

<b>Document Reference:-</b>		NPS/002/017	<b>Document Type:-</b>		Code of Practice			
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## **Appendix 6 – Pre-Commission testing, routine inspection and maintenance requirements**

Suppliers shall provide details of the recommended pre-commission testing and inspection required.

They shall also provide information regarding periodic inspection and maintenance requirements to be undertaken during the lifetime of their product. Detailed inspection and maintenance instructions shall also be provided.

<b>Testing ,inspection or maintenance</b>			
<b>Clause</b>	<b>Requirement</b>	<b>Conformance Code</b>	<b>Remarks</b>
Pre commissioning Testing	Please state any pre commissioning tests	Y/N	
Routine Inspection	Please state any inspections required during life time of the joint or termination		
Routine Maintenance	Please state any routine maintenance required during the normal expected life of the joint or termination		

## **Appendix 7 – Technical information check list**

The following information shall be provided by the supplier for technical review by the Company. Additional information shall be provided if requested.

<b>Requirement</b>	<b>Provided (Y/N)</b>
Full product descriptions and part number/reference	
Completed self-certification conformance declaration (Appendix 4)	
Complete set of drawings for each variant	
Type test evidence	
Routine test plan (example)	
Pre-commissioning testing and inspection requirements (Appendix 6)	
Recommended periodical inspection and maintenance requirements (Appendix 6)	
Packaging and delivery information (Appendix 3)	