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TECHNICAL SPECIFICATION FOR FIBRE OPTIC CABLES

1. INTENT OF SPECIFICATION:

This specification governs the requirements of design, manufacture, testing at vendor's works, inspection by purchaser, packing at vendor's work and delivery of Fibre Optic cables to site.

2. SCOPE OF SUPPLY – As per enquiry

3. INSTRUCTIONS TO BIDDER:

3.1 Bidders are advised to contact BHEL for essential technical queries in writing within one week of issue of Enquiry. Offers with incomplete information will not be considered for evaluation, and are likely to be rejected outright without any further interaction with the Bidder.

3.2 Any technical features [over & above BHEL enquiry specification requirements] proposed by Bidder will not be given preference for the purpose of evaluation.

3.3 In the event of any conflict between these specifications, data sheets, related standards, codes etc. the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same, bidder shall proceed with the manufacture of the items in question.

3.4 Bidder shall mandatorily quote all the items against each material code of enquiry. No deviation is acceptable. If any deviation taken on this aspect, then offer will be rejected without any intimation. Hence bidder shall offer all the items

3.5 Bidder shall submit duly filled deviation format as per attached format along with technical offer, otherwise, it will be presumed that there are no deviations from this specification. Offer without this deviation list will not be evaluated & shall be considered for rejection. If, there are no deviations, bidder shall submit signed copy of this format, mentioning "No Deviations".

3.6 Bidder shall submit duly filled deviation format given in elsewhere in this specification.

4. APPLICABLE STANDARDS:

The optical fibre cables shall be designed, manufactured and tested in accordance with the relevant parts of the following Standards and all amendments issued from time to time except where varied by this specification.

The fibres supplied should fully meet the requirements of all appropriate international specification including IEC Specification 11801- OM1, IEC 60793 Generic Fibre Specification, and IEC 60794 wherever appropriate and ITU-T fibre recommendations.

All cables are to be supplied with Low Smoke Zero Halogen (LSZH) jackets in accordance with the international standard fire performance criteria.

Cable should, in general, be ISO/IEC and EIA/TIA compliant and conform to Mechanical conditions as per IEC 60794-1-2-X Standards for Tensile force, Crush Resistance, Impact Resistance, Torsion, Kink,Bend,Repeated Bending and Water Penetration etc.,

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5 CABLE REQUIREMENTS:

5.1 Optic Fiber cable shall be 4/8/12 core; electrolytically chrome plated corrugated steel Taped (ECCST), fully water blocked with dielectric central member for outdoor/indoor application so as to prevent any physical damage. The cable shall have multiple single-mode or multi-mode fibers on as required basis so as to avoid the usage of any repeaters. The core and cladding diameter shall be 9 +/- 1 micrometer and 125 +/- 1 micrometer respectively. The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturer, progressive automatic sequential on-line marking of length in meters at every meter on outer sheath.

5.2 The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Dielectric central member, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with Thixotropic jelly etc. The cable shall be suitable for a maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum & crush resistance 4000 N minimum. The operating temperature shall be – 20 deg. C to 70 deg.C

5.3 All testing of The fiber optic cable being supplied shall be as per the relevant IEC, EIA and Other international standards

5.5 Cables shall be suitable for laying in conduits (GI/HDPE), ducts, trenches, racks and underground buried installation.

5.4 Spliced / Repaired cables are not acceptable.

5.5 Penetration of water resistance and impact resistance shall be as per IEC standard.

MULTI-MODE ARMOURED CABLE:

Multi-mode fiber utilized in the optical fiber cable shall meet ITU G.651, IEC Specification 11801– OM1, with following specifications:

i) FIBER AND BUFFERING:

a. Fiber type: Graded index multimode Fiber
b. Core diameter: 62.5 microns ±3 microns
c. Cladding diameter 125 microns ± 3 microns
d. Cladding non-circularity < 1%
e. Core non-circularity < 5%
f. Primary coating diameter 245 m ± 10 m

ii) ATTENUATION & BANDWIDTH:

a. At 850 nm, attenuation < = 3.5 dB / Km
b. At 1310 nm, attenuation < = 1.5 dB / Km
c. Coupling loss <0.75db/connection

Note: For all other parameter refer to the General specifications

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SINGLE-MODE ARMOURED CABLE:

The single-mode fiber utilized in the optical fiber cable shall meet ITU G.652D, IEC Specification 60793-2-50 Type B1.3

i.) FIBER AND BUFFERING:

a. Fiber type: Stepped single mode Fiber
b. Core diameter 9 ± 1 microns
c. Cladding diameter 125 microns ± 0.7 micron
d. Cladding non-circularity < 1.0 %
e. Core non-circularity < 0.8_m
f. Primary coating diameter 245 m ± 5 m

ii.) ATTENUATION & BANDWIDTH:

a. At 1550 nm, attenuation < = 0.23dB / Km
b. At 1310 nm, attenuation < = 0.35dB / Km
c. Coupling loss <0.75 db/connection

Note: For all other parameter refer to the General specifications

GENERAL SPECIFICATION:

Mechanical, Geometrical, Transmission and Environmental characteristics should be as per relevant IEC 60794-1-2-X spec
Stripping Ability: All layers easily removed with commercially available tools.
Fibre Identification: All the fibers in the PBT lose tube are to be colour for identification purpose with UV curable inks. The tube colour will be natural.
Marking: The cable should have identification marking at regular intervals of 1 meter which will be of permanent nature. The accuracy of the sequential marking should be within + 0.5%. The optical fibre cable shall as a minimum have the following markings in every meter.
i) Type of Cable, ii) Running meter length, iii) Number of fibres, iv) Type of fibre,
v) Manufacturer's name vi) Employer's Name – BHEL
Immunity: The cables shall be immune to corrosive element found naturally in the ground. Optical fibers shall be coated with protective materials / coatings and should not have any reaction with cladding or core materials.
Life of cable: The minimum expected life of the cable shall be 25 years.
Cable Ends: Running end shall be provided with pulling eye & the other end shall be sealed with thermal shrink cap.
Length of The cable drum: The length can be standard factory length. Care to be taken to minimize wastage while cutting to length by optimizing drum lengths in line with site requirement.
Drum to have a tolerance of +5%.
Compliance: Cable should, in general, be ISO/IEC and EIA/TIA compliant and conform to Mechanical conditions as per IEC 60794-1-2-X Standards for Tensile force, Crush Resistance, Impact Resistance, Torsion, Kink, Repeated Bending and Water Penetration, etc.

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Variants

A: <u>Multi-Mode 62.5µm/125µm Fibre Optic Cable</u>

1. **4 Core, Uni-Tube, Armoured, Direct Burial 62.5 µm /125 µm MM FO Cable**
   Four-Fiber Multi-Tube Construction, Gel Filled, Multimode Optical Fibre Cable (OFC) with 4 Nos. 62.5/125 Microns Colour Coded Fibres as per G.651 Standards, ECCST Armour, Central FRP Strength Member, Inner Sheath,Water Swellable/Water Blocking Tape & Outer UV Resistant and Fire Retardant LSZH Sheath having Anti-Termite and Anti-Rodent Properties, Suitable for Direct/Duct Burial and Laying on Cable Trays.
   Quantity Tolerance: Upto +5% of Total Length Extra.

2. **6 Core, Uni-Tube, Armoured, Direct Burial 62.5 µm /125 µm MM FO Cable**
   Six-Fibre, Unitube Construction, Gel Filled, Multimode Optical Fibre Cable (OFC) with 6 Nos. 62.5/125 Microns Colour Coded Fibres as per G.651Standards, ECCST Armour, Embedded Steel Wire / FRP Strength Members, with Water Swellable/Water Blocking Tape & Outer UV Resistant and Fire Retardant LSZH Sheath having Anti-Termite and Anti-Rodent Properties, Suitable for Direct/Duct Burial and Laying on Cable Trays.
   Quantity Tolerance: Upto +5% of Total Length Extra.

3. **6 Core, Multi-Tube, Armoured, Direct Burial 62.5 µm /125 µm MM FO Cable**
   Six-Fiber Multi-Tube Construction Gel Filled, Multimode Optical Fibre Cable (OFC) with 6 Nos. 62.5/125 Microns Colour Coded Fibres as per G.651 Standards, ECCST Armour, Central FRP Strength Member, Inner Sheath,Water Swellable/Water Blocking Tape & Outer UV Resistant and Fire Retardant LSZH Sheath having Anti-Termite and Anti-Rodent Properties, Suitable for Direct/Duct Burial and Laying on Cable Trays.
   Quantity Tolerance: Upto +5% of Total Length Extra.

4. **8 Core, Multi-Tube, Armoured, Direct Burial 62.5 µm /125 µm MM FO Cable**
   Eight Fibre Multi Tube Construction (4 Fibers per Tube) Gel Filled Multimode Optical Fibre Cable (OFC) with 08 Nos. 62.5/125 Microns Color Coded Fibres as per G.651 Standards, ECCST Armour, Central FRP Strength Member, Inner Sheath, Water Swellable/Water Blocking Tape & Outer UV Resistant and Fire Retardant LSZH Sheath having Anti-Termite and Anti-Rodent Properties, Suitable for Direct/Duct Burial and Laying on Cable Trays.
   Quantity Tolerance +5% of Total Length Extra.

5. **12 Core, Multi-Tube, Armoured, Direct Burial 62.5 µm /125 µm MM FO Cable**
   Twelve Fibre Multi Tube Construction (4 Fibers per Tube) Gel Filled Multimode Optical Fibre Cable (OFC) with 12 Nos. 62.5/125 Microns Color Coded Fibres as per G.651 Standards, ECCST Armour, Central FRP Strength Member, Inner Sheath, Water Swellable/Water Blocking Tape & Outer UV Resistant and Fire Retardant LSZH Sheath having Anti-Termite and Anti-Rodent Properties, Suitable for Direct/Duct Burial and Laying on Cable Trays.
   Quantity Tolerance +5% of Total Length Extra

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B: Single-Mode 9µm/125µm Fibre Optic Cable

1. **4 Core, Uni-Tube, Armoured, Direct Burial 9 µm /125 µm SM FO Cable**
   Four Fibre Uni-Tube Construction, Gel Filled, Single Mode Optical Fibre Cable (OFC) With 04 Nos. 9/125 Microns Color Coded Fibres as per G.652 Standards, ECCST Armour, Embedded Steel Wire / FRP Strength Members, with Water Swellable/Water Blocking Tape & Outer UV Resistant and Fire Retardant LSZH Sheath having Anti-Termite and Anti-Rodent Properties, Suitable for Direct/Duct Burial and Laying on Cable Trays. Quantity Tolerance: Upto +5% of Total Length Extra

2. **4 Core, Multi-Tube, Armoured, Direct Burial 9µm/125µm SM FO Cable**
   Four Fibre Multi Tube Construction Gel Filled, Single Mode Optical Fibre Cable (OFC) with 04 Nos. 9/125 Microns Color Coded Fibres as per G.652 Standards, ECCST Armour Central FRP Strength Members, Inner Sheath, Water Swellable/Water Blocking Tape & Outer UV Resistant and Fire Retardant LSZH Sheath having Anti-Termite and Anti-Rodent Properties, Suitable for Direct/Duct Burial and Laying on Cable Trays. Quantity Tolerance: Upto +5% of Total Length Extra

3. **6 Core, Uni-Tube, Armoured, Direct Burial 9µm/125µm SM FO Cable**
   Six Fibre Uni-Tube Construction, Gel Filled, Single Mode Optical Fibre Cable (OFC) with 06 Nos. 9/125 Microns Color Coded Fibres as per G.652 Standards, ECCST Armour, Embedded Steel Wire / FRP Strength Members, with Water Swellable/ Water Blocking Tape & Outer UV Resistant and Fire Retardant LSZH Sheath having Anti-Termite and Anti-Rodent Properties, Suitable for Direct/Duct Burial and Laying on Cable Trays. Quantity Tolerance: Upto +5% of Total Length Extra

4. **6 Core, Multi-Tube, Armoured, Direct Burial 9µm/125µm SM FO Cable**
   Six Fibre Multi Tube Construction Gel Filled, Single Mode Optical Fibre Cable (OFC) with 06 Nos. 9/125 Microns Color Coded Fibres as per G.652 Standards, ECCST Armour, Central FRP Strength Members, Inner Sheath,Water Swellable/Water Blocking Tape & Outer UV Resistant and Fire Retardant LSZH Sheath having Anti-Termite and Anti-Rodent Properties, Suitable for Direct/Duct Burial and Laying on Cable Trays. Quantity Tolerance: Upto +5% of Total Length Extra

5. **8 Core, Multi-Tube, Armoured, Direct Burial 9µm/125µm SM FO Cable**
   Eight Fibre Multi Tube Construction (4 Fibers per Tube), Gel Filled, Single Mode Optical Fibre Cable (OFC) with 08 Nos. 9/125 Microns Color Coded Fibres as per G.652 Standards, ECCST Armour, Central FRP Strength Members, Inner Sheath, Water Swellable/Water Blocking Tape & Outer UV Resistant and Fire Retardant LSZH Sheath having Anti-Termite and Anti-Rodent Properties, Suitable for Direct/Duct Burial and Laying on Cable Trays. Quantity Tolerance: Upto +5% of Total Length Extra

6. **12 Core, Multi-Tube, Armoured, Direct Burial 9µm/125µm SM FO Cable**

   Twelve Fibre Multi Tube Construction (4 Fibers per Tube), Gel Filled, Single Mode Optical Fibre Cable (OFC) with 12 Nos. 9/125 Microns Color Coded Fibres as per G.652 Standards, ECCST Armour, Central FRP Strength Members, Inner Sheath, Water Swellable/Water Blocking Tape & Outer UV Resistant and Fire Retardant LSZH Sheath

having Anti-Termite and Anti-Rodent Properties, Suitable for Direct/Duct Burial and Laying on Cable Trays. Quantity Tolerance: Upto +5% of Total Length Extra

6 TESTS:

6.1 All cables supplied shall be of Type tested design. BHEL/End User reserves the right to witness all tests with sufficient advance notice from vendor.

6.2 Cables offered shall have valid Type test certificates of recognized testing house such as CPRI, CMRI, PTB, BASEEFA, UL or equivalent.

6.3 The cables shall be tested and inspected at the vendor's works. All the materials used in manufacture of the cable shall be subjected, both before and after manufacture, to examination, testing and approval by BHEL/End User.

6.4 Vendor shall furnish all necessary information concerning the supply to BHEL.

6.5 The inspector shall have free access to the vendor's works for the purpose of inspecting the process of manufacture in all its stages and will have the power to reject any material, which appears to be of unsuitable description or of unsatisfactory quality.

6.6 The vendor shall give at least 2 weeks advance notice to the purchaser, regarding the date of Testing to enable him or his representative to witness the tests.

6.7 Type Tests as per the relevant standards mentioned elsewhere to be conducted/Valid Certificates to be submitted. If Type tests certificates are not available same shall be conducted by vendor at his own cost in any recognized laboratory. If in-house test facilities are to be used then the testing equipments shall be calibrated (valid calibration certificates shall be produced during inspection) & traced back to National Calibration standards and these tests shall be witnessed by end customer/consultant, BHEL. The reports shall be submitted to BHEL/end customer/consultant for approval before dispatch of the cables. There shall not be any delivery and commercial implications on this account.
The type test reports earlier approved for any of NTPC projects shall be treated as reference. For current project of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

6.8 Factory Acceptance test as per IEC 60794-1-2-X and other relevant specs will have to be carried out in presence of BHEL / BHEL customers at vendor's works All testing of the fiber optic cable being supplied shall be as per the relevant IEC, EIA and other international standards
Following Test Certificates to be submitted as a minimum:
1. Tensile Strength Test
2. Crush Test (Compressive Test)
3. Impact Test
4. Repeated Bending Test
5. Torsion Test
6. Kink Test
7. Cable Bend Test

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8. Temperature Cycling
9. Water penetration Test

6.9 QAP:

Manufacturer's data sheet and QAP in the format provided by BHEL (Annexure-2) will have to be submitted before manufacturing to get end customer approval.

vendor to furnish manufacturer's compliance certificate in original for LSZH, Anti-Rodent and Anti-Termite properties for the outer sheath of The OFC, preferably with the Test Report for the raw material /compound provided by the outer sheath raw material manufacturer.

7.0 PACKING AND DESPATCH:

7.1 Cables shall be dispatched in non-returnable wooden or steel drums of suitable barrel diameter, securely battened of heavy construction, with the take-off end fully protected against mechanical damage. The wood used for construction of The drum shall be properly seasoned, sound and free from defects. Wood preservatives shall be applied to the entire drum. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection.
The inner end of the cable shall be secured to the drum to ensure that the end will not flick off the drum barrel when the cable is being run out. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.

7.2 PVC/Rubber end caps shall be supplied free of cost for each drum with a minimum of eight per thousand meter length.

7.3 On the flange of The drum, necessary information such as purchaser's name, address, contact number, item number, project title, vendor's name, type, size, voltage grade of The cable, length of The cable in meters, drum no, cable code, BIS certification mark, gross weight etc. shall be printed. An arrow shall be printed on the drum with suitable instructions to show the direction of the rotation of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

7.4 Acceptable tolerance is +5% (No Negative tolerance) per drum per standard packing length. The total length of the cable against the specified material code to be supplied by vendor as per the BHEL enquiry. Further if any additional length required for conducting tests as per BHEL specification shall be considered by vendor over and above the length mentioned in the BHEL enquiry.

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8.0 DRAWINGS, DATA AND MANUAL:

8.1 To be submitted along with bid

a) Manufacturer's data sheet with all technical parameters shall be submitted for information.
b) Deviations, if any, to our specification to be mentioned in deviation schedule.
c) Filled in check list provided in this specification
d) Type Test Certificates as applicable. Cable should, in general, confirm to Mechanical Strength and dimensions of relevant IEC 60794-1-X Spec.

8.2 To be submitted in 6 sets after award of contract

S.No.	Description
1.	Completely filled in technical data sheets Datasheets as per Annexure-1 shall be furnished.
2.	Transport/Shipping dimension drawing
3.	Type Test Certificates
4.	Erection manual
5.	Catalogues

No. of copies to be submitted for each submission shall be as follows

- For Approval & Review documents shall be in 6 copies.

TABLE-1 MATERIAL CODIFICATION

Sl. No.	MATERIAL CODE	DESCRIPTION
1	PY9755248056	4 Core, Uni-Tube, Armoured, Direct Burial 9 µm /125 µm Single Mode FO Cable

The above material description shall supercede the description mentioned against material code in the enquiry & the same to be considered for submission of offer.

Note: Price to be mentioned separately per meter of OFC cable. Quantities mentioned are tentative requirement. Based on the actual requirement, quantity can be increased or decreased by about 20% on overall qty. If any change,final BOQ will be informed before price bid opening. Unit rates shall be applicable for the revised BOQ also. The total length of the cable for the mentioned material code to be supplied by vendor shall be as per BHEL enquiry.

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CHECKLIST

[TO BE SUBMITTED ALONG WITH TECHNICAL OFFER (MANDATORY)]

Sl. No.	Description	Enclosed (Yes/ No)
1.	Technical offer confirming to technical specification PY55248, pre-bid clarifications (if any) etc., Bidder to confirm (Yes / No).	
2.	Bidder confirms that they have read the provisions of the Deviation Schedule and have included the deviation Schedule in the Offer after agreeing to the said Provisions (Yes/No).	
3.	Bidder confirms that Prices for all items have been Quoted. Unpriced & Priced Schedules are included in the Techno-commercial Offer and Priced Offer respectively.(Yes/NO)	
4.	As per specification, bidder confirms that complete set of test certificates as applicable have been included along with the Offer. In case bidder has not submitted test certificates, bidder confirms to conduct the tests and submit the report to BHEL/customer for approval. (YES/NO)	

Notes: Offer received without affirmative confirmation against any of the above points may not be considered for evaluation.

(Signature and stamp of bidder with date)

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Enquiry No.:
Item:
Name of Bidder:
Offer Ref. No.:

DEVIATION FORMAT

Sl. No.	Clause no. & Spec. no.	Description as per Specification	Deviation taken	Nature of Deviation	Remarks

NOTES:

1. Technical offer of the bidder will be evaluated only on the basis of Deviation Schedule. Deviation Schedule constitutes this sheet (with these Notes) duly signed and stamped.
2. Deviations, if any, shall be clearly brought out only in this format. Deviations mentioned / taken elsewhere or in any other format will be ignored.
3. Additional sheets in the same format can be attached by the vendor, if necessary.
4. Nature of Deviations shall only be of Design / Manufacturing constraints and non-availability of items / components / makes in market.
5. No price implications shall be entertained for deviations withdrawn during the technical scrutiny. If any deviations are accepted by BHEL during technical scrutiny then also there will be no price implication. Hence, in no case there will be consideration of Price implications.
6. Reasons for the deviations shall be specified in the Remarks column.
7. If there are no deviations from the specifications, bidder still has to submit the Deviation Schedule by writing “NO Deviations” in this format.
8. If the “Deviation Schedule” is not submitted along with the offer, the bidder’s offer is likely to be rejected without any further interaction with the bidder.
9. Only the accepted deviations in conjunction with the original tender shall constitute the contract document for the award of job to the bidder.

SIGNATURE OF BIDDER _____

NAME _____

DESIGNATION _____

COMPANY SEAL

DATE _____

RECORD OF REVISIONS

Rev. No.	Date	Revision Details	Revised	Approved
00	03 Jan 2017	Original Issue	-	PCS

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Ref. Doc

Annexure-1 of Specification

TECHNICAL DATA SHEET

	Characteristics	Details	Standard as per
1.0	**Make**		
2.0	**Type**		
3	**Mechanical Characteristics**		
	Maximum continuous operating temperature		
	Cable Bending Radius		
	Repeated Bending		
	Tensile Force		
	Torsion Resistance		
	Crush Resistance		
	Impact Resistance		
	Kink Resistance		
	Water Penetration		
	Sheath to Ground Dielectric Strength Test		
	Cable Weight		
	Cable Diameter		
4	**Optical Characteristics**		
	Attenuation & Bandwidth: a. At 1550 nm b. At 1310 nm		
	Coupling loss /connection		
	Chromatic Dispersion at 1550nm		
	Chromatic Dispersion at 1285-1330nm		
	Cladding Diameter		
	Mode field diameter at 1310nm (Core Diameter)		
	Zero dispersion wavelength		
	Fibre cut off wavelength		
5	**Colour coding and Fibre Identification**		
6	**Cable Construction details**		
	Primary Coated Fibre		
	Tube filling compound		
	Loose Tubes		
	Water blocking Medium		
	Embedded Strength Member		
	Cable filling compound		
	Armouring		
	Outer Sheath		
	Strength Member		
	Core Diameter		
	Cladding Diameter		
	Cladding non-circularity		
	Core non-circularity		
	Primary coating diameter		

SIGNATURE OF TENDERER: _____