

UNITED ARAB EMIRATES
FEDERAL ELECTRICITY & WATER
AUTHORITY

TECHNICAL SPECIFICATIONS
FOR
FIBRE OPTIC CABLE (FOC)

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1. GENERAL CONDITIONS OF SUPPLY OF FOC

This specification covers the design, manufacture, factory testing, marking, packing, shipping, transportation to site, installation, site testing and commissioning of Fibre Optic Cable. Further detailed and specific data are contained in the Technical Data Sheets and other documents that form part of these Tender Documents.

The Fibre Optic Cables shall be generally installed along the underground power cable circuits of the 11, 33 & 132 kV cables in trenches.

The Fibre Optic Cable to be offered shall be designed such as to have a service life of not less than 30 years in the working conditions and installation environment prevailing in UAE. It shall also fully satisfy the safety, health and environmental requirements enforced by the laws established in UAE.

The binding delivery quantities, upon awarding the Contract shall be determined based on the approved cable routes, and therefore the prices shall be adjusted accordingly.

Further clarifications of the local conditions, if deemed necessary for the preparation of the Proposal, shall be the responsibility of the Bidder/Contractor.

All cables shall be designed in accordance with the latest issues of IEC & ITU-T Publications and other standards as may be approved by FEWA.

The cables shall be suitable for in-door and outdoor use, either directly buried in the ground or laid in ducts/cable trays.

The cables may be exposed to the direct rays of the sun at the termination gantries, etc. The cable outer sheath shall be capable of withstanding such exposure continuously without any detrimental effect.

The Fibre optic cable shall have optical Fibres of the single-mode type. The Fibre cores shall be laid loose in buffer tubes. Water blocking compound shall be provided inside the buffer tubes as well as in the interstices between these buffer tubes. The construction of the cable shall be such as not to allow water/moisture penetration either longitudinally or axially.

The Fibre cores shall be made of ultra pure fused silica glass suitable for operation at 1310 and 1550 nm wave lengths. The design shall be generally as per the latest versions of recommendations and specifications made by International Committees/Organizations such as ITU-T and IEC, and others which might be referred to, if required, for the conventional single mode Fibre optic cable. It shall provide low dispersion values for the entire possible wavelength range above the cut-off wavelength of the cabled Fibre, which should not be more than 1270 nm.

The Bidder/Contractor shall submit along with his Tender Proposal supporting documents comparing test conditions and measurement results especially at 1310 and 1550 nm wave lengths.

Further technical details are stated in the Technical Data Sheets.

The required Fibre Optic Cable shall generally be laid either separately, or in the same trench, parallel to the power cable or water pipes and shall be terminated in suitable enclosures.

2. FIBRE OPTICAL CABLE CONSTRUCTION

2.1. Central Strength Member

In the centre of the Fibre Optic Cable, a rod made of, preferably, Glass Reinforced Plastic (GRP) shall be placed, around which the buffer tubes which, house the Fibres are to be stranded. This member shall serve both, as a support, and as a strain relief member.

2.2. Buffer Tube

The Fibre Optic Cable shall have Loose buffer tubes to accommodate the Fibre cores which, shall be distributed among these tubes equally. The buffer tube must hold its shape, be tough, not susceptible to ageing and be very flexible, so that it can be handled without noticeable stressing the optical Fibres.

The buffer tube shall be composed of an inner layer with very low friction coefficient and an outer layer to shield the Fibre against mechanical influences. The design of the loose buffer shall be in such a way that the elongation of the cable under normal operating conditions does not result in increase in the attenuation beyond the limits specified by the above mentioned standards.

For the technical requirements of loose buffer tubes reference shall be made to DIN VDE 0888 in connection with dimensions, color codes and temperature range.

2.2.1. Buffer Tube Filling Compound

The buffer tubes and the interstices among them shall be filled with a slightly thixotropic and chemically neutral compound. This is to prevent water from entering the buffer and running through it which may affect the Fibre and result in attenuation increases. This compound shall not corrode the Fibre or cause it to swell. It also shall not drip out at the temperature range of: 0°C to + 60°C and shall be easy to wipe and wash off without leaving residue that would make it difficult to connect the Fibres.

The compound shall not contain highly inflammable materials and shall have relatively low thermal coefficient.

2.2.2. The Cable Core

The buffer tubes with the fillers, stranded around a GRP (glass-reinforced plastic) central member shall form the core of the Fibre Optic Cable. The GRP member shall serve both, as a support (buckling protection against kink) and as a strain relief member.

The stranding shall be in such a way, that the bending radius will be as low as possible and the optical Fibres having a well defined free space within which strain, buckling, pressure and bending stresses will have no influence on the transmission characteristics.

The stranded buffer tubes/fillers around the GRP member with the moisture resistant compound in the empty interstices among them are wrapped by the core covering which consists of at least one layer of non-hygroscopic tape, applied helically or longitudinally with an overlap.

2.2.3. Inner Sheath

A PE sheath layer shall be extruded above the core covering with a thickness of not less than 1.5 mm.

2.2.4. Aramide Layer

An aramide yarns layer is laid above the PE inner sheath layer to serve mainly as strength member.

2.2.5. Intermediate Sheath

The intermediate sheath shall consist of PE (ST5) with a thickness of not less than 1.0 mm.

2.2.6. Armoring

The armoring shall consist of a corrugated steel tape applied longitudinally with an overlap. The tape thickness shall not be less than 0.2 mm.

2.2.7. Outer Sheath

The outer sheath (PE ST7) layer shall be covered by a semi-conductive layer. The thickness of the outer sheath shall not be less than 1.5 mm.

2.2.8. Color Coding of the Fibre/Buffer Tube

The color coding shall be generally in compliance with Standard EIA-A-359 (or IEC 304). However a mutual agreement between FEWA and Bidder/Contractor may still have to be considered.

2.2.9. Marking

The outer sheath of the Fibre cable shall have the following marking, repeated every 1.00 m:

- Fibre Optical Cable (Fibre Optic Cable)-32 Fibers
- Manufacturer's Name & Country of Manufacturer
- Year of manufacturing, Manufacturer"
- length of cable (running meter)
- PROPERTY OF FEWA

2.3. Optical Fibre Cables Installation

2.3.1. General

A great care shall be paid when laying the optical fibre cable either directly buried in the ground or into PVC conduits.

In the concrete trenches between substation buildings optical fibre cables shall be installed in suitable galvanised iron heavy-duty conduits.

Fibre Optical Cables within cities shall be laid in separate PVC conduits, at the same depth of the power cable and adjacent to them.

The jointing kit shall include all necessary materials such as consumables and other components, which are required to complete the jointing work.

The recommended method is to lay by hand into PVC conduits in such a way to have the maximum possible continuous length to minimize the number of joints. In case of laying in ducts, separate ducts shall be used for each optical fibre cable.

2.3.2. Splicing/Non-Permanent Joints/Straight Joints

Splicing of the optical fibre cable either along the route or at the terminals shall be carried out in such a way to have minimum losses (maximum average loss of any individual splice is ≤ 0.1 dB).

The non-permanent connectors are located at the route ends only. These connectors shall have a minimum attenuation (losses of connector and bulkhead together with the pigtail splice loss shall not be more than 0.3 dB) and shall comply with the latest technology at the time of the Contract Agreement's date.

Straight joints shall be made and buried in the ground at suitable locations and in such a way as to match the soil conditions at Site. Fusion splicing shall be adopted. Average optical loss shall not exceed 0.08 dB per splice. No single splice shall exceed 0.1dB.

The optical fibre joints shall be straight, embedded in reinforced nylon/glass fibre sleeves. The joints shall be complete with cable clamps, inner split sleeve, protecting sheet, fibre guide, adapter core, outer sleeve, auxiliary heat shrinkable sleeve, self-bonding tape, etc.

2.3.3. Fibre Optic Cable Splicing and Termination (Substation Station End)

The optical fibre cables shall be terminated at easily accessible terminal blocks inside distribution/termination boxes. The fibres shall be terminated in low loss, screw-on type of connectors suitable for withstanding high voltage hazards.

The connectors shall be fixed inside the termination box on connector holder, which shall allow easy access to each of the connectors. The Patch cord cable's length shall be 10m and shall be provided with suitable male connector in order to form screw-on type. The loss of connector bulkhead and pig tail splice shall not be more than 0.3 dB.

2.3.4. Indoor Termination FOC boxes

The optical fibre cables shall be terminated at easily accessible terminal blocks inside distribution/termination boxes. The fibres shall be terminated in low loss ferrule type of connectors suitable for withstanding high voltage hazards. The marshalling cabinets shall be insect-proof and water-tight with protection degree of IP55W (weatherproof) made of hot-dip galvanised steel or aluminium and shall be designed such as to form an extremely rigid structure. The doors shall be of hinged construction with self-locking arrangement. The marshalling cabinets shall be suitable for wall mounting or for erection on steel structures in telecommunication room, adjacent to the terminal equipment with which the optical link is associated.

Termination of the Fibres shall be that the sheath and any armouring shall be stripped and then affixed to the termination box. Finally, the buffer fibres are affixed in special fibre splice trays (plastic or metal) and stripped with sufficient extra length. The fibres are stored on these trays and spliced to the departing fibres. The number of splice slots shall not be less than 40.

Also suitable cable clamping gland be provided at the base for cable entry.

Each fiber shall be fitted with demountable connectors at the termination of each optical link. All patch cords and FOC shall be clearly marked and labelled.

3. TESTING AND INSPECTION

The Bidder/Contractor shall carry out electrical and function Tests of the optical fibre cable according to the relevant latest issues of ITU-T& IEC recommendations and the relevant Electra Publication, valid at time of awarding the Contract.

3.1. Type Tests

Type tests shall be performed, comprising as a minimum, the following tests:

Test Item	Test passing Criteria
Mechanical characteristics	
- Tensile performance	No fibre break (up to 100% UTS)
- Crush test	0.1 dB, increase in the attenuation
- Impact test	No change (negligible) in the attenuation
- Repeated bending	0.1 dB increase in the attenuation
- Kink	No kink shall occur
- Bend	No change in the attenuation (negligible)
- Bending under tension (sheave test)	No change in attenuation - As per IEC 794-1-2-E18
- Abrasion test conditions shall be at 45 C deg. and 80% RH.	No perforation of the sheath and no optical degrading after performing the number of cycles as per IEC 794-1-2. – E19 or the latest
- Tube kinking test	As per IEC 794-1-2. - or the latest
- Torsion	As per IEC 794-1-2 –E7 or the latest
- Compound flow (drip)	As per IEC 794-1-2-E14 or the latest
- Bleeding and evaporation	As per IEC 794-1-2-E15 or the latest
Transmission and optical characteristics	
- Attenuation at wave lengths (1310 and 1550 nm)	Attenuation at 1310 and 1550 nm should be as per Technical Data Sheets
- Refractive index profile	As per Technical Data Sheets
- Chromatic dispersion	As per Technical Data Sheets
- Mode field diameter	As per Technical Data Sheets

Environmental characteristics	
- Temperature cycling	0.1 dB/km increase in the attenuation
- Fire condition test (if required)	No fire break out
- Water penetration	No penetration/hence no attenuation change

3.2. Sample Tests

Sample tests shall be performed and comprise at least:

Test Item	Test passing Criteria
Dimension Tests	
- Diameter of core	To be checked against manufacturer proposal and approved documents
- Diameter of cladding	-do-
- Diameter of primary coating	-do-
- Diameter of buffer	-do-
- Non-circularity	As per Technical Data Sheets
- Concentricity errors	-do-
- Length of cable/fibre	To be checked against manufacturer proposal and approved documents
- Thickness of insulation	As per Technical Data Sheets
- Thickness of sheath	-do-
- Overall dimension	To be checked against manufacturer proposal and approved documents
Transmission and optical characteristics	
- Cable Cut-Off wave length	As per Technical Data Sheets

3.3. Factory Acceptance Tests (Routine Tests)

Following factory (routine) tests shall be performed, comprise as a minimum and witnessed by FEWA:

Test Item	Test passing Criteria
Transmission and optical characteristics	
- Attenuation at wavelength , (1270, 1310 and 1500 nm)	As per Technical Data Sheets (at 1310 and 1550 nm)
Environmental characteristics	
- Sheath defects, voltage test on the outer sheath with 10 kV _{DC} /1min between steel tape and graphic coating	No break down

Electrical characteristics	
- Dielectric strength	No breakdown
- Insulation resistance of outer sheath	Refer to IEC standards for the given insulation thickness

ROUTINE TEST (To be done each drum before delivery to FEWA)

- TDR Scan (Trace to be retained for future reference, inclusion in the final test report)
- Attenuation (Trace to be retained for future reference, inclusion in the final test report)

3.4. At Site (Tests after installation including all Accessories)

Following tests are performed:

- a) Splice Tests for every joint (Attenuation & Backscatter)
- b) Link Tests for every section (OTDR scan, Dispersion)

3.5. Test Report

All of the test results shall be clearly annotated with date/ time; item identification; test equipment type and serial number; switch settings; screen axis names and dimensions and the marking of all points of special interest with comments. Detailed analysis and summary sections shall be included and the whole compiled into a single volume for presentation within one month of the overall link acceptance. The test results shall comply in all respect with the requirement as set out in the specification and data stated in technical particular and guaranteed data and with standards ASTM-B 415 and B416, ITUT (CCITT) G651 and G654, IEC 60793-1 and 60794-1, IEC-60068-2-14, IEC-2-52. Method and procedure of test shall be guided by the standard as above or such other standard as may be provided.

3.6. Test Equipment

The Bidder/Contractor shall provide the test equipment for the above tests. The Bidder/ Contractor shall ensure that the test equipment is calibrated and suitable for these tests. Calibration certificates shall be valid for at least six months.

4. MARKING AND PACKING

4.1. Marking

Each cable drum shall be identified with permanently attached nameplate of approved material/design. Inscriptions on these plates must coincide with the data given in the respective documents/drawings.

The drums shall be marked in English as given below:

- FEDERAL ELECTRICITY & WATER AUTHORITY - UAE
- PROJECT NAME
- CONTRACTOR'S / SUB-CONTRACTOR'S NAME

- PORT OF DESTINATION
- CONSIGNMENT/DRUM SERIAL NO.
- GROSS WEIGHT
- NET WEIGHT
- SIZE OF DRUM/BOX OR BUNDLE (LENGTH X WIDTH X HEIGHT)
- BRIEF INDICATION OF CONTENTS

4.2. Packing

Immediately after tests at the Bidder/Contractor's premises, both ends of every length of cable shall be sealed with a metal cap (with pulling eye for power cables) which shall be plumbed to the sheath.

All cables on drums shall be seaworthy.

All packing shall be suitable for transport from factories to the port of embarkation, sea/air freight, and rough handling at the port of destination and movement to and on the Site.

For the pilot/telephone cables, the end of factory lengths shall be marked "A" and "Z", "A" being the end at which the sequence of core numbers runs clockwise.

All cables and conductors shall have the inner ends brought out and suitably fixed to the drum to avoid any damage during handling or pulling operations.

The cables shall be rolled on drums as specified in the technical data sheets. The drums shall also be suitable for storage in the open air without additional protection by casing or shutters for a period of at least two years.

All markings wherever applicable shall be legible. Weatherproof tags where used, shall be durable, securely attached.

All accessories, together with the applicable instruction books, packing lists and special site storage instructions shall be carefully crated or otherwise adequately protected for overseas shipment.

All bright parts liable to rust shall be treated by using an anti corrosion coat and shall be suitably protected. Surfaces of Flanges, Studs, etc, shall be properly protected before shipment.

Accessories items susceptible to damage by water or high humidity shall be encased in watertight and/or airtight, rugged containers to ensure a low humidity atmosphere therein.

Further reference is made to the individual chapters of the Standard Technical Specification for underground and submarine cables.

5. INFORMATION TO BE PROVIDED WITH THE BID

Technical descriptions, data sheets, catalogues and other material submitted with the Bid must be sufficient to enable FEWA to thoroughly evaluate the proposal as to its compliance with the requirements of these Specifications.

Minimum Requirements

- Detailed summary of deviations from the Specification
- All data sheets duly filled-in and signed
- Material safety data sheet of all chemical materials such as insulating fluid, powder and grease to be used for jointing and termination work
- Material safety data sheet of the cold pour filling compound in the fibre glass box of the cable joint, this includes the base resin, hardener (if applicable) before curing, also material data sheet showing its electrical, mechanical and chemical properties after curing of the resin compound
- Detailed cross sectional drawings showing all the cable components
- Quality control system and handling procedure
- Sales record of cables/cable accessories proposed of the same design
- Brochures and catalogues containing outline dimensions, main electrical data and installation details
- Listing of accessories included in the proposal
- Applicable design specifications
- Tests carried out on the offered cables/cable accessories

6. APPROVAL DATA AND DRAWINGS

All drawings shall be in A3 or A4 size sheets with title blocks approved by FEWA.

At the times, and in the quantities agreed upon, the following information and data must be submitted to FEWA for approval prior to manufacturing of the equipment:

- Vendor(s) details / reference list
- Completely filled in data sheets
- Testing schedule and procedures

7. SPARE PARTS

Bidder/Contractor shall provide a list of "Recommended Spare Part" based on recommendation from the manufacturer, taking into considerations, the statistical record of the operation life of the cables/cable accessories, in similar environmental conditions as prevailing in UAE.

All spare items shall comply with applicable Clauses of Cables and Accessories Specifications.

All spare accessories shall be identical to the approved ones, under this Contract, for installation. It must also be from the same manufacturer of the installation accessories.

All spare cables/accessories shall be suitably packed/boxed and placed in storage areas as designated by FEWA.

The Bidder/Contractor shall provide all labour, tools, equipment and appurtenances to carefully load, transport, unload and place all spares in storage. No materials, drums, reels, boxes or crates shall be stored directly on the ground or similar horizontal surface.

The required spares for the cables and their accessories shall be strictly interchangeable with the parts they are intended to replace and shall be treated and packed for long storage under the climatic conditions specified in Technical Standard Specification.

For all spare cut lengths of cable, which are to be delivered to the FEWA's stores, approved sealing caps of correct sizes shall be supplied and properly mounted immediately after the respective cable length is cut.

8. DOCUMENTATION

The cables/cable accessories supplied under this specification shall be documented to the extent as to enable the end user to understand the product, its theory of operation, its application, performance and maintenance.

Furthermore, it must enable FEWA to efficiently communicate with the manufacturer about all aspects of operation, maintenance and servicing/spare parts ordering.

The following documents must be submitted to FEWA:

- Bill of equipment showing complete re-ordering information for all replaceable parts
- Spare parts location, identification and price list in accordance with the Contract price tabulation sheets
- Installation, operation and maintenance instructions
- Prior to shipment, copies of all routine test certificates shall be made available to FEWA. If, during testing, changes are made to any of the cable accessories if approved by FEWA, the deviations must be corrected in the relevant submitted drawings to reflect the exact status on delivery. These corrections must be completed immediately following the actual changes

The format, standards, and quality and quantities of drawings may be as per manufacturer's standard, however, subject to FEWA approval in light of the requirements of these Specifications.

Language in all documents and drawings shall be in English and the dimensions shall be in metric SI-units.

OPTIC FIBRE CABLE ACCESSORIES

(Technical schedules to be completed by tenderer)

No.	DESCRIPTION	REQUIRED
TENDERED		
1.0	TERMINATION CUBICLE	
1.1	Splice loss max. (when measured from both sides).....	0.05 dB
1.2	Connector loss, max.....	0.3 dB
1.3	Insect proof.....	Yes
1.4	type of connector.....	FC-PC
1.5	number of connector can be accommodated in connector holder, min.....	40
1.6	Splice type.....	fusion splice
1.7	Number of splices can be accommodated in splice holder, min.....	40
2.0	HEAT SHRINK STRAIGHT JOINT	
2.1	Type Test (Date and testing station).....	
2.2	Maker's name and country.....	
2.3	Weight of heat-shrink straight joint.....	kg
2.4	Service life of heat-shrink straight joint.....	year
2.5	Shelf life of joint component.....	year
2.6	Dimensions of heat-shrink straight joint(length & width).....	mm
2.7	Protective housing material.....	glass-fibre
2.8	Dimensions of Protective housing (length & width).....	mm
2.9	Filling compound name and type inside protective housing.....	
2.10	Minimum external heat-shrink hose/tube overlapping after shrinking	100mm
3.0	COLD SHRINK TYPE STRAIGHT JOINT	
3.1	Type Test (Date and testing station).....	
3.2	Maker's name and country.....	
3.3	Weight of cold-shrink straight joint.....	kg
3.4	Service life of cold-shrink straight joint.....	year
3.5	Shelf life of joint component.....	year
3.6	Dimensions of cold-shrink straight joint(length & width).....	mm
3.7	Protective housing material.....	glass-fibre
3.8	Dimensions of Protective housing (length & width).....	mm
3.9	Filling compound name and type inside protective housing.....	
3.10	Minimum external cold-shrink hose/tube overlapping after shrinking	100mm
4.0	SUPPORTING DOCUMENTS	
4.1	Type test reports enclosed.....	Yes
4.2	Technical literature enclosed.....	Yes
4.3	Relevant drawings enclosed.....	Yes

OPTIC FIBRE CABLE

(Technical schedules to be completed by tenderer)

No.	Description	Required
	Tendered	
1.	Maker's name and country	
2.	Applicable standard (ITU-T- G652, IEC,EN).....	
3.	Type Test (Date, Testing Station).....	
4.	DESIGN DATA	
4.1	Central strength member material.....nonmetallic	
4.2	Number of tubes4	
4.3	Materialthermoplastic/polyester	
4.4	Applicable standards.....IEC 60794-1	
4.5	Thickness of the buffer tube.....0.4mm	
4.6	Tube filling material.....PE	
4.7	Number of fibers.....32	
4.8	Mode.....SM	
4.9	Material of fibers.....high grade silica	
4.10	Thickness of protective coating (primary)...U.V cured acrylate/0.062mm	
4.11	Thickness of PE Inner sheath.....1.5mm	
4.12	Material/Thickness of Intermediate sheath.....PE ST5/1mm	
4.13	Material/Thickness of Armour.....Corrugated steel tape/0.2mm	
4.14	Material/Thickness of Outer sheath.....PEST7/1.5mm	
4.15	UV resistant/Termite..... Yes	
4.16	Length marking at every meter interval.....Yes	
4.17	Text embossed as specified.....Yes	
4.18	Material for semi-conducting layer.....extruded/graphite	
4.19	Overall diameter of cable.....	
4.20	Minimum Operating Temperature Range... ..(0-60) ° C	
5.	OPTICAL/ELECTRICAL DATA	
5.1	Mode field diameter at 1310nm9.2um	
5.2	tolerance.....+/-0.4um	
5.3	Transmission modeSM	
5.4	Cut off wave length.....<1270nm	
5.5	Dispersion at 1310nm.....(ps/nm.km).....<3.5	
5.6	Attenuation at 1310nm before installation.....<0.35 dB/km	
5.7	Attenuation at 1310nm after installation.....<0.4 dB/km (including all splices)	
5.8	Attenuation at 1550nm before installation.....<0.25 dB/km	
5.9	Attenuation at 1550nm after installation.....<0.3 dB/km (including all splices)	
5.10	Voltage withstand between armour and and ground for (1minute).....10kV DC	

6. OTHER DATA

- 6.1 Minimum permissible bending radius D.....
- 6.2 Maximum permissible pulling force
- 6.3 Delivery length per drum.....(<4000m)
- 6.4 Guaranteed ultimate breaking strength kg
- 6.5 Weight kg/m

7. Drum for O.F. Cables

- a) Diameter of flanges mm
- b) Diameter of drum mm
- c) Width of drum mm
- d) Width of lagging mm
- e) Thickness of lagging mm
- f) Spindle hole diameter mm
- g) Weight of drum kg.
- h) Gross weight of drum including weight of FOCkg.
- i) Maximum length in each drum km
- j) Steel/Wooden drum