# UNITED ARAB EMIRATES

# FEDERAL ELECTRICITY & WATER AUTHORITY

# FEWA SPECIFICATION NO. 2.4 – SPECIFICATION FOR COLD SHRINKABLE/PRE-MOULDED JOINTS AND TERMINATIONS

**SPECIFICATION NO. 2.4**
**(Revised in May 2002)**

# SPECIFICATION FOR (A) COLD SHRINKABLE TERMINATION (B) PRE-MOULDED JOINT AND TERMINATION KITS FOR 11KV AND 33KV XLPE INSULATED CABLES

## (Straight Joints and Indoor/Outdoor Terminations)

1 Standard Specifications:

The joint and termination shall conform to the latest edition of VDE 0278, IEEE 48-1990 and B.S.C - 89, IEEE-404 for completed cable accessories and for components ASTMD 149-90, D150-87, D412-87 and D2303-90, or any other equivalent international standard, which shall be subject to the approval of the Authority. One copy of each specification in English language to which the joints and terminations are manufactured and tested shall be submitted with the offer.

2 Site Conditions:

The joints and terminations shall be installed indoors and outdoors in U.A.E. in salt laden dusty atmosphere where the maximum humidity of 100% and maximum ambient temperature of 50 deg.C. can be experienced. The joints and terminations shall be suitable for continuous operation at the above site conditions.

3 Scope and nature of work:

The specification provides for design, manufacture test at manufacturer's works in presence of FEWA representatives, suitable packing, transportation and off loading at FEWA stores in satisfactory condition and proper stacking as directed by FEWA or otherwise specified elsewhere. These joints and terminations shall be used for XLPE insulated cable, indoor or outdoor, for 11kV and 33kV system.

4 System voltage, quality of joints and terminations etc.:

Joints and terminations kits are required for XLPE insulated cables in 11kV and 33kV nominal voltage, 50Hz, 3-phase system with system highest voltages of 12kV and 36kV respectively. Both outdoor and indoor type of joints and terminations are required as per B.O.Q. The length of cold shrink tubing shall be stated during tendering for items requested in the Bill of Quantity.

Components shall not be adversely affected in any manner by contact with other materials normally used in the construction of cable terminations and shall not increase the rates of corrosion of any metal with which they may come into contact. Assembled components forming part of a supply system shall perform without distress under the following conditions:

i) Normal conditions:

Continuous operation at a conductor temperature of 90 deg.C. for XLPE insulated cables.

ii) Fault conditions:

Operation at a conductor and screen temperature of 250 deg.C. for XLPE.

5 Types of cables for which joints and terminations are required.

5.1 11 kV Cables

3 core, XLPE insulated, copper tape/wire screened, steel wire armoured, PVC sheathed Aluminium conductor cables or otherwise as stated in the Bill of Quantity.

Single core copper conductor for compacted circular stranded annealed plain wires, XLPE insulated, copper tape/wire screened, PVC sheathed as stated in Bill of quantity.

5.2 33 kV Cables

Single core copper conductor of compacted circular stranded annealed plain wires, XLPE insulated, copper tape/wire screened and PVC over sheathed cables as per IEC 502/94 or otherwise as stated in the Bill of Quantity.

Three core copper conductor XLPE insulated copper tape/ wire screened, steel wire armour, PVC sheathed cable as per IEC 502/94 or other wise stated in Bill of Quantity.

A. Cold Shrinkable Termination Kits

A.6 Technical Specifications:

The term cold shrink applies to materials, which are capable of shrinking without raising the material above the ambient temperature of its immediate surroundings. The material of the rubber insulator used in the Cold Shrink Terminations shall be silicone which is factory expanded and placed on a removable core. The removing of the core when the termination is positioned over the cable shall cause the termination to shrink. The termination shall maintain a compressive force on the cable continuously throughout the life of the product. This pressure will ensure a complete moisture seal without the use of adhesives.

Electric field stress control shall be achieved by using a high dielectric constant cold shrink electrometric tube. This tube shall be completely covered by a cold shrink-able silicone insulator having adequate track resistance. The two pieces shall be prestretched in the factory and placed on the one removable core.

The term PST refers to Pre Stretched Tubing.

The material used for the terminations shall display a high surface tension or hydrophobic property. This is essential to minimize surface wetting and in turn minimize or eliminate damaging leakage currents.

These components shall be weather, ultra violet light and salt pollution resistant.

A full drawing of the termination including all parts must be forwarded with the tender documents.

A.7 Main Components

A.7.1 3-finger PST silicone rubber cold shrink break out boot.

A.7.2 PST silicone rubber insulator.

a) PST silicone rubber cold shrink insulator with water shed skirts and with a high dielectric constant PST cold shrink stress relief tube (11kV outdoor termination).

b) PST silicone rubber cold shrink insulator with water shed skirts and with a high dielectric constant PST cold shrink stress relief tube (33kV outdoor termination).

c) PST silicone rubber cold shrink insulator without water shed skirts and with a high dielectric constant PST cold shrink stress relief tube (indoor termination 11kV).

d) PST silicone rubber cold shrink insulator with water shed skirts and with a high dielectric constant PST cold shrink stress relief tube (Indoor termination 33kV).

e) Straight & right angle boots shall be provided for indoor terminations.

A.7.3 Termination accessories including sealing and semi conductive tapes, earthing clamps and earthing braid.

A.8 <u>General requirements of installed joints & terminations:</u>

The installed joints and terminations must provide the following:

A.8.1 Complete external leakage insulation between the high voltage conductor and earth potential using anti-track cold shrink material.

A.8.2 Electrical stress control using a stress relief tube incorporated inside the PST silicone rubber cold shrink insulator.

A.8.3 The installed terminations shall meet the electrical requirements laid down in this specification.

A.8.4 Outdoor terminations shall incorporate a design feature to prevent flexing of the terminated cores under short circuit conditions.

A.8.5 Terminations must be insensitive to cable manufacturers tolerances allowed under BSS 6480-1988 or IEC 55.

A.8.6 The successful tenderers will be required to supply overhead line insulators and support bracket for outdoor terminations in line with the schedule of quantities. These brackets must be designed for mounting on wooden poles such that the terminating cores may be cut to the same length measured up from the sheath terminus of the cable termination.

A.8.7 The length of core insulation required with switchgear and transformer terminations is 450mm for three and single core 11kV and 450mm for single and three core 33kV cables.

A.8.8 The length of core insulation required with outdoor pole-top terminations is 900mm per phase for three and single core 11kV and 1200mm for single and three core 33kV.

A.8.9 Copper braid should be provided to connect the metal shield of XLPE cable.

B. Pre-moulded Kits

B.6 Technical Specifications

Premoulded shall mean factory moulded ETHYLENE-PROPYLENE - DIENE TERPOLYMERS (EPDM) rubber cable joints and terminations for XLPE insulated power cables. Moulding shall be in the shape that it will take when installed. They shall conform to the following design criteria:-

Material for cable joint housing termination stress and rain sheds shall be of Peroxide cured EPDM rubber.

Housing and stress cone shall have stress relief, conductive insert, insulation and conductive outer layer moulded as to form one unit per phase.

Joint shall be fully submersible for direct burial, vault or cable tray applications.

No special tools will be required for the installation of complete jointing and termination kits. Installation is performed by sliding the pre-moulded joint housing over the cable. The use of heat is not a part of the installation procedure for the pre-moulded joint housing.

Internal diameter of the housing shall be of a size suitable for the specified cable so as to produce a waterproof and airtight interface with insulation and semi-conductive layer of cables.

Joint or termination kits shall come with all required components to produce a complete cable joint or termination including compression ferrule to suit specified conductor. The components of the joints and termination shall be weather, U.V. light and salt pollution resistant.

Ampacity of completed joint and termination shall be equal to the cable to which it has been installed.

Full drawing of the joint and termination including all parts must be forwarded with the tender documents.

B.7(i) Main Components for Joints

1. Pre-moulded joint housing.
2. Crimp connectors
3. Armour wrap kit (for mechanical strength) (for armoured cables).
4. Aluminium back-up ring (for armoured cables)
5. Worm drive clip (for armoured cables)
6. Constant force spring
7. Silicon grease.
8. Copper mesh
9. Outer jacket tube (heat shrinkable)
10. PVC tape
11. Installation manual.

B.7(ii) Main Components for Terminations

1. Two hole crimping lugs/connectors.
2. Sealant mastic butyl tape.
3. Silicon rubber tape (for outdoor termination).

4. Non-tracking rubber module skirts.
5. Pre-moulded stress cone (s).
6. Ground clamp.
7. Ground wire.
8. Jacketing tape/PVC tape.
9. Constant force spring.
10. Grounding flat copper braid.
11. Trifurcating boot (for 3 core cables).
12. Heat shrinkable tubings (for 3 core cables - outdoor terminations).
13. Heat shrinkable straight right angle boots (for indoor terminations only).
14. Silicon grease.
15. Complete with lubricant, wiping cloth, installation instructions.
16. Stand-off insulator with bracket (3 Nos. insulators + 1 No. bracket) (For outdoor terminations only).

B.8 General requirements of installed joints & terminations

The installed joints and terminations shall provide the following :-

B.8.1 Complete external leakage insulation between the high voltage conductor and earth potential. Factory moulded EPDM rubber joint housing.

B.8.2 The joint kit has to supplied with adhesive pre-coated heat shrinkable external protective tubing. The adhesive to be activated by the heat application to shrink the tubing, which shall be in excess of 125 Deg.C.

Uniform adhesive flow from the adhered heat shrink tubing into the adjoining surfaces will be used as an indicator that shrinking is complete, and therefore, the adhesive must be suitable for this purpose.

B.8.3 The installed joints and terminations shall meet the electrical requirements laid down in this specification.

B.8.4 Joints and terminations must be insensitive to cable manufacturers tolerances allowed under BS 6480, IEC 55 or any other equivalent International Standards.

B.8.5 Galvanized steel joint case comprising of wrap around shell shall be provided for mechanical strength (For armoured cable).

9 Supply of technical information, test certificates and samples
(Common to both cold shrink and premoulded)

9.1 Tenderers must submit full specification and samples of the materials offered.

9.2 Tenderers must submit a detailed design of the overhead line support brackets for outdoor terminations offered, including details of the materials used in manufacture of the bracket. For each outdoor kit a suitable approved type bracket made of galvanized steel shall be supplied within the quoted price.

9.3 Manufacturers who have not previously supplied cable accessories to FEWA must submit a list of all electrical utilities in the Middle East to whom they have supplied cable accessories at voltages of 11kV and above. The information listed below must be for each order quoted:

1. Name of utility

2. Order Number

3. Order period (From.....To.....)

4. Order value

5. Total number of joints/terminations supplied

6. Number and details of each size of joints/ termination supplied.

7. System voltage for which joints/terminations were supplied.

8. Specification of the cable for which the joints/terminations were supplied.

9. Set of installation instructions for the joints/terminations supplied showing clearly the components used in making the termination.

10 Testing :

Electrical performance tests mentioned in clause 10.4 shall be carried out on samples chosen at random in presence of FEWA representatives at manufacturer's works. Certified copies of the type test certificates mentioned in clause 10.2 and 10.3 shall be supplied along with the offer. The supplier shall make provision in his offer to bear all costs that are incurred in carrying out these tests to the satisfaction of FEWA. However, costs towards travel, accommodation etc. of FEWA representatives shall not to be included in the quoted price.

A. COLD SHRINKABLE KITS :

A.10.1 Material tests :

The following tests shall be performed to verify the quality of material requirements. The tests shall be carried out in the manner specified in ASTM D412, D150, D149 and shall satisfy the requirements stated therein.

A.10.2 Tests for components :

a) Silicone Rubber Insulator

| | | | |
|---|---|---|---|
| 1) | Permanent Set | - | 22 Hours "100 deg.C,<br>100% Elongation,<br>5 Minute recovery |
| 2) | Ultimate Tensile Strength | - | ASTM D412-87 |
| 3) | Dielectric Constant | -<br>- | ASTM D150-87 23 deg.C<br>90 deg.C, 130 deg.C |
| 4) | Dissipation Factor | -<br>- | ASTM D150-70 23 deg.C<br>90 deg.C, 130 deg.C |
| 5) | Dielectric Strength | -<br>- | ASTM D149-90<br>75 mil gap |
| 6) | Track Resistance | - | ASTM 2303-90<br>2.5 KV 10K Ohms<br>3.25 KV 50K Ohms |

b) Stress Control Tube

| | | | |
|---|---|---|---|
| 1) | Permanent Set | - | 22 Hours @ 100 deg.C, 100% Elongation,15 Minute recovery. |
| 2) | Ultimate Tensile Strength | - | ASTM D412-87 |
| 3) | Dielectric Constant | - | ASTM D150-87 23 deg.C 65 deg.C, 90 deg.C |
| 4) | Dissipation Factor | - | ASTM D150-87 23 deg.C 65 deg.C, 90 deg.C |

B. PREMOULDED KITS :

B.10.1 Material/component tests :

The premoulded joint components shall be tested as per IEEE-404 and termination components to IEEE-48 and type test (design test) certificates provided.

B.10.2 i) Type test (Design tests) :

Type tests shall be performed an randomly selected joints and terminations ordered as per IEEE 404 and IEEE 48 in the presence of FEWA representatives. The results of these tests shall be recorded in the form of a report certifying that a joint/termination design meets the requirements of the standard.

If these tests have been earlier witnessed by FEWA reprehensive and design has not been changed, the witnessing may be waived at the sole discretion of FEWA.

For cyclic aging test FEWA may accept type test certificate of a reputed independent laboratory at its sole discretion.

ii) Routine Tests (Production tests) :

The following production tests shall be performed on 100% of all joints ordered as per IEEE 404 in the presence of FEWA representatives:

a) Partial discharge (corona) voltage level.

b) AC voltage withstand test.

10.3 Electrical Performance Tests :
(Common to cold shrink and premoulded kits)

The following tests shall be carried out to check the electrical performance of the joints and terminations as per VDE 0278, IEEE 48 or 404 or any other equivalent standards.

1) A.C. Voltage withstand
2) Partial Discharge
3) Impulse Voltage withstand
4) Load Cycling/Pressure tests/Water tightness
5) Thermal Short Circuit

6) D.C. Voltage withstand
7) Humidity & Condensation/salt-fog
8) Dynamic short circuit

Test values shall be forwarded in four copies to FEWA representative.

10.4 Test Methods : (Common to cold shrink & premoulded kits)

1. Nominal A.C. Voltage Withstand

This test shall be carried out in accordance with VDE 0278/IEEE 48/IEEE 404. For test No. 1 in the sequence, the test voltage shall be applied for 1 minute. For outdoor terminations, the test shall be carried out under rain. The rain shall have an incidence angle of 45 deg., a rate of 3mm/minute and a conductivity of 100 uS/cm.

The test voltage shall be 35/28kV for the 11kV system and 75/70kV for the 33kV system. The voltage shall be applied between the phase and ground.

For outdoor terminations, the test shall be run a second time (before the salt fog test) but without rain.

2. Partial Discharge

This test shall be carried out in accordance with VDE 0278/IEEE 48/IEEE 404. The test voltage shall be 12kV phase/ground for the 11kV and 36kV for the 33kV systems. The requirement is that the discharge level shall not exceed 5 pC.

3. Impulse Voltage Withstand Test

The test shall be in accordance with VDE 0278/ IEEE-404. The phase/ground test values for indoor and outdoor use shall be 75kV/110kV (peak) for 11kV and 170kV/220kV (peak) for 33kV systems. 10 positive and 10 negative, 1.2/50 us impulses shall be applied.

4. Load Cycling Test

The test shall be in accordance with VDE 0278/ IEEE-404. The test voltages shall be 15kV and 45kV for 11kV and 33kV systems respectively.

5. Thermal Short Circuit Test

Test shall be in accordance with VDE 0278/IEEE 404. Two of one second tests each shall be performed.

6. Water Tightness Test

The test shall be carried out in accordance with VDE 0278/IEEE-404. The entire joint shall be submerged in water filled tank. In this position terminations shall be exposed to 9 Load Cycles (as in 4).

7. D.C. Voltage Withstand Test

The D.C. Voltage withstand test shall be in accordance with VDE 0278/IEEE48 and 404 at test voltages of 48kV and 144kV (30 minutes) for 11kV and 33kV systems respectively.

8. Humidity Test

Terminations shall be tested in accordance with VDE 0278/IEEE-48. The sample shall be subjected to an A.C. Voltage for 100 hours in a humidity chamber, where water with a conductivity of 700+/-100 uS/cm. shall be sprayed at a rate of 0.3+/-0.1 L/h per cubic meter of the test chamber. The test voltages shall be 7kV and 21kV for 11kV and 33kV systems respectively.

9. Salt Fog Test

This test shall be carried out in accordance with VDE 0278/IEEE-48 on outdoor terminations only. The sample shall be exposed for 1000 hours to a salt-water spray with a conductivity of 16+/-2mS/cm at a rate of 0.4+/-0.1 L/m3/h. The phase/ground test voltages shall be 7kV and 21kV for 11kV and 33kV systems respectively.

11. Identification and Packaging

Components shall normally be supplied in a package as a complete termination, which shall be clearly marked with the supplier's name, reference number, batch reference, voltage, application and cable size. In addition FEWA part No. as indicated in the B.O.Q. shall be marked on the package.

Packaging shall be designed to protect against ingress of moisture and mechanical damage. Self fusing tapes shall have means to prevent the fusing of surfaces from each other.

The complete cold shrinkable components, required to complete in all respects one termination, shall be supplied in a kit form.

For Cold shrink kits

For the purposes of identification, PST silicone cold shrink break out boots shall be marked clearly and permanently in a prominent position with the supplier's name.

Electrically semi-conducting tape shall be marked "Semi Conducting" clearly and permanently.

12 Storage

Components shall be capable of being stored without deterioration within the temperature range of -10 deg.C to 45 deg.C. Components or materials, if subject to a shelf life limitation shall have the final date of use, date of manufacture prominently and permanently shown on all packaging.

## SCHEDULE 'A'

## SUB-MANUFACTURERS

The Tenderer shall state below the names of the sub-manufacturers to the main manufacturer and details of the equipment proposed to be manufactured or supplied by them:

| Name & Address of the Sub-Manufacturer | Description of Equipment |
|---|---|
| | |

Signature :_____

Designation :_____

Name of Tenderer ;_____

Date :_____

## SCHEDULE 'B'

## PLACE OF MANUFACTURE, TESTING AND INSPECTION

The Tenderer to complete the following schedule for all materials he proposes to supply

| Item No. | Description | Manufacturer | Place of manufacture | Place of testing and inspection |
|---|---|---|---|---|
| | | | | |

Signature :_____

Designation :_____

Name of Tenderer :_____

Date :_____

## SCHEDULE 'C'

## DEVIATION FROM TENDER SPECIFICATION

The Tenderer to state in the following schedule the deviations from the tender specifications proposed in his offer. Deviations other than those specifically listed below will not be taken note of:

| Item No. | Description | Precise Details of the Deviations |
|---|---|---|
| | | |

Signature :_____

Designation :_____

Name of Tenderer :_____

Date :_____

## SCHEDULE 'D'
## GUARANTEED PARTICULARS FOR COLD SHRINKABLE KITS

Tenderers are to give the following particulars for straight through joints and terminations. Tenderers are also required to submit a detailed list of the components of each joint and termination.

| Sl No. | Description | Termination | | | | | | Straight Joint | |
|---|---|---|---|---|---|---|---|---|---|
| | | Outdoor | | Indoor with | | | | | |
| | | | | Right Angle boot | | Straight Angle Boot | | | |
| | | 33KV | 11KV | 33KV | 11KV | 33KV | 11KV | 33KV | 11KV |
| 1. | Manufacturers Name | | | | | | | | |
| 2. | Applicable Standard | | | | | | | | |
| 3. | Nominal Voltage KV | | | | | | | | |
| 4. | One minute dry withstand Voltage KVrms | | | | | | | | |
| 5. | One minute wet withstand Voltage KVrms | | | | | | | | |
| 6. | DC withstand voltage for 30 minutes in KV | | | | | | | | |
| 7. | Impulse withstand voltage Dry in KV(Peak) | | | | | | | | |
| 8. | Partial discharge level in pc | | | | | | | | |
| 9. | a) Discharge inception voltage KV | | | | | | | | |
| 10. | b) Discharge extinction voltage KV | | | | | | | | |
| 11. | Material of the heat Shrinkable kit | | | | | | | | |
| 12. | Dielectric strength KV/mm | | | | | | | | |
| 13. | Volume resistivity Ohm/cm | | | | | | | | |
| 14. | Dielectric constant | | | | | | | | |
| 15. | Dissipation factor Tensile strength N/mm2 | | | | | | | | |
| 16. | Elongation % | | | | | | | | |
| 17. | Moisture absorption % | | | | | | | | |

**(Contd…..)**

**(Contd…..)**

## SCHEDULE 'D'

## GUARANTEED PARTICULARS FOR COLD SHRINKABLE KITS

| Sl No. | Description | Termination | | | | | | Straight Joint | |
|---|---|---|---|---|---|---|---|---|---|
| | | Outdoor | | Indoor with | | | | | |
| | | | | Right Angle boot | | Straight Angle Boot | | | |
| | | 33KV | 11KV | 33KV | 11KV | 33KV | 11KV | 33KV | 11KV |
| 18. | Brittle temperature | | | | | | | | |
| 19. | Standards | | | | | | | | |
| 20. | Safe continuous operating temp. | | | | | | | | |
| 21. | Tail length in termination | | | | | | | | |
| 22. | Stress control distribution, attach literature for joints and terminations | 1200 | 900 | 450 | 450 | 450 | 450 | - | - |
| 23. | Provision of catalogues for joints and terminations | | | | | | | | |

Signature :_____

Designation :_____

Name of Tenderer ;_____

Date :_____

## SCHEDULE 'E'

## DETAILS OF PAST EXPERIENCE OF MANUFACTURER

## JOINTS / TERMINATION KITS

| Name and address | Quantity supplied | Year of supply | remarks |
|---|---|---|---|
| | | | |

Signature :_____

Designation :_____

Name of Tenderer ;_____

Date :_____