

**SPECIFICATION NO. 2.3.1**  
**(Revised in Sept. 1986)**

**SPECIFICATION FOR HEAT SHRINKABLE TERMINATIONS AND JOINTS**  
**FOR 600/1000 VOLTS XLPE INSULATED CABLES**

1. Standard Specifications:

The heat shrinkable terminations and joints (Kits) shall conform to the latest edition of ESI-09-11 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 terminations and joints are manufactured and tested shall be submitted with the offer.

2. Site Conditions:

The kits shall be suitable for use with cables installed in trenches (underground), indoors and outdoors in U.A.E. in salt laden dusty atmosphere where the maximum ambient temperature of 50 Deg. C and 100% humidity can be experienced. The kits shall be suitable for continuous operation at the above site conditions.

3. Scope and Nature of work:

The specification provides for the design, manufacture, test at manufacturer's works in presence of two FEWA Inspectors, suitable packing, transportation and off-loading at FEWA stores in satisfactory condition and proper stacking as directed by FEWA of heat shrinkable terminations and joints suitable for 600/1000 V XLPE insulated cables.

4. System voltage, Quality of Joints, etc.:

The kits are required for XLPE insulated cables installed on electrical systems of grade 600/1000 volts nominal voltage, 50 Hz, 3 phases, 4 wire system with solid earthed neutrals. Both outdoor and indoor type of joints and terminations are required as per the Bill of Quantities. For outdoor and indoor terminations, the tubing length shall be stated in the offer for items requested in Bill of Quantity.

Components shall not be adversely affected in any manner by contact with other materials normally used in the construction of cable joints and terminations, and shall not increase the rate 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.
- ii) Fault conditions: Operation at peak transient conductor and sheath/earth wire temperature of 250 Deg. C.

5. TYPE OF CABLES FOR WHICH JOINTS/TERMINATIONS ARE REQUIRED

5.1 Construction:

The low voltage cables shall be of 2, 3.5 or 4 core, cross linked polyethylene insulated, steel wire armoured and PVC served. The conductor shall be made from standard Aluminium or Copper as specified in the bill of quantities and shall conform to the latest edition of relevant BSS, IEC or any equivalent international standard.

5.2 Neutral:

The neutral of the 3.5 core cables shall have half the size of the phase conductors while that of 4 core cables shall have the same size as for the phase conductors.

5.3 Shape of Cores:

- i) 2 core cables - The two cores shall be round shaped
- ii) 3.5 core cables - The three cores for the phases shall be sector shaped and the 1/2 core for the neutral shall be sector/round shaped.
- iii) 4 cores cables - All cores shall be sector shaped.

5.4 Sizes of 2, 3.5 and 4 core cables:

- i) Size of conductor for 2 core cable shall be 25 sq.mm
- ii) Sizes of conductor for 3.5 core cable for the phases shall be:
  - a) 300 sq.mm
  - b) 185 sq.mm
  - and c) 95 sq.mm
- iii) Sizes of conductor for 4 core cables shall be:
  - a) 70 sq.mm
  - b) 50 sq.mm
  - c) 35 sq.mm
  - d) 25 sq.mm

6. TECHNICAL SPECIFICATIONS:

The term "heat shrinkable" is applied to extruded or moulded polymeric materials, which are cross linked either by irradiation or chemical means, such that when their temperature is raised beyond the normal base polymer crystalline melting point, they do not melt but merely become rubbery. In this state if the material is then mechanically expanded and held in this position until the temperature falls below the crystalline melting point, it remains in the expanded state. Subsequent heating in an unconstrained state will then result in the material recovering or "shrinking" to its original extended or moulded size and shape.

Electric stress control for the cable insulation screen in termination and joints shall be achieved by heat shrinkable tubing. Joints shall include ferrules and all necessary items.

This tubing shall have defined impedance characteristic, volume resistivity, and dielectric constant in accordance with relevant IEC.

Sealing of the interfaces between heat shrinkable materials and/or cable surfaces shall be achieved by using a track resistant sealant or a hot melt adhesive. This sealant/adhesive shall be precoated inside the heat shrinkable components and activated by the heat applied to shrink the components.

Complete external leakage insulation between the low voltage conductor and ground shall be achieved by utilizing heat shrinkable tubing and moulded parts. No filling medium shall be required.

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

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

Technical characteristics already established for termination and joints must meet minimum requirements of lists 1,2,3 and 4 of ESI standard 09-11.

## 7. COMPONENT TYPES AND SEALANTS:

### 7.1 Tubing Components:

The tubing components shall conform to the requirements given in List 1 of ESI -09-11.

### 7.2 Moulded Components:

The moulded components shall conform to the requirements given in List 2 of ESI 09-11.

### 7.3 Sealants:

The sealants shall conform to the requirements given in List 3 of ESI 09-11.

## 8. GENERAL REQUIREMENTS OF INSTALLED JOINTS AND TERMINATIONS

The installed joints and terminations must provide the following:-

- 8.1 Complete external leakage insulation between the low voltage conductor and earth potential using heat shrinkable polymeric tubing for indoor, outdoor and underground use.
- 8.2 A heat shrinkable polymeric moulding electrically insulating and suitable for indoor, outdoor and underground use.
- 8.3 The sealants shall be used in conjunction with heat shrinkable components to effect seals on joints and terminations and shall be able to accommodate the creep or relaxations that may occur with recovered heat shrinkable materials.

The sealant shall maintain hermetic and moisture seals between components at all times.

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

- 8.4 The installed terminations and joints shall meet the electrical requirements laid down in this specification.
- 8.5 Joints and terminations must be insensitive to cable manufacturers tolerances.

## 9. SUPPLY OF TECHNICAL INFORMATION TEST CERTIFICATES AND SAMPLES

- 9.1 Tenderers must submit full specifications, details of components and samples of the materials offered.

9.2 Manufacturers who have not previously supplied heat shrinkable joints and terminations to FEWA must submit a list of all electrical utilities in the Middle East to whom they have supplied heat shrinkable joints and terminations at 600/1000 volts. The information listed below must be supplied for each order quoted:

1. Name of utility
2. Order Number
3. Order period (From ..... to .....)
4. Order value
5. Total value of joints and terminations supplied.
6. Number and details of each size of joint or terminations supplied.
7. System voltage for which joints and terminations were supplied.
8. Specification of the cable for which the joints or terminations were supplied.
9. Set of installation instructions for the joints and terminations supplied showing clearly the components used in making the joint or termination.

10. TESTING:

The performance tests detailed in item 1.10.4 shall be conducted in random samples of heat shrinkable terminations and joints in presence of two FEWA inspectors at manufacturer's works. Copies of test certificates for the tests indicated in items 1.10.2 and 1.10.3 and copies of all applicable type tests according to the relevant standard shall be enclosed 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 be included in the quoted price.

10.1 Materials 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 ESI 09-11, parts 3 and 4 shall satisfy the requirements stated therein.

10.2 Tests for Tubing and Moulded Components:

1. Chemically Resistance
2. Corrosion Resistance
3. Density
4. Dimensions
5. Electric Strength
6. Flame Retardance
7. Fungus Resistance
8. Heat Shock
9. Low temperature flexibility
10. Secant Modulus
11. Solvent Resistance
12. Tensile strength and ultimate elongation
13. Thermal Ageing
14. Visual Examination
15. Water Absorbtion
16. Water Vapour Permeability
17. Weather Resistance

### 10.3 Tests for Sealants:

1. Corrosion Resistance
2. Flow of elevated temperature
3. Low temperature flexibility
4. Peel strength
5. Solvent resistance

### 10.4 Performance Tests:

The following tests shall be carried out to check the electrical performance of the components.

	<u>Standard</u>
i) A.C voltage withstand for indoor termination	IEC 60
ii) Impulse voltage withstand	IEC 60 & IEC 230
iii) Thermal short circuit	VDE 0278
iv) D.C voltage withstand	IEC 60
v) Insulation resistance	VDE 0278
vi) Impact - Electricity Council Engineering recommendation	C.81

Copies of the above recommendation shall be forwarded in quadruplicate to FEWA representative.

The preferred test sequence shall be:

1. Insulation Resistance
2. Impact (Joints for armoured cables only)
3. A.C voltage withstand
4. Impulse voltage withstand
5. Insulation resistance
6. Thermal short circuit
7. Insulation resistance
8. Impulse voltage withstand
9. D.C. voltage withstand.

### 10.5 Test Methods:

#### 1. A.C Voltage Withstand

The test procedure shall conform to IEC publication 60.

During the test, the cable accessory or the cable (in case of terminations) shall be immersed in a water bath. 4 KV A.C voltage shall be applied for 15 minutes between each conductor in turn and the water bath, shield, armour and all other remaining conductors shall be grounded.

No breakdown or flashover shall be observed during the test.

## 2. Impulse Voltage Withstand

This test should conform to IEC Publication 60 and 230. 10 positive and 10 negative impulses with a 1.2/50 micro second waveform and a peak value of 8 KV shall be applied to the sample. The impulse voltage should be applied between each conductor in turn and the water bath, armour, shield and all other conductors shall be grounded.

No breakdown or flashover shall be observed during the test.

## 3. Thermal Short Circuit

The test shall conform to VDE 0278.

The test samples shall in each test be subjected to one-second short circuit twice to attain the specified temperature. Between the tests the sample shall be allowed to cool.

- a) In case of symmetrical faults, the conductor temperature shall conform to the appropriate cable specification.
- b) For earth fault, the screen, sheath or armour temperature shall conform to the respective cable specification.

During the test no visible signs of damage shall be observed.

## 4. D.C. Voltage Withsand:

The test shall conform to IEC Publication 60.

15KV D.C voltage should be applied for 5 minutes between each conductor in turn and the water bath, armour, shield and all other conductors shall be grounded.

No breakdown or flashover shall be observed during the test.

## 5. Impact

The test shall conform to Electricity Council Engineering recommendation C.81 at an ambient temperature ranging from 10 Deg. C to 25 Deg. C. The test is intended for joints in armour cables.

The joint shall rest upon a hard base e.g. floor or a concrete slab. A wedge shaped weight of 4 kg. having a 2mm. radius impacting edge and 90 Deg. angle shall be dropped from a height of 2M, for 6 times onto the sample so that the impacting edge is horizontal and at right angle to the axis of the joint. The drops shall be distributed over the length of the joint.

No visible damage of the joint, which may affect the function of the joint, shall be observed.

## 6. Insulation Resistance:

- a) Under the test sequence 1, the test shall conform to VDE 0278.

The test sample shall be immersed in a water bath. The insulation resistance shall be measured at a D.C voltage of not less than 600 volts between each conductor in turn and all other conductors and the waterbath. The connectors of the terminations shall be above the water surface.

The insulation resistance of test sample shall be greater than or equal to 1000 Mega ohm.

- b) As per 6 (a) under the test sequence 7, the insulation resistance shall be greater than or equal to 1000 Mega ohm. Also the value shall be greater than or equal to 10% of the value of insulation resistance before the load cycling test.

## 2.2 IDENTIFICATION AND PACKING:

For the purpose of identification moulded parts shall be marked clearly and permanently in a prominent position with the supplier's name and reference number.

Electrically conducting components shall be marked "Conducting" clearly and permanently.

Components required for each joint or termination shall normally be supplied in a package as a complete joint or termination which shall be clearly marked with the supplier's name, reference number, batch references, voltage, application and cable size. In addition, FEWA part numbers as indicated in the Bill of Quantity shall be marked on the package.

Packaging shall be designed to protect against ingress of moisture and mechanical damage. Components supplied with adhesive coatings shall have means to prevent the coated surfaces from adhering to each other.

## 2.2 STORAGE:

Components shall be capable of being stored without deterioration within the temperature range of 0 Deg. C to + 45 Deg. C. Components or materials, if subject to a shelf life limitation, shall have the final date of use prominently and permanently shown on all packaging and should not be less than years from the date of supply to FEWA Stores.

2.3.1/8  
**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 : \_\_\_\_\_

2.3.1/9  
**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 : \_\_\_\_\_

2.3.1/10  
**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 HEAR SHRINKABLE TERMINATION & JOINTS**

Tenderers are to give the following particulars for the straight through joints and the terminations:

Sl. No.	Description	Terminations		Straight Joint
		Outdoor	Indoor	
1.	Nominal voltage in Volts			
2.	15 minutes wet withstand voltage in KV r.m.s.			
3.	D.C. withstand voltage for 5 minutes in KV			
4.	Impulse withstand voltage dry in KV (Peak Value) for 10 positive and 10 negative impulses with 1.2/50 Micro second wave form.			
5.	Material of the heat shrinkable kit			
6.	Dielectric strength KV/mm.			
7.	Volume resistivity Ohm/cm.			
8.	Dielectric constant			
9.	Dissipation factor			
10.	Tensile strength N/sq.mm			
11.	Elongation			%
12.	Moisture absorption			%
13.	Brittle temperature - Deg. C.			
14.	Standards			
15.	Safe continuous operating temp. Deg. C			
16.	Maximum permissible temperature for short circuit Deg. C			
17.	Tail length in termination ( mm )			

Signature of Tenderer : \_\_\_\_\_

2.3.1/12  
**SCHEDULE 'D'**

**GUARANTEED PARTICULARS FOR HEAR SHRINKABLE TERMINATION & JOINTS**

Tenderers are to give the following particulars for the straight through joints and the terminations:

Sl. No.	Description	Terminations		Straight Joint
		Outdoor	Indoor	
18.	Stress control distribution, attach literature for joints and terminations.			
19.	Provision of catalogues for joints and terminations.			

Signature :

Designation :

Name of Tenderer :

Date :

**2.3.1/13**  
**SCHEDULE 'E'**

**DETAILS OF PAST EXPERIENCE OF MANUFACTURER**

Name and address	Quantity Supplied	Year of supply	Remarks

Signature : \_\_\_\_\_

Designation : \_\_\_\_\_

Name of Tenderer ; \_\_\_\_\_

Date : \_\_\_\_\_