EDMS 13-101-1

SPECIFICATION

FOR

DEADBREAK ELBOW 12/20 (24 kV)

(SCREENED SEPARABLE INSULATED CONNECTOR FOR XLPE-INSULATED CABLES)

Issue: Nov.-2021/ Rev- 1

- This revision contains option items that must be selected by EDC before bidding.

CONTENTS

1. SCOPE

This specification describes the minimum technical requirements for design, manufacturing, testing, inspection, packing, and delivery of deadbreak elbow connectors (screened separable insulated connectors). The required elbows are intended to suit 12/20 (24 kV) cables inside the medium voltage distribution networks of the Egyptian Electricity Distribution Companies (EDCs). This specification covers both (L-shape) and (T-shape) elbows. The required elbows are suitable to be used with XLPE-insulation power cables of different constructions:

- Three core and single core.
- Armored and non-armored.
- Copper and Aluminum conductors.
- Conductors of CSA up to 400 mm^2.
- The materials of the elbow shall be compatible with the materials of the cables.
- Unless otherwise specified by _ _ EDC, the elbow bushing is outside cone interface type (C1), bolted screw type of up to 630 A in compliance to EN 50181.

2. APPLICABLE STANDARDS

– The equipment/material covered in this specification shall comply with the latest edition/amendment of the standards given in Table (1). Where any provision of this specification differs from those of the standards listed below, the provisions of this specification shall apply. Any deviations from the listed standards or the provisions of this specification should be clearly set out in the offer.

Table (1)

Standard No.	Description
IEC 60502-2	Cables for rated voltages from 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)
IEC 60502-4	Test requirements on accessories for cables with rated voltages from 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)
IEC 61442	Test methods for accessories for power cables with rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (U_m = 36 kV)
IEC 60228	Conductors of insulated cables
IEC 60060	High-voltage test techniques
IEC 60230	Impulse tests on cables and their accessories
IEC 60885-3	Electrical test methods for electric cables Part 3: Test methods for partial discharge measurements on lengths of extruded power cables
IEC 62271-1	High-voltage switchgear and control-gear – Part1:Commonspecifications for alternating current switchgear and control gear
EN50180	Bushings above 1 kV up to 52 kV and from 250 A to 3.15 kA for liquid filled transformers
EN50181	Plug-in type bushings above 1 kV up to 52 kV and from 250 A to 2.50 kA for equipment other than liquid filled transformers
IEC 60137	Insulated bushings for alternating voltages above 1000 V

– This specification shall be read in conjunction with the latest revisions of the following EDMS specifications:

EDMS 03-400	Supply of under-ground three core medium voltage armored cables 12/20 kV and 18/30 kV
EDMS 15-300	Compression-type lugs for Cables up to 24 kV (Aluminum / Copper / Bimetallic)

3. ENVIRONMENTAL CONDITIONS

– The electrical and mechanical properties of the required materials should be guaranteed under the environmental conditions given in Table (2). Any differences in the guaranteed performance should be clearly set out in the offer.

Table (2)

Ambient temperature	-5°C to +45°C (50°C as option according to _ _ EDC)
Maximum relative humidity	Up to 95 %
Altitude	Up to 1000 m above sea-level

4. SYSTEM CHARACTERISTICS

– The required deadbreak elbow should have a safe electrical behavior for the electrical system given in Table (3).

– The elbow shall be suitable for use on cables having maximum conductor temperatures as normal operation 90 °C at normal conditions, and maximum conductor temperatures of the cables under short-circuit conditions is 250 °C.

Table (3)

Nominal voltage	11 kV
Highest system voltage	12 kV
Voltage designation of cables U_o/U (U_m) (*)	12/20 (24 kV)
Power frequency	50 Hz
Number of phases	Single-core or Three-core cables installed in three-phase system
Full-wave lightning impulse L1	75 kV
Maximum prospective Fault level	25 kA for one second

(*) U_o: is the rated power frequency voltage between conductor and earth or metal screen for which the cable is designed (phase voltage); U: is the rated power frequency voltage between conductors for which the cable is designed (line voltage); U_m: is the maximum value of the "highest system voltage" for which the equipment may be used.

5. DESIGN CRITERIA

- The separable connector housing of the elbow shall be factory molded in the shape that it will take when installed
- The molded layers of the elbow housing (the inner semi conductive layer, insulation layer, and semi conductive shield layer) shall be integrated during the molding injection processes. It shall be made of Ethylene Propylene Diene Monomer (EPDM) rubber (or other material has the same performance).
- Elbow housing and cable adaptor have integrated geometrical stress control, using of tapes or mastic paste for control/damping the electrical fields are not accepted.
- Elbow housing insulation thickness shall not be less than the cable insulation thickness.
- Elbow housing has semi conductive integrated faraday cage surrounding the elbow lug and connections area. The minimum thickness for this layer 3.0 mm.
- The minimum thickness at any point of the outer semi-conductive layer is 2.5 mm, painted outer semi-conductive layer is not accepted.
- The maximum surface resistance of elbow housing is 5 kΩ.
- The insulation thickness of the cable adaptor shall not less than 6 mm (unstretched - as applicable).
- Elbow lugs should be of the compression-type. Bolted lugs are not accepted.
- All the produced elbow housing shall be electrically tested in the factory.
- The Installation is performed by sliding the elbow housing and adaptor over a prepared cable and connected the cable lugs with the interfacing bushing by connecting stud.

- The use of heat is not a part of the installation procedure except the breakout and outer jacket tubes.
- The outer semi-conductive layer of the elbow housing shall be overlapped with cable adaptor semi-conductive layer by at least 10 mm.
- The supplier shall ensure that the preparation techniques of the medium-voltage elbow kits are adhering to accepted best industry practices, and international guidelines.
- The cross-sectional area of the copper-braid shall be at least equal to the effective cross-sectional area of the cable copper screen.

6. TESTING and INSPECTION

- All tests shall be carried out by and at the expense of the supplier in accordance to the latest relevant standard.
- _ _ EDC reserves the right to visit the factory during manufacture of any or all items covered by this specification, for inspection of material or witness of tests. Accordingly, the manufacturer shall give _ _ EDC testing schedule.

6.1 Type Tests:

- Type Testing should be made to demonstrate satisfactory performance characteristics according to the international standard to meet the intended application.
- It is not necessary to repeat the tests, once successfully completed, unless changes are made in the materials, design or manufacturing process which might affect the performance characteristics.

- Cables used for testing shall comply with IEC 60502-2.
- Accessories should be assembled in the manner specified by the manufacturer's instructions.
- Type tests should be done in an independent and approved testing laboratory.
- The type test sequences and requirements for screened deadbreak separable connectors should be conducted as given in Table (4).
- Tests should follow the method prescribed in IEC 61442. Furthermore, the test values should meet the requirements of table 14 of IEC 60502-4.
- The cable used for the type test shall be selected to follow the cross-sectional area prescribed in table 1 of IEC 60502-4.
- Range of approval of the Type test shall comply clause 7 of IEC 60502-4.
- To extend the approval range of the type test to smaller and/or larger conductor cross-sectional areas, additional tests shall be applied in accordance to table 11 of IEC 60502-4. However, to extend the compliance of separable connectors to larger conductor cross-sections, the test current shall be limited to the current rating of the bushing and the cable adaptor size.
- Type tests approved for a voltage class shall cover the same or all lower voltage classes. For example, type tests approved for voltage class 36 kV will cover the voltage classes 12 kV, 24 kV, and 36 kV.
- Tests no. 13 and 14 in Table (4) are applicable for elbow interfaces of type A or B only. No need to carry out these tests for elbow interfaces of type C or D.

Table (4) Test sequences and requirements for

Screened deadbreak separable connectors

(Reference: table 8 of IEC60502-4)

Tests [a]		Requirements	Test methods of IEC 61442	Test sequences (see Figure 4)			
				4.1	4.2	4.3	4.4
1	AC and DC voltage	AC for 5 min at 4,5 U_0 and d.c. for 15 min at 4 U_0	Clauses 4 and 5	x	x	x	
2	Partial discharge [b]	10 pC max. at 1,73 U_0	Clause 7	x			
3	Impulse at θ_t [c]	10 impulses of each polarity	Clause 6	x			
4	Thermal short-circuit (screen) [f]	Two short-circuits at I_{sc} of the cable screen. No visible deterioration	Clause 10		x	X [g]	
5	Thermal short-circuit (conductor)	Two short-circuits to raise conductor to θ_{sc} of the cable. No visible deterioration	Clause 11		x	X [g]	
6	Dynamic short-circuit [h]	One short-circuit at I_d. No visible deterioration	Clause 12			x	
7	Heating cycles in air	30 cycles[d] at θ_t[c] and 2,5 U_0[l]	Clause 9	x			
8	Heating cycles under water	30 cycles [d] at θ_t [c] and 2,5 U_0[l]	Clause 9	x			
9	Disconnect/connect [i]	Five times. No visible damage to contact	–	x	x	x	
10	Partial discharge[b] at θ_t[c, e] and ambient temperature	10 pC max. at 1,73 U_0	Clause 7	x			
11	Impulse	10 impulses of each polarity	Clause 6	x	x	x	
12	AC voltage	15 min at 2,5 U_0	Clause 4	x	x	x	

Tests [a]		Requirements	Test methods of IEC 61442	Test sequences (see Figure 4)			
13	Operating eye	Axial force 1 300 N for 1 min. Torque 14 N × m	Clause 19				x
14	Partial discharge [b]	10 pC max. at 1,73 U_0	Clause 7				x
15	Examination	For information only [m]	–	x	x	x	x
16	Screen resistance [j]	Maximum 5 000 Ω	Clause 15	Tests 16 to 20 are carried out on separate samples. For tests 16 and 19, no cable is required. For tests 17, 18 and 20, appropriate cable lengths are to be used			
17	Screen leakage current [j]	Maximum 0,5 mA at U_m	Clause 16				
18	Fault current initiation	See notes [j, k]	Clause 17				
19	Operating force	Force <900 N	Clause 18				
20	Capacitive test point	Capacitance of test point to cable conductor: C_{tc} > 1,0 pF Ratio of capacitance of test point to earth C_{te} and capacitance of test point to cable conductor C_{tc}: $C_{te}/C_{tc} \leq 12,0$	Clause 20				

[a] Unless otherwise specified, tests shall be carried out at ambient temperature.

[b] Not required for accessories installed on 3,6/6 (7,2) kV cables having unscreened insulation.

[c] θ_t is the maximum cable conductor temperature in normal operation +5 K to 10 K.

[d] 8 h total with ≥2 h steady and ≥3 h cooling.

[e] Measurement is made at the end of the heating period.

[f] This test applies only to separable connectors that are equipped with a connection to, or adaptor for, the metallic screen of the cable.

[g] Thermal short-circuit may be combined with the dynamic short-circuit.

[h] Only required for single-core cable accessories designed for initial peak currents I_p > 80 kA and three-core accessories designed for I_p > 63 kA. Value of I_d shall be declared by the manufacturer.

[i] The test shall be carried out only when the cable is de-energized.

[j] The test is required for separable connectors without a metallic housing or with a removable metallic housing. The metallic housing shall be removed prior to the test. This test is not required for separable connectors which can only be used in service with the metallic housing in position.

[k] For solidly earthed systems, the fault initiation shall occur within 3 s. For unearthed or impedance earthed systems, the fault current shall flow continuously.

[l] Current, see Table 1.

[m] It is advised that the accessory is examined for signs of any of the following:

(i) cracking in the filling media and/or tape or tube components; and/or

(ii) a moisture path across a primary seal; and/or

(iii) corrosion and/or tracking and/or erosion; and/or

(iv) leakage of any insulating material.

6.2 Routine Tests:

– Tests made by the manufacturer on each finished product or components of accessories in the manufacturer facility to check that each product/ component meets the specified requirements.

System Voltage (U_m)	Partial discharge (corona) voltage test discharge magnitude (<10 pC) The values of tests as per IEC 60502-4	AC withstand voltage (5 minute) The values of tests as per IEC 60502-2
12 kV	20 kV	42 kV

7. PACKING and MARKING

7.1 Packing

– Packing should be robust and able to withstand very rough handling during transportation. It should be protected against ingress of moisture.

– Each kit should be supplied with a packing note stating the quantities and descriptions of components contained in the kit. The following document should be attached inside each kit:

Elbow Instructions of installation (Arabic and English) for the offered accessories which must include the steps of installation, the number of dies, detailed drawing of the lugs explaining the number & sequence of crimping and the width of each crimping, (Each crimping should be hexagonal).

- **Kit Components**: The kit of the elbow should include but not limited for the following items:
  - Elbow housing “The main insulation part”.
  - Cable adaptor (as applicable).
  - Compression lug.
  - Insulated Plug “As applicable”.
  - Insulation plug Cap “As applicable”.
  - Connection Stud, to connect the cable lugs with the busing interface.
  - Outer jacket Heat shrinkable tube.
  - Earthing connection for both of elbow housing and cable screen.

7.2 Marking

- The components of the Separable connector kit should be distinctly and clearly marked with the manufacturer's name.
- All components should be capable of being stored without deterioration within the temperature range of -5ºC to +45ºC (+50 ºC as option). Components or materials, if subjected to a shelf-life limitation, should have the final date of use prominently and permanently shown on all packages.
- The elbow housing (main insulation part) must be marked with the following data:

  1. Manufacturer name.
  2. Production indicator for traceability.
  3. Cross-section, diameter, or application range should be marked.
- Packaging as well for each cable accessory should be printed with the following information:

1. Manufacturer's name.
2. Manufacturer’s Type.
3. Cable size or cable diameter.
4. Nominal Voltage.
5. Year of manufacturing.
6. Manufacturer’s batch No. or any tracing no.
7. Shipping Mark Guide.

8. GUARANTEE

– The supplier guarantee the supplied materials against all defects arising out of faulty design or workmanship, or of defective material for a period of two years at least from date of delivery.

9. TRAINING

– The manufacturer / supplier shall provide a sufficient on-site training to _ _EDC teams for free on the installations and commissioning works. The elbow product should be installed using the proper tools recommended by the manufacturer.

10. AFTER-SALES SERVICE

– Upon _ _ EDC request, the supplier is obligated to deliver as soon as possible all services, spare parts, materials and accessories required during the after-sales maintenance.

11. SUBMITTALS

11.1 Submittals required with tender:

– The supplier shall complete and return one copy of the attached Data Schedule.
– Technical data and original catalogues shall be submitted with the offer.

- Specimen (option item according to _ _ EDC requirement)
  One specimen of the offered elbow shall be submitted with the offer for evaluation prior to issuance of the purchase order. The specimen should correspond in all respects with the material they intend to supply. Dimensional verification, indelible markings and finishing shall be checked.
- All necessary drawings including layout, dimensions, should be submitted with the offer.
- Details of the packing method and list of the kit components should be submitted with the offer.
- A valid approval certificate issued by Egyptian Electricity Holding Company.
- Copy of type test reports.
- List of deviations and clauses to which exception is taken (if any).

11.2 Submittals required following award of contract:

- Details of manufacturing and testing schedules
- Routine test reports
- The supplier should provide all the instructions of use/storing in (Arabic and English).

12. TECHNICAL DATA SCHEDULE

- The tenderer must fill in thoroughly the attached technical data schedule.
- Any offer does not accompanied with clear and complete technical data schedule shall be rejected.
- The attached schedule of deviations from this specification should be filled and signed by the tenderer. If there are no deviations or reservations, this should be explicitly stated in this schedule.

Technical Data Schedule
Separable Connector, Pre-Molded, ____×_____ mm^2, _____kV

Item	Description	Vendor Specifications
1	Type---------- Catalogue no----------	---------- ----------
2	Name of manufacturer ----------	----------
3	Max. Design voltage ---------- kV	----------
4	Period for which this accessory has been supplied for Service conditions similar to Egypt------- years	----------
5	Average splicing time----------hrs	----------
	1-Compression lugs, with seal against moisture:- - Material composition (Cu %)/(Al %) - No of compressions.---------- - Total length ----------mm - Plate hole of lug(Diam.) ----------mm - Conductor hole (lug inner diam.)---------- mm 2-Adaptor:- - Number of adaptors - application range-------mm 3-Breakout (spreader cap) :-Dims in------mm - Total Length /inner diam., for cable side /inner diam., lug -Inner diam. /thickness for cable side after free shrink ----------mm/mm -Inner diam./thick ness for Lug side after free shrink ----------mm/mm 4- Copper earthing braids: - Material composition and weight ---------- gm -Total length / cross-sectional area ------ mm / mm^2 5- outer jacketing tubes (If any) length / inner diameters supplied----------mm/mm	---------- ----------
7	Any special tool required----------	----------
8	Any special accessories required	----------
9	Type/Quantity of cleaning solvent----------	----------
10	Length of tin wire solder with flux----------cm.	----------
11	Weight of silicon grease----------gm.	----------
12	Binding tapes: A- PVC tapes: -Length /thickness--------m/mm	---------- ----------

13	Mastic pastes:- type/ number/ length each	----------
14	Any other tape: type, length----------	----------
15	Attach details on rated short circuit current capacity:- a) Copper mesh or Braid b) Amour c) Bonded mesh or Braid with armour	---------- ---------- ----------
16	Copy of works routine test reports and if requested by …..EDC also batch / type test reports on the kits being supplied	---------- ---------- ----------
17	Confirm that visual inspection and routine tests shall be carried out on each kit----------	Yes / No
18	Confirm compliance to the appropriate requirements of clause 5 ----------	Yes / No
19	Marking and packing: - a) Marking as per clause 7.2 ---------- b) Packing as per clause 7.1 ---------- c) Each kit with components shall be complete in itself and separately packed---------- d) Detailed packing list are submitted	Yes /No Yes /No Yes /No Submitted / not submitted
20	Guarantee confirm compliance to clause 8 ----	Yes /No
21	For direct technical clarification from the manufacturer Submit the details mentioned below of the persons responsible:- Name :---------- Designation :---------- Address :---------- Telephone :---------- FAX :----------	---------- ---------- ---------- ---------- ----------

Schedule of deviations from this specification

Item Number On tender	Precise details of minor deviations Included in the offer.

We guarantee the data given above for the offered insulator to …...EDC.

Signature: …… Date: ……