KINGDOM OF CAMBODIA

Nation Religion King

ELECTRICITE DU CAMBODGE

TECHNICAL RULE

EDC-TR-010

ELECTRICAL TESTS FOR LV UNDERGROUND CABLE

(Delivery, Commissioning and Fault Location)

July 2024

ELECTRICITE DU CAMBODGE

Version	Date	Technical Specification Name	Authorized by : (name and signature)
1.0	July, 2024	Electrical Tests for LV Underground Cable (Delivery, Commissioning and Fault Location)	AUN HEMRITH

Version	Drafted/reviewed by	Verified by	Approved by	Date
Draft1	AD			04/2023

Content

[Blank]

Electrical Tests for LV Underground Cable

(Delivery, Commissioning and Fault Location)

1 Scope of Application

This document defines the electrical tests to be carried out:

- At cable delivery for LV cable acceptance
- On newly installed LV underground cables for commissioning and acceptance of the cable.
- On existing LV cables fault Location

2 Safety

Necessary safety procedures are not mentioned and taken into consideration in this document.

It is of the testing staff and network operation staff own responsibility to apply those safety procedure on site for their own as well as for the safety of other persons.

Position "LV Test in Progress" signs at all ends of the LV cable prior to testing.

Where public access is possible, position Safety Observer and barricade exposed ends of cable during insulation test.

3 Testing staff

The staff must perfectly know the testing equipment, apparatuses and testing procedures.

4 Testing equipment

The testing equipment is constituted of:

- 1KV insulation resistance tester (2.5 kV insulation tester could be used but Maximum voltage to be applied shall be strictly limited to 1 kV),
- Reflectomer,
- Hi pot (thumping) equipment with voltage limited to 1.5 kV

The equipment and all accessories (e.g. connecting leads, etc...) must be in perfect status and being yearly checked by the manufacturer.

Similar functions that are incorporated in UGC fault Location vans can be used. Some vans includes cable outer sheath specific apparatus. This one will be used because it allow testing and also location of eventual damage to the cable outer sheath.

VLF tests are not applicable to LV cables. They are reserved to MV and HV cables

In all cases, the testing team shall be trained by the equipment manufacturer for carrying out such testing on new cable (as well as for fault location).

5 Testing at cable delivery

The tests carried out at delivery of cable drums are:

- Visual inspection
- Insulation resistance test (DC: 1kV & 1min)
- Conductor resistance (Neutral & phases)

5.1 Visual inspection

The cable characteristics (cable type, manufacturer, cross section, etc....) shall be verified according the cable order.

Cables Drums and cables shall be inspected in order to notice if those were chocked of deformed.

5.2 Insulation resistance test

The insulation resistance test shall be carried out using insulation resistance tester with a **maximum DC voltage of 1kV during 1 minute maximum.**

The test is considered a successful if and only if all measurement between conductors are almost the same.

Values are recorded in a data base taking into account brand, section, and drum reference of number.

5.3 Conductor resistance

The conductor resistance is measured with a micro ohm meter (max DC voltage 1kV).

Measures values are compared with the cable manufactured ones.

The resistance values of phases must be almost the same for the considered cable.

As above, values are recorded in a data base.

Values are recorded in a data base.

6 LV cable commissioning and acceptance tests

The tests are carried out **on fully installed LV underground cables**. This means that all connecting accessories must be properly installed on the cable. So that cable and connecting accessories are tested.

6.1 Cable Characteristics

In all cases, the cable characteristics (cable type, manufacturer, cross section, etc....) mentioned on the cable outer sheath are verified and recorded.

6.2 Testing order

The testing order is as followed:

1. Outer sheath test integrity
2. Insulation resistance
3. Verification of connections

6.2.1 Outer sheath test integrity

An outer sheath integrity test at a voltage of 1000V DC applied for 1 minute is carried out with an insulation resistance tester, **between the Metallic Screen and armour and earth**. This will identify if there has been any damage to the sheath during installation.

It is to be noticed that using a specific outer sheath testing equipment is more convenient because this tester is specifically design for such task and for most of them, allow location of damaged outer sheath (in case of).

The metallic screen and armour shall be isolated from earth at both ends of the cable to be tested.

Results: If no flash over occurs and if the outer sheath resistance test is:

Outer sheath	New cable
ST2 or ST7	≥ 1.0 MΩ (*)

(*): IEC 60364-6

The test is considered as passed.

It is to be noted that the resistance value varies according cable temperature.

It should be remembered that the minimum sheath resistance figure is determined against an ambient temperature of 20°C and any difference in this upon testing will require correction factors to be applied.

Measures values are recorded.

6.2.2 Insulation resistance test

An insulation resistance test at a voltage of 1000V DC (maximum) applied for 1 minute maximum is carried out with an insulation resistance tester, **between all cores**.

Results: the test is considered as passed if no flash over occurs and if measured values are:

Length of Cable (m)	**Minimum Acceptable Insulation Resistance Value (MΩ)** IEEE 525
60	8
100	5
150	3.2
200	2.3
300	1.6

It is to be noted that the resistance value varies according cable temperature and cable length.

In some cases, lower insulation resistance values are acceptable provided that the cable under test can withstand the recommended test voltage.

Given values are standard values so it is always fruitful to get insulation data (resistance/ km) from manufacturer.

7 Tests during fault location

As soon as the LV cable faulty section is identified thanks an Ohm meter connected successively between all cores, the following tests are carried out:

- Insulation test in order to verify the faulty cores
- ARM Reflectomer test for pre-localisation of the fault
- Cable path determination
- Thumping (pulses) for exact fault localisation

7.1 Insulation test for determination of the kind of fault

This test is carried out as mentioned above for identifying the faulty conductor(s). Measurement shall be done also between cores and metallic screen and armour and also between this metallic screen and armour and earth.

7.2 Fault Pre-localisation, Reflectomer test

Specific light and portable reflectomers with arc reflexion method for LV cables are available. They should be preferred than ARM reflectometers used for pre localisation of MV cable fault. Nevertheless MV ARM reflectometer can be used.

This test, according the curve on the screen allow to pre-locate the faulty part of the cable. Measure of distance between the end of the cable and the fault is of upmost importance.

7.3 Determination of the cable path

It is mandatory to know exactly the path of the LV cable especially in case of absence of soil surface path identification with small markings.

Specific equipment using acoustic frequencies with emitter and receptor are available and need to be used for determining the cable path inside the ground. For some of them and depending of the kind of fault, it is also possible to precisely locate the exact location of the fault.

7.4 Thumping test

In case the faulty part is not located using cable path equipment, this test send chocks in the cable in order to locate precisely the fault.

Specific equipment with an adjustable thumping voltage that not exceed 1.5 kV is available. This one if of small volume and small weight.

The increase in Voltage shall be stopped as soon as the thumping start.
In all cases, the thumping voltage shall not exceed 1kV and be limited in time. For that purpose one operator turn on the thumping system ONLY when another one is ready to "listen" the thumping at the pre-located site. They must communicate between them because the cable thumping MUST be stopped as soon the fault is located by the second operator.

Low Voltage Cable Testing at Delivery
TEST REPORT

Date:	Location:	Temperature:

Manufacturer Name:	Supplier Name:
Contract Reference:	Contract date:
Type of LV cable:	Year of manufacturing:
Routine test supplied: YES: □ NO: □	

I: VISUAL INSPECTION and DIMENSIONS

Item	A: Drums	Findings	Result
1	Drums reference	(Listing to be attached)	
2	Drums Status		
3	Length of LV cable per drum		
Item	**B:Cable**	**Findings**	**Result**
4	Cable cross sections		
5	Cable marking as per technical specification	YES □ NO □	
6	Cable ends suitably protected against water penetration	YES □ NO □	
7	Cable average diameter (mm)		
8	Four insulated cores	YES □ NO □	
9	Filler	YES □ NO □	
10	Inner covering	YES □ NO □	
11	Armour made of 2 galvanized steel tapes of each 0.5mm thickness	YES □ NO □	
12	Outer sheath of black colour	YES □ NO □	
Item	**C: Conductors**	**Findings**	**Result**
13	Core material for Phase / neutral	/	
14	Circular core shape for Phases and Neutral	YES □ NO □	
15	Neutral conductor diameter (mm)		
16	Phase conductors diameter (mm)		
17	Neutral number of wires and wires diameter (mm)		
18	Phases number of wires and wires diameter (mm)		
19	Cores insulation material (XLPE required)		
20	Thickness of Neutral conductor insulation (mm)		
21	Thickness of Phase conductors insulation (mm)		
22	Core marking/coloured	Neutral: Black □ Phases: Red + Yellow + Blue □	
23	Core marking type	Full Mass coloured □ Band mass coloured □	

II. INSULATION RESISTANCE TEST
DC VOLTAGE: 1kV /1 minute

Brand/model of test device:			Serial Number:		
Phase A/Phase B	MΩ	Phase B/Phase C	MΩ	Phase A / Armour	MΩ
Phase A/Phase C	MΩ	Phase B/Neutral	MΩ	Phase B / Armour	MΩ
Phase A/Neutral	MΩ	Phase C/Neutral	MΩ	Phase C / Armour	MΩ
Test Result: Not less than 100 MΩ:			**Passed** □		**Failed:** □

III. CONDUCTOR RESISTANCE TEST

Brand/model of test device:		Serial Number:		
Resistance of Neutral conductor Value	Ω			**Passed** □
Resistance of Phase conductors Values	A: Ω	B: Ω	C: Ω	**Failed:** □

RESPONSIBILITY	TESTED BY				WITNESS BY
Company					
Name					
Signature					
Date					

Low Voltage Cable Testing after Installation for Commissioning
TEST REPORT

Date:		
Manufacturer Name:		Contractor Name:
Type of LV cable:		Year of manufacturing:
Cable marking:		
Exact cable Location:		

I: VISUAL INSPECTION

Item		Findings	Result
1	Length of underground cable (m):		
2	Depth of burying (m) to be checked on site:		
3	Cable ends suitably protected against water penetration if not connected	YES ☐ NO ☐	
4	Heat shrinkable gloves and tubes properly installed:	YES ☐ NO ☐	
5	Map of cable path supplied:	YES ☐ NO ☐	

II: OUTER SHEATH INTEGRITY TEST
DC VOLTAGE: 1kV /1 minute or Specific testing apparatus

Brand/model of test device:	Serial Number:	
Between armour tapes and Earth (Soil)	MΩ	
Test Result: Not less than 1 MΩ:	**Passed** ☐	**Failed:** ☐

II. INSULATION RESISTANCE TEST
DC VOLTAGE: 1kV /1 minute

Brand/model of test device:			Serial Number:		
Phase A/Phase B	MΩ	Phase B/Phase C	MΩ	Phase A / Armour	MΩ
Phase A/Phase C	MΩ	Phase B/Neutral	MΩ	Phase B / Armour	MΩ
Phase A/Neutral	MΩ	Phase C/Neutral	MΩ	Phase C / Armour	MΩ

Test Result:

Length of Cable (m)	Acceptable Insulation Resistance Value between cores (MΩ) IEEE 525
60	8
100	5
150	3.2
200	2.3
300	1.6

⚠ **the insulation resistance value varies according cable temperature and cable length**

Passed ☐ **Failed:** ☐

III. VERIFICATION OF CONNEXIONS

Phasing (colours) in accordance for each cable section	YES ☐ NO ☐
Lugs/sleeves of the right cross section	YES ☐ NO ☐
Connectors properly tightened	YES ☐ NO ☐
Conductors properly arranged before connexion to terminals	YES ☐ NO ☐

The LV cable can be energized: YES ☐ NO ☐

RESPONSIBILITY	**TESTED BY**			**WITNESS BY**
Company				
Name				
Signature				
Date				

Low Voltage Cable Fault Location
REPORT

Date:		
Manufacturer Name:	Year of manufacturing:	
Type of LV cable:		
Cable marking:		
Exact cable Location:		

I: DETERMINATION OF KIND OF FAULT by INSULATION RESISTANCE TEST
DC VOLTAGE: 1kV /1 minute

Brand/model of test device:				Serial Number:	
Phase A/Phase B	Ω	Phase B/Phase C	Ω	Phase A / Armour	Ω
Phase A/Phase C	Ω	Phase B/Neutral	Ω	Phase B / Armour	Ω
Phase A/Neutral	Ω	Phase C/Neutral	Ω	Phase C / Armour	Ω
Armour/earth	Ω				
Conclusion:					

II: PRELOCALISATION OF FAULT (Reflectometer)

Brand/model of test device:	Serial Number:	
Use of Arc reflection method (ARM)	YES ☐	NO ☐
Estimated distance (m)		

III: DETERMINATION OF CABLE PATH

Brand/model of test device:	Serial Number:	
Determination of cable path done?	YES ☐	NO ☐
Fault location finding during determination of cable path	YES ☐	NO ☐

IV: FAULT LOCATION (thumping)

Brand/model of test device:	Serial Number:
Thumping starting voltage (V)	
Maximum voltage applied (V)	

V. INSULATION RESISTANCE TEST AFTER CABLE REPAIR
DC VOLTAGE: 1kV /1 minute

Brand/model of test device:				Serial Number:	
Phase A/Phase B	MΩ	Phase B/Phase C	MΩ	Phase A / Armour	MΩ
Phase A/Phase C	MΩ	Phase B/Neutral	MΩ	Phase B / Armour	MΩ
Phase A/Neutral	MΩ	Phase C/Neutral	MΩ	Phase C / Armour	MΩ

Test Result:

Length of Cable (m)	Acceptable Insulation Resistance Value between cores (MΩ) IEEE 525
60	8
100	5
150	3.2
200	2.3
300	1.6

⚠ **the insulation resistance value varies according cable temperature and cable length**

The LV cable can be energized again: YES ☐ NO ☐

RESPONSIBILITY	TESTED BY			WITNESS BY
Company				
Name				
Signature				
Date				