



KINGDOM OF CAMBODIA

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ELECTRICITE DU CAMBODGE

ANNEX of TECHNICAL POLICY

EDC-TP-002-TDS

Technical Data Sheets

**EARTHINGS for MV and LV Distribution
Networks**

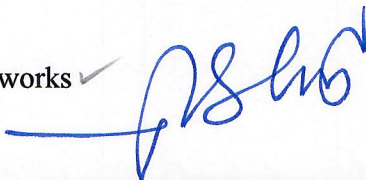
VERSION 2: July 2021

007 L2





ELECTRICITE DU CAMBODGE

Version	Date	Technical Specification Name	Authorized by : (name and signature)
1.0	November, 2017	Technical Data Sheets Earthing for MV and LV distribution networks	
2.0	January, 2022	Technical Data Sheets Earthing for MV and LV distribution networks ✓	

Dr. Praing Chulasa



Version	Drafted/reviewed by	Verified by	Approved by	Date
Draft1	AD			
Draft 2	EDC/AD			August 2018
Draft 3	EDC/AD			December 2018
Version 2	EDC/AD			July 2021

Version 2: July 2021

Modification from V1 December 2018

TDS 10.a and TDS 11 are cancelled

Le 00/01/21

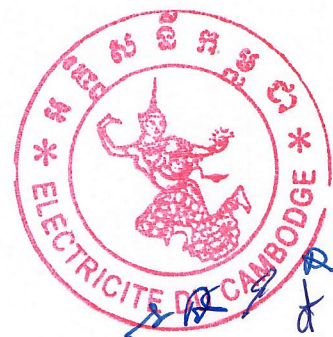


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EDC-TP-002	Ohmic value of earthing and periodicity of controls	TDS N°1.1
Technical data sheets	HV/MV and MV/MV Substations	December 2018

1.1.1 HV/MV Substations

HV/MV SUBSTATIONS		
	Maximal value	Checking of value
Mass earthing of the whole substation	1 Ω	Every year

1.1.2 MV Reflexion point Substations

Depending on their final destination, the MV reflexion point (dispatcher stations) are handled:

- either in HV/MV substation logic (see above)
- either in an MV/LV substation logic (see below)



EDC-TP-002	Ohmic value of earthing and periodicity of controls	TDS N°1.2
Technical data sheets	MV/LV Indoor Substations, PTT, RMU cabinet, and OPS	December 2018

Legend:

LBE = loop at the bottom of excavation EB = equipotential Belt

Notes: 1. the values in the tables in this sheet are maximum values; 2. Substation integrated to buildings does not have an equipotential belt

Area	Type of earthing	Earthing value (22kV phase/earth current limited to 800 Amperes)
Urban and peri-urban areas		
- with MV masses earthing and LV neutral earthing interconnected after realization		
Before connection	LBE + EB (Masses)	Not mention if full urban area with full MV underground network (10Ω in peri-urban area)
	Global value of LV neutral earthing	5Ω or less
After connection	Global earthing (Mass + LV neutral)	1Ω or less
Peri-urban areas and rural areas		
- with separated MV masses earthing and LV neutral earthing after realization		
	MV masses earthing	10 Ω with LBE and EB
	Global LV neutral earthing	5 Ω or less

Periodicity of controls: every 5 years at least

Types of checking carried out:

- Urban and peri-urban areas with full MV underground network: Verification of links (continuity, connections);
- Peri-urban with interconnection of the earthing connections: measurement of the value of the earth connection of the interconnected system, if this type of measurement is physically possible taking into account the environment of the structure, and verification of the links (continuity, connections);
- Peri-urban or rural areas with separation of the earthings (MV masses and LV neutral): measurement of earthing value of the MV masses, the global earthing of the LV neutral and the coupling coefficient of the first grounding of the LV neutral with grounding of MV masses.



EDC-TP-002	Ohmic value of earthing and Periodicity of controls	TDS N°1.3
Technical data sheets	Other MV equipment	December 2018

Equipment	Max Ohmic value	Periodicity of control
Metallic pole	100	No
Load Break switch	10	5 years
Recloser	10	5 years
AVR	10	5 years
Pole mounted substation	10	5 years



EDC-TP-002	Separated MV mass and LV neutral earthings	TDS N°2
Technical data sheets	Distance between earthings to be respected	January 2018








When the earthing of the MV masses and LV neutral are not connected together, the distances to be respected between those earthings are given in the table below.

Minimal distance between MV mass earthing and any LV neutral earthing	
Soil resistivity ρ	Minimum distance (with 22kV MV neutral impedance limiting the fault current to about 800A)
$\rho < 300 \Omega.m$	25 m
$300 \Omega.m < \rho < 500 \Omega.m$	50 m
$500 \Omega.m < \rho < 1000 \Omega.m$	75 m
$\rho > 1000 \Omega.m$	To be studied case by case



EDC-TP-002		TDS N°3
Technical data sheets	Forms of earthings	December 2018

Flow of fault currents

Soil resistivity	Loop at bottom of excavation		Rod	Net or grid	Folded conductors (serpentine)			Multidirectional
								
	2 m perimeter	10 m perimeter	3 m	2m x 0.4m 0.8 m deep	10 m in trench 3m	2x10m in 2 trenches 3m	2x15m in 2 trenches 5m	3 rectilinear branches of 10 m + 1 central injection point (from 3 to 5m)
50 Ω.m	30 Ω	8 Ω	17 Ω	12 Ω	12 Ω	7 Ω	5 Ω	3 Ω
100 Ω.m	60 Ω	17 Ω	34 Ω	25 Ω	25 Ω	14 Ω	10 Ω	6 Ω
200 Ω.m	120 Ω	34 Ω	66 Ω	50 Ω	50 Ω	28 Ω	20 Ω	12 Ω
300 Ω.m		50 Ω	100 Ω	75 Ω	75 Ω	42 Ω	30 Ω	18 Ω
400 Ω.m		66 Ω	133 Ω	100 Ω	100 Ω	56 Ω	40 Ω	24 Ω
500 Ω.m				125 Ω	125 Ω	70 Ω	50 Ω	30 Ω
750 Ω.m						105 Ω	75 Ω	45 Ω
1000 Ω.m							100 Ω	60 Ω

Expected grounding values based on soil resistivity and shape



Efficient only at 50 Hz

Efficient at 50 Hz and high frequency currents (Surges)

Flow of impulse fault currents (atmospheric, surge ..)

The shape of the grounding is preponderant in its ability to flow surge currents; in the current state of knowledge, an earthing formed by a crow's foot on the surface (3 straight strands, associated or not with nets, 5 to 10 m maximum) associated with a central injection point (rod of 3 to 5 m) allows the flow in good conditions of the atmospheric currents.

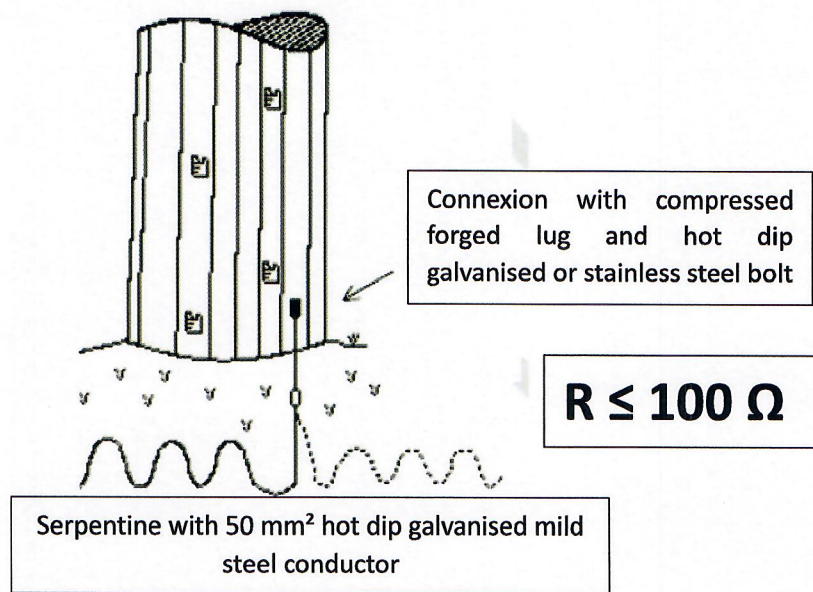
A multi-directional surface earth should first be investigated and then, if necessary, lengthened conductors or nets to obtain the necessary ohmic value.

This is the mass earthing form to be used in case of surge arresters

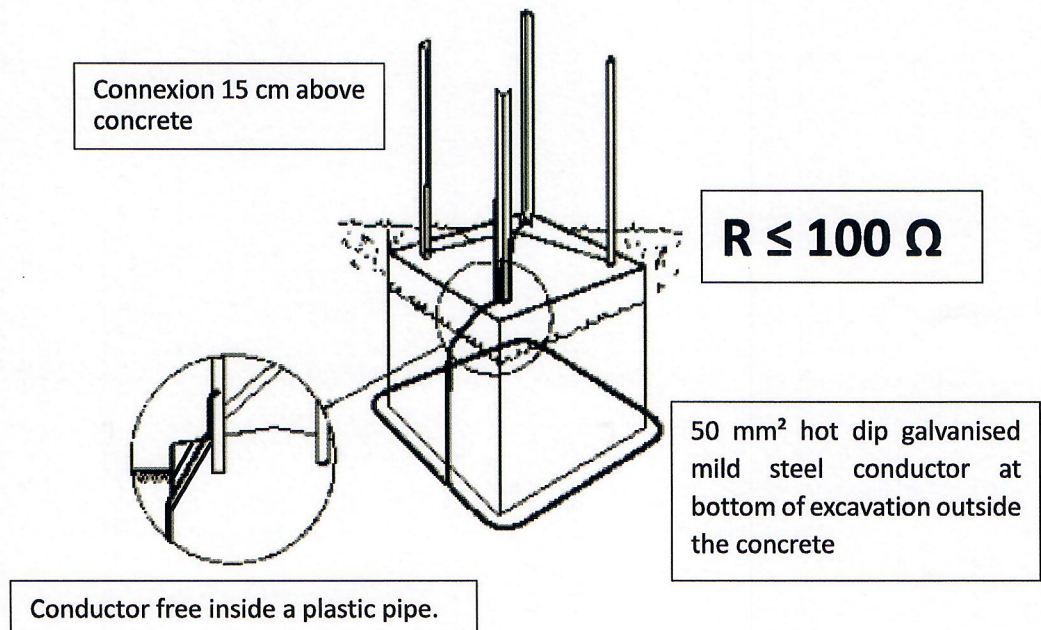


EDC-TP-002		TDS N°4
Technical data sheets	Earthings of a MV metallic tubular pole or steel tower	December 2018

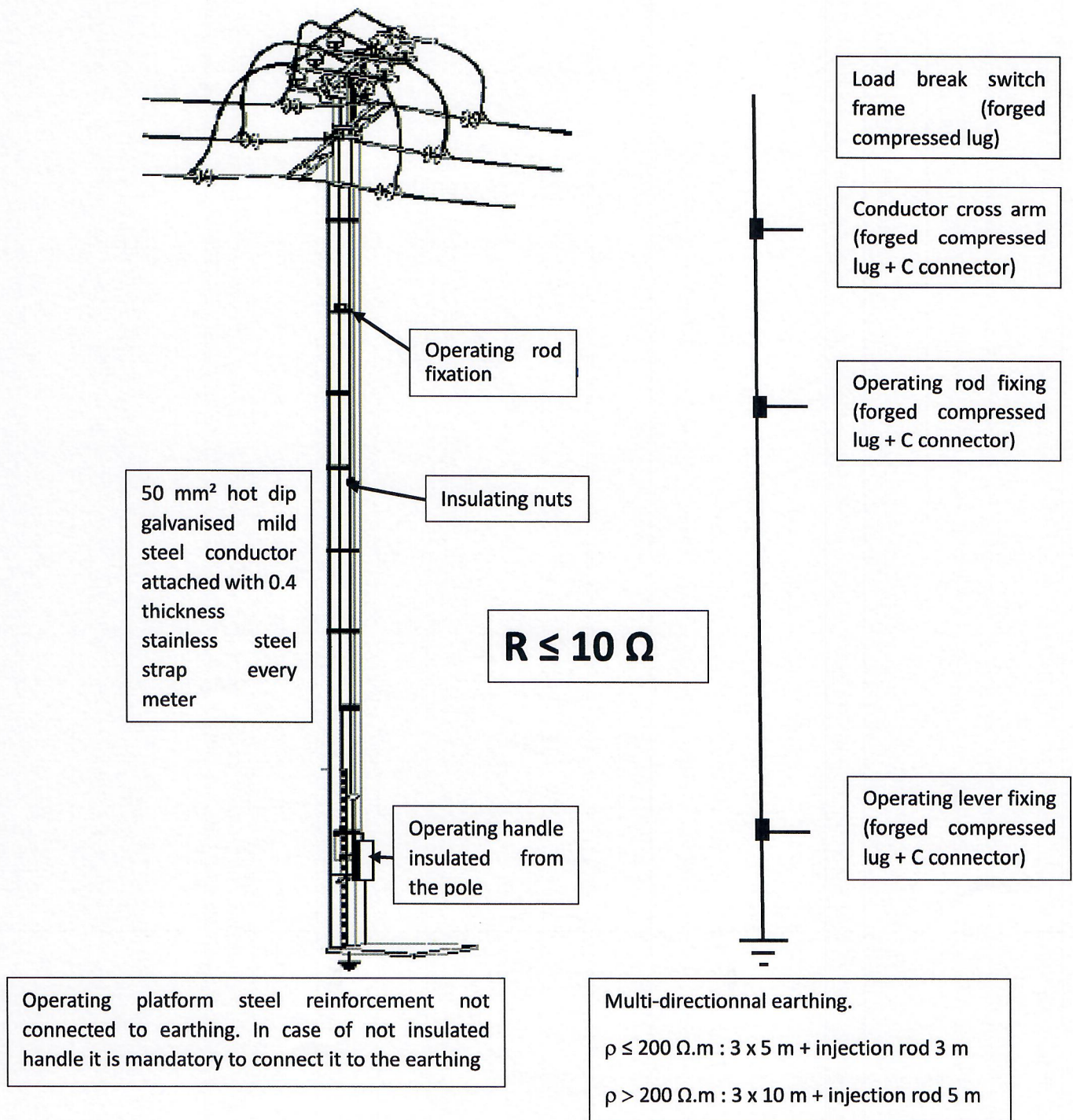
Tubular metallic pole



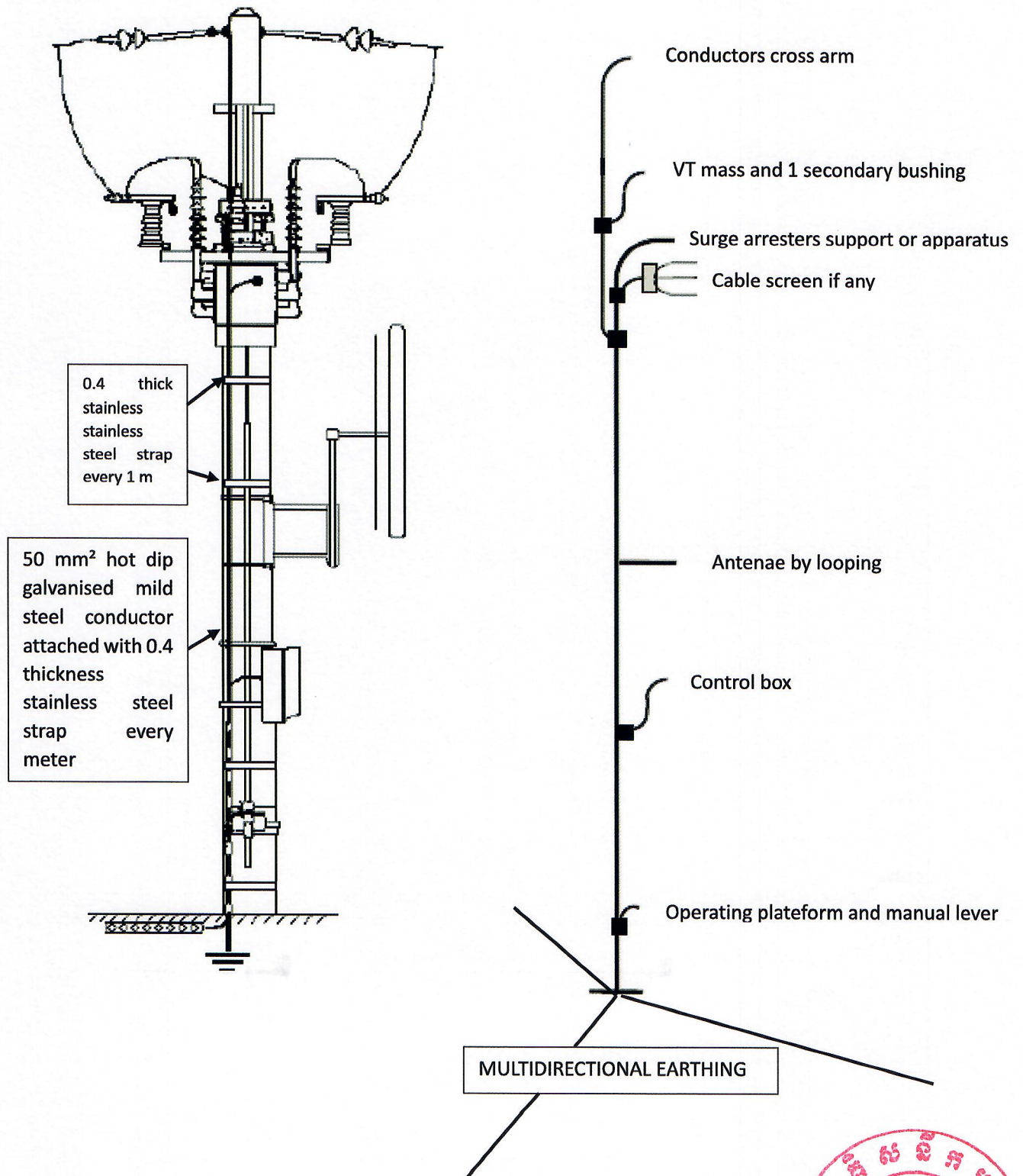
Steel tower



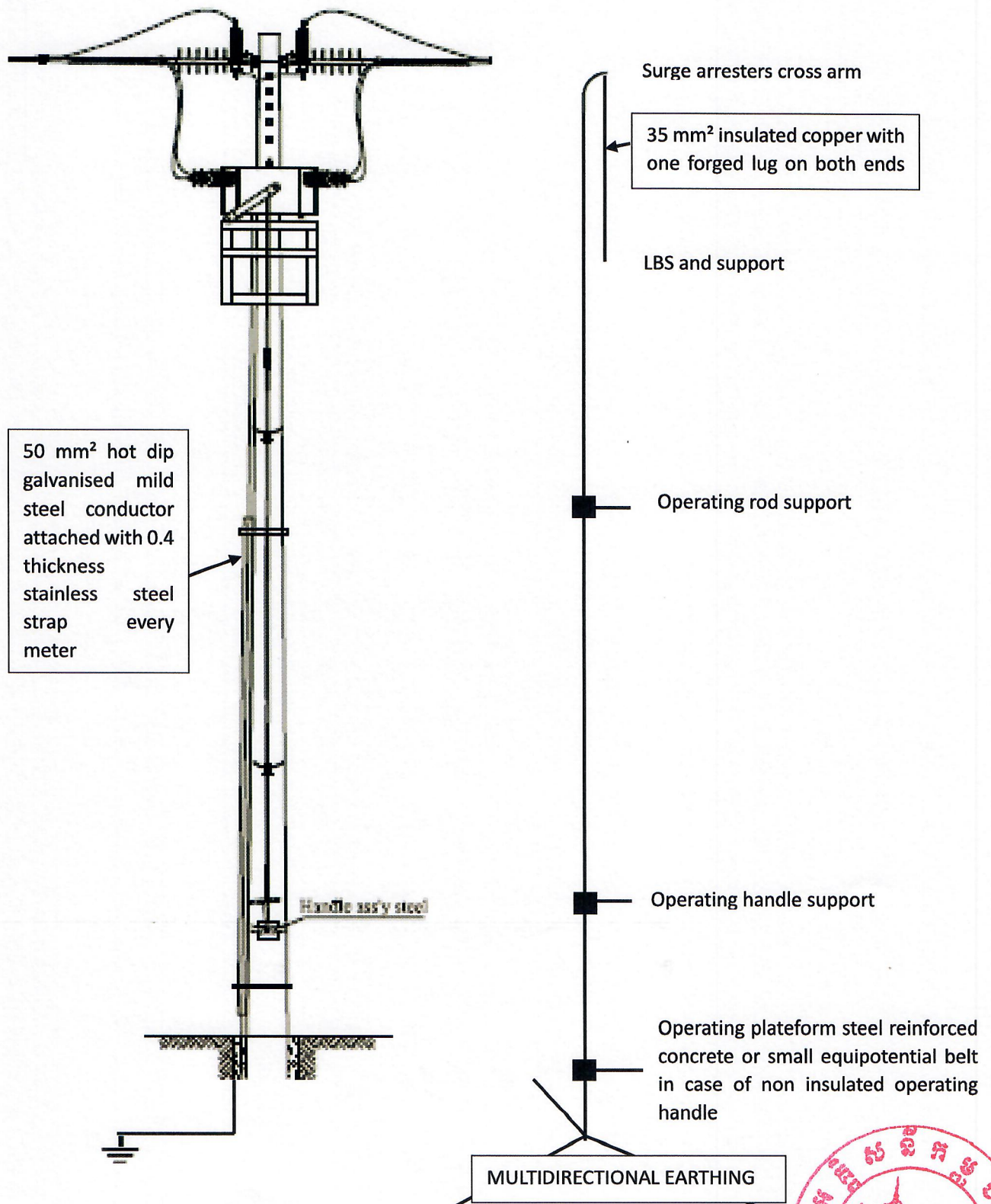
EDC-TP-002	Earthings of:	TDS N°5
Technical data sheets	manually operated pole mounted load break switch	December 2018



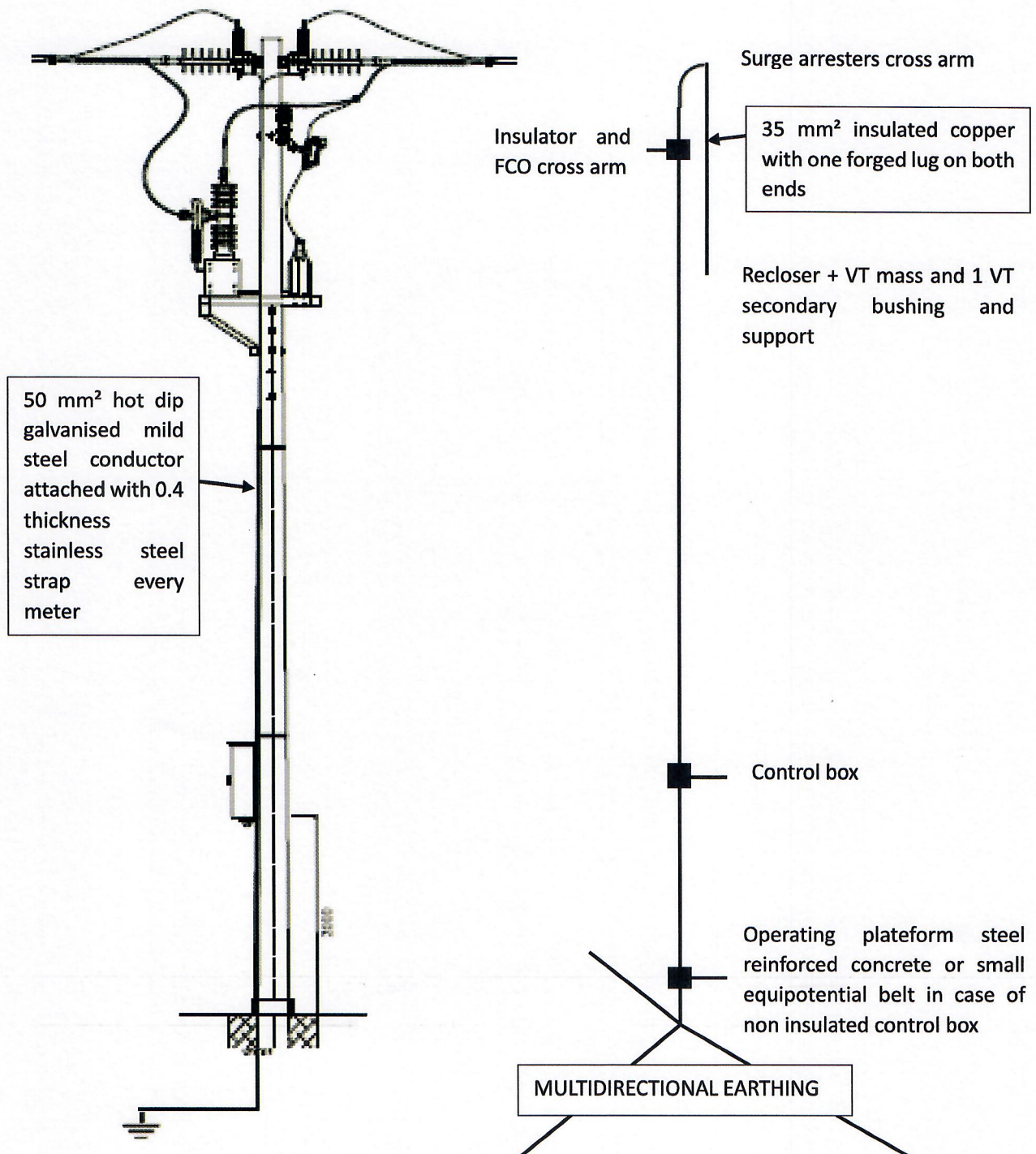
EDC-TP-002	Earthings of	TDS N°6
Technical data sheets	Remote controlled pole mounted load break switch and Recloser with surge arresters fixed onto the apparatus	December 2018



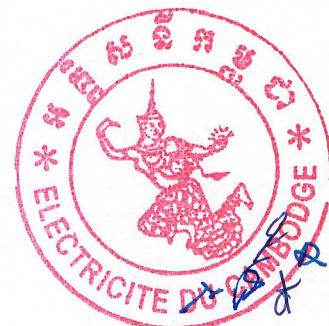
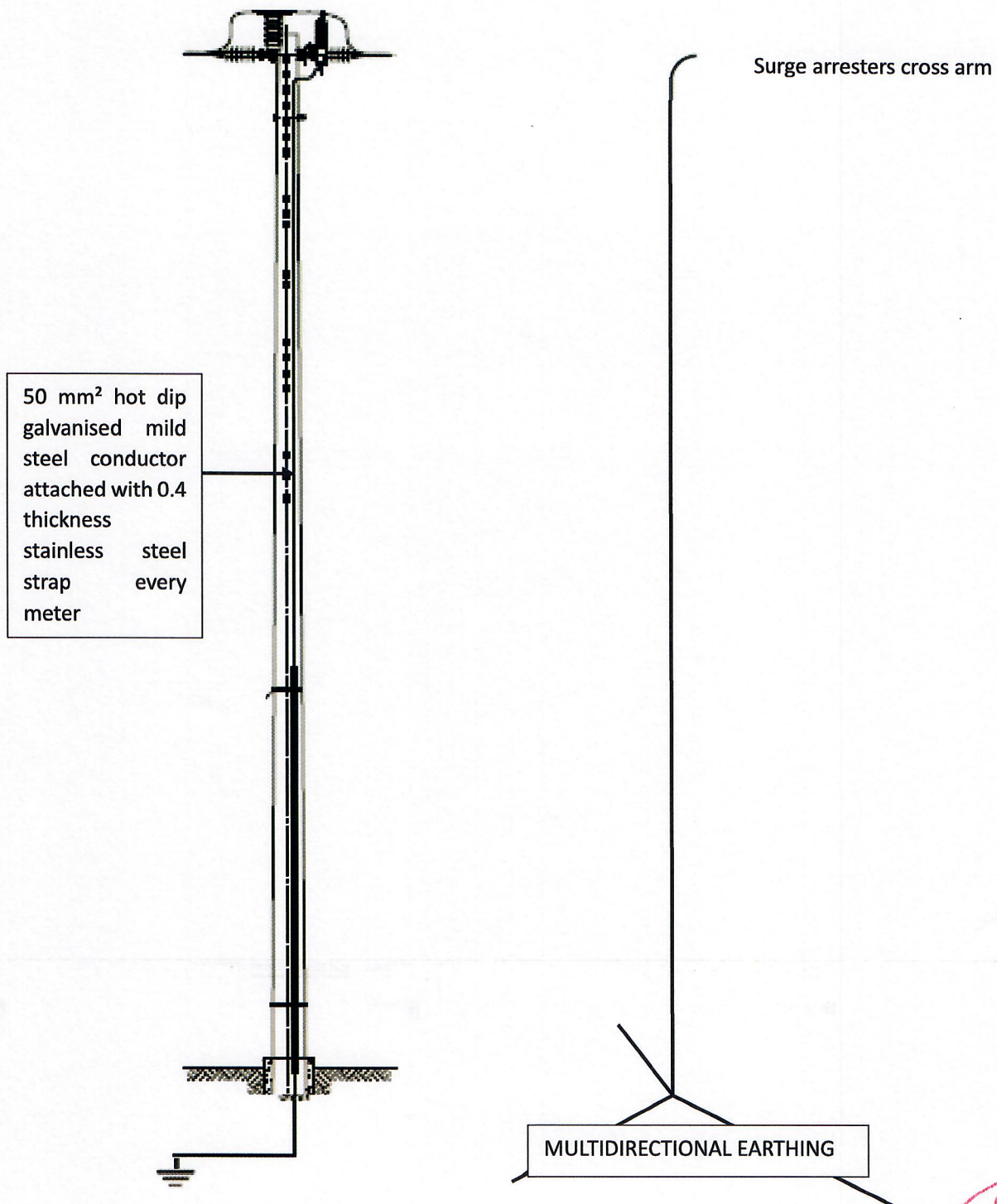
EDC-TP-002	Earthings of	TDS N°7
Technical data sheets	Pole mounted load break switch with surge arresters on cross arm	December 2018



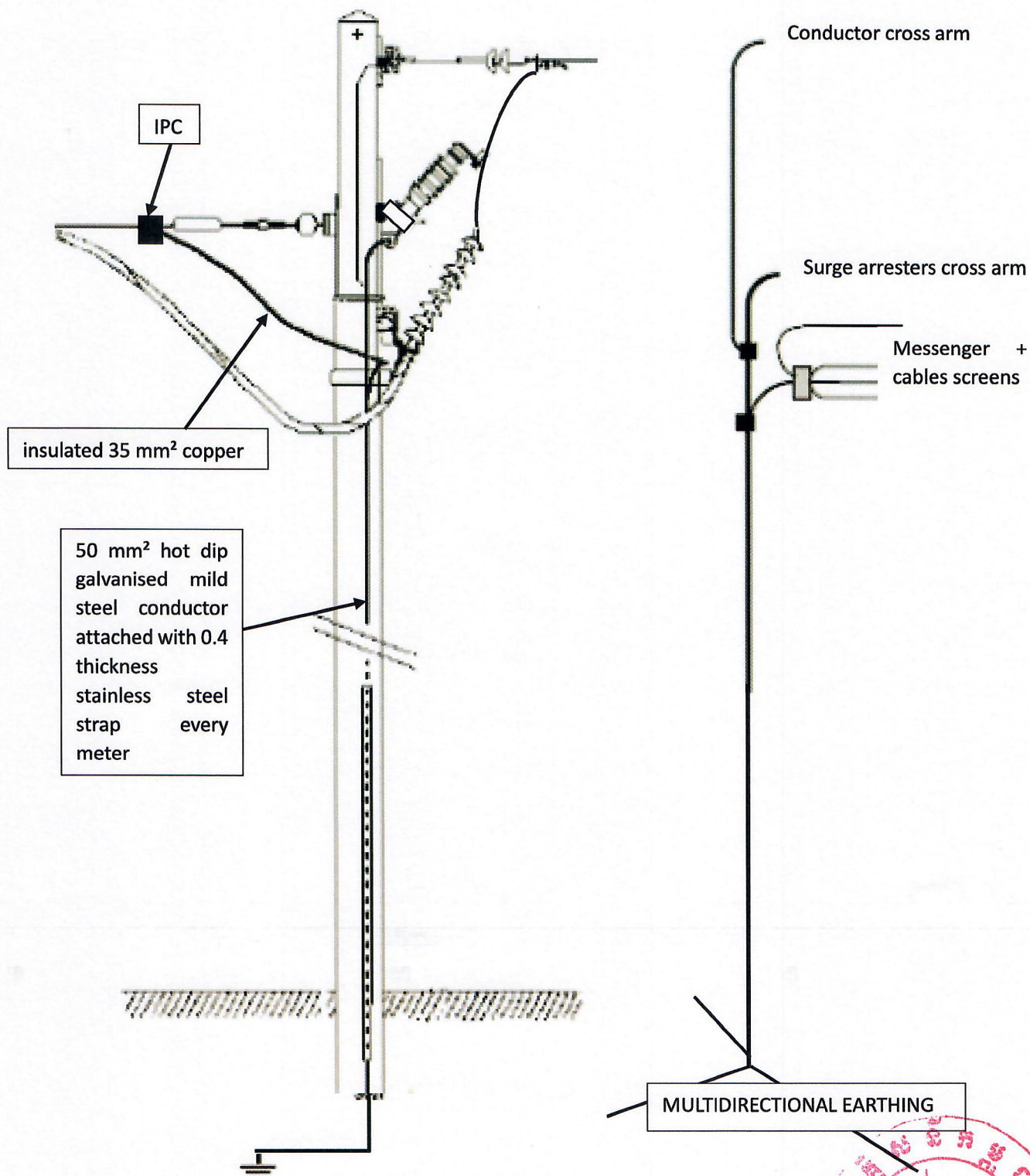
EDC-TP-002	Earthings of	TDS N°8
Technical data sheets	Pole mounted auto recloser	December 2018



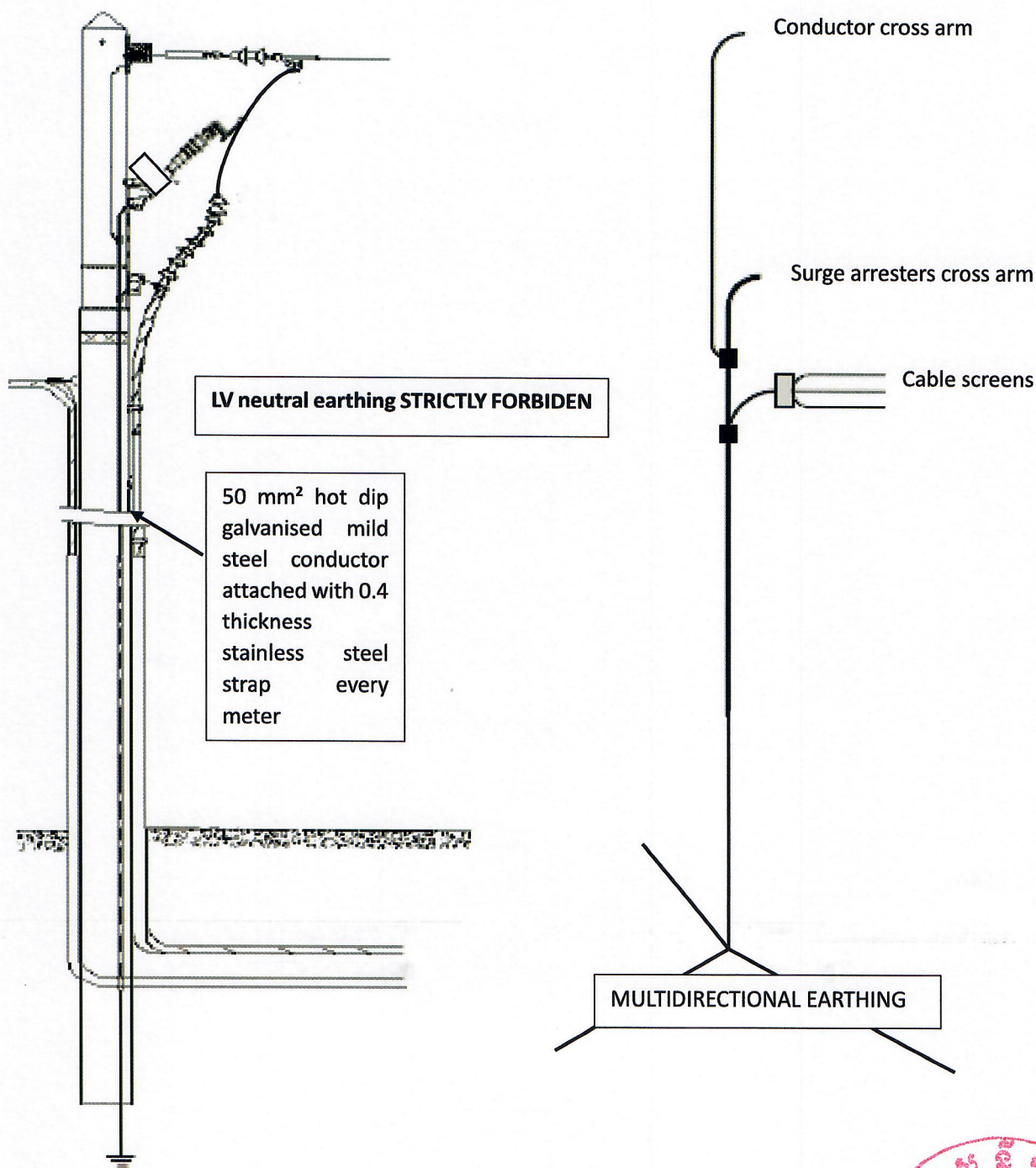
EDC-TP-002	Earthings of	TDS N°9
Technical data sheets	Surge arresters and cross arm only	December 2018



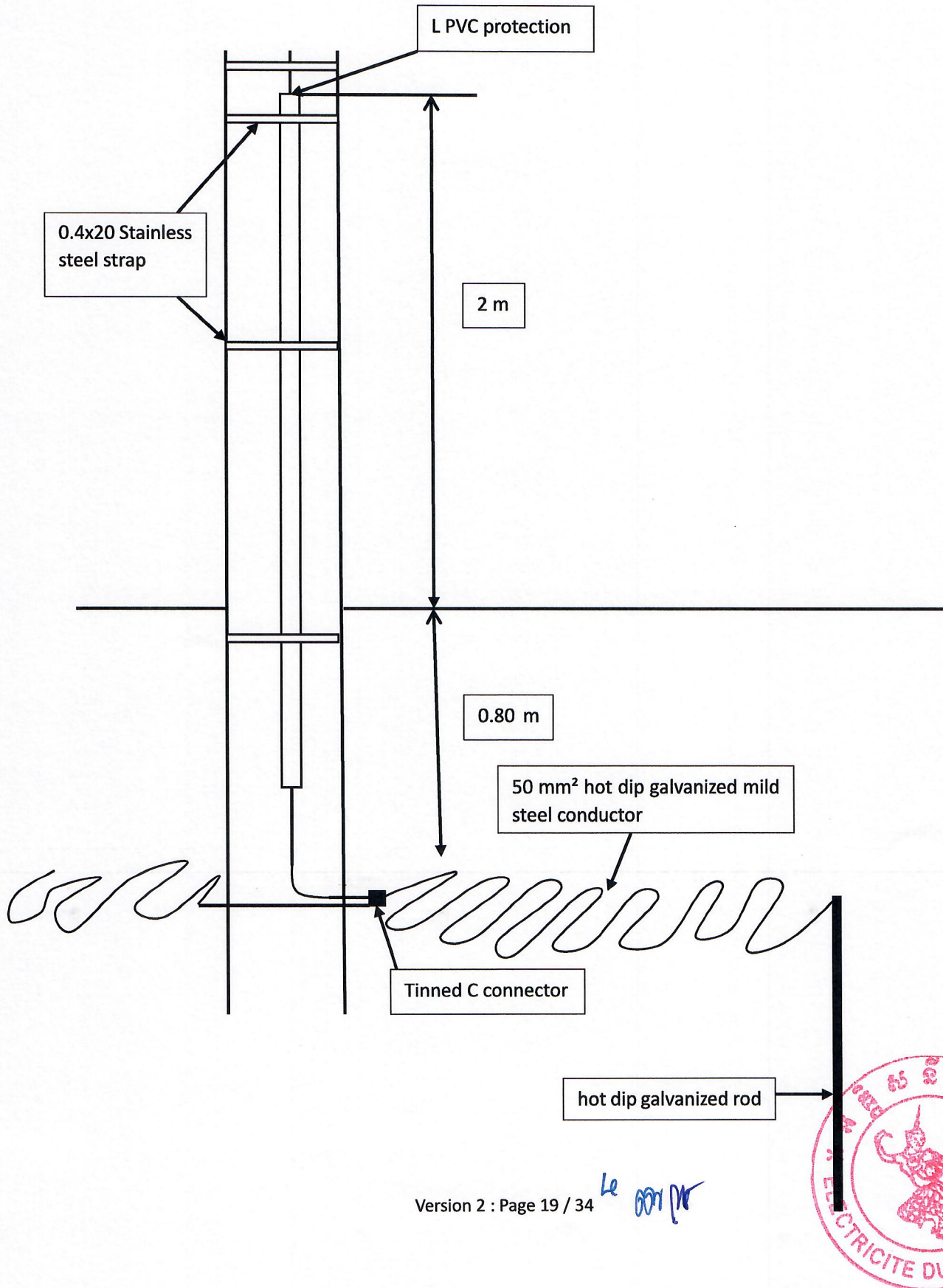
EDC-TP-002	Earthings of:	TDS N°10.b
Technical data sheets	MV ABC overhead network: ends	December 2018



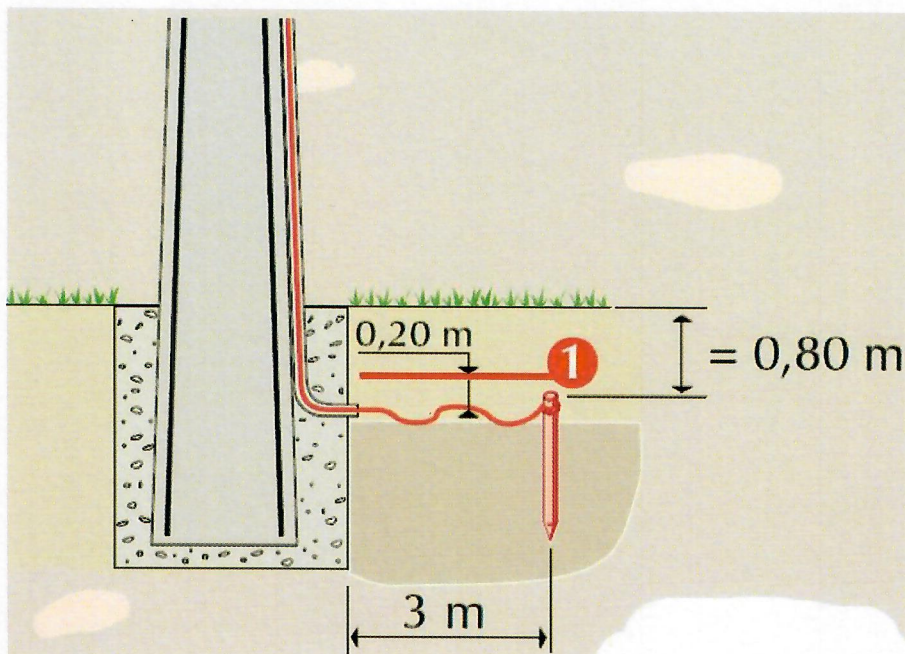
EDC-TP-002	Earthings of:	TDS N°12
Technical data sheets	MV overhead/underground interface	December 2018



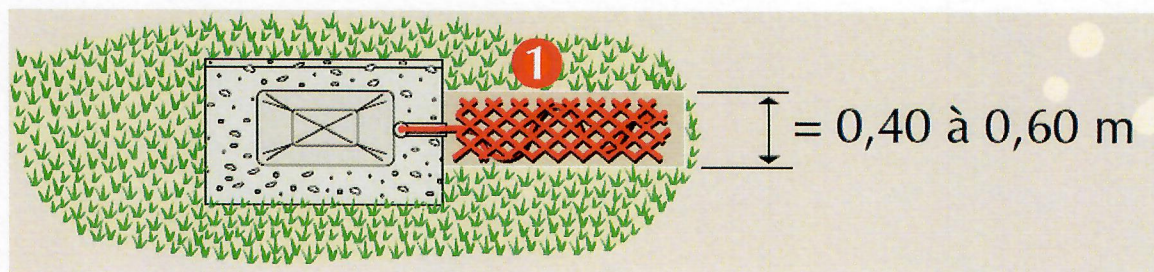
EDC-TP-002		TDS N°13
Technical data sheets	Pole Earthings Installation	December 2018



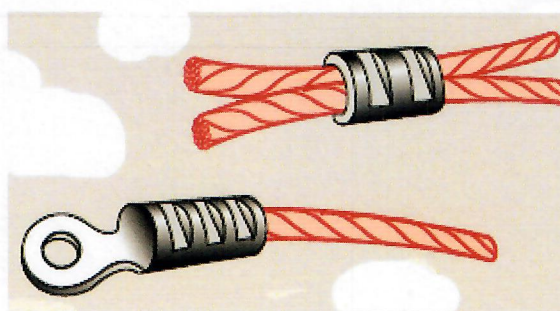
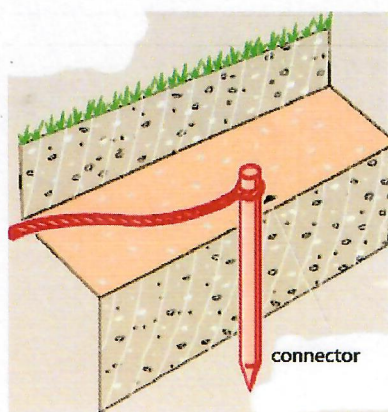
EDC-TP-002		TDS N°13
Technical data sheets	Pole Earthings Installation	December 2018



View from top



1 Red Plastic warning net



EDC-TP-002	Masses Earthings:	TDS N°14
Technical data sheets	OPS, RMU cabinet, Prefabricated and indoor substation, Equipment to be connected to the equipotential bonding conductor	December 2018

One Pilar Substation (OPS):

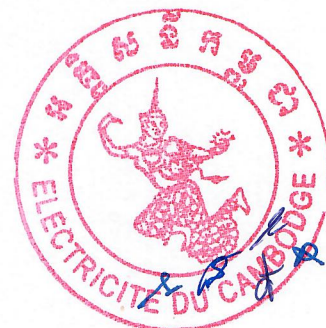
- Transformer
- Separable connector earthing braids (cable screen)
- Frame of LVDB
- Metallic body of OPS (care shall be taken that the door is connected to the body with extra flexible conductor)
- Any other metallic mass

RMU Cabinet:

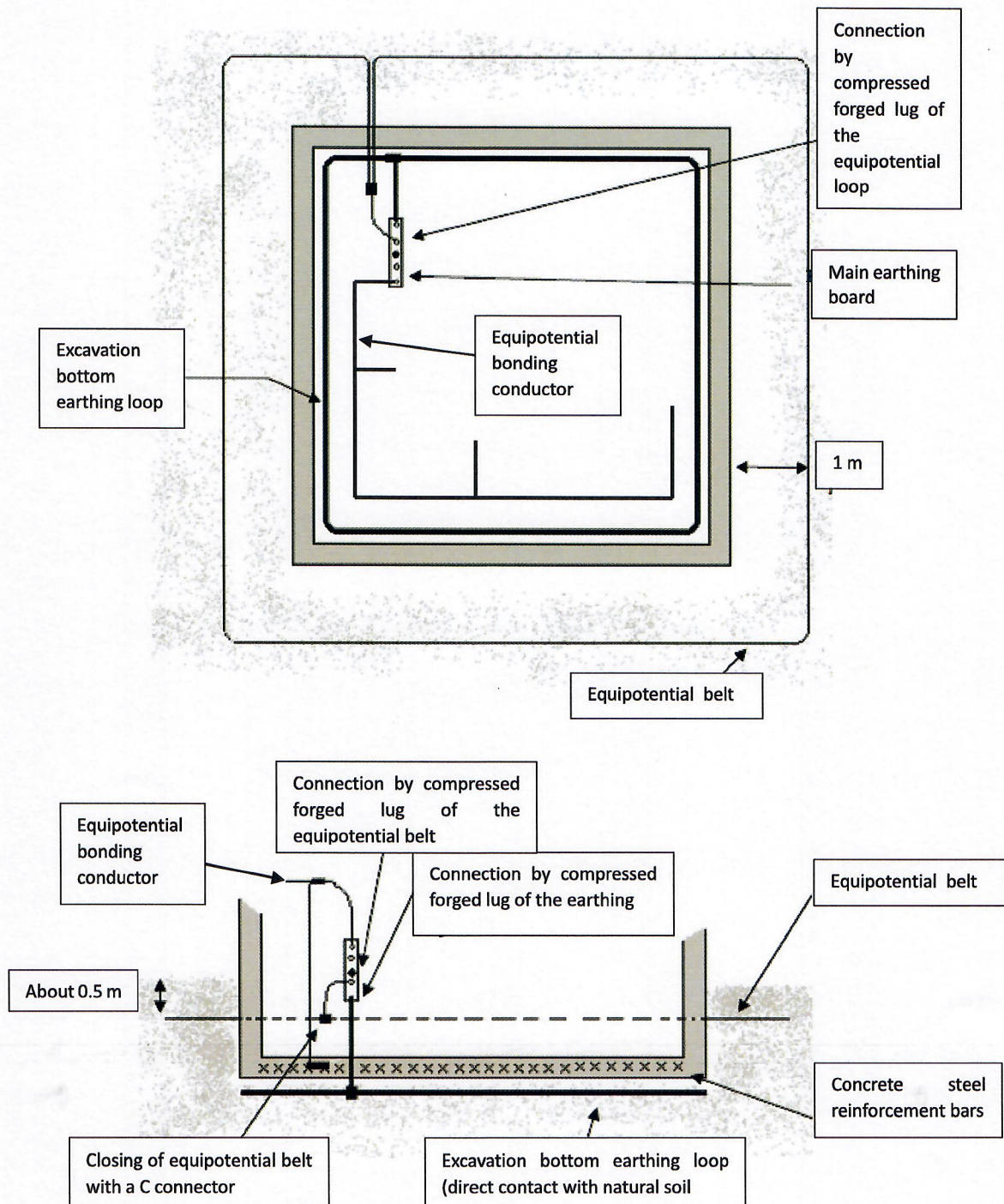
- RMU
- Metallic body of Cabinet (care shall be taken that the doors are connected to the body with extra flexible conductor)
- Any other electrical equipment as RTU, etc....

Prefabricated (PTT) and indoor substations:

- Steel reinforcement of the concrete by a connection connecting one of the bars of the reinforcement to the main equipotential bonding conductor
- the MV cable screens via the protective conductor of the MV switchboard;
- the MV RMU via a terminal provided for this purpose;
- the frame of LV switchboards;
- metal cable trays;
- the transformer tank;
- Transformer separable connector cable screens;
- earth terminals of measurement transformers, capacitors, etc ;
- protective metal screens and panels;
- the cell fences, the control panel of the devices and the various fittings in the open type substations
- the doors;
- the masses of control equipment
- RTU if any,
- envelop of metallic prefabricated substation
- any other metal masses.



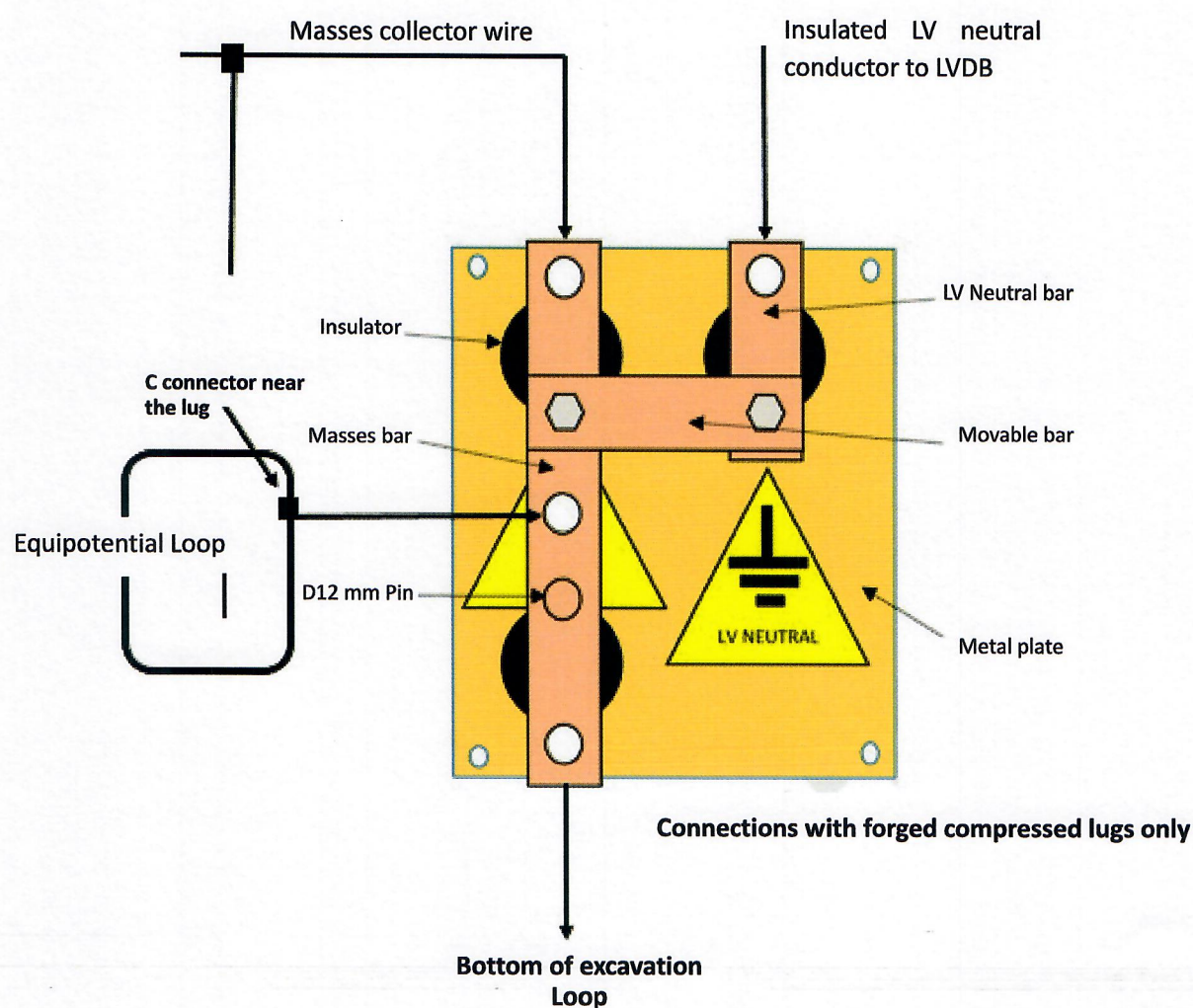
EDC-TP-002 Technical data sheets	Masses Earthings: Prefabricated or built substation, OPS and RMU cabinet Earthing circuit	TDS N°15 December 2018
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Additional grounding may be required to obtain the required ohmic value; it will then be crimped downstream of the main earth terminal.



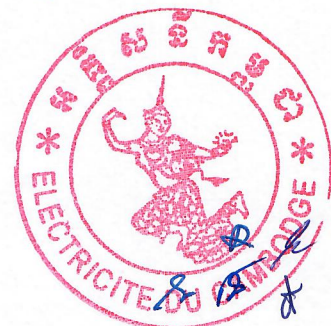
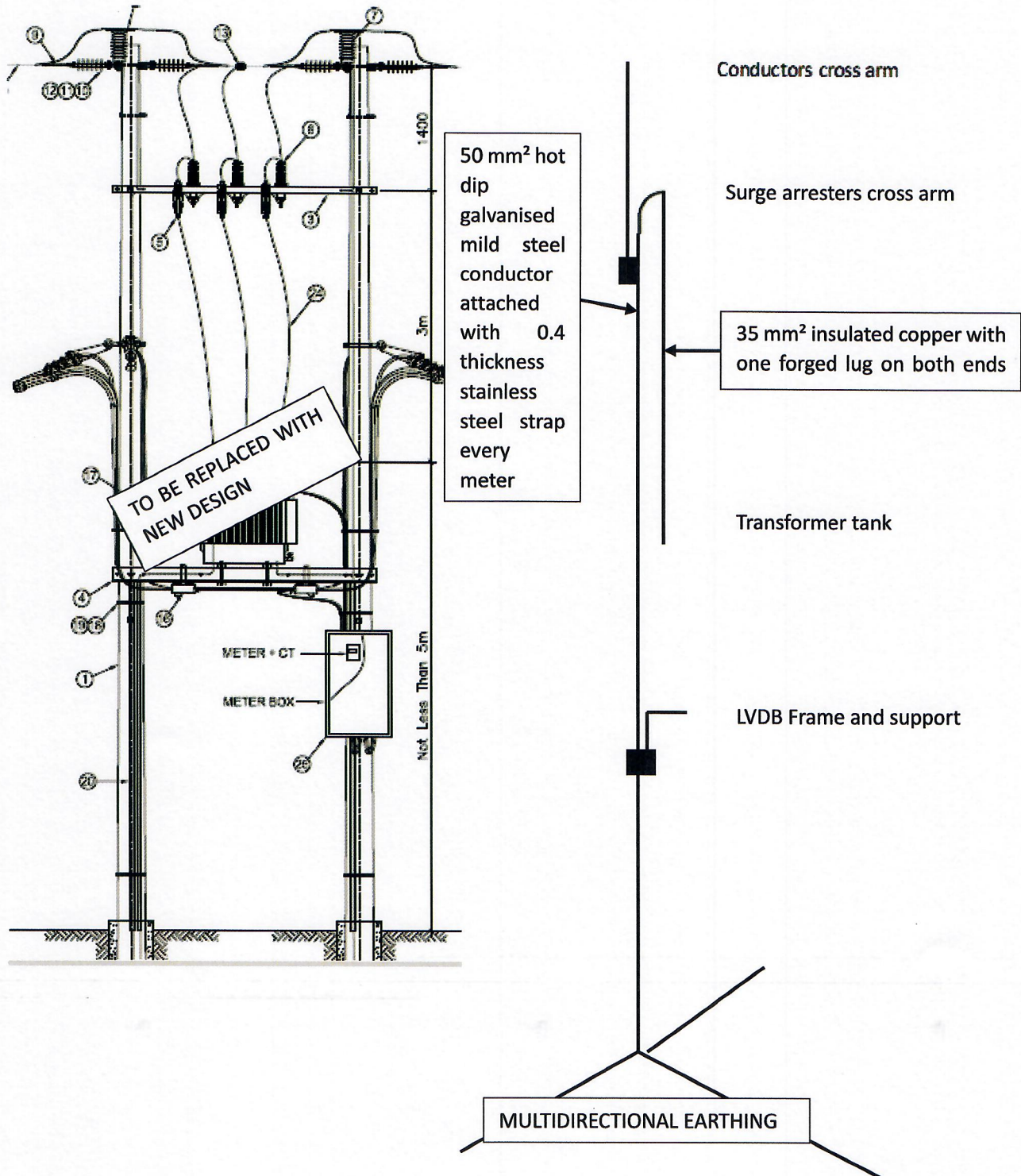
EDC-TP-002	Masses Earthings:	TDS N°16
Technical data sheets	Prefabricated or built substation, OPS and RMU cabinet - Main earthing board	December 2018



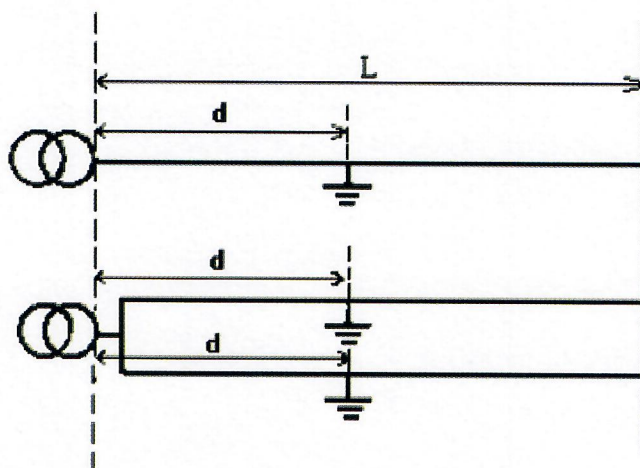
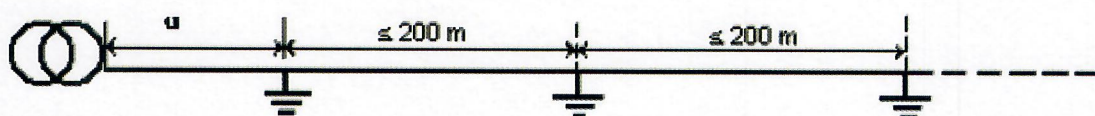
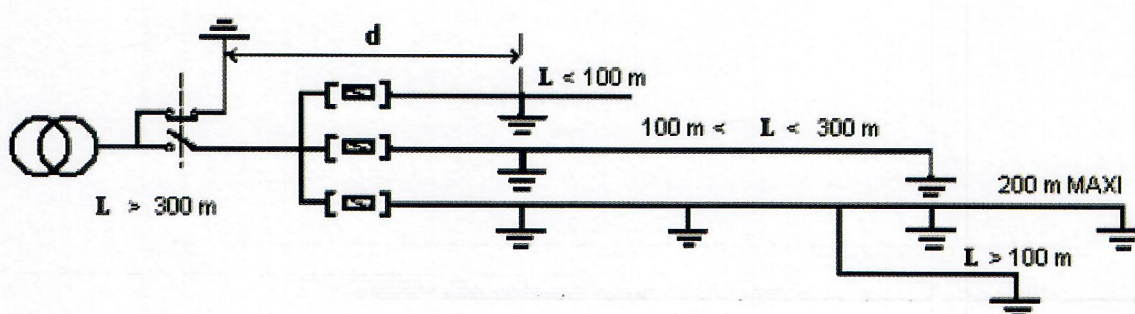
Main earthing board : Made of 20 mm x 3 mm copper bar. Hole diameters = 10.5 mm. Central pin dimensions: L = 40 mm Φ = 12 mm. Fixed against the wall with a distance of about 25 mm



EDC-TP-002	Earthings of:	TDS N°17
Technical data sheets	Pole mounted Substation	December 2018



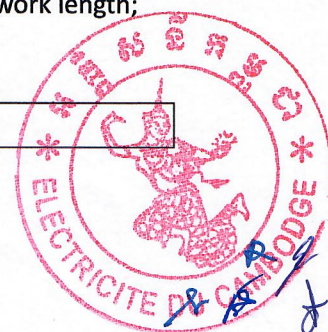
EDC-TP-002		TDS N°18
Technical data sheets	LV neutral earthings on ABC network	December 2018

Feeder length $L \leq 100\text{m}$ **Feeder length $> 100\text{ m}$** **Case of several feeders**

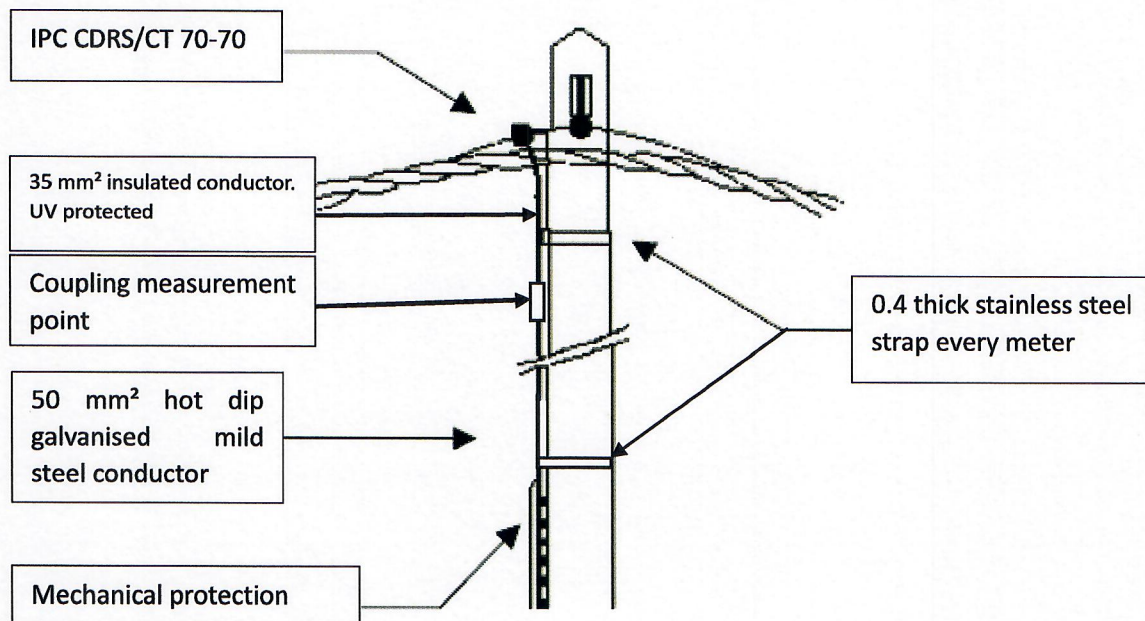
Distribution of LV neutral earthings:

- in addition to a point in the network as soon as the length of the line exceeds 100 meters;
- the number of earthing is equal to or greater than one every 200 meters of feeder network length;
- One LV neutral earthing near each major branch or group of individual branches.

The distance d is specified in technical data sheet N°2.

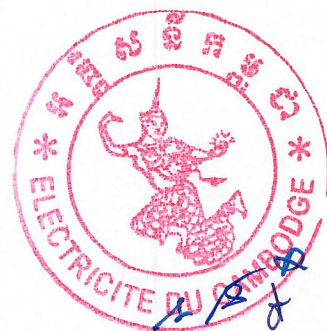


EDC-TP-002		TDS N°19
Technical data sheets	LV neutral earthing connection on LV ABC	December 2018

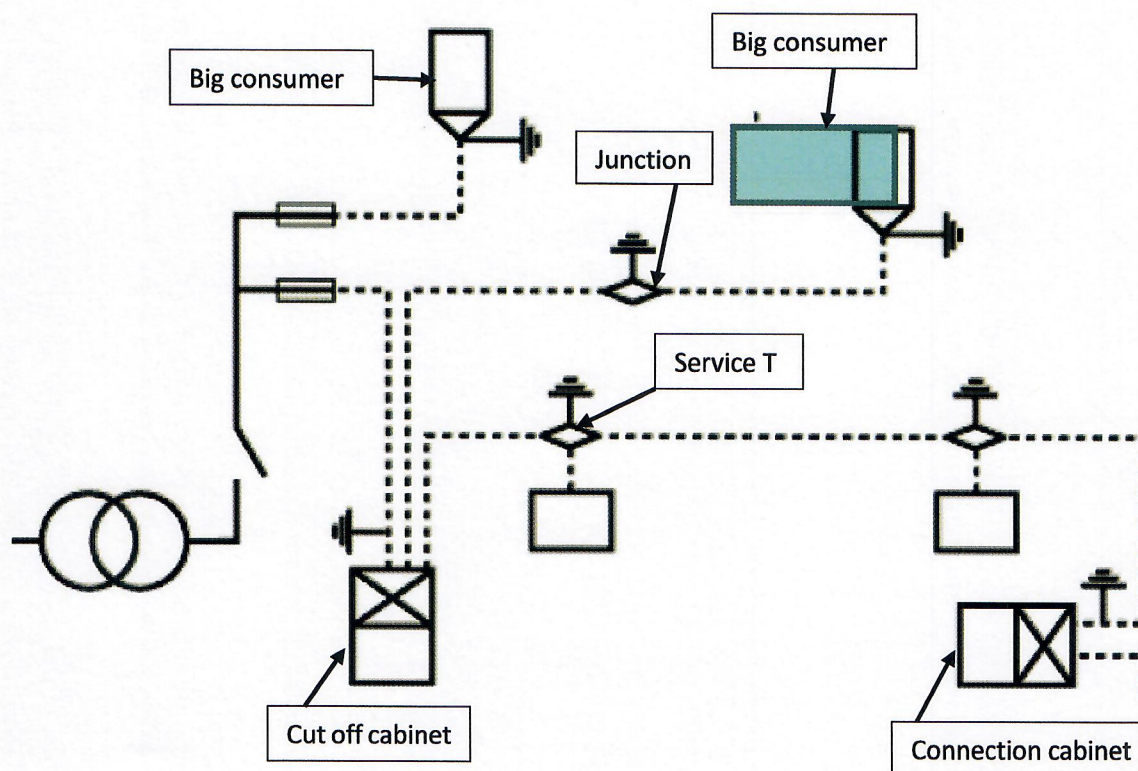


The coupling measurement point is located about 1 meter below the ABC. It is constituted of 2 compressed tin copper forged lugs and one stainless steel bolt (see TDS below)

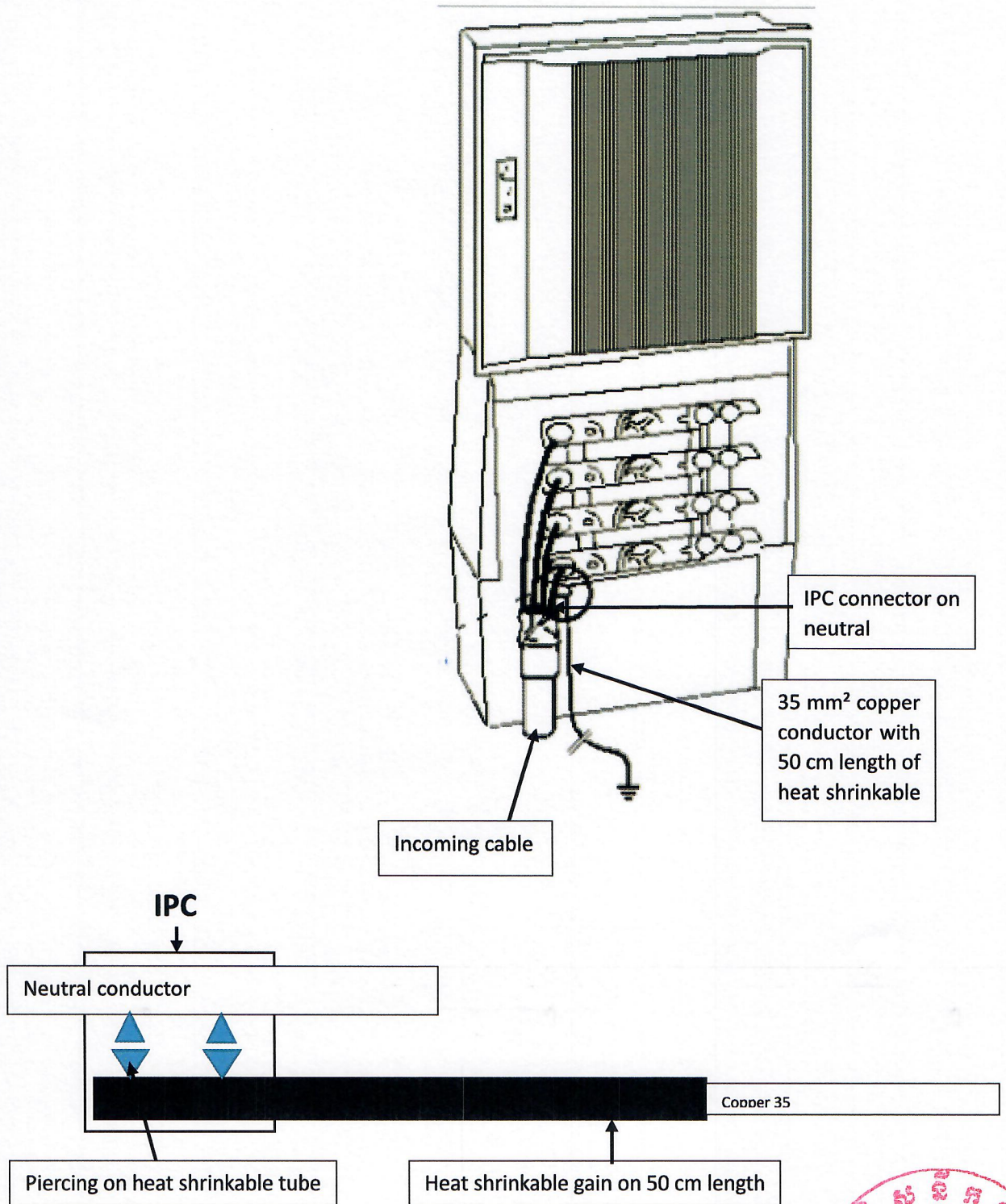
The 35 mm² copper insulated UV protected conductor is mandatorily attached to the ABC before entering in the IPC and the outer sheath is removed. Piercing is done through the insulation.



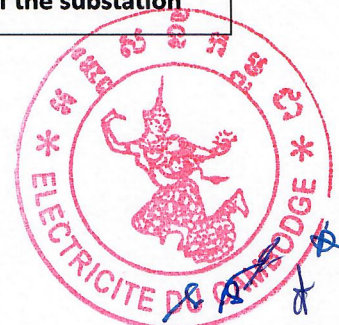
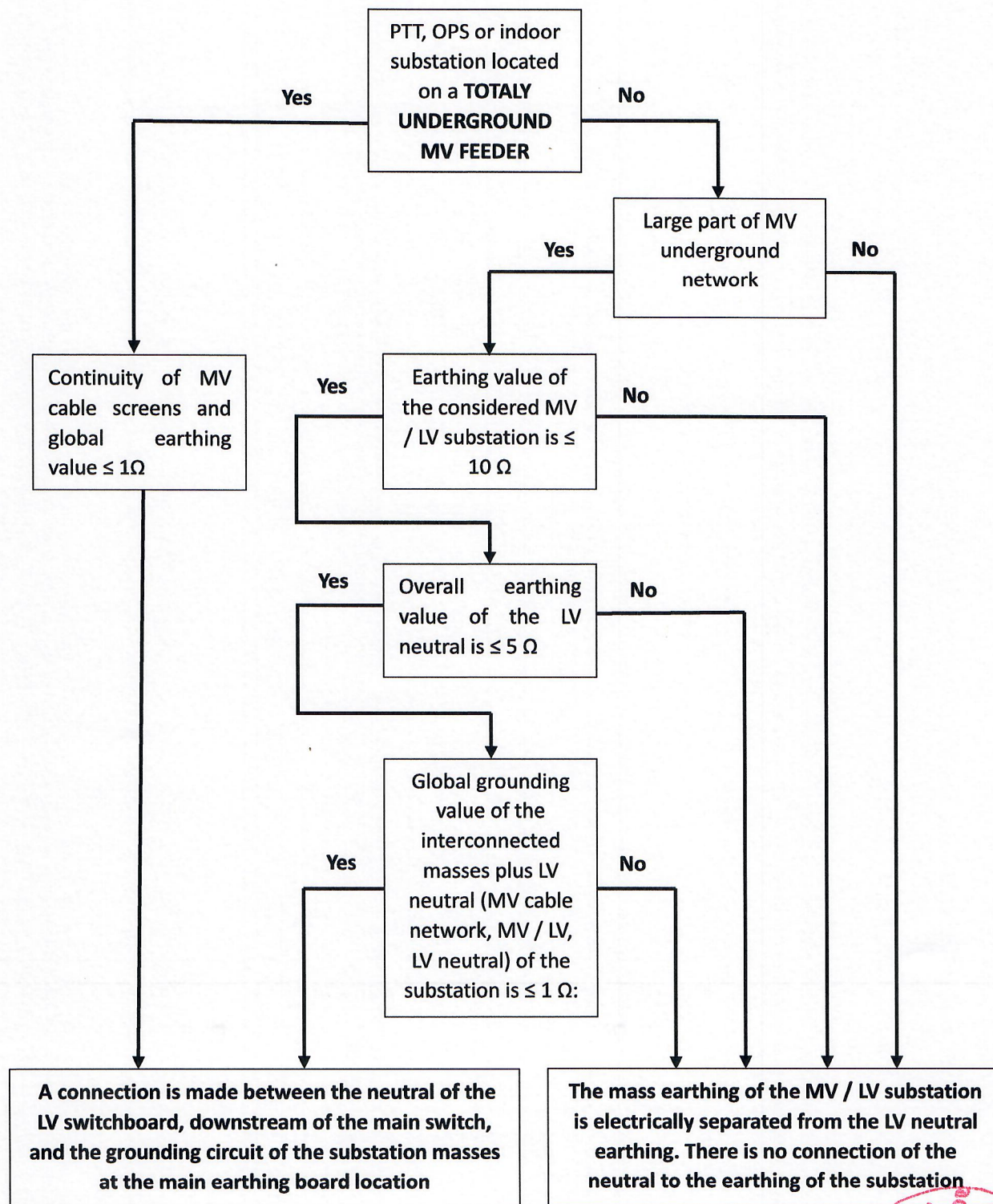
EDC-TP-002		TDS N°20
Technical data sheets	LV neutral earthing connection on underground LV network	January 2018



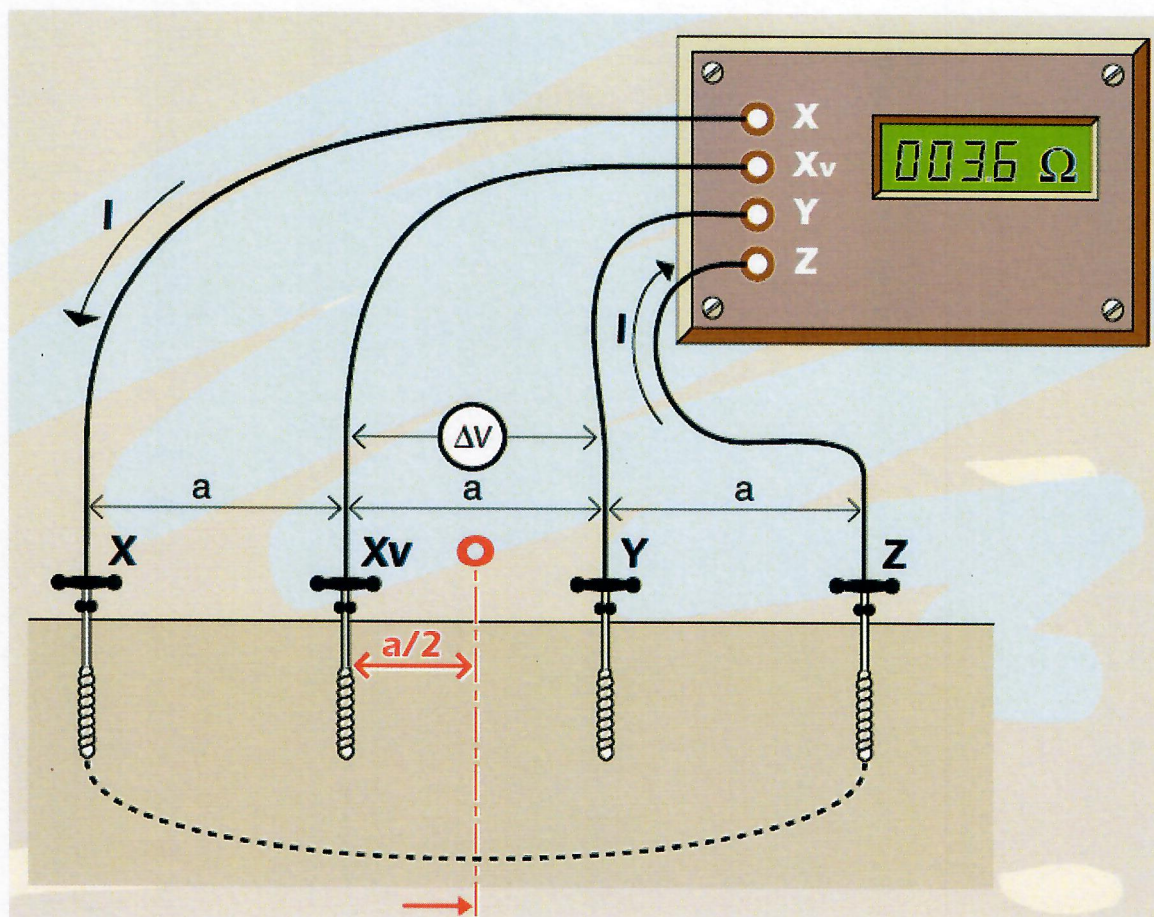
EDC-TP-002	LV neutral earthing connection inside LV underground network connection cabinets	TDS N°21
Technical data sheets		December 2018



EDC-TP-002	Condition of connection of LV neutral to mass earthing	TDS N°22
Technical data sheets		December 2018



EDC-TP-002		TDS N°23
Technical data sheets	Measurement of soil resistivity	December 2018



0: Location of future earthing

Nota: The four rods **MUST** be in straight line

a : 4 m

ρ: Soil resistivity in Ωm

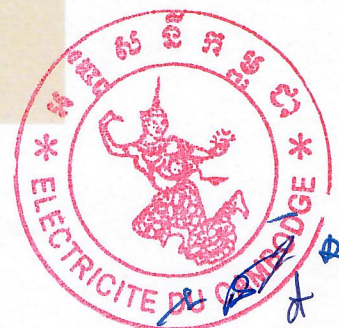
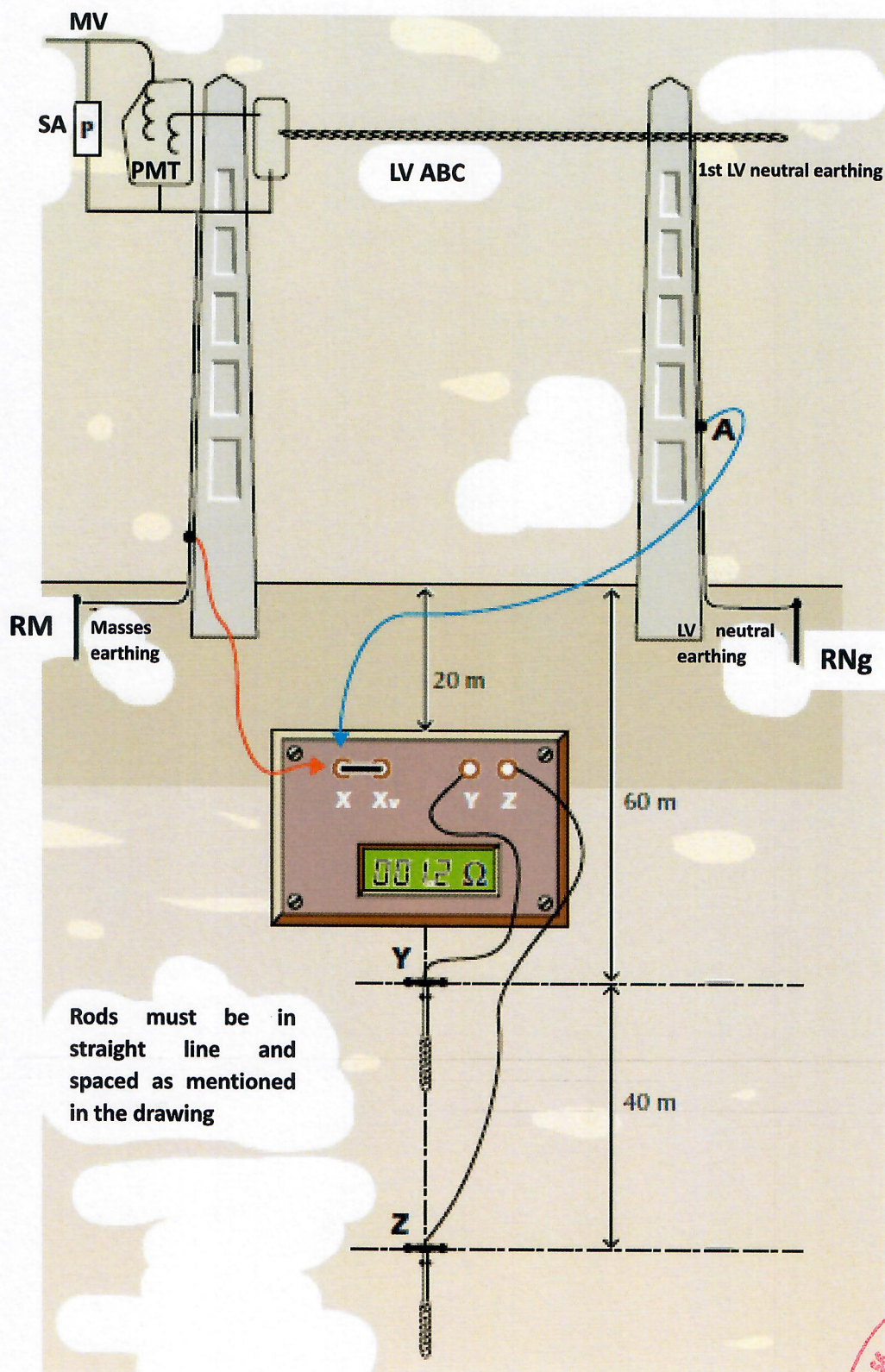
R: Value measured on the testing apparatus

For a = 4 m we have $\rho = 25 R$

The general formulae is: $\rho = 2\pi \cdot a \cdot R$

a may vary for deeper measurement.

EDC-TP-002		TDS N°24.a
Technical data sheets	Measure of earthing resistances on 2 and 3 phase PMT	December 2018



EDC-TP-002		TDS N°24.b
Technical data sheets	Process for measuring earthing resistances and coupling	December 2018

1/ Measure the RM resistance with the red cord (see drawing 24.a). Note: This method applies to any measure of single earthing.

2/ Measure the resistance of the **global earthing** of the LV neutral RNg with the blue (see drawing 24.a).

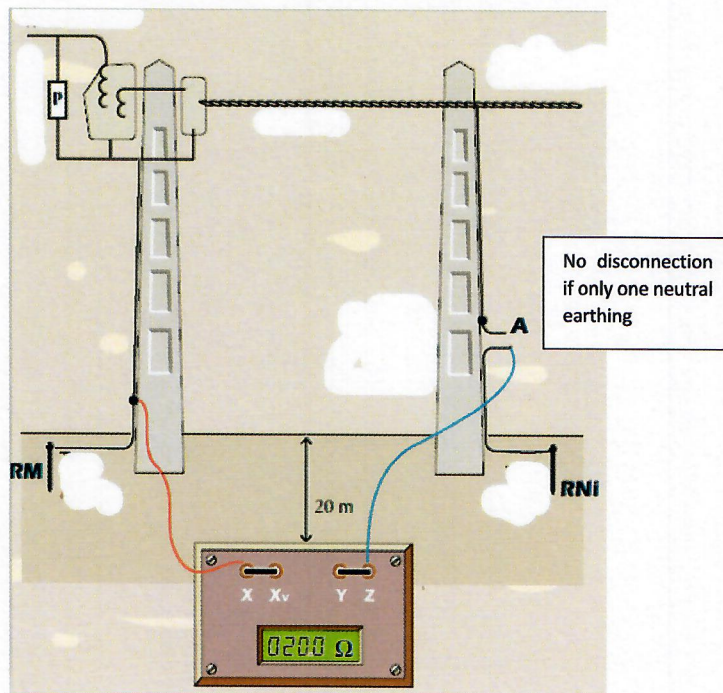
3/ Determine the coefficient of coupling:

3.1/ If there is only one neutral earthing, do not disconnect because $RNg = RNi$ and go to step 3.4

3.2/ if there are several neutral earthings on the network, disconnect the point A and measure the resistance of the individual LV neutral earthing RNi (blue cord in place with A disconnected)

3.3/ Check that $RNi > RNg$.

3.4/ Proceed to RNM measurement according to the following drawing.



3.5/ Check that $RM + RNi \geq RNM$.

3.6/ Calculate the coupling resistance Rc

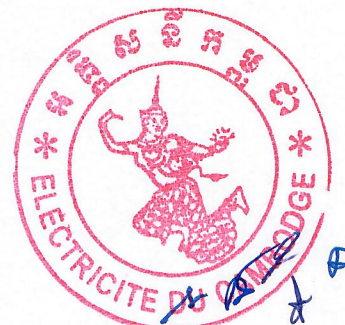
$$Rc = \frac{RM + RNi - RNM}{2}$$

3.7/ Calculate the coefficient of coupling C

$$C = Rc / RM$$

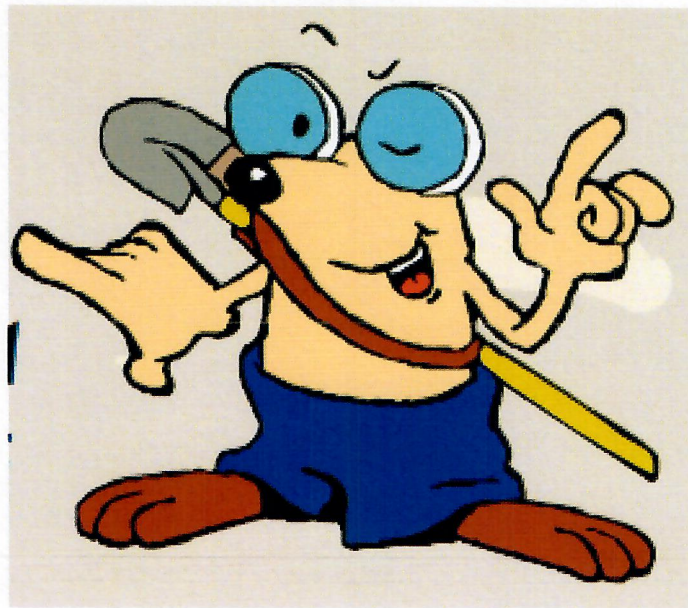
Make sure that $C < 0.15$.

4/ Restore the link at point A.



EDC-TP-002		TDS N°25
Technical data sheets	Safety	December 2018

- It is forbidden to intervene during thunderstorms on the earthing circuit of a structure in service.
- The operator must wear its individual protection equipment as well as LV insulating gloves and be located on the insulating mat.
- The absence of voltage between two earthing must be permanently checked
- In case the work requires the opening of the earthing circuit of a structure in service, the continuity of the grounding of each circuit element to be separated must be ensured: either by placing a shunt maintained throughout the intervention, either by connecting the part to be separated from the earth ground to an existing or created auxiliary earth ground.

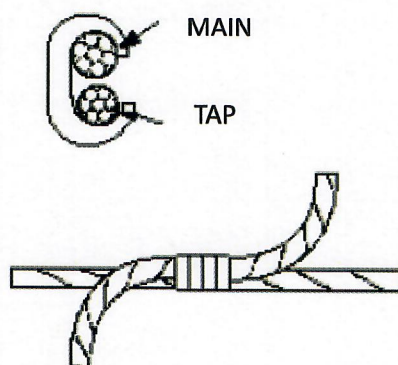


EDC-TP-002		TDS N°26
Technical data sheets	Specific connectors for earthing	December 2018

Tin copper C connector for earthing tap connection

Can be used buried in the ground

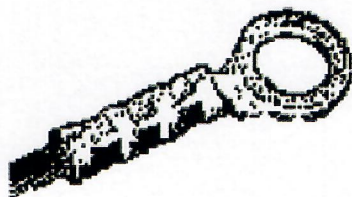
For connection of copper or galvanized mild steel earthing conductors



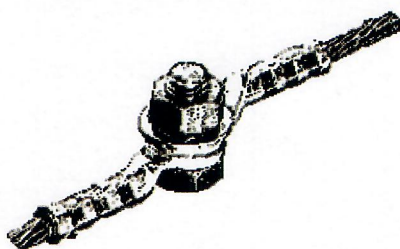
Tin copper forged lug

For mass connection. Cannot be buried

For connection of copper earthing conductors. Associated with heat shrinkable tube for hot dip galvanized earthing conductor



LV neutral coupling measuring point



Le 001/15

