PART II

APPENDICES

APPENDIX 1

PRINCIPLE TECHNICAL REQUIREMENTS FOR ELECTRICAL MATERIALS AND CONSTRUCTION STRUCTURE

1-1. General requirements

1-1.1. Applied Standards

All equipment and materials must satisfy Vietnamese Standards and International Standards permitted for application in Vietnam

1-1.2. Environmental Conditions

To ensure the unification in selection of equipment and materials, the technical characteristics of equipment and materials must satisfy the following environmental conditions:

+ Maximal environmental Temperature:	45^oC
+ Average environmental Temperature :	25^oC
+ Minimal environmental Temperature :	0^oC
+ Average Humidity:	85%
+ Maximal Humidity at $T^o=35^oC$ for the duration of 10 days:	100 %
+ Earthquake factor :	0.1 g
+ Maximal Wind Speed :	160 km/h

1-1.3. Other Requirements

In the design process the selection of appropriate technical parameters of equipment and materials should be based on the specific features of the distribution network. This appendix presents some of the main parameters and standard data for convenient application in the design.

1-1.3.1. Dimensioning Current Density:

Conductor	Dimensioning Current Density, A/mm^2		
	Number of hours of Max. capacity use (Utilisation Time), h/year		
	Above 1000 to 3000	Above 3000 to 5000	Above 5000
Bare bus bar and bare conductors:			
+ Copper	2.5	2.1	1.8
+ Aluminum	1.3	1.1	1.0
Paper insulated, Rubber or PVC covered conductors:			
+ Copper core	3.0	2.5	2.0
+ Aluminum core	1.6	1.4	1.2
Rubber or Composite insulation Cable:			
+ Copper core	3.5	3.1	2.7
+ Aluminum core	1.9	1.7	1.6

1-1.3.2. Permissible current value of Cables with three cores and paper insulation soaked in oil:

Aluminum with Core cross- Section (mm^2)	Current Carrying Capacity (Permissible current value), A					
	22kV			35kV		
	Laying in					
	Ground	Water	Air	Ground	Water	Air
25	110	120	85	-	-	-
35	135	145	100	-	-	-
50	165	180	120	-	-	-
70	200	225	150	-	-	-
95	240	275	180	-	-	-
120	275	315	205	270	290	205
150	315	350	230	310	-	230
185	355	390	265	-	-	-

1-1.3.3. LV Fuse melting wire selection:

Breaking current value for melting wire (A)	Melting wire Diameter (mm)		
	Copper	Lead	Aluminum
1	0.05	0.21	0.15
2	0.09	0.27	0.17
3	0.11	9.37	0.19
4	0.13	0.45	0.20
5	0.15	0.55	0.22
10	0.25	0.90	0.26
12	0.27	1.00	0.30
15	0.31	1.20	0.33
20	0.38	1.40	0.40
25	0.42	1.75	0.46
28	0.46	1.80	0.50
32	0.50	2.05	0.60
35	0.55	2.21	0.65
40	0.60	2.30	0.80
50	0.70	2.75	0.90
60	0.85	3.20	1.00
70	0.92	3.48	1.10
80	1.00	3.82	1.20
90	1.08	4.12	1.30
100	1.16	4.42	1.40
120	1.31	5.00	1.60
150	1.50	5.80	1.90
200	1.80	8.80	2.30
300	2.30	9.10	2.90

1-1.3.4. Simultaneous factor:

- Simultaneous factors to be used for calculation of peak load of uniform customers are as follows:

- Public service demand: $K_{dt} = 1$
- Household demand: $K_{dt} = 0.9$
- Commercial service and office demand: $K_{dt} = 0.85$
- Small industry and handcraft demand: $K_{dt} = 0.4 \div 0.5$

In case there is no reliable basis for simultaneous factor selection, the peak load (P_{max}) can be calculated by the following approximate formula:

$$P_{max} = K_{dt} (P_{assh} + P_{cn,\ tcn} + P_{nn}) = K_{dt}.\sum P,$$

Where

P_{ashh}: total demand for domestic lighting

$P_{cn,\ tcn}$: total demand for industry or small industry

P_{nn}: total demand for agriculture

K_{dt} is the simultaneous factor for all loads in the area, which can be calculated as follows:

$K_{dt} = 0.6$ if $P_{ashh} \leq 0.5 \sum P$

$K_{dt} = 0.7$ if $P_{ashh} = 0.7 \sum P$

$K_{dt} = 0.9$ if $P_{ashh} = \sum P$

In other cases K_{dt} can be interpolated

- Simultaneous factors to be used for calculation of peak load of power lines 6 - 35kV is as follows:

- For lines, supplying 3 - 5 transformer substations: $K_{dt} = 0.9$
- For lines, supplying 6 - 10 transformer substations: $K_{dt} = 0.8$
- For lines, supplying 11 - 20 transformer substations: $K_{dt} = 0.75$
- For lines, supplying more than 20 transformer substations: $K_{dt} = 0.7$

1-2. Transformer (symbol - BT)

1-2.1. Applied Standards:
TCVN - 1984 – 1994, IEC - 76

1- 2.2. Working Condition of Transformers and Transformer substation Equipment

Nominal Voltage	(kV)	35		22	15	10	6	0.40
Rated Voltage	(kV)	35	35	23	16.5	11	6.6	0.38

Maximal operation Voltage	(kV)	38.5	40.5	24	17.5	12	7.2	0.40
Testing Voltage at 50Hz during 1 minute	(kV)	75	80	50	38	28	20	2.5
Maximal lightning impulse withstand Voltage	(kV)	180	190	125	95	75	60	-
Frequency	(Hz)	50	50	50	50	50	50	50
Rated short circuit current during 1 second	(kA)	20	20	20	20	20	20	16
Cooling system		Sealed transformer type with natural cooling system by oil						

1-2.3. Technical parameters of Transformers

1-2.3.1. Three-phase Transformers:

- 3-phase, 2 windings soaked in oil, placed outdoor
- Vector group Δ/Yo-11 or Y/Yo-12.
- Off-load voltage regulation ± 2x2.5 %.
- Off-load Tap Changer operated from outside of the transformer

Capacity (kVA)	Nominal voltages (kV)	Losses (W)		No- load current (Io %)	Short-circuit impedance (Zk %)
		No- load	On-load		
30	22(6-10-15)/0.4 35(22)/0.4	150 180	600	1.9	4 4.5
50	22(6-10-15)/0.4 35(22)/0.4	190 235	1000	1.8	4 5
75	22(6-10-15)/0.4 35(22)/0.4	250 290	1300	1.8	4 5
100	22(6-10-15)/0.4 35(22)/0.4	310 330	1750	1.8	4 5
160	22(6-10-15)/0.4 35(22)/0.4	445 465	2350	1.7	4 5
200	22(6-10-15)/0.4	500	2800	1.7	4

	35(22)/0.4	530			5
250	22(6-10-15)/0.4 35(22)/0.4	620 640	3250	1.7	4 5
400	22(6-10-15)/0.4 35(22)/0.4	900 920	4600	1.5	4 5

1-2.3.2. Two-phase transformers:

- Phase-phase, 3 windings soaked in oil, placed outdoor
- Type: Sealed type or distribution transformer
- Off-load voltage regulation ± 2x2.5 %.
- Off-load Tap Changer operated from outside of transformer

Capacity (kVA)	Nominal Voltages	Losses (W)		No loading current (Io%)	Short-circuit impedance (Zk%)
		No loading	loading		
15	22(6-10-15)/2x0.23kV 35(22)/2x0.23kV	65 75	300	2	4
25	22(6-10-15)/2x0.23kV 35(22)/2x0.23kV	110 135	500	2	4
37.5	22(6-10-15)/2x0.23kV 35(22)/2x0.23kV	130 160	600	2	4
50	22(6-10-15)/2x0.23kV 35(22)/2x0.23kV	190 235	1000	2	4

1-2.3.3. Single phase transformers:

- Single phase, 3 windings soaked in the oil, placed outdoor
- Type: Sealed transformer or distribution transformer
- Off-load voltage regulation ± 2x2.5 %.
- Off-load Tap Changer operated from outside of transformer

Capacity (kVA)	Nominal Voltage (kV)	Losses (W)		No load current (Io %)	Short-circuit impedance (Zk %)
		At no load	At nominal load at 75°C		
15	12,7(6-10-8,66)/2x0.23 20,2(12,7)/2x0.23	54 62	219	2	4
25	12,7(6-10-8,66)/2x0.23 20,2(12,7)/2x0,23	69 85	343	2	4
37.5	12,7(6-10-8,66)/2x0.23 20,2(12,7)/2x0.23	95 117	433	2	4
50	12,7(6-10-8,66)/2x0.23 20,2(12,7)/2x0.23	111 137	587	2	4
75	12,7(6-10-8,66)/2x0.23 20,2(12,7)/2x0.23	152 175	961	2	4

1-3. Switching Equipment

1-3.1. 35kV and 24kV Recloser (REC-35 and REC-24) :

- Standards: IEC - 255; ANSI C37.60-1981
- Type: Three-phase, placed outdoor
- Technical parameters: (Table 1-3.1)

Nominal Voltage	(kV)	35		22
Rated Voltage	(kV)	35	35	23
Maximal operation Voltage	(kV)	38.5	40.5	24
Testing Voltage at 50Hz during 1 minute	(kV)	75	80	50
Maximal lightning impulse withstand Voltage	(kV)	180	190	125
Nominal current (for REC)	(A)	≥ 400		≥ 400
Nominal current (for LBS and DS)	(A)	≥ 200		≥ 200

Nominal current (for FCO)	(A)	≥ 100	≥ 100
Nominal short-circuit current	(kA/1s)	≥ 20	≥ 12.5
Closing time (for REC)	(ms)	≤ 100	≤ 100
Cutting time (for REC)	(ms)	≤ 80	≤ 80
Driving mechanism (for REC)		Spring	Spring
Number of mechanical operations	(Nos)	≥ 5000	≥ 6000
Frequency	(Hz)	50	50

1-3.2. 35kV and 24kV Loading Disconnetors (LBS - 35 LBS - 24)

- Standards: TCVN 5768 - 1993; IEC -129; IEC - 265 ; IEC -694
- Type: 3-phase, placed outdoor
- Technical parameters: (see Table 1-3.1)

1-3.3. Three-phase 35kV and 24kV Disconnectors (DS - 35 and DS - 22)

- Standards: TCVN 5768 - 1993; IEC - 129; IEC - 265
- Type: 3-phase, placed outdoor, 3-phase trip-switching
- Technical parameters: (see Table 1-3.1)

1-3.4. 35kV and 22kV Fuse Cutout (FCO - 35 and FCO - 22)

- - Standard: IEC - 282 - 1
- Type: Single phase, placed outdoor
- Technical parameters: (See Table 1-3.1)

1-3.5. 0.4kV Fuse Cut-out (CZ51)

- Type: Three-phase, placed outdoor
- Technical parameters:

+ Nominal voltage (kV)	0.4
+ Maximal operation voltage (kV)	0.6
+ Lightning impulse withstand voltage (kV)	2.5
+ 50Hz withstand voltage in one minute (kV)	1.0
+ Nominal current (A)	160
+ Melting current of fuse wire (A)	Setting up

1-4. Protection equipment

1-4.1. Surge Arrester (Symbol LA)

- Standards: TCVN 5717 – 1993; IEC - 99.4
- Type: ZnO with gap, outdoor.
- Technical parameters:

+ Nominal voltage	kV	35	35*	22	15	10	6
+ Maximal constant operation voltage	kV	38.5	22.2	13.9	9.6	11	6.6
+ Industrial frequency (50Hz) withstand voltage	kV	70	70	50	36	25	15
+ Remanent Voltage, responding the wave 8/20μs, discharging current of 5kA	kV	126	95	60	45	45	30
+ Energy absorbing capability	kJ/kV	2.5	2.5	2.5	2.5	2.5	2.5

Note: Nominal voltage 35 kV applied for 35kV network with solidly grounding neutral.*

1-5. Insulators and Spare-parts

1-5.1. Line post Insulator

- Material: porcelain or glass.
- Standard: TCVN-4759-1993; TCVN-5851-1994 or equivalent international standards.
- Insulator sole made by material with mechanical destroying load for bending of not less than 1.1 times of destroying load for the insulator
- Metallic sole gluing with insulator or between its components must satisfy the requirements of quality standards in TCVN - 4759 - 1993.
- Technical characteristics of Insulators:

Type of insulators		35 kV	22kV
+ Nominal voltage of network	kV	35	22
+ Maintaining voltage at 50Hz :			
* Dry condition	kV	≥ 110(110)	≥ 75(85)
* Wet condition	kV	≥ 85(85)	≥ 55(60)
+ Breakthrough voltage at 50Hz	kV	≥ 200(200)	≥ 160(160)
+ Maintaining impulse voltage with 1.2 / 50μs	kV	≥ 190(195)	≥ 125(150)
+ Mechanical destroying load for bending	kg	1600(1500)	1300(1400)
+ Leakage current length			
* Normal condition:	mm	≥ 595(595)	≥ 360(440)

* Polluted condition:	mm	≥ 770(-)	≥ 484(-)

Note: Numbers in brackets (..) are applied for glass insulation

1-5.2. Suspended Insulator

- Standards: TCVN 5849 - 1994; TCVN 5850 - 1994; IEC-305-1978

Leakage current length of insulation bowl must not be less than 250mm.

1-5.2.1. Technical requirements for pottery and glass bowls:

- Mechanical destroying tension	kN	70	40
- Maintaining voltage at 50Hz in 1 minute			
+ Dry condition	kV	82	60
+ Wet condition	kV	55	40
- Standard impulse voltage	kV	125	120
- Breakthrough voltage	kV	120	90

1-5.2.2. Technical requirements for Composite Chain Insulators (SILICON, RUBBER):

Nominal Voltage	kV	35		22	
		Normal condition	Polluted condition	Normal condition	Polluted condition
- Mechanical destroying load	kN	70	70	70	40
- Minimal leakage current length	mm	770	970	500	600
- Maintaining voltage at 50Hz in 1 minute:					
+ Dry condition	kV	165	165	105	105
+ Wet condition	kV	90	90	60	60
- Standard impulse voltage	kV	230	230	170	170

1-5.3. Hardware: In accordance with Vietnamese Standard 11-TCN37-2005

- All hardware is to be designed, manufactured and tested in order to satisfy the electro-mechanical requirements and convenient assembly. Steel utilised for hardware must satisfy the following requirements:

  + Possibility to withstand impact at the minimal temperatures, special manufactured and no defects.

  + Assembly of details to be implemented in articulated form.

  + All details to be zink-plated by hot dipping with uniform plated thickness in accordance with Vietnamese and equivalent International standards.

- Conductor clamps must satisfy the following requirements:

  + High mechanical durability

  + Possibility to bear all loading capacity of conductors

  + Possibility to withstand corrosion and negative impact from polluted environment

  + Possibility to withstand high temperature in short circuit case

  + Possibility to bear the weight of conductors

  + Surface contacting with conductor must be smooth.

  + Low corona and magnetic losses

  + Easy assembly

  + Size suitable to conductor

  + Made by aluminum alloy

  + Other details to be made by hot-dipping zink-plated steel.

1-6. Cables and conductors

1-6.1. Copper cables with PVC cover (2 and 4 core), voltage 0.6/1.0kV

- Core material: Copper fibers
- Number of core: 2 or 4
- Insulation material: XLPE, and being tested for PVC:

  + Insulation thickness

  + Mechanical durability

  + Heating durability

  + Dielectric durability

in accordance wit TCVN5844-1994, IEC 227.2; IEC332-1 and respective regulations in IEC 811.

- Standard insulating voltage: 1kV
- Other Main Technical parameters:

XLPE, PVC Copper Cable. Cross. section (mm^2)	Diameter (mm)		Weight (Kg/Km)	Resistance (Ω/Km)	Current Carrying Capacity (A)	
	Core	Cover			Indoor	Outdoor
2x1.5	1.40	10.50	127	12.10	37	26
2x2.5	1.80	11.50	155	4.41	48	36
2x4	2.25	13.00	211	4.61	63	49
2x6	2.90	14,00	285	3.08	80	63
2x10	3.80	16.00	390	1.83	104	86
2x16	4.80	18.50	535	1.15	136	115
2x25	6.00	22.00	830	0.727	173	149
2x35	7.10	24.50	1105	0.524	208	185
3x35+1x25	7.1/6.0	27.3	1680	0.254/0.727	174	158
3x50+1x35	8.4/7.1	31.1	2225	0.387/0.524	206	192
3x70+1x35	10/7.1	36.2	2985	0.268/0.524	254	246
3x70+1x50	10/8.4	36.2	3120	0.268/0.387	254	246
3x95+1x50	11.1/8.4	40.6	3910	0.193/0.387	301	298
3x120+1x70	12.6/10	45.4	5090	0.153/0.268	343	346
3x150+1x70	14/10	49.5	6055	0.124/0.268	397	395
3x185+1x70	15.6/10	54.4	7400	0.991/0.268	434	450
3x240+1x95	17.9/11.1	61.5	9600	0.754/0.193	501	538

1-6.2. Copper cable with XLPE, PVC cover (single core), voltage 0.6/1.0kV (Symbol PVC 1M…):

- Core material: Copper fiber
- Number of cores: 1
- Insulation material: XLPE, PVC, being tested for:
  + Insulation thickness

+ Mechanical durability

+ Heating durability

+ Dielectric durability

+ Resistance

in accordance with TCVN5844-1994, and applicable regulations in IEC 227.2; IEC332-1.

- Standard insulating voltage: 1kV
- Other main technical parameters:

Type of XLPE, PVC Cable	Nominal cross-section (mm^2)	Maximal resistance of conductor core at 20°C (Ω/Km)	Minimal resistance at 20°C (MΩ/Km)	Testing voltage (kV)	Manufacturing length (m)
M50	50	0.3688	10	3.5	500
M70	70	0.2723	10	3.5	500
M95	95	0.1944	10	3.5	500
M120	120	0.1560	10	3.5	500
M150	150	0.1238	10	3.5	500
M185	185	0.1001	10	3.5	500
M240	240	0.0789	10	3.5	500
M240	240	0.0789	10	3.5	500

1-6.3. Aluminum cable with XLPE, PVC cover (single core), voltage 0.38/0.66kV (Symbol AV…)

- Core material: Aluminum fibers
- Number of cores: 1
- Insulating material: XLPE, PVC, being tested for:

+ Insulating thickness

+ Mechanical durability

+ Heating durability

+ Dielectric durability

+ Resistance

in accordance with TCVN 5064-1994, IEC227.2, IEC 332-1 and applicable regulations in

IEC 811

- Standard insulation voltage: 0.66 kV
- Other main technical parameters:

-

Type of Cable	Nominal cross-section (mm^2)	Upper limit of average diameter (mm)	Max. resistance of conductor at 20°C (Ω/Km	Minimal resistance of insulation at 20°C (MΩ/Km)	Testing voltage (kV)	Manufacturing length (m)
AV 35	35	13.0	0.8347	10	3	2000
AV 50	50	15.0	0.5748	10	3	2000
AV 70	70	17.0	0.4131	10	3	1500
AV 95	95	19.0	0.3114	10	3	1500
AV 120	120	21.0	0.2459	10	3	1500
AV 150	150	23.0	0.1944	10	3	1000
AV 185	185	25.5	0.1574	10	3	1000
AV 240	240	28.5	0.1205	10	3	1000

1-6.4. Technical parameters of ABC, Aluminum core, withstanding equilateral strength:

Parameters	Unit	Nominal cross-section of conducting core, mm^2							
		16	25	35	50	70	95	120	150
Number of conductor cores	Nos	2/4	2/3/4	2/3/4	2/3/4	4	2/4	4	4
Form of conductor core		Round cross-section, tightly plaited and pressed							
Compressed stranded aluminum fibers in 1 conductor core	Nos	7	7	7	7	19(*)	19(*)	19(*)	19(*)
Minimal diameter of conductor core	mm	4.5	5.8	6.8	8.0	9.6	11.3	12.8	14.1
Maximal diameter of conductor core	mm	4.8	6.1	7.2	8.4	10.1	11.9	13.5	14.9
Maximal DC resistance of conductor core at 20°C.	Ω/km	1.910	1.200	0.868	0.641	0.443	0.320	0.253	0.206
Minimal breaking strength of conductor	kN	2.2	3.5	4.9	7.0	9.8	13.3	16.8	21

strength of conductor core									
Minimal average insulating thickness	mm	1.3	1.3	1.3	1.5	1.5	1.7	1.7	1.7
Minimal insulating thickness at any point	mm	1.07	1.07	1.07	1.25	1.25	1.43	1.43	1.43
Maximal insulating thickness at any point	mm	1.9	1.9	1.9	2.1	2.1	2.3	2.3	2.3
Maximal diameter of cable	mm	7.9	9.2	10.3	11.9	13.6	15.9	17.5	18.9
Minimal loading of clinging insulation - X-90 - X-FP-90	kg kg	+ +	+ +	+ +	100 +	140 +	190 110	240 +	300 +

Note: (*) Allowable error = ± 1 Aluminum fiber. "+": Not specified.

1-6.5. Bare Aluminum conductor with steel core (Symbol AC ...)

- Material: Aluminum, multi-fiber, steel core
- Standard: TCVN5064 - 1994
- Main technical parameters:

Type of Conductor	Max resistance of conductor at 20°C (Ω/Km)	Approximate cross-section (mm^2)			Min destroying tension (daN)	Current carrying capacity (A)
		Aluminum	Steel	Total		
AC35/6.2	0.7774	36.9	6.15	43.05	13524	175
AC50/8	0.5951	48.2	8.04	56.24	1711	210
AC70/11	0.4218	68.0	11.3	79.3	2413	265
AC95/16	0.3007	95.4	15.9	111.3	3337	330
AC120/19	0.2440	118	18.8	136.8	4152	380

1-6.6. Bare Aluminum conductor without steel core (Symbol A ...)

- Material: Aluminum multi-fiber
- Standard: TCVN5064 - 1994
- Main technical parameters:

Type of Conductor	Diameter (mm)	Resistance of conductor (Ω/Km)	Min. destroying tension (daN)	Current Carrying capacity (A)
A-16	5.1	1.98	270	105
A-25	6.4	1.28	420	135
A-35	7.5	0.92	591	170
A-50	9.0	0.64	820	215
A-70	10.7	0.46	1129	265
A-95	12.4	0.34	1478	320
A-120	14.0	0.27	1989	357

1-6.7. Bare Aluminum conductor with steel core and corrosion protection (Symbol A.A)

- Material: Aluminum multi-fiber with steel core for withstanding load, both steel and aluminum wires smeared by grease for corrosion protection
- Standard: TCVN5064 - 1994
- Main technical parameters:

Type of Conductor	Max resistance of conductor at T^o = 20°C (Ω/Km)	Approximate cross-section (mm^2)			Min. destroying tension (daN)	Amount of heat-withstanding grease (kg/km)	Manufacturing length (m)
		Al	Steel	Total			
AC.A50/8	0.5951	48.2	8.04	56.24	1711	3.0	3000
AC.A70/11	0.4218	68.0	11.3	79.3	2413	4.5	2000
AC.A95/16	0.3007	95.4	15.9	111.3	3337	6.0	2000
AC.A120/19	0.2440	118	18.8	136.8	4152	35	2000
AC.A150/19	0.2046	148	18.8	166.8	4631	42	1500
AC.A185/24	0.1540	187	24.2	211.2	5807	51	1500
AC.A240/32	0.1182	244	31.7	275.7	7505	66	1500

1-6.8. Bare Aluminum conductor without steel core, with corrosion protection (Symbol A.A)

- Material: Aluminum multi-fiber, applied by grease for corrosion protection - Standard: TCVN5064 - 1994

- Main technical parameters:

Type of Conductor	Approximate cross-section (mm^2)	Max. resistance of conductor at 20°C (Ω/Km)	Min. destroying tension (daN)	Amount of heat-withstanding grease (kg/km)	Manufacturing length (m)
A.A35	34.3	0.8347	591	2.0	3000
A.A50	49.5	0.5758	820	2.7	3000
A.A70	69.3	0.4131	1129	4.0	2000
A.A95	92.4	0.3114	1478	5.0	2000
A.A120	117.0	0.2459	1989	31.0	2000
A.A150	148.0	0.1944	2442	38.0	1500
A.A185	182.8	0.1574	2983	45.0	1500

A.A240	238.7	0.1205	3819	58.0	1500

1-6.9. Bare copper conductor (Symbol M...)

- Material: Copper multi-fiber
- Main technical parameters:

Type of Conductor	Approximate cross-section (mm^2)	Max. resistance of conductor at 20^oC (Ω/Km)	Min. destroying tension (daN)	Manufacturing length (m)
M35	34.61	0.5238	1314	3000
M50	49.4	0.3688	1745	2000
M70	67.7	0.2723	2711	1500
M95	94.6	0.1944	3763	1000
M120	117	0.1560	4684	1000
M150	148	0.1238	5515	800
M185	183	0.1001	7330	800
M240	234	0.0789	9383	800

1-7. Circuit breaker

1-7-1. Manufacturing Standard: IEC 157 - 1;
IEC 947 - 2;
IEC 898

1-7.2. Main technical parameters:

Type of Circuit Breaker	Nominal current (A)	Nominal voltage (V)	Number of circuit poles	Rated short-time withstand current (kA)	Over-current mechanism	Operating mechanism	Frequency HZ	Note
3 phase	400	415	3	16	Heat-Magnetic	Manual	50/60	Control Board in 400V cabinet of Transformer
	300	415	3	16	Ditto	Ditto	50/60	Ditto
	250	415	3	16	Ditto	Ditto	50/60	Ditto
	150	415	3	16	Ditto	Ditto	50/60	Ditto
	125	415	3	16	Ditto	Ditto	50/60	Ditto
	75	415	3	16	Ditto	Ditto	50/60	Ditto
	50	415	3	16	Ditto	Ditto	50/60	Ditto
2 phase	250	250	2	16	Ditto	Ditto	50/60	Ditto
	150	250	2	16	Ditto	Ditto	50/60	Ditto
	125	250	2	16	Ditto	Ditto	50/60	Ditto
	75	250	2	16	Ditto	Ditto	50/60	Ditto
1 phase	50	240	1	1.5	Ditto	Ditto	50/60	Ditto
	30	240	1	1.5	Ditto	Ditto	50/60	Ditto
	20	240	1	1.5	Ditto	Ditto	50/60	Ditto

1-8. Meter and Meter box

1-8.1. Meter-Manufacturing standard IEC521

No	Type of Meter	Nominal current (A)	Over-load current (A)	Nominal voltage (V)	Frequency (Hz)	Capability of withstand short-circuit current in 1μS	Starting current	Accuracy class
1	Single-phase meter - 1(4);1(3)	1	4 (3)	240	50/60	25 ÷50I_{max}	0.5%I_N	2
2	Single-phase meter - 3(9)	3	9	240	50/60	25÷50I_{max}	0.5% I_N	2
3	Single-phase meter - 5(10)	5	10	240	50/60	25÷50I_{max}	0.5% I_N	2
4	Single-phase meter - 10(40)	10	40	240	50/60	25÷50I_{max}	0.5% I_N	2
5	Three-phase meter - 3x10 (40)	10	40	240/415	50/60	25÷50I_{max}	0.5% I_N	2
6	Three phase meter 3x20(80)	20	80	240/415	50/60	25+50 Imax	0.5% I_N	2
7	Three phase meter 3x50(100)	50	100	240/415	50/60	25+50 Imax	0.5% I_N	2

1-8.2. Meter Box, Symbol H_1, H_2, H_4, H_6

1-8.2.1. Specification

No	Type	Number of meters in the box	Common Switching	Circuit Breaker or Fuse (A)
1	H_1	1	30A	1 x 20(1x30)
2	H_1*	1	3x50	3x50
3	H_2	2	30A	2x20(2x30)
4	H_2*	2	3x50	(2x3x50)
5	H_4	4	50A	4x20(4x30)
6	H_6	6	50A	6x20(6x30)

Note: Box H_1; H_2* utilized for three-phase meters.*

1-8.2.2. Material: Meter boxes made by fire protecting materials like steel, applied by electrostatic paint, innoxious or composite

1-9. Centrifugal concrete poles

1-9.1. Centrifugal concrete poles

Manufacturing standard: Centrifugal concrete poles (CCPs) manufactured in accordance with Vietnamese Standard TCVN 5847 - 1994. It is allowed to use 10.5 m, 12 A1 CCPs with the main parameters in bellow table and being manufactured according to Vietnamese standards on steel-core concrete structure.

No	Pole Symbol	Pole length (m)	Outer size		Limiting tension on pole head (kG)	Note
			Pole top (mm)	Pole bottom (mm)		
1	LT.10A	10	190	323	320	Solid stem
2	LT.10B	10	190	323	420	Solid stem
3	LT.10C	10	190	323	520	Solid stem
4	LT.10.5A	10.5	190	330	300	Solid stem
5	LT.10.5B	10.5	190	330	400	Solid stem
6	LT.10.5C	10.5	190	330	500	Solid stem
7	LT.12A1	12	190	350	340	Solid stem
8	LT.12A	12	190	350	540	Solid stem

No	Pole Symbol	Pole length (m)	Outer size		Limiting tension on pole head (kG)	Note
			Pole top (mm)	Pole bottom (mm)		
9	LT.12B	12	190	350	720	Solid stem
10	LT.12C	12	190	350	900	Solid stem
11	LT.14A	14	190	377	650	Solid stem or joining $10^m + 4^m$
12	LT.14B	14	190	377	850	Solid stem or joining $10^m + 4^m$
13	LT.14C	14	190	377	1,100	Solid stem or joining $10^m + 4^m$
14	**LT.16B**	16	190	403	920	Joining $10^m + 6^m$
15	**LT.16C**	16	190	403	1,100	Joining $10^m + 6^m$
16	LT.18B	18	190	429	920	Joining $10^m + 8^m$
17	LT.18C	18	190	429	1.200	Joining $10^m + 8^m$
18	LT.20B	20	190	456	920	Joining $10^m + 10^m$
19	LT.20C	20	190	456	1.000	Joining $10^m + 10^m$
20	LT.20D	20	190	456	1.300	Joining $10^m + 10^m$

- Thickness of concrete layers on pole top ≥ 50mm and on pole bottom ≥ 60mm.
- Mark of pole concrete at least > M300.
- Tension standing steel rod of diameter d ≤ 16mm with the minimal calculating tension $R^H_{Xmin} \geq 2600daN/cm^2$.
- Poles used must have labels specifying the type of pole and its manufacturer.

1-9.2. Pre-stressed centrifugal concrete poles (PCCP)

Main technical parameters:

No	Pole symbol	Pole	Outer size	Limiting	Note

		length (m)	Pole top (m)	Pole bottom (m)	tension on pole head (kG)	
1	LT-6(ULT)	6.0	120	184	100	One section
2	LT-6,5A(ULT)	6.5	160	230	150	One section
3	LT-6,5B(ULT)	6.5	160	230	230	One section
4	LT-7,5A(ULT)	7.5	160	244	200	One section
5	LT-7,5B(ULT)	7.5	160	344	300	One section
6	LT-8,5A(ULT)	8.5	160	255	200	One section
7	LT-8,5B(ULT)	8.5	160	255	300	One section
8	LT-10,5A(ULT)	10.5	190	330	320	One section
9	LT-10,5B(ULT)	10.5	190	330	420	One section
10	LT-10,5C(ULT)	10.5	190	330	480	One section
11	LT-12A(ULT)	12	190	350	350	One section
12	LT-12B(ULT)	12	190	350	540	One section
13	LT-12C(ULT)	12	190	350	720	One section
14	LT-12D(ULT)	12	190	350	900	One section
15	LT-14B(ULT)	14	190	377	650	One section
16	LT-14C(ULT)	14	190	377	900	One section
17	LT-14D(ULT)	14	190	377	1100	One section
18	LT-18,5C(ULT)	18.5	190	436	1000	LT-8GC+ LT-10,5C
19	LT-20C(ULT)	20	190	456	1000	LT-8GC+ LT-12C
20	LT-20D(ULT)	20	190	456	1300	LT8GD+ **LT-12D**

1-9.3. LV Line Concrete Poles

Square and centrifugal concrete poles for LV lines manufactured in accordance with Vietnamese Standards with following main parameters:

No	Pole symbol	Pole length (m)	Outer size		Limiting tension on pole head (kG)	Note
			Pole top (m)	Pole bottom (m)		
1	H6.5A	6.5	140 x 140	230 x 310	230	
2	H6.5B	6.5	140 x 140	230 x 310	360	
3	H6.5C	6.5	140 x 140	230 x 310	460	
4	H7.5A	7.5	140 x 140	240 x 340	230	
5	H7.5B	7.5	140 x 140	240 x 340	360	
6	H7.5C	7.5	140 x 140	240 x 340	460	
7	H8.5A	8.5	140 x 140	250 x 370	230	
8	H8.5B	8.5	140 x 140	250 x 370	360	
9	H8.5C	8.5	140 x 140	250 x 370	460	
10	T7.5A	7.5	D =160	D = 257	230	
11	T7.5B	7.5	D = 160	D = 257	320	
12	T7.5C	7.5	D = 160	D = 257	420	
13	T8.5A	8.5	D = 160	D = 270	300	
14	T8.5B	8.5	D = 160	D = 270	400	
15	T8.5C	8.5	D = 160	D = 270	500	

- Thickness of concrete layers ≥ 60mm on top for square poles; 50mm and ≥ 60mm on top and bottom respectively for centrifugal concrete poles.

- Mark of pole concrete at least M200 for H-form poles and M300 for centrifugal concrete poles.

- Tension withstanding steel rod of diameter d ≤ 16mm with minimal calculation tension $R^{H}_{Xmin} \geq 2600daN/cm^2$.

APPENDIX 2

PRINCIPLE DIAGRAMS AND]EQUIPMENT ARRANGEMENT PLAN

2-1. Transformer Substation

2-2. Medium Voltage Line

2-3. Low Voltage Line

2-1. Transformer Substation

2-1.1. Three-phase Transformer Substations 35/0.4kV

S35-3P.A:

Diagram of 3-phase Transformer substation 35/0.4kV with circuit breakers (CB) on the LV side

M35.2-3P.A:

Drawings of three-phase transformer substation 35/0.4kV arranged on two poles with CB on the LV side

M35.1-3PA:

Drawings of three-phase transformer substation 35/0.4kV arranged on one pole with CB on the LV side.

S35-3P.C:

Diagram of 3-phase transformer substation 35/0.4kV with fuses on the LV side

M35.2-3P.C:

Drawings of three-phase transformer substation 35/0.4kV arranged on two poles with fuses on the LV side

M35.1-3P.C:

Drawings of three-phase transformer substation 35/0.4kV arranged on one pole with fuses on the LV side

2-1.2. Phase-phase Transformer Substations 35/0.4kV

S35-2P.A:

Diagram of 2-phase Transformer substation 35/0.4kV with circuit breakers (CB) on the LV side

M35.1-2P.A:

Drawings of 2-phase transformer substation 35/0.4kV arranged on one pole with CB on the LV side

S35-2P.C:

Diagram of 2-phase transformer substation 35/0.4kV arranged on one pole with fuses on the LV side

M35.1-2P.C:

Drawings of 2-phase transformer substation 35/0.4kV arranged on one pole with fuses on the LV side

2-1.3. Single-phase Transformer Substation 35/0.4kV

S35-1P.A:

Diagram of single phase transformer substation 35/0.4kV with circuit breakers (CB) on the LV side

M35.1-1P.A:

Drawings of single phase transformer substation 35/0.4kV arranged on one pole with CB on the LV side

S35-1P.C:

Diagram of single phase transformer substation 35/0.4kV with fuses on the LV side

M35.1-1P.C:

Drawings of single phase transformer substation 35/0.4kV arranged on one pole with fuses on the LV side

2-1.4. Three-phase Transformer Substations 22/0.4kV

S22-3P.A:

Diagram of 3-phase transformer substation 22/0.4kV with circuit breakers (CB) on the LV side

M22.2-3P.A:

Drawings of three-phase transformer substation 22/0.4kV arranged on two poles with CB on the LV side

M22.1-3P.A:

Drawings of drawings of three-phase transformer substation 22/0.4kV arranged on one pole with CB on the LV side

S22-3P.C:

Diagram of 3-phase transformer substation 35/0.4kV with fuses on the LV side

M22.2-3P.C:

Drawings of three-phase transformer substation 22/0.4kV arranged on two poles with fuses on the LV side

M22.1-3P.C:

Drawings of three-phase transformer substation 22/0.4kV arranged on one pole with fuses on the LV side

2-1.5. Phase-phase Transformer Substations 22/0.4kV

S22-2P.A:

Diagram of 2-phase transformer substation 22/0.4kV with circuit breakers (CB) on the LV side

M22.1-2P.A:

Drawings of 2-phase transformer substation 22/0.4kV arranged on one pole with CB on the LV side

S22-2P.C:

Drawings of Diagram of 2-phase transformer substation 22/0.4kV with fuses on the LV side

M22.1-2P.C:

Drawings of 2-phase transformer substation 22/0.4kV arranged on one pole with fuses on the LV side

2-1.6. Single-phase Transformer Substation 22/0.4kV

S22-1P.A:

Diagram of single phase transformer substation 22/0.4kV with circuit breakers (CB) on the LV side

M22.1-1P.A:

Drawings of single phase transformer substation 22/0.4kV arranged on one pole with CB on the LV side

S22-1P.C:

Diagram of single phase transformer substation 22/0.4kV with the fuses on the LV side

M22.1-1P.C:

Drawings of single phase transformer substation 22/0.4kV arranged on one pole with fuses on the LV side

2-1.7. Transformer Substation 22/0.4kV - three single phase Transformers

S22-3x1P.A:

Diagram of substation 22/0.4kV- 3 single phase Transformers with circuit breakers (CB) on LV side

M22.1-3x1P.A:

Drawings of Transformer substation 22/0.4kV – 3 single phase transformers arranged on one pole with CB on LV side

S22-3x1P.C:

Diagram of transformer substation 22/0.4kV- 3 single phase transformers with fuses on LV side

M22.1-3x1P.C:

Drawings of Transformer substation 22/0.4kV- 3 single phase transformers arranged on one pole with fuses on LV side

2-1.8. On-ground Transformer Substation 35-22/0.4kV

ST 35(22)-3P.A:

Diagram of on-ground indoor Transformer substation (OGTS) 35- 22/0.4kV-3-phase with CB on the LV side

MT1.35(22)-3P.A:

Drawings of indoor OGTS 35-22/0.4kV - 3 phase with CB on the LV side

MT2.35(22)-3P.A:

Drawings of OGTS 35-22/0.4kV-3-phase with fuses on the LV side

ST35(22)-3P.C:

Diagram of OGTS35-22/0.4kV-3 phase with fuses on the LV side

MT35(22)-3P.C:

Drawings of OGTS 35-22/0.4kV - 3 phase with fuses on the LV line

2-2. Medium Voltage Line

CTA-DT1:

Arrangement of conductors on normal supporting poles

CTA-DT1+HA:

Arrangement of conductors on normal supporting poles for lines on common poles with LV lines

CTA-ND1:

Arrangement of conductors on single stay poles

CTA-ND1+HA:

Arrangement of conductors on single stay poles for lines on common poles with LV lines

CTA-NGP:

Arrangement of conductors on couple and Π poles

CTA-NG2S:

Arrangement of conductors on poles with double insulators

CTA-2M:

Arrangement of conductors on poles for double circuit lines

CTA-DN1:

Drawings of structure of staying single poles

CTA-DN2:

Drawings of structure of staying Π and single phase poles

MTA-1:

Drawings of structures of pole foundation types

MTA-2:

Drawings of Plate and Cylindrical foundations

TDB-35(22):

Drawings of installation of compensation capacitors on the MV line

LC-35(22):

Drawings of installation of 35(22) kV underground cables

2-3. Low Voltage Line

CHA-D1:

Arrangement of conductors on single-line supporting poles

CHA-ND1:

Arrangement of conductors on stay and couple poles

CHA-DN1:

Drawings of staying single-poles

CHA-DN2:

Drawings of staying ∏ and phase- and single-poles

MHA-1:

Drawing of pole foundation types

ABC-01:

Drawings of ABC connections with other lines

ABC-02:

Drawings of ABC connections on T-of position

ABC-03:

Drawings of ABC supporting and staying poles

ABC-04:

Drawings of ABC and equipment connections

SL-CT:

Drawings of Meter installations