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TECHNICAL RULE

EDC-TR-001

LVDB, Fuse Switch Disconnectors, Transformer LV Cables and LV Fuses Choice

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Content

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LVDB, Fuse Switch Disconnectors, Transformer LV Cables and LV Fuses Choice

1 Scope of Application

In a first part, this document defines the LVDB to be installed according to the transformer capacity as well as type of cable, metal, cross section and number of cables to be installed between a transformer and a LVDB.

This document clarify the methods and necessary equipment to be used for pole mounted transformer, built and prefabricated substation as well as one pillar substations. In addition, this document gives the LV fuse choice to be installed on LVDB monoblocks according to the downstream cable cross-section.

The second part deals with gang LV fuse switch disconnectors (LVFSD) wiring and installation on PMT located in remote areas.

2 LVDB

LVDB to be used on indoor substations, pole mounted substation, and OPS are standardized respectively by:

- EDC-DTS-LV003 V2- LV Distribution Board for Indoor Substation and OPS
- EDC-DTS-LV004- LV Distribution Board for Pole-Mounted Substation

LVDB for indoor and pole-mounted substations are very similar (except for small capacity transformers), whereas the LVDB for OPS is enclosed in a narrow volume metallic pillar and the switch operating lever is located approximately in the centre axle of LVDB.

2.1 Neutral conductor position

The neutral of the standardised LVDB is located on the left side of the LVDB as requested by EDC Technical Design Standard and Cambodia standards.

2.2 LVDB for indoor substation

Three types of LVDB are standardized according to the capacity of transformer as follows:

Designation	Maximum number of LV Monobloc outgoing feeders	Maximum transformer capacity
Type 4-800	4	400kVA
Type 8-1200	8	630kVA
Type 8-1800	8	1000kVA

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Other types of LVDB (type 4-1200 for example) **are strictly forbidden** because they are not electrically and economically justified. In fact, most of the time the LV network is overhead, and the maximum admissible current in a 3x150mm² + 70mm²N is 340 A and this current is limited by a 315A fuse.

It is largely better to install a Type 8-1200 with only 4 monobloc outgoing feeders and four reservation panels. This allows the installation of new monoblocs for powering future LV feeders for distribution or for big LV customers.

2.2.1 Transformers/LVDB cables

For indoor substations (built or prefabricated), the LV cables between transformer and LVDB are made of Copper or Aluminium with a cross-section of 240mm².

According to the transformer capacity and the LVDB, the numbers of cables are as follows:

2.2.1.1 Copper cables

Transformer capacity	LVDB	240 mm² Copper cable
100, 160, 200 and 250kVA	T4-800	One cable for each phase and one cable for neutral
315, 400kVA	T4-800	Two cables for each phase and one cable for neutral
500, 630kVA	T8-1200	Two cables for each phase and one cable for neutral
800, 1000kVA	T8-1800	Three cables for each phase and two cables for neutral

2.2.1.2 Aluminium cables

Transformer capacity	LVDB	240 mm² Aluminium cable
100, 160, 200 and 250kVA	T4-800	One cable for each phase and one cable for neutral
315, 400kVA	T4-800	Two cables for each phase and one cable for neutral
500, 630kVA	T8-1200	Three cables for each phase and two cables for neutral
800, 1000kVA	T8-1800	Four cables for each phase and two cables for neutral

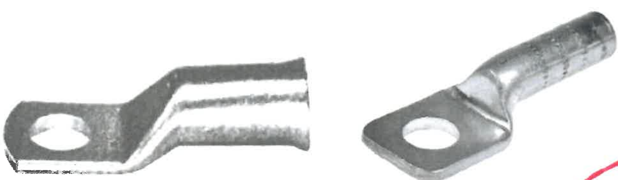
2.2.1.3 Very exceptional case

In the very exceptional case of 1250kVA transformer, 2 LVDB T8-1200 shall be installed. The number of cables as well as cross section **for each LVDB** shall be identical to for 630kVA transformer.

2.2.1.4 End lugs

2.2.1.4.1 Copper cables:

For copper cables, tinned copper lugs are hexagonally compressed on both sides.



Prefered type (massive)

Bolted lugs or slots can be used also.

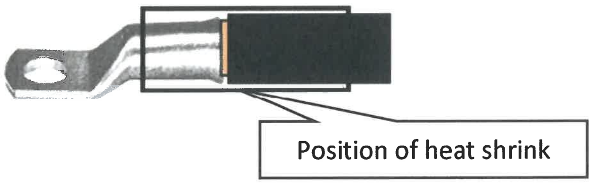
2.2.1.4.2 Aluminium cables

For aluminium cables, they are connected on both sides using standard bi-metallic lugs hexagonally compressed or deep indented.

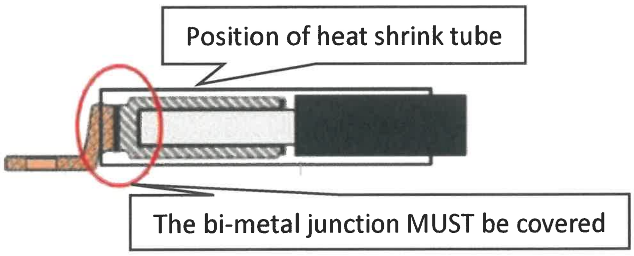
2.2.1.5 Heat shrink tube

In both cases above, the lugs are fitted with heat shrinkable tubes **with compound inside** to avoid penetration of humidity and water inside the cable as well as destroy the bi-metallic welding of the bi-metal lug by electrogalvanic corrosion.

A/ Copper lugs:

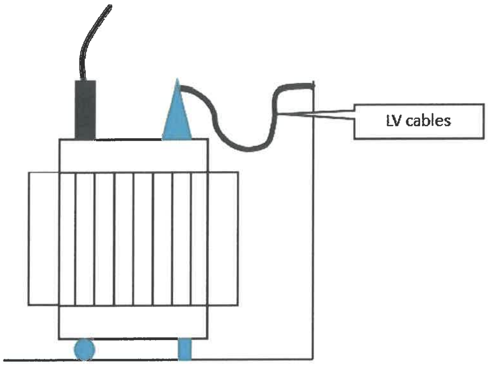


B/ Bi metallic AL/CU lugs



It is reminded that the LV cables are solidly attached to a galvanized cable tray that is connected to the earthing circuit of the substation.

A sufficient length of cable shall allow the connection of a bigger capacity or higher transformer.



2.2.2 Choice of LVDB according to the transformer and load increase

In urban and peri-urban areas, the load is characterised by a fast increasing rate. It is essential to foresee the equipment if one wants to avoid waste investment by changing equipment installed only two or three years ago.

In addition, the most difficult and time-consuming equipment to change inside a substation is the LVDB. This is why it is necessary to choose perfectly this one when a new substation, built or prefabricated, is installed on the MV/LV grid.

As standardised LVDB accommodates several transformer capacities for each LVDB type, the choice is based on the capacity of the transformer installed in the MV/LV substation at commissioning as follows:

Transformer Capacity (kVA)	Type of LVDB to be installed at substation commissioning	Recommendation
100 to 315	T4-800	Can be used with a 400kVA so this choice allows transformer capacity upgrade.
400 and 500	T8-1200	Can be used with a 630kVA so this choice allows transformer capacity upgrade.
630 to 800	T8-1800	Can be used with a 1000kVA so this choice allows transformer capacity upgrade.
1000	T8-1800	There is no possible capacity upgrade of the transformer.

In the very exceptional case of 1250kVA transformer, 2 LVDB T8-1200 shall be installed. Anyway, this is largely better to install 2 x 630kVA transformers if the substation is large enough.

In all cases, as the general metering CT's need to be changed, **the cable link between the transformer and the LVDB shall be upgraded in accordance with the chapter 2.1.1 when upgrading the transformer capacity.**

2.3 LVDB for pole-mounted substation

2.3.1 Pole-mounted substation with a Transformer Capacity Max. of 160kVA with LVDB

Only one type of specific LVDB for pole-mounted substation shall be installed for the following transformers:

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	Transformer capacity (kVA)
Two-phase transformers	25, 30, 50, 75
Three phase transformers	25, 50, 100, 160

For this purpose, only fuse number installed and fuse ampacity will change according to the transformer type, capacity, and LV cable. The fuse board and the cabinet shall be identical for all transformer capacities and shall allow the upgrading of the transformer only with fuse ampacity changing.

For 2-phase transformers with 2 LV wires (25 or 30kVA), 2-phase transformers with 3 LV wires (50, 75, 100 kVA), and 3-phase transformers (50, 75, 100 and 160 kVA), the same LVDB comprising four poles fuse cut out (Size 2 fuse) included in a small cabinet (about 530 x 530 x 250 mm) is installed onto one pole using 0.7x20 mm stainless steel strap or bolts and metallic collars (See EDC-DTS-LV004).

2.3.1.1 PMT Transformer/LVDB cable

In all cases, the cable link between the transformer and the LVDB shall be done using LV ABC aluminium conform to EDC-DTS-LV001 as follows:

Transformer type	No. of LV bushings	ABC type
Two phases 25 and 30kVA	2 bushings (a, n)	3 x 70 mm² + 70 mm² N
Two phases 50, 75, 100kVA	3 bushings (a, b, n)	3 x 70 mm² + 70 mm² N
Three phases less than 100kVA	4 bushing (a, b, c, n)	3 x 70 mm² + 70 mm² N
Three phases 100 and 160kVA	4 bushing (a, b, c, n)	3 x 150 mm² + 70 mm² N

Installation of ABC 3 x 150 mm² + 70 mm² N is the preferred solution even for small capacity transformers because later when loads will increase and the transformer capacity will be increased, the wiring remains not to be upgraded.

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For 2 and 3 LV wires transformers, only the necessary conductors will be connected so respectively:

- Neutral and Phase 1 for 2 LV wire transformers
- Neutral and phase 1 and 2 for 3 LV wire transformers

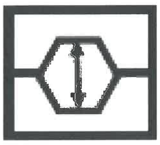
The not-used conductors shall be carefully insulated and protected against water penetration by installation of insulation end caps conform to the requirement of EDC-DTS-LV002 standard.

2.3.1.1.1 ABC connection on transformer LV bushings

This ABC shall be connected to the transformer LV bushing using pre-insulated bi-metallic lugs (conform to EDC-DTS-LV002 standard) hexagonally compressed onto the ABC conductors.

The minimum force of the hydraulic press shall be 50kN and the hexagonal dies to be used shall be as follows:

- 70mm² neutral (white colour): E173
- 150mm² phases (violet colour): E215



Nevertheless dies verification shall be done on site before compression by reading the die reference directly onto the lug to be compressed.

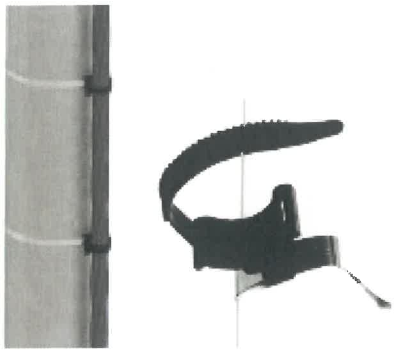
2.3.1.1.2 ABC fixing along the pole

The ABC shall be **mandatorily attached** all along the pole.

This shall be done using 0.4x20mm stainless steel strap (EDC-DTS-MV015) and insulated brackets for stainless steel strap (30 to 50mm) every meter conforms to EDC-DTS-LV002.

It will be necessary to install **two brackets for each stainless steel strap**:

- one for the cable link between the transformer and the LVDB
- one for the LV feeder from the LVDB to the overhead LV ABC



2.3.1.1.3 Connection on LVDB

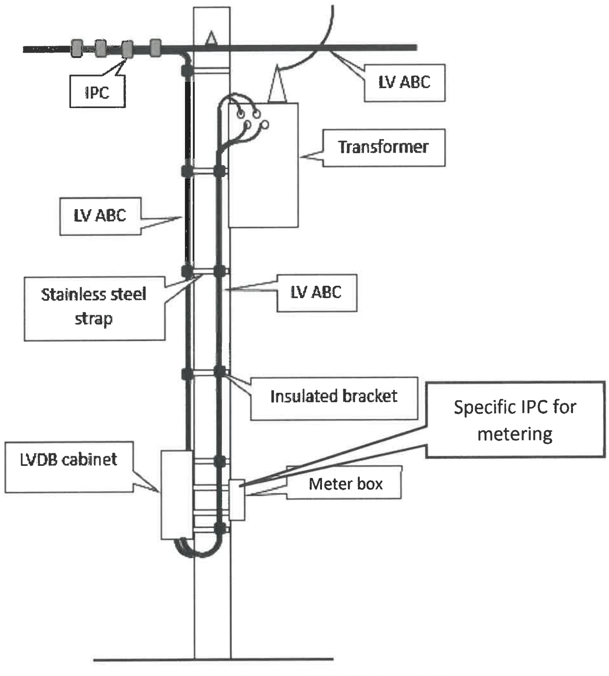
The connection on the LVDB is done directly on the terminals without the need for other accessories.

2.3.1.1.4 Location of current transformers for metering

The necessary CT for substation LV general metering shall installed advantageously inside the LVDB cabinet onto the outgoing LV ABC.

A metering box conforming to the requirement to EDC requirements containing the LV meter shall be fixed on the pole in the opposite side of the LVDB cabinet.

2.3.1.2 Schematic drawing



Installation on double pole substation is similar

2.3.2 Pole-mounted substation with a Transformer Capacity of 200 kVA and more

The LVDB are identical to the LVDB for indoor substation but they are enclosed in a glass fibre-reinforced polyester cabinet.

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Designation	Maximum number of LV Monobloc outgoing feeders	Transformer capacity kVA
Type 4-800	4	200, 250, 315, 400
Type 8-1200	8	500, 630

Other types of LVDB (type 4-1200 for example) are **strictly forbidden** because they are not electrically and economically justified. In fact, most of the time the LV network is overhead, and the maximum admissible current in a 3x150mm² + 70mm²N is 340A and this current is limited by a 315A fuse.

It is largely better to install a Type 8-1200 with only 4 monobloc outgoing feeders and four reservation panels. This allows the installation of new monoblocs for powering future LV feeders for distribution or for big LV customers.

LVDB cabinets are fixed on two U beams (70 mm) attached between the two poles.

2.3.2.1 Transformer/LVDB cable

Two cases are considered:

- 200, 250, 315kVA transformers
- 400 kVA, 500kVA and 630kVA transformers

2.3.2.1.1 200, 250, 315 kVA transformers

Only Type 4-800 LVDB shall be used.

The cable link between the transformer and the LVDB shall be done with **2 aluminium ABC 3x150mm² + 1x70mm conform to EDC-DTS-LV001 connected in parallel.**

The connection on the transformer and on the type 4-800 LVDB shall be done using pre-insulated lugs for LV ABC as described afore.

2.3.2.1.2 400 kVA and more transformers

Type 4 LVDB shall be used for 400kVA and type 8-1200 for 500 and 630kVA transformers.

The LV cables between the transformer and LVDB are made of aluminium with a cross-section of 240 mm².

Transformer capacity	LVDB	240 mm² Aluminium
400kVA	T4-800	Two cables for each phase and one cable for neutral
500, 630kVA	T8-1200	Three cables for each phase and two cables for neutral

2.3.2.1.3 Cable lugs

For aluminium cables, they are connected on both sides using standard bi-metallic lugs hexagonally compressed or deep indented.

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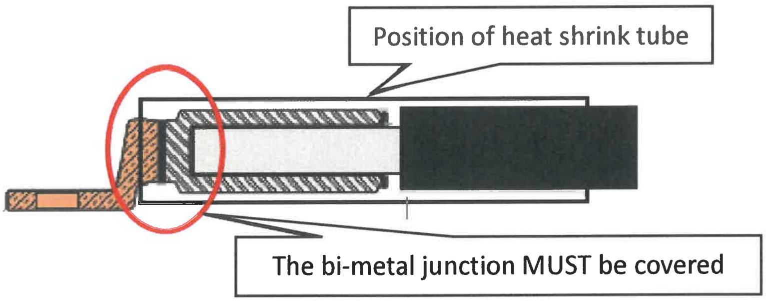
2.3.2.2 Heat shrink tube

The lugs are fitted with heat shrinkable tubes **with compound inside** to avoid penetration of humidity and water inside the cable as well as destroy the bi-metallic welding of the lug by electro-galvanic corrosion.



2.3.2.3 Choice of LVDB according to the transformer and load increase

In case the substation is installed in a fast-growing loads area, the chapter 2.2.2 shall be applied.

2.3.2.4 Cables and ABC fixing along the poles

The ABC and aluminium cables shall be **mandatorily attached** all along the pole every meter in the manner described above in paragraph 2.2.1.2.

For that, insulating brackets for stainless steel straps conform to the requirement of EDC-DTS-LV002 shall be used.

Two dimensions are available:

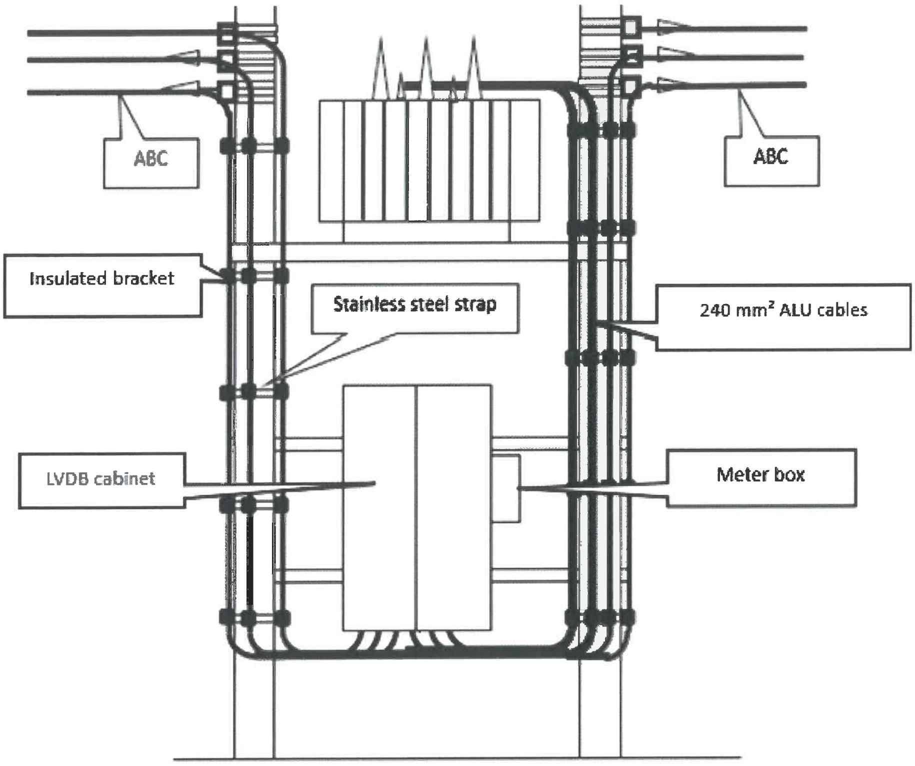
- For cable with a diameter from 30mm to 50mm
- For cable with a diameter from 50mm to 90mm

Smaller brackets shall be used for fixing a single ABC and bigger will be advantageously used for attaching several (3 maximum) 240mm^2 aluminium insulated conductors or 2 ABC.

2.3.2.5 Location of current transformers for metering

The necessary CT for substation LV general metering shall installed advantageously inside the LVDB cabinet onto the incoming LV cables, behind the LVDB.

2.3.2.6 Schematic drawing



Sample of 500 or 630 kVA PMT with 6 LV feeders

2.4 LVDB for one pillar substation

The LVDB for one pillar substation is defined by EDC-DTS-LV003.

Only one 1200 Amperes LVDB with a maximum of 4 feeder monoblocs (max 400A) is suitable for all transformer capacities.

Its small volume allows the LVDB to be easily installed inside the pillar. The operating lever is located approximately in the axle of the LVDB.

2.4.1 Transformer/LVDB cable

For OPS the LV cables between the transformer and LVDB are made of aluminium with a cross-section of 240mm².

According to the transformer capacity and the LVDB, the number of cables is:

Transformer capacity	LVDB	240 mm² Aluminium cable
250kVA	TR4-1200 OPS	one cable for each phase and one cable for neutral
400kVA	TR4-1200 OPS	Two cables for each phase and one cable for neutral
630kVA	TR4-1200 OPS	Three cables for each phase and two cables for neutral

As there is only one LVDB type for all capacity of OPS transformer, the transformer capacity upgrade (from 250 to 400kVA and from 400 to 630kVA is always possible by adding the correct number of LV cable links between the transformer and LVDB.

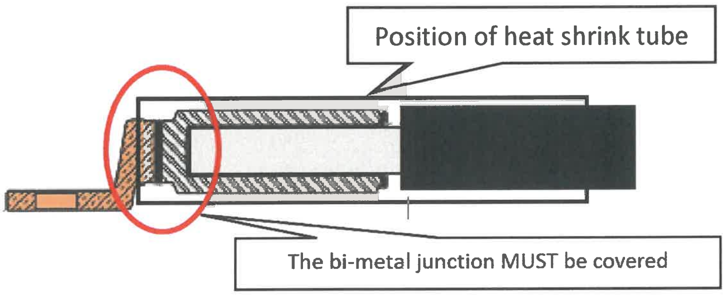
It is reminded that the LV cables being solidly attached inside the pillar if possible to a galvanized cable tray that is connected to the earthing circuit of the substation.

2.4.1.1 Cable lugs

For aluminium cables, they are connected on both sides using standard bi-metallic lugs hexagonally compressed or deep indented.

2.4.1.2 Heat shrink tube

The lugs are fitted with heat shrinkable tubes **with coumpound inside** to avoid penetration of humidity and water inside the cable as well as destroy the bi-metallic welding of the lug by electrogalvanic corrosion.



2.5 LV fuse choice for LVDB

2.5.1 General

First of all, fuses are installed on the network in order that a problem on the fuse downstream equipment being not reflected on the upstream network and equipment.

The protection against pole-mounted transformer problems is done by the expulsion fuses installed in the fuse cut-outs.

For indoor transformers protected by RMU, the overload protection with MV fuses is not possible and in urban areas the main choice is priority for energy supply. In urban or peri-urban area despite transformers could accept temporarily 120 or 130% overload, it is **necessary to monitor and check the LV loads on monoblocs or cables between transformer and LVDB** in order to know if a transformer (or LV feeder) begin to be overloaded. **The monitoring of the loads on a transformer is easy to implement by using a specific equipment connected to the general meter substation or on the metering current transformer. Specific long period current recorders are widely available on the market.**

2.5.2 Indoor substations

LV fuses to be installed on monoblocs are of size 2 according to the requirement of EDC-DTS-LV003.

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Fuses shall be installed on monobloc using the **specific transparent fuse holder that must mandatorily stay on the fuse after fuse installation.**

The current of LV fuses is chosen according to the cross-section downstream (LV feeder) and the LV load. The main cross-section must be taken into account.

As example:

- LV overhead feeder: ABC 3x150 + 1x70N
- Link between monobloc and ABC: Underground cable 3x240 + 1x120

The main cross section is the ABC 3x150 + 1x70N so LV fuses must be chosen accordingly.

2.5.3 Table of LV fuses choice

2.5.3.1 Indoor substations, OPS, and pole mounted transformers of 200 kVA and more

The following table shall be applied:

Aluminium cables cross-section	Type of cable	Maximum Fuse rating
3x50mm² + 50mm²	UGC	125A
3x70mm² + 1x70mm²N	ABC	200A
3x95mm² + 50mm²	UGC	250A
3x150mm² + 1x70mm²N	ABC	315A
3x150mm² + 95mm²	UGC	315A
3x240mm² + 120mm²	UGC	315A

Installation of higher current fuses for each type of cable is STRICLY FORBIDDEN.

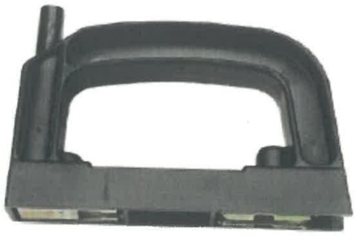
It is recalled that the fuse rating must be chosen according to the loads connected onto the cable. As example a 250A fuse shall be installed on a 3 x 150mm² + 70mm² N LV ABC if the connected loads are less than this current. When the loads will increase, it shall be possible to install 315A fuses.

In case of a direct cable supplying energy to a big consumer, the fuse shall be chosen according to the maximum current subscribed by this customer.

2.5.3.2 Pole-mounted substation with a Transformer Capacity of 160kVA Maximum and specific LVDB

In that case, the specific LVDB allows the connection of only one cable.

As for monoblocs, the fuse is size 2. For installation, the fuses need to be inserted with a removable fuse handle that is also suitable for all fuse sizes.



It is **strongly recommended** that the cross-section of the LV network be chosen according to the maximum capacity of the transformer (taking into account the voltage drops) as well as the fuse ratings as follows according to the number of LV wires.

2.5.3.2.1 2 LV bushing 1P + N

Transformer capacity	Current / phase	ABC cross-section	Maximum Fuse rating
25kVA	109A	ABC 2x1Cx35mm² (ABC 2x1Cx50 mm² preferred)	100A
30kVA	130A	ABC 2x1Cx50mm²	125A

2.5.3.2.2 3 LV bushing 2P + N

Transformer capacity	Current / phase	ABC cross-section	Maximum Fuse rating
50kVA	109A	2 x ABC 2x1Cx50mm²	100A
75kVA	163A	2 x ABC 2x1Cx70mm²	160A
100kVA	217A	2 x ABC 2x1Cx70mm²	200A

2.5.3.2.3 4 LV bushing 3P + N

Transformer capacity	Current / phase	ABC cross-section	Maximum Fuse rating
50kVA	72A	ABC 3x1Cx70 + 1Cx70mm² N (4x35 possible if short length)	63A
75kVA	105A	ABC 3x1Cx70 + 1Cx70mm² N	100A
100kVA	151A	ABC 3x1Cx70 + 1Cx70mm² N	160A
160kVA	225A	ABC 3x1Cx150 + 1Cx70mm² N	250A

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3 PMT with Gang LV fuse switch disconnectors

Use of Gang LV fuse switch disconnectors is authorized only **in PMT located outside cities when the transformer capacity is equal to or less than 250kVA.**

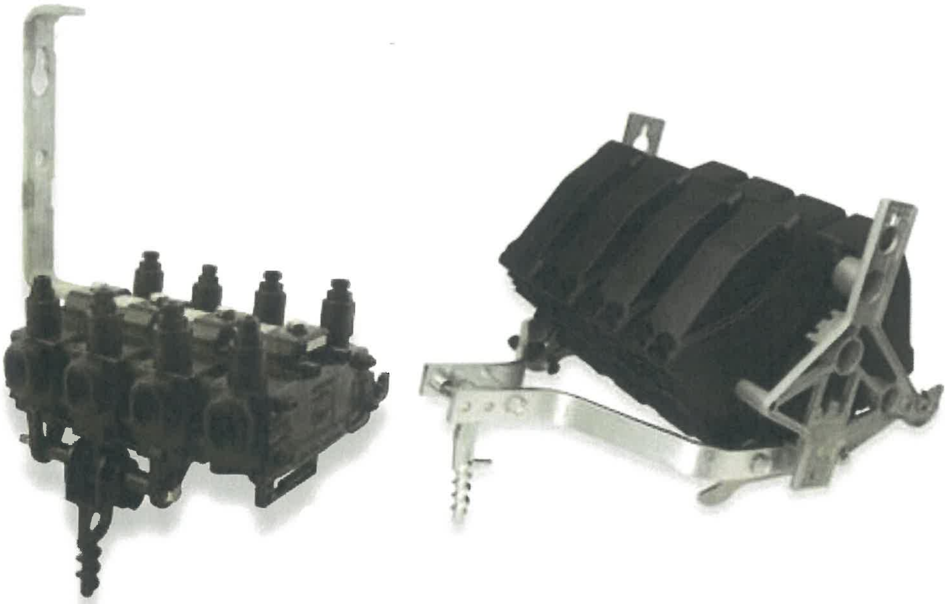
The number of LV feeders is limited to 2 LV feeders maximum.

3.1 LV gang fuse switch disconnectors (FSD)

All LV gang fuse switch disconnectors shall be of 4 poles only (Neutral + 3 phases) or 2 poles (Neutral + phase) because the neutral scheme of LV network is TT so the neutral is considered as active conductor.

2 kinds of LV gang fuse switch disconnectors shall be used:

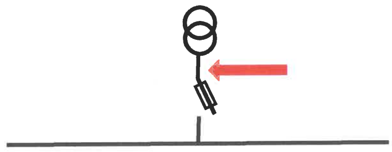
- 160A with size 3 LV fuses (size 2) plus one neutral bar.
- 400A with size 3 LV fuses (size 2) plus one neutral bar.



3.2 Cables between transformer and FSD number (general case).

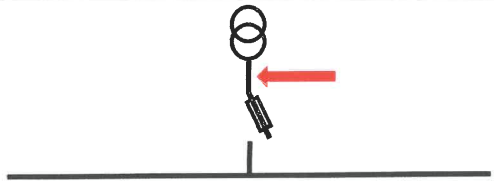
According to transformer type and capacities, the following **LV cable between transformer and FSD gang** max number shall be used:

Transformer capacity	Current	Transformer/FSD Cable	Maximum number of FSD
		2 LV bushing 1P + N	
25kVA	109A	ABC 2x1Cx35 mm² (ABC 2x1Cx50 mm² preferred)	1x (1x160A+N)
30kVA	130A	ABC 2x1Cx50 mm²	1x (1x160A+N)



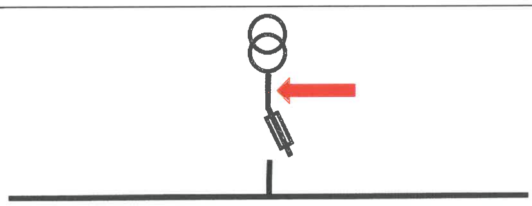
LV feeder

		3 LV bushing 2P + N	
50 kVA	109 A	2 x ABC 2x1Cx50 mm²	1x (2x160A+N)
75 kVA	163 A	2 x ABC 2x1Cx70 mm²	1x (2x160A+N)
100 kVA	217 A	2 x ABC 2x1Cx70 mm²	1x (2x400A+N)



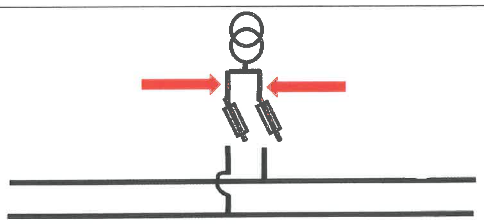
LV feeder

		4 LV bushing 3P + N	
50	72 A	ABC 3x1Cx70 mm²+ 1Cx70mm²N	1x(3x160A+N)
75	105 A	ABC 3x1Cx70 mm²+ 1Cx70mm²N	1x(3x160A+N)
100	151 A	ABC 3x1Cx70 mm²+ 1Cx70mm²N	1x(3x160A+N)
160	225 A	ABC 3x1Cx150 mm² + 1Cx70 mm²N	1x(3x400A+N)



LV feeder

250	352	2 x ABC 3x1Cx150 mm² + 1Cx70 mm²N	2x(3x400A+N)



LV feeders

3.3 Case with strict necessity to install more FSD

For some exceptional cases, it could be necessary to install more FSD.

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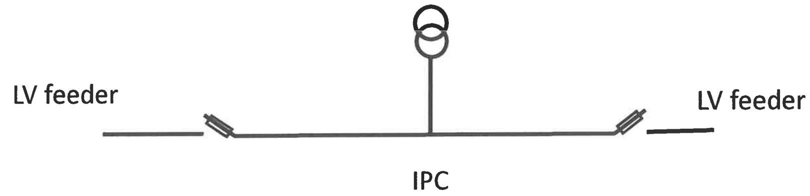
In those cases, the FSD shall be mandatorily installed on the first LV pole after the PMT. The cable link cross-section between the Transformer LV bushings and the ABC shall be the same as mentioned above and it shall be connected to the LV ABC feeder using IPCs.



3.4 Connection onto LV Transformer bushings

The connection of the ABC link is done using exclusively pre-insulated lugs as per chapter 2.3.1.1.1 afore.

3.5 LV fuse maximum rating.

Refer above.

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