

## **2. LOAD ESTIMATE**

### **MAIN CONSIDERATIONS**

This instruction establishes the following classification:

- Buildings mainly intended for housing.
- Commercial use or office buildings.
- Buildings destined to specific industries use.
- Buildings destined to industrial clustering use.

These estimates shall be compulsory for every new installation or modification over the existing ones.

### **ELECTRIFICATION LEVEL AND POWER ESTIMATE FOR HOUSING**

The maximum load per home depends on the usage level desired. Thus, the following electrification levels are established: basic and high.

#### *• Basic electrification*

It's the one needed for the coverage of the possible primary usage needs without having to resort to further adaptation works.

It must allow the proper functioning of a house's commonly used electrical devices. It corresponds to the minimum estimated installation, with a power of 5750W. That is obtained as a product of the new European voltage (230V) and the 25A of the MI (mains isolator).

Five compulsory circuits are considered in basic electrification installations, all of them protected by a single residual-current device:

- Lighting (only pre-installed lights, not including outlets).
- General use circuit (outlets).
- Stove and oven.
- Washing machine.
- Outlets and lighting of humid premises.

#### *• High electrification*

It's the one devised for housing with a higher estimated electrical appliance/white good usage than that of a basic electrification one. It's also applicable on those that expect using electrical heating systems, air conditioning devices, have net floor areas over 160m<sup>2</sup> or those incurring any combination of the previously stated situations.

For high electrification houses, the power estimate shall never be less than 9200W (40A).

### Power estimate

The developer, owner or user of the premises shall set the estimated power, in agreement with the supply company. For new buildings, its value won't be inferior to 5750W at 230V for every single house, with independency of the power later hired by each user, which shall depend on their particular usage of the electrical installation.

In any of the cases, the estimated power shall be given by the maximum capacity of the installation. Likewise, that capacity shall be determined by the intensity of the MI.

### TOTAL LOAD OF A BUILDING MAINLY INTENDED FOR HOUSING

The total load of a building mainly intended for housing results from the addition of: the loads of the group of flats itself, those of the building's general services, those of its commercial premises and those of the parking lots that belong to it.

The total load of a group of flats or services shall be obtained in accordance to the following sections:

### Load of the group of flats

It shall be obtained by multiplying the arithmetical average of the maximum expected power on each house and the simultaneity coefficient determined by the following chart, depending on the number of premises.

Number of premises	Simultaneity coefficient	Number of premises	Simultaneity coefficient
1	1	12	9.9
2	2	13	10.6
3	3	14	11.3
4	3.8	15	11.9
5	4.6	16	12.5
6	5.4	17	13.1
7	6.2	18	13.7
8	7	19	14.3
9	7.8	20	14.8
10	8.5	21	15.3
11	9.2	n>21	15.3+(n-21) x 0.5

### Simultaneity coefficient

For those buildings whose installation is prepared for the application of the night tariff, simultaneity shall be 1 (simultaneity coefficient = number of premises).

#### Load of the building's general services

It shall be the sum the power estimates of: lifts; other elevating devices; heat and cold treatment stations; water pumping stations; hall, staircase and common areas' lighting; intercom and telecom stations, etc. No simultaneity reduction factor shall be applicable in any part of this electrical service (simultaneity factor = 1).

The most usual services to consider are:

- Lift: 3500W
- Intercom + Telecom stations: 1500W
- Common areas' lighting (area must be previously calculated):
  - 4W/m<sup>2</sup> for fluorescent lighting
  - 15W/m<sup>2</sup> for incandescent lightning

#### Load of the building's commercial premises

It shall be calculated by using an estimate value of 100W/m<sup>2</sup> of its area, with a minimum of 3450W (15A) at 230V per premise and simultaneity coefficient = 1.

#### Load of the building's parking lot

It shall be calculated by using an estimate value of 10W/m<sup>2</sup> in natural air circulation parking lots and 20W/m<sup>2</sup> for those in need of forced air circulation means, with a minimum of 3450W (15A) at 230V and simultaneity coefficient = 1.

When implementation of NBE-CPI-96 makes it necessary to use a forced air circulation system, as to appropriately evacuate an eventual fire's smoke, the load estimate of the parking lot shall be specifically calculated.

#### TOTAL LOAD BUILDINGS DESTINED TO COMMERCIAL USE, OFFICES OR SINGLE/CLUSTERED INDUSTRIES

Usually, the power demand shall determine the estimated load in these situations, never being less, though, than the following values:

#### Commercial use or office buildings.

It shall be calculated by using an estimate value of 100W/m<sup>2</sup>, with a minimum of 3450W (15A) at 230V per premise and simultaneity coefficient = 1.

Buildings destined to industrial clustering use.

It shall be calculated by using an estimate value of  $125\text{W}/\text{m}^2$ , with a minimum of 10350W (45A) at 230V per premise and simultaneity coefficient = 1.

CALCULATION PROCESS

- 1 - Define housing electrification level.
- 2 - Assign the proper simultaneity coefficient according to the number of flats.
- 3 - Calculate the load of the group of flats.
- 4 - Calculate the load of the building's general services.
- 5 - Calculate the load of the building's commercial premises according to its area.
- 6 - Calculate the load of the building's parking lot according to its area.
- 7 - Calculate the total load by adding all the previously calculated partial loads.

### **3. LOW VOLTAGE DISTRIBUTION NETWORK**

#### **3.1. OVERHEAD LOW VOLTAGE DISTRIBUTION LINES**

##### MATERIALS

##### Conductors

Conductors used in overhead lines shall be made of copper, aluminum or any other material or alloy with proper electrical and mechanical properties. Preferably, they shall be insulated.

##### *• Insulated conductors.*

Insulated conductors shall have no lesser assigned voltage than 0,6/1kV, and their insulating cover shall guarantee good resistance to the elements.

Minimum allowed section for aluminum conductors shall be 16mm<sup>2</sup>, and for those made of copper it shall be 10mm<sup>2</sup>. For any other material, it shall be that which guarantees a mechanical resistance and electrical conductivity no lesser than the ones previously stated for copper ones.

##### *• Bare conductors.*

Bare conductors shall be resistant to the elements, and its minimum traction breaking load shall be 410daN.

Any conductor with less than 0,6/1kV nominal voltage insulation shall be regarded as a bare conductor.

Their implementation shall only be allowed in special and appropriately justified situations, excluding woodland areas and those with high fire risk.

##### Insulators

Insulators shall be made of porcelain, glass or any other insulating materials capable of withstanding the elements, especially temperature variation and corrosion. Those must offer, however, equal mechanical resistance and insulating level to that of porcelain and glass insulators.

Their attaching to the pylons shall be made by screwing action or cementation. This shall be performed by using substances that shall not cause harm to any of the parts. Neither shall they be subjected to size variations that may pose a risk to the insulators themselves or to their attaching.

### Attaching accessories

Accessories used on overhead lines must be adequately protected against corrosion and aging. They shall also be able to withstand any mechanical stress they may be subjected to, with a security coefficient no lesser than that of the pylon they are installed on.

### Supports

Supports may be made of metal, concrete, wood or any other material properly authorized by the competent authority. They shall have to feature high resistance to the elements, and, in case they don't have it per se, they shall have to be adequately treated towards that end.

### Braces y struts

Braces shall be made by ribs or metal wires, properly protected against corrosion, with a minimum breaking load of 1.400daN.

Struts may be made of metal, concrete, wood or any other material capable of withstanding the stresses it's subjected to and properly protected against the elements. Both braces and struts usage must avoided if possible.

## INSTALLATION EXECUTION

### Insulated conductors lay out

Conductors with insulating covers, with less than 0,6/1kV nominal voltage shall be regarded, for the purposes of lay out, as a bare conductors.

Insulated conductors with less than 0,6/1kV nominal voltage may be installed as:

#### *• Set wires.*

Directly set over facades or walls, using elements-resistant attached clamps. Conductors shall be adequately protected in those places where they may suffer any deterioration, be it mechanical or any of other type.

On empty spaces, conductors shall be considered taut. Generally, a minimum height of 2,5m to the ground must be kept at all times. Near to facades' openings, the following minimum distances must be kept:

- Windows: 0,3m to the upper edge and 0,5m to the inferior and side ones.
- Balconies: 0,3m to the upper edge and 1m to the side ones.

· *Taut wires.*

Wires with a neutral guarantor may be taut between special pieces placed over the supports, facades or walls, with an appropriate mechanical tension, not taking into consideration for this calculation the insulation as a resistant element. For the rest of the taut wires, galvanized steel guarantors shall be used, with a breaking resistance no lesser than 800daN. Insulated conductors shall then be attached to them by using clamps or other proper mechanisms.

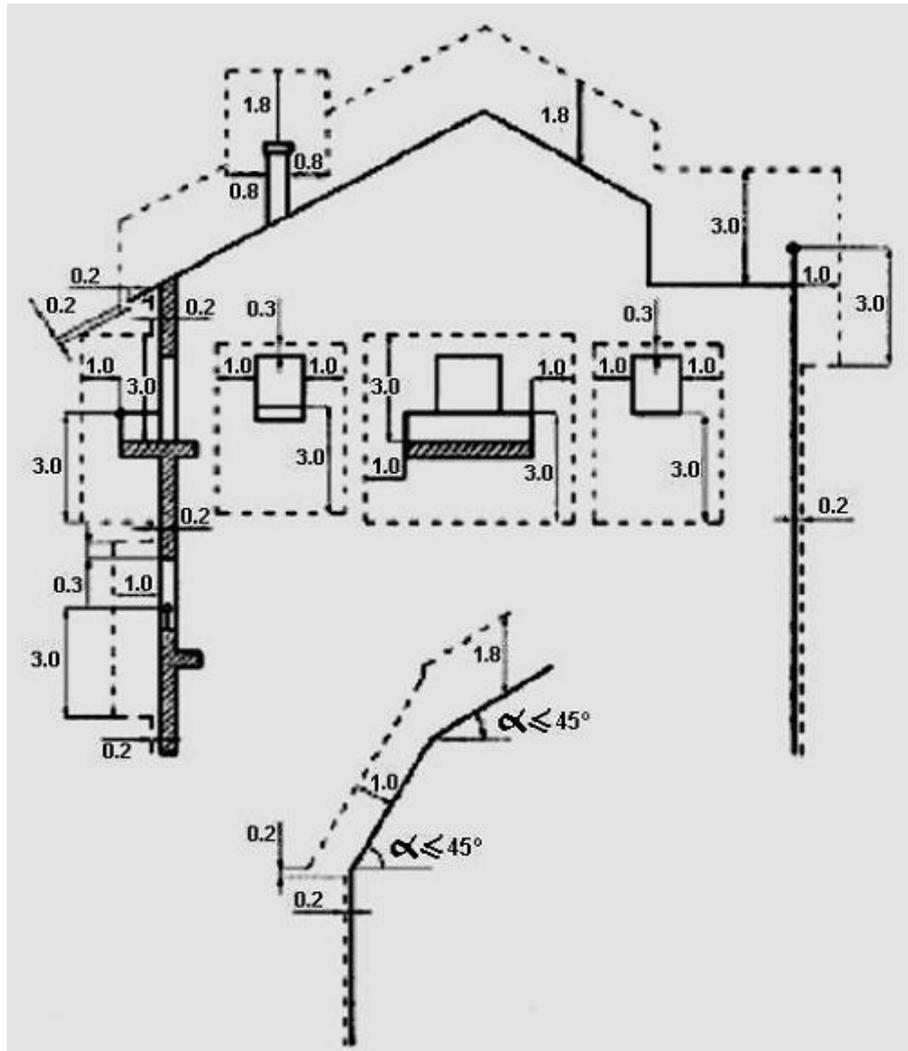
- Distance to the ground: 4m, except for the one needed in crossing cases.

Bare conductors lay out

Bare conductors shall be attached to the insulators in a way that guarantees their correct position in the insulator and so that it doesn't imply a noticeable weakening of its own mechanical resistance nor produce any corrosion effect. The attachment of the conductors to the insulator must be made, preferably, on the latter's side groove, nearest to the support. In case of making it at an angle, it shall be set so that the conductor's mechanical stress is faced against the insulator.

Distance of bare conductors to the ground and building's protection zones:

- *To the ground:* 4m, except for the one needed in crossing cases.
- *Protection zones:* protection zones' limits are established in the following chart.



Protection zones for bare conductors

Minimum distances between bare conductors of different polarity, and between them and buildings' walls, shall be no less than:

- Openings up to 4m: 0,10m
- Openings from 4 to 6m: 0,15m
- Openings from 6 to 30m: 0,20m
- Openings from 30 to 50m: 0,30m
- For openings bigger than 50m, the following formula must be used. F is the maximum deflection (expressed in meters).

$$D = 0,55 \cdot \sqrt{F}$$

In supports housing branches, distance between every and each of those branches and the conductors of different polarity of the main line may be reduced down to 50% of the previously stated values, being no less than 0,10m in any case.

These conductors, placed over supports properly attached to the facades of the building shall be separated, at least, 0,20m from its surface.

#### General conditions for crossing cases and parallelisms

##### · ***Crossing cases***

· *With high voltage electrical lines.*

Low voltage line must cross under the high voltage one. Minimum vertical distance between both conductors (d), worst case scenario, shall not be less than

$$d \geq 1,5 + (U + L1 + L2) / 100$$

- U = Nominal voltage, in kV, of the high voltage line.
- L1 = Distance, in meters, from the junction to the nearest support of the high voltage line.
- L2 = Distance, in meters, from the junction to the nearest support of the low voltage line.
- Protection wires shall be made of galvanized steel and grounded.

· *Among low voltage electrical lines.*

In case any of the lines has bare conductors, if established in different supports, distance between the nearest conductors of the two lines shall be more than 0,50m. If the crossing point happens at the same support, distance shall be determined by the previous point formula. If both lines are insulated, they may be in contact.

· *With overhead telecom lines.*

Low voltage lines with bare conductors must cross over the telecom ones. Exceptionally they may cross under them, adopting one of the following solutions:

- Placing a protection device between both lines, consisting in a bundle of steel wires, situated amidst of them, with enough mechanical resistance to withstand the weight of the telecom line conductors in case they were to break or fall down. Protection wires shall be made of galvanized steel and grounded.
- Using insulated conductors in the low voltage line of 0,6/1kV in the crossing segment.
- Using insulated conductors in the telecom line of 0,6/1kV in the crossing segment

If the crossing happens in different supports, minimum distance between bare conductors of low voltage and telecom lines shall be no lesser than 1m. If the crossing happens at the same support, distance may be decreased down to 0,50m.

· *With highways and non-electrified railroads*

Conductors shall have a breaking resistance no lesser than 410daN, accepting a value of 280daN in insulated conductors' connections. Minimum height of the lowest conductor, worst deflection scenario, shall be 6m.

Conductors shall not have any joint in the crossing segment, admitting however, during exploitation and for maintenance duties, one joint per segment.

· *With electrified railroads, trams and trolley buses.*

Minimum height of the conductors over the line or supporting wiring and conductors of the contact line shall be 2m.

Moreover, in the case of railroads, trams or trolley buses with connecting devices that may accidentally disconnect from their respective contact line, electrical line conductors shall have to be at enough height so that, upon disconnection of the device, it shall never reach a position, worst case scenario, at less than 0,30m to the low voltage line conductors themselves.

· *With wire cars and transportation wires.*

In case low voltage line runs over the other system, minimum distance between conductors and any element of the wire car installation shall be 2m.

In case low voltage line runs under the other system, the distance shall not be less than 3m. Wire car's adjacent supports to the crossing segment shall be grounded.

· *With rivers and navigable or floatable waterways.*

Minimum height between the conductors and the water surface for its maximum reaching level shall be  $h = G + 1m$ , G being the gauge. In cases of gauge not being specified, it shall be considered to be of 6m.

· *With radio and TV antennas.*

Conductors of the low voltage line, when bare, shall be kept, at the very least, 1m away of the antenna itself, its braces and connections, were they not to be attached to the walls to prevent the possible contact with said line.

It is forbidden to use the low voltage line's supports and pylons to attach radio or TV antennas and/or their braces.

· *With water and gas pipelines.*

Minimum distance between electrical power lines and water or gas pipelines shall be 0,20m. Crossing over the water or gas pipelines' joints and the electrical lines joints shall be avoided as much as possible, placing them further than 1m to the crossing point. For bare conductor overhead lines, minimum distance shall be 1m.

· ***Proximities and parallelisms***

· *With high voltage electrical lines.*

High Voltage Overhead Electrical Lines Regulation directives shall be upheld, so as to avoid placing lines parallel to those of high voltage closer than 1,5 times the height of the highest pylon located in the segment where conductors are closest.

The previous directive shall not affect power plants Access lines, transformer stations and transformer nodes. These situations shall be subjected to the high voltage installation regulation directives. However, parallelisms of lines with 66kV maximum voltage shall never feature distances inferior to 2m between the contiguous conductors, 3m in case of higher voltages.

Low voltage electrical lines may share high voltage ones' pylons as long as the following requirements are met:

- High voltage line's conductors shall feature a minimum breaking resistance of 480daN and be placed over those of low voltage.
- Distance between the closest conductors of both lines shall be, at the very least, same as the one between the high voltage conductors.
- Shared pylons must feature a sign, placed between the low and high voltage lines warning all low voltage works assigned personnel of the dangers surrounding the high voltage line running over them.
- Low voltage line insulation shall not be lesser than that of high voltage line's grounding line's one.

· *With other overhead low voltage or telecom lines.*

If both lines feature insulated conductors, minimum distance shall be 0,10m. If either of the lines features bare conductors, minimum distance shall be 1m. If both lines run over the same supports, minimum distance may be reduced down to 0,50m. Insulating level of the telecom line shall be, at the very least, that of the low voltage lines, or it shall be considered as a bare conductor line.

When parallelism occurs between low voltage bare conductor lines, minimum distances are the ones established at point 3.2.2.

· *With streets and highways.*

Overhead lines with bare conductors may be placed close to these public ways, having to keep the minimum distance of 6m on its layout if they are hovering over them at zones or spaces with potential vehicular traffic; elsewhere it shall be 5m. It may be reduced down to 4m as long as they are insulated conductors and they are not hovering over zones or spaces with potential vehicular traffic.

· *With electrified railroads, trams and trolley buses.*

Horizontal distance between conductors and the contact line installation shall be, at the very least, 1,5m.

· *With woodland zones.*

Bundled insulated wire shall be used preferably. If the line features bare conductors, appropriate steps shall be taken so that neither tree nor branches end up making contact with the line.

· *With water pipelines.*

Minimum distance between electrical power lines and water pipelines shall be 0,20m. Minimum distance between the electrical lines joints or bare conductors and water pipelines' joints shall be 1m.

Minimum distance of 0,20m horizontal projection must be kept. Water pipeline shall be placed under the electrical line level as long as possible.

Main water supply pipelines shall be laid in a way that guarantees distances over 1m to the low voltage electrical lines.

· *With gas pipelines.*

Minimum distance between electrical power lines and gas pipelines shall be 0,20m, except for high pressure gas pipelines (more than 4 bars), in which distance shall be 0,40m. Minimum distance between the electrical lines joints or bare conductors and gas pipelines' joints shall be 1m.

Minimum distance of 0,20m horizontal projection must be kept as long as possible. Main gas supply pipelines shall be laid in a way that guarantees distances over 1m to the low voltage electrical lines.

## MAXIMUM INTENSITIES FOR CONDUCTORS

### Main considerations

The following maximum allowed intensities are appliwire to lines with assigned voltage of 0,6/1kV and bare conductors used in overhead lines.

### Wires made by cross-linked polyethylene (XLPE)-insulated braided conductor bundles

#### • *Maximum allowed intensities*

Charts 1, 2 and 3 feature the maximum allowed permanent scheme intensities for some of these types of wire. Normal layout conditions, that is to say, open-air placed single wire at 40°C ambient temperature, are considered.

Number of conductors per section (mm <sup>2</sup> )	Maximum intensity (A)
1 x 25 Al/54,6 Alm	110
1 x 50 Al/54,6 Alm	165
3 x 25 Al/54,6 Alm	100
3 x 50 Al/54,6 Alm	150
3 x 95 Al/54,6 Alm	230
3 x 150 Al/80 Alm	305

Chart 1, Maximum allowed intensities at 40°C

Number of conductors per section (mm <sup>2</sup> )	Maximum intensity (A)	
	Set over facades	Featuring steel guarantor
2 x 16 Al	73	81
2 x 25 Al	101	109
4 x 16 Al	67	72
4 x 25 Al	90	97
4 x 50 Al	133	144
3 x 95/50 Al	207	223
3 x 150/95 Al	277	301

Chart 2, Maximum allowed intensities at 40°C

Number of conductors per section (mm <sup>2</sup> )	Maximum intensity (A)	
	Set over facades	Featuring steel guarantor
2 x 10 Cu	77	85
4 x 10 Cu	65	72
4 x 16 Cu	86	95

Chart 3, Maximum allowed intensities at 40°C

For other installation conditions or other variables to take into account, correction factors shall be used.

Chart 1 is intended for wires with a steel neutral guarantor made of Aluminum-Magnesium-Silicon alloy (Almelec) for taut wire layouts.

Charts 2 and 3 are intended for wires without neutral guarantor, for set or steel guarantor taut wire layouts.

• *Correction factors*

For layouts directly exposed to the sunlight. Zones featuring high levels of solar radiation, wires' surface heating in relation to ambient temperature shall be taken into consideration. In this situations, a correction factor of 0,9 or less is used.

Number of wires	1	2	3	+ de 3
Correction factor	1,00	0,89	0,80	0,75

Correction factors for wire bundles

Temperature (°C)	20	25	30	35	40	45	50
Cross-linked polyethylene isolated	1,18	1,14	1,10	1,05	1,00	0,95	0,90

Correction factors for isolated wires depending on ambient temperature

Maximum short-circuit allowed intensities at the lines' conductors, depending on the short-circuit duration, are featured in the following charts:

Conductor section (mm <sup>2</sup> )	Short-circuit duration (S)								
	0.1	0.2	0.3	0.5	1.0	1.5	2.0	2.5	3.0
16	4,7	3,2	2,7	2,1	1,4	1,2	1,0	0,9	0,8
25	7,3	5,0	4,2	3,3	2,3	1,9	1,0	1,4	1,3
50	14,7	10,1	8,5	6,6	4,6	3,8	3,3	2,9	2,7
95	27,9	19,2	16,1	12,5	8,8	7,2	6,2	5,6	5,1
150	44,1	30,4	25,5	19,8	13,9	11,4	9,9	8,8	8,1

Maximum short-circuit intensities for aluminum conductors (kA)

Conductor section (mm <sup>2</sup> )	Short-circuit duration (S)								
	0.1	0.2	0.3	0.5	1.0	1.5	2.0	2.5	3.0
10	4,81	3,29	2,70	2,11	1,52	1,26	1,11	1,00	0,92
16	7,34	5,23	4,29	3,35	2,40	1,99	1,74	1,57	1,44

Maximum short-circuit intensities for copper conductors (kA)

#### Bare copper and aluminum conductors

Maximum intensities for bare conductors are as follows:

Nominal section (mm <sup>2</sup> )	Current density	
	Copper	Aluminum
10	8,75	--
16	7,60	6,00
25	6,35	5,00
35	5,75	4,55
50	5,10	4,00
70	4,50	3,55
95	4,05	3,20
120	--	2,90
150	--	2,70

Current density (A/mm<sup>2</sup>) for open-air bare conductors

### **3.2. UNDERGROUND LOW VOLTAGE ELECTRICAL LINES**

#### **WIRES**

Conductors of the wires used in underground lines shall be made of copper or aluminum, and shall be insulated with de adequate mixes of polymeric compounds. Moreover, they shall be properly protected against corrosion potentially induced by the terrain they are installed. They shall also feature enough mechanical resistance to withstand the stresses they may be subjected to.

Wires may contain one or more conductors and their assigned voltage shall not be less than 0,6/1kV. Their section shall be the one suitable to the expected intensities and voltage drop. It shall never be less than 6mm<sup>2</sup> for copper conductors and 16mm<sup>2</sup> for aluminum ones.

Depending on the number of conductors the distribution is made of, minimum section of the neutral conductor shall be:

- a) With 2 or 3 conductors: same as the one of the phase conductors.
- b) With 4 conductors, neutral one section shall be, at the very least, as the following chart states:

Phase conductors (mm <sup>2</sup> )	Neutral conductor section (mm <sup>2</sup> )
<b>6 (Cu)</b>	6
<b>10 (Cu)</b>	10
<b>16 (Cu)</b>	10
<b>16 (Al)</b>	16
<b>25</b>	16
<b>35</b>	16
<b>50</b>	25
<b>70</b>	35
<b>95</b>	50
<b>120</b>	70
<b>150</b>	70
<b>185</b>	95
<b>240</b>	120
<b>300</b>	150
<b>400</b>	185

Neutral conductor minimum section

## INSTALLATION EXECUTION

### Insulated conductors lay out

Grooving will be laid, generally, in public property perfectly limited terrain, preferably under the sidewalks. Layout shall be as straight as possible and, as much as possible, parallel to permanent references such as facade lines and kerbs. Likewise, minimum manufacturer-defined radiuses of curvature at direction changes shall be upheld. Insulated wires may be laid:

#### *• Directly buried*

Depth, down to the wire's inferior side shall not be less than 0,60m under sidewalks and 0,80m under road.

Trench-bed for the line shall be even, without sharp edges, pebbles, stones, etc. Wire shall be laid upon a layer of mine or river sand, with a minimum thickness of 0,05m placed at the bottom of the trench.

Over the wire, another sand or filtered soil 0,10m-thick layer shall be placed. Both layers will extend throughout the trench's total width, which shall be enough to keep a distance of 0,05m between the wires and the side walls.

Above the sand layer, all the wires shall have a mechanical protection, such as cross-placed concrete or ceramic floor tiles, plastic protector plates or bricks. The usage of other equivalent mechanical protections shall be allowed. A signaling band shall also be placed to warn about the existence of the low voltage electrical wire. Its minimum distance to the floor shall be 0,10m, and 0,25m to the wire's topmost part.

Laying plates capable of performing both the mechanical protection and signaling functions shall be allowed.

#### *• Piped grooves*

No more than one circuit shall be installed in each pipe

As much as possible, pipe direction changes shall be avoided. At the points where they happen, in an effort to make wire manipulation easier, lid hatches (accessible or not) shall be placed. To make the wire laying easier, straight segments shall feature accessible or shut halfway hatches or simply probes no further than 40m between them. This distance may be modified in a reasonable way, depending on junctions, crossings or any other situation. Hatches plugs shall have the pipes appropriately sealed on their ends, to prevent water and rodent entrances.

• *In underground passages*

### ***Accessible underground passages***

Accessible underground passages shall be used, preferably, in power electrical installations, control wires and telecoms. Never shall electrical and gas installations be placed together in the same gallery.

Neither is it advisable for them to be placed along water pipelines. Yet, should the necessity arise, water pipelines shall always be placed below any other one, and a drain, situated over the level the gutter or the waste pipe the gallery drains to, must necessarily be set.

Accessible galleries shall feature corridors to walk in, at least 0,90m wide and 2m high. Access to the gallery must be kept closed so that no trespasser is allowed in, but exit is guaranteed to anyone already inside. Access points shall be placed on each gallery end. Gallery air circulation shall be enough to grant complete air renewal 6 times every hour, to avoid gas accumulation and humidity condensation, and to grant a maximum temperature compatible with the services inside, never rising beyond 40°C.

Underground passages shall feature anti-slip flooring, with the appropriate slope and an effective drain which prevents puddles from being formed.

Wires layout shall be straight, keeping their relative positions as unaltered as possible. Wires' access and exit points to and from the gallery shall be made so that they don't make it difficult neither to maintain the existing wires nor to lay new ones.

Once laid, all the wires shall be left properly signaled and identified. Their identification shall also feature the company they belong to. They shall be attached to the walls of gallery's structure by using appropriate attaching elements (multi-sockets, brackets, trays, flanges, etc.).

Every metallic attachment element meant to support the wires (brackets, trays, flanges, etc.) or other man-accessible metallic elements which run through the galleries (pavement, handrails, metallic structures or pipes, etc.) shall be electrically connected to the gallery's ground conductor.

Every gallery longer than 400m shall feature:

- a) Permanent interior lighting.
- b) Permanent toxic gas detection installations, with minimum sensitivity of 300ppm.
- c) Illuminated indicators to regulate access points.
- d) Man-sized Access points every 400m tops.
- e) Interior signaling indicators to give information about the exits and outside references.
- f) Fireproof zoning partition walls (RF120) according to NBE-CPI-96.
- g) Fire doors (RF 90) according to NBE-CPI-96.

### ***Accessible grooves and galleries.***

Such galleries allow the installation of high voltage, low voltage, lighting, telecom and control wires. Under any circumstances, gas pipelines are not allowed. Water pipelines are only allowed if given a potential leak, other services imperviousness can be guaranteed. Must satisfy:

- Lock impermeability.
- Appropriate air circulation in the zone the electrical wires are placed, as to avoid gas accumulation and humidity condensation, and to better dissipate heat.

### General conditions for crossing cases and parallelisms

Underground wires, when directly buried in the terrain, must fulfill the following prerequisites:

#### ***· Crossing cases***

##### *· With streets and highways.*

Wires shall be placed inside protective pipes, as established at the protecting pipes section, then concrete-buried at a minimum depth of 0,80m. As much as possible, crossings will be made perpendicularly to the way's axis.

##### *· With railways.*

Wires shall be placed inside protective pipes, as established at the protecting pipes section, then concrete-buried at a minimum depth of 1,3m to the sleepers' inferior side. As much as possible, crossings will be made perpendicularly to the railway's axis, pipes ends stretching 1,5m on each side of the railway.

##### *· With other electrical wires.*

Low voltage wires will be placed so that they run over high voltage ones whenever possible. Minimum distance between low voltage wires and any other electrical wire shall be 0,25m to high voltage ones and 0,10m to low voltage ones. Distance from the crossing point to junctions shall be over 1m. If these requirements failed to be met, wires shall be set in piped grooves.

##### *· With telecom wires.*

Minimum distance between electrical wires and any telecom wire shall be 0,20m. Distance from the crossing point to junctions, for both electrical and telecom wires, shall be over 1m. If these requirements failed to be met, wires shall be set in piped grooves.

· *With water and gas pipelines.*

Whenever possible, wires shall be installed over water pipelines.

Minimum distance between electrical wires and water or gas pipelines shall be 0,20m. Crossing over the water or gas pipelines' joints and the electrical lines joints shall be avoided as much as possible, placing them further than 1m to the crossing point. If these requirements failed to be met, wires shall be set in piped grooves.

· *With gutters.*

Whenever possible, wires shall be installed over gutters

Affecting their interior shall not be accepted. If these requirements failed to be met, wires shall be set in piped grooves.

· *With fuel tanks.*

Wires shall be set in piped grooves, 0,20m away from the tank at the very least. Pipes' ends shall stretch 1,5m on each side of the tank.

· ***Proximities and parallelisms***

· *With other electrical wires.*

Low voltage wires may be laid in parallel towards other low or high voltage wires, keeping a distance of 0,25m to high voltage ones and 0,10m to low voltage ones. If these requirements failed to be met, wires shall be set in piped grooves.

· *With telecom wires.*

Minimum distance between electrical wires and any telecom wire shall be 0,20m. If these requirements failed to be met, wires shall be set in piped grooves.

· *With water pipelines.*

Minimum distance between electrical wires and water pipelines shall be 0,20m. Minimum distance between the electrical wires joints s and water pipelines' joints shall be 1m. If these requirements failed to be met, wires shall be set in piped grooves.

Minimum distance of 0,20m horizontal projection must be kept and water pipeline shall be placed under the electrical wire level as long as possible. Main water supply pipelines shall be laid in a way that guarantees distances over 1m to the low voltage electrical wires.

· *With gas pipelines.*

Minimum distance between electrical lines and gas pipelines shall be 0,20m, except for high pressure gas pipelines (more than 4 bars), in which distance shall be 0,40m. Minimum distance between the electrical lines joints and gas pipelines' joints shall be 1m. If these requirements failed to be met, wires shall be set in piped grooves.

Minimum distance of 0,20m horizontal projection must be kept as long as possible. Main gas supply pipelines shall be laid in a way that guarantees distances over 1m to the low voltage electrical lines. Main gas supply pipelines shall be laid in a way that guarantees distances over 1m to the low voltage electrical wires.

· *Inputs (supply connections)*

In case there's a crossing or parallelism between electrical wires and any of the previously described supply lines taking place in a building's input segment, a minimum distance of 0,20m shall be kept. If these requirements failed to be met, wires shall be set in piped grooves. Electrical input at the entrance of a building shall be capped until an adequate sealing level is achieved.

## MAXIMUM ALLOWED INTENSITIES

### Maximum permanent intensities allowed at the wires' conductors

· *Maximum allowed temperature*

Maximum permanent service intensities allowed depend, in each case, on the maximum temperature the insulator can withstand without seeing its electrical, chemical or mechanical properties compromised.

Dry insulation type	Maximum temperature °C	
	Permanent service	Short-circuit T=5s
PVC  <b>S = 300 mm<sup>2</sup></b> <b>S &gt; 300 mm<sup>2</sup></b>	70	160
	70	140
XLPE	90	250
EPR	90	250

Insulated wires with dry insulation

• *Buried installation conditions*

So as to determine the maximum allowed intensity, the following type installation:

A single tripolar or tetrapolar wire, or three unipolar wires in mutual contact; or one bipolar or two unipolar wire in mutual contact, directly buried in all its length inside a 0,70m deep trench, in a ground with thermal resistivity of 1 K·m/W and ambient temperature at that point of the ground set at 25°C.

Wires	Conductor nominal section (mm <sup>2</sup> )	Intensity
<b>3 x 50 Al + 16 Cu</b>	50	160
<b>3 x 95 Al + 30 Cu</b>	95	235
<b>3 x 150 Al + 50 Cu</b>	150	305
<b>3 x 240 Al + 80 Cu</b>	240	395

Maximum allowed intensities (A) for tetrapolar wires made of aluminum with copper neutral

Nominal section (mm <sup>2</sup> )	3 unipolar wires			1 tri/tetrapolar		
	Insulation type					
	XLPE	EPR	PVC	XLPE	EPR	PVC
16	97	94	86	90	86	76
25	125	120	110	115	110	98
35	150	145	130	140	135	120
50	180	175	155	165	160	140
70	220	215	190	205	220	170
95	260	255	225	240	235	210
120	295	290	260	275	270	235
150	330	325	290	310	305	265
185	375	365	325	350	345	300
240	430	420	380	405	395	350
300	485	475	430	460	445	395
400	550	540	480	520	500	445
500	615	605	525	-	-	-
630	690	680	600	-	-	-

Maximum allowed intensities (A) aluminum wires

Nominal section (mm <sup>2</sup> )	3 unipolar wires			1 tri/tetrapolar		
	Insulation type					
	XLPE	EPR	PVC	XLPE	EPR	PVC
<b>6</b>	72	70	63	66	64	56
<b>10</b>	96	94	85	88	85	75
<b>16</b>	125	120	110	115	110	97
<b>25</b>	160	155	140	150	140	125
<b>35</b>	190	185	170	180	175	150
<b>50</b>	230	225	200	215	205	180
<b>70</b>	280	270	245	260	250	220
<b>95</b>	335	325	290	310	305	265
<b>120</b>	380	375	335	355	350	305
<b>150</b>	425	415	370	400	390	340
<b>185</b>	480	470	420	450	440	385
<b>240</b>	550	540	485	520	505	445
<b>300</b>	620	610	550	590	565	505
<b>400</b>	705	690	615	665	645	570
<b>500</b>	790	775	685	-	-	-
<b>630</b>	885	870	770	-	-	-

Maximum allowed intensities (A) copper wires

- Maximum conductor temperature: 90°C.
- Ground temperature: 25°C.
- Installation depth: 0,70m.
- Ground thermal resistivity: 1 K·m/W.

Insulation:

- XLPE – cross-linked polyethylene - Maximum conductor temperature 90°C (permanent service).
- EPR – Ethylene propylene - Maximum conductor temperature 90°C (permanent service).
- PVC – Polyvinyl chloride - Maximum conductor temperature 70°C (permanent service).
- Ground temperature: 25°C.
- Installation depth: 0,70m.
- Ground thermal resistivity: 1 K·m/W.

## **5. CONNECTION INSTALLATION**

### **5.1. MAIN DISTRIBUTION BOX (MDB)**

#### **MAIN CHARACTERISTICS**

Is the box which protects, connects and separates the supply company's installation from the building's one, marking the point where user property begins. Two or more main distribution boxes shall be installed in the same building, should it be needed to fulfill the power demand.

MDB shall be sealable, with an insulating cover, and shall fundamentally contain the connection terminals and fuses' base. Material shall be alkalis-proof, and the insulation shall be, at the very least, class A heat-resistant and auto-extinguishable.

• *Box protection level:*

- 417, for indoor boxes
- 437, for outdoor boxes

• *Maximum exterior sizes:*

- Height 700mm
- Width 600mm
- Depth 250mm

• *Shutting elements:*

Boxes shutting system shall be performed by using triangle-headed 11mm-long unmissable screws.

• *Air circulation:*

As to prevent potential condensation, boxes shall allow enough air circulation for the electrical devices.

• *Wires' access points and joints:*

For boxes for intensities higher than 80<sup>a</sup>, wires' access and exit points shall allow for their connection without having to be threaded through the box's base. This layout shall allow for the wires to access the corners, preventing their excessive curvature once inside the box. Cones, cable conduits, etc. may be used as long as they follow the previous rules. Moreover, they shall be designed in a way that potential protection pipes may be leaned against the wall through all their length. If the box is located outdoors, their access and exit points shall be placed in its lower part.

• *Fuses' base:*

Circuit-breaker fuses' bases shall be as specified in UNE 21.102 II (Spain).

• *Terminals:*

Terminals shall be used to directly connect the wires, making the use of halfway-pieces unnecessary. Both access and exit terminals shall connect indistinctly to either copper or aluminum conductors. If

nominal intensity is over 160A and MDB is located outdoors, both access and exit terminals shall be placed in its lower part. Furthermore, terminals shall be unmovable and placed in a way so that each conductor may connect to a terminal without having to manipulate other terminals.

• *Wires and plates:*

MDB which feature access, exit and two fuse base equipped user branches, line's access and exit joint shall be performed by using insulated plates or wires.

• *Neutral position and layout:*

Neutral connection shall be unmovable and situated to the left of the bases. Both its connection and disconnection shall be made without manipulating any wire.

• *Plates or wire's colors:*

Phase plates or wires shall be black, brown or grey colored. Neutral shall be blue

#### LOCATION AND LAYOUT

They shall be installed preferably on the buildings' exterior walls, with free permanent access. Its exact location shall be mutually convened by both proprietor and supply company.

For those buildings hosting a low voltage distribution transform center, that center's low voltage box's fuses may be used as protection for the main supply line, working as its MDB. In that situation, both protection property and maintenance shall be the supply companies'.

If the connection is aerial, they may be installed superficially, at height between 3 and 4m to the ground. If it's a zone where the transition from aerial to underground installation is devised, MDB shall be located as if it were an underground connection.

If there's an underground connection, it shall always be installed inside a niche on the wall, which shall be shut by a door. Preferably, it shall be metallic, with IK 10 protection level according to UNE-EN 50.102. It shall have an exterior coating that grants its resistance against the elements and corrosion, with a lock or padlock standardized by the supply company. Door's lower edge shall be placed at least 30cm over ground level.

Niche shall feature the necessary holes as to allocate the conduits to grant access and exit to the underground main network connections, according to the regulations regarding protection conduits for built-in connections.

Chosen location shall always try to be the closest possible one to the public distribution network. It shall also try to be far away or adequately protected from other installations such as water or gas pipelines, phone lines, etc., such as indicated at LV supply.

If a facade doesn't border public ways, MDB shall be placed at the border between the public and private properties. More than two boxes shall not be placed inside the same niche, thus having only one box per main supply line.

If a supply requires more than two boxes, other technical solutions may be implemented as long as they are previously agreed between owners and the supply company.

Users or authorized electrician installer shall only have access and permission to manipulate main supply line's connections if they had previously communicated so to the supply company.

### MDB TYPES

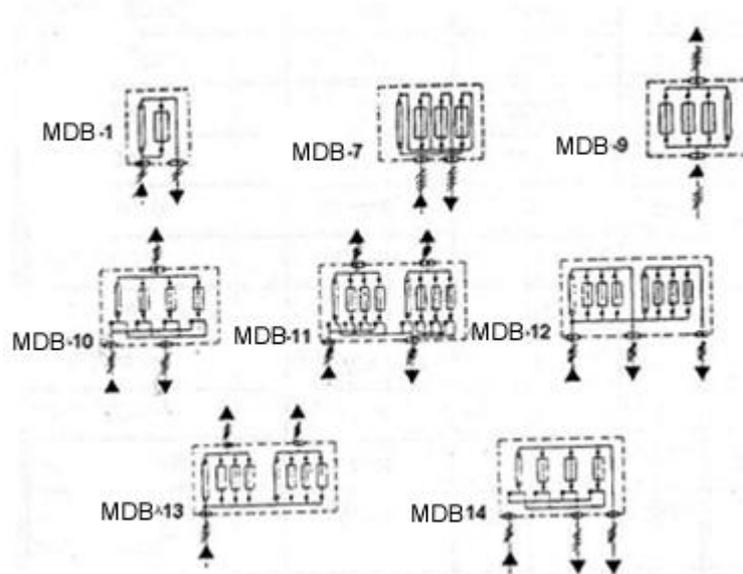


Image 1

#### · *MDB-1*

This MDB type shall be used only in monophase supplying (has only one fuses' base). Both access and exit are placed in its lower part; thus, it may be eligible to use in both indoor and outdoor locations. Its range of use is very limited as it cannot be used in triphase supplying.

#### · *MDB-7*

It's used in triphase supplying. Both access and exit are placed in its lower part; thus, it may be eligible to use in outdoor locations, preferably to underground connections by guaranteeing it's sealed. If located indoor, has the advantage that as long as meters are placed under its height, main supply line will get to them directly through a protective conduit.

#### · *MDB -9*

It's also used in triphase supplying with same main characteristics as those of MDB-7. Their main difference lies in the main supply line having its exit on the upper side, thus rendering it ineligible for outdoor locations. That way, it's limited to indoor usage, preferably when meters are placed over its own height.

• *MDB -10*

It's used in triphase supplying. It has the special feature of housing the crossing line, the one user's main supply line comes from, inside. Crossing line accesses and exits the box via its lower part without going through the fuses (unprotected) while the main supply line, on the contrary, exits through the box's upper side after going through the fuses. It has the same advantages and downsides as those of MDB -9, yet unlike MDB -12, if the crossing line needs to be repaired, it won't be possible to supply the user via that line.

• *MDB -11*

It's used in triphase supplying. It has the same main characteristics as those of MDB-10; however it has exit for two main supply lines, and with each one's own set of fuses and exit through the box's upper side. Main advantage is the capacity of protecting two main supply lines with a single box; yet has the major downgrade of being unable to supply the user should the crossing line need to be repaired.

• *MDB -12*

It's used in triphase supplying. It has one access and two exits in the lower part of the box; one exit is protected by a set of fuses while the other one is the one that branches off to the user. It has the main advantage of allowing distribution line manipulation while keeping the user supplied. It has the same advantages and downsides as those of MDB -7.

• *MDB -13*

It's used in triphase supplying. It has the same main characteristics as those of MDB-12; however both exits are placed at the box's upper side. It has the same advantages and downsides as those of MDB -9.

• *MDB -14*

It's used in triphase supplying. It has the same main characteristics as those of MDB-10; however distribution line exit is placed at the box's lower part. It has the same advantages and downsides as those of MDB -7.

MDB CHARACTERISTICS

MDB-7 and MDB-9 are the most widely used. Following chart depicts the different characteristics of those MDB depending on their maximum amperage.

MDB DESIGNATION	CIRCUIT-BREAKING FUSES			ACCESS AND EXIT CONNECTIONS
	BASES		FUSES	
	NUMBER	SIZE	MAX. I (A)	
MDB-7-160	3	0	160	M10 Screw
MDB-7-250	3	1	250	
MDB-7-400	3	2	400	M10 Screw
MDB-9-160	3	0	160	M10 Screw
MDB-9-250	3	1	250	
MDB-9-400	3	2	400	M10 Screw
MDB-9-630	3	3	630	2 M10 screws in phases and neutral further than 40mm

Chart 1

### CALCULATIONS

Building or property's total power must be calculated by using the following formula (it varies depending on the supply monophase or triphase, usually the latter) so that the minimum MDB amperage is obtained. Thus, immediately superior rank MDB shall be chosen.

$$I (\text{monophase}) = \frac{P}{V} = \frac{P}{230}$$

$$I (\text{triphase}) = \frac{P}{\sqrt{3} \cdot V \cdot 0,85} = \frac{P}{588,98}$$

### METERING AND PROTECTION BOX (MPB)

If the supply is for only one user or two users supplied from the same place, due to inexistence of a main supply line, installations may be simplified by merging in the same box the main distribution box and the metering device; then receiving the name of Metering and Protection Box.

For this location and layout the previous section's statements shall be used, but for surface layout not being eligible. Furthermore, the reading displays of the metering devices shall be placed at height between 0,7m and 1,8m. Metering and protection boxes to be used shall correspond to one of the types displayed in the technical specs of the supply company, which shall be authorized by the competent authority, depending on the number and properties of the supply.

Metering and protection boxes shall follow all the regulations defined by Rule UNE-EN 60.439 -1 about it, namely an inflammability level according to UNE-EN 60.439 -3, once-installed protection level of IP43 according to UNE 20.324 and IK09 according to UNE-EN 50.102 and being sealable. Its cover must have the proper means of air circulation as to prevent condensation from forming. Transparent material intended for display reading shall be UV rays-resistant.

#### MPB CALCULATIONS

It shall be directly calculated as if it were the mains isolator (MI).



MDB photo



MDB photo



MDB photo

## 5.2. MAIN SUPPLY LINE (MSL)

### DEFINITION

It's the one connecting the main distribution box to the meters. Depending on those meters dispositions it shall be called:

- *Collective derivation*: in case meters are grouped at the same premise. In this situation, main supply line will be more or less horizontal.
- *Post column*: meters shall be centralized by floor or individually, vertically running inside of the building.

Out of the same main supply line derivations to different meter centralizations may be made. Main supply lines shall consist of:

- Insulated conductors inside built-in pipes.
- Insulated conductors inside underground pipes.
- Insulated conductors inside surface-laid pipes.
- Insulated conductors inside protective conduits only practicable by using a specific tool.
- Prefabricated electrical conduits following UNE-EN 60.439 -2.
- Insulated conductors inside expressly planned and built brick-enclosed conduits. In the previous situations, pipes and conduits and their layout will follow the protective conduits regulations, except for what's said in the present regulation. Conduits shall always incorporate the protective conductor.

### CONDUCTORS

Only copper or aluminum, unipolar and insulated conductors, three phases and a neutral one, shall be used. Their assigned voltage shall be 0,6/1kV.

Wires and wire-conducting systems shall be installed as to not reduce building's structure fireproofing characteristics. Wires shall be fire non-spreaders and feature reduced smoke emissions and opacity.

As long as aluminum conductors are used, their connections shall be performed using the appropriate techniques so that conductor damages due to dangerous potential galvanic pairs. Wire section shall be uniform throughout all its length and lack joints, with the exception of derivations made inside boxes to supply meters' centralizations. Minimum section shall be 10mm<sup>2</sup> for copper ones or 16mm<sup>2</sup> for aluminum ones. For the purpose of calculating the wires' section, both maximum allowed voltage drop and maximum allowed intensity shall be considered. Maximum allowed voltage drop shall be:

- For general supply lines destined to completely centralized meters: 0,5%
- For general supply lines destined to partially centralized meters: 1%

Maximum allowed intensity shall be the one regulated by UNE 20.460 -5-523, with the proper correction factors given its layout, according to the power expectation.

For neutral conductor's section, maximum unbalance, harmonic currents and their behavior, shall be considered, depending on the protections established against potential overloads and short-circuits that may occur.

Neutral conductor shall have a minimum section approximately 50% of the phase conductor's, never going, though, below the values in chart 2.

Sections (mm <sup>2</sup> )		Exterior diam. of the pipes (mm)
PHASE	NEUTRAL	
10	10	75
16	10	75
16	16	75
25	16	110
35	16	110
50	25	125
70	35	140
95	50	140
120	70	160
150	70	160
185	95	180
240	120	200

Chart 2

## INSTALLATION

Layout of the main supply line shall be as short and straight as possible, going through common use areas.

When installed inside pipes, its diameter depending on the to-be-laid wire's section shall be the one depicted at chart 2.

Other types of conduits' dimensions shall allow a conductor sections' increase of 100%.

Insulated wires and underground pipe-enclosed protection conductors shall follow the LV directives, except for what's said in the present regulation.

Rigid pipe joints shall be either screwed or stuffed so that edges may not come apart.

Moreover, as long as main supply line runs vertically, it shall do so through a groove or brick-enclosed conduit, built-in or attached to the staircase shaft through common access areas. Main supply line shall not be attached or built-in to the staircase shaft or common area if those premises are protected according to NBE-CPI-96. Curves, directions changes and thermal influence of other conduits in the building shall be avoided. The conduit shall be practicable and sealable in every floor, with fire-breaks at least every three floors; its walls shall feature fire resistance RF 120 according to NBE-CPI-96. Access lids shall feature a minimum fire resistance RF 30. Minimum dimensions of the

conduit shall be 30 x 30cm and its use shall be exclusively the allocation of the main supply line and the protection conductor.

At the landings before flats' entrances or commercial premises, sealable derivation boxes shall be placed, from which individual derivations shall connect to each user's meter. These boxes may host the safety fuses.

Electrical supply in case of a lone user will not feature MSL, given that MDB shall be directly connected to the meter (MPB) and that to general control and safety panel.

### CALCULATIONS

Calculations on the conductor's section voltage drop shall be performed using the following formulas:

Monophase formula:

$$e = \frac{2 \cdot P \cdot L}{\gamma \cdot 230 \cdot S \cdot 2,3}$$

Triphase formula:

$$e = \frac{P \cdot L}{\gamma \cdot 400 \cdot S \cdot 4}$$

- e = Voltage drop (%)
- P = Power (W)
- L = Length (m)
- $\gamma$  = Conductivity (Cu=56 Al=35)
- S = Section (mm<sup>2</sup>)

Maximum voltage drop shall be:

- 1% if it affects individual meters or floor concentrated ones.
- 0,5% if it affects a single meter centralization.

Afterwards, whether the section is enough according to the calculated intensity at the main distribution box shall be confirmed by using chart 3 (insulation type) and 4 (conductor type).

**CHART 52-B1 (UNE 20460-5-523:2004) INSTALLATION METHODS REFERENCE**

Reference layout			Chart and column			
			Simple circuit allowed intensity			
			PVC insulation		XLPE or EPR insulation	
			Number of conductors			
			2	3	2	3
	Thermally-isolated wall conduit-enclosed conductors	A1	Chart A.52-1 bis column 4	Chart A.52-1 bis column 3	Chart A.52-1 bis column 7	Chart A.52-1 bis column 6
	Thermally-isolated wall conduit-enclosed multiconductor	A2	Chart A.52-1 bis column 3	Chart A.52-1 bis column 2	Chart A.52-1 bis column 6	Chart A.52-1 bis column 5
	Insulated conductors inside a conduit over wood or fabric wall	B1	Chart A.52-1 bis column 6	Chart A.52-1 bis column 5	Chart A.52-1 bis column 10	Chart A.52-1 bis column 8
	Multiconductors inside a conduit over wood or fabric wall	B2	Chart A.52-1 bis column 5	Chart A.52-1 bis column 4	Chart A.52-1 bis column 8	Chart A.52-1 bis column 7
	Unipolar or multipolar wires over wood or fabric wall	C	Chart A.52-1 bis column 8	Chart A.52-1 bis column 6	Chart A.52-1 bis column 11	Chart A.52-1 bis column 9
	Underground conduit-enclosed multiconductor wire	D	Chart A.52-2 bis column 3	Chart A.52-2 bis column 4	Chart A.52-2 bis column 5	Chart A.52-2 bis column 6
	Open-air multiconductor (dist. to the wall 0,3 x wire diam.)	E	Chart A.52-1 bis column 9	Chart A.52-1 bis column 7	Chart A.52-1 bis column 12	Chart A.52-1 bis column 10
	Open-air unipolars in contact (dist. to the wall = wire diam.)	F	Chart A.52-1 bis column 10	Chart A.52-1 bis column 8	Chart A.52-1 bis column 13	Chart A.52-1 bis column 11
	Open-air spaced unipolars (dist. to the wall = wire diam.)	G	---	See UNE 20460-5-523	---	See UNE 20460-5-523

**XLPE – cross-linked polyethylene - (90°C) EPR – Ethylene propylene - (90°C) PVC – Polyvinyl chloride - (70°C)**

Copper:  $\rho_{20} = 1/56 \Omega \text{mm}^2/\text{m}$ ; Aluminum:  $\rho_{20} = 1/35 \Omega \text{mm}^2/\text{m}$

$$\rho = K_{\theta} \cdot \rho_{20}$$

For copper and aluminum:  $\theta = 70^{\circ}\text{C} \rightarrow K_{\theta} = 1,20$ ;  $\theta = 90^{\circ}\text{C} \rightarrow K_{\theta} = 1,28$

**NORMALIZED TRANSFORMER POWER (Kva):**

5, 10, 15, 20, 30, 50, 75, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000

**SAFETY FACTORS  $K_0$ :** 1,25 for motors and 1,8 for gas-discharge lamps

**CHART A.52-1 BIS (UNE 20460-5-523:2004)**  
**Maximum allowed intensity (A)**  
**Ambient temperature 40°C in the air**

Layout method of chart 52-B1	Number of charged conductors and insulation type												
		PVC3	PVC2		XLPE3	XLPE2							
A1													
A2	PVC3	PVC2		XLPE3	XLPE2								
B1				PVC3	PVC2		XLPE3		XLPE2				
B2			PVC3	PVC2		XLPE3	XLPE2						
C					PVC3		PVC2	XLPE3		XLPE2			
E						PVC3		PVC2	XLPE3		XLPE2		
F							PVC3		PVC2	XLPE3		XLPE2	
1	2	3	4	5	6	7	8	9	10	11	12	13	
Section mm <sup>2</sup>													
<b>Copper</b>													
1,5	11	11,5	13	13,5	15	16	16,5	19	20	21	24	-	
2,5	15	16	17,5	18,5	21	22	23	26	26,5	29	33	-	
4	20	21	23	24	27	30	31	34	36	38	45	-	
6	25	27	30	32	36	37	40	44	46	49	57	-	
10	34	37	40	44	50	52	54	60	65	68	76	-	
16	45	49	54	59	66	70	73	81	87	91	105	-	
25	59	64	70	77	84	88	95	103	110	116	123	140	
35	-	77	86	96	104	110	119	127	137	144	154	174	
50	-	94	103	117	125	133	145	155	167	175	188	210	
70	-	-	-	149	160	171	185	199	214	224	244	269	
95	-	-	-	180	194	207	224	241	259	271	296	327	
120	-	-	-	208	225	240	260	280	301	314	348	380	
150	-	-	-	236	260	278	299	322	343	363	404	438	
185	-	-	-	268	297	317	341	368	391	415	464	500	
240	-	-	-	315	350	374	401	435	468	490	552	590	
<b>Aluminum</b>													
2,5	11,5	12	13,5	14	16	17	18	20	20	22	25	-	
4	15	16	18,5	19	22	24	24	26,5	27,5	29	35	-	
6	20	21	24	25	28	30	31	33	36	38	45	-	
10	27	28	32	34	38	42	42	46	50	53	61	-	
16	36	38	42	46	51	56	57	63	66	70	83	-	
25	46	50	54	61	64	71	72	78	84	88	94	105	
35	-	61	67	75	78	88	89	97	104	109	117	130	
50	-	73	80	90	96	106	108	118	127	133	145	160	
70	-	-	-	116	122	136	139	151	162	170	187	206	
95	-	-	-	140	148	167	169	183	197	207	230	251	
120	-	-	-	162	171	193	196,5	213	228	239	269	293	
150	-	-	-	187	197	223	227	246	264	277	312	338	
185	-	-	-	212	225	236	259	281	301	316	359	388	
240	-	-	-	248	265	300	306	332	355	372	429	461	

XLPE – cross-linked polyethylene - (90°C) EPR – Ethylene propylene - (90°C) PVC – Polyvinyl chloride - (70°C)

Chart 4

### **5.3. METERS**

#### MAIN CHARACTERISTICS

##### Metering systems

Electric meters determine the active energy (kilovoltamperes per hour) or the reactive one (reactive kilovoltamperes per hour), emitted by a generator or absorbed by a receptor. They are divided into two groups, motor meters and static meters.

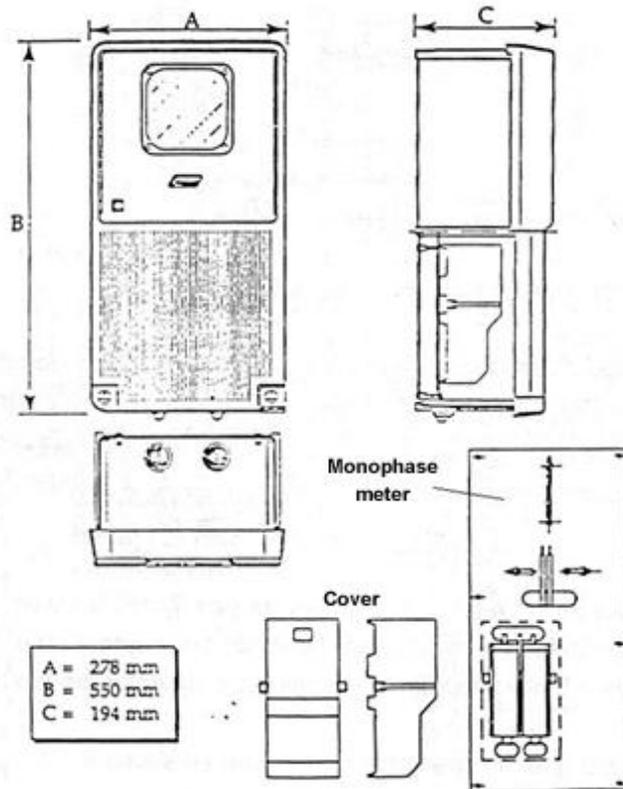
These devices measure the power by calculating the product of wired voltage and current intensity ( $P = I \cdot V$ , for continuous current  $y P = X \cdot (\cos y)$  for alternating current). In practical terms, the addition of a storing system and the count of its consumed energy as time passes is what are used to make its calculation for a specific time period.

##### Operation

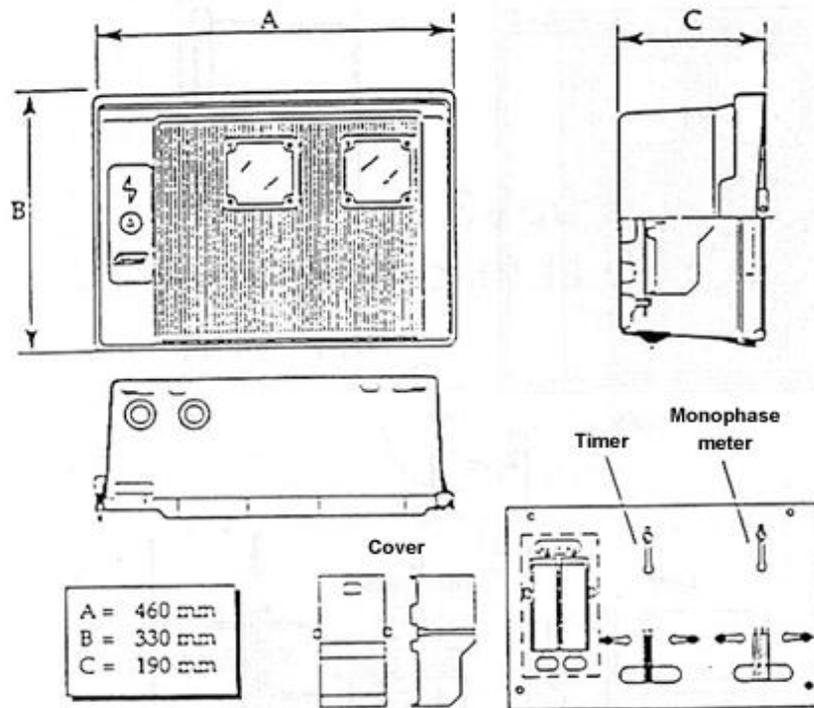
This section studies the operation of normal motor-type meters, which are most widely extended nowadays. The static ones were only used in the past in continuous current situations, and the electronic ones are still being developed, and their high prices make them difficult to find.

Among motor-type meters, induction ones are the most important. They are made up of a small electric motor, whose rotor shaft and inductor are made of coils which, once current circulates through them, make the motor spin because of the created torque. Current running through the inductor creates a magnetic field which is proportional to the circuit's intensity, and the current circulating through the rotor shaft creates a voltage which is proportional to the circuit's. Thus, the torque is proportional to the product of intensity and voltage; that is, power.

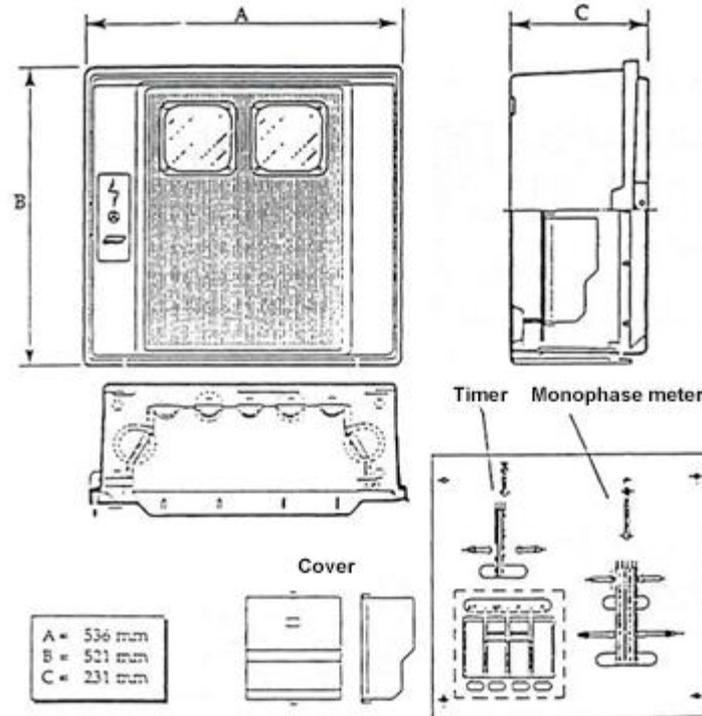
The resisting torque made by an aluminum disk that spins, generating the so-called Foucault currents, opposes the motor's movement by acting as a brake. This resisting torque is proportional to the spinning speed. Once regime speed is achieved, both torques are balanced, resulting in the motor's speed which is proportional to the power. Thus, by measuring the total number of spins of the motor by using a totalizer (made by numerous cogwheels linked to the rotor axis by using a gear and a worm screw), total energy consumed by the circuit is obtained.



Monophase meter detailed view



Timer-equipped monophase meter detailed view



Timer-equipped triphase meter detailed view

### General aspects

Meters and other electrical energy measurement devices may be located at:

- Modules (boxes with sealable lids)
- Boxes
- Cabinets

Minimum protection levels these elements as a whole shall achieve, according to Rules UNE 20.324 and UNE-EN 50.102 is:

- Indoor installations: IP40; IK 09
- Outdoor installations: IP43; IK 09

They shall allow direct reading of the meters and time switches, as much as of the other measurement devices should the necessity arise. Transparent material intended for display reading shall be UV rays-resistant.

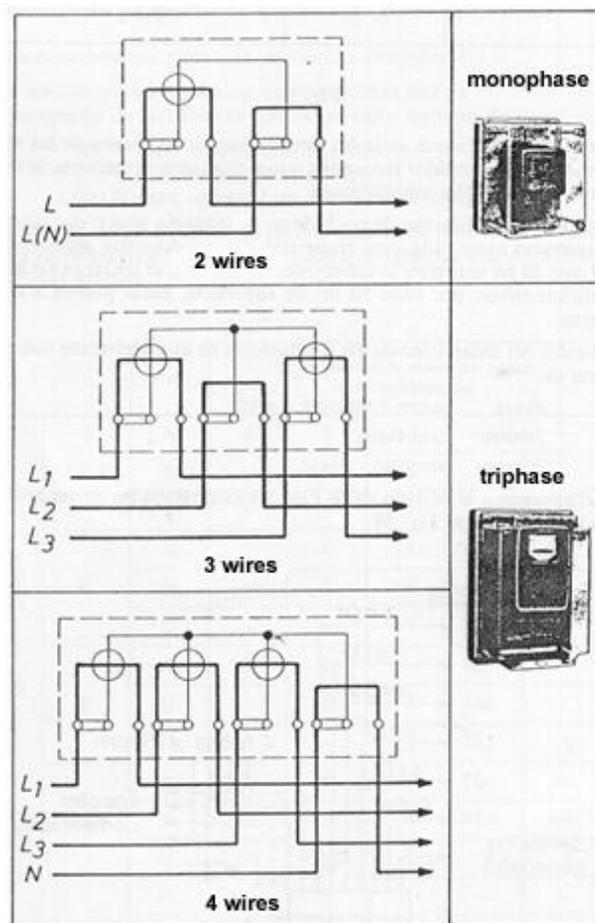
When modules or cabinets are used, those shall feature internal air circulation to prevent condensation from forming, yet it can't maim its protection level. Modules, boxes, and cabinets' measurements shall be the proper ones given the number, type of meters and any other energy billing devices, depending on the supply type the work with.

Every individual derivation shall feature, at its origin, its own protection. It shall be made of safety fuses, not taking into consideration each supply's internal protective means.

Fuses shall be installed before the meter and placed in each of the phase or polar wires that access it. They shall feature an adequate circuit-breaking capacity in accordance to maximum potential short-circuit intensity present at that point. They shall be properly sealed by the supply company.

Wires shall have a  $6\text{mm}^2$  section, with the exception of prescriptive regulations not being obeyed in regards of load estimates and voltage drops, in which situations it shall be bigger. Wires shall have an expected voltage of 450/750 V and feature copper conductors, class 2 according to UNE 21.022, with dry insulation extruded from thermoplastic or thermostable mixtures. They shall be identified in accordance to the installation conductors' regulated colors.

Wires shall be fire non-spreaders and feature reduced smoke emissions and opacity. Wires with characteristics similar to the ones depicted by Rule UNE 21.027 -9 (thermostable mixtures) or Rule UNE 21.1002 (thermoplastic mixtures) all follow this regulation. Likewise, it shall feature the necessary wires for the control and safety circuits as to fulfill the prevailing billing dispositions. Wire shall have the same aforementioned characteristics, its identification color being red and a section of  $1,5\text{mm}^2$ . Connections shall be performed directly and conductors shall not require special treatment or terminals.



Monophase and triphase meters basic layout

## LAYOUT METHODS

### Individual layout

This layout shall only be used if supply is for only one independent user or two users supplied from the same place. Metering and Protection Box shall be used, thus grouping general protection fuses, meter and timing device inside the same box. In this situation, safety fuses are the same as general protection ones.

Location of the Metering and Protection Box shall be as indicated in the Main Distribution Boxes' section.

For industrial, commercial or any indirect measurement supplies, given the complexity and range wideness they are subjected to, the solution to be implemented shall be the one specified in the particular prerequisites defined by the supply company for every individual situation, according to the following principles:

- Measurement devices are easy to read.
- General protection fuses have permanent access.
- Maintenance and safety are guaranteed.

Users shall be held responsible if they were to break the seals placed official organisms or supply companies, as much as if they were to damage any of the elements under their custody, should the meter be installed inside their properties premises. In case meter is placed outside, responsibility will lay upon the building's owner.

### Concentrated layout

Case of:

- Buildings intended for housing and commercial use.
- Commercial buildings.
- Buildings destined to industrial clustering use.

Meters and the rest of electrical energy measurement devices from each user and building's general services may be concentrated in one or more places. Each of them shall have the prevision of an appropriate cabinet or premise in the building, which shall host the different elements compulsory to the installation. If there're more than 16 meters to be installed, its location shall be a premise.

Depending on the type and number of meters and the number of floors in the building, meter concentration shall be placed according to the following dispositions:

- Buildings up to 12 floors shall have them at ground level, mezzanine or first basement.
- Buildings higher than 12 floors may have concentrations at intermediate floors, each one hosting concentrations of 6 or more floor's meters.

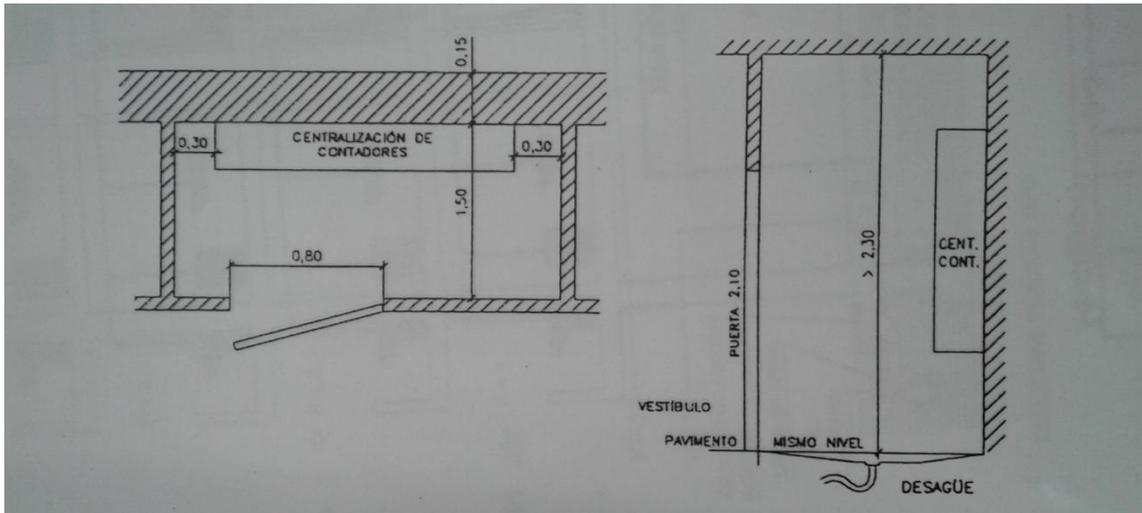
- Floor concentrations may be used as long as each concentration's meter number is over 16.

• **Premise layout**

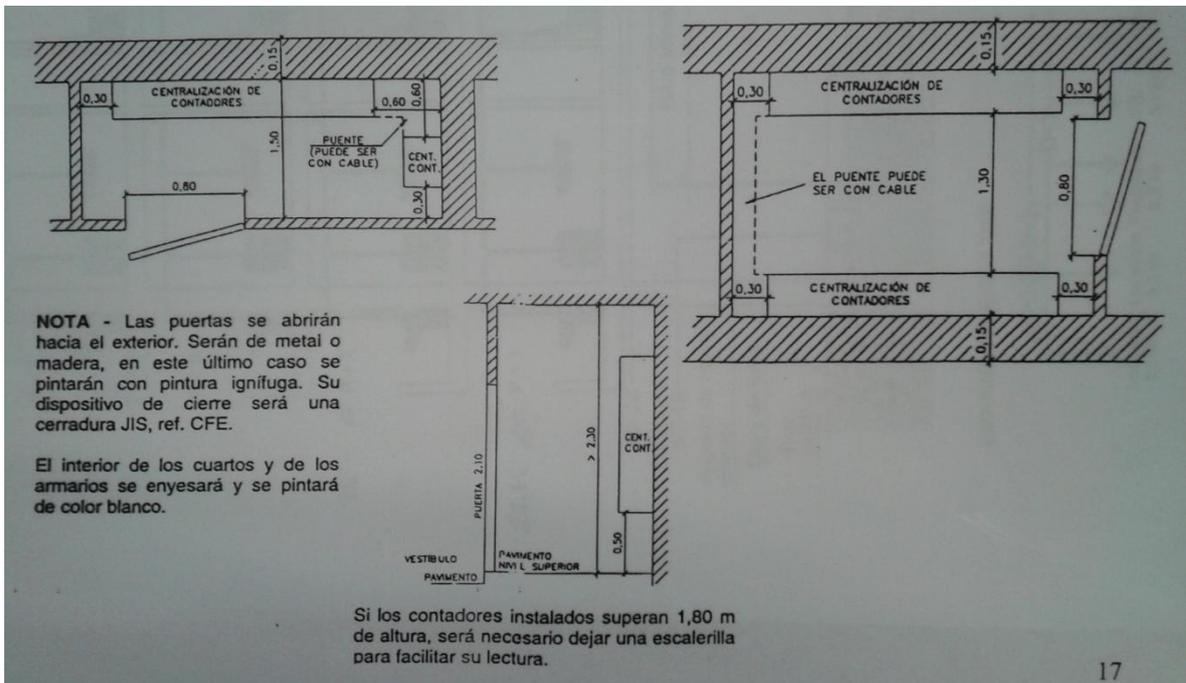
Premise shall be exclusively dedicated to this purpose. It may also feature, if the supply company needs it for managing the supply that starts from that centralization, data-gathering and communication equipment they may wish to install. It may also feature the general control and safety panel for the building's common services as long as regulated dimensions allow it.

Premise shall meet the low special risk premises' fire protection conditions established in NBECPI- 96, as well as the following requirements:

- It shall be located at ground level, mezzanine or first basement, with the exception of concentrations at floors, at place as close as possible to the building's entrance and to the individual derivations' conduits. Access shall be easy and free, just as the portal or porter's lodge, and must never be the same as that of other services, such as boiler room, water or gas meters' concentration, telecom, elevator machinery; or others such as storages, garbage rooms, etc.
- It shall never be other premises' walkway or access.
- It shall feature class M0 walls and class M1 floor, separated from other fire-risky or corrosive vapor-producing premises. It shall be exposed to neither vibrations nor humidity.
- It shall feature enough air circulation and lighting to be able to check the entire concentration component's well-functioning.
- If ground level were to be equal or lower than the adjoining walkways or premises, water drains shall be placed as to, case of malfunction, error or water pipe leaks, avoid the flooding of the premise.
- Walls meter concentrations are to be attached to shall feature a resistance no lesser than that of a half-foot brick wall.
- It shall feature a minimum height of 2,30m, and a minimum width at the walls occupied by meters of 1,50m. Its dimensions shall be the ones that guarantee that distances, from the wall occupied by the meters to the first obstacle on its opposite side are 1,10m. Distance from the sides of the meters to the adjoining walls shall be 20cm. Premise shall meet the low special risk premises' fire protection conditions established in NBECPI- 96.
- Access door shall open outwards, with a minimum size of 0,70 x 2m, and it shall meet the low special risk premises doors' fire protection conditions established in NBECPI- 96. Its lock shall be standardized by the supply company.
- Inside the premise and right next to the entrance, an autonomous emergency lighting device shall be installed, with autonomy no lesser than 1 hour and a minimum lighting level of 5 lux.
- Outside the premise yet as close as possible to its entrance, a mobile fire extinguisher with a minimum efficiency 21B shall be placed. Its installation and maintenance shall be responsibility of the building's ownership.



Meter premise detailed view



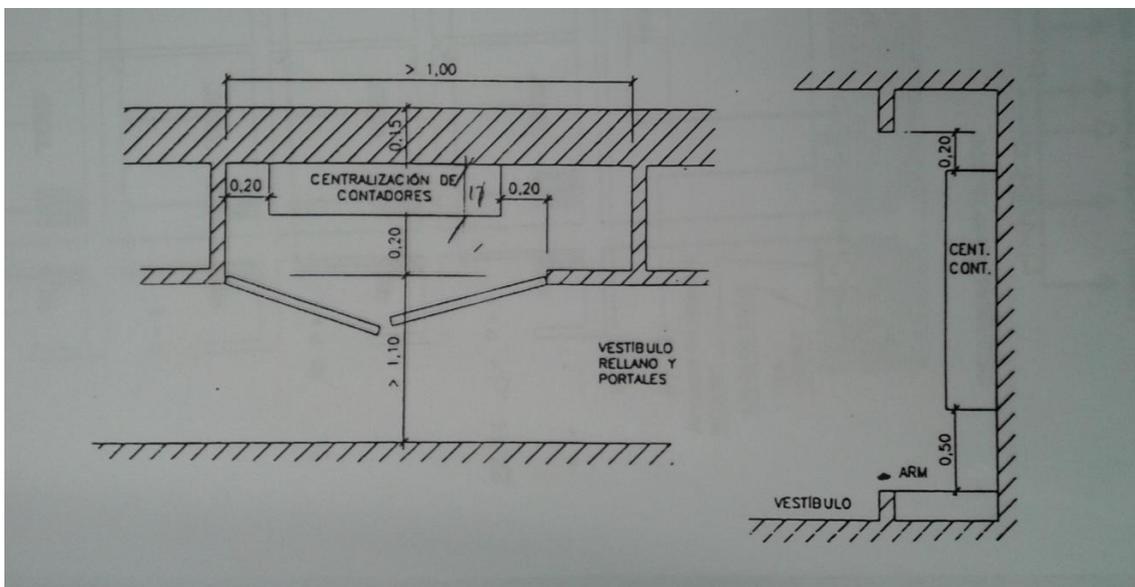
Meter premise detailed view

• **Cabinet layout**

As long as centralization's meter number is 16 or less, the concentration may be installed inside an exclusively dedicated cabinet, apart from the usual premise.

The cabinet must meet the following requirements:

- It shall be located at ground level, mezzanine or first basement, with the exception of concentrations at floors, built-in or attached on a common zone's wall at place as close as possible to the building's entrance and to the individual derivations' conduits.
- It shall not have stretchers which may make layout or meters and other devices' reading difficult.
- From the cabinet's outmost part to the opposite wall there shall be a walkway at least 1,5m wide.
- Cabinets shall feature a minimum fire-proofing level of PF 30.
- Its door's lock shall be standardized by the supply company.
- It shall feature enough air circulation and lighting, and a mobile fire extinguisher with a minimum efficiency 21B shall be placed nearby. Its installation and maintenance shall be responsibility of the building's ownership. Likewise, an outlet with a 16 A grounding shall place for maintenance service.



Meter cabine detailed view

### METER CONCENTRATIONS

Meter concentrations are devised to host the metering devices, control (MI aside) and protection of each and every individual derivation supplied from that concentration. Its fire-proofing shall fulfill the requirements of the incandescent wire test as described at Rule UNE-EN 60.695 -2-1, at a 960°C temperature for the insulating materials directly in contact with the current-carrying elements, and 850°C for the rest of them, such as cover, lids, etc. If there're covers, those shall be equipped with sealable devices as to prevent any interior handling, and may be grouped in one or more clusters.

If needed, elements belonging to the concentration shall be marked in a notorious way to allow correct and easy identification of the supply they are related to.

Building's owner or users shall be held responsible were they to break the properly placed seals or manipulate the installed elements under their custody at the premise or cabinet the meter concentration is located.

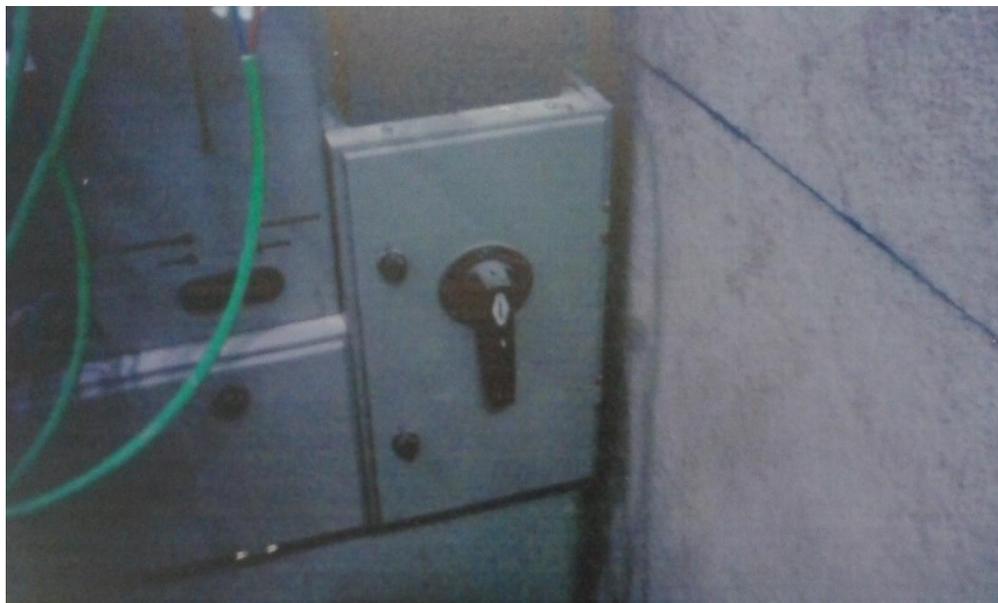
Concentrations shall allow the layout of the elements necessary to fulfill the prevailing billing dispositions and to incorporate eventual technological advances.

Meter concentration shall be placed so that at least 0,25m are kept between ground level and its lowest part, and the highest reading display is not higher than 1,80m. Wires that perform the connection between bars-meters-exit terminals may run inside pipes or conduits.

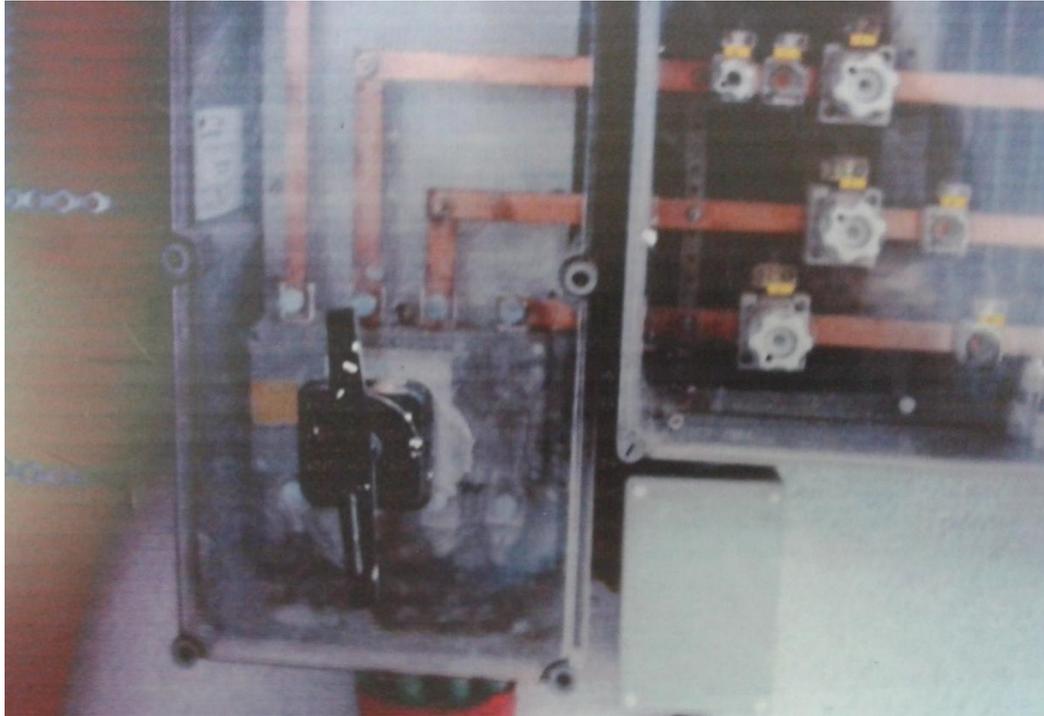
Concentrations shall be made by the following functional units:

#### General Operation Circuit-breaker functional unit (GOCB)

Its duty is to leave out of service, should the necessity arise, all the meter concentration. It shall be compulsory for more than 2 user's concentrations. This unit shall be installed inside a cover with double independent insulation, featuring an omnipolar circuit-breaker; with charged aperture which shall grant the neutral wire is not cut before the other poles. It shall be installed between the main supply line and the general bars of the meter concentration. If there's more than one main supply line, a circuit-breaker shall be placed for each of them. Circuit-breakers shall be, at least, 160A for load previsions up to 90 kW, and 250 A for higher load previsions up to 150kW.



General Operation Circuit-breaker functional unit (GOCB)



General Operation Circuit-breaker functional unit (GOCB) sketch

Safety fuses and general bars functional unit

It shall contain the general bars of the meter concentration and safety fuses belonging to all the supplies connected. It shall feature an insulating protection as to prevent accidental contact with the general bars when manipulating the safety fuses.



Safety fuses and general bars functional unit

### Metering functional unit

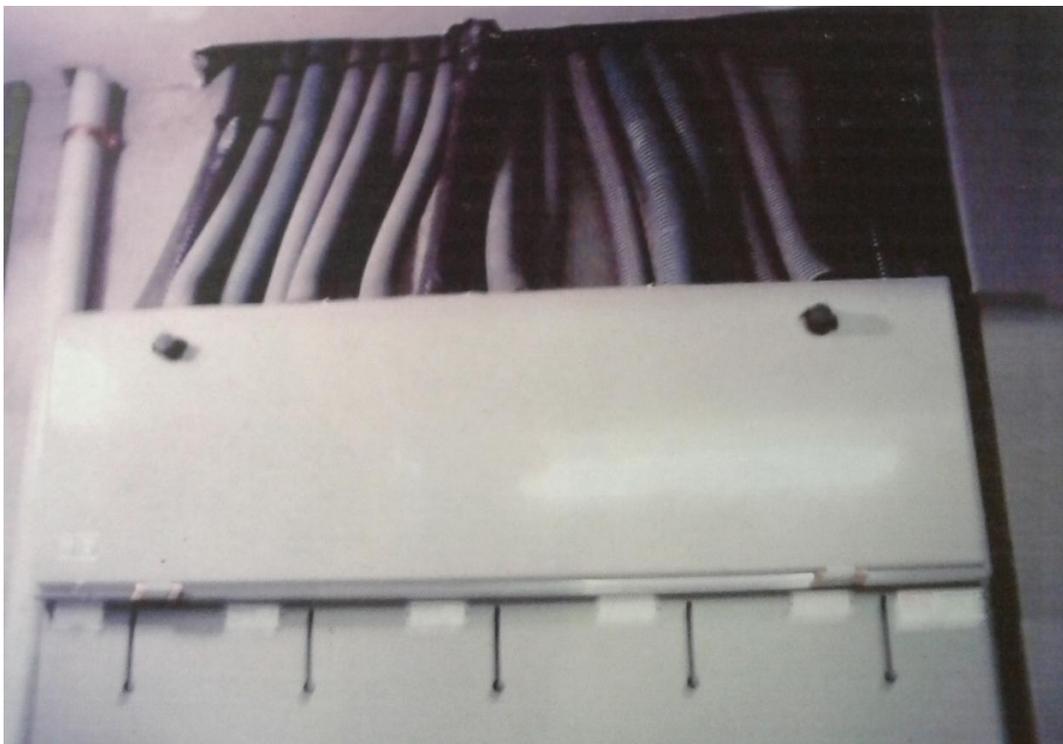
It features the meters, time switches and/or control devices to measure the electrical energy.

### Control functional unit (non-compulsory)

It features the control devices to change each supply's tariff changes.

### Protection bars and exit terminals' functional unit

It features the protection bars where the protection wires of each individual derivation shall be connected, as well as the exit terminals of the individual derivations. Protection bars shall be marked with its regulated grounding symbol.



Exit terminals' functional unit and individual derivations

### Telecom functional unit (non-compulsory)

Features the space required for the telecom and data-gathering devices.

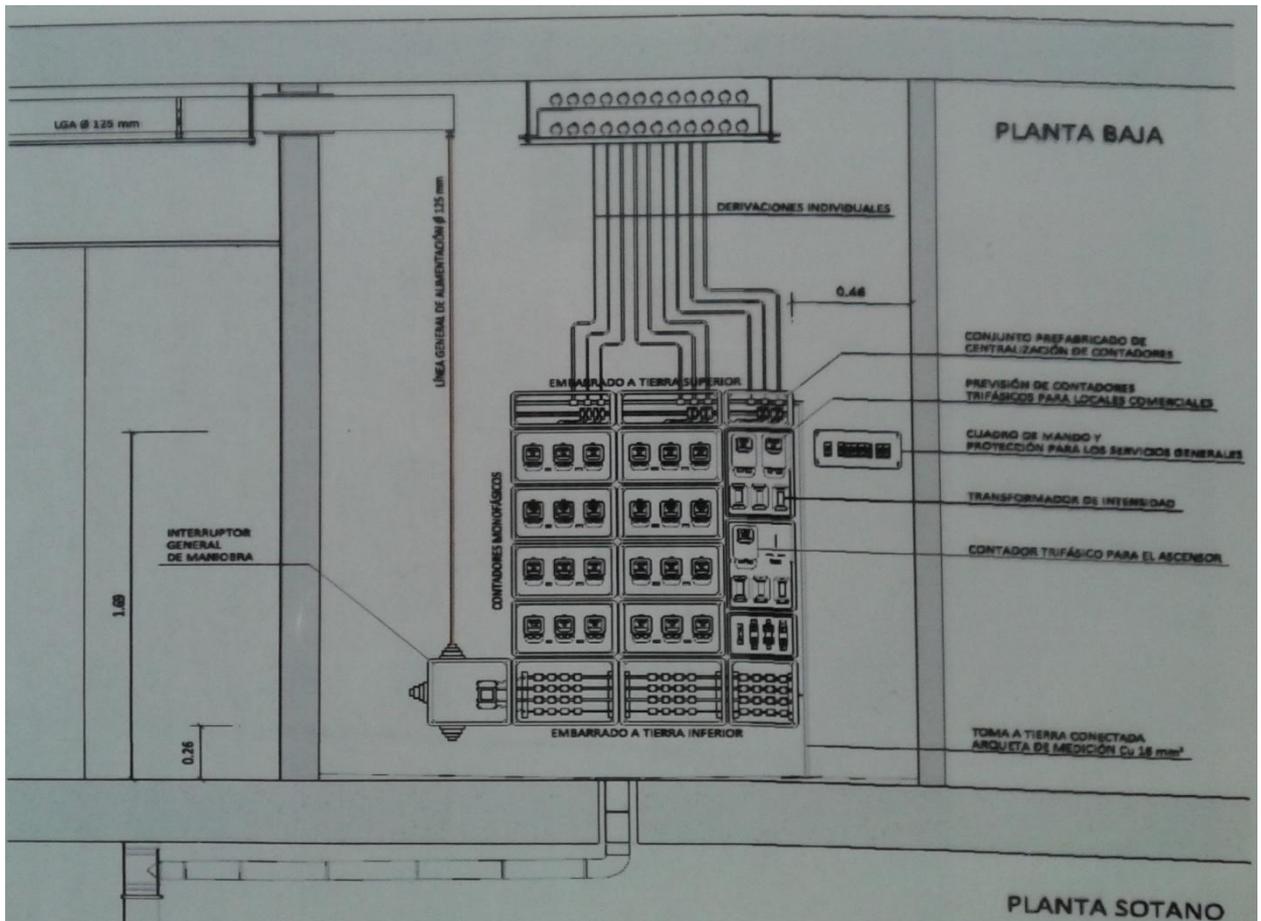
## SYSTEM CHOICE

As to make these installations more homogeneous, the supply company and the owner shall reach an agreement upon the choice of the most appropriate among the presented options. If an agreement failed to be reached, the Administration's competent bureau shall decide. Other solutions shall be admitted, such as individual meters at premises or flats if recent telemanagement techniques were to be implemented.

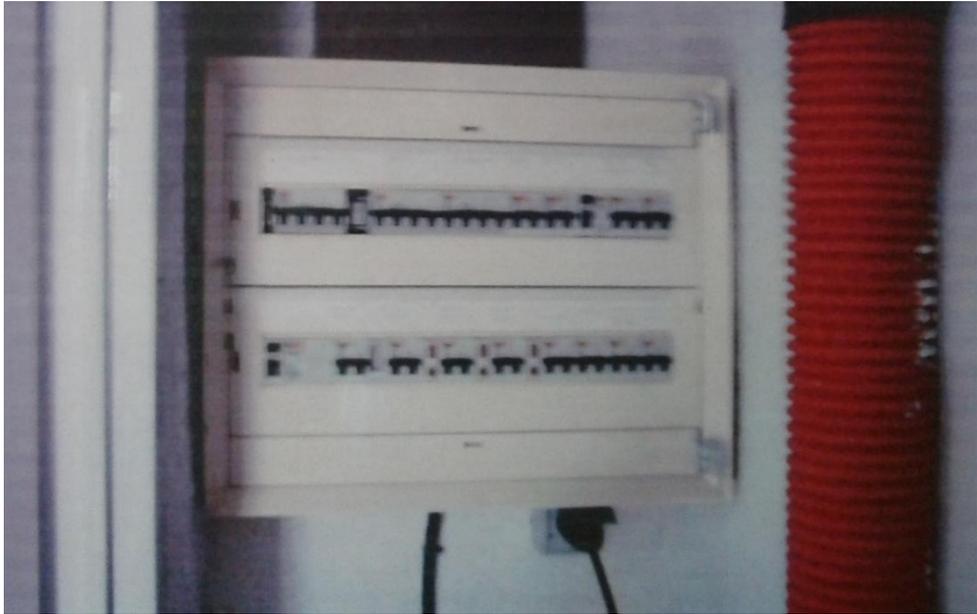
## MOST USUAL METER TYPES

The most usual meters may be monophase, triphase or reactive energy's, with different electrical connection. The most usual type, be it monophase or triphase, is the direct connection to the circuit; whereas for high intensities or voltages, voltage or intensity transformers-connected meter are used. In practical terms, monophase meters are installed for maximum intensities of 40A, and directly connected triphase meters up to 75A. From that intensity on, the relation  $X / 5A$  is kept.

In case of high voltage supplies, voltage and intensity transformers-connected meter are used. Alternating current monophase and triphase meters may be supplied with a with a double tariff count mechanism, as to register daytime and nighttime (or high cost and low cost period) consumed energy separately.



Meters sketch



General control and safety panel (general services)



Meters

## CALCULATIONS

Determining the maximum general operation circuit-breaker (GOCB) intensity with a load prevision (160 o 250 A).

It shall be calculated by adding the number of monophasic and triphasic meters (the latter count as 2 monophasic each) and then calculate the meter premise's dimensions according to the following chart:

$$\text{Monophasic Nbr} + (\text{Triphasic Nbr} \times 3) = \text{Safety fuses' Nbr}$$

$$\text{Monophasic Nbr} + (\text{Triphasic Nbr} \times 2) = \text{Monophasic Nbr}$$

Monophasic Meter Number	Up to 12	Up to 20	Up to 25	Up to 30	Up to 40	Up to 50	More than 50
Free Wall Width (m)	1,00	1,50	1,75	2,50	3,00	3,50	4,00
Free Height	2,30						
Free Depth	1,50						

Chart 5

## **5.4. INDIVIDUAL DERIVATIONS**

### **DEFINITION**

Individual derivation is the part of the installation that delivers the electric supply from the meter centralization to the final user's electrical installation.

Individual derivation starts at the general bars and comprises the safety fuses, the measuring devices and the general control and safety devices.

Individual derivations are made up of:

- Insulated conductors inside built-in pipes.
- Insulated conductors inside underground pipes.
- Insulated conductors inside surface-laid pipes.
- Insulated conductors inside protective conduits only practicable by using a specific tool.
- Prefabricated electrical conduits following UNE-EN 60.439 -2.
- Insulated conductors inside expressly planned and built brick-enclosed conduits.

In the previous situations, pipes and conduits and their layout will follow the protective conduits regulations, except for what's said in the present regulation.

Conduits shall always incorporate the protective conductor. Every individual derivation shall be completely independent from other users'.

### **LAYOUT**

Pipes and protective conduits shall feature a nominal section which dimensions allow initially laid conductor sections' increase of 100%. Under those layout premises, minimum nominal outer diameters of individual derivations pipes shall be 32mm.

When a coincidence in the layout forces a gathering of two or more individual derivations, those shall be installed simultaneously inside a protective conduit by using covered wires which shall guarantee the necessary separation between individual derivations. Anyway, a reserve pipe shall be laid every ten individual derivations or fraction, from the meter concentrations to the flats or premises, as to easily adjust to potential extensions. Premises with undefined subdivisions shall feature at least one pipe every 50 m<sup>2</sup> surface. Rigid pipe joints shall be either screwed or stuffed so that edges may not come apart.

In case of buildings mainly intended for housing, commercial buildings or buildings destined to industrial clustering use, individual derivations shall proceed through common use areas or have their obligations properly determined if that's not possible.

As long as individual derivations runs vertically, it shall do so through an exclusively dedicated groove or brick-enclosed conduit, built-in or attached to the staircase shaft through common access areas, namely the staircase shaft or common area unless those premises are protected according to NBE-

CPI-96. Curves, directions changes and thermal influence of other conduits in the building shall be avoided. The conduit shall be practicable and sealable in every floor, with fire-breaks at least every three floors to prevent fires and object drops; its walls shall feature fire resistance RF 120 and access lids with the same dimensions as the groove itself, to make maintenance and inspection duties easier, according to NBE-CPI-96. Access lids shall feature a minimum fire resistance RF 30.

Groove or brick-enclosed conduit minimum dimensions shall adjust to chart 6 contents.

<b>DIMENSIONS</b>		
<b>NUMBER OF DERIVATIONS</b>	<b>WIDTH L (m)</b>	
	<b>Depth P=0,15m one row</b>	<b>Depth P=0,30m two rows</b>
<b>Up to 12</b>	0.65	0.50
13 -24	1.25	0.65
25 - 36	1.85	0.95
36 - 48	2.45	1.35

Chart 6

For more than the reflected individual derivations, necessary number of conduits or grooves shall be laid. Minimum height to the control lids shall be 0,30m, and their width shall be the same as the groove itself. Their upper part shall be located, at least, 0,20m away from the ceiling. As to make layout easier, sealable control boxes may be placed every 15m, common to every individual derivation pipe, no hosting, though, any joint among conductors. Boxes shall be made of insulating materials, fire non-spreaders and a fire-proofing level V-1, according to UNE-EN 6069511-10.

For insulated wires inside underground pipes, individual derivation will follow the LV supply for underground lines' regulations, except for what's said in the present regulation.

## WIRES

Number of conductors shall be defined by the number of necessary phases to be used by the receivers on that derivation, and according to their power, every line featuring its own neutral conductor and the protection one.

In case of individual supplies, connection point of the protection conductor shall be decided by the project manager. Moreover, every individual derivation shall include a control wire as to make it possible to implement different tariffs. Common neutral or protection conductor for different supplies shall not be accepted.

To consider the number of phases of a individual derivation, the monophasic power the supply company is able to provide to the user shall be taken into account.

Wires shall have a uniform sections and shall not feature joints, with the exception of the connections performed at the meters' location and to the protection devices.

Copper or aluminum conductors, insulated and generally unipolar shall be used. Its assigned voltage shall be 450/750V. Following color code is compulsory:

- *Light blue*, neutral conductor or phase expected to become neutral
- *Green-yellow*, protection conductor.
- *Brown, grey or black*, phases conductors.

In case multiconductor wires or underground pipe-enclosed individual derivations are used, their conductors' insulation shall have an assigned voltage 0,6/1kV.

Wires and wire-conduction systems shall be installed in a way the building's fire-proofing structure characteristics is not affected.

Wires shall be fire non-spreaders and feature reduced smoke emissions and opacity. Wires with characteristics similar to the ones depicted by Rule UNE 21.123 part 4 or 5; or Rule UNE-EN 50086-1, all follow this regulation.

Wire-conduction elements with characteristics similar to the ones regarded as fire non-spreaders, depicted by Rule UNE-EN 50085-1 or Rule UNE 21.1002 (depending on the assigned voltage), all follow this regulation.

Minimum section shall be 6mm<sup>2</sup> for polar, neutral and protection wires, while the control one shall be red and have a section of 1,5mm<sup>2</sup>.

## CALCULATIONS

To calculate the conductors' section, the following premises shall be taken into account:

- a) Each user's expected demand, with its minimum being defined by the load and its intensity controlled by the private control and protection devices.
- b) Maximum allowed voltage drop shall be:
  - For meters concentrated at various places: 0,5%.
  - For meters concentrated at a single place: 1%.
  - For individual derivations in supplies of a single user without main distribution line: 1,5%.

Conductor section shall be calculated by the voltage drop by using the same formulas and charts as the main supply lines':

Monophase formula:

$$e = \frac{2 \cdot P \cdot L}{\gamma \cdot 230 \cdot S \cdot 2,3}$$

Triphase formula:

$$e = \frac{P \cdot L}{\gamma \cdot 400 \cdot S \cdot 4}$$

- e = Voltage drop (%)
- P = Power (W)
- L = Length (m)
- $\gamma$  = Conductivity (Cu=56 Al=35)
- S = Section (mm<sup>2</sup>)

## **5.5. GENERAL CONTROL AND SAFETY PANEL**

### **DEFINITION AND CHARACTERISTICS**

It's the group of devices placed at the beginning of the inner installation, with the objective is protection, safety and control. It's made up by two different devices: a mains isolator (MI) and the control and safety panel.

General and individual control and safety devices, whose operation position shall be vertical, shall be placed inside one or various distribution panels from which inner circuits shall start.

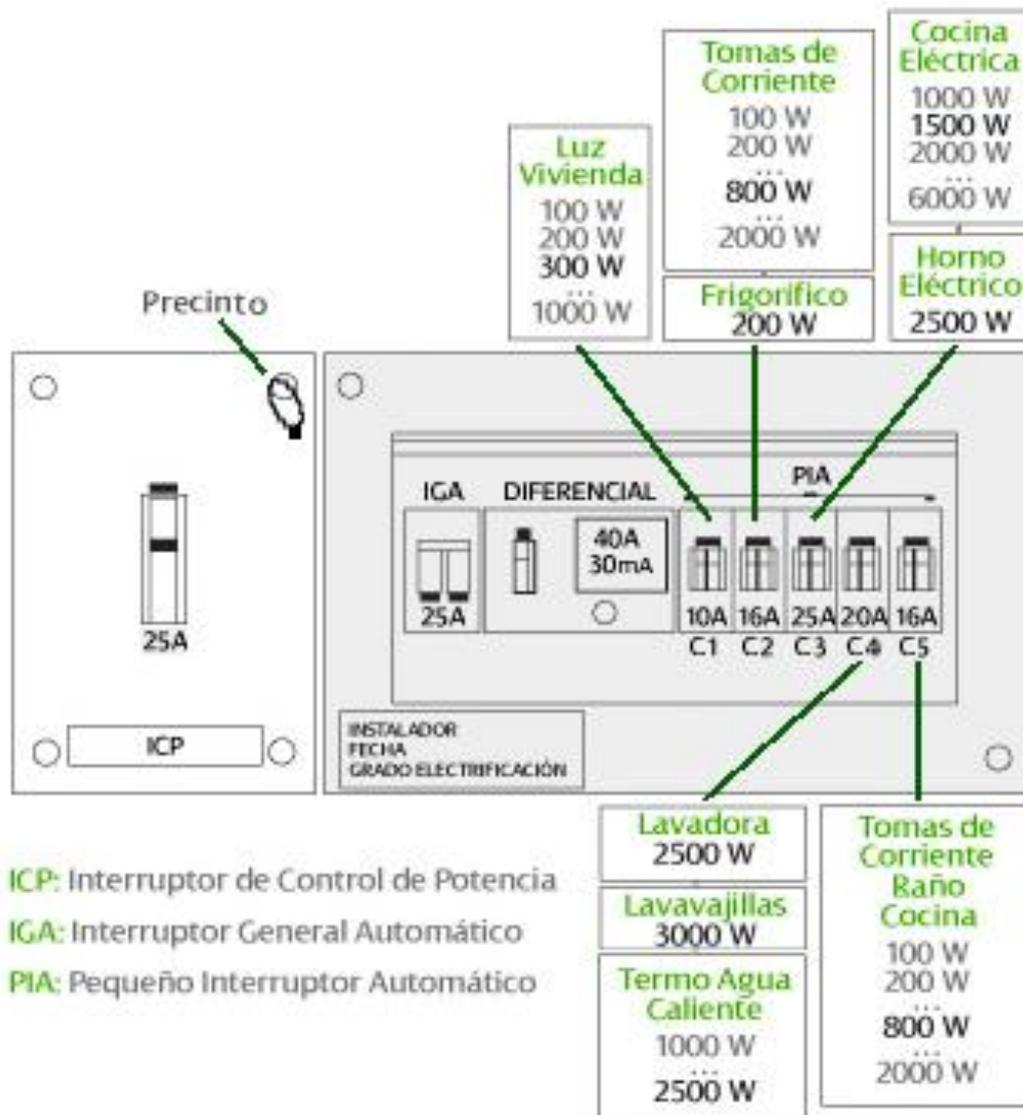
Panel's covers shall follow Rules UNE 20.451 and UNE-EN 60.439 -3, with a minimum protection level IP 30 according to UNE 20.324 and IK07 according to UNE-EN 50.102. Cover of the mains isolator shall be sealable and its dimensions shall be proper to the supply type and prevailing tariff. Its characteristics and type shall be those of an officially tested model. General and individual control and safety devices shall be, at least:

- A master circuit-breaker (MCB) with omnipolar circuit-breaking, which allows manual activation and is equipped with overload and short-circuit protection elements. This circuit-breaker shall be independent from the mains isolator (MI).
- A main residual-current device (RCD), destined to protect against indirect contacts among all circuits, with the exception of indirect contacts made among other devices.
- Omnipolar circuit-breaking devices, destined to protect against overload and short-circuit in each flat or premise inner circuit.
- Overload protection device, according to preventive installations, if necessary.

If installation's type or characteristics made it compulsory to install a residual-current device per circuit or circuit group, the main residual-current device may be not featured, as long as all circuits remain protected.

In case there's more than one serial residual-current device, there shall be a selectivity among them.

Depending on the prevailing tariff, the panel shall feature the installation of the control mechanisms needed by the tariff implementation needs.



General Protection and Safety Panel sketch



General Protection and Safety Panel

#### MAINS ISOLATOR AND MASTER CIRCUIT-BREAKER (MI MCB)

General magnetothermic automatic switch shall feature the following characteristics:

- Omnipolar circuit-breaker.
- Manual activation.
- Types: unipolar, bipolar, tripolar, tetrapolar, unipolar plus neutral and tripolar plus neutral.
- Equipped with overload and short-circuit protection elements.

UNESA 6101 directive determines these devices' operating characteristics.

Nominal serial intensities depicted in chart 7 relate to both bipolar and tetrapolar execution. Minimum value for the short-circuit power on these devices shall be 40A.

Nominal intensity, $I_n$ (A)	Normal non-circuit-breaking intensity (A)	Normal circuit-breaking intensity (A)
1,5	1,6	2,35
3	3,3	4,65
3,5	3,8	5,43
5	5,5	7,75
7,5	8,2	11,63
10	11	15,50
15	16,5	22,50
20	22	37,50
25	27,5	30
30	33	45
35	38,5	52,50
40	44	60
45	49,5	67,50
50	55	75
63	69,3	94,50

Chart 7

#### MAIN RESIDUAL-CURRENT DEVICE (RCD)

Residual-current devices are those which automatically break the circuit when the vector addition of intensities going through the devices poles reaches a certain level. Minimum intensity needed for the residual-current device to safely shut off the circuit corresponds to the device's sensitivity or grounding defect nominal intensity (DNI). Differential protection is associated as a grounding mass protective system. Grounding maximum resistance value, depending on the differential relay sensitivity, is calculated by the following formula:

$$R_t = U_b / I_{FN}$$

- $R_t$  = Grounding maximum resistance.
- $U_b$  = Maximum allowed contact voltage (24 V for wet premises 50 V for dry ones).
- $I_{FN}$  = Defect nominal intensity of the residual-current device (sensitivity).

Generally, given that it's not always easy to find appropriate values to the grounding resistance, medium and high sensitivity devices are used (300 y 30mA). These devices, setting aside the mission of protecting against direct and indirect contacts, also feature a very effective contribution against fires by limiting to very low power levels the potential insulation defects-derived electrical energy leaks. Both Industry and Energy Ministry and electric companies recommend high-sensitivity residual-current devices (30mA) installation.

· *Technical specs:*

- Manufactured according to Rule UNE 20383 and CEE-Publ. 27
- Pole number: 2 and 4.
- Frequency: 50 to 60Hz
- Nominal intensity  $I_N$ : 25, 40 and 63A
- Defect nominal intensity  $I_{FN}$ : 10, 30, 300mA
- Reaction time  $0,5 a 1 I_{FN}$
- Breaking time:
  - $I_{FN} > 0,2s$
  - $10 I_{FN} > 0,03s$

SMALL CIRCUIT-BREAKERS (SCB)

Automatic circuit-breakers of overload and short-circuit protection elements. Their objective is to protect each of the circuits that make up the inner installation. These circuit-breakers shall be chosen upon the conductor's section and the circuit's maximum expected power. However, as to get some selectivity, they shall never have the same caliber as the MI, having to be, at most, in the immediately lower level.

In reality, installation selectivity can only be said to be achieved when, during an overload or short-circuit, the only protection device which reacts is always that which is nearest to the failure point. As SCB, it may be used the same circuit-breaker defined as MI, that is to say UNESA featured. However, it is advisable to choose the one most appropriate to the line to be protected.

· *L feature:*

Automatic switches with «L» feature are mainly used to protect lighting and control circuits' lines. Electromagnetic shutting point margin is situated, depending on the device's nominal intensity, somewhere between 3,5 y 5  $I_N$ .

· *H feature:*

Automatic switches with «H» feature differ from those with «L» feature only in their electromagnetic shutting point margin, between 2 and 3 times nominal intensity value.

These ones achieve, arguably better than «L» feature ones, more efficient dangerous voltages contact protection, especially for devices in close contact with people.

· *K feature:*

Automatic switches with «K» feature are used to protect force circuits and particularly thermal overload-sensitive devices, such as motors, transformers, spotlights and incandescence lamps clusters.

Their electromagnetic shutting point margin is between 8 and 12 times nominal intensity value.

### LID ATTACHMENT

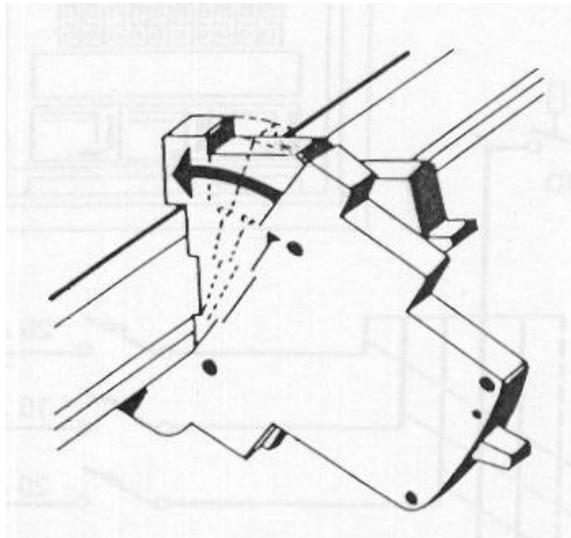
General Control and Safety Panel shall feature two compartments, each one with an independent lid, absolutely separated as shown in the previous sketch. The one destined to host exclusively the MI shall feature four sealable screws with cylindrical head and M4 thread, according to UNE 17703 and be 15mm long. The lid shall be equipped with four holed protuberances for them to be sealed. The other one shall host RCD and SCB shall also feature four screws with identical characteristics to the ones previously defined, though they may be non-sealable.

Lids shall have the following text engraved:

- a) Manufacturer's name or brand.
- b) Manufacturer's catalog reference.
- c) UNESA quality seal.
- d) Mains Isolator inscription.

### DEVICES SETTING

Setting, both MI and residual-current device and SCBs' to the panel's back shall be made by using the symmetrical profile 50022-35 x 7,5 according to UNE 21822. The setting of this matrix or metal profile to the back of the panel shall be made so that no metallic parts are left outside.



GCSF setting

### LOCATION

General control and safety devices shall be placed as close as possible to individual derivation's flat or premise entrance point. For flats, commercial and industrial premises which may need it, a box destined to host the mains isolator, immediately before any other device, independently set and sealable shall be placed. That box may be located inside the same panel the other general control and safety devices are placed.

Location of general control and safety devices near the entrance shall be predicted in flats, and it shall not be placed in bedrooms, baths, etc. Premises destined to commercial or industrial activities shall have it placed as close as possible to their respective entrance.

Each circuit's individual control and safety devices, starting point of the inner installation, may be placed in separate panels and other locations.

Common use or public affluence premises shall have their control and safety devices feature the proper precautionary measures as to prevent general public access.

Flats' general and individual circuit control and safety devices shall be placed at a height somewhere between 1,4 y 2m from the ground. In commercial premises, minimum height from the ground shall be 1m.

