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ELECTRICAL INSTALLATION AND AUTOMATION OF A PUMPING SUBSTATION

Final career project

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DATE: 21-05-2016

AGRAÏMENTS

M'agradaria donar els meus agraïment a totes aquelles persones que han fet possible la realització d'aquest projecte donant-me suport per seguir endavant.

Als meus pares, per la seva gran paciència, pels seus consells en moments de crisis i per tot el suport que m'han donat al llarg dels meus estudis.

Als meus amics, que sempre han estat disposats a ajudar-me.

També agrair al meu director del projecte, en Ricard Horta, pel suport que m'ha donat durant el llarg d'aquest treball via mail i per la sinceritat i empatia que ha demostrat en moments crítics.

Finalment, volia realitzar un agraïment especial a dos grans persones que formen part de la meva vida, Marta Palomar i Laura Esteban. Es podria dir que sense elles, mai hauria pogut finalitzar aquest treball. No hi ha agraïments suficients per tot el que han fet per mi. Moltes Gràcies.

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1 INTRODUCTION

Before starting the technical writing of the project, I have decided to carry out a little introduction about some subjects that I consider related to the project's main topic but make little sense if included in the technical part.

These topics are subcategorized in antecedents, aim, scope and even the project determinants.

1.1 ANTECEDENT

The performance of this project starts from a business proposal at my current workplace. A client proposed the construction of a pumping station in Lleida area. That takes us to proceed to the project writing while we also work on the technical development of the project for the clients. That way, most of my working hours were spent on my degree project.

This pumping station was a new construction inside an already existing industrial unit, which had been built for that purpose.

1.2 AIM

The aim of choosing this project is the proposal of expanding my experience about the writing and designing of projects based on installations related to pumping stations and electrical industrial installations given that the company that I currently work for is specialized in this field.

The other aim is to be able to apply the knowledge acquired during the academic terms that I have spent studying the electrical engineering.

1.3 SCOPE

Even though at the beginning the title of the project is “Pumping substation electrical installation and automation”, due to some determiners which I will explain later, the scope of my project is restricted to the electrical part of a pumping station, without considering the electrical automation part.

To justify the scope reduction on my project, I could state that the title is the first choice that one has to make in order to register the final degree project and, therefore, at that moment I was not aware of the amount of information that I was facing nor the fact that my company could not teach me regarding automation.

The restrictions of the project are better detailed in the report.

1.4 DETERMINANTS

In this part, I point out the difficulties that I have found during the project’s performance.

One of the most important determinants that I have faced is the fact that the project design has not actually been carried out. Once the project was registered, the client who initially had proposed it decided not to continue. That is the reason why I lost the project and my company support and I had to create a pumping installation out of nothing, gathering data under my own criteria and lacking the amount of in-company time that I had previewed for the matter.

As a consequence, I was forced to reduce the scope of the project, focusing on the electrical discipline and making it last one term longer.

2 REPORT

The following pages are the project report.

2.1 AIM

The aim of this project is the study, design and calculations of the items which shall be installed in a low and medium voltage electrical system of a pumping station.

The task consists on providing electrical power to the whole plant. The proper power supply to every piece of equipment in the plant needs to be granted as well.

The MV power supply application and contract work and the control system of the plant are not included in the project.

2.2 STANDARDS

The project has been carried out considering the following laws and regulations.

- Regulations on technical requirements and safety guarantees at electrical plants, substations and electrical power transformation stations, approved by RD 3275/1982 and the additional technical directions MIE-RAT included in this decree-law.
- Regulations on electrical verifications and power supply consistency.
- Low voltage technical regulations, approved by the ministers' council, expressed in 842/2002 on August, the 2nd 2002 and issued in BOE number 224 on September, the 18th 2002.
- RD 1495/1986, May 26th, through which equipment safety standards are approved.
- RD 830/1991, which modifies the equipment safety standards.
- Technological rules on building, NT from industry ministry, issued in BOE on 02/12/1971.
- UNE 21062, 20099,20324 standards
- Supplier companies specific standards.
- CEI 289 standards
- General safety and health rules at the workplace.

2.3 INSTALLATION DESCRIPTION

2.3.1 Environmental conditions

The facilities shall be located at less than 1000 m over the sea level and they will be subject to a maximum ambient temperature of 25 °C. Also, the soil resistivity is within 400 Ω·m.

2.3.2 Facility distribution

The ship was built in order to accommodate the pumping station, so all the spaces are reserved for hosting a type of facility and meet the standards of building and as appropriate.

In the case of transformers, this will in a few rooms where there will be a single transformer room in order to avoid propagation in case of accidents or breakdowns. These rooms are sectored and has a door providing access to the exterior of the ship.

Also planned a room for the reception, sectioning, and protection and measuring 25 kV and protecting transformers. In this room are both cell company, such as the pumping station.

All panels and transformers are at ground level, while the pumps are located on a lower level will be to avoid accidents due to a water leak.

The plane "01. General. Electric Distribution equipment "chapter" Plans "of this project can be seen in detail the distribution of the pumping station.

2.4 ELECTRICAL INSTALLATION

2.4.1 Power Supply

In order to provide the required power for the pumping station to work, it is necessary to get the feed from the power supplier company directly to the pumping station building. The power supplier company needs direct access from the outside to the cabinet's room through a door with company lock.

The installation feeds will be supplied at medium voltage from a transformer station, located at the technical room, which does not concern this project, designed for that matter.

2.4.2 Supply features

The main features of the medium voltage supply shall be:

Features	Value
Supply	Medium voltage
Supply line, V_n	25 kV
MT network short-circuit initial symmetric power, S'_{K}	500 MVA
System	3-Phase
Frequency	50 Hz
Switch breaker power	500 MVA
Supply line construction	Underground
Supplier company	FECSA-ENDESA
Neutral connexion	To the ground through impedance
SE neutral earthing line	$R_n = 0 \Omega$, $X_n = 25 \Omega$

Taula 1-1. Characteristics of electricity supply

2.4.3 Electrical installation power

The installed power is the sum of all power installation has all the motors of pumps, valves and all necessary auxiliary receivers to the station. Regardless the mode of operation of the pumps.

Therefore, the pumping station has a total installed capacity of **9194.35 kW**

	EB1 Power	EB2 and EBA Power	Auxiliary service Power	Total Power
Installed Power	4.260 kW	4.720 kW	214,35 kW	9.194,35 kW
Permissible Power	3.824,26 kW	3.824,26 kW	160 kW	7.808,52 kW

Taula 1-2. Electrical installation power

The justification for these powers is broken down under "Calculate" of the current project.

2.4.4 Medium voltage installation

In this section we describe the components of the electrical system working in medium voltage. These are basically shielded cubicles and power transformers.

2.4.4.1 Shielded cubicles

The type of switchgear shall be with module cubicles of insulation and cut with sulphur hexafluoride (SF6) of Ormazabal brand and bus bars connected through junction boxes which grant a completely shielded and unaffected by external factors connection. These must be approved by the power supplier company, produced in series, reduced size and the following electrical features:

Features	Value
Nominal voltage, V_n	36 kV
Frequency	50 Hz
Insulation level at 50 Hz, $t = 1$ min	
- Earthing and between lines	70 kV
- At isolating distance	80 kV
Insulation level against lightning	
- Earthing and between lines	170 kV
- At isolating distance	195 kV
Short-time withstand current (1/3 s)	16 / 20 kA
Withstand current. Peak value	50 kA
Short-circuit breaking capacity	20 kA
Short-circuit closing capacity	50 kA

Taula 1-3. Shielded cubicles features

The cabinets shall be placed on metallic benches, which will be hot galvanized and U-shape.

As a safety measure, for the proper working of the cabinets without voltage, we have foreseen the installation of 48Vcc batteries charging equipment, as described in point 2.4.5.7.1. “48Vcc battery panels” in this same chapter.

2.4.4.1.1 Line Cubicles

Three CGM.3-L type cubicles from Ormazabal shall be installed.

Inside those cubicles, there are:

- One 3-positions rotary switch (connection, switching, earthing) $U_n = 36$ kV, $I_n = 400$ A, closing capacity on short-circuit 40kA, with motor.
- 3 capacitive sensors at 36kV voltage
- They shall be used for company income, company outcome and outcome towards the pumping station.

Their electrical features are as follows:

Features	Value
Nominal intensity	
- In bus bar and cubicles connection	400/630 A
- Supply line	400/630 A

Taula 1-4. CGM.3-L electrical features

2.4.4.1.2 Protection cubicles with breaker

A protection cubicle with CGM.3-P breaker from Ormazabal shall be installed in order to protect the transformer of the auxiliary services (lighting, power and others) of 250kVA.

Inside this cubicle, there are:

- One 3-positions rotary switch (connection, switching, earthing) $U_n = 36 \text{ kV}$, $I_n = 400\text{A}$, closing capacity on short-circuit 40kA, BR type manual driver, opening coil and auxiliary connections and a breaker fusion opening system.
- 3 fuse holders for 36kV cartridges, according to DIN-43.625
- 3 36kV fuse cartridges according to DIN-43.625
- One p.a.t. switch, which makes the earthing connection on the fuses lower connections. Manual control.
- 3 capacitive sensors at 25kV voltage.
- One 3-Phase protection relay for the transformer (III+N)
- 3 toroidal intensity sensors for intensity protection
- One toroidal intensity sensors for earth fault protection

Their electrical features are:

Features	Value
Nominal Intensity	
- In bus bar and cubicles connection	400/630 A
- Transformer output	200 A

Taula 1-5. CGM.3-P electrical features

2.4.4.1.3 Transformer protection cubicles and general protection

Four CGM.3-V type protection cubicles from Ormazabal brand shall be installed.

These cubicles have a vacuum circuit breaker in series with the 3-positions breaker switch, toroidal intensity transformers and voltage sensors.

The cubicles that take care of the 6300kVA transformers will also have an indirect relay of phase-zero overloads in order to protect the transformers with a control box with switchboard to control the temperature on the transformers windings.

The cubicle that takes care of general protection shall also have indirect relay of phase-zero overloads, with control box, network and services analyser connected to the measurement transformers of the measurement cubicle.

The intensity transformers will have a double secondary. One of them will be for the overload protection relay and the other for the network analyzer.

Its electrical features are:

Features	Value
Nominal Intensity	
- In bus bar and cubicles connection	400/630 A
- Supply line	400/630 A

Taula 1-6. CGM.3-V electrical features

2.4.4.1.4 Measurement cubicle

A measurement cubicle type CGM.3-M from Ormazabal brand shall be installed. This cubicle is used to accommodate the transformers for intensity and voltage measurement, according to the contracted power, allowing to communicate with the all cubicles busbar.

2.4.4.1.5 Rising cubicle

A rising cubicle type CGM.3-Rci from Ormazabal brand shall be installed. This cubicle will be used to accommodate the supply cables to the all cubicles busbar.

Its electrical features are:

Features	Value
Nominal intensity	
- In bus bar and cubicles connection	400/630 A
- Supply line	400/630 A

Taula 1-7. CGM.3-RCi electrical features

2.4.4.2 Shielded cubicles auxiliary elements

2.4.4.2.1 *Fuses*

Fuses will only be installed in the cubicle that takes care of protecting the auxiliary services transformer (CGM.3-P).

According to 1-8 table, obtained from the catalogue “*Aparamenta de MT Distribución Secundaria*” from Ormazabal, the fuses should have a 16A nominal intensity for a 250kVA transformer (without overloads) and a 25 kV voltage.

SELECCIÓN DE FUSIBLES RECOMENDADOS, CON PERCUTOR TIPO MEDIO DE SIBA, DE BAJAS PÉRDIDAS														
Potencia Nominal del Transformador SIN SOBRECARGA [kVA]														
	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000
U _n [kVA]	Intensidad Nominal del fusible [A] IEC 60282-1													
25	6,3	10	16	16	16	20	20	31,5	31,5	40	40	50	63	80 ^[*]
30	6,3	6,3	10	16	16	16	20	20	31,5	31,5	40	40	63	63

Taula 1-8. Fuses value

2.4.4.2.2 Intensity transformers

Intensity transformers will be of Ormazabal brand and they will be installed in the bar room and/or the cable room. They present the following main features:

- Toroidal type
- Installed at the outside of the switch room, above the medium voltage connections.
- Unsensitive to environmental conditions
- Encapsulated

Their electrical features are:

Features	Value
Insulation level	0,72 kV
Nominal withstand alternating current	3 kV/ 1 min
Designated frequency	50 Hz
Accuracy type	E

Taula 1-9. Intensity transformer features

2.4.4.2.3 Voltage transformers

The voltage transformers shall be from Ormazabal brand and they will be installed in the bar room and/or the cable room. They present the following features:

- Plug-in type
- One-phase
- Insulated
- Shielded
- Induction based working
- Installed at the outside of the switch room
- Unsensitive to environmental conditions
- Explosion-proof

Their electrical features are:

Features	Value
Nominal Voltage	3,6 -36 kV
Static voltage factor	1,2 x Un
Nominal voltage factor, Un / 8h	1,9 Hz
Secondary voltage	100/ $\sqrt{3}$ V – 110/ $\sqrt{3}$ V
	100/3 V-110/3 V
Accuracy power	25 – 50 VA
Accuracy type	0,2 - 0,5 - 1 (measure)
	3P-6P (Protection)

Taula 1-10. Voltage transformer features

2.4.4.3 Measurement equipment

According to the power supplier company regulations, a 25kV measurement system will be installed, ready for both free market and regulated rate.

If the ownership chooses free market, they will be allowed to install a rental measurement system.

Depending on the estimated power consumption, a type 1 measurement system shall be installed according to article 3 of “*Instruccions Tècniques Complementàries del Reglament de Punts de Mesura i Trànsit d’Energia Elèctrica*”.

2.4.4.4 Power transformers (Pumping)

Inside the building, in rooms specifically designed to that matter, three 3-phase column type 6300kVA transformers shall be installed. Two of these transformers will be working continuously whereas the other will be spare to replace one of the other two in case of failure. They do not work in parallel in order to keep short-circuit intensity from becoming too high.

These will present star-delta connection with neutral-earth.

One transformer will feed the EB-1 pumping, consisting of 710kW pumps at 690V, while the other active transformer will feed the EB-2 and EBA, consisting of 500 kW, 160 kW, 630 kW and 400 kW pumps at 690V.

These transformers present the following electrical features

Features	Value
Nominal power	6300 kVA
Frequency	50 Hz
Phase number	3
Transformer ratio	25 / 0,69 kV
Connection group and time index	Dyn11
Cooling system	ONAN
Isolation liquid	Oil
Standards	IEC 60076

Insulation level in high	36 kV
Insulation level in low	7,2 kV
Thermic insulation type	A
Short-circuit voltage (120°C)	7%
Lightning impulse withstand voltage (Peak value)	
- Primary coil	145 kV
Industrial frequency withstand voltage (effective value)	
- Primary coil	70 kV / 1 min
- Secondary coil	20 kV / 1 min
Maximum room temperature	40 °C

Taula 1-11. 6300 kVA Transformer features

Besides that, the transformers will also be equipped with the following complementary devices:

- Control cabinet
- Identification plate
- Junction box
- Overpressure valve
- Lifting and dragging eyebolts
- Earthing terminals
- Temperature measurement system
- Oil saving equipment and atmospheric sealing
- Buchholz relay (protection against dielectric failure)

2.4.4.5 Power transformers (Auxiliary services)

A three-phase, dry 250kVA transformer will be installed inside the building, with the purpose of taking care of the 400V power supply. This transformer will work continuously.

This transformer will have the following features:

Features	Value
Nominal power	250 kVA
Frequency	50 Hz
Phase number	3
Transformer ratio	25 / 0,42 kV
Connection group and time index	Dyn11
Cooling system	AN
Standards	UNE 21538-1-2007
	UNE EN 60076-11
Insulation level in high	36 kV
Insulation level in low	1,1 kV
Thermic insulation type	F
Short-circuit voltage (120°C)	6%

Lightning impulse withstand voltage (Peak value)	
- Primary coil	170 kV
Industrial frequency withstands voltage (effective value)	
- Primary coil	70 kV / 1 min
- Secondary coil	3 kV / 1 min
Maximum room temperature	40 °C

Taula 1-12. 250 kVA Transformer features

Besides that, the transformer will also have the following complementary devices:

- Earthing terminals
- Temperature control unit TMD-T4
- PTC130/150 probes
- Identification plate
- Voltage commutator in the primary winding
- Lifting rings

2.4.4.6 Protection against earthing failure

For the protection against earthing failures, a residual current differential device on the earthing wire of each transformer system. It will be consisting of the following items:

- Sensor: Toroidal transformer around the earthing wire of each transformer system.
- Actuating device: This item will receive the signal of the toroidal transformer it will produce another signal which opens the appropriate power switches.

The equipment shall be adjustable in sensitivity and operation time.

2.4.4.7 MV 25kV switchgear interconnection

For the interconnection within the MV 25kV switchgear, a single-pole conductor of Prysmian brand will be used for each phase and another one for the neutral. These are sized in chapter 2.5 “ *Calculation of MV Cross-sections*” of the calculations part of this project.

Those conductors will present the following features:

Feature	Value
Type	AL RH5Z1
Insulation	XLPE
Single nominal voltage	18 kV
Nominal voltage between phases, U	30 kV
Maximum voltage between phases, Um	36 kV
Impulse withstand voltage, Up	170 kV
Maximum withstand temperature at continuous working conductors	105 °C
Maximum withstand temperature in short-circuit	250 °C

Taula 1-13. General features of MV Cables

Generally, the switchgear from the cubicles will be connected with 30x5 mm copper plates.

2.4.4.7.1 Conductor for interconnection between cubicles and 6300kVA transformers

Features	Value
Cross section	240 mm ²
Maximum withstand intensity (Air)	455 A
Maximum withstand short-circuit intensity in the conductor, t= 1s	22,56 kA
Resistance of the conductor (20°C)	0,125 Ω/km
Inductive reactance	0,114 Ω/km

Taula 1-14. Features of flex cable for 6300 kVA transformer

2.4.4.7.2 Conductor for interconnection between cubicles and 250kVA transformers

Features	Value
Cross sections	150 mm ²
Maximum withstand intensity (Air)	335A
Maximum withstand short-circuit intensity in the conductor, t= 1s	14,1 kA
Resistance of the conductor (20°C)	0,206 Ω/km
Inductive reactance	0,123 Ω/km

Taula 1-15. Features of flex cable for 250 kVA transformer

2.4.5 LOW VOLTAGE INSTALLATION

2.4.5.1 General feature

The pumping station low voltage installation shall be basically consisting of:

- Installation to feed the pumps from the power transformers matching 690V.
- Installation of valves, fans and gantry cranes at 400/230V.
- Installation of auxiliary power services, lighting and auxiliary equipment at 400/230V.

2.4.5.2 General description

The low voltage installation of this project consists of protection and distribution electrical panels, the interconnection conductors between the different items, electric channels, connections to pump motors, power receptors, lighting and sockets.

Every piece of low voltage equipment will be in compliance with the appropriate Low voltage technical directions of the Low voltage regulations.

The control system, along with its auxiliary items, would also be part of the low voltage installation, although it is beyond the scope of this project.

2.4.5.3 CCM-1 panel

The CCM-1 panel services all the pumps in the pumping station, which has three pumping systems inside:

- EB-1 pumping: Six 710kVA pumps at 5+1 working ratio.
- EB-2 pumping: Five 500kVA pumps at 4+1 working ratio.
- EB-A pumping: One 160kVA pump, two 630kVA pumps at 1+1 working ratio and two 400kVA pumps at 1+1 working ratio.

This panel is directly fed from the 6300kVA 25/0,69 kV power transformers, consequently, two busbars will be formed. Busbar for EB.-1 pumping feeds from one of the transformers, whereas the other transformer will supply the busbar for EB-1 and EB-A pumpings.

Line features and foreseen panels location, at the low voltage room in the pumping station, can be observed at the layouts attached to the pertinent chapter.

2.4.5.3.1 CCM-1 features

- CCM-1 modules dimensions are 1200x2100x650 mm for each switchgear and an additional module for busbar.
- The connection between these modules shall be done with junction parts, supplied by the manufacturer, forming a permanent assembling.
- The steel sheet shall be properly treated and painted in colour RAL 7032, granite grey.
- It will contain all the essential items for the proper operation of the installation in accordance with the layouts and diagrams that can be found within the chapter “layouts” of this project.
- These panels are filled into with protection and operation items in accordance with the supplied power and the branch lines power, matching their nominal intensity.
- They shall have high conductivity busbar, able to withstand the regular intensity and the short-circuit intensity, specified for each case. They shall be sized so that they can withstand, without deformation, dynamic and thermic efforts caused by the maximum foreseeable short-circuit.
- The feedings from the transformers are located in the middle of the busbars, in order to minimize the intensity on the boards. Each transformer feeding shall take up one module.
- The feedings from the transformers shall be protected by automatic circuit-breakers, monitored with adjustable protection devices against overloads and short-circuits.
- The feedings from the transformers will have a network parameters control unit with digital display for energy control and protection system against grid and atmospheric overvoltage.
- The branch circuits to pumps are protected by automatic circuit-breakers, monitored with adjustable protection devices against overloads and short-circuits, and differential protection by toroidal and associated relay, adjustable in sensitivity and response time.

- The pumps start-up is expected to be done with soft contactors and starters or with variators equipped with driver unit.
- The panels shall have an air conditioning system, consisting of heating resistor and artificial air ventilation system with air income by its lower part through grids with filtration system, and air outcome by the top part, making sure not to exceed a temperature of 40°C inside.

2.4.5.4 CCM-2 panel

CCM-2 mainly services the valves and other pumping motors at a 400/230V voltage. It is fed from the 250kVA, 25/0.4kV transformer. Line features and foreseen panels location, at the low voltage room in the pumping station, can be observed at the layouts attached to the pertinent chapter.

2.4.5.4.1 *CCM-2 features*

- CCM-2 consists of metallic modules whose dimensions are 1000x1200x600mm to place the switchgear.
- The panel shall be set for 3-phase distribution at 400/230V 50Hz.
- The steel sheet shall be properly treated and painted in colour RAL 7032, granite grey.
- It will contain all the essential items for the proper operation of the installation in accordance with the layouts and diagrams that can be found within the chapter “layouts” of this project.
- These panels are filled into with protection and operation items in accordance with the supplied power and the branch lines power, matching their nominal intensity.
- They shall have high conductivity busbar, able to withstand the regular intensity and the short-circuit intensity, specified for each case. They shall be sized so that they can withstand, without deformation, dynamic and thermic efforts caused by the maximum foreseeable short-circuit.
- The feeding from the distribution general panel at 400/230V will have a load break switch and protection system against grid and atmospheric overvoltages.
- This panel has the starting, protection and operation items of the auxiliary equipment of the pumping station, throttle valves, fans, gantry crane, cathodic

protection system panel, etc., as it can be observed in the single line diagram.

The equipment list and auxiliary lines, along with their expected power, can be observed in the layouts and the calculations chapter.

- The panels shall have an air conditioning system, consisting of heating resistor and artificial air ventilation system with air income by its lower part through grids with filtration system, and air outcome by the top part, making sure not to exceed a temperature of 40°C inside.

2.4.5.5 CCM-3 panel

CCM-3 function is to service power and lighting circuits of the pumping station at a 400/230V voltage. This panel is fed from CCM-2.

Line features and foreseen panels location, at the low voltage room in the pumping station, can be observed at the layouts attached to the pertinent chapter.

2.4.5.5.1 *CCM-3 features*

CCM-3 consists of metallic modules whose dimensions are 1000x1200x600mm to place the switchgear.

- The panel shall be set for 3-phase distribution at 400/230V 50Hz
- The steel sheet shall be properly treated and painted in colour RAL 7032, granite grey.
- It will contain all the essential items for the proper operation of the installation in accordance with the layouts and diagrams that can be found within the chapter “layouts” of this project.
- The feeding from the distribution general panel at 400/230V will have a load break switch.
- This panel has protection and operation devices in accordance with the supplied power and the branch lines power, pertinent to their nominal intensity.
- They shall have high conductivity busbar, able to withstand the regular intensity and the short-circuit intensity, specified for each case. They shall be sized so that they can withstand, without deformation, dynamic and thermic efforts caused by the maximum foreseeable short-circuit.

2.4.5.6 Capacitor batteries

In other to get a $\cos \phi$ of 0.96 or higher, a reactive energy compensation will be done at CCM-1 level with adjustable battery, and at transformer level with constant batteries.

The adjustable reactive energy compensation equipment is fed from CCM-1 for pumps and it basically consists of a metallic cabinet, designed for 3-phase distribution at 690V and 50Hz, including:

- Single fuse bases with the pertinent NH cartridges of the proper gauge by the capacitor protection.
- Electronic regulator with microprocessor, staged circle connection, power factor digital meter, intensity measurement on the secondary coil of the power transformer installed at the auxiliary services panel, compensation failure alarm, programmable connection delay, etc.
- Contactors III, preceded by resistors that confine the connection intensity.
- Inductance III, for low tune harmonics filter, 189Hz.
- 690V capacitors, where applicable, tubular type with pressure breaker.

The capacitors nominal voltages shall be oversized in accordance with the estimated overloads that may be.

In order to compensate the reactive energy generated by motors, we will use 3x150+1x300+1x200+2x400 kVA equipment at 690V. The stages shall be automated.

The adjustable reactive energy compensation equipment basically consists of a metallic cabinet, designed for 3-phase distribution at 690V and 50Hz, including:

- 3 Single fuse bases with the pertinent 70kA NH cartridges of the proper gauge by the capacitor protection.
- Contactors III, preceded by resistors that confine the connection intensity.
- Inductance III, for low tune harmonics filter, 189Hz.
- 690V capacitors, where applicable, tubular type with pressure breaker

400 kVAr at 690V equipment has been set out for each one of the 25/0.69kV transformers.

2.4.5.7 Uninterruptible power system (UPS)

A UPS shall be installed to supply low and medium voltage critical equipment.

2.4.5.7.1 *48Vdc batteries panel*

The 48Vdc batteries panel shall be fed from CCM-1.

It includes the 48Vdc supplier source, the batteries and the charger. Medium voltage protection relays, dry encapsulated thermic protection relays for the transformers and medium voltage module services, are fed from this cabinet.

This panel includes the protection and operation devices in accordance with the power supplied and the branch lines power, pertinent to their nominal intensity.

2.4.5.8 BT conductors

2.4.5.8.1 *Conductors generalities*

As a general criterion, the low voltage cable shall be multi-core wire up to 70mm² cross section and it shall be single pole wire for higher cross sections, with copper conductors and 0.6/1kV insulation, buried inside pipes and laid on trays.

The cross section of these conductors will be pertinent to the foreseen intensities, according to calculations, and it will fulfil the additional technical directions of the “*Reglament Electrotècnic de Baixa tensió*”. More specifically, ITC-BT-19, where the maximum withstand intensity is established depending on the installation type and insulation.

The cables for underground installation will have metallic protection with aluminium or steel shielding hose, depending on the type of cable (single-pole, multi-pole).

Every cable line installed on a tray shall be identified at its origin, its ending, and, at least, every 30m. This identification will be made with flanges and undeleteable tags.

Cable lines outcoming from a junction box shall be identified at the very boxes with undeleteable markers.

Cables aimed to feed the motors with starting system through frequency variator, if there were any, and the ones aimed to control digital or analog signals, will have metallic protection with copper braid screen and the conductor shall be of compact circular cable.

2.4.5.8.2 Installation conductors inside tray or pipe

Cables with 0.6/1kV insulation for indoors facilities on tray or pipe for equipment and panels supply, shall be multipolar and have the following features:

Features	Value
General designation	RV-K (0,6/1 kV)
Design standards	UNE 21.123-2; CEI 60227-3
Conductor type	Cu Electrolytic, annealing
Insulation	XLPE
Cover	PVC
Testing standards	
- Flame retardant	UNE-EN 60332-1-2; IEC 60332-1-2
- Low halogen emission	≤ 14 %, s/UNE-EN 50267-2-1; IEC 60754-1
- Nominal voltage	U ₀ /U = 0,6/1 kV
- Testing voltage	3,5 kV, s/UNE 21.123.3

- Maximum operating temperature	90 °C in conductors
- Maximum short-circuit temperature	250 °C in conductors

Taula 1-16. Features inner conductor trays / tubes

2.4.5.8.3 *Outdoors facilities buried conductors*

Cables with 0.6/1kV insulation for the outdoors underground facilities, with single-pole conductors, have the following features:

Features	Value
General designation	RVFAV-K (Aluminium strip armor)
Design standards	UNE 21123-2
Conductor type	Cu Electrolytic, annealing
Insulation	XLPE
Cover	PVC
Testing standards	
- Flame retardant	IEC 60332-1-2; IEC 60332-3-24
- No spread of fire	
- Low halogen emission	≤ 14 %, s/UNE-EN 50267-2-1; IEC 60754-1
- Nominal voltage	U ₀ /U = 0,6/1 kV
- Testing voltage	3,5 kV, s/UNE 21.123.3

- Maximum operating temperature	90 °C in conductors
- Maximum short-circuit temperature	250 °C in conductors

Taula 1-17. Features unipolar external conductors buried

Cables with 0.6/1kV insulation for the outdoors underground facilities, with multi-pole conductors, have the following features:

Features	Value
General designation	RVFV-K (Iron strip armor)
Design standards	UNE 21123-2
Conductor type	Cu Electrolytic, annealing
Insulation	XLPE
Cover	PVC
Testing standards	
- Flame retardant	IEC 60332-1-2; IEC 60332-3-24
- No spread of fire	
- Low halogen emission	≤ 14 %, s/UNE-EN 50267-2-1; IEC 60754-1
- Nominal voltage	$U_0/U = 0,6/1$ kV
- Testing voltage	3,5 kV, s/UNE 21.123.3

- Maximum operating temperature	90 °C in conductors
- Maximum short-circuit temperature	250 °C in conductors

Taula 1-18. Features multi-pole external conductors buried

2.4.5.8.4 *Conductors supplying motors with frequency variator*

Indoors conductors, either on tray or pipe, supplying motors with start-up system through frequency variator, will have the following features:

Features	Value
General designation	RVKV-K (Shielded)
Design standards	UNE 21123-2
Conductor type	Cu Electrolytic, annealing
Insulation	XLPE
Cover	PVC
Testing standards	
- Flame retardant	IEC 60332-1-2; IEC 60332-3-24
- No spread of fire	
- Low halogen emission	≤ 14 %, s/UNE-EN 50267-2-1; IEC 60754-1
- Nominal voltage	U ₀ /U = 0,6/1 kV
- Testing voltage	3,5 kV, s/UNE 21.123.3

- Maximum operating temperature	90 °C in conductors
- Maximum short-circuit temperature	250 °C in conductors

Taula 1-19. Features variable frequency cables

2.4.5.9 Electric conduits

2.4.5.9.1 *Conduits generalities*

The minimum nominal diameter of the protection pipes, depending on the amount, type and cross section of the conductors to be lodged, installation method, as well as the kind of pipe, are established by standard ITC-BT-21.

The trays or pipes for the power cables shall be different from the ones used for control and communication cables. There is a 30cm distance between power and control cable parallel conduits.

The conduits setting shall be done in compliance with standard ITC-BT-20.

2.4.5.9.2 *Conduit types*

Depending on the type of wiring, these would be the conduits they go through:

- **RV 0,6/1 kV cables**

They will be laid on PVC trays, with lid, going through the underground of the panel room, control room and pumps room. If they go through pipes to the receptor branches from the main tray, it can be made of galvanized steel, either shockproof rigid thermoplastic or shockproof flexible thermoplastic.

- **RVFAV-K and RVFV-K cables**

They shall be installed inside buried high density polyethylene pipes.

The conduits include, inside the same circuit, active conductors, neutral and protection. The protection one, which has the same insulation level, will be either parallel or part of the same cable, making easy its identification.

2.4.5.9.3 Junction boxes

The connections between conductors must be done inside junction boxes. Junction boxes are insulated, have high mechanical resistance and self-extinguishing fulfilling standard UNE 53.315, or metallic, depending on each case. They feature adjusting parts for the pipes incoming and terminals that fit the cross section of the branch cables.

The size of these boxes is so that they can loosely lodge all the wires inside them. Their depth is, at least, as the diameter of the biggest pipe plus fifty per cent of that, with a minimum depth of 40mm and 80mm on the lower side. Proper cable glands shall be used if it is necessary to seal the pipe entry.

2.4.5.10 Electrical receivers and auxiliary services

Receivers installed outdoors will have to fulfil the legal requirements related to wet environments according to ITC-BT-30.

The inlets to junction boxes of motors shall be made with cable glands or similar parts which grant an IP-55 minimum protection level for outdoors facilities.

2.4.5.10.1 Power

Power circuits supply the loads from the auxiliary services panel at the pumping station. These loads basically correspond to valves, pumps heating resistors, filters, gates, fans, air conditioning systems, sockets and socket boxes.

In the control rooms and all those rooms where there can usually be members of the staff, single-phase and three-phase sockets, depending on the case, shall be installed for the staff regular work.

It is also foreseen the installation of socket boxes spread along the pumps room for the maintenance works.

The socket boxes for maintenance and various purposes shall be IP54 and shall be equipped with one 32A electrical outlet III, two 16A electrical outlets with the pertinent protection each. The sockets distribution is detailed in the layouts.

2.4.5.10.2 Lighting

The lighting system is divided into three parts: indoors, outdoors and emergency.

Every light shall be sealed in order to make their maintenance and cleaning easier and, therefore, keeping their good condition. The metallic parts will be connected to the earthing grid.

The lighting installation is designed with light levels based on the following criteria:

Place	Situation	Value
Outdoors	Road	20-50 Lux
Indoors		
	Pumps room	200 Lux
	Low voltage room	200 Lux
	Control room	300 Lux
	Medium voltage room	250 Lux
	Transformer cabinets	200 Lux

Taula 1-20. Level lumens

Once the general considerations regarding lighting are stated, we start to define the lighting by areas:

a) Control room and panels room

For both control room and low voltage electric panels room, it is designed a lighting with lamps made of galvanized steel sheet and painted in white colour with omnidirectional optic control system, equipped with two TL 36W fluorescent tubes and electronic equipment.

The average light level, at a workplace located 0.80m over the pavement level and installation conservation rate of 0.80, is around 250lux.

The corresponding circuits are fed from CCM-3 and operated from pushbuttons that activate step relays located at the entry of each area.

b) Pumps room

The pumps room lighting consists of symmetric projectors made of aluminium injected base, and reflector made of anodized aluminium and thermally hardened sealing glass, equipped with a 250W metal halide or mercury vapour lamp and start-up equipment.

In addition, the design includes 2x36W airtight luminaires placed at the perimeter.

The average light level, at a workplace located 0.80m over the pavement level and installation conservation rate of 0.80, is around 200lux.

The corresponding circuits are fed from the auxiliary services panel and operated from pushbuttons that activate step relays located at the entry of the pumps room.

c) Medium voltage room and trays

For the MV room, transformers modules, etc. lighting, the lighting shall be with airtight fluorescent luminaires, IP67, equipped with 2 TL 36W fluorescent tubes and electronic equipment.

The average light level, at a workplace located 0.80 m over the pavement level and installation conservation rate of 0.80, is around 200lux.

The corresponding circuits are fed from the auxiliary services panel and operated from pushbuttons that activate step relays located at the entry of the pumps room or the switches room, depending on the case.

d) Outdoors

The outdoors lighting shall light the street around the station building through two independent installations:

- Minimum level installation, around 20lux.
- Additional installation, with luminaires of the same kind and power, placed in-between the previous ones, making the combination balanced and evenly spread regarding both brightness level and consumption per phase. There are additional luminaires, which provide a minimum level of 50lux at the areas near the building controlled by the presence signal that the PLC will deliver when an open door is detected.

The control and protection installation has been placed inside the lighting cabinet CCM-3, which has an incoming line from CCM-2 motors control center, of which depend, through magneto-thermal and differential switches, outdoors lighting lines. The activation of these lines is with contactors, controlled by the photoelectric cell and the previously mentioned presence of voltage signal, also having a manual switch for each circuit at the panel door.

The cable cross sections have been calculated according to the maximum withstand voltage drop and the current density, although in most cases the 4 mm² minimum outdoors lighting cross section prevails.

An earthing line will be set, made of bare copper, that will join all the lamps, welded with aluminium, with connection to each lamp.

e) Emergency lighting

The indoors emergency lighting is placed on top of each door, each stairway and, generally, at the exit areas and at the panels which need to be checked on even with lack of light.

The emergency equipment shall be self-contained and will comply with the requirements established in standards UNE20062 and 20392 and complementary directions.

They will be equipped with Ni-Cd batteries with embedded charger and the average level shall be 5 lux.

The luminaires are located in order to show the way out in case of emergency. See layouts.

2.4.5.11 Maximum allowable intensity and voltage drops

The power circuit sizing has been done considering the current density and voltage drops, accounting for the full usage of power.

It has been taken into consideration the type of cable, its installation method and the corresponding reduction factor due to installation inside pipe, tray or group.

The maximum allowable intensity has been obtained from ITC-BT-07 for cables with 1000V rated insulation voltage with Copper conductors, underground installation, applying the pertinent correcting factor on each case.

The obtained voltage drops, between the beginning of the BT facilities and any point of use, are lower than 3 per cent of nominal tension at the beginning of the lighting installation and lower than 5 per cent for the other purposes; this voltage drop has been calculated considering the supply of all the devices which can be working simultaneously. The sizing of all the power circuits is justified in the document "Calculations".

The protection conductors have been sized according to part 2.3 on standard ITC-BT-19.

2.5 ELECTRIC PROTECTIONS

2.5.1 Protection against short-circuit overloads

General protection is ensured by the main automatic switch with the pertinent neutral and phase overload relays. These relays in the general module will be adjusted in compliance with the supplier company rules and will be sealed according to the contracted power.

The transformers protection is ensured by their own automatic breaker and neutral and phase overload relays. These protection relays will be adjusted according to the power to supply and properly coordinated to the protection relay in the general module.

The relays feed will be made through 48Vdc safe voltage. The operating from the modules will be done through the pertinent connection and disconnection coils.

2.5.2 Protection against accidental direct contact

The protection against accidental contact with a live conductor is assured by the installation of prefabricated metallic modules with mechanical interlock that do not allow inside as long as the corresponding earthing breaker is not connected, depending on the following interlocks:

- **Door interlock:** Does not allow opening when the main equipment is closed or the earthing breaker is disconnected.
- **Operating interlock:** Prevents from operating the main equipment and the earthing breaker from opening if the door is open.
- **Earthing interlock:** Prevents earthing breaker from closing if the switch is closed or vice versa.

There is a mechanical interlock system with key, so it is impossible to enter the power transformer rooms without previously disconnecting and earthing the pertinent protection module, automatic breaker or circuit breaker.

In order to prevent return of voltage risk with the transformers connected in parallel, electrical interlocks have been provided for, between the protection module and the corresponding LV switch, that way, if the MV breaker disconnects, it will automatically trip the LV breaker.

In order to avoid accidents, signs showing the operating sequence shall be installed.

There will be standard “danger of dead” plates on every door to MV areas.

Reachable ventilation grids shall be V-profile, keeping outside objects from entering.

2.5.3 Protection against indirect contact

There is provided a combined system earthing of the metal masses and the action of cutting devices for fault current.

The facility will have differential switches universal cut that will interrupt power to the circuit in the case of circulation of a ground fault current greater than the sensitivity of the same value. This sensitivity is 0.03 A or 0.3 A as receivers and such compliance with the ITC-BT-24.

2.5.4 Protection against overvoltage

The facility will have protections against permanent overvoltage to meet the vademecum of FECSA-ENDESA.

2.5.5 Earthing line installation

The earthing installation from the transformers will be performed as follows:

- **Protection ground:** Using 50 mm² cross section copper cable which will connect all the transformer modules metallic parts, which are usually without voltage but might be with voltage due to failure, accidents, lightnings or overloads; metallic doors, transformers housing, metallic structures, rails, etc. Bare cable will be connected to a copper plate which will be connected to the earthing general grid, with the pertinent items, through 95 mm² cross section and H07V-K AV insulation copper cable and inside a thermoplastic pipe and through a breaker box.
- **Service grounds:** Using H07V-K AV insulated 95 mm² cross section copper cable, which will connect the transformer's neutral to the copper plate and the earthing grid, with the proper items and go through a thermoplastic pipe until the service grounds electrode so as not to impact the protection grounds.

2.5.6 Transformer protection

A safety installation for transformers protection will be performed with a digital temperature meter which, in case of failure, will act on the corresponding protection breaker.

Transformers safety is ensured by coil temperature monitoring, including:

- Pt100 probes installed inside the active part of the transformer
- Pt100 probe terminal box attached to the top part of the transformer.
- Digital temperature meter with three independent circuits. Two of the circuits control the temperature sensed by the Pt100 probes, one for warning and the other for action; the third circuit controls probe failure or power supply loss.

Note that the encapsulated dry transformers are thermic class F, therefore it is advisable to program the warning circuit at a maximum temperature of 150 °C and the breaker circuit at 160 °C. The digital thermometer will be installed on the control panel of the transformer protection cabinet. The connection between the probe terminal box and the digital thermometer will be through shielded and braid (20 revs. per m), inside a thermoplastic material pipe.

2.5.7 Additional safety measures

A rescue kit will be installed inside the plant as additional safety measure, including:

- 36 kV Insulating bench
- 36 kV Insulating gloves
- Earthing lines
- “Danger of death” warning plates on all the items with equipment in voltage, entry doors, etc.
- First aid plates
- Operating sequences directions.

Equipotential surfaces will be installed at areas at risk of dangerous contact voltages.

2.5.8 Neutral connection

According to REBT ITC-BT-08 “*Sistemes de connexió del neutre i de les masses en xarxes de distribució d’energia elèctrica*” and UNE 20460, installations directly fed from a public distribution network by using the proper transformers, can be settled in three different basic earthing connection diagrams, also known as neutral connection. These three diagrams are TT, IT and TN.

Choosing one or the other depends on different factors, such as the supply needed, the possibility of expanding the installation, the facility maintenance, etc.

2.5.8.1 Installation rules

Whatever the pre-existing earthing connection diagram of an installation is, regulations require that:

- Masses that can be simultaneously reached must be connected to the same earthing line
- Each mass must be connected to an earthing line through the protection conductor.
- A breaker device must disconnect all the part of the installation where a dangerous touch voltage can be originated.
- The breaking time of this device must be lower than the established maximum time.

2.5.8.2 TT Diagram

This is the neutral connection diagram that we will use for the installation of this project.

According to 1.2”Esquema TT” of ITC-BT-08 of REBT, “*l’esquema TT té un punt d’alimentació, generalment el neutre o compensador, connectat directament a terra. Les masses de la instal·lació receptora estan connectades a una toma de terra separada de la toma de terra de la alimentació*”.

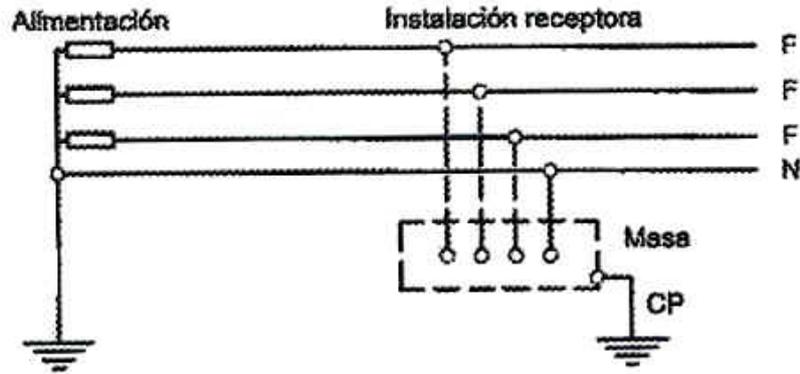


Figura 2.1. Circuit diagram. TT ground

To summarize, we can say that TT:

- Is the cheapest simpler solution
- Does not require permanent attention
- Due to the differential breakers there is higher prevention of indirect contact and fire if their sensitivity is lower than 300mA.
- Every insulation fail causes a break.

2.6 CONCLUSIONS

Having reached the end of the project, and based on all the realized points, we can conclude that:

- The values of cables and protections have a similar expected value before starting the project.
- The Switchgear is selected based on short circuits and overloads. We can ensure that this adjusted as much as possible to reality.
- All connections and canalazaciones have been made according to regulations REBT and ITC MIE RAT.
- The engines could have a better system boot by using frequency inverters or soft starters. For lack of resources, this was out of the project.
- For the electrical part, also lack the calculation of forced ventilation in rooms where excessive heat losses produced by the machines can damage the electrical components of the pumping station.

- The planes are quite similar to those of a pumping station that is in operation currently.

Finally, commenting that it was a shame not to go deeper into this project, due to several factors, and I never thought that a pumping station was so complete knowledge to develop and expand.

2.7 BIBLIOGRAPHY AND WEBGRAPHY

For the successful completion of this project, we used the following teaching materials.

2.7.1 Book and standards

- IEC Rules
- UNE Rules
- Reglamento electrotécnico para baja tensión e Instrucciones técnicas Complementarias (ITC) de la BT 01 a la BT 51. Real Decreto 842/2002
- Reglamento sobre condiciones técnicas y garantías e seguridad en líneas eléctricas de alta tensión y sus instrucciones técnicas complementarias ITC-LAT 01 a 09. Real decreto 223/2008
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2.7.2 Webgraphy

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- Ingesco, <http://www.ingesco.com/es>

3 CALCULATIONS

In this chapter will proceed with the drafting of the calculations of the project.

3.1 AIM

The purpose of this chapter is justified calculations, and more technical solutions used to perform the electrical installation of the pump station.

This chapter includes the justification of the following parts:

- Charge forecasting and estimation of consumption
- Calculations of nominal intensities
- Calculations of short-circuit intensities
- Calculation of MV Cross-sections
- Calculation busbar of shielded cubicles
- Selecting switchgear
- Calculation of Cross-sections by low voltage
- Calculation of the reactive compensation
- Calculation of grounding system
- Calculation of luminaries

3.2 CHARGE FORECASTING

This section presents the estimated consumption of pumps.

The pumping station in question is divided into three pumps, two of them with a pond and a third network.

There are six pumps (EB1) of 710 kW fed 690 V, operating 5 + 1, which will feed from a transformer. In addition, there will be a second pumping (EB2) with 5 pumps of 500 kW fed 690 V, operating 4 + 1, plus a filling pump 160 kW fed to 690 V. Finally, we have a third pumping (EBA) formed by two bombs of 630 kW and two pumps of 400 kW in operation mode 3 + 1 (Two pumps of 630 kW and one pumps of 400 kW), all powered to 690 V.

03. Calculations

For pumping EB1, we'll have a consumption:

$$\frac{(n^{\circ} \text{ pump} \cdot P)}{\cos \varphi} = \frac{5 \cdot 710 \text{ kW}}{0,8} = 4437,5 \text{ kVA} \quad (\text{Ec. 3.1})$$

It is intended that the transformers don't work normally loaded with an index of more than 80% to avoid overheating and make your life has more durability.

$$\frac{4437,5 \text{ kVA}}{0,8} = 5546,88 \text{ kVA} \quad (\text{Ec. 3.2})$$

In the case of EB2 + EBA, the highest consumption will be:

$$\frac{(4 \cdot 500 \text{ kW}) + (2 \cdot 630 \text{ kW}) + 400 \text{ kW} + 160 \text{ kW}}{0,8} = 4775 \text{ kVA} \quad (\text{Ec. 3.3})$$

As in the previous case, it is intended that the transformers don't work normally loaded with an index of more than 80% to avoid overheating and make your life has more durability.

$$\frac{4775 \text{ kVA}}{0,8} = 5968,75 \text{ kVA} \quad (\text{Ec. 3.4})$$

Therefore, it chooses to do feeding pumps with two 6300 kVA transformer with a transformation ratio of 25 / 0.69 kV, one for EB1 and the other for EB2 and EBA. So, we can use a third transformer with the same characteristics as a reserve in case of failure of one of the two transformers. So in total will have to install three 6300 kVA transformers, with transformation ratio of 25 / 0.69 kV.

There are also auxiliary services necessary for the proper functioning of the pumps, they are a total of 214.35 kW and 160 kW of installed permissible maximum, therefore:

$$\frac{160 \text{ kW}}{0,8} = 200 \text{ kVA} \quad (\text{Ec. 3.5})$$

03. Calculations

As in the previous case, it is intended that the transformers don't work normally loaded with an index of more than 80% to avoid overheating and make your life has more durability.

$$\frac{160 \text{ kVA}}{0,8} = 250 \text{ kVA} \quad (\text{Ec. 3.6})$$

Therefore, we'll use a 250 kVA transformer with transformation ratio of 25 / 0.4 kV.

The expected power in transformation is:

$$2 \cdot 6300 \text{ kVA} + 250 \text{ kVA} = 12850 \text{ kVA} \quad (\text{Ec. 3.7})$$

Thus, if we consider a relationship kW / kVA of 0.8, we'll obtain the active power that we can offer to install our transformers.

$$12850 \text{ kVA} \cdot 0,8 = 10280 \text{ kW} \quad (\text{Ec. 3.8})$$

3.3 NOMINAL INTENSITY

3.3.1 6300 kVA transformer nominal intensity

The intensity transformer primary phase is determined by the expression:

$$I_{1n} = \frac{S_n}{\sqrt{3} \cdot U_{1n}} \quad (\text{Ec. 3.9})$$

Where:

I_{1n} Primary nominal intensity, in A

S_n Transformer nominal power, in kVA

U_{1n} Primary nominal voltage, in kV

03. Calculations

If we substitute the values corresponding, we'll obtain:

$$I_{1n} = \frac{6300 \text{ kVA}}{\sqrt{3} \cdot 25 \text{ kV}} = 145,5 \text{ A} \quad (\text{Ec. 3.10})$$

3.3.1.1 Secondary 6300 kVA transformer nominal intensity

The intensity transformer secondary phase is determined by the expression:

$$I_{2n} = \frac{S_n}{\sqrt{3} \cdot U_{2n}} \quad (\text{Ec. 3.11})$$

On

I_{2n} Secondary nominal intensity, in A

S_n Transformer nominal power, in kVA

U_{2n} Secondary nominal voltage, in kV

If we substitute the values corresponding, we'll obtain:

$$I_{2n} = \frac{6300 \text{ kVA}}{\sqrt{3} \cdot 0,69 \text{ kV}} = 5271,45 \text{ A} \quad (\text{Ec. 3.12})$$

3.3.2 250 kVA transformer nominal intensity

3.3.2.1 Primary 250 kVA transformer nominal intensity

Using the same equation as before, replace the corresponding values:

$$I_{1n} = \frac{250 \text{ kVA}}{\sqrt{3} \cdot 25 \text{ kV}} = 5,77 \text{ A} \quad (\text{Ec. 3.13})$$

03. Calculations

3.3.2.2 Secondary 250 kVA transformer nominal intensity

Using the same equation as before, replace the corresponding values:

$$I_{2n} = \frac{250 \text{ kVA}}{\sqrt{3} \cdot 0,4 \text{ kV}} = 360,84 \text{ A} \quad (\text{Ec. 3.14})$$

3.3.3 Nominal intensity 710 kW pump motor

The nominal intensity in a three-phase motor is determined by the expression:

$$I_n = \frac{P_n}{\sqrt{3} \cdot U_n \cdot \cos \varphi} \quad (\text{Ec. 3.15})$$

Where:

I_n Nominal intensity, in A

P_n Nominal motor power, in W

U_n Nominal voltage, in V

For this type of pump, suppose a $\cos \varphi = 0.88$. If it replaced by corresponding values, we get:

$$I_n = \frac{710 \times 10^3 \text{ W}}{\sqrt{3} \cdot 690 \text{ V} \cdot 0,88} = 675,1 \text{ A} \quad (\text{Ec. 3.16})$$

3.3.4 Nominal intensity 500 kW pump motor

$$I_n = \frac{500 \times 10^3 \text{ W}}{\sqrt{3} \cdot 690 \text{ V} \cdot 0,88} = 475,42 \text{ A} \quad (\text{Ec. 3.17})$$

3.3.5 Nominal intensity 160 kW pump motor

$$I_n = \frac{160 \times 10^3 \text{ W}}{\sqrt{3} \cdot 690 \text{ V} \cdot 0,88} = 152,13 \text{ A} \quad (\text{Ec. 3.18})$$

3.3.6 Nominal intensity 630 kW pump motor

$$I_n = \frac{630 \times 10^3 \text{ W}}{\sqrt{3} \cdot 690 \text{ V} \cdot 0,88} = 599,02 \text{ A} \quad (\text{Ec. 3.19})$$

3.3.7 Nominal intensity 400 kW pump motor

$$I_n = \frac{400 \times 10^3 \text{ W}}{\sqrt{3} \cdot 690 \text{ V} \cdot 0,88} = 380,34 \text{ A} \quad (\text{Ec. 3.20})$$

3.4 SHORT-CIRCUIT INTENSITY

In this section we calculated short-circuit intensities for later choose the type of cable and adequate protection for each circuit.

3.4.1 Short-circuit intensity of MV side

To perform this calculation, we take the value provided by the company of 500 MVA power for the initial symmetrical short-circuit network and service voltage of 25 kV. We'll use the following mathematical expression:

$$I_{ccp} = \frac{S_{cc}}{\sqrt{3} \cdot U_p} \quad (\text{Ec. 3.21})$$

Where:

I_{ccp} Short-circuit intensity, in kA

S_{cc} Network short-circuit power, in kVA

U_p Service voltage, in kV

Substituting values:

$$I_{ccp} = \frac{500 \times 10^3 \text{ kVA}}{\sqrt{3} \cdot 25 \text{ kV}} = 11,55 \text{ kA} \quad (\text{Ec. 3.22})$$

03. Calculations

3.4.2 Short-circuit intensity of LV side

The secondary side short-circuit intensity of a three-phase transformer is determined by the following expression:

$$I_{ccs} = \frac{S}{\sqrt{3} \cdot \frac{U_{cc}}{100} \cdot U_s} \quad (Ec. 3.23)$$

Where:

I_{ccs} Secondary short-circuit intensity, in kA

S Transformer power, in kVA

U_{cc} Short circuit voltage of a transformer, in %

U_s Secondary voltage, in V

3.4.2.1 6300 kVA Transformer

$$I_{ccs} = \frac{6300 \text{ kVA}}{\sqrt{3} \cdot \frac{7}{100} \cdot 690 \text{ V}} = 75,31 \text{ kA} \quad (Ec. 3.24)$$

3.4.2.2 250 kVA Transformer

$$I_{ccs} = \frac{250 \text{ kVA}}{\sqrt{3} \cdot \frac{6}{100} \cdot 400 \text{ V}} = 6,01 \text{ kA} \quad (Ec. 3.25)$$

3.5 CALCULATION OF MV CROSS-SECTIONS

The conductors that connecting to shielded cubicles until to transformers to 6300 kVA and 250 kVA will be of the type RH5Z1. Its characteristics are described in Table 1-13, point 2.4.4.7. "MV 25kV Switchgear interconnection" of chapter "Report".

3.5.1 Generalities for dimensioning

These calculations are based on the conditions stipulated by the ITC-LAT-08 and its tables with corrections.

The standard conditions from the point 5.1.1.2 "*Condición tipo de instalación*" are:

- Unipolar cables circuit with aluminum conductors, cables in bundle around guidewire with proper insulation.
- Ambient air temperature, 40 °C
- Willingness to grant an effective renewal of air

3.5.2 Interconnection between cubicles and 6300kVA transformers

To make the relevant calculations, we use the following data:

- | | |
|--|----------|
| - Voltage between phase | 25 kV |
| - Maximum power to transport | 6300 kVA |
| - Nominal intensity (Ec. 1.10) | 145,5 A |
| - Short-circuit power for line | 500 MVA |
| - Short-circuit intensity (Ec. 1.22) | 11,55 kA |
| - Maximum protection time ¹ | 0,65 s |

¹ This period corresponds to the maximum time it takes for open the protection.

3.5.2.1 Short-circuit intensity calculation

For the calculation of short circuit current cable, we apply the following mathematical expression:

$$I_{cc} = \frac{K \cdot S}{\sqrt{t}} \quad (\text{Ec. 3.26})$$

Where:

I_{cc}	Short-circuit intensity, in A.
K	Cable's coefficient ²
t	Duration of the short-circuit intensity; 0,65 seconds
S	Cross-section, in mm ²

Therefore, the minimum section we needed is:

$$S = \frac{I_{cc} \cdot \sqrt{t}}{K} = \frac{11,55 \times 10^3 \text{ A} \cdot \sqrt{0,65 \text{ s}}}{92,8} = 100,34 \text{ mm}^2 \quad (\text{Ec. 3.27})$$

² Coefficient that depends on the nature of the driver, and the temperature at the beginning and end of the short circuit. For cables with aluminium conductor and insulation XPLE coefficient K is 92.8. [1]

03. Calculations

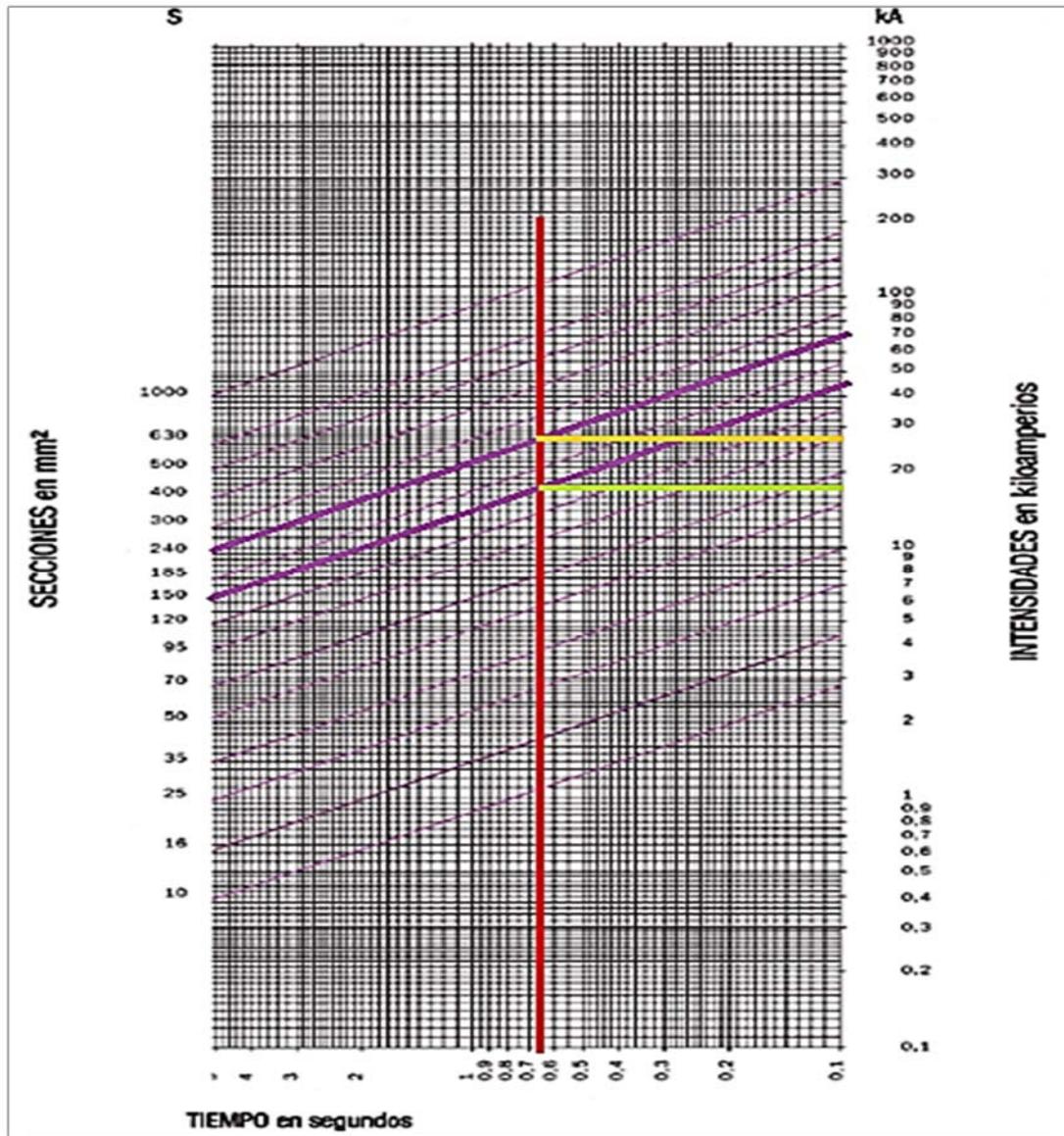


Figura 2.2. Graphic of thermal intensity admissible in short-circuit (Aluminium) according to UNE 21192

According to Figure 2.2., for a time of 0.65 s and can bear 11.55 kA short-circuit intensity, we can choose from 150 mm² section or more, as 120 mm² are very fair. Although already comply with 150 mm², we take a 240 mm² section, because being a conductor of aluminum with short length, the difference in price between these sections is very small and will win a better security factor front shorted.

With 240 mm² section tolerate 22.56 kA for one second, or about 27 kA in 0.65 seconds. Therefore, the cable is acceptable.

03. Calculations

3.5.2.2 Admissible current intensity calculation

To the nominal intensity, obtained previously, it should will apply two correction factors with the corresponding values according to the ITC-LAT-08. These factors are:

- Correction factor for grouping cables or short lists of three-phase unipolar cables.
- Correction factor for temperature.

a) Correction factor for grouping cables

The grouping factor will be 0.8 to 3 cables corresponding to $d = 0.25$ m apart.

b) Correction factor for temperature

TEMPERATURA °C	15	20	25	30	35	40	45	50
Factor de correcció	1,23	1,18	1,14	1,10	1,05	1	0,95	0,90

Taula 1-21. Temperature correction factor

According to Table 1-1 taken from Table 7 of the ITC-LAT-08, the temperature factor is 0.9 corresponding to 50 °C. We assume the worst, since the maximum temperature shouldn't ever get to 50 °C. Is only for oversize the cable.

c) Apply the factors

$$I_{\max} = \frac{145,5 A}{0,8 \cdot 0,9} = 202,08 A \quad (\text{Ec. 3.28})$$

The cable AL RH5Z1 1 x 240 mm² section tolerate 455 A, in an installation to air and service permanently. Therefore, the cable is acceptable.

3.5.2.3 Voltage drop calculation

Apply the following mathematical expression:

$$cdt = \sqrt{3} \cdot L \cdot I \cdot \sqrt{R^2 + X^2} \quad (Ec. 3.29)$$

Where:

cdt	Voltage drop, in V
L	Length of the considered section, in km
I	Nominal intensity, in A
R	Resistance of conductor, in Ω/km
X	Inductive reactance, in Ω/km

Therefore, considering a maximum length of 30 m:

$$cdt = \sqrt{3} \cdot 0,03 \text{ km} \cdot 145,5 \text{ A} \cdot \sqrt{0,125^2 + 0,114^2} = 1,28 \text{ V} \quad (Ec. 3.30)$$

The voltage drop can be considered negligible.

3.5.2.4 Data of required cable

After the calculations, the cable for interconnection between cubicles and 6300kVA transformer will be:

- Three conductor AL RH5Z1 unipolar, type XLPE, 1x240 mm² section.

The characteristics of this conductor can be seen in more detail in point 2.4.4.7 in the chapter "Report" of this project.

03. Calculations

3.5.3 Interconnection between cubicles and 250kVA transformer

To make the relevant calculations, we use the following data:

- Voltage between phase 25 kV
- Maximum power to transport 250 kVA
- Nominal intensity (Ec. 1.10) 5,7 A
- Short-circuit power for line 500 MVA
- Short-circuit intensity (Ec. 1.22) 11,55 kA
- Maximum protection time ³ 0,65 s

3.5.3.1 Short circuit intensity calculation

$$S = \frac{I_{cc} \cdot \sqrt{t}}{K} = \frac{11,55 \times 10^3 \text{ A} \cdot \sqrt{0,65 \text{ s}}}{92,8} = 100,34 \text{ mm}^2 \quad (\text{Ec. 3.31})$$

According to Figure 2.2., for a time of 0.65 s and can bear 11.55 kA short-circuit intensity, we can choose from 150 mm² section or more, as 120 mm² are very fair. In this case, we take a 150 mm² section, because in this transformer, compared than other of 6300 kVAR, doesn't circulate much current.

With 150 mm² section tolerate 14,1 kA for one second, or about 17 kA in 0.65 seconds. Therefore, the cable is acceptable.

3.5.3.2 Admissible current intensity calculation

To the nominal intensity, obtained previously, it should will apply two correction factors with the corresponding values according to the ITC-LAT-08. These factors are:

- Correction factor for grouping cables or short lists of three-phase unipolar cables.
- Correction factor for temperature.

³ This period corresponds to the maximum time it takes for open the protection.

03. Calculations

a) Correction factor for grouping cables

The grouping factor will be 0.8 to 3 cables corresponding to $d = 0.25$ m apart

b) Correction factor for temperature

According to Table 1-1 taken from Table 7 of the ITC-LAT-08, the temperature factor is 0.9 corresponding to 50 °C. We assume the worst, since the maximum temperature shouldn't ever get to 50 °C. Is only for oversize the cable.

c) Apply the factors

$$I_{\max} = \frac{5,77 \text{ A}}{0,8 \cdot 0,9} = 8,01 \text{ A} \quad (\text{Ec. 3.32})$$

The cable AL RH5Z1 1 x 150 mm² section tolerate 335 A, in an installation to air and service permanently. Therefore, the cable is acceptable

3.5.3.3 Voltage drop calculation

Therefore, considering a maximum length of 40 m:

$$cdt = \sqrt{3} \cdot 0,04 \text{ km} \cdot 5,77 \text{ A} \cdot \sqrt{0,206^2 + 0,123^2} = 0,09 \text{ V} \quad (\text{Ec. 3.33})$$

The voltage drop can be considered negligible.

3.5.3.4 Data of required cable

After the calculations, the cable for interconnection between cubicles and 250kVA transformer will be:

- Three conductor AL RH5Z1 unipolar, type XLPE, 1x150 mm² section.

The characteristics of this conductor can be seen in more detail in point 2.4.4.7 in the chapter "Report" of this project.

3.5.4 Summary

Below is a summary of the cables 18/30 kV calculated:

- Shielded cubicles to 6300 kVA transformer $3(1 \times 240 \text{mm}^3) + 50 \text{mm}^2$
- Shielded cubicles to 250 kVA transformer $3(1 \times 150 \text{mm}^2) + 50 \text{mm}^2$

3.6 BUSBAR CALCULATION OF SHIELDED CUBICLES

The cubicles are planned prefabricated, modular system, integral insulation and SF6 have been subjected to tests to certify the values shown on the plates of features, so it is not necessary to carry out theoretical calculations or hypothesis of behavior cubicles.

3.6.1 Check for current density

The check for the current density is intended to verify that the specified driver is able to drive maximum rated current without exceeding the maximum density possible for the conductive material. This, in addition to theoretical calculations, can be seen performing a test nominal intensity, with the object of ensuring sufficient margin of safety, it is considered that the intensity of the loop, which in this case is set at 630 A for cubicles to 25 kV.

3.6.2 Verification by request electrodynamicics

The dynamics intensity in short-circuit is valued in approximately 2.5 times the intensity effective short-circuit, 11.55 kA at 25 kV, therefore:

$$I_{cc(din)25kV} = 11,55 \text{ kA} \cdot 2,5 = 28,88 \text{ kA} \quad (\text{Ec. 3.34})$$

3.6.3 Checking for thermal application

A check for thermal application aims to ensure that there will be no excessive heating apparatus in default of a short circuit.

03. Calculations

This check can be done by theoretical calculations but preferably, more in case of prefabricated cubicles, must perform a test under current regulations. In this case, we weigh up effective short-circuit intensity, its value is 11.55 kA at 25 kV.

3.7 SELECTION OF SWITCHGEAR

3.7.1 Selection of the circuit breaker in MV

To protect the medium voltage installation of our cubicles have settled with armored breakers inside.

The characteristics of the shielded cubicles CGM.3-V, brand Ormazabal, were the following:

- Assigned Voltage:	36 kV
- Assigned Intensity:	630 A
- Short-time withstand current:	20 kA
- Withstand current. Peak value:	50 kA
- Short-circuit breaking capacity:	50 kA
- Short-circuit closing capacity:	20 kA

In our facility we obtained the following data:

- Nominal voltage:	25 kV
- Nominal intensity (6300 kVA):	145,5 A
- Short-circuit intensity	11,55 kA

Therefore, comparing the data we see that the cubicles protects the installation of medium voltage.

03. Calculations

3.7.2 Selection of shielded cubicle with fuse

This cubicle protects the MV side from the interconnection with 250 kVA transformer cables. This transformer has the following features to the primary part:

- Nominal voltage: 25 kV
- Nominal intensity (250 kVA): 5,77 A
- Short-circuit intensity 11,55 kA

According to Table 1-8 to chapter "Report" of this project, the fuse was assigned is 16 A. As we can see, this is valid to work normally.

3.7.3 Selection of line cubicles

To determine whether the cubicle is valid or not, we must first know what nominal intensity circulate each cubicle. If we add all the apparent powers of the installation, power of transformers, we can divide between the number of line cubicles to take over the intensity that flows through each of them.

We have all active power of the installation, it is 12.850 kVA. If you divide for three line cubicles, we get that for every cell circulate 4.283.33 kVA.

So we see that:

$$I_{nc} = \frac{S_c}{\sqrt{3} \cdot U_{n1}} = \frac{4283,33 \text{ kVA}}{\sqrt{3} \cdot 25 \text{ kV}} = 98,92 \text{ A} \quad (\text{Ec. 3.35})$$

Where:

I_{nc} Nominal intensity circulating by line cubicle, in A.

S_{Lin} Power supplied by line, in MVA.

U_{n1} Nominal voltage in the primary, in kV

Each line cubicle has the following properties:

- Nominal intensity

In bus bar and cubicles connection 400 / 630 A

Supply line 400 / 630 A

Therefore, the circulating intensity is lower than allowed for each cubicle. These line cubicles are valid.

3.7.4 Selection of the circuit breaker in LV

The calculation of low voltage protection will be carried out to meet the following guidelines.

3.7.4.1 Overload

According to UNE 20-460-90 / 4-43, the operating characteristics of a device that has to protect a driver of overloading must satisfy two fundamental conditions.

$$I_b \leq I_n \leq I_z \quad (\text{Ec. 3.36})$$

$$I_2 \leq 1,45 I_z \quad (\text{Ec. 3.37})$$

When:

I_b Intensity of calculation used in circuit, in A

I_z Intensity driver admissible according to UNE 20-460 / 5-523

I_n Intensity nominal protection device. If the device is adjustable, the I_n will be the regulated intensity at that time.

I_2 Intensity ensuring the effective operation of the protective device. In practice I_2 is taken equal to:

- The intensity of operation in conventional time, for circuit breakers.
- The intensity of fusion time conventional for fuses. In Fuse, usually $I_2 = 1,6 \cdot I_n$, making it the nominal intensity of fuse.

Therefore to fulfill the second condition that must be verified:

$$1,6 \cdot I_n = 1,45 I_z \quad (\text{Ec. 3.38})$$

$$\frac{1,6}{1,45} \cdot I_n = I_z \quad (\text{Ec. 3.39})$$

$$1,1 \cdot I_n = I_z \quad (\text{Ec. 3.40})$$

This inequality means that the cable allowable intensity when the protection is done with fuses must be greater than the nominal current of the fuse in a ratio of 1.1.

Therefore, for the election of the breaker only have to consider two things:

- - Maximum protection: In closest to Ib
- - Minimum Protection: In closest to Iz

3.7.4.2 Short-circuit with magneto-thermal

For protection against short circuits must be fulfilled two conditions:

1st Condition

$$I_{cn} \text{ o } I_{cu} \geq I_{cc} \quad (\text{Ec. 3.41})$$

Where:

I_{cn} o I_{cu} Breaking capacity switch (last), in A

I_{cc} Short-circuit intensity, in A

We'll choose a switch that could higher cut intensity than expected to I_{cc} at the point where that is the maximum that can occur in the circuit.

2nd Condition

The cutting time of device must be less than the time required for the temperature reaches the allowable limit for drivers.

To perform this calculation use the Ec. 1:25.

This condition must be verified by both the maximum I_{cc} as the I_{cc} minimum.

03. Calculations

3.7.4.3 Selectivity

The selectivity ensures that the opening of switch occurs in that it is located just upstream of the defect.

In the case of short circuit, amperimetric selectivity not be total. In this case, you should also implement chronometric selectivity.

Typically, manufacturers indicate the catalog selectivity between their gamut.

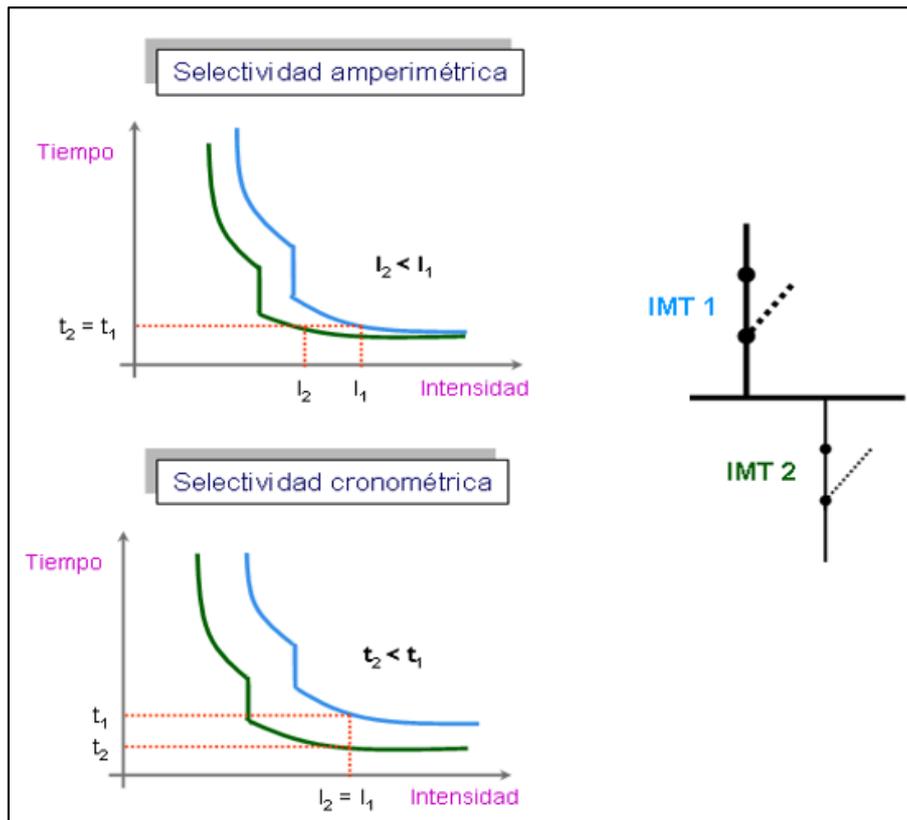


Figura 2.3. Gràfic intensitats tèrmicament admissibles en cc (Alumini) segons UNE 21192

3.8 LV CROSS-SECTION CALCULATE

Due to the large number of low voltage receivers that are in the pumping station, the calculation of the sections is done through a calculation program Low Voltage.

The calculations will be checked to verify its consistency with everything described in the previous sections, and applying all relevant correction factors.

In addition, this program will also undertake the calculation of protection and trays / tubes that have installation.

The program is used in calculation of CIEBT DMELECT.

3.8.1 Electrical panel CCM1

3.8.1.1 Power demand

- Installed total power:

Trafo 1 (EB1):

Pump 5	710000 W
Pump 6	710000 W
Pump 7	710000 W
Pump 8	710000 W
Pump 9	710000 W
Pump 10	710000 W
TOTAL....	4260000 W

Trafo 2 (EB2 and EBA):

Pump 11	500000 W
Pump 12	500000 W
Pump 13	500000 W
Pump 14	500000 W
Pump 15	500000 W
Filling pump	160000 W
Pump 1	630000 W
Pump 2	630000 W
Pump 3	400000 W
Pump 4	400000 W
TOTAL....	4720000 W

03. Calculations

3.8.1.2 Calculation of individual branch line A and B (EB1)

- Service voltage: 690 V.
- Canalization: C-Unip.or Poli.on wall
- Length: 20 m; Cos φ : 0.8; X_u ($\mu\Omega/m$): 0;
- Installed power: 4260000 W.
- Calculating power: (According to ITC-BT-47):
 $710000 \times 1.25 + 2868400 = 3755900$ W (Simultaneity coefficient: 0.84)

$$I = 3755900 / (1,732 \times 690 \times 0.8) = 3928.5 \text{ A.}$$

Selected cables: Single-pole 14(3x240/120+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE+Pol - No fire propagation or smoke emissions and reduced opacity -. Desig. UNE: RZ1-K (AS)

I.ad. to 40°C (Cf=0.66) 4019.4 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 80.78

$$e(\text{partial}) = 20 \times 3755900 / (44.87 \times 690 \times 10 \times 240) = 1.01 \text{ V.} = 0.15 \%$$

$$e(\text{total}) = 0.15\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

I. Aut./Tet. In.: 4000 A. Thermal Adj. Adjustable Switch: 4000 A.

3.8.1.3 Line calculation: Pump 5

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 75 m; Cos φ : 0.88; X_u ($\mu\Omega/m$): 0; R: 0.97
- Installed power: 710000 W.
- Calculating power: (According to ITC-BT-47):
 $710000 \times 1.25 = 887500$ W.

$$I = 887500 / (1,732 \times 690 \times 0.88 \times 0.97) = 870 \text{ A.}$$

Selected cables: Single-pole 3(3x240+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=0.8) 962.4 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 80.86

$$e(\text{partial}) = 75 \times 887500 / (44.85 \times 690 \times 3 \times 240 \times 0.97) = 3.08 \text{ V.} = 0.45 \%$$

$$e(\text{total}) = 0.6\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 1000 A. Thermal Adj. Adjustable Switch: 916 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

03. Calculations

Contactor:

3-Pole Contactor I_n : 1000 A.

3.8.1.4 Line calculation: Pump 6

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 80 m; $\cos \varphi$: 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 710000 W.
- Calculating power: (According to ITC-BT-47):
 $710000 \times 1.25 = 887500$ W.

$$I = 887500 / (1.732 \times 690 \times 0.88 \times 0.97) = 870 \text{ A.}$$

Selected cables: Single-pole 3(3x240+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C ($C_f=0.8$) 962.4 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 80.86

$$e(\text{partial}) = 80 \times 887500 / (44.85 \times 690 \times 3 \times 240 \times 0.97) = 3.28 \text{ V.} = 0.48 \%$$

$$e(\text{total}) = 0.63\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. I_n : 1000 A. Thermal Adj. Adjustable Switch: 916 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor I_n : 1000 A.

3.8.1.5 Line calculation: Pump 7

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 85 m; $\cos \varphi$: 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 710000 W.
- Calculating power: (According to ITC-BT-47):
 $710000 \times 1.25 = 887500$ W.

$$I = 887500 / (1.732 \times 690 \times 0.88 \times 0.97) = 870 \text{ A.}$$

Selected cables: Single-pole 3(3x240+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C ($C_f=0.8$) 962.4 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 80.86

$$e(\text{partial}) = 85 \times 887500 / (44.85 \times 690 \times 3 \times 240 \times 0.97) = 3.49 \text{ V.} = 0.51 \%$$

$$e(\text{total}) = 0.66\% \text{ ADMIS (5\% MAX.)}$$

03. Calculations

Thermal power:

I. Aut./Tri. *In.*: 1000 A. Thermal Adj. Adjustable Switch: 916 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor: 3-Pole Contactor *In*: 1000 A.

3.8.1.6 Line calculation: Pump 8

- Service voltage: 690 V.

- Canalization: B1-Unip. Superf. Tray or Built In

- Length: 90 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97

- Installed power: 710000 W.

- Calculating power: (According to ITC-BT-47):
 $710000 \times 1.25 = 887500$ W.

$I = 887500 / (1,732 \times 690 \times 0.88 \times 0.97) = 870$ A.

Selected cables: Single-pole 3(3x240+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=0.8) 962.4 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 80.86

$e(\text{partial}) = 90 \times 887500 / (44.85 \times 690 \times 3 \times 240 \times 0.97) = 3.7$ V. = 0.54 %

$e(\text{total}) = 0.69\%$ ADMIS (5% MAX.)

Thermal power:

I. Aut./Tri. *In.*: 1000 A. Thermal Adj. Adjustable Switch: 916 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor *In*: 1000 A.

3.8.1.7 Line calculation: Pump 9

- Service voltage: 690 V.

- Canalization: B1-Unip. Superf. Tray or Built In

- Length: 95 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97

- Installed power: 710000 W.

- Calculating power: (According to ITC-BT-47):
 $710000 \times 1.25 = 887500$ W.

$I = 887500 / (1,732 \times 690 \times 0.88 \times 0.97) = 870$ A.

Selected cables: Single-pole 3(3x240+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=0.8) 962.4 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 80.86

$e(\text{partial}) = 95 \times 887500 / (44.85 \times 690 \times 3 \times 240 \times 0.97) = 3.9$ V. = 0.57 %

$e(\text{total}) = 0.72\%$ ADMIS (5% MAX.)

03. Calculations

Thermal power:

I. Aut./Tri. *In*.: 1000 A. Thermal Adj. Adjustable Switch: 916 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor *In*: 1000 A.

3.8.1.8 Line calculation: Pump 10

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 100 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 710000 W.
- Calculating power: (According to ITC-BT-47):
 $710000 \times 1.25 = 887500$ W.

$I = 887500 / (1.732 \times 690 \times 0.88 \times 0.97) = 870$ A.

Selected cables: Single-pole 3(3x240+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=0.8) 962.4 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 80.86

$e(\text{partial}) = 100 \times 887500 / (44.85 \times 690 \times 3 \times 240 \times 0.97) = 4.11$ V. = 0.6 %

$e(\text{total}) = 0.75\%$ ADMIS (5% MAX.)

Thermal power:

I. Aut./Tri. *In*.: 1000 A. Thermal Adj. Adjustable Switch: 916 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor *In*: 1000 A.

3.8.1.9 Busbar calculation of the control and protection general panel EB13.8.1.9.1 *Information*

- Metal: Cu
- Condition decks: Bared
- N°. busbars per phase: 4
- Separation between busbars, d(cm): 10
- Separation between suport, L(cm): 25
- C.C. duration time(s): 0.5

3.8.1.9.2 *Select Busbar*

- Cross-section (mm²): 800
- Breadth (mm): 80

03. Calculations

- Depth (mm): 10
- W_x, I_x, W_y, I_y (cm³, cm⁴) : 10.66, 42.6, 1.333, 0.666
- Admissible intensity in Busbar (A): 4200

3.8.1.9.3 *Electrodynamic calculation*

$$s_{max} = I_{pcc}^2 \cdot L^2 / (60 \cdot d \cdot W_y \cdot n) = 46.83^2 \cdot 25^2 / (60 \cdot 10 \cdot 1.333 \cdot 4) = 428.517 \leq 1200 \text{ kg/cm}^2 \text{ Cu}$$

3.8.1.9.4 *Thermal calculation for allowable intensity*

$$I_{cal} = 3928.5 \text{ A}$$

$$I_{adm} = 4200 \text{ A}$$

3.8.1.9.5 *Checking for thermal application in shorted*

$$I_{pcc} = 46.83 \text{ ca}$$

$$I_{ccs} = K_c \cdot S / (1000 \cdot \sqrt{t_{cc}}) = 164 \cdot 800 \cdot 4 / (1000 \cdot \sqrt{0.5}) = 742.18 \text{ ca}$$

3.8.1.10 Calculation of individual branch line A and B (EB2 and EBA)

- Service voltage: 690 V.
- Canalization: C-Unip. or Poli. on wall
- Length: 20 m; Cos φ : 0.8; X_u ($\mu\Omega$ /m): 0;
- Installed power: 4720000 W.
- Calculating power: (According to ITC-BT-47):
 $630000 \times 1.25 + 3004400 = 3791900 \text{ W}$. (Simultaneity coefficient: 0.77)

$$I = 3791900 / (1.732 \times 690 \times 0.8) = 3966.16 \text{ A.}$$

Selected cables: Single-pole 14(3x240/120+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE+Pol - No fire propagation or smoke emissions and reduced opacity - . Desig. UNE: RZ1-K (AS)

I.ad. to 40°C (Cf=0.66) 4019.4 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 81.57

$$e(\text{partial}) = 20 \times 3791900 / (44.75 \times 690 \times 10 \times 240) = 1.02 \text{ V.} = 0.15 \%$$

$$e(\text{total}) = 0.16\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

I. Aut./Tet. In.: 4000 A. Thermal Adj. Adjustable Switch: 4000 A.

3.8.1.11 Line calculation: Pump 11

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 80 m; Cos φ : 0.88; X_u ($\mu\Omega$ /m): 0; R: 0.97

03. Calculations

- Installed power: 500000 W.
- Calculating power: (According to ITC-BT-47):
500000x1.25=625000 W.

$I=625000/1,732 \times 690 \times 0.88 \times 0.97=612.67$ A.
 Selected cables: Single-pole 2(3x240+TT)mm²Cu
 Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=0.8) 641.6 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 85.59
 $e(\text{partial})=80 \times 625000/44.19 \times 690 \times 2 \times 240 \times 0.97=3.52$ V.=0.51 %
 $e(\text{total})=0.63\%$ ADMIS (5% MAX.)

Thermal power:

I. Aut./Tri. In.: 630 A. Thermal Adj. Adjustable Switch: 627 A.
 Differential protection:
 Relay and transf. Differential susceptibility: 300 mA.
 Contactor:
 3-Pole Contactor In: 650 A.

3.8.1.12 Line calculation: Pump 12

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 85 m; Cos φ: 0.88; Xu(μΩ/m): 0; R: 0.97
- Installed power: 500000 W.
- Calculating power: (According to ITC-BT-47):
500000x1.25=625000 W.

$I=625000/1,732 \times 690 \times 0.88 \times 0.97=612.67$ A.
 Selected cables: Single-pole 2(3x240+TT)mm²Cu
 Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=0.8) 641.6 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 85.59
 $e(\text{partial})=85 \times 625000/44.19 \times 690 \times 2 \times 240 \times 0.97=3.74$ V.=0.54 %
 $e(\text{total})=0.67\%$ ADMIS (5% MAX.)

Thermal power:

I. Aut./Tri. In.: 630 A. Thermal Adj. Adjustable Switch: 627 A.
 Differential protection:
 Relay and transf. Differential susceptibility: 300 mA.
 Contactor:
 3-Pole Contactor In: 650 A.

03. Calculations

3.8.1.13 Line calculation: Pump 13

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 90 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 500000 W.
- Calculating power: (According to ITC-BT-47):
 $500000 \times 1.25 = 625000$ W.

$$I = 625000 / (1,732 \times 690 \times 0.88 \times 0.97) = 612.67 \text{ A.}$$

Selected cables: Single-pole 2(3x240+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=0.8) 641.6 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 85.59

$$e(\text{partial}) = 90 \times 625000 / (44.19 \times 690 \times 2 \times 240 \times 0.97) = 3.96 \text{ V.} = 0.57 \%$$

$$e(\text{total}) = 0.7\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 630 A. Thermal Adj. Adjustable Switch: 627 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor In: 650 A.

3.8.1.14 Line calculation: Pump 14

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 95 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 500000 W.
- Calculating power: (According to ITC-BT-47):
 $500000 \times 1.25 = 625000$ W.

$$I = 625000 / (1,732 \times 690 \times 0.88 \times 0.97) = 612.67 \text{ A.}$$

Selected cables: Single-pole 2(3x240+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=0.8) 641.6 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 85.59

$$e(\text{partial}) = 95 \times 625000 / (44.19 \times 690 \times 2 \times 240 \times 0.97) = 4.18 \text{ V.} = 0.61 \%$$

$$e(\text{total}) = 0.73\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 630 A. Thermal Adj. Adjustable Switch: 627 A.

Differential protection:

03. Calculations

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor I_n : 650 A.

3.8.1.15 Line calculation: Pump 15

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 100 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 500000 W.
- Calculating power: (According to ITC-BT-47):
 $500000 \times 1.25 = 625000$ W.

$$I = 625000 / (1.732 \times 690 \times 0.88 \times 0.97) = 612.67 \text{ A.}$$

Selected cables: Single-pole 2(3x240+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C ($C_f=0.8$) 641.6 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 85.59

$$e(\text{partial}) = 100 \times 625000 / (44.19 \times 690 \times 2 \times 240 \times 0.97) = 4.4 \text{ V.} = 0.64 \%$$

$$e(\text{total}) = 0.76\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. I_n : 630 A. Thermal Adj. Adjustable Switch: 627 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor I_n : 650 A.

3.8.1.16 Line calculation: Filling pump

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 100 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 160000 W.
- Calculating power: (According to ITC-BT-47):
 $160000 \times 1.25 = 200000$ W.

$$I = 200000 / (1.732 \times 690 \times 0.88 \times 0.97) = 196.06 \text{ A.}$$

Selected cables: Single-pole 3x95+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C ($C_f=1$) 224 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 78.3

$$e(\text{partial}) = 100 \times 200000 / (45.22 \times 690 \times 95 \times 0.97) = 6.96 \text{ V.} = 1.01 \%$$

$$e(\text{total}) = 1.13\% \text{ ADMIS (5\% MAX.)}$$

03. Calculations

Thermal power:

I. Aut./Tri. *In.*: 250 A. Thermal Adj. Adjustable Switch: 210 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor *In.*: 250 A.

3.8.1.17 Line calculation: Pump 1

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 85 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 630000 W.
- Calculating power: (According to ITC-BT-47):
 $630000 \times 1.25 = 787500$ W.

$$I = 787500 / (1.732 \times 690 \times 0.88 \times 0.97) = 771.97 \text{ A.}$$

Selected cables: Single-pole 3(3x185+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C ($C_f=0.8$) 818.4 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 84.49

$$e(\text{partial}) = 85 \times 787500 / (44.35 \times 690 \times 3 \times 185 \times 0.97) = 4.06 \text{ V.} = 0.59 \%$$

$$e(\text{total}) = 0.71\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. *In.*: 800 A. Thermal Adj. Adjustable Switch: 795 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor *In.*: 1000 A.

3.8.1.18 Line calculation: Pump 2

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 89 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 630000 W.
- Calculating power: (According to ITC-BT-47):
 $630000 \times 1.25 = 787500$ W.

$$I = 787500 / (1.732 \times 690 \times 0.88 \times 0.97) = 771.97 \text{ A.}$$

Selected cables: Single-pole 3(3x185+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C ($C_f=0.8$) 818.4 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 84.49

03. Calculations

$$e(\text{partial})=89 \times 787500 / 44.35 \times 690 \times 3 \times 185 \times 0.97 = 4.25 \text{ V.} = 0.62 \%$$

$$e(\text{total})=0.74\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. *In.*: 800 A. Thermal Adj. Adjustable Switch: 795 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor *In.*: 1000 A.

3.8.1.19 Line calculation: Pump 3

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 94 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 400000 W.
- Calculating power: (According to ITC-BT-47):
 $400000 \times 1 = 400000 \text{ W.}$

$$I=400000 / 1,732 \times 690 \times 0.88 \times 0.97 = 392.11 \text{ A.}$$

Selected cables: Single-pole 2(3x120+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE, Apantallat. Desig. UNE: RVKV-K
I.ad. to 40°C (Cf=0.8) 416 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 84.42

$$e(\text{partial})=94 \times 400000 / 44.35 \times 690 \times 2 \times 120 \times 0.97 = 5.28 \text{ V.} = 0.76 \%$$

$$e(\text{total})=0.89\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. *In.*: 400 A. Thermal Adj. Adjustable Switch: 400 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor *In.*: 450 A.

3.8.1.20 Line calculation: Pump 4

- Service voltage: 690 V.
- Canalization: B1-Unip. Superf. Tray or Built In
- Length: 99 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 400000 W.
- Calculating power: (According to ITC-BT-47):
 $400000 \times 1 = 400000 \text{ W.}$

$$I=400000 / 1,732 \times 690 \times 0.88 \times 0.97 = 392.11 \text{ A.}$$

Selected cables: Single-pole 2(3x120+TT)mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE, Apantallat. Desig. UNE: RVKV-K
I.ad. to 40°C (Cf=0.8) 416 A. according to ITC-BT-19

03. Calculations

Voltage drop:

Temperature cable (°C): 84.42

$e(\text{partial}) = 99 \times 400000 / 44.35 \times 690 \times 2 \times 120 \times 0.97 = 5.56 \text{ V.} = 0.81 \%$

$e(\text{total}) = 0.93\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 400 A. Thermal Adj. Adjustable Switch: 400 A.

Differential protection:

Relay and transf. Differential susceptibility: 300 mA.

Contactor:

3-Pole Contactor In: 450 A.

3.8.1.21 Busbar calculation of the control and protection general panel (EB2-EBA)

3.8.1.21.1 Information

- Metal: Cu
- Condition decks: Bared
- N°. busbars per phase: 4
- Separation between busbars, d(cm): 10
- Separation between suport, L(cm): 25
- C.C. duration time(s): 0.5

3.8.1.21.2 Select Busbar

- Cross-section (mm²): 800
- Breadth (mm): 80
- Depth (mm): 10
- Wx, Ix, Wy, Iy (cm³,cm⁴) : 10.66, 42.6, 1.333, 0.666
- Admissible intensity in Busbar (A): 4200

3.8.1.21.3 Electrodynamic calculation

$$s_{\text{max}} = I_{\text{pcc}}^2 \cdot L^2 / (60 \cdot d \cdot W_y \cdot n) = 46.89^2 \cdot 25^2 / (60 \cdot 10 \cdot 1.333 \cdot 4) = 429.494$$

$\leq 1200 \text{ kg/cm}^2 \text{ Cu}$

3.8.1.21.4 Thermal calculation for allowable intensity

$$I_{\text{cal}} = 3966.16 \text{ A}$$

$$I_{\text{adm}} = 4200 \text{ A}$$

3.8.1.21.5 Checking for thermal application in shorted

$$I_{\text{pcc}} = 46.89 \text{ ca}$$

$$I_{\text{ccs}} = K_c \cdot S / (1000 \cdot \ddot{O}_{\text{tcc}}) = 164 \cdot 800 \cdot 4 / (1000 \cdot \sqrt{0.5}) = 742.18 \text{ ca}$$

03. Calculations

3.8.2 Electrical panel: CCM2

3.8.2.1 Power demand

- Installed total power:

Overhead crane 1	6000 W
Overhead crane 2	6000 W
General suction Valve 1	200 W
General suction Valve 2	200 W
General suction Valve 3	200 W
General suction Valve 4	200 W
Valve 5	200 W
Valve 6	200 W
Valve 7	200 W
Valve 8	200 W
Valve 9	200 W
Valve 10	200 W
Valve 11	200 W
Valve 12	200 W
Impulsion valve EB-2	200 W
Valve 14	200 W
Valve 15	200 W
Valve 16	200 W
Valve 17	200 W
Valve 18	200 W
Valve 19	200 W
Valve 20	200 W
Valve 21	200 W
Valve 22	200 W
Valve 23	200 W
Valve 24	200 W
Valve 25	200 W
Impulsion valve EB-1	200 W
Valve 27	200 W
Valve 28	200 W
Valve 29	200 W
Valve 30	200 W
Valve 31	200 W
Valve 32	200 W
Valve 33	200 W
Valve 34	200 W
Valve 35	200 W
Valve 36	200 W
Impulsion valve EB-A	200 W
Filling pump valve	200 W
CCM3	194750 W
TOTAL....	214350 W

03. Calculations

3.8.2.2 Calculation of individual branch line CCM2

- Service voltage: 400 V.
- Canalization: C-Unip.or Poli.on wall
- Length: 20 m; Cos φ : 0.8; X_u ($\mu\Omega/m$): 0;
- Installed power: 231350 W.
- Calculating power: (According to ITC-BT-47 i ITC-BT-44):
 $8000 \times 1.25 + 165985 = 175985$ W. (Simultaneity coefficient: 0.7)

$$I = 175985 / (1,732 \times 400 \times 0.8) = 317.52 \text{ A.}$$

Selected cables: Single-pole 3x185/95+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE+Pol - No fire propagation or smoke emissions and reduced opacity -. Desig. UNE: RZ1-K (AS)

I.ad. to 40°C (Cf=1) 368 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 77.22

$$e(\text{partial}) = 20 \times 175985 / (45.38 \times 400 \times 185) = 1.05 \text{ V.} = 0.26 \%$$

$$e(\text{total}) = 0.28\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

I. Aut./Tet. In.: 400 A. Thermal Adj. Adjustable Switch: 343 A.

3.8.2.3 Line calculation: Overhead crane 1

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 55 m; Cos φ : 0.88; X_u ($\mu\Omega/m$): 0; R: 0.97
- Installed power: 6000 W.
- Calculating power: (According to ITC-BT-47):
 $6000 \times 1.25 = 7500$ W.

$$I = 7500 / (1,732 \times 400 \times 0.88 \times 0.97) = 12.68 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 56.62

$$e(\text{partial}) = 55 \times 7500 / (48.58 \times 400 \times 2.5 \times 0.97) = 8.75 \text{ V.} = 2.19 \%$$

$$e(\text{total}) = 2.47\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 16 A. Thermal Adj. Adjustable Switch: 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.4 Line calculation: Overhead crane 2

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 55 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 6000 W.
- Calculating power: (According to ITC-BT-47):
 $6000 \times 1.25 = 7500$ W.

$$I = 7500 / 1,732 \times 400 \times 0.88 \times 0.97 = 12.68 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 56.62

$$e(\text{partial}) = 55 \times 7500 / 48.58 \times 400 \times 2.5 \times 0.97 = 8.75 \text{ V.} = 2.19 \%$$

$$e(\text{total}) = 2.47\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 16 A. Thermal Adj. Adjustable Switch: 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.5 Line calculation: Valve Aspiració General 1

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 25 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
 $200 \times 1.25 = 250$ W.

$$I = 250 / 1,732 \times 400 \times 0.88 \times 0.97 = 0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial}) = 25 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97 = 0.13 \text{ V.} = 0.03 \%$$

$$e(\text{total}) = 0.31\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.6 Line calculation: General suction Valve 2

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 25 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97v/v
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=25 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.13 \text{ V.}=0.03 \%$$

$$e(\text{total})=0.31\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.7 Line calculation: Valve Aspiració General 3

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 25 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=25 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.13 \text{ V.}=0.03 \%$$

$$e(\text{total})=0.31\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.8 Line calculation: Valve Aspiració General 4

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 25 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=25 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.13 \text{ V.}=0.03 \%$$

$$e(\text{total})=0.31\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.9 Line calculation: Valve 5

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.10 Line calculation: Valve 6

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.11 Line calculation: Valve 7

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.12 Line calculation: Valve 8

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.13 Line calculation: Valve 9

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.14 Line calculation: Valve 10

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.15 Line calculation: Valve 11

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.16 Line calculation: Valve 12

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.17 Line calculation: Impulsion valve EB-2

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 64 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=64 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.32 \text{ V.}=0.08 \%$$

$$e(\text{total})=0.36\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.18 Line calculation: Valve 14

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 78 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=78 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.19 Line calculation: Valve 15

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 78 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTx2.5mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=78 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.20 Line calculation: Valve 16

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 78 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=78 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.21 Line calculation: Valve 17

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 83 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=83 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.42 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.22 Line calculation: Valve 18

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 88 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=88 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.44 \text{ V.}=0.11 \%$$

$$e(\text{total})=0.39\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.23 Line calculation: Valve 19

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 93 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=93 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.47 \text{ V.}=0.12 \%$$

$$e(\text{total})=0.4\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.24 Line calculation: Valve 20

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 100 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=100 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.5 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.25 Line calculation: Valve 21

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 103 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=103 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.52 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.26 Line calculation: Valve 22

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 103 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=103 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.52 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.27 Line calculation: Valve 23

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 103 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=103 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.52 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.28 Line calculation: Valve 5

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.29 Line calculation: Valve 6

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.30 Line calculation: Valve 7

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.31 Line calculation: Valve 8

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.32 Line calculation: Valve 9

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.33 Line calculation: Valve 10

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.34 Line calculation: Valve 11

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.35 Line calculation: Valve 12

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 77 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=77 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.36 Line calculation: Impulsion valve EB-2

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 64 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=64 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.32 \text{ V.}=0.08 \%$$

$$e(\text{total})=0.36\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.37 Line calculation: Valve 14

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 78 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=78 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.38 Line calculation: Valve 15

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 78 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTx2.5mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=78 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.39 Line calculation: Valve 16

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 78 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=78 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.39 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.40 Line calculation: Valve 17

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 83 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=83 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.42 \text{ V.}=0.1 \%$$

$$e(\text{total})=0.38\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.41 Line calculation: Valve 18

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 88 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=88 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.44 \text{ V.}=0.11 \%$$

$$e(\text{total})=0.39\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.42 Line calculation: Valve 19

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 93 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=93 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.47 \text{ V.}=0.12 \%$$

$$e(\text{total})=0.4\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.43 Line calculation: Valve 20

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 100 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=100 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.5 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.44 Line calculation: Valve 21

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 103 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=103 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.52 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.45 Line calculation: Valve 22

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 103 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=103 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.52 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.46 Line calculation: Valve 23

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 103 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=103 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.52 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.47 Line calculation: Valve 24

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 103 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=103 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.52 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.48 Line calculation: Valve 25

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 103 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=103 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.52 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.49 Line calculation: Impulsion valve EB-1

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 67 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=67 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.34 \text{ V.}=0.08 \%$$

$$e(\text{total})=0.36\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.50 Line calculation: Valve 27

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 88 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=88 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.44 \text{ V.}=0.11 \%$$

$$e(\text{total})=0.39\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.51 Line calculation: Valve 28

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 88 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=88 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.44 \text{ V.}=0.11 \%$$

$$e(\text{total})=0.39\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.52 Line calculation: Valve 29

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 88 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=88 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.44 \text{ V.}=0.11 \%$$

$$e(\text{total})=0.39\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.53 Line calculation: Valve 30

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 92 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=92 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.46 \text{ V.}=0.12 \%$$

$$e(\text{total})=0.4\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.54 Line calculation: Valve 31

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 97 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=97 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.49 \text{ V.}=0.12 \%$$

$$e(\text{total})=0.4\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.55 Line calculation: Valve 32

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 102 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=102 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.51 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.56 Line calculation: Valve 33

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 102 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=102 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.51 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.57 Line calculation: Valve 34

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 102 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=102 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.51 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.58 Line calculation: Valve 35

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 102 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=102 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.51 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.59 Line calculation: Valve 36

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 102 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=102 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.51 \text{ V.}=0.13 \%$$

$$e(\text{total})=0.41\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.60 Line calculation: Impulsion valve EB-A

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 68 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=68 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.34 \text{ V.}=0.09 \%$$

$$e(\text{total})=0.37\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.2.61 Line calculation: Filling pump Valve

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 68 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 200 W.
- Calculating power: (According to ITC-BT-47):
200x1.25=250 W.

$$I=250/1,732 \times 400 \times 0.88 \times 0.97=0.42 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.02

$$e(\text{partial})=68 \times 250 / 51.51 \times 400 \times 2.5 \times 0.97=0.34 \text{ V.}=0.09 \%$$

$$e(\text{total})=0.37\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.2.62 Line calculation: CCM3

- Service voltage: 400 V.
- Canalization: B2-Poli. Superf. Tray or Built In
- Length: 3 m; Cos φ : 0.8; $X_u(\mu\Omega/m)$: 0;
- Installed power: 209750 W.
- Calculating power: (According to ITC-BT-47 i ITC-BT-44):
 $8000 \times 1.25 + 150865 = 160865$ W. (Simultaneity coefficient: 0.7)

$$I = 160865 / (1.732 \times 400 \times 0.8) = 290.24 \text{ A.}$$

Selected cables: Tetra-polar 4x185mm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 317 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 81.92

$$e(\text{partial}) = 3 \times 160865 / (44.71 \times 400 \times 185) = 0.15 \text{ V.} = 0.04 \%$$

$$e(\text{total}) = 0.32\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

I. Aut./Tet. In.: 400 A. Thermal Adj. Adjustable Switch: 304 A.

Differential protection:

Relay and transf. Differential susceptibility: 30 mA.

3.8.2.63 Busbar calculation of the control and protection general panel CCM23.8.2.63.1 *Information*

- Metal: Cu
- Condition decks: Bared
- N°. busbars per phase: 4
- Separation between busbars, d(cm): 10
- Separation between suport, L(cm): 25
- C.C. duration time(s): 0.5

3.8.2.63.2 *Select Busbar*

- Cross-section (mm²): 250
- Breadth (mm): 50
- Depth (mm): 5
- W_x, I_x, W_y, I_y (cm³, cm⁴) : 2.08, 5.2, 0.208, 0.052
- Admissible intensity in Busbar (A): 2100

3.8.2.63.3 *Electrodynamic calculation*

$$s_{\text{max}} = I_{\text{pcc}}^2 \cdot L^2 / (60 \cdot d \cdot W_y \cdot n) = 6.88^2 \cdot 25^2 / (60 \cdot 10 \cdot 0.208 \cdot 4) = 59.274$$

<= 1200 kg/cm² Cu

03. Calculations

3.8.2.63.4 Thermal calculation for allowable intensity

$$I_{cal} = 317.52 \text{ A}$$

$$I_{adm} = 2100 \text{ A}$$

3.8.2.63.5 Checking for thermal application in shorted

$$I_{pcc} = 6.88 \text{ ca}$$

$$I_{cccs} = K_c \cdot S / (1000 \cdot \ddot{O}tcc) = 164 \cdot 250 \cdot 4 / (1000 \cdot \sqrt{0.5}) = 231.93 \text{ ca}$$

3.8.3 Electrical panel CCM3

3.8.3.1 Power demand

- Installed total power:

Ventilation of pumps 1	5000 W
Ventilation of pumps 2	5000 W
Ventilation of pumps 3	5000 W
Ventilation of pumps 4	5000 W
Ventilation of pumps 5	5000 W
Ventilation of pumps 6	5000 W
Ventilation of pumps 7	5000 W
Ventilation of pumps 8	5000 W
Ventilation of pumps 9	5000 W
Ventilation of pumps 10	5000 W
Ventilation of MT room	250 W
Ventilation trafo 25/0,4	1100 W
Ventilation trafo 25/0,6	3800 W
Ventilation trafo 25/0,6	3800 W
Ventilation trafo 25/0,6	3800 W
BT Air conditioning 1	8000 W
BT Air conditioning 2	8000 W
BT Air conditioning 3	8000 W
Power outlet 1	6000 W
Power outlet 2	6000 W
Power outlet 3	6000 W
Power outlet 4	6000 W
Power outlet 5	6000 W
Power outlet 6	6000 W
Power outlet 7	6000 W
Power outlet 8	6000 W
Power outlet 9	6000 W
Power outlet 10	6000 W
Power outlet 11	6000 W
Lighting of Pumps 1	6500 W
Lighting of Pumps 2	6500 W
Lighting of Trafo 25/0,69	300 W
Lighting of Trafo 25/0,69	300 W

03. Calculations

Lighting of Trafo 25/0,69	300 W
Lighting of Trafo 25/0,42	300 W
Lighting of MT cubicles	300 W
Lighting BT	1000 W
Lighting of services	300 W
Lighting of warehouse	300 W
Exterior Lighting 1	2100 W
Exterior Lighting 2	2100 W
Crepuscular and intrusion Lighting.	1000 W
Emergency lights	700 W
Peripheral	20000 W
TOTAL....	194750 W

3.8.3.2 Line calculation: Ventilation of pumps 1

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 55 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 5000 W.
- Calculating power: (According to ITC-BT-47):
 $5000 \times 1.25 = 6250$ W.

$$I = 6250 / 1,732 \times 400 \times 0.88 \times 0.97 = 10.57 \text{ A.}$$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 51.54

$$e(\text{partial}) = 55 \times 6250 / 49.44 \times 400 \times 2.5 \times 0.97 = 7.17 \text{ V.} = 1.79 \%$$

$$e(\text{total}) = 2.11\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

I. Aut./Tri. In.: 16 A.

Thermal Adj. Adjustable Switch: 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.3 Line calculation: Ventilation of pumps 2

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 55 m; Cos φ : 0.88; $X_u(\mu\Omega/m)$: 0; R: 0.97
- Installed power: 5000 W.
- Calculating power: (According to ITC-BT-47):
 $5000 \times 1.25 = 6250$ W.

$$I = 6250 / 1,732 \times 400 \times 0.88 \times 0.97 = 10.57 \text{ A.}$$

03. Calculations

Selected cables: Tri-polar 3x2.5+TTmm²Cu
 Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 51.54
 $e(\text{partial}) = 55 \times 6250 / 49.44 \times 400 \times 2.5 \times 0.97 = 7.17 \text{ V} = 1.79 \%$
 $e(\text{total}) = 2.11\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 16 A. Thermal Adj. Adjustable Switch: 16 A.
 Differential protection:
 Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.4 Line calculation: Ventilation of pumps 3

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 55 m; Cos φ: 0.88; Xu(μΩ/m): 0; R: 0.97
- Installed power: 5000 W.
- Calculating power: (According to ITC-BT-47):
 $5000 \times 1.25 = 6250 \text{ W}.$

$I = 6250 / 1,732 \times 400 \times 0.88 \times 0.97 = 10.57 \text{ A}.$

Selected cables: Tri-polar 3x2.5+TTmm²Cu
 Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 51.54
 $e(\text{partial}) = 55 \times 6250 / 49.44 \times 400 \times 2.5 \times 0.97 = 7.17 \text{ V} = 1.79 \%$
 $e(\text{total}) = 2.11\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 16 A. Thermal Adj. Adjustable Switch: 16 A.
 Differential protection:
 Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.5 Line calculation: Ventilation of pumps 4

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 55 m; Cos φ: 0.88; Xu(μΩ/m): 0; R: 0.97
- Installed power: 5000 W.
- Calculating power: (According to ITC-BT-47):
 $5000 \times 1.25 = 6250 \text{ W}.$

$I = 6250 / 1,732 \times 400 \times 0.88 \times 0.97 = 10.57 \text{ A}.$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

03. Calculations

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 51.54

$e(\text{partial})=55 \times 6250 / 49.44 \times 400 \times 2.5 \times 0.97 = 7.17 \text{ V} = 1.79 \%$

$e(\text{total})=2.11\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. *In.*: 16 A.

Thermal Adj. Adjustable Switch: 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.6 Line calculation: Ventilation of pumps 5

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 55 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97
- Installed power: 5000 W.
- Calculating power: (According to ITC-BT-47):
 $5000 \times 1.25 = 6250 \text{ W}.$

$I=6250/1,732 \times 400 \times 0.88 \times 0.97 = 10.57 \text{ A}.$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 51.54

$e(\text{partial})=55 \times 6250 / 49.44 \times 400 \times 2.5 \times 0.97 = 7.17 \text{ V} = 1.79 \%$

$e(\text{total})=2.11\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. *In.*: 16 A. Thermal Adj. Adjustable Switch: 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.7 Line calculation: Ventilation of pumps 6

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 55 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97
- Installed power: 5000 W.
- Calculating power: (According to ITC-BT-47):
 $5000 \times 1.25 = 6250 \text{ W}.$

$I=6250/1,732 \times 400 \times 0.88 \times 0.97 = 10.57 \text{ A}.$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

03. Calculations

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 51.54

$e(\text{partial})=55 \times 6250 / 49.44 \times 400 \times 2.5 \times 0.97 = 7.17 \text{ V.} = 1.79 \%$

$e(\text{total})=2.11\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 16 A. Thermal Adj. Adjustable Switch: 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.8 Line calculation: Ventilation of pumps 7

- Service voltage: 400 V.

- Canalization: B2-Mult.Tubs Superf.o Emp.Obra

- Length: 55 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97

- Installed power: 5000 W.

- Calculating power: (According to ITC-BT-47):

$5000 \times 1.25 = 6250 \text{ W.}$

$I=6250 / 1,732 \times 400 \times 0.88 \times 0.97 = 10.57 \text{ A.}$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 51.54

$e(\text{partial})=55 \times 6250 / 49.44 \times 400 \times 2.5 \times 0.97 = 7.17 \text{ V.} = 1.79 \%$

$e(\text{total})=2.11\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 16 A.

Thermal Adj. Adjustable Switch: 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.9 Line calculation: Ventilation of pumps 8

- Service voltage: 400 V.

- Canalization: B2-Mult.Tubs Superf.o Emp.Obra

- Length: 55 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97

- Installed power: 5000 W.

- Calculating power: (According to ITC-BT-47):

$5000 \times 1.25 = 6250 \text{ W.}$

$I=6250 / 1,732 \times 400 \times 0.88 \times 0.97 = 10.57 \text{ A.}$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

03. Calculations

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 51.54

$e(\text{partial})=55 \times 6250 / 49.44 \times 400 \times 2.5 \times 0.97 = 7.17 \text{ V} = 1.79 \%$

$e(\text{total})=2.11\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 16 A. Thermal Adj. Adjustable Switch: 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.10 Line calculation: Ventilation of pumps 9

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 55 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97
- Installed power: 5000 W.
- Calculating power: (According to ITC-BT-47):
 $5000 \times 1.25 = 6250 \text{ W}.$

$I=6250 / 1,732 \times 400 \times 0.88 \times 0.97 = 10.57 \text{ A}.$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 51.54

$e(\text{partial})=55 \times 6250 / 49.44 \times 400 \times 2.5 \times 0.97 = 7.17 \text{ V} = 1.79 \%$

$e(\text{total})=2.11\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 16 A. Thermal Adj. Adjustable Switch: 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.11 Line calculation: Ventilation of pumps 10

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 55 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97
- Installed power: 5000 W.
- Calculating power: (According to ITC-BT-47):
 $5000 \times 1.25 = 6250 \text{ W}.$

$I=6250 / 1,732 \times 400 \times 0.88 \times 0.97 = 10.57 \text{ A}.$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

03. Calculations

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 51.54

$e(\text{partial})=55 \times 6250 / 49.44 \times 400 \times 2.5 \times 0.97 = 7.17 \text{ V} = 1.79 \%$

$e(\text{total})=2.11\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 16 A.

Thermal Adj. Adjustable Switch: 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.12 Line calculation: Ventilation of MT room

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 30 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97
- Installed power: 250 W.
- Calculating power: (According to ITC-BT-47):
 $250 \times 1.25 = 312.5 \text{ W}$.

$I=312.5/1,732 \times 400 \times 0.88 \times 0.97 = 0.53 \text{ A}$.

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.03

$e(\text{partial})=30 \times 312.5 / 51.51 \times 400 \times 2.5 \times 0.97 = 0.19 \text{ V} = 0.05 \%$

$e(\text{total})=0.36\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Mag. Tripolar Int. 6 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.13 Line calculation: Ventilation trafo 25/0,4

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 32 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97
- Installed power: 1100 W.
- Calculating power: (According to ITC-BT-47):
 $1100 \times 1.25 = 1375 \text{ W}$.

$I=1375/1,732 \times 400 \times 0.88 \times 0.97 = 2.33 \text{ A}$.

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

03. Calculations

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.56

$e(\text{partial})=32 \times 1375 / 51.41 \times 400 \times 2.5 \times 0.97 = 0.88 \text{ V.} = 0.22 \%$

$e(\text{total})=0.54\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Mag. Tripolar Int. 6 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.14 Line calculation: Ventilation trafo 25/0,6

- Service voltage: 400 V.

- Canalization: B2-Mult.Tubs Superf.o Emp.Obra

- Length: 45 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97

- Installed power: 3800 W.

- Calculating power: (According to ITC-BT-47):
 $3800 \times 1.25 = 4750 \text{ W.}$

$I=4750 / 1,732 \times 400 \times 0.88 \times 0.97 = 8.03 \text{ A.}$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 46.66

$e(\text{partial})=45 \times 4750 / 50.3 \times 400 \times 2.5 \times 0.97 = 4.38 \text{ V.} = 1.1 \%$

$e(\text{total})=1.41\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 10 A.

Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.15 Line calculation: Ventilation trafo 25/0,6

- Service voltage: 400 V.

- Canalization: B2-Mult.Tubs Superf.o Emp.Obra

- Length: 43 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97

- Installed power: 3800 W.

- Calculating power: (According to ITC-BT-47):
 $3800 \times 1.25 = 4750 \text{ W.}$

$I=4750 / 1,732 \times 400 \times 0.88 \times 0.97 = 8.03 \text{ A.}$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

03. Calculations

Voltage drop:

Temperature cable (°C): 46.66

$e(\text{partial})=43 \times 4750 / 50.3 \times 400 \times 2.5 \times 0.97 = 4.19 \text{ V} = 1.05 \%$

$e(\text{total})=1.36\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.16 Line calculation: Ventilation trafo 25/0,6

- Service voltage: 400 V.

- Canalization: B2-Mult.Tubs Superf.o Emp.Obra

- Length: 39 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97

- Installed power: 3800 W.

- Calculating power: (According to ITC-BT-47):
 $3800 \times 1.25 = 4750 \text{ W}.$

$I=4750/1,732 \times 400 \times 0.88 \times 0.97 = 8.03 \text{ A}.$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 46.66

$e(\text{partial})=39 \times 4750 / 50.3 \times 400 \times 2.5 \times 0.97 = 3.8 \text{ V} = 0.95 \%$

$e(\text{total})=1.27\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 10 A. Thermal Adj. Adjustable Switch: 10 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.17 Line calculation: BT Air conditioning 1

- Service voltage: 400 V.

- Canalization: B2-Mult.Tubs Superf.o Emp.Obra

- Length: 25 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97

- Installed power: 8000 W.

- Calculating power: (According to ITC-BT-47):
 $8000 \times 1.25 = 10000 \text{ W}.$

$I=10000/1,732 \times 400 \times 0.88 \times 0.97 = 16.91 \text{ A}.$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

03. Calculations

Voltage drop:

Temperature cable (°C): 69.54

$e(\text{partial})=25 \times 10000 / 46.52 \times 400 \times 2.5 \times 0.97 = 5.54 \text{ V} = 1.39 \%$

$e(\text{total})=1.7\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 20 A.

Thermal Adj. Adjustable Switch: 19 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.18 Line calculation: BT Air conditioning 2

- Service voltage: 400 V.

- Canalization: B2-Mult.Tubs Superf.o Emp.Obra

- Length: 25 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97

- Installed power: 8000 W.

- Calculating power: (According to ITC-BT-47):
 $8000 \times 1.25 = 10000 \text{ W}.$

$I=10000/1,732 \times 400 \times 0.88 \times 0.97 = 16.91 \text{ A}.$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 69.54

$e(\text{partial})=25 \times 10000 / 46.52 \times 400 \times 2.5 \times 0.97 = 5.54 \text{ V} = 1.39 \%$

$e(\text{total})=1.7\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 20 A. Thermal Adj. Adjustable Switch: 19 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.19 Line calculation: BT Air conditioning 3

- Service voltage: 400 V.

- Canalization: B2-Mult.Tubs Superf.o Emp.Obra

- Length: 25 m; Cos φ : 0.88; $X_u(\mu\Omega/\text{m})$: 0; R: 0.97

- Installed power: 8000 W.

- Calculating power: (According to ITC-BT-47):
 $8000 \times 1.25 = 10000 \text{ W}.$

$I=10000/1,732 \times 400 \times 0.88 \times 0.97 = 16.91 \text{ A}.$

Selected cables: Tri-polar 3x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

03. Calculations

Voltage drop:

Temperature cable (°C): 69.54

$e(\text{partial}) = 25 \times 10000 / 46.52 \times 400 \times 2.5 \times 0.97 = 5.54 \text{ V} = 1.39 \%$

$e(\text{total}) = 1.7\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

I. Aut./Tri. In.: 20 A. Thermal Adj. Adjustable Switch: 19 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.20 Line calculation: Power outlet 1

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 50 m; Cos φ : 0.8; $X_u(\mu\Omega/\text{m})$: 0;
- Installed power: 6000 W.
- Calculating power: 6000 W.

$I = 6000 / 1,732 \times 400 \times 0.8 = 10.83 \text{ A}$.

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 52.11

$e(\text{partial}) = 50 \times 6000 / 49.35 \times 400 \times 2.5 = 6.08 \text{ V} = 1.52 \%$

$e(\text{total}) = 1.84\% \text{ ADMIS (5\% MAX.)}$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.21 Line calculation: Power outlet 2

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 25 m; Cos φ : 0.8; $X_u(\mu\Omega/\text{m})$: 0;
- Installed power: 6000 W.
- Calculating power: 6000 W.

$I = 6000 / 1,732 \times 400 \times 0.8 = 10.83 \text{ A}$.

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

03. Calculations

Temperature cable (°C): 52.11
 $e(\text{partial})=25 \times 6000 / 49.35 \times 400 \times 2.5 = 3.04 \text{ V} = 0.76 \%$
 $e(\text{total})=1.08\% \text{ ADMIS (5\% MAX.)}$

Thermal power:
 Magnetothermic switch. Tetra-polar Int. 16 A.
 Differential protection:
 Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.22 Line calculation: Power outlet 3

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 62 m; Cos φ : 0.8; $X_u(\mu\Omega/\text{m})$: 0;
- Installed power: 6000 W.
- Calculating power: 6000 W.

$I=6000/1,732 \times 400 \times 0.8 = 10.83 \text{ A}$.
 Selected cables: Tetra-polar 4x2.5+TTmm²Cu
 Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:
 Temperature cable (°C): 52.11
 $e(\text{partial})=62 \times 6000 / 49.35 \times 400 \times 2.5 = 7.54 \text{ V} = 1.88 \%$
 $e(\text{total})=2.2\% \text{ ADMIS (5\% MAX.)}$

Thermal power:
 Magnetothermic switch. Tetra-polar Int. 16 A.
 Differential protection:
 Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.23 Line calculation: Power outlet 4

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 47 m; Cos φ : 0.8; $X_u(\mu\Omega/\text{m})$: 0;
- Installed power: 6000 W.
- Calculating power: 6000 W.

$I=6000/1,732 \times 400 \times 0.8 = 10.83 \text{ A}$.
 Selected cables: Tetra-polar 4x2.5+TTmm²Cu
 Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:
 Temperature cable (°C): 52.11
 $e(\text{partial})=47 \times 6000 / 49.35 \times 400 \times 2.5 = 5.71 \text{ V} = 1.43 \%$
 $e(\text{total})=1.75\% \text{ ADMIS (5\% MAX.)}$

03. Calculations

Thermal power:

Magnetothermic switch. Tetra-polar Int. 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.24 Line calculation: Power outlet 5

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 39 m; Cos φ : 0.8; $X_u(\mu\Omega/m)$: 0;
- Installed power: 6000 W.
- Calculating power: 6000 W.

$$I=6000/1,732 \times 400 \times 0.8=10.83 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 52.11

$$e(\text{partial})=39 \times 6000 / 49.35 \times 400 \times 2.5=4.74 \text{ V.}=1.19 \%$$

$$e(\text{total})=1.5\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.25 Line calculation: Power outlet 6

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 39 m; Cos φ : 0.8; $X_u(\mu\Omega/m)$: 0;
- Installed power: 6000 W.
- Calculating power: 6000 W.

$$I=6000/1,732 \times 400 \times 0.8=10.83 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 52.11

$$e(\text{partial})=39 \times 6000 / 49.35 \times 400 \times 2.5=4.74 \text{ V.}=1.19 \%$$

$$e(\text{total})=1.5\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

03. Calculations

Magnetothermic switch. Tetra-polar Int. 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.26 Line calculation: Power outlet 7

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 32 m; Cos φ : 0.8; $X_u(\mu\Omega/m)$: 0;
- Installed power: 6000 W.
- Calculating power: 6000 W.

$$I=6000/1,732 \times 400 \times 0.8=10.83 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 52.11

$$e(\text{partial})=32 \times 6000 / 49.35 \times 400 \times 2.5=3.89 \text{ V.}=0.97 \%$$

$$e(\text{total})=1.29\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.27 Line calculation: Power outlet 8

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 29 m; Cos φ : 0.8; $X_u(\mu\Omega/m)$: 0;
- Installed power: 6000 W.
- Calculating power: 6000 W.

$$I=6000/1,732 \times 400 \times 0.8=10.83 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 52.11

$$e(\text{partial})=29 \times 6000 / 49.35 \times 400 \times 2.5=3.53 \text{ V.}=0.88 \%$$

$$e(\text{total})=1.2\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.28 Line calculation: Power outlet 9

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 29 m; Cos φ : 0.8; $X_u(\mu\Omega/m)$: 0;
- Installed power: 6000 W.
- Calculating power: 6000 W.

$$I=6000/1,732 \times 400 \times 0.8=10.83 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 52.11

$$e(\text{partial})=29 \times 6000 / 49.35 \times 400 \times 2.5=3.53 \text{ V.}=0.88 \%$$

$$e(\text{total})=1.2\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.29 Line calculation: Power outlet 10

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 27 m; Cos φ : 0.8; $X_u(\mu\Omega/m)$: 0;
- Installed power: 6000 W.
- Calculating power: 6000 W.

$$I=6000/1,732 \times 400 \times 0.8=10.83 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 52.11

$$e(\text{partial})=27 \times 6000 / 49.35 \times 400 \times 2.5=3.28 \text{ V.}=0.82 \%$$

$$e(\text{total})=1.14\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

03. Calculations

3.8.3.30 Line calculation: Power outlet 11

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 32 m; Cos φ : 0.8; $X_u(\mu\Omega/m)$: 0;
- Installed power: 6000 W.
- Calculating power: 6000 W.

$$I=6000/1,732 \times 400 \times 0.8=10.83 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 52.11

$$e(\text{partial})=32 \times 6000 / 49.35 \times 400 \times 2.5=3.89 \text{ V.}=0.97 \%$$

$$e(\text{total})=1.29\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 16 A.

Differential protection:

Diff. switch, Tetra-polar, Int.: 25 A. Susceptibility: 300 mA.

3.8.3.31 Line calculation: Lighting of Pumps 1

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 340 m; Cos φ : 1; $X_u(\mu\Omega/m)$: 0;
- Installed power: 6500 W.
- Calculating power: (According to ITC-BT-44):
6500x1.8=11700 W.

$$I=11700/1,732 \times 400 \times 1=16.89 \text{ A.}$$

Selected cables: Tetra-polar 4x25+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 88 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 41.84

$$e(\text{partial})=340 \times 11700 / 51.17 \times 400 \times 25=7.77 \text{ V.}=1.94 \%$$

$$e(\text{total})=2.26\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 20 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

Contactors:

3-Pole Contactor *I_n*: 25 A.

3.8.3.32 Line calculation: Lighting of Pumps 2

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 340 m; Cos φ : 1; $X_u(\mu\Omega/m)$: 0;
- Installed power: 6500 W.
- Calculating power: (According to ITC-BT-44):
 $6500 \times 1.8 = 11700$ W.

$$I = 11700 / (1.732 \times 400) = 16.89 \text{ A.}$$

Selected cables: Tetra-polar 4x25+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=1) 88 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 41.84

$$e(\text{partial}) = 340 \times 11700 / (51.17 \times 400 \times 25) = 7.77 \text{ V.} = 1.94 \%$$

$$e(\text{total}) = 2.26\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 20 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

Contactors:

3-Pole Contactor I_n : 25 A.

3.8.3.33 Line calculation: Lighting of Trafo 25/0,69

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 78 m; Cos φ : 1; $X_u(\mu\Omega/m)$: 0;
- Installed power: 300 W.
- Calculating power: (According to ITC-BT-44):
 $300 \times 1.8 = 540$ W.

$$I = 540 / (1.732 \times 400) = 0.78 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.06

$$e(\text{partial}) = 78 \times 540 / (51.5 \times 400 \times 2.5) = 0.82 \text{ V.} = 0.2 \%$$

$$e(\text{total}) = 0.52\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 6 A.

03. Calculations

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

Contactor:

3-Pole Contactor I_n : 10 A.

3.8.3.34 Line calculation: Lighting of Trafo 25/0,69

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 84 m; Cos φ : 1; $X_u(\mu\Omega/m)$: 0;
- Installed power: 300 W.
- Calculating power: (According to ITC-BT-44):
 $300 \times 1.8 = 540$ W.

$$I = 540 / 1,732 \times 400 \times 1 = 0.78 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C ($C_f=1$) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.06

$$e(\text{partial}) = 84 \times 540 / 51.5 \times 400 \times 2.5 = 0.88 \text{ V.} = 0.22 \%$$

$$e(\text{total}) = 0.54\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 6 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

Contactor:

3-Pole Contactor I_n : 10 A.

3.8.3.35 Line calculation: Lighting of Trafo 25/0,69

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 96 m; Cos φ : 1; $X_u(\mu\Omega/m)$: 0;
- Installed power: 300 W.
- Calculating power: (According to ITC-BT-44):
 $300 \times 1.8 = 540$ W.

$$I = 540 / 1,732 \times 400 \times 1 = 0.78 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C ($C_f=1$) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.06

$$e(\text{partial}) = 96 \times 540 / 51.5 \times 400 \times 2.5 = 1.01 \text{ V.} = 0.25 \%$$

$$e(\text{total}) = 0.57\% \text{ ADMIS (3\% MAX.)}$$

03. Calculations

Thermal power:

Magnetothermic switch. Tetra-polar Int. 6 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

Contactor:

3-Pole Contactor I_n : 10 A.

3.8.3.36 Line calculation: Lighting of Trafo 25/0,42

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 100 m; Cos φ : 1; $X_u(\mu\Omega/m)$: 0;
- Installed power: 300 W.
- Calculating power: (According to ITC-BT-44):
 $300 \times 1.8 = 540$ W.

$$I = 540 / 1,732 \times 400 \times 1 = 0.78 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.06

$$e(\text{partial}) = 100 \times 540 / 51.5 \times 400 \times 2.5 = 1.05 \text{ V.} = 0.26 \%$$

$$e(\text{total}) = 0.58\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 6 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

Contactor:

3-Pole Contactor I_n : 10 A.

3.8.3.37 Line calculation: Lighting of MT cubicles

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 105 m; Cos φ : 1; $X_u(\mu\Omega/m)$: 0;
- Installed power: 300 W.
- Calculating power: (According to ITC-BT-44):
 $300 \times 1.8 = 540$ W.

$$I = 540 / 1,732 \times 400 \times 1 = 0.78 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

03. Calculations

Temperature cable (°C): 40.06
 $e(\text{partial})=105 \times 540 / 51.5 \times 400 \times 2.5 = 1.1 \text{ V} = 0.28 \%$
 $e(\text{total})=0.59\% \text{ ADMIS (3\% MAX.)}$

Thermal power:
 Magnetothermic switch. Tetra-polar Int. 6 A.
 Differential protection:
 Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.
 Contactor:
 3-Pole Contactor I_n : 10 A.

3.8.3.38 Line calculation: Lighting BT

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 80 m; Cos φ : 1; $X_u(\mu\Omega/\text{m})$: 0;
- Installed power: 1000 W.
- Calculating power: (According to ITC-BT-44):
 $1000 \times 1.8 = 1800 \text{ W}$.

$I = 1800 / 1,732 \times 400 \times 1 = 2.6 \text{ A}$.
 Selected cables: Tetra-polar 4x2.5+TTmm²Cu
 Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K
 I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:
 Temperature cable (°C): 40.7
 $e(\text{partial})=80 \times 1800 / 51.39 \times 400 \times 2.5 = 2.8 \text{ V} = 0.7 \%$
 $e(\text{total})=1.02\% \text{ ADMIS (3\% MAX.)}$

Thermal power:
 Magnetothermic switch. Tetra-polar Int. 6 A.
 Differential protection:
 Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.
 Contactor:
 3-Pole Contactor I_n : 10 A.

3.8.3.39 Line calculation: Lighting of services

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 30 m; Cos φ : 1; $X_u(\mu\Omega/\text{m})$: 0;
- Installed power: 300 W.
- Calculating power: (According to ITC-BT-44):
 $300 \times 1.8 = 540 \text{ W}$.

$I = 540 / 1,732 \times 400 \times 1 = 0.78 \text{ A}$.
 Selected cables: Tetra-polar 4x2.5+TTmm²Cu
 Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

03. Calculations

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.06

$e(\text{partial})=30 \times 540 / 51.5 \times 400 \times 2.5 = 0.31 \text{ V} = 0.08 \%$

$e(\text{total})=0.4\% \text{ ADMIS (3\% MAX.)}$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 6 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

Contactora:

3-Pole Contactora *I_n*: 10 A.

3.8.3.40 Line calculation: Lighting of warehouse

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 36 m; Cos φ: 1; $X_u(\mu\Omega/\text{m})$: 0;
- Installed power: 300 W.
- Calculating power: (According to ITC-BT-44):
 $300 \times 1.8 = 540 \text{ W}$.

$I=540/1,732 \times 400 \times 1 = 0.78 \text{ A}$.

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.06

$e(\text{partial})=36 \times 540 / 51.5 \times 400 \times 2.5 = 0.38 \text{ V} = 0.09 \%$

$e(\text{total})=0.41\% \text{ ADMIS (3\% MAX.)}$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 6 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

Contactora:

3-Pole Contactora *I_n*: 10 A.

3.8.3.41 Line calculation: Exterior Lighting 1

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 380 m; Cos φ: 1; $X_u(\mu\Omega/\text{m})$: 0;
- Installed power: 2100 W.
- Calculating power: (According to ITC-BT-44):
 $2100 \times 1.8 = 3780 \text{ W}$.

03. Calculations

$$I=3780/1,732 \times 400 \times 1=5.46 \text{ A.}$$

Selected cables: Tetra-polar 4x10+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 52 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.55

$$e(\text{partial})=380 \times 3780 / 51.41 \times 400 \times 10=6.98 \text{ V.}=1.75 \%$$

$$e(\text{total})=2.06\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 6 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

Contactora:

3-Pole Contactora *In*: 10 A.

3.8.3.42 Line calculation: Exterior Lighting 2

- Service voltage: 400 V.

- Canalization: B2-Mult.Tubs Superf.o Emp.Obra

- Length: 380 m; Cos φ: 1; Xu(μΩ/m): 0;

- Installed power: 2100 W.

- Calculating power: (According to ITC-BT-44):
2100x1.8=3780 W.

$$I=3780/1,732 \times 400 \times 1=5.46 \text{ A.}$$

Selected cables: Tetra-polar 4x10+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 52 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.55

$$e(\text{partial})=380 \times 3780 / 51.41 \times 400 \times 10=6.98 \text{ V.}=1.75 \%$$

$$e(\text{total})=2.06\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 6 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

Contactora:

3-Pole Contactora *In*: 10 A.

3.8.3.43 Line calculation: Crepuscular and intrusion Lighting.

- Service voltage: 400 V.

- Canalization: B2-Mult.Tubs Superf.o Emp.Obra

- Length: 80 m; Cos φ: 1; Xu(μΩ/m): 0;

03. Calculations

- Installed power: 1000 W.
- Calculating power: (According to ITC-BT-44):
 $1000 \times 1.8 = 1800$ W.

$$I = 1800 / (1.732 \times 400) = 2.6 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.7

$$e(\text{partial}) = 80 \times 1800 / (51.39 \times 400 \times 2.5) = 2.8 \text{ V.} = 0.7 \%$$

$$e(\text{total}) = 1.02\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 6 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

Contactors:

3-Pole Contactor *I_n*: 10 A.

3.8.3.44 Line calculation: Emergency lights

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra
- Length: 80 m; Cos φ: 1; X_u(μΩ/m): 0;
- Installed power: 700 W.
- Calculating power: (According to ITC-BT-44):
 $200 \times 1.8 + 500 = 860$ W.

$$I = 860 / (1.732 \times 400) = 1.24 \text{ A.}$$

Selected cables: Tetra-polar 4x2.5+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 22 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 40.16

$$e(\text{partial}) = 80 \times 860 / (51.49 \times 400 \times 2.5) = 1.34 \text{ V.} = 0.33 \%$$

$$e(\text{total}) = 0.65\% \text{ ADMIS (3\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 6 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 25 A. Sens. Int.: 30 mA.

3.8.3.45 Line calculation: Peripheral

- Service voltage: 400 V.
- Canalization: B2-Mult.Tubs Superf.o Emp.Obra

03. Calculations

- Length: 20 m; Cos φ : 0.8; $X_u(\mu\Omega/m)$: 0;
- Installed power: 20000 W.
- Calculating power: 20000 W.

$$I=20000/1,732 \times 400 \times 0.8=36.09 \text{ A.}$$

Selected cables: Tetra-polar 4x10+TTmm²Cu

Insulation level, Insulation: 0.6/1 kV, XLPE. Desig. UNE: RV-K

I.ad. to 40°C (Cf=1) 52 A. according to ITC-BT-19

Voltage drop:

Temperature cable (°C): 64.08

$$e(\text{partial})=20 \times 20000 / 47.37 \times 400 \times 10=2.11 \text{ V.}=0.53 \%$$

$$e(\text{total})=0.84\% \text{ ADMIS (5\% MAX.)}$$

Thermal power:

Magnetothermic switch. Tetra-polar Int. 38 A.

Differential protection:

Inter. Dif. Tetrapolar Int.: 40 A. Sens. Int.: 300 mA.

03. Calculations

3.8.4 Summary of results

3.8.4.1 Summary of panel CCM1

EB1

Name	Calc. Pow. (W)	Length.Calc (m)	Cross-section (mm ²)	I.Calc. (A)	I.Admi. (A)	V. Drops Parc (%)	V. Drops Total (%)
BRANCH LINE	3755900	20	14(3x240/120+TT) Cu	3928.5	4019.4	0.15	0.15
Pump 5	887500	75	3(3x240+TT) Cu	870	962.4	0.45	0.6
Pump 6	887500	80	3(3x240+TT) Cu	870	962.4	0.48	0.63
Pump 7	887500	85	3(3x240+TT) Cu	870	962.4	0.51	0.66
Pump 8	887500	90	3(3x240+TT) Cu	870	962.4	0.54	0.69
Pump 9	887500	95	3(3x240+TT) Cu	870	962.4	0.57	0.72
Pump 10	887500	100	3(3x240+TT) Cu	870	962.4	0.6	0.75

Short-circuit

Name	Length (m)	Cross-section (mm ²)	I _{pccI} (ca)	P de C (ca)	I _{pccF} (A)	T _{mcc} (sg)	Valid curves
BRANCH LINE	20	14(3x240/120+TT)Cu	70.26	100	34943.8	96.46	4000;B
Pump 5	75	3(3x240+TT)Cu	46.65	50	20621.64	24.93	1000;B,C,D
Pump 6	80	3(3x240+TT)Cu	46.65	50	20376.92	25.53	1000;B,C,D
Pump 7	85	3(3x240+TT)Cu	46.65	50	20129.68	26.16	1000;B,C,D
Pump 8	90	3(3x240+TT)Cu	46.65	50	19880.6	26.82	1000;B,C
Pump 9	95	3(3x240+TT)Cu	46.65	50	19630.3	27.51	1000;B,C
Pump 10	100	3(3x240+TT)Cu	46.65	50	19379.39	28.23	1000;B,C

EB2 and EBA

Name	Calc. Pow. (W)	Length.Calc (m)	Cross-section (mm ²)	I.Calc. (A)	I.Admi. (A)	V. Drops Parc (%)	V. Drops Total (%)
BRANCH LINE	3791900	20	14(3x240/120+TT) Cu	3966.16	4019.4	0.15	0.16
Pump 11	625000	80	2(3x240+TT) Cu	612.67	641.6	0.51	0.63
Pump 12	625000	85	2(3x240+TT) Cu	612.67	641.6	0.54	0.67
Pump 13	625000	90	2(3x240+TT) Cu	612.67	641.6	0.57	0.7
Pump 14	625000	95	2(3x240+TT) Cu	612.67	641.6	0.61	0.73
Pump 15	625000	100	2(3x240+TT) Cu	612.67	641.6	0.64	0.76
Filling pump	200000	100	3x95+TT Cu	196.06	224	1.01	1.13
Pump 1	787500	85	3(3x185+TT) Cu	771.97	818.4	0.59	0.71
Pump 2	787500	89	3(3x185+TT) Cu	771.97	818.4	0.62	0.74
Pump 3	400000	94	2(3x120+TT) Cu	392.11	416	0.76	0.89
Pump 4	400000	99	2(3x120+TT) Cu	392.11	416	0.81	0.93

03. Calculations

Short-circuit

Name	Length (m)	Cross-section (mm ²)	I _{pccI} (ca)	P de C (ca)	I _{pccF} (A)	t _{mcc} (sg)	Valid curves
BRANCH LINE	20	14(3x240/120+TT)Cu	70.26	100	34943.8	96.46	4000;B
Pump 11	80	2(3x240+TT)Cu	46.7	50	18450.32	13.84	630;B,C,D
Pump 12	85	2(3x240+TT)Cu	46.7	50	18079.97	14.41	630;B,C,D
Pump 13	90	2(3x240+TT)Cu	46.7	50	17714.13	15.01	630;B,C,D
Pump 14	95	2(3x240+TT)Cu	46.7	50	17353.72	15.64	630;B,C,D
Pump 15	100	2(3x240+TT)Cu	46.7	50	16999.49	16.3	630;B,C,D
Filling pump	100	3x95+TTCu	46.7	50	5343.8	6.46	250;B,C,D
Pump 1	85	3(3x185+TT)Cu	46.7	50	18935.69	17.57	800;B,C,D
Pump 2	89	3(3x185+TT)Cu	46.7	50	18676.28	18.06	800;B,C,D
Pump 3	94	2(3x120+TT)Cu	46.7	50	12023.86	8.15	400;B,C,D
Pump 4	99	2(3x120+TT)Cu	46.7	50	11602.13	8.75	400;B,C,D

3.8.4.2 Resum del quadre CCM2

Name	Calc. Pow. (W)	Length.Calc (m)	Cross-section (mm ²)	I.Calc. (A)	I.Admi. (A)	V. Drops Parc (%)	V. Drops Total (%)
BRANCH LINE	175985	20	3x185/95+TTCu	317.52	368	0.26	0.28
Overhead crane 1	7500	55	3x2.5+TTCu	12.68	22	2.19	2.47
Overhead crane 2	7500	55	3x2.5+TTCu	12.68	22	2.19	2.47
General suction Valve 1	250	25	3x2.5+TTCu	0.42	22	0.03	0.31
General suction Valve 2	250	25	3x2.5+TTCu	0.42	22	0.03	0.31
General suction Valve 3	250	25	3x2.5+TTCu	0.42	22	0.03	0.31
General suction Valve 4	250	25	3x2.5+TTCu	0.42	22	0.03	0.31
Valve 5	250	77	3x2.5+TTCu	0.42	22	0.1	0.38
Valve 6	250	77	3x2.5+TTCu	0.42	22	0.1	0.38
Valve 7	250	77	3x2.5+TTCu	0.42	22	0.1	0.38
Valve 8	250	77	3x2.5+TTCu	0.42	22	0.1	0.38
Valve 9	250	77	3x2.5+TTCu	0.42	22	0.1	0.38
Valve 10	250	77	3x2.5+TTCu	0.42	22	0.1	0.38
Valve 11	250	77	3x2.5+TTCu	0.42	22	0.1	0.38
Valve 12	250	77	3x2.5+TTCu	0.42	22	0.1	0.38
Impulsion valve EB-2	250	64	3x2.5+TTCu	0.42	22	0.08	0.36
Valve 14	250	78	3x2.5+TTCu	0.42	22	0.1	0.38
Valve 15	250	78	3x2.5+TTCu	0.42	22	0.1	0.38
Valve 16	250	78	3x2.5+TTCu	0.42	22	0.1	0.38
Valve 17	250	83	3x2.5+TTCu	0.42	22	0.1	0.38
Valve 18	250	88	3x2.5+TTCu	0.42	22	0.11	0.39
Valve 19	250	93	3x2.5+TTCu	0.42	22	0.12	0.4
Valve 20	250	100	3x2.5+TTCu	0.42	22	0.13	0.41
Valve 21	250	103	3x2.5+TTCu	0.42	22	0.13	0.41
Valve 22	250	103	3x2.5+TTCu	0.42	22	0.13	0.41

03. Calculations

Valve 23	250	103	3x2.5+TTCu	0.42	22	0.13	0.41
Valve 24	250	103	3x2.5+TTCu	0.42	22	0.13	0.41
Valve 25	250	103	3x2.5+TTCu	0.42	22	0.13	0.41
Impulsion valve EB-1	250	67	3x2.5+TTCu	0.42	22	0.08	0.36
Valve 27	250	88	3x2.5+TTCu	0.42	22	0.11	0.39
Valve 28	250	88	3x2.5+TTCu	0.42	22	0.11	0.39
Valve 29	250	88	3x2.5+TTCu	0.42	22	0.11	0.39
Valve 30	250	92	3x2.5+TTCu	0.42	22	0.12	0.4
Valve 31	250	97	3x2.5+TTCu	0.42	22	0.12	0.4
Valve 32	250	102	3x2.5+TTCu	0.42	22	0.13	0.41
Valve 33	250	102	3x2.5+TTCu	0.42	22	0.13	0.41
Valve 34	250	102	3x2.5+TTCu	0.42	22	0.13	0.41
Valve 35	250	102	3x2.5+TTCu	0.42	22	0.13	0.41
Valve 36	250	102	3x2.5+TTCu	0.42	22	0.13	0.41
Impulsion valve EB-A	250	68	3x2.5+TTCu	0.42	22	0.09	0.37
Filling pump Valve	250	68	3x2.5+TTCu	0.42	22	0.09	0.37
CCM3	160865	3	4x185Cu	290.24	317	0.04	0.32

Short-circuit

Name	Length (m)	Cross-section (mm ²)	IpccI (ca)	P de C (ca)	IpccF (A)	tmcicc (sg)	Valid curves
BRANCH LINE	20	3x185/95+TTCu	7.2	10	3440.33	59.13	400;B
Overhead crane 1	55	3x2.5+TTCu	6.91	10	153.05	5.46	16;B
Overhead crane 2	55	3x2.5+TTCu	6.91	10	153.05	5.46	16;B
General suction Valve 1	25	3x2.5+TTCu	6.91	10	328.26	1.19	10;B,C,D
General suction Valve 2	25	3x2.5+TTCu	6.91	10	328.26	1.19	10;B,C,D
General suction Valve 3	25	3x2.5+TTCu	6.91	10	328.26	1.19	10;B,C,D
General suction Valve 4	25	3x2.5+TTCu	6.91	10	328.26	1.19	10;B,C,D
Valve 5	77	3x2.5+TTCu	6.91	10	109.95	10.57	10;B,C
Valve 6	77	3x2.5+TTCu	6.91	10	109.95	10.57	10;B,C
Valve 7	77	3x2.5+TTCu	6.91	10	109.95	10.57	10;B,C
Valve 8	77	3x2.5+TTCu	6.91	10	109.95	10.57	10;B,C
Valve 9	77	3x2.5+TTCu	6.91	10	109.95	10.57	10;B,C
Valve 10	77	3x2.5+TTCu	6.91	10	109.95	10.57	10;B,C
Valve 11	77	3x2.5+TTCu	6.91	10	109.95	10.57	10;B,C
Valve 12	77	3x2.5+TTCu	6.91	10	109.95	10.57	10;B,C
Impulsion valve EB-2	64	3x2.5+TTCu	6.91	10	131.9	7.35	10;B,C
Valve 14	78	3x2.5+TTCu	6.91	10	108.57	10.84	10;B,C
Valve 15	78	3x2.5+TTCu	6.91	10	108.57	10.84	10;B,C
Valve 16	78	3x2.5+TTCu	6.91	10	108.57	10.84	10;B,C
Valve 17	83	3x2.5+TTCu	6.91	10	102.11	12.26	10;B,C
Valve 18	88	3x2.5+TTCu	6.91	10	96.38	13.76	10;B
Valve 19	93	3x2.5+TTCu	6.91	10	91.26	15.34	10;B
Valve 20	100	3x2.5+TTCu	6.91	10	84.94	17.71	10;B

03. Calculations

Valve 21	103	3x2.5+TTCu	6.91	10	82.5	18.78	10;B
Valve 22	103	3x2.5+TTCu	6.91	10	82.5	18.78	10;B
Valve 23	103	3x2.5+TTCu	6.91	10	82.5	18.78	10;B
Valve 24	103	3x2.5+TTCu	6.91	10	82.5	18.78	10;B
Valve 25	103	3x2.5+TTCu	6.91	10	82.5	18.78	10;B
Impulsion valve EB-1	67	3x2.5+TTCu	6.91	10	126.09	8.04	10;B,C
Valve 27	88	3x2.5+TTCu	6.91	10	96.38	13.76	10;B
Valve 28	88	3x2.5+TTCu	6.91	10	96.38	13.76	10;B
Valve 29	88	3x2.5+TTCu	6.91	10	96.38	13.76	10;B
Valve 30	92	3x2.5+TTCu	6.91	10	92.24	15.02	10;B
Valve 31	97	3x2.5+TTCu	6.91	10	87.54	16.68	10;B
Valve 32	102	3x2.5+TTCu	6.91	10	83.3	18.42	10;B
Valve 33	102	3x2.5+TTCu	6.91	10	83.3	18.42	10;B
Valve 34	102	3x2.5+TTCu	6.91	10	83.3	18.42	10;B
Valve 35	102	3x2.5+TTCu	6.91	10	83.3	18.42	10;B
Valve 36	102	3x2.5+TTCu	6.91	10	83.3	18.42	10;B
Impulsion valve EB-A	68	3x2.5+TTCu	6.91	10	124.27	8.28	10;B,C
Filling pump Valve	68	3x2.5+TTCu	6.91	10	124.27	8.28	10;B,C
CCM3	3	4x185Cu	6.91	10	3416.4	59.96	400

3.8.4.3 Resum del quadre CCM3

Name	Calc. Pow. (W)	Length.Calc (m)	Cross-section (mm ²)	I.Calc. (A)	I.Adm. (A)	V. Drops Parc (%)	V. Drops Total (%)
Ventilation of pumps 1	6250	55	3x2.5+TTCu	10.57	22	1.79	2.11
Ventilation of pumps 2	6250	55	3x2.5+TTCu	10.57	22	1.79	2.11
Ventilation of pumps 3	6250	55	3x2.5+TTCu	10.57	22	1.79	2.11
Ventilation of pumps 4	6250	55	3x2.5+TTCu	10.57	22	1.79	2.11
Ventilation of pumps 5	6250	55	3x2.5+TTCu	10.57	22	1.79	2.11
Ventilation of pumps 6	6250	55	3x2.5+TTCu	10.57	22	1.79	2.11
Ventilation of pumps 7	6250	55	3x2.5+TTCu	10.57	22	1.79	2.11
Ventilation of pumps 8	6250	55	3x2.5+TTCu	10.57	22	1.79	2.11
Ventilation of pumps 9	6250	55	3x2.5+TTCu	10.57	22	1.79	2.11
Ventilation of pumps 10	6250	55	3x2.5+TTCu	10.57	22	1.79	2.11
Ventilation of MT room	312.5	30	3x2.5+TTCu	0.53	22	0.05	0.36
Ventilation trafo 25/0,4	1375	32	3x2.5+TTCu	2.33	22	0.22	0.54
Ventilation trafo 25/0,6	4750	45	3x2.5+TTCu	8.03	22	1.1	1.41
Ventilation trafo 25/0,6	4750	43	3x2.5+TTCu	8.03	22	1.05	1.36
Ventilation trafo 25/0,6	4750	39	3x2.5+TTCu	8.03	22	0.95	1.27
BT Air conditioning 1	10000	25	3x2.5+TTCu	16.91	22	1.39	1.7
BT Air conditioning 2	10000	25	3x2.5+TTCu	16.91	22	1.39	1.7
BT Air conditioning 3	10000	25	3x2.5+TTCu	16.91	22	1.39	1.7
Power outlet 1	6000	50	4x2.5+TTCu	10.83	22	1.52	1.84
Power outlet 2	6000	25	4x2.5+TTCu	10.83	22	0.76	1.08
Power outlet 3	6000	62	4x2.5+TTCu	10.83	22	1.88	2.2
Power outlet 4	6000	47	4x2.5+TTCu	10.83	22	1.43	1.75

03. Calculations

Power outlet 5	6000	39	4x2.5+TTCu	10.83	22	1.19	1.5
Power outlet 6	6000	39	4x2.5+TTCu	10.83	22	1.19	1.5
Power outlet 7	6000	32	4x2.5+TTCu	10.83	22	0.97	1.29
Power outlet 8	6000	29	4x2.5+TTCu	10.83	22	0.88	1.2
Power outlet 9	6000	29	4x2.5+TTCu	10.83	22	0.88	1.2
Power outlet 10	6000	27	4x2.5+TTCu	10.83	22	0.82	1.14
Power outlet 11	6000	32	4x2.5+TTCu	10.83	22	0.97	1.29
Lighting of Pumps 1	11700	340	4x25+TTCu	16.89	88	1.94	2.26
Lighting of Pumps 2	11700	340	4x25+TTCu	16.89	88	1.94	2.26
Lighting of Trafo 25/0,69	540	78	4x2.5+TTCu	0.78	22	0.2	0.52
Lighting of Trafo 25/0,69	540	84	4x2.5+TTCu	0.78	22	0.22	0.54
Lighting of Trafo 25/0,69	540	96	4x2.5+TTCu	0.78	22	0.25	0.57
Lighting of Trafo 25/0,42	540	100	4x2.5+TTCu	0.78	22	0.26	0.58
Lighting of MT cubicles	540	105	4x2.5+TTCu	0.78	22	0.28	0.59
Lighting BT	1800	80	4x2.5+TTCu	2.6	22	0.7	1.02
Lighting of services	540	30	4x2.5+TTCu	0.78	22	0.08	0.4
Lighting of warehouse	540	36	4x2.5+TTCu	0.78	22	0.09	0.41
Exterior Lighting 1	3780	380	4x10+TTCu	5.46	52	1.75	2.06
Exterior Lighting 2	3780	380	4x10+TTCu	5.46	52	1.75	2.06
Crepuscular and intrusion Lighting.	1800	80	4x2.5+TTCu	2.6	22	0.7	1.02
Emergency lights	860	80	4x2.5+TTCu	1.24	22	0.33	0.65
Peripheral	20000	20	4x10+TTCu	36.09	52	0.53	0.84

Short-circuit

Name	Length (m)	Cross-section (mm ²)	I _{pccI} (ca)	P de C (ca)	I _{pccF} (A)	t _{mccic} (sg)	Valid curves
Ventilation of pumps 1	55	3x2.5+TTCu	6.86	10	152.93	5.46	16;B
Ventilation of pumps 2	55	3x2.5+TTCu	6.86	10	152.93	5.46	16;B
Ventilation of pumps 3	55	3x2.5+TTCu	6.86	10	152.93	5.46	16;B
Ventilation of pumps 4	55	3x2.5+TTCu	6.86	10	152.93	5.46	16;B
Ventilation of pumps 5	55	3x2.5+TTCu	6.86	10	152.93	5.46	16;B
Ventilation of pumps 6	55	3x2.5+TTCu	6.86	10	152.93	5.46	16;B
Ventilation of pumps 7	55	3x2.5+TTCu	6.86	10	152.93	5.46	16;B
Ventilation of pumps 8	55	3x2.5+TTCu	6.86	10	152.93	5.46	16;B
Ventilation of pumps 9	55	3x2.5+TTCu	6.86	10	152.93	5.46	16;B
Ventilation of pumps 10	55	3x2.5+TTCu	6.86	10	152.93	5.46	16;B
Ventilation of MT room	30	3x2.5+TTCu	6.86	10	275.37	1.69	6;B,C,D
Ventilation trafo 25/0,4	32	3x2.5+TTCu	6.86	10	258.81	1.91	6;B,C,D
Ventilation trafo 25/0,6	45	3x2.5+TTCu	6.86	10	186.04	3.69	10;B,C
Ventilation trafo 25/0,6	43	3x2.5+TTCu	6.86	10	194.45	3.38	10;B,C
Ventilation trafo 25/0,6	39	3x2.5+TTCu	6.86	10	213.79	2.8	10;B,C,D
BT Air conditioning 1	25	3x2.5+TTCu	6.86	10	327.76	1.19	20;B,C
BT Air conditioning 2	25	3x2.5+TTCu	6.86	10	327.76	1.19	20;B,C
BT Air conditioning 3	25	3x2.5+TTCu	6.86	10	327.76	1.19	20;B,C

03. Calculations

Power outlet 1	50	4x2.5+TTCu	6.86	10	167.87	4.54	16;B,C
Power outlet 2	25	4x2.5+TTCu	6.86	10	327.76	1.19	16;B,C,D
Power outlet 3	62	4x2.5+TTCu	6.86	10	135.99	6.91	16;B
Power outlet 4	47	4x2.5+TTCu	6.86	10	178.32	4.02	16;B,C
Power outlet 5	39	4x2.5+TTCu	6.86	10	213.79	2.8	16;B,C
Power outlet 6	39	4x2.5+TTCu	6.86	10	213.79	2.8	16;B,C
Power outlet 7	32	4x2.5+TTCu	6.86	10	258.81	1.91	16;B,C
Power outlet 8	29	4x2.5+TTCu	6.86	10	284.47	1.58	16;B,C
Power outlet 9	29	4x2.5+TTCu	6.86	10	284.47	1.58	16;B,C
Power outlet 10	27	4x2.5+TTCu	6.86	10	304.59	1.38	16;B,C
Power outlet 11	32	4x2.5+TTCu	6.86	10	258.81	1.91	16;B,C
Lighting of Pumps 1	340	4x25+TTCu	6.86	10	244.13	214.45	20;B,C
Lighting of Pumps 2	340	4x25+TTCu	6.86	10	244.13	214.45	20;B,C
Lighting of Trafo 25/0,69	78	4x2.5+TTCu	6.86	10	108.51	10.85	6;B,C
Lighting of Trafo 25/0,69	84	4x2.5+TTCu	6.86	10	100.86	12.56	6;B,C
Lighting of Trafo 25/0,69	96	4x2.5+TTCu	6.86	10	88.41	16.35	6;B,C
Lighting of Trafo 25/0,42	100	4x2.5+TTCu	6.86	10	84.91	17.73	6;B,C
Lighting of MT cubicles	105	4x2.5+TTCu	6.86	10	80.91	19.52	6;B,C
Lighting BT	80	4x2.5+TTCu	6.86	10	105.84	11.41	6;B,C
Lighting of services	30	4x2.5+TTCu	6.86	10	275.37	1.69	6;B,C,D
Lighting of warehouse	36	4x2.5+TTCu	6.86	10	231.02	2.39	6;B,C,D
Exterior Lighting 1	380	4x10+TTCu	6.86	10	89.33	256.28	6;B,C
Exterior Lighting 2	380	4x10+TTCu	6.86	10	89.33	256.28	6;B,C
Crepuscular and intrusion Lighting.	80	4x2.5+TTCu	6.86	10	105.84	11.41	6;B,C
Emergency lights	80	4x2.5+TTCu	6.86	10	105.84	11.41	6;B,C
Peripheral	20	4x10+TTCu	6.86	10	1319.9	1.17	38;B,C,D

3.9 CALCULATION COMPENSATION FACTOR

3.9.1 Transformers

3.9.1.1 Transformer 6.300 kVA of 25/0,69 kV

Data Transformer:

Power Transformer, S, 6.300 kVA

Primary tension, in empty U1, 25 kV

Empty current 0,8 %, I₀ = 1,16 A

Short circuit voltage of a transformer uk, 7 %

Transformer load index I_c, 0,8

Reactive empty power

$$Q_0 = 1,732 \times 25 \text{ kV} \times 1,16 = 50,23 \text{ kVAr} \quad (\text{Ec. 3.42})$$

Reactive load power

$$Q_s = \frac{7\%}{100} \times 6.300 \text{ kVA} \times 0.8 = 352,8 \text{ kVAr} \quad (\text{Ec. 3.43})$$

So demand will total reactive power:

$$Q = 50,23 \text{ kVAr} + 352,8 \text{ kVAr} = 403,03 \text{ kVAr} \quad (\text{Ec. 3.44})$$

In order to non over-compensate and taking into account the standardized equipment, is expected compensation for transformer 6300 kVA of 25 / 0,69 kV, 400 kVAr.

The battery will be fixed each transformer connected to the closest possible to the transformer.

03. Calculations

3.9.2 Motors

3.9.2.1 710 kW Motor a 690 V

Date of motor:

Nominal Power P_N , 710 kW.Performance η , 0,87. $\cos \varphi$, 0,88. $\sin \varphi$, 0,47.

Reactive load power:

$$Q = 0,9 \times \frac{710 \text{ kW}}{0,87} \times \frac{1 - 0,88}{0,88 \times 0,47} = 213 \text{ kvar} \quad (\text{Ec. 3.45})$$

It's provides for pumping EB1, with five pumps, a battery adjustable with two steps of 400 kVAr and another of 200 kVAr, in this way, are activated so that the steps for each of the pumps once it has finished maneuver before the start up and stop the maneuver.

3.9.2.2 630 kW Motor to 690 V

Date of motor:

Nominal Power P_N , 630 kW.Performance η , 0,87. $\cos \varphi$, 0,87. $\sin \varphi$, 0,49.

Reactive load power:

$$Q = 0,9 \times \frac{630 \text{ kW}}{0,87} \times \frac{1 - 0,87}{0,87 \times 0,49} = 198,74 \text{ kvar} \quad (\text{Ec. 3.46})$$

03. Calculations

It's provides for pumping EB2, with four pumps, a battery adjustable with two steps of 175 kVAr activated so that the steps for each of the pumps once it has finished the maneuver and turned before start the maneuver stop.

3.9.2.3 500 kW Motor to 690 V

Dates of motor:

Nominal Power P_N , 500 kW.

Performance η , 0,87.

$\cos \varphi$, 0,87.

$\sin \varphi$, 0,49.

Reactive load power:

$$Q = 0,9 \times \frac{500 \text{ kW}}{0,87} \times \frac{1 - 0,87}{0,87 \times 0,49} = 157,73 \text{ kvar} \quad (\text{Ec. 3.47})$$

It's provides for pumping EB2, with four pumps, a battery adjustable with two steps of 150 kVAr and another of 300 kVAr, in this way, are activated so that the steps for each of the pumps once it has finished maneuver before the start up and stop the maneuver.

3.10 CALCULATION OF GROUNDING SYSTEM

3.10.1 Investigation of soil characteristics

The RAT indicates that for installations 3th category intensities and short circuit less than or equal to 16 kA is possible to estimate the resistivity of the ground being measured need for higher currents.

It thus determines an average resistivity of 400 ohm · m.

3.10.2 Càlcul de la resistència del sistema de terra

Characteristics of the power network:

- Voltage: $V_n = 25 \text{ kV}$
- Limits of intensity on earth, $I_{dm} = 300 \text{ A}$
- Isolation Levels installations in BT: $V_{bt} = 1000 \text{ V}$
- Terrain features
 - ✓ Earth Resistance $R_o = 400 \text{ ohm} \cdot \text{m}$
 - ✓ Resistencia Formigo = $3000 \text{ ohm} \cdot \text{m}$

The maximum resistance of the grounding transformer protection, and the intensity of the defect are calculated:

$$I_d \cdot R_t \leq V_{bt} \quad (\text{Ec. 3.48})$$

Where:

I_d Intensity ground fault, in A → In this case, $I_d = I_{dm}$

R_t Total resistance grounding, in ohms

V_{bt} Isolation voltage in Low voltage, in V

Making the relevant calculations find that:

03. Calculations

$$R_t = \frac{V_{bt}}{I_d} = \frac{10000 V}{300 A} = 33,33 \Omega \quad (Ec. 3.49)$$

Having obtained this result, fix the electrode type that meets the requirement of having a closer Kr or less calculated for the case:

- Unit value of resistance grounding electrode

$$K_r \leq \frac{R_t}{R_o} \quad (Ec. 3.50)$$

Rt Total resistance grounding, in Ω
 Ro Resistivity ground, in $\Omega \cdot m$
 Kr The electrode coefficient Kr

For our particular case and according to the values listed above:

$$K_r \leq \frac{33,33 \Omega}{400 \Omega \cdot m} = 0,083 \quad (Ec. 3.51)$$

The appropriate setting for this event has the following properties:

CT dimensions	9x3,5
UNESAfactor	40-40/8/42
Rods length (m)	D14x2
Nº Rods	4
Depth (m)	0,8
Kr Resistance	0,02
Kp, voltage step	0,0144
Kc = Kp (acc). Outdoor contact-voltage	0,0447

To avoid the appearance of external or internal tensions contact, adapt the following security measures:

03. Calculations

- The doors and metal bars facing the outside of the center masses have no electrical contact with conductors that may be under stress due to defects or faults.
- On the floor of a transformer installed “*mallazo*” covered by a concrete layer 10 cm, connected to the grounding protection center.
- If installing sinks in a row, they have aligned with the front of the building.
- Once selected electrode, the real value of the resistance of grounding transformer will be:

$$R't = Kr \cdot Ro = 0,02 \cdot 400 \Omega = 8 \Omega \quad (Ec. 3.52)$$

And the intensity of default:

$$I'd = 549,9 \text{ A}$$

3.10.3 Calculation of step tension inside of the installation

Adopting additional security measures will not be calculated step and touch voltages inside, as these are practically zero.

The default voltage is given by:

$$V'd = R't \cdot I'd \quad (Ec. 3.53)$$

As in this case:

$$V'd = 4399,1 \text{ V} \quad (Ec. 3.54)$$

The step voltage in the access will be equal to the value of maximum of the contact voltage, provided that have a mesh surrounding the industrial unity connected to electrode to the ground, according to the formula:

$$V'c = kc \cdot Ro \cdot I'd \quad (Ec. 3.55)$$

03. Calculations

As we:

$$V'c = 9831,1 V \quad (Ec. 3.56)$$

3.10.4 Calculation of step tension outside of the installation

Adopting additional security measures will not be calculated step and touch voltages outside, as these are practically zero.

The default voltage is given by:

$$V'p = kp \cdot Ro \cdot I'd \quad (Ec. 3.57)$$

As in this case:

$$V'p = 3167,3 V \quad (Ec. 3.58)$$

3.10.5 Calculation of the stresses applied

The securities are admissible for a total duration of fault equal to:

- T = 0,7 s
- K = 72
- n = 1

Outside step voltage:

$$Vp = \frac{10 \cdot K}{t \cdot n} \left(1 + \frac{6 \cdot Ro}{1000} \right) \quad (Ec. 3.59)$$

$$Vp = \frac{10 \cdot 72}{0,7 \cdot 1} \left(1 + \frac{6 \cdot 400}{1000} \right) = 3497,14 V \quad (Ec. 3.60)$$

Step voltage in the access of Transformation center:

$$Vp (acc) = \frac{10 \cdot K}{t \cdot n} \left(1 + \frac{3 \cdot Ro + 3 \cdot R'o}{1000} \right) \quad (Ec. 3.61)$$

$$Vp (acc) = \frac{10 \cdot 72}{0,7 \cdot 1} \left(1 + \frac{3 \cdot 400 + 3 \cdot 3000}{1000} \right) = 11520 V \quad (Ec. 3.62)$$

03. Calculations

Now we check that the values calculated for the case of the transformer are lower than the permissible values:

- outside step voltage

$$V'p < Vp$$

$$3167,3 V < 3497,1 V$$

- Step voltage in the access

$$V'p(acc) < Vp(acc)$$

$$9831,9 V < 11520 V$$

- Default voltage:

$$V'd = 4399,1 V < Vbt = 10000 V$$

- Default intensity:

$$Ia = 0A \leq Id = 300 \leq Idm = 549,9 V$$

3.10.6 Outside transferable Tensions

To ensure that the system does not transfer land protection system tensions the ground services, thus avoiding affecting users must set up a separation between the electrodes closest of these two systems, provided that the voltage defects exceeding 1000 V.

In this case it is essential to keep this separation, the voltage was 1000 V defects than indicated.

The minimum distance separation between land systems is given by the expression:

$$D = \frac{R_o \cdot I'd}{2000 \cdot \pi} \quad (Ec. 3.63)$$

03. Calculations

For this C.T.

$$D = \frac{400 \cdot 549,9}{2000 \cdot \pi} = 35 \text{ m} \quad (\text{Ec. 3.64})$$

It connects to the system ground service neutral transformer.

The system features ground service are:

Identification	5/32 (according to UNESA)
Geometry:	Row Rods
Nº Rods:	3
Trench between rods:	0,5 m

The configuration parameters according to this ground are:

$$K_r = 0,135$$

$$K_c = 0,0252$$

The criteria for selecting service ground is doesn't cause the electrode voltage greater than 24 V when there is a defect in the installation of BT ground protected against indirect contact with a differential of 650 mA. So resistance grounding service must be less than 37 Ohm.

$$R_{t_{serv}} = K_r \cdot R_o = 0,135 \cdot 200 = 27 < 37 \Omega \quad (\text{Ec. 3.65})$$

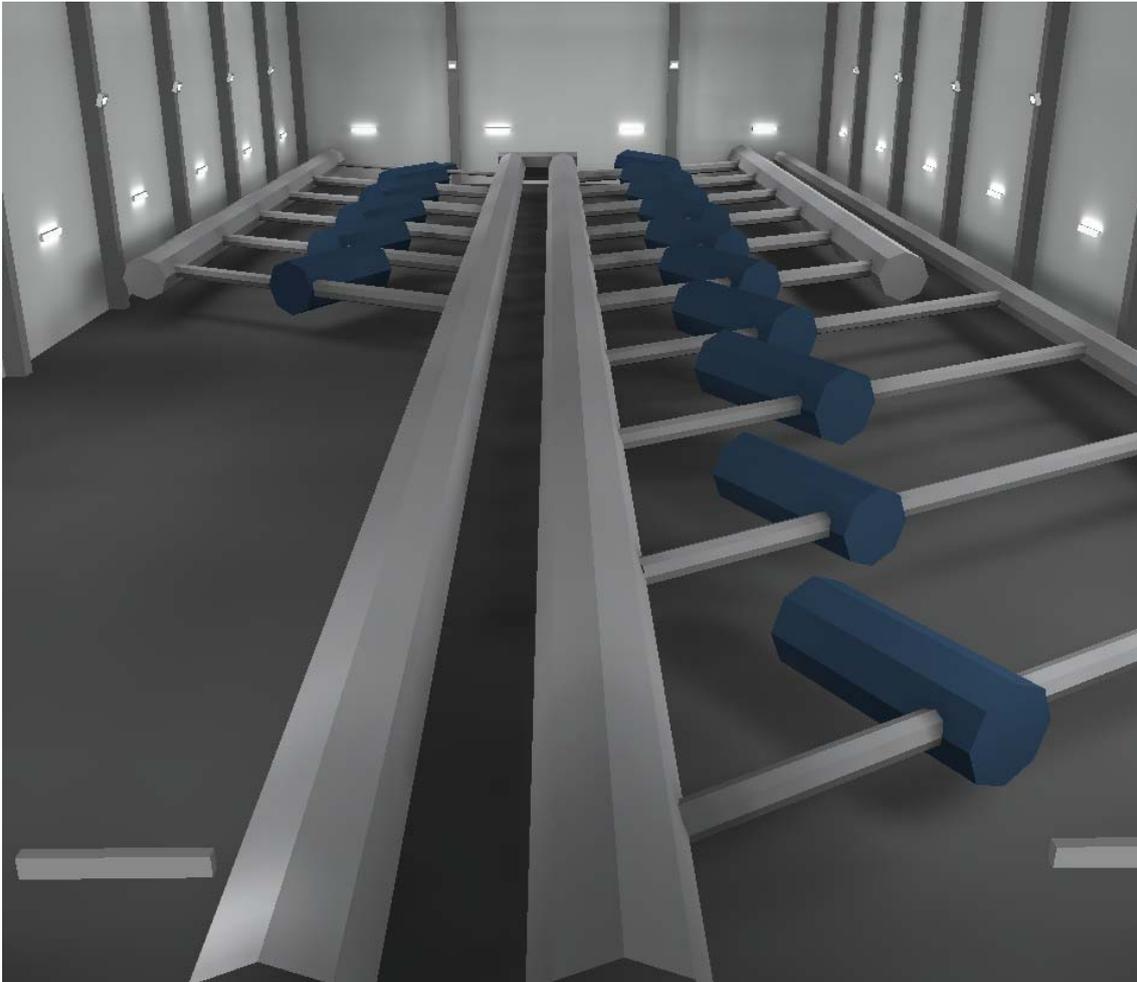
To keep the two separate grounding systems including network neutral grounding shall be insulated cable with 0.6 / 1 kV, protected with PVC pipe seventh grade at least against mechanical damage.

3.11 LIGHTING CALCULATION

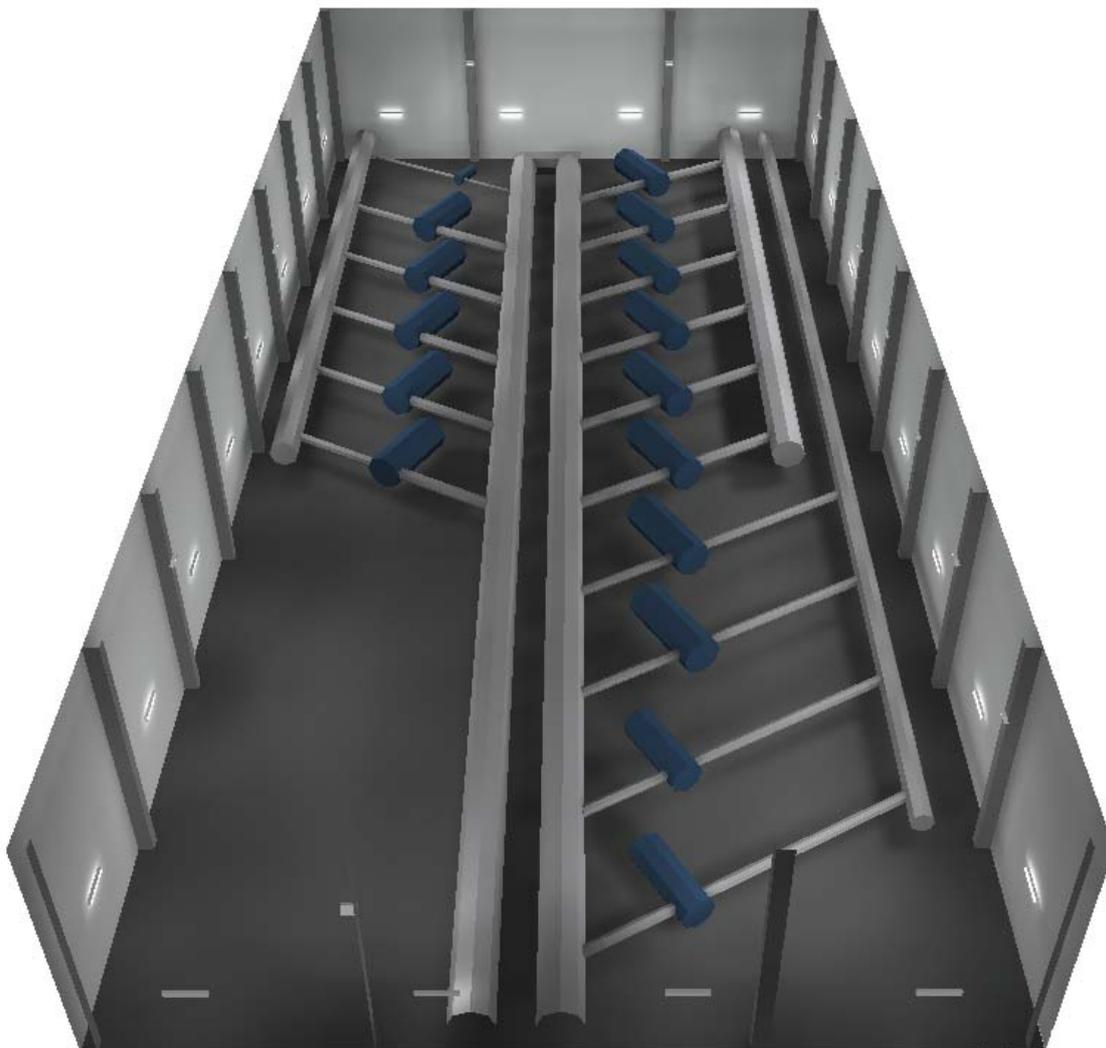
We will then calculate luminaires realized with the calculation program DIALUX.

3.11.1 Pumping station

3.11.1.1 Rendering (3D)

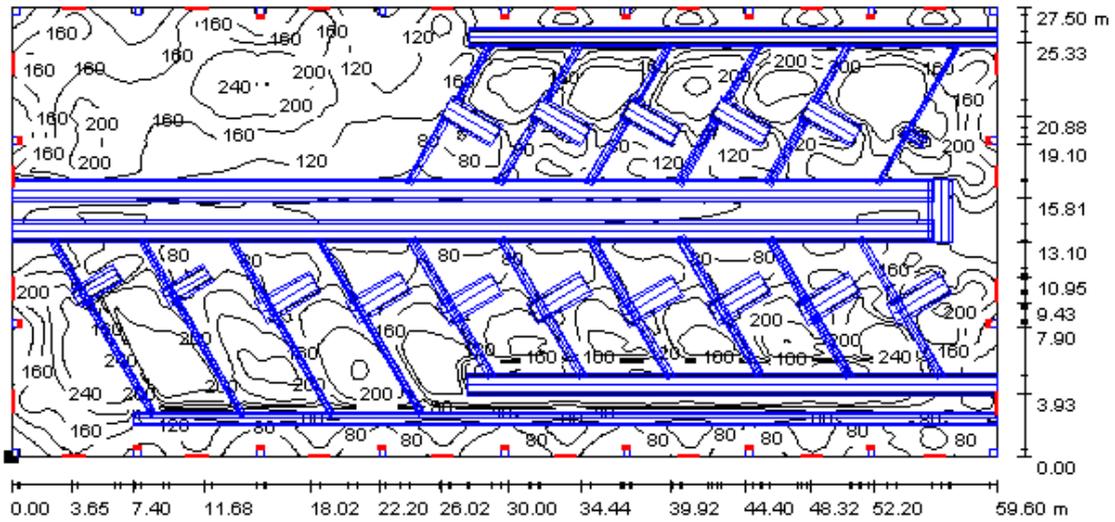


03. Calculations



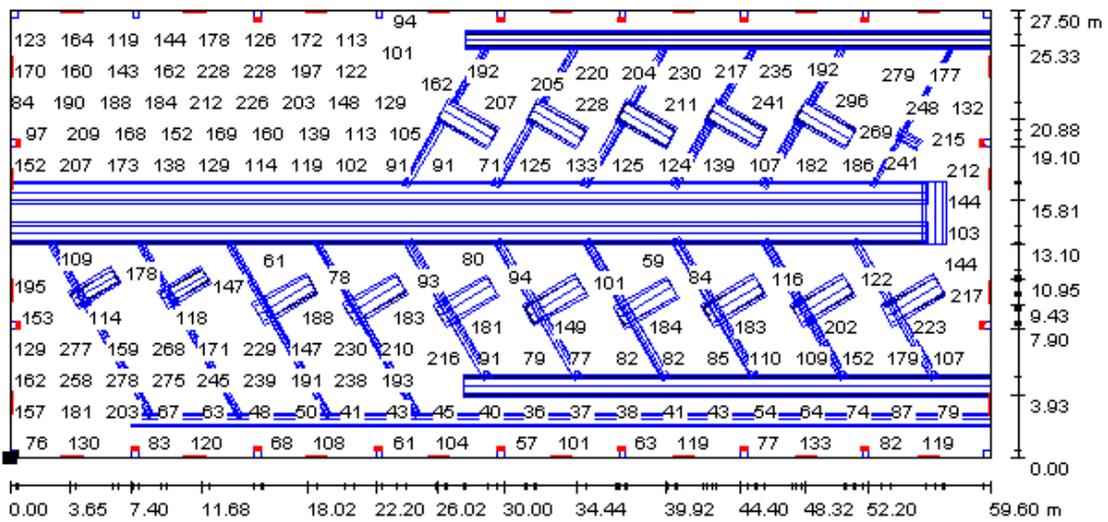
03. Calculations

3.11.1.2 Isolineas



Lux Value

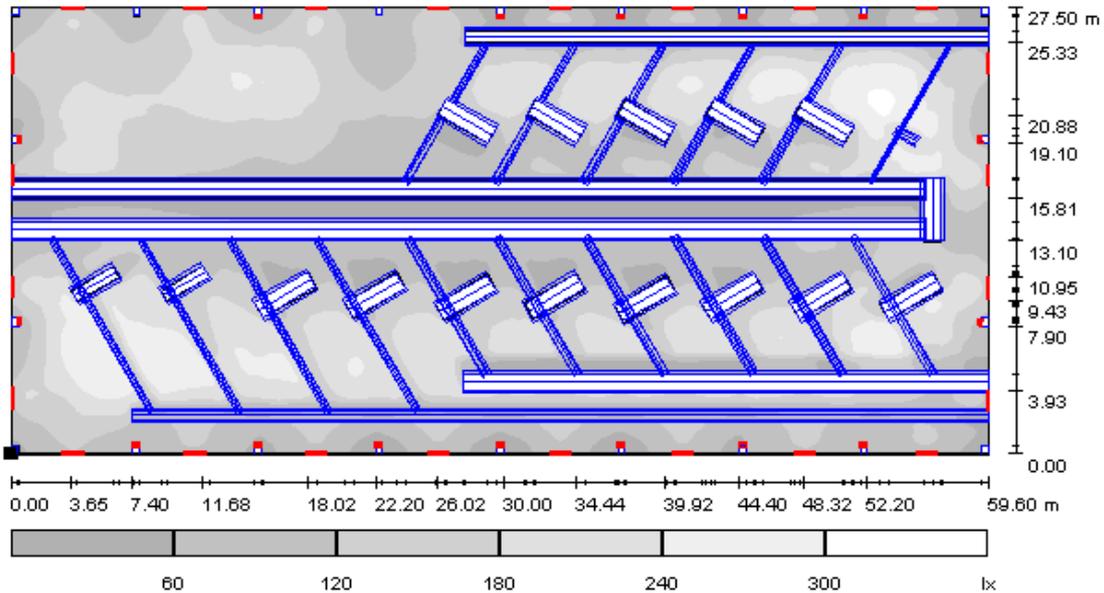
3.11.1.3 Graphic stock (E)



Lux Value

03. Calculations

3.11.1.4 Grey scale

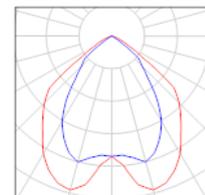


3.11.1.5 Lighting summary

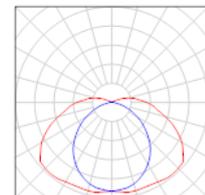
Lista de piezas - Luminarias

Nº	Pieza	Designación (Factor de corrección)	Φ [lm]	P [W]
1	16	Lledo OD-8242 1X400W EXT OD-8242 (1.000)	32000	450.0
2	24	Lledo OD-8551 2X36W OD-8551 (1.000)	6700	96.0
Total:			672800	9504.0

16 Pieza Lledo OD-8242 1X400W EXT OD-8242
 Nº de artículo: OD-8242 1X400W EXT
 Flujo luminoso de las luminarias: 32000 lm
 Potencia de las luminarias: 450.0 W
 Clasificación luminarias según CIE: 100
 Código CIE Flux: 70 97 100 100 84
 Armamento: 1 x HIT-T 400 W EXT (Factor de corrección 1.000).



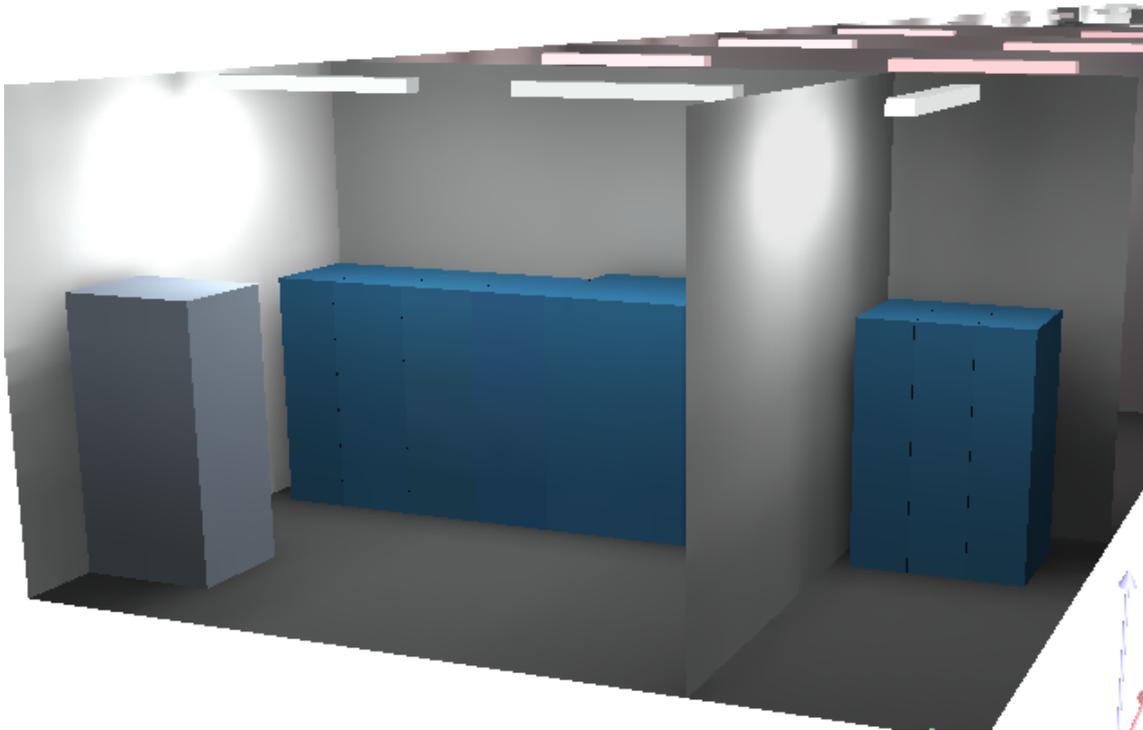
24 Pieza Lledo OD-8551 2X36W OD-8551
 Nº de artículo: OD-8551 2X36W
 Flujo luminoso de las luminarias: 6700 lm
 Potencia de las luminarias: 96.0 W
 Clasificación luminarias según CIE: 93
 Código CIE Flux: 37 68 89 94 59
 Armamento: 2 x TL 36 W (Factor de corrección 1.000).



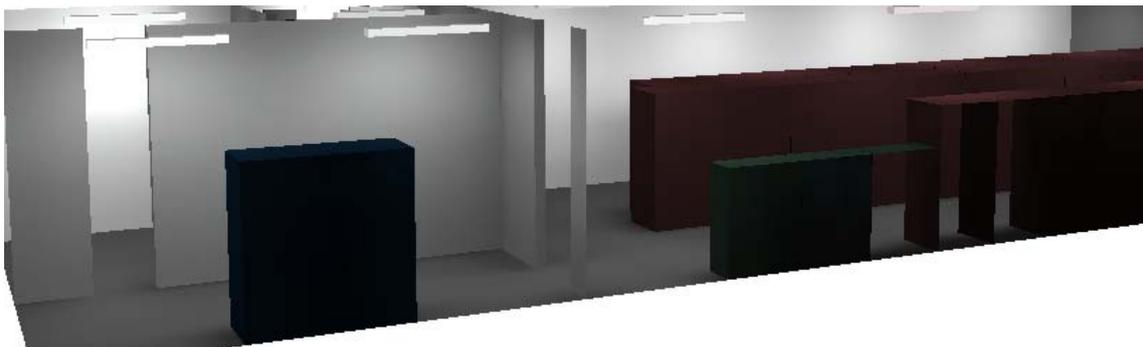
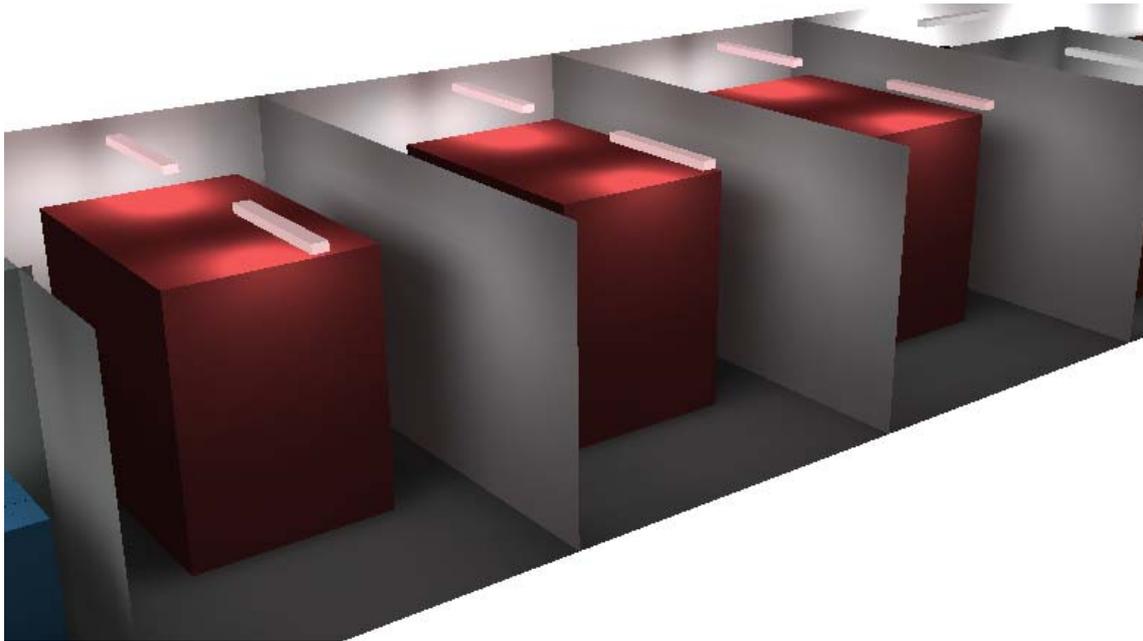
03. Calculations

3.11.2 Technical room

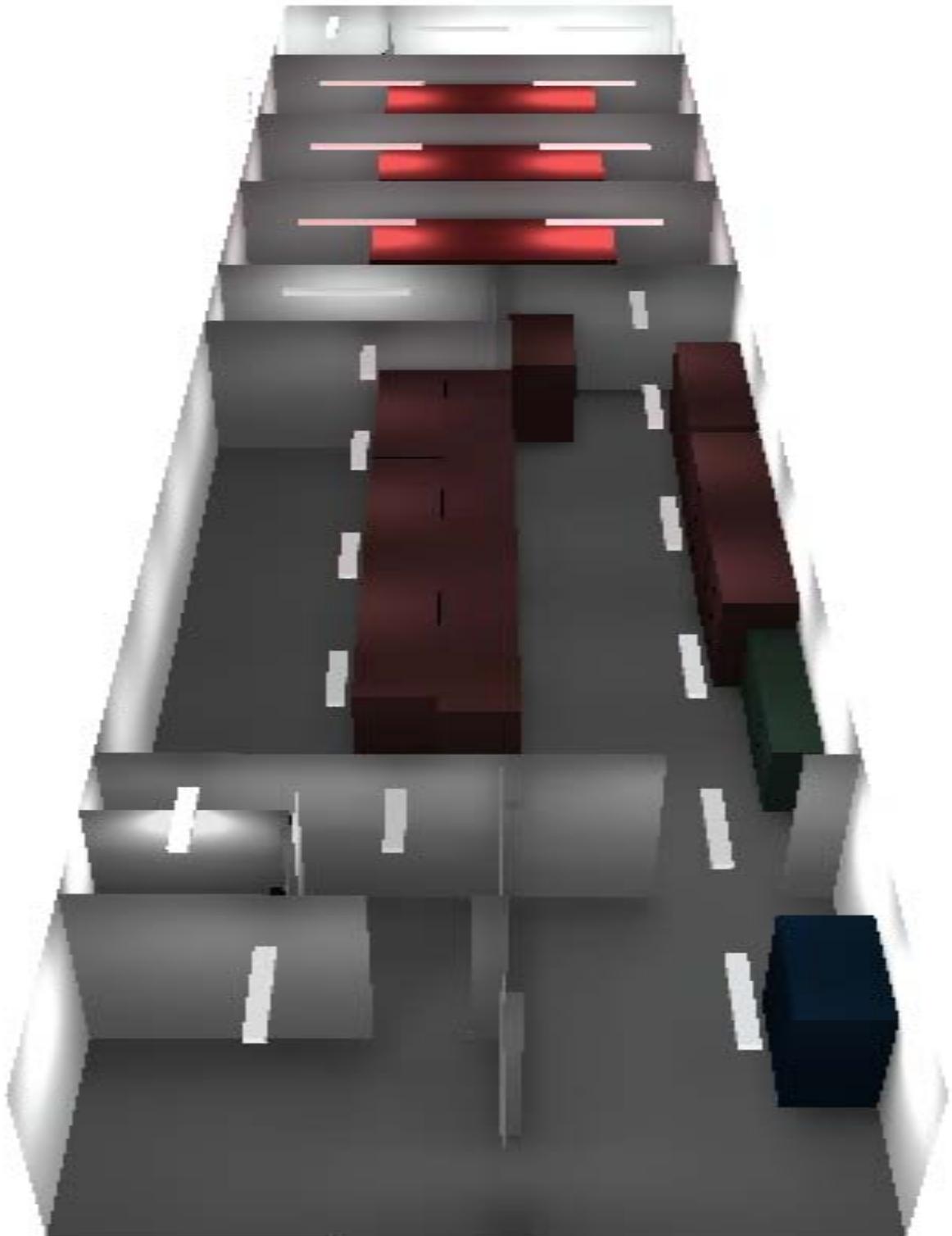
3.11.2.1 Rendering (3D)



03. Calculations

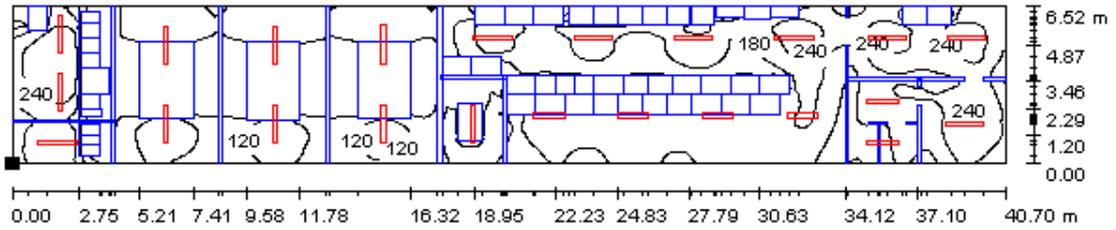


03. Calculations



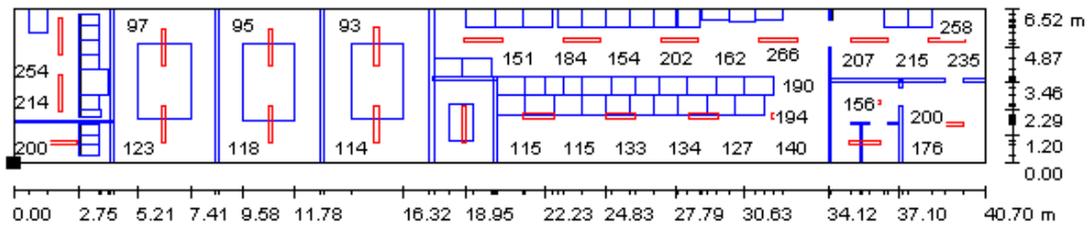
03. Calculations

3.11.2.2 Isolinies



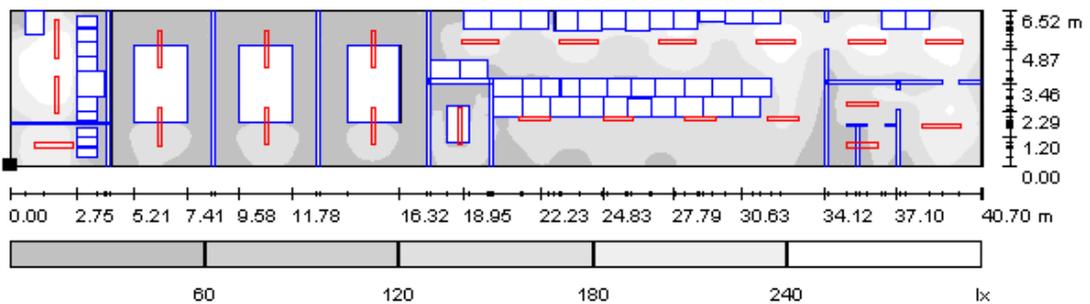
Lux Value

3.11.2.3 Graphic stock (E)



Lux Value

3.11.2.4 Grey scale



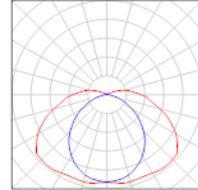
03. Calculations

3.11.2.5 Lighting summary

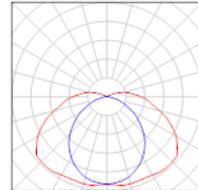
Lista de piezas - Luminarias

Nº	Pieza	Designación (Factor de corrección)	Φ [lm]	P [W]
1	6	Lledo OD-8551 2X36W OD-8551 (1.000)	6700	96.0
2	17	Lledo OD-8551 2X58W OD-8551 (1.000)	10400	150.0
Total:			217000	3126.0

6 Pieza
 Lledo OD-8551 2X36W OD-8551
 N° de artículo: OD-8551 2X36W
 Flujo luminoso de las luminarias: 6700 lm
 Potencia de las luminarias: 96.0 W
 Clasificación luminarias según CIE: 93
 Código CIE Flux: 37 68 89 94 59
 Armamento: 2 x TL 36 W (Factor de corrección 1.000).



17 Pieza
 Lledo OD-8551 2X58W OD-8551
 N° de artículo: OD-8551 2X58W
 Flujo luminoso de las luminarias: 10400 lm
 Potencia de las luminarias: 150.0 W
 Clasificación luminarias según CIE: 93
 Código CIE Flux: 37 68 89 94 59
 Armamento: 2 x TL 58 W (Factor de corrección 1.000).



4 ELECTRICAL PLANES

4.1 General

4.1.1 Electrical Equipment Distribution

4.2 Lighting

4.2.1 Lighting Distribution

4.3 Tray and Trench

4.3.1 Tray Distribution 690 V

4.3.2 Tray Distribution 400 V

4.3.3 Trench Distribution

4.4 Ground

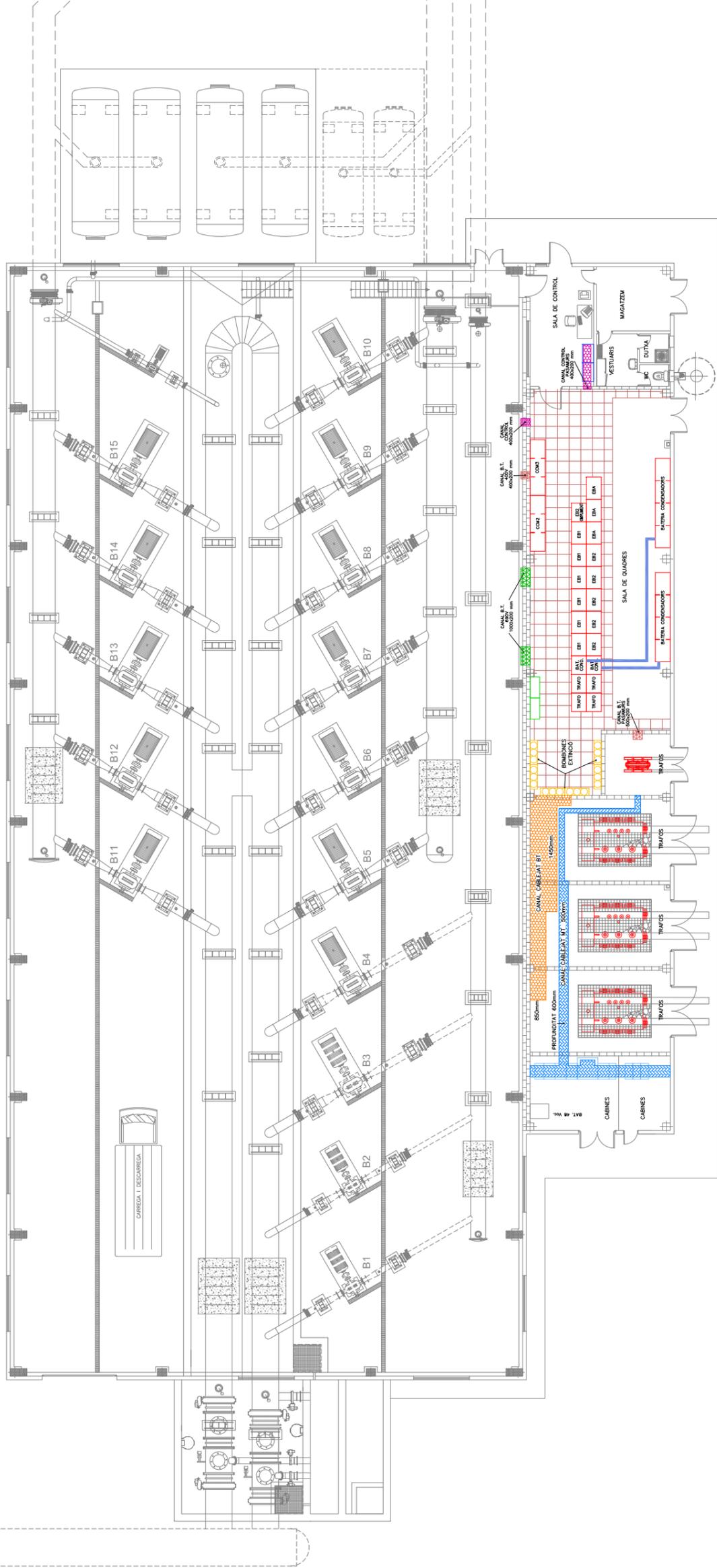
4.4.1 Situation Ground

4.4.2 Situation Ground B.T.

4.5 One-line diagram

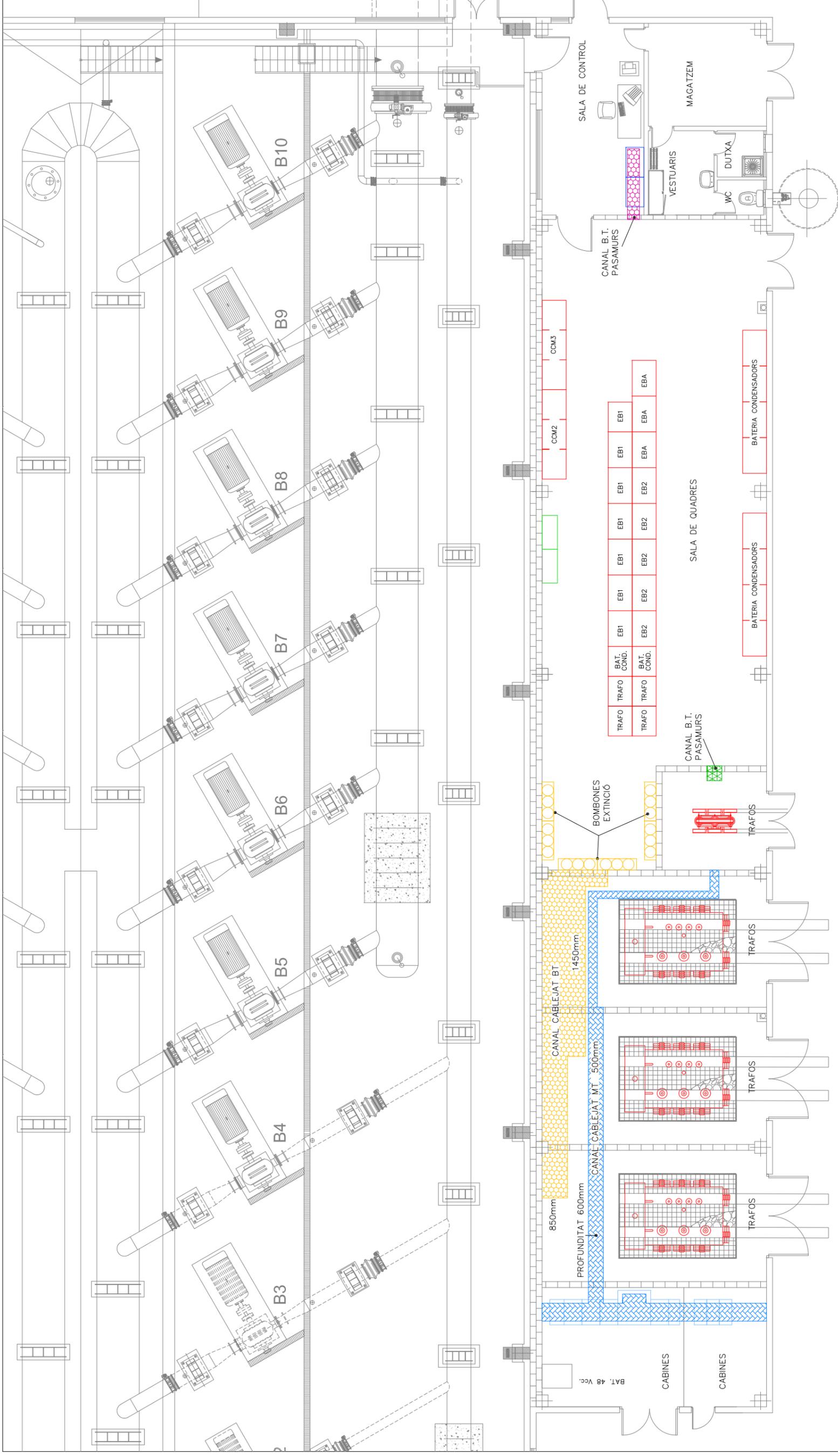
4.5.1 CCM1

4.5.2 CCM2 and CCM3

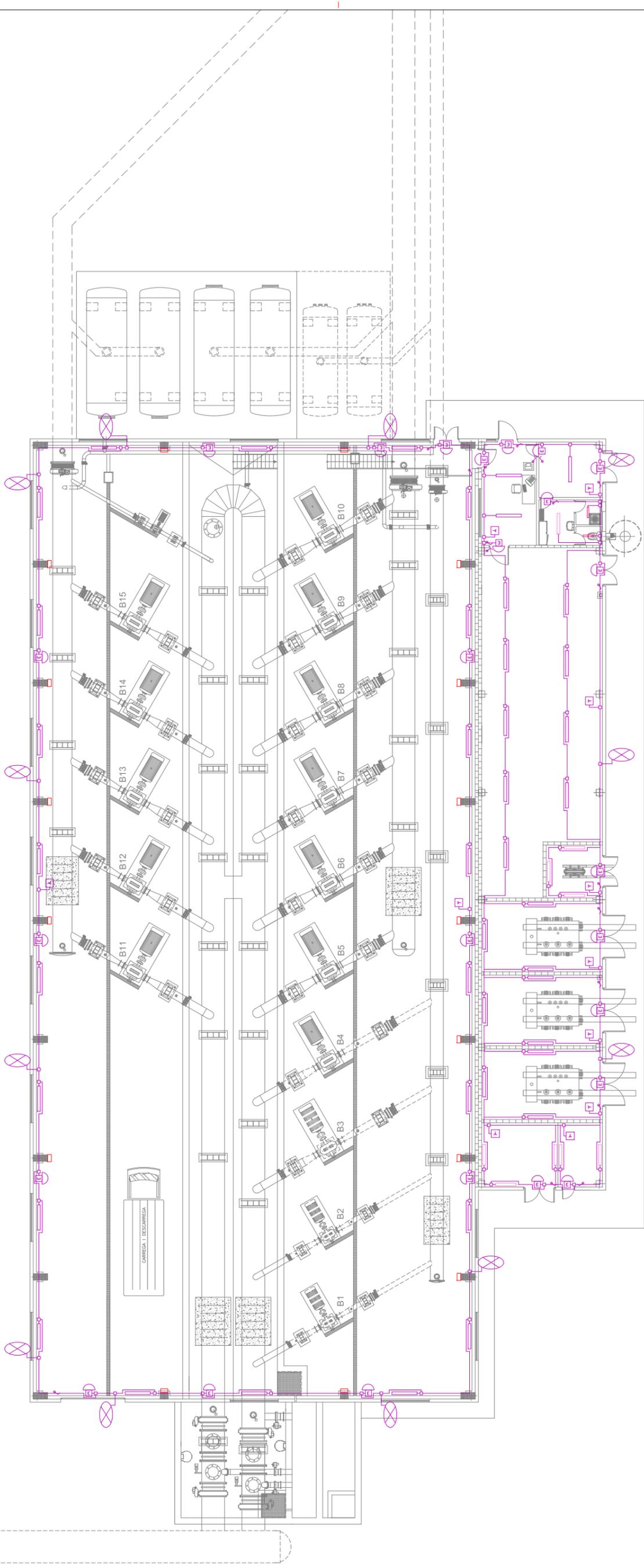


- ELECTRIC CABINET
- CONTROL CABINET
- SHIELDED CUBICLES
- ▤ RAISED FLOOR
- CORRUGATED TUBE Ø160mm





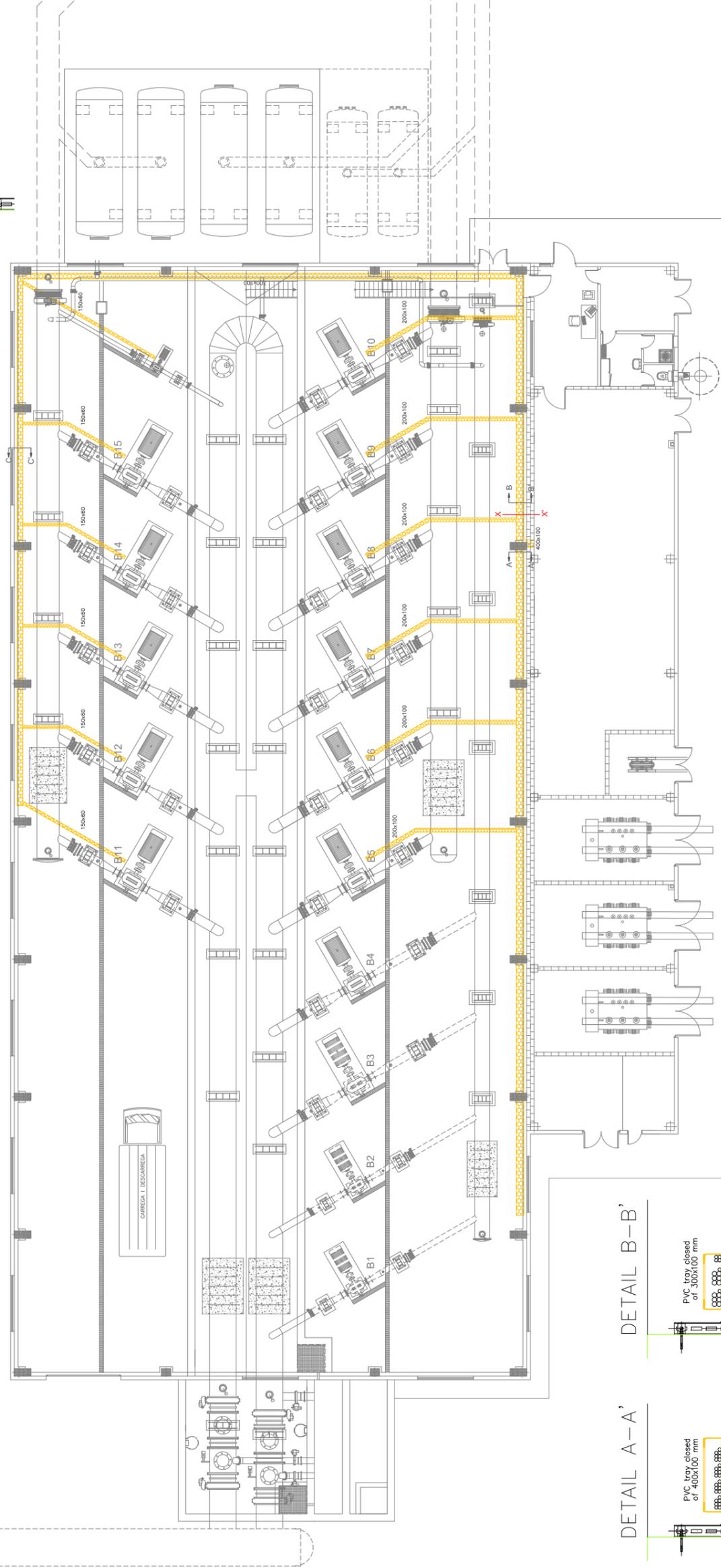
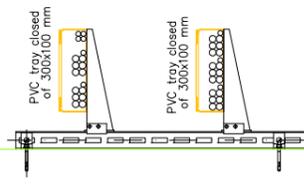
- ELECTRIC CABINET
- CONTROL CABINET
- SHIELDED CUBICLES
- RAISED FLOOR
- CORRUGATED TUBE Ø160mm



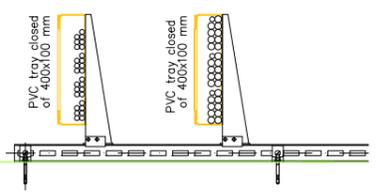
- FLUORESCENT LAMP 2x58 W
- FLUORESCENT LAMP 2x36 W
- FLUORESCENT LAMP 1x18 W
- INDOOR FOCUS 400 W
- CONNECTIONS BOX
- EMERGENCY LIGHT
- COMMUTATOR
- POWER POINT
- OUTDOOR FOCUS 250 W



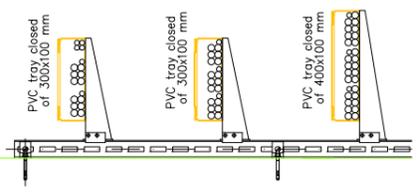
DETAIL C-C'

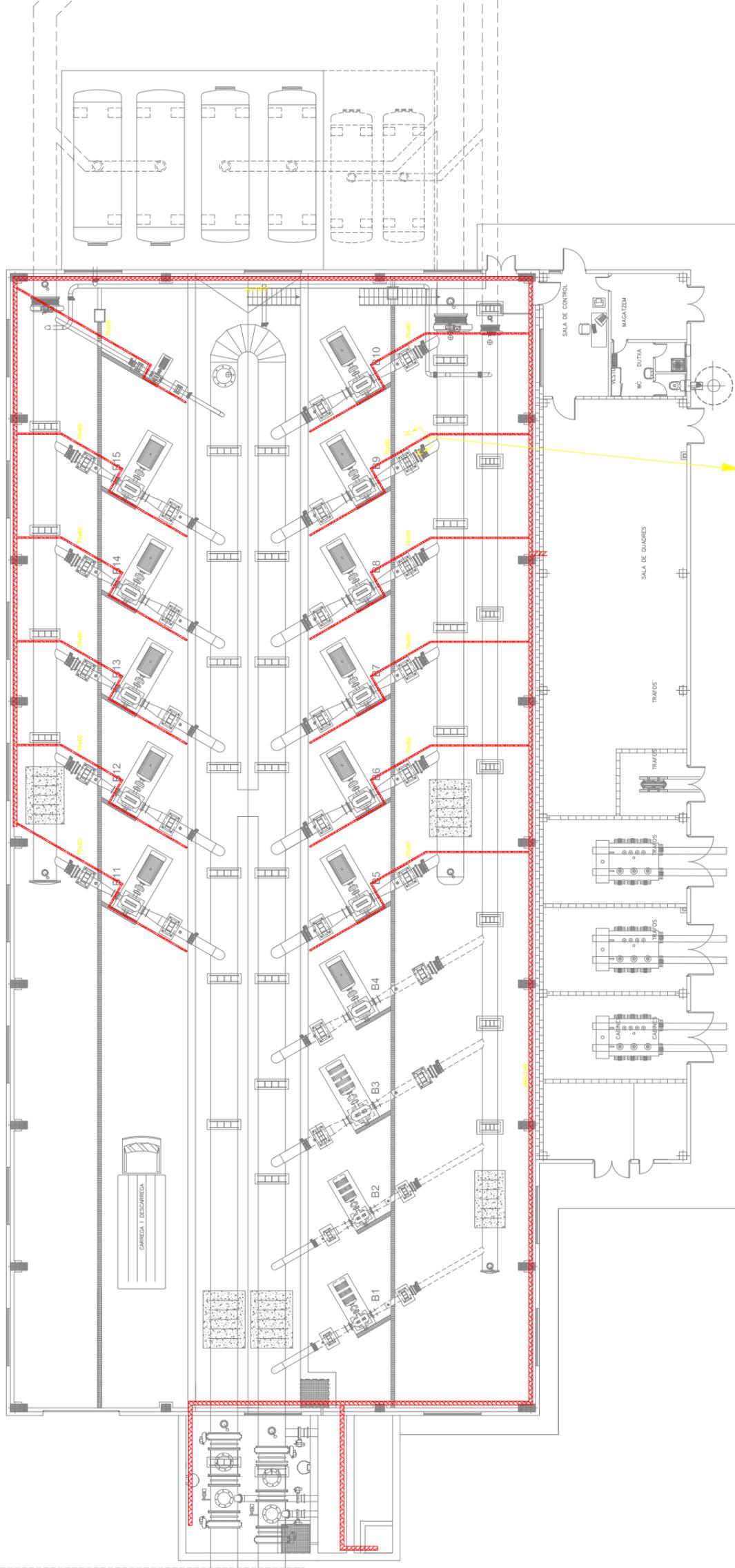


DETAIL A-A'

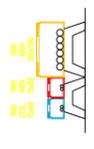


DETAIL B-B'

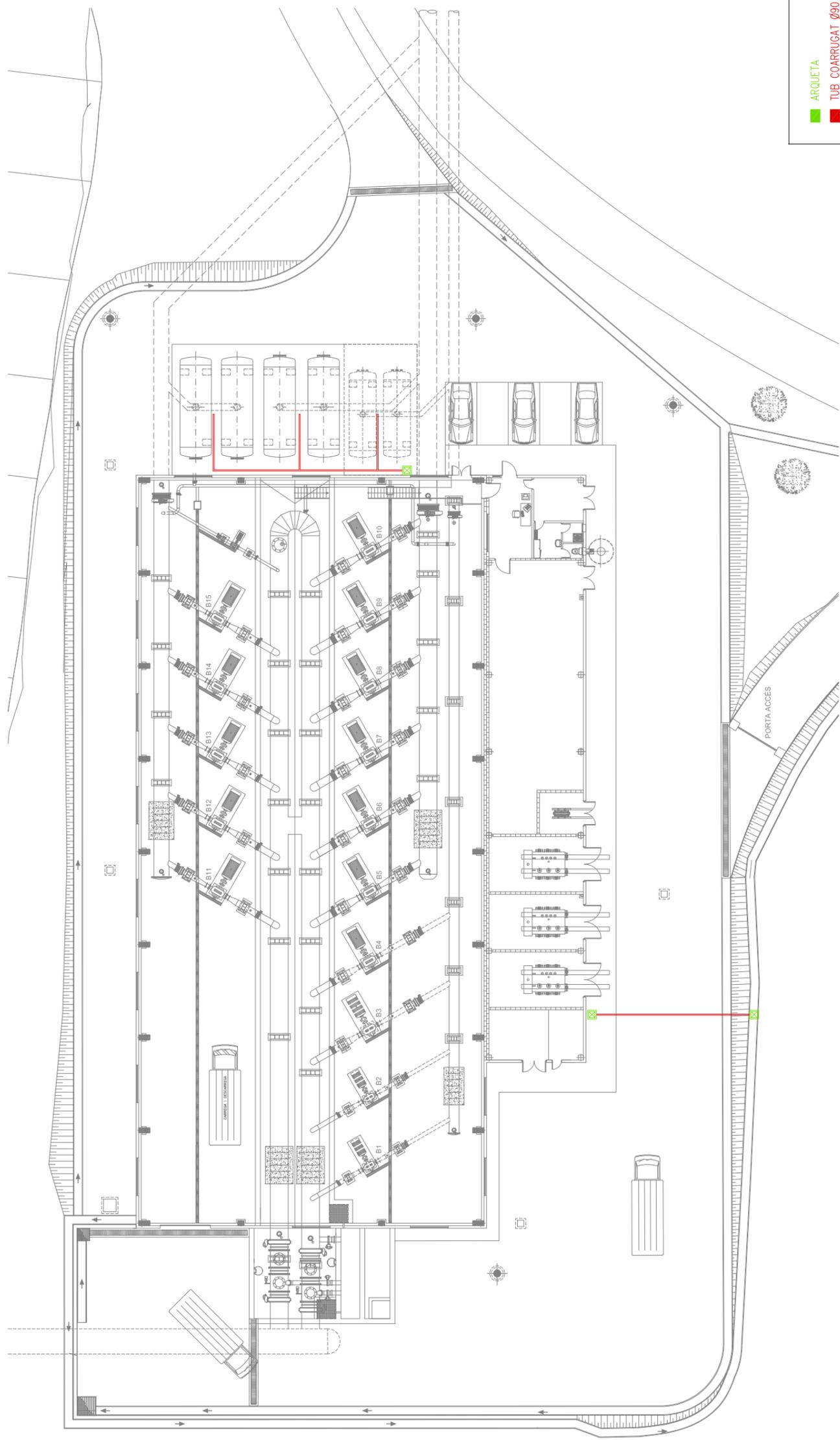




DETAIL A-A'

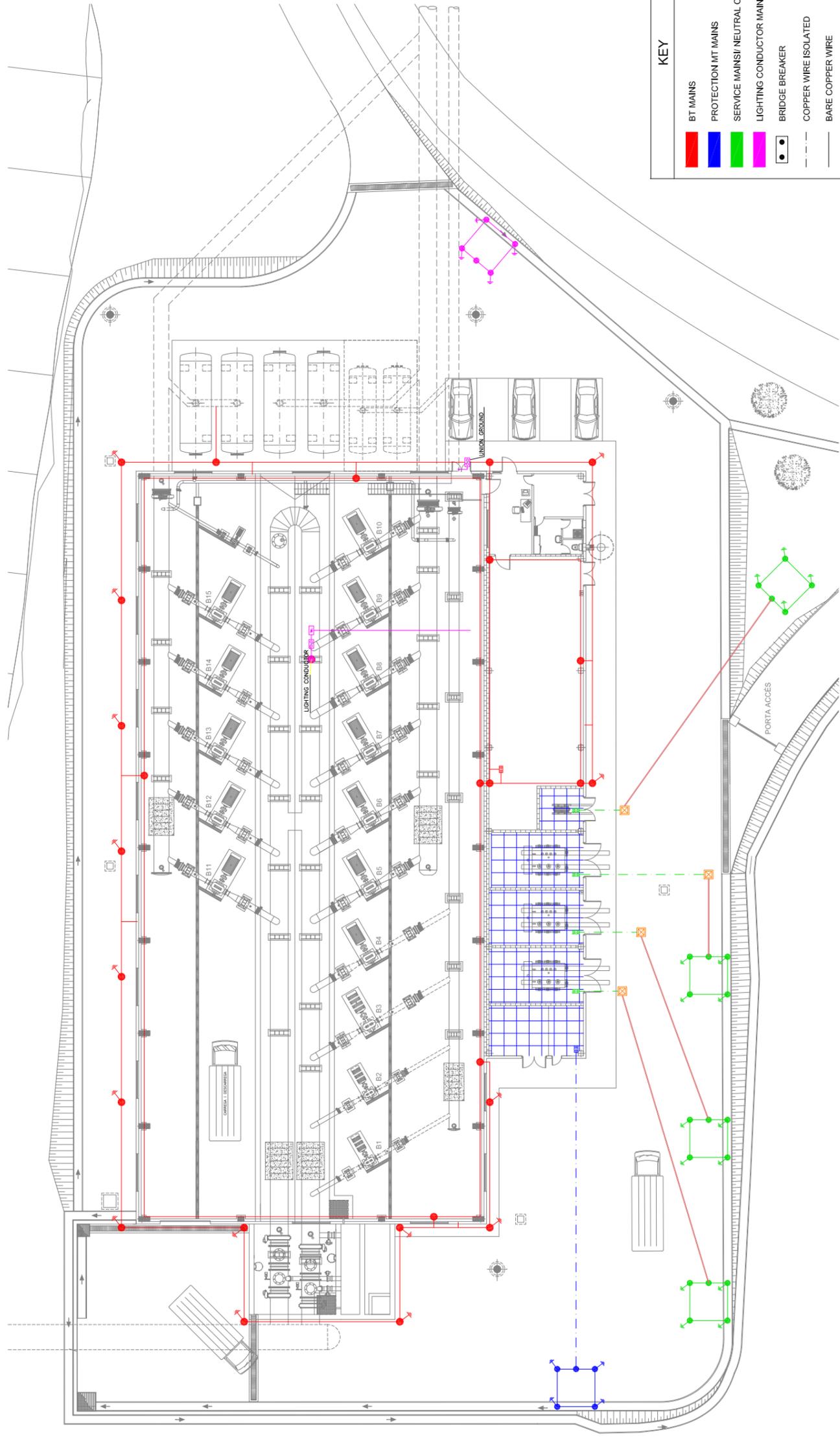


TRAY 400 V



ARQUETA
TUB COARRUGAT Ø90

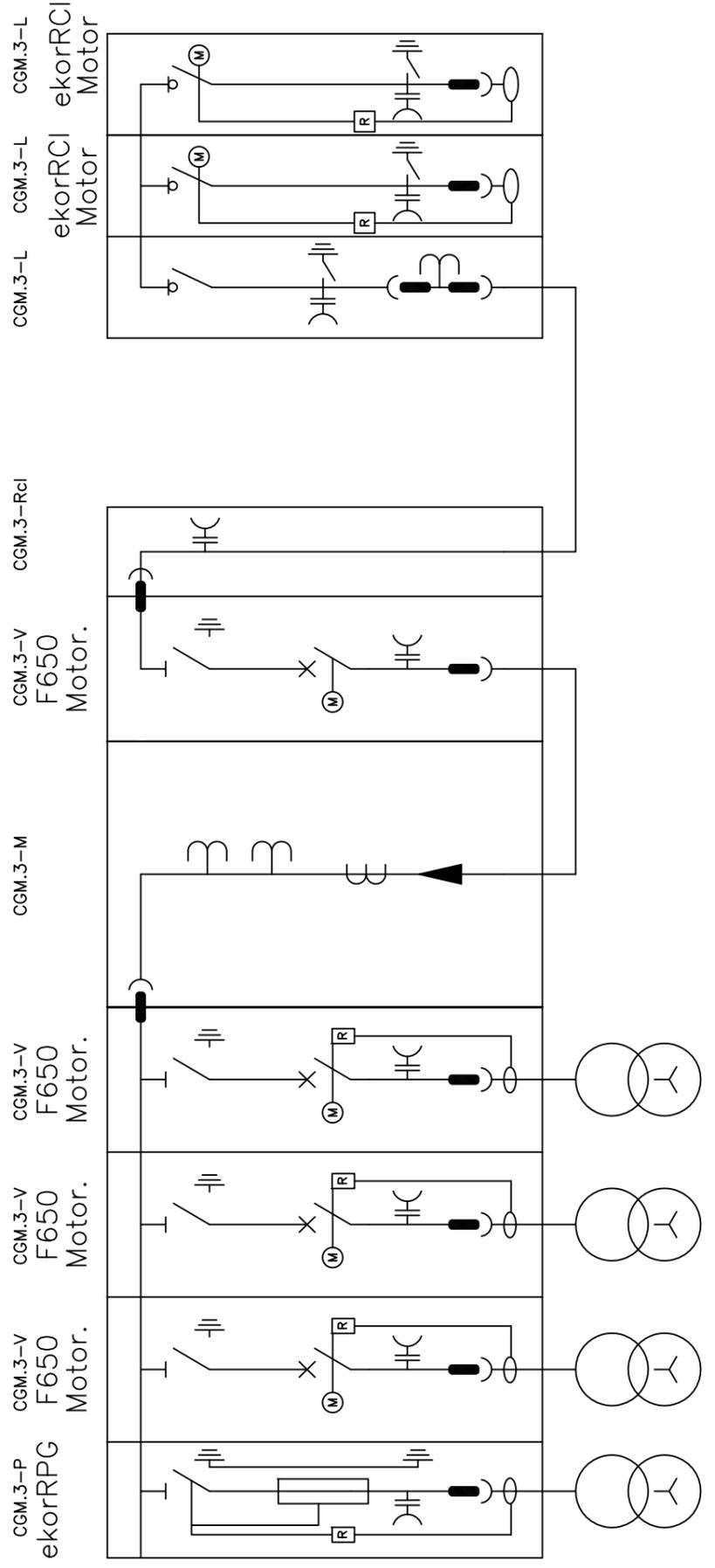
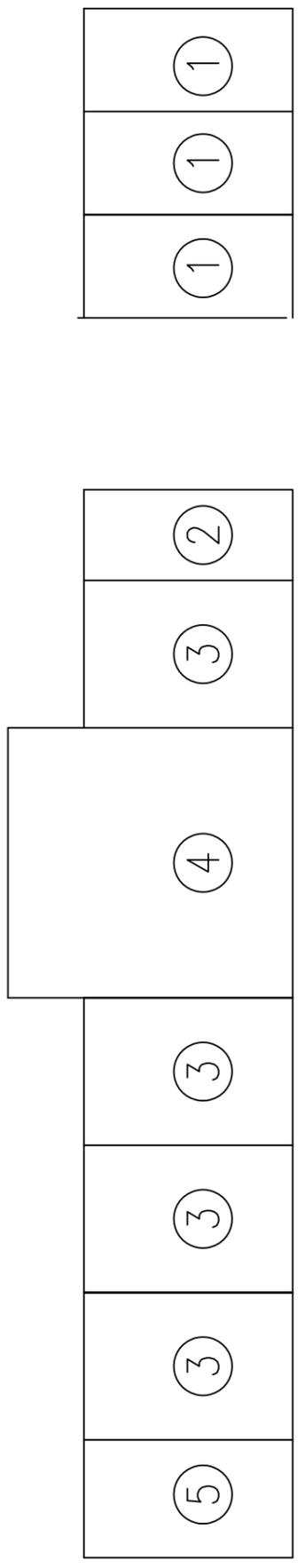




KEY	
	BT MAINS
	PROTECTION MT MAINS
	SERVICE MAINS/ NEUTRAL OF TRANSFORMER
	LIGHTING CONDUCTOR MAINS
	BRIDGE BREAKER
	COPPER WIRE ISOLATED
	BARE COPPER WIRE
	THERMAL ALUMINUM WELDING
	PIKE OF GROUND, 2M. I 14.6 MM Ø
	INSPECTION COVER
	CORRUGATED DOUBLE LAYER Ø60

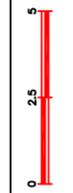


- ① CGM.3-L
- ② CGM.3-Rci
- ③ CGM.3-V
- ④ CGM.3-M
- ⑤ CGM.3-P

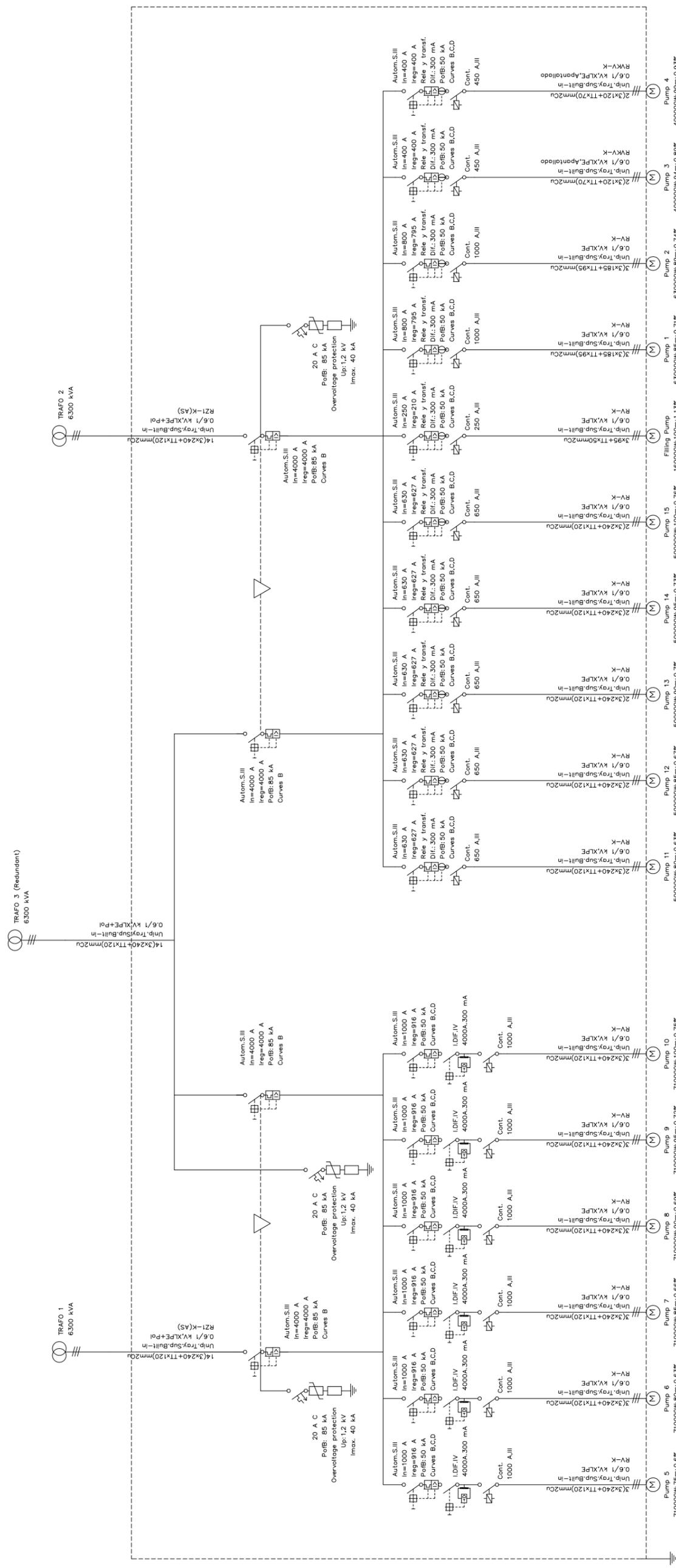


NAME OF PROJECT:
ELECTRICAL INSTALLATION AND AUTOMATION
OF A PUMPING SUBSTATION

SCALE:
ORIGINAL LINE A3

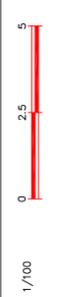


NAME OF PLANE:
PUMPING STATION
ONE-LINE DIAGRAM
at the site substation



NAME OF PROJECT:
ELECTRICAL INSTALLATION AND AUTOMATION
OF A PUMPING SUBSTATION

SCALE: 1/100



NAME OF PLAN:
PUMPING STATION
ONE-LINE DIAGRAM
CONT. (EPT1EBZ.1 EBA)

DATE: May 2016
DRAWN BY:
Juan Carlos Carrasco

PLAN NUMB.
05

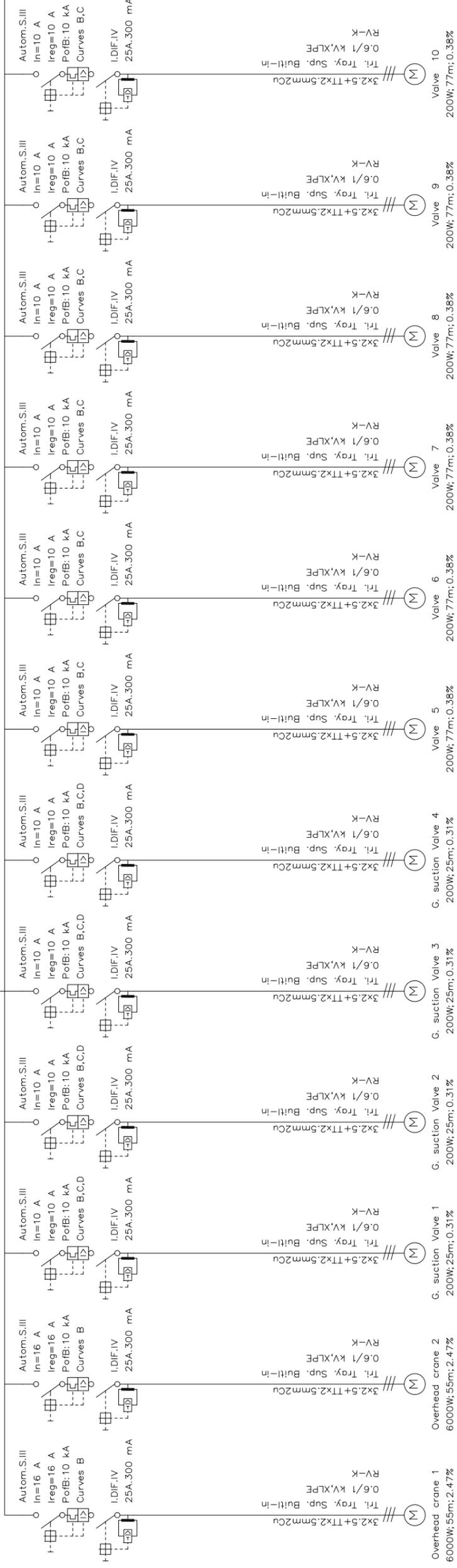
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TRAFD 2
250 kVA

3x185/95+1Tx95mm²Cu
Unip. Tray Sup. Built-in
0.6/1 kV, XLPE+Pcl
RZI-K(4S)

Automatic breakc switch: 400 A, IV
Reg: 34.3 A; PofB: 10 kA; Curves B

20 A C
PofB: 85 kA
Overvoltage protection
Up: 1.2 kV
Imax: 40 kA



Overhead crane 1
6000W; 55m; 2.47%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

Overhead crane 2
6000W; 55m; 2.47%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

G. suction Valve 1
200W; 25m; 0.31%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

G. suction Valve 2
200W; 25m; 0.31%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

G. suction Valve 3
200W; 25m; 0.31%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

G. suction Valve 4
200W; 25m; 0.31%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

Valve 5
200W; 77m; 0.38%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

Valve 6
200W; 77m; 0.38%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

Valve 7
200W; 77m; 0.38%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

Valve 8
200W; 77m; 0.38%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

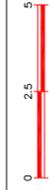
Valve 9
200W; 77m; 0.38%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

Valve 10
200W; 77m; 0.38%
RV-K
0.6/1 kV, XLPE
Tri. Tray. Sup. Built-in
3x2.5+Tx2.5mm²Cu

NAME OF PROJECT:
ELECTRICAL INSTALLATION AND AUTOMATION
OF A PUMPING SUBSTATION



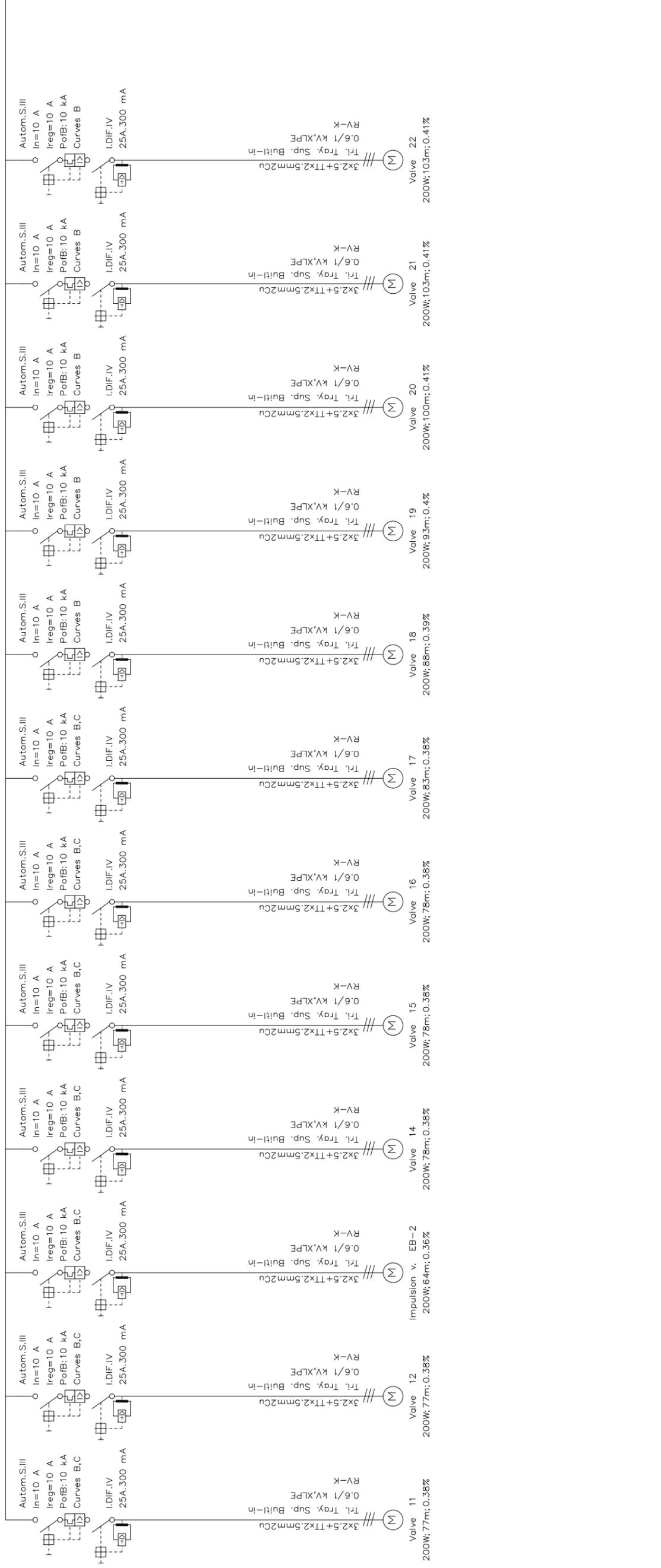
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NAME OF PLAN:
PUMPING STATION
ONE-LINE DIAGRAM
CCM2

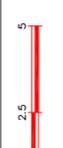
DATE: May 2016
DRAWN BY: Juan Carlos Carrasco

PLAN NUMB:
05
Page 03 of 10



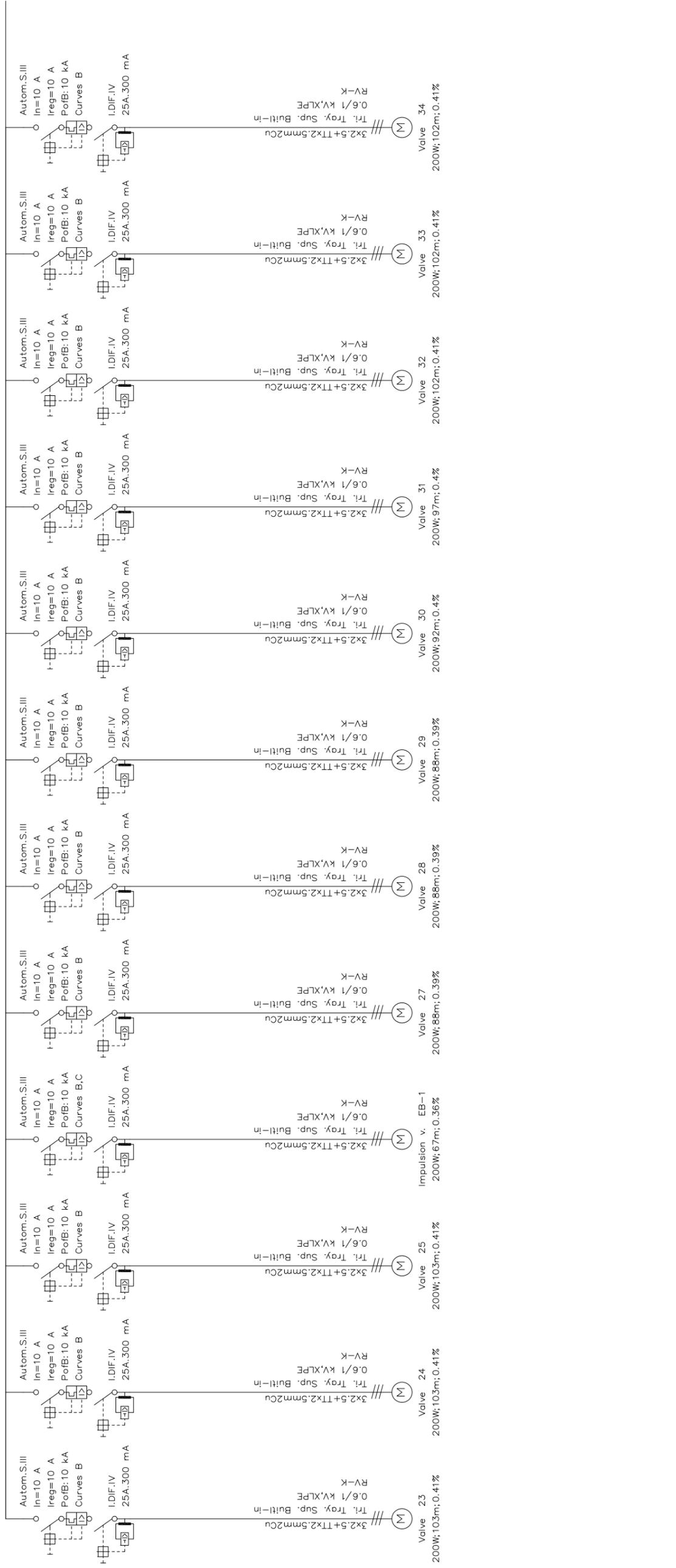
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ELECTRICAL INSTALLATION AND AUTOMATION
OF A PUMPING SUBSTATION

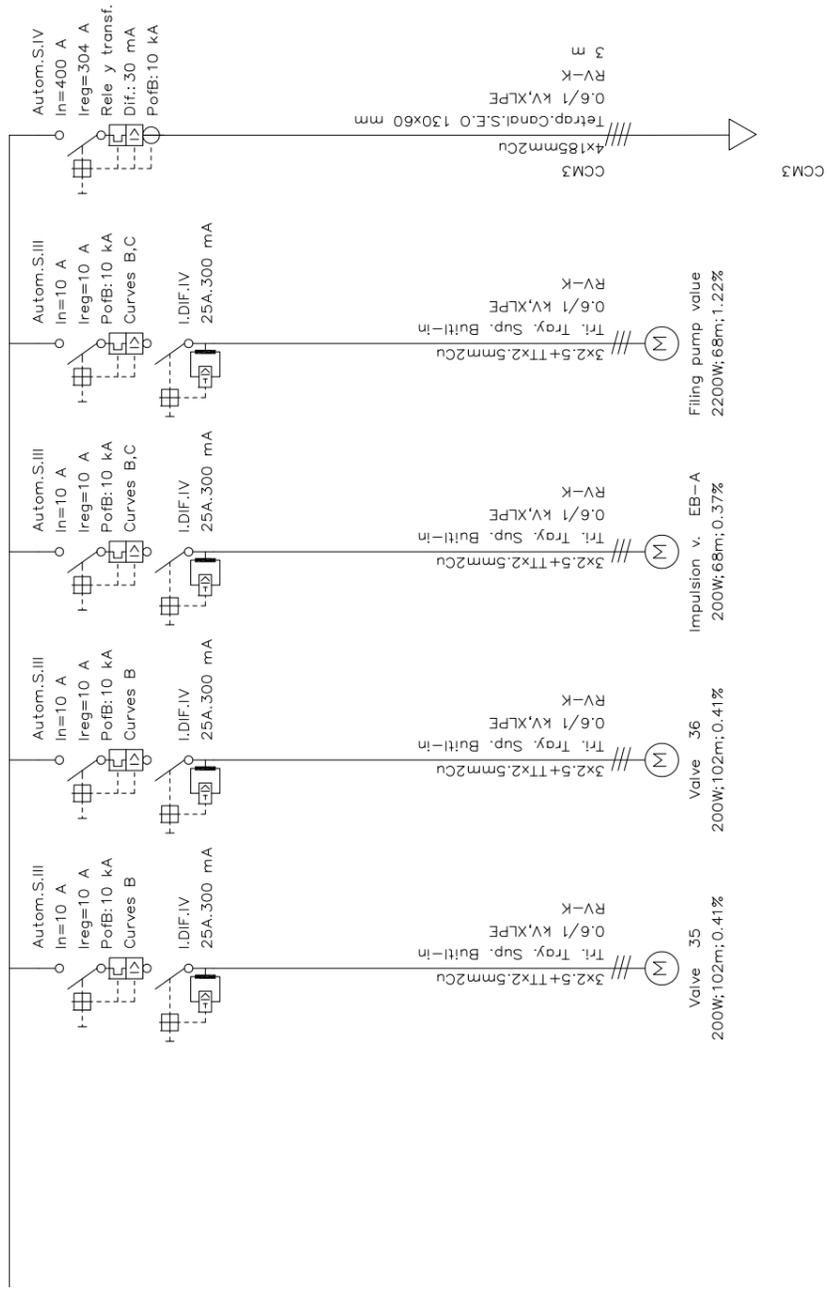
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ORIGINAL LINE A3



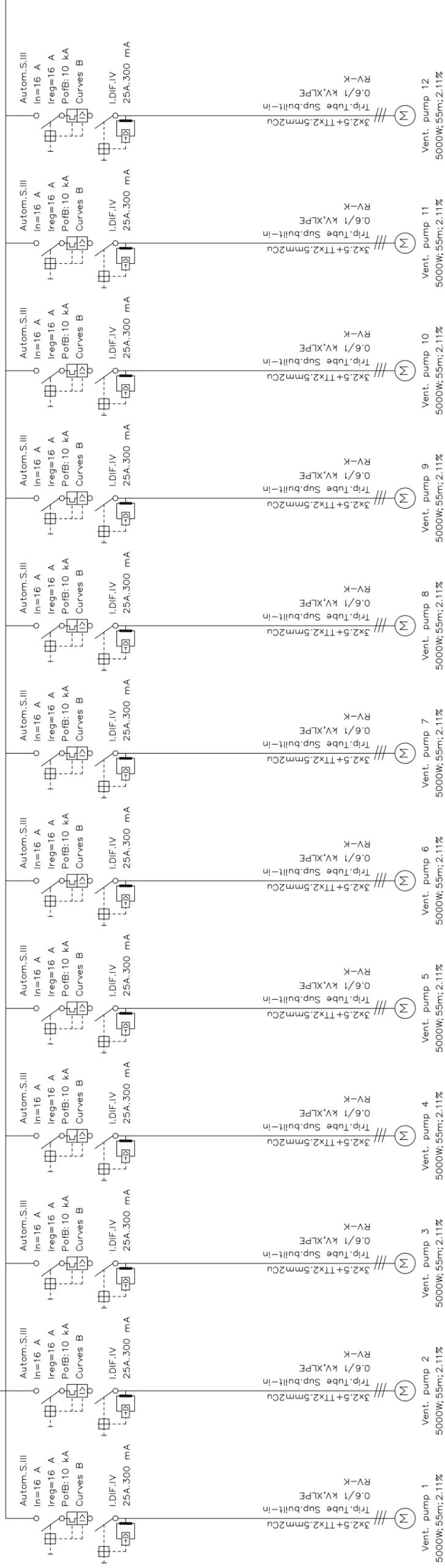
NAME OF PLAN:
PUMPING STATION
ONE-LINE DIAGRAM
CCM2

DATE: May 2016
DRAWN BY: Juan Carlos Carrasco
PLAN NUMB: 05
Page 04 of 10





CCM2



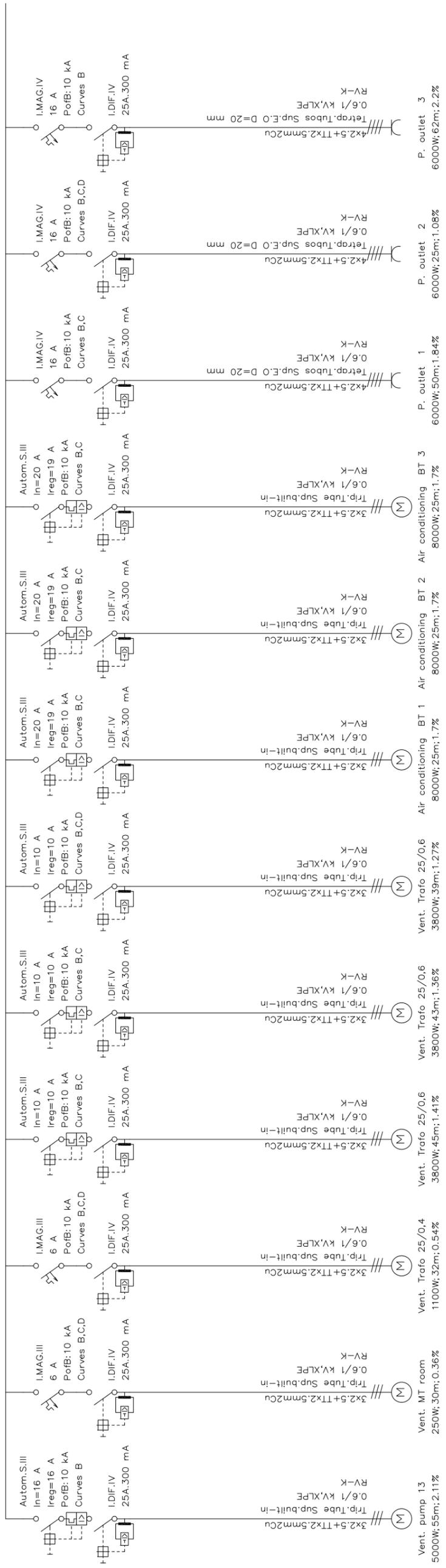
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OF A PUMPING SUBSTATION

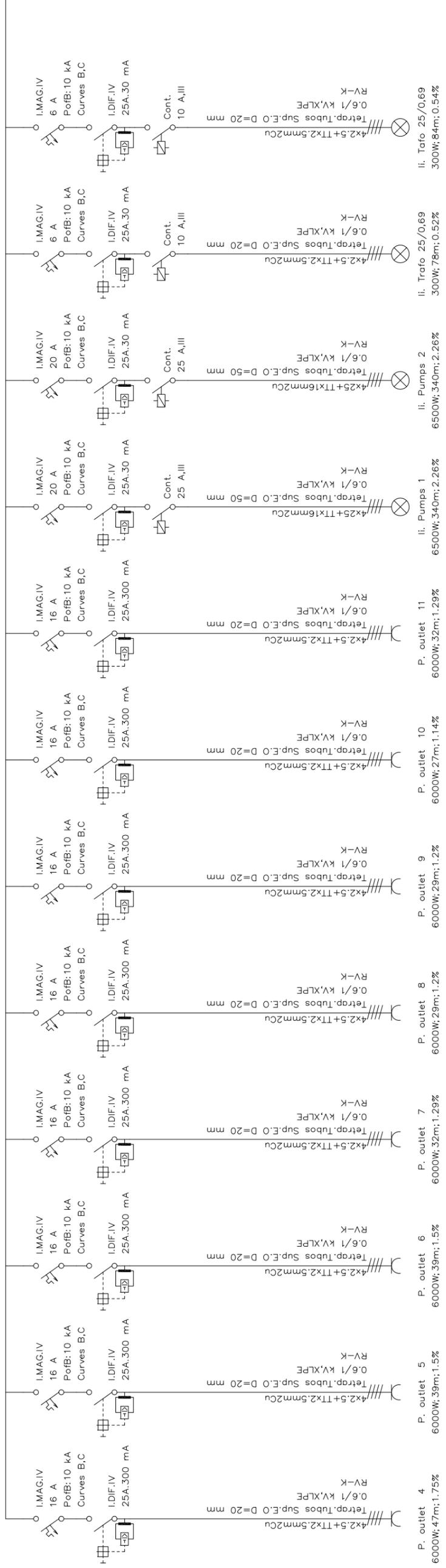
SCALE: 1/100
ORIGINAL LINE A3



NAME OF PLAN:
PUMPING STATION
ONE-LINE DIAGRAM
CCM2

DATE: May 2016
DRAWN BY: Juan Carlos Carrasco
PLAN NUMB. 05
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NAME OF PROJECT:
 ELECTRICAL INSTALLATION AND AUTOMATION
 OF A PUMPING SUBSTATION

SCALE: 1/100
 ORIGINAL LINE A3

NAME OF PLAN:
 PUMPING STATION
 ONE-LINE DIAGRAM

DATE: May 2016
 DRAWN BY: Juan Carlos Carrasco
 PLAN NUMB: 05
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