School of Industrial and

ICT Engineering

Low voltage electrical installation of a craft beer brewery with transformation center

Industrial

Engineering Degree

Final Degree Project

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Summary

The following project consists on the electrical installation of an industrial unit, destinated to craft beer brewing, with transformation center.

The different installation loads would be studied, machinery (necessary for beer elaboration) lighting (for a correct lighting in the different areas of the industrial unit) and power outlets. Once all the powers and currents have been calculated, the loads would be grouped in electrical panels, which would include their respective protections. Moreover, the conductors sections would be examined so there is an adequate supply and the necessary transformer would be chosen. Also, a capacitor bank would be selected for correcting the power factor to a unitary one. Likewise, the specification sheet, the budget and the basic health and safety study of the installation have been carried out.

The current regulations set out in the Low Voltage Electrotechnical Regulations have been followed at all times.

For the project realization the following programmes have been used:

- Autocad, for plan realization.
- DIALux, for light calculations and the choice of lighting.
- Excel, as a calculator to obtain powers, currents…
- Word, for writing the project.

The project structure is 8 well-defined documents:

- Document No.1: Report
- Document No.2: Calculations
- Document No.3: Plans
- Document No.4: Specification sheet
- Document No.5: Budget
- Document No.6: Basic health and safety study
- Document No.7: Bibliography
- Document No.8: Annexes

Key words

- Electrical installation
- Transformation center
- Craft beer brewery

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Low voltage electrical installation of a craft beer brewery with transformation center

Document No.1: Report

Javier Urdániz Viejo

June 1, 2020

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1.1. Precedent

1.1.1. Objective

The purpose of this report is to study and design the low voltage electrical installation of an industrial unit with transformation center, which has been adapted and conditioned for the establishment of a craft beer brewery.

The electrical needs based on which the installation will be projected would be studied, gathering the minimum conditions and guarantees required by current regulations, in order to obtain administrative authorization for its start-up, as well as serve as a basis when proceed to the execution of said process. Therefore, this report contains:

- Interior, exterior and emergency lighting installation.
- Power installation and power outlets distribution.
- Transformation center from medium to low voltage.
- Protections choice.
- Grounding installation.
- Improvement of the power factor by means of a capacitor bank.

1.1.2. Developer

The developer of this project is José Javier Crespo Ganuza, professor at the Public University of Navarra (UPNA).

1.1.3. Project executor

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1.2. Industrial unit description

1.2.1. Situation

The industrial unit is located in the Mutilva Baja industrial estate, 10 minutes far from the city center (by car). It is the industrial unit number 22, located on E street (smallholding 304, unit UC12MB of the NNSS of Aranguren, Navarra).

The total surface of the smallholding is 661.64 m^2 (34 meters long and 19.46 meters wide) of which 500 m^2 are destined for the industrial unit, being only useful 486m^2.

Figure 1: Industrial unit situation.

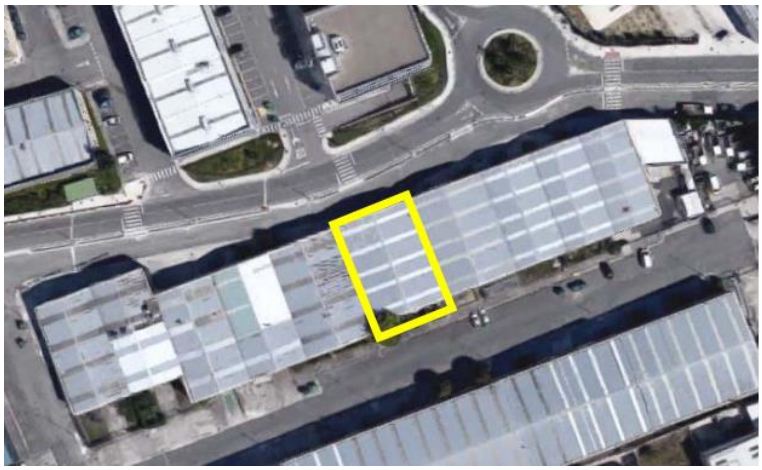

Figure 2: Industrial unit situation.

As seen in the images, the industrial unit adjoins two other units on its long sides. The entrances to it are made through its short sides, located on E and F streets. However, the first one is 3 meters below the second, respectively.

E street entrance:

Figure 3: E street entrance.

F street entrance:

Figure 4: F street entrance.

1.2.2. Industrial unit layout

The industrial unit is divided into two zones, interior zone and exterior zone. The first one would be used for beer production, while the second one would serve as parking and is where the transformation center would be located.

Indoor area

The indoor area of the industrial unit is distributed over two floors, a ground floor where the machinery, the dining room, the quality and R&D room… are located and a first floor where the office, the shop and tasting & workshops room could be found. The surface of each zone is shown in the following tables:

- Ground floor

Zone	Surface (m^2)
Production area[1]	257,26
Raw materials warehouse	28,75
Secondary materials warehouse	23,61
Stokehold	32,50
Male changing room	4,00
Female changing room	4,00
Dining room	16,98
Male WC	4,00
Female WC	4,00
Big WC	7,00
Quality and R&D room	32,24
Acclimatised room	20,00
Pallet truck	9,40

Table 1: Ground floor surfaces.

- First floor

Zone	Surface (m^2)
Tasting & workshops room	23,20
Tasting & workshops WC	4,30
Office and meeting room	24,21
Shop	37,10
Corridor	26,97

Table 2: First floor surfaces.

Outdoor area

In the outdoor area it would be placed the transformation center, necessary to transform the mains voltage to 400V (line voltage) and therefore, supply the industrial unit.

Zone	Surface (m^2)
Outdoor	161,61
TC	10,00

Table 3: Outdoor area surfaces.

1.2.3. Energy supply

The energy supply comes from Iberdrola Distribución Eléctrica S.A. to the transformer through a medium voltage underground connection (13.2 kV) and a frequency of 50 Hz. The main requirements of this supply are:

- Three – phase AC
- Frequency: 50 Hz.

[1] The production area includes the hall (product loading and unloading area) and the machinery area.

- Service voltage of 13,2 kV.

1.3. Regulations

The regulations that regulate the following installation are:

- Royal Decree 842/2002, of August 2, which approves the Low Voltage Electrotechnical Regulation.
- Technological Building Rules "TBR", sections "Electrical Installations", "Transformation Centers" and "Grounding".
- Royal Decree 337/2014, of May 9, which approves the regulation on technical conditions and safety guarantees in high voltage electrical installations and its complementary technical instructions “ITCRAT 01 to 23 “(BOE 09.06.14).
- Royal Decree 2267/2004, of December 3, which approves the regulation of fire safety in industrial establishments.
- UNE regulations.
- Municipal ordinances, corresponding to the location of the TC.
- Royal Decree 830/1991, of May 24, which modifies the Machine Safety Regulation.

1.4. Distribution scheme

In order to determine the characteristics of the protection measures against electric shocks, when defect (indirect contacts), and against overcurrents, it would be necessary to take into account the distribution scheme used. Moreover, for determining the specifications of the devices responsible of such functions, it would also be important to consider the scheme. Distribution schemes are established based on the ground connections of the distribution grid and the masses of the receiving installation.

The denomination is made with a letter code:

- First letter: refers to the situation of the power supply with respect to ground.
  - T: Direct connection of a point of the power supply to ground.
  - I: Isolation of all active parts of the power supply with respect to ground or connection of a point to ground through an impedance.
- Second letter: Refers to the situation of the masses of the receiving installation with respect to ground.
  - T: Masses connected directly to ground, regardless the eventual grounding of the power supply.
  - N: Masses connected directly to the grounded point of the power supply (in AC, this point is normally the neutral point).

- Other letters: They refer to the relative situation of the neutral conductor and the protective conductor.
    - S: The neutral and protection functions, ensured by separated conductors.
    - C: The neutral and protection functions, combined in a single conductor (CPN conductor).

1.4.1. Scheme types

1.4.1.1. TN scheme

These diagrams have a power supply point, generally neutral, directly grounded and the masses of the receiving installation connected to that point. Furthermore, in these schemes any phase to mass dead fault current is a short-circuit current. The defect would be constituted exclusively by metallic conductive elements.

It is possible to differentiate three different schemes due to the situation of the neutral and protective conductors:

1. TN-S scheme: The neutral conductor and the protective conductor are different at any point of the scheme:

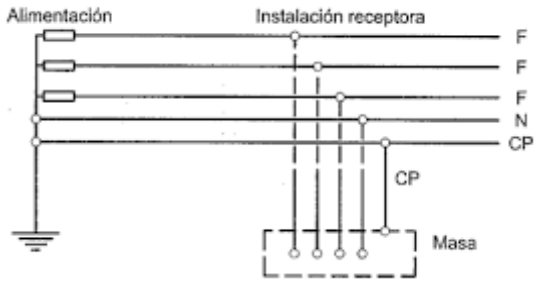

Figure 5: TN-S scheme.

2. TN-C scheme: The neutral and protection functions are combined in a single conductor all along the scheme:

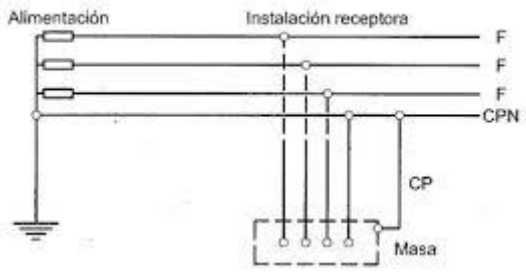

Figure 6: TN-C scheme.

3. TN-C-S scheme: The neutral and protection functions are combined in a single conductor in one part of the scheme:

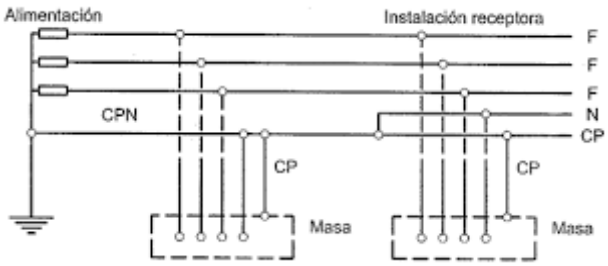

Figure 7: TN-C-S scheme.

1.4.1.2. TT scheme

In this type of scheme there is a power supply point, usually the neutral or compensator, directly grounded. The masses of the receiving installation are connected to a different grounding than the power supply one. In addition, the phase to mass or phase to ground fault currents may have lower values than the short-circuit ones, but they may be sufficient to cause the appearance of dangerous voltages.

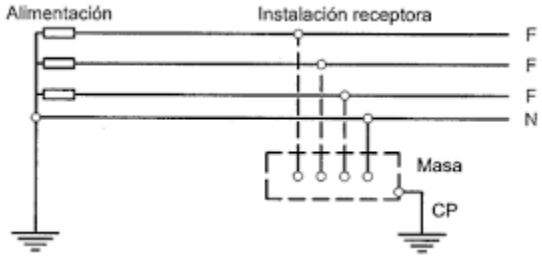

Figure 8: TT scheme.

1.4.1.3. IT scheme

This type of scheme does not have any power supply point directly connected to ground. The masses of the receiving installation are directly grounded. Furthermore, the intensity resulting from a first phase to mass or phase to ground fault has a value low enough for not causing the appearance of dangerous contact voltages.

The current limitation resulting from a first phase to mass or phase to ground fault is obtained either by the absence of a ground connection in the power supply, or by the insertion of a sufficient impedance between a point in the power supply and ground.

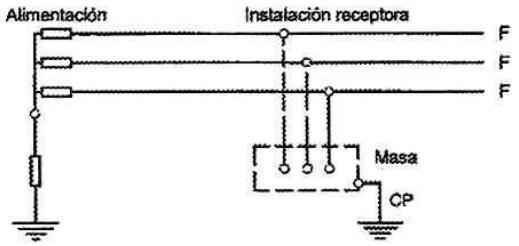

Figure 9: IT scheme.

1.4.2. Scheme application

The choice of the distribution scheme must be made according to the technical and economical characteristics of each installation, however, it is important to take into account the following principles:

- Low voltage public distribution grids have a point directly grounded by regulatory prescription, this point corresponds to the neutral. The distribution scheme for receiving installations supplied directly from a public low-voltage distribution grid is the TT scheme.

- In low voltage installations supplied from a residential transformation center, any of the three schemes can be chosen.

- An IT scheme can be established in part or parts of an installation supplied directly from a public distribution grid by using suitable transformers.

1.4.3. Solution adopted

The distribution scheme chosen to supply the different receivers of the industrial unit is the TT scheme. The reason for this decision is due to the advantages of this scheme in maintenance terms and future extensions.

1.5. Industrial unit lighting

Lighting is one of the most important factors of any facility in which a work activity is carried out. Poor lighting can cause errors in the development of the activity (brewing in this case), for example a deficient quality control, and occupational accidents. This is why good lighting is essential at all times. Lighting is adequate if the work activity can be carried out without visual effort and with the greatest possible comfort and safety.

Note: For a better understanding of the lighting installation, it is recommended to consult the following plans in the document **Plans**:

- Plan 5: Ground floor lighting distribution.
- Plan 6: First floor lighting distribution.
- Plan 7: Ground floor emergency lighting distribution.
- Plan 8: First floor emergency lighting distribution.
- Plan 12: T.C. elements distribution
- Plan 25: A.P. multiple line power diagram
- Plan 26: A.P. multiple line control diagram
- Plan 28: A.E.P. multiple line power diagram
- Plan 29: A.E.P. multiple line control diagram

1.5.1. Interior & exterior lighting

1.5.1.1. Average illuminance

When choosing the type and quantity of luminaires for a zone of the industrial unit, it is important to know the average illuminance required, since, depending on the activity carried out, this level must be higher or lower. To know the minimum values of average illuminance in each zone, it is necessary to go to the UNE-12464.1 standard. The following table shows these values:

Zone	Surface (m^2)	Average illuminance, E_m (Lux)
Production area	257,26	300
Raw materials warehouse	28,75	200
Secondary materials warehouse	23,61	200
Stokehold	32,50	100
Male changing room	4,00	200
Female changing room	4,00	200
Dining room	16,98	200
Male WC	4,00	200
Female WC	4,00	200
Big WC	7,00	200
Quality and R&D room	32,24	1000
Acclimatised room	20,00	300
Tasting & workshops room	23,20	500
Tasting & workshops WC	4,30	200
Office and meeting room	24,21	500
Shop	37,10	500
Corridor[2]	26,97	150
Pallet truck	9,40	100
TC	10,00	150
Outdoors	161,64	20

Table 4: Average illuminance per zone.

1.5.1.2. Types of lamps

1. Incandescent lamps

   These lamps emit light by incandescence, produced by the heat emitted when passing an electric current through a conductive material filament. The filament is made of Tungsten, since it has a high melting point, a key characteristic in this kind of lamps. These lamps were very popular for home use until the arrival of LED lamps.

   Their main drawback is their poor lighting efficiency, since a great part of the energy is transformed into heat.

[2] The corridor of the first floor is followed by stairs. In order to homogenize the illuminance in this area, the minimum average illuminance for the stairs (150 Lux) is used, as it is greater than the corridors one (100Lux).

2. Discharge lamps

   Different types can be distinguished:

   - Fluorescent lamps: The operating principle is based on low pressurized mercury vapor, which, by effect of an electric shock, is responsible for emitting ultraviolet light that is transformed into visible light. This type of lamps cannot be connected directly to the mains, they need a device called ballast (disadvantage), however, they have a very good lighting efficiency and a very long service life.

   - Low pressure sodium vapor lamps: This is a type of discharge luminaire whose operating principle is produced through low pressurized sodium. This type of luminaires has the disadvantage of sensitivity to substations.

3. LED lamps

   The operating principle lies in a light-emitting diode. LEDs emit light by electroluminescence, a phenomenon in which a material emits light in photons form when an electric current is passed through it due the change in energy level of electrons while moving through a semiconductor material.

   The main characteristic of these lamps is their good efficiency, which, added to their great durability, is replacing other lamps. The main disadvantage is the initial outlay, however, it ends up being amortized by the low energy expense.

1.5.1.3. Solution adopted

DIALux program has been used to perform these calculations and obtain the desired illumination levels in each zone. This program calculates the luminaires arrangement after entering the following parameters:

- Lamp type
- Dimensions of the area
- Lamp height
- Desired illumination level

When selecting lamps, the following factors have been taken into account:

- Consumption
- Luminous flux
- Price

The result obtained is:

Zone	Lamp model	Power (W)	PF	Quantity	P_{Rated} (W)
Production area	BY480P LED170S/840 PSD WB GC SI	120,00	0,90	9	1080
Raw materials warehouse					
Secondary materials warehouse	BY121P G4 LED200S/865 PSU WB	138,00	0,90	1	138
Stoke hold	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	3	70,5
Male changing room	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	23,6
Female changing room	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	23,6
Dining room	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	3	70,5
Male WC	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	23,6
Female WC	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	23,6
Big WC	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	3	35,4
Quality and R&D room	BY121P G4 LED200S/865 PSU WB	138,00	0,90	3	414
Acclimatised room	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	3	70,5
Tasting & workshops room	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	5	117,5
Tasting & workshops WC	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	23,6
Office & meeting room	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	6	141
Shop	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	10	235
Corridors	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	3	70,5
Pallet truck	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	1	23,5
T.C.	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	23,6
Outdoors	AOK-OT-200W-T4	200,00	0,90	6	1200
TOTAL					3808

Table 5: Luminaires results per zone.

In order to minimize power consumption while maintaining good lighting levels, all the lamps used are LED type. The lighting connection would vary according to the area, being three-phase in the production area, outside and in the raw materials warehouse, and single-phase in the other areas.

All the luminaires used indoors are Philips, while the exterior ones are AOK. These two manufacturers have been chosen due to their high reliability, good performance and good quality / price ratio.

Due walls absence between the production area and the raw materials warehouse, it has been decided to unify the areas using the most restrictive average illuminance.

In the production area and in the warehouses (raw materials and secondary materials) the luminaires would be suspended from the ceiling at a height of 5.5 meters from the ground. The rest of the luminaires would be attached to the ceiling of the corresponding area.

Regarding the on and off controls, different devices would be used depending on the connection. In the indoor three-phase lighting areas, contactors would be used to control the lamps, having 12 on and 12 off buttons, so that each two pairs of buttons control one area of the lighting. Therefore, it is able to illuminate the front part of the production area, the middle part or the rear from two different sides of the industrial unit. On the other hand, single-phase zones would be controlled by simple or toggle switches, depending on the zone. Finally, the exterior lighting would be, like the three-phase interior lighting, controlled by contactors. These luminaires are automated by means of an astronomical clock, however, they also have start and stop buttons to facilitate maintenance and to check at any time if any lamp has burned out.

Note: The calculations for obtaining the number of lamps required, as well as other factors taken into account when placing the lighting, are described in the document **Calculations**.

1.5.2. Emergency lighting

According to ITC-BT-28, the purpose of emergency lighting installations is to ensure, in case of failure of the general lighting, the evacuation in a satisfactory way and to avoid panic in lack of light moments.

In addition, at the points where fire protection equipment, that requires manual use, is located, the lighting will be at least 5 Lux.

These luminaires are classified as follows:

- According the power supply
    - Autonomous devices: Emergency luminaire, permanent or non-permanent, in which all the elements necessary for its operation are contained inside the luminaire or less than a meter from it.
    - Central source powered luminaire: A permanent or non-permanent, emergency luminaire that is powered from a central emergency power system.
- According its use:
    - Permanent: These luminaires are always on and in case of a power cut, they have a mechanism that prevents them from turning off.
    - Non-permanent: These luminaires start working only when the power supply for the general lighting has a problem, when the rated voltage value is interrupted or falls below 70%.
    - Combined: These luminaires contain two or more lamps, of which at least one is supplied by the emergency lighting supply and the others by the same power supply than normal luminaires.

The solution adopted is autonomous, non-permanent, battery-powered luminaires. After comparing many manufacturers, it has been decided to use Luxiona emergency lighting, due to its high reliability, good quality / price ratio and good performance. Within the catalogue, the model PT-300C Plat has been chosen. In this way the result obtained is:

Zone	Lamp model	Power (W)	PF	Quantity	P_{Rated} (W)
Production area	Luxiona PT-300C Plat	12	0,90	16	192,00
Raw materials warehouse					
Secondary materials warehouse	Luxiona PT-300C Plat	12	0,90	1	12,00
Stoke hold	Luxiona PT-300C Plat	12	0,90	1	12,00
Male changing room	Luxiona PT-300C Plat	12	0,90	1	12,00
Female changing room	Luxiona PT-300C Plat	12	0,90	1	12,00
Dining room	Luxiona PT-300C Plat	12	0,90	1	12,00
Male WC	Luxiona PT-300C Plat	12	0,90	1	12,00
Female WC	Luxiona PT-300C Plat	12	0,90	1	12,00
Big WC	Luxiona PT-300C Plat	12	0,90	1	12,00
Qualty and R&D room	Luxiona PT-300C Plat	12	0,90	2	24,00
Acclimatised room	Luxiona PT-300C Plat	12	0,90	1	12,00
Tasting & workshops room	Luxiona PT-300C Plat	12	0,90	1	12,00
Tasting & workshops WC	Luxiona PT-300C Plat	12	0,90	1	12,00
Office & meeting room	Luxiona PT-300C Plat	12	0,90	1	12,00
Shop	Luxiona PT-300C Plat	12	0,90	2	24,00
Corridors	Luxiona PT-300C Plat	12	0,90	4	48,00
Pallet truck	Luxiona PT-300C Plat	12	0,90	1	12,00
T.C.	Luxiona PT-300C Plat	12	0,90	1	12,00
TOTAL					456,00

Table 6: Emergency luminaires results per zone.

In the production area and warehouses (raw materials and secondary materials) the luminaires suspended from the ceiling would be 5.5 meters high and those attached to the wall would be 2.5 meters high (above the ground). In the rest of the areas, the luminaires would be placed above the doors at a height of 2.3 meters above the ground.

Note: The calculations for obtaining the number of lamps required, as well as other factors taken into account when placing the lighting, are described in the document **Calculations**.

1.6. Loads

The loads of the installation can be divided in three groups: Motors (machinery), lighting and power outlets. These receivers must meet certain requirements in accordance with a correct installation, use and safety. Moreover, during their operation they must not cause disturbances in the mains.

1.6.1. Motors

According to ITC_BT_47 (Low Voltage Technical Regulation, in its Instruction 47) in order to avoid installation problems, such as overtemperatures in the connection conductors, the power of the electric motors would be increased as follows:

$$P = 1{,}25 \cdot P_{Motor}$$

Therefore, the total calculation power would be the rated power of each motor plus a 25% increase. These values are shown in the following table:

Water cooler	Manufacturer	Model	P_{Rated} (W)	$P_{Calculation}$ (W)	S_{Rated} (VA)	$S_{Calculation}$ (VA)
Malt mill	Czech Brewery System	MM-283 EWR	2200	2750	2588	3235
Screw conveyor	Czech Brewery System	SCR-40	1400	1750	1647	2059
Wort brew machine	Czech Brewery System	Brewox tritank 1000	6000	7500	7059	8824
Fermentation tanks	Czech Brewery System	CCT-1000CSQ	6400	8000	7529	9412
Bottler	Czech Brewery System	BFSA4-250	370	462,5	425	532
Bottle labeling machine	Czech Brewery System	BLM-BM1202	200	250	230	287
Hot water tank	Czech Brewery System	HWT-1000	2200	2750	2529	3161
Steam generator	Czech Brewery System	EWG-120	50000	62500	57471	71839
Water cooler	Czech Brewery System	GCU-25	2300	2875	2556	3194
Air compressor	Czech Brewery System	ACO-2M	370	462,5	411	514
Air conditioning	Riello	AARIA ECO AMK 35P	1100	1375	1222	1528
CIP station	Czech Brewery System	CIP-51	4250	5312,5	4722	5903
TOTAL			76790	95988	88390	110487

Table 7: Machinery power.

Machine	Manufacturer	Model	PF	Voltage (V)	I_{Rated} (A)	$I_{Calculation}$ (A)
Malt mill	Czech Brewery System	MM-283 EWR	0,85	400	3,18	3,97
Screw conveyor	Czech Brewery System	SCR-40	0,85	400	2,02	2,53
Wort brew machine	Czech Brewery System	Brewox tritank 1000	0,85	400	8,66	10,83
Fermentation tanks	Czech Brewery System	CCT-1000CSQ	0,85	400	9,24	11,55
Bottler	Czech Brewery System	BFSA4-250	0,87	400	0,53	0,67
Bottle labeling machine	Czech Brewery System	BLM-BM1202	0,87	400	0,29	0,36
Hot water tank	Czech Brewery System	HWT-1000	0,87	400	3,18	3,97
Steam generator	Czech Brewery System	EWG-120	0,87	400	72,17	90,21
Water cooler	Czech Brewery System	GCU-25	0,90	400	3,32	4,15
Air compressor	Czech Brewery System	ACO-2M	0,90	400	0,53	0,67
Air conditioning	Riello	AARIA ECO AMK 35P	0,90	400	1,59	1,98
CIP station	Czech Brewery System	CIP-51	0,90	400	6,13	7,67
TOTAL					110,84	138,55

Table 8: Machinery electric currents

1.6.2. Lighting

As previously mentioned, the lamps used are all LED, so no power increase would be necessary. The following table shows the values of voltage, power and current in the different areas:

Zone	Voltage (V)	PF	P_{Rated} (W)	I_{Rated} (A)	S_{Rated} (VA)
Three-phase interior lighting	400	0,9	1080,0	1,56	1200
Single-phase interior lighting	230	0,9	1504,4	6,54	1672
Exterior lighting	230	0,9	1200,0	1,73	1333
Emergency lighting	230	0,9	456,0	1,98	507
T.C.	230	0,9	23,6	0,10	26
TOTAL			4264,0	11,9	4738

Table 9: Emergency lighting powers and currents.

1.6.3. Power outlets

In this section would be proceeded the dimensioning of the power outlets destined to elements different than machinery. The installation would have single-phase (16A at 230V) and three-phase (32A at 400V) outlets.

The distribution of these power outlets would be carried out in 4-outlet power strips at 400V for three-phase outlets, while single-phase outlets would be distributed individually or in 2 or 3-outlet power strips at 230V.

Due to the fact that the loads connected to these power outlets are not going to be, in general, of great power (monitors, computers ...), simultaneity and utilization factors have been used to approximate the power value to a more real one. In this way, the obtained results are:

Zone	16 A outlets	32 A outlets	Cs	Cu	FP
Production area 1F	9	0	0,3	0,2	0,9
Production area 3F	0	8	0,3	0,2	0,9
Ground floor	21	0	0,3	0,3	0,9
First floor	21	0	0,3	0,5	0,9
T.C.	2	0	0,3	0,2	0,9
TOTAL	53	8	-	-	-

Table 10: Power outlets parameters.

Zone	I_{Rated} (A)	$I_{Calculation}$ (A)	P_{Rated} (W)	$P_{Calculation}$ (W)	S_{Rated} (VA)	$S_{Calculation}$ (VA)
Production area 1F	8,64	10,80	1987	2484	2208	2760
Production area 3F	8,87	11,09	6144	7680	6827	8533
Ground floor	8,87	11,09	6955	8694	7728	9660
First floor	30,24	37,80	11592	14490	12880	16100
T.C.	50,40	63,00	442	552	491	613
TOTAL	107,02	133,77	27120	33900	30133	37667

Table 11: Power outlets powers and currents.

The single-phase power outlets are distributed as follows:

Zone	Number of outlets
Production area	9
Stoke hold	4
Male changing room	1
Female changing room	1
Dining room	4
Male WC	1
Female WC	1
Big WC	1
Qualtiy and R&D room	6
Acclimatised room	2
Tasting & workshops room	6
Tasting & workshops WC	1
Office & meeting room	8
Shop	6
T.C.	2
TOTAL	53

Table 12: Single-phase power outlets distribution

In the production area the power outlets would have a height of 1.6 meters above the ground and would be grouped in a special box according to ITC-BT-27. On the other

hand, the rest of the power outlets would be fixed to the wall at a height of 35 centimetres above the ground.

Note: For a better understanding of the distribution of the electrical outlets, it is recommended to consult the following plans in the document **Plans**:

- Plan 9: Ground floor power outlets distribution.
- Plan 10: First floor power outlet distribution
- Plan 12: T.C. elements distribution
- Plan 23: S.P.3. single line diagram
- Plan 24: A.P. single line diagram

1.7. Low voltage distribution

Once all the receivers have been dimensioned, the installation is distributed, always trying to do it as equitably as possible. In this point, all the necessary electrical installations used is treated, from the connection point of the low voltage panel to the receiving elements. This distribution is carried out using two elements:

- Electrical panels
- Conductors

It should be noted that the electrical distribution would be carried out in three-phase AC 400/230 V, since, as indicated in the Low Voltage Electrotechnical Regulations, standard voltages must be used.

1.7.1. Electrical panels

The electrical panels are the devices where the command and protection equipment of the installation must be installed, in addition, the receivers must be branched so, in case of failure of one of them, only a limited sector is affected and not the entire installation.

Likewise, all the panels would have corresponding locks so their manipulation by any person external to the maintenance personnel is prevented. Regarding the location, the panels would be located at a height of 1.5 meters above the ground.

Therefore, the distribution is as follows:

First of all, a three-phase grid with neutral comes out of the transformer, which is taken to the low voltage panel (L.V.P.), which, in turn, supply two different panels, the general distribution panel (G.D.P) and the transformation center auxiliary panel (T.C.A.P).

L.V.P.							
Line	Element	Voltage (V)	PF	P_{Rated} (W)	$P_{Calculation}$ (W)	I_{Rated} (A)	$I_{Calculation}$ (A)
A	G.D.P.	400	1,00	107734	133601	220,87	273,12
B	T.C.A.P.	230	1,00	477	588	2,08	2,56
TOTAL				108211	134189	222,95	275,68

Table 13: Low voltage panel powers & currents.

To the general distribution panel (G.D.P.) the three phases and the neutral are taken, and to the transformation center auxiliary panel (T.C.A.P.), one phase and the neutral (single-phase panel) are taken. From the G.D.P. The 3 phases would supply the secondary panels 1 and 2 (motor panels in which the neutral is not necessary) and the capacitor bank (connected in triangle), in addition, on the other hand, the secondary panel 3 would be supplied with the 3 phases and the neutral. The G.D.P. would be installed inside the industrial unit, located in a service area not accessible to the public. The T.C.A.P. would only supply the lighting (single-phase and emergency) of the transformation center and 2 power outlets. It would be located in the transformer house.

T.C.A.P.							
Line	Element	Voltage (V)	PF	P_{Rated} (W)	$P_{Calculation}$ (W)	I_{Rated} (A)	$I_{Calculation}$ (A)
B.1.	Single-phase lighting	230	1,00	24	24	0,10	0,10
B.2.	Emergency lighting	230	1,00	12	12	0,06	0,06
B.3.	Power outlets	230	1,00	442	552	1,92	2,40
TOTAL				477	588	2,08	2,56

Table 14: Transformation center auxiliary panel powers & currents.

G.D.P.							
Line	Element	Voltage (V)	PF	P_{Rated} (W)	$P_{Calculation}$ (W)	I_{Rated} (A)	$I_{Calculation}$ (A)
A.1.	Secondary panel 1	400	1,00	50000	62500	72,17	90,21
A.2.	Secondary panel 2	400	1,00	26790	33488	38,67	48,34
A.3.	Secondary panel 3	400	1,00	30944	37613	110,03	134,57
A.4.	Capacitors bank	400				105,53	105,53
TOTAL				107734	133601	220,87	273,12

Table 15: General distribution panel powers & currents.

The secondary panels must be installed, like the G.D.P., in places not accessible to the public. In addition, they must be separated from areas with fire hazard by fire-resistant elements such as RF doors. The distribution of receivers in the different tables has been carried out as follows:

S.P.1.							
Line	Element	Voltage (V)	PF	P_{Rated} (W)	$P_{Calculation}$ (W)	I_{Rated} (A)	$I_{Calculation}$ (A)
A.1.1.	Steam generator	400	1,00	50000	62500	72,17	90,21
TOTAL				50000	62500	72,17	90,21

Table 16: Secondary panel 1 powers & currents.

S.P.2.							
Line	Element	Voltage (V)	PF	P_{Rated} (W)	$P_{Calculation}$ (W)	I_{Rated} (A)	$I_{Calculation}$ (A)
A.2.1.	Malt mill	400	1,00	2200	2750	3,18	3,97
A.2.2.	Screw conveyor	400	1,00	1400	1750	2,02	2,53
A.2.3.	Wort brew machine	400	1,00	6000	7500	8,66	10,83
A.2.4.	Fermentation tanks	400	1,00	6400	8000	9,24	11,55
A.2.5.	Bottler	400	1,00	370	462,5	0,53	0,67
A.2.6.	Bottle labeling machine	400	1,00	200	250	0,29	0,36
A.2.7.	Hot water tank	400	1,00	2200	2750	3,18	3,97
A.2.8.	Water cooler	400	1,00	2300	2875	3,32	4,15
A.2.9.	Air compressor	400	1,00	370	462,5	0,53	0,67
A.2.10.	Air conditioning	400	1,00	1100	1375	1,59	1,98
A.2.11.	CIP station	400	1,00	4250	5312,5	6,13	7,67
TOTAL				26790	33488	38,67	48,34

Table 17: Secondary panel 2 powers & currents.

S.P.3.							
Line	Element	Voltage (V)	PF	P_{Rated} (W)	$P_{Calculation}$ (W)	I_{Rated} (A)	$I_{Calculation}$ (A)
A.3.1.	Single-phase lighting	230	1,00	1504	1504	6,54	6,54
A.3.2.	Emergency lighting	230	1,00	456	456	1,98	1,98
A.3.3.	Ground floor power outlets	230	1,00	6955,2	8694	30,24	37,80
A.3.4.	First floor power outlets	230	1,00	11592	14490	50,40	63,00
A.3.5.	Auxiliary panel	400	1,00	9211	11244	19,07	23,44
A.3.6.	Auxiliary exterior panel	400	1,00	1225	1225	1,80	1,80
TOTAL				30944	37613	110,03	134,57

Table 18: Secondary panel 3 powers & currents.

This way, the machine that most power demands (steam generator), and therefore most current, is separated from the rest of machines, lighting and power outlets. This has been done since, in case of failure in that machine, for an overcurrent for example, the rest of the machinery can continue working and the industrial unit does not stay without lighting. It is observed as S.P.3., in turn, supplies to two auxiliary panels, the auxiliary panel (A.P.) and the auxiliary exterior panel (A.E.P.).

A.P.							
Line	Element	Voltage (V)	PF	P_{Rated} (W)	$P_{Calculation}$ (W)	I_{Rated} (A)	$I_{Calculation}$ (A)
A.3.5.1.	Three-phase lighting 1	400	1,00	360	360	0,52	0,52
A.3.5.2.	Three-phase lighting 2	400	1,00	360	360	0,52	0,52
A. 3.5.3.	Three-phase lighting 3	400	1,00	360	360	0,52	0,52
A.3.5.4.	Single-phase power outlets (PA)	230	1,00	1987	2484	8,64	10,80
A.3.5.5.	Three-phase power outlets (PA)	400	1,00	6144	7680	8,87	11,09
TOTAL				9211	11244	19,07	23,44

Table 19: Auxiliary panel powers & currents.

A.E.P.							
Line	Element	Voltage (V)	PF	P_{Rated} (W)	$P_{Calculation}$ (W)	I_{Rated} (A)	$I_{Calculation}$ (A)
A.3.6.1.	Three-phase exterior lighting	400	1,00	1200	1200	1,73	1,73
A.3.6.2.	Exterior lighting control	24	1,00	25	25	0,07	0,07
TOTAL				1225	1225	1,80	1,80

Table 20: Auxiliary exterior panel powers & currents.

Finally, it should be noted that due to the installation of a capacitor bank (which would be explained in detail later) it would be possible to obtain a unitary power factor.

Note: For a better understanding of the location of the electric panels in the industrial unit, it is recommended to consult the following plans in the document **Plans:**

- Plan 13: Electric panels distribution
- Plan 18: L.V.P. single line diagram
- Plan 19: T.C.A.P. single line diagram
- Plan 20: G.D.P. single line diagram
- Plan 21: S.P.1. single line diagram
- Plan 22: S.P.2. single line diagram
- Plan 23: S.P.3. single line diagram
- Plan 24: A.P. single line diagram
- Plan 27: A.E.P. single line diagram

1.7.2. Conductors

The conductors are the elements in charge of distributing the electricity to the different receivers, it could be from panel to load (machine, lighting or power outlet) or from a panel to another panel.

These electric current conductors must be calculated in such a way that they do not suffer excessive heating (thermal limit) as well as a voltage drop outside the limits established by the Low Voltage Electrotechnical Regulations.

In this installation, it has been decided to use copper conductors, since is better conductor than aluminium, with cross-linked polystyrene insulation, XLPE. In addition, the standard colour code has been used:

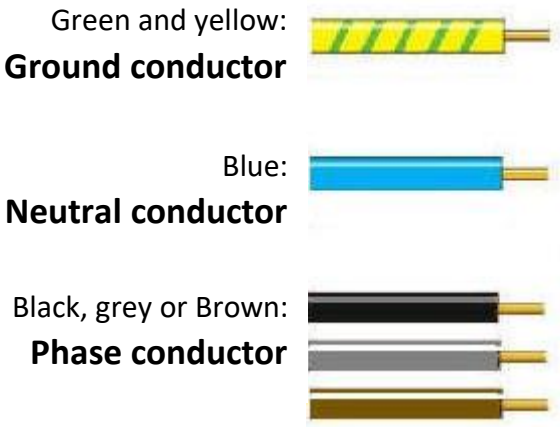

Figure 10: Conductors colour code.

Note: The conductors' section has been obtained after performing the thermal and voltage drop calculations, choosing the most restrictive section. These results can be seen in the document **Calculations**.

1.7.1.1. Protective conductor

Protective conductors serve to electrically join the masses of an installation to certain elements in order to ensure protection against indirect contacts.

These conductors section has been chosen as dictated in ITC-BT-18 of the Low Voltage Electrotechnical Regulation:

Phase conductors' section (mm^2)	Minimum section of the protective conductor (mm^2)
$S \leq 16$	S (*)
$16 < S \leq 35$	16
$S > 35$	S/2

Table 21: Protective conductor section.

In all cases, the protective conductors that are not part of the supply channelling would be of copper with a section, at least of:

- 2,5 mm^2, if the protective conductors have mechanical protection.
- 4 mm^2, if the protective conductors do not have mechanical protection

When the protection conductor is common to several circuits, its section must be dimensioned according to the largest section of the phase conductors.

1.7.1.2. Channelling system

It has been decided that the conductors of the installation are channelled through protective tubes. These tubes must fulfil, at least, the characteristics according to their installation detailed in ITC-BT-21:

- Tubes in fixed channels on the surface
    - In the superficial channels, the tubes should preferably be rigid, and, in special cases, bendable tubes may be used. These tubes must have a diameter big enough to allow easy accommodation and removal of insulated cables or conductors. Likewise, minimum diameters are provided depending on the number and section of the conductors.
- Tubes in embedded channels
    - In embedded channels, the protective tubes may be rigid, bendable or flexible. Ordinary pre-wired channels intended to be embedded in grooves made construction (walls, ceilings and false ceilings) would be flexible or bendable. The tubes must have a diameter such that they allow easy accommodation and removal of insulated cables or conductors.

- Air channelling or with tubes

  - In air channels, that supply to machines or elements with restricted mobility, the tubes would be flexible. It is recommended not to use this type of installation for rated conductor sections greater than 16 mm^2.

1.7.2. Solution adopted

Therefore, after performing the required calculations for obtaining the sections of each conductor and choosing the sections of the tubes as regulated, the following results have been obtained:

L.V.P.							
Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A	G.D.P.	240	240	120	0,09	3 x 240 + 1 x 240 + TT x 120	-
B	T.C.A.P.	1,5	1,5	4	0,13	1 x 1,5 + 1 x 1,5 + TT x 4	16

Table 22: Low voltage panel sections.

T.C.A.P.							
Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
B.1.	Single-phase lighting	1,5	1,5	4	0,01	1 x 1,5 + 1 x 1,5 + TT x 4	16
B.2.	Emergency lighting	1,5	1,5	4	0,00	1 x 1,5 + 1 x 1,5 + TT x 4	16
B.3.	Power outlets	1,5	1,5	4	0,07	1 x 1,5 + 1 x 1,5 + TT x 4	16

Table 23: T.C. auxiliary panel sections.

G.D.P.							
Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.1.	Secondary panel 1	50	-	25	0,45	3 x 50 + TT x 25	-
A.2.	Secondary panel 2	16	-	16	0,77	3 x 16 + TT x 16	-
A.3.	Secondary panel 3	70	35	35	0,22	3 x 70 + 1 x 35 + TT x 35	-
A.4.	Capacitors bank	50	-	25	0,00	3 x 50 + TT x 25	50

Table 24: General distribution panel sections.

S.P.1.							
Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.1.1.	Steam generator	25	-	16	0,36	3 x 25 + TT x 16	32

Table 25: Secondary panel 1 sections.

S.P.2.							
Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.2.1.	Malt mill	2,5	-	4	0,17	3 x 2,5 + TT x 4	16
A.2.2.	Screw conveyor	2,5	-	4	0,08	3 x 2,5 + TT x 4	16
A.2.3.	Wort brew machine	2,5	-	4	0,37	3 x 2,5 + TT x 4	16
A.2.4.	Fermentation tanks	2,5	-	4	1,07	3 x 2,5 + TT x 4	16
A.2.5.	Bottler	2,5	-	4	0,05	3 x 2,5 + TT x 4	16
A.2.6.	Bottle labeling machine	2,5	-	4	0,03	3 x 2,5 + TT x 4	16
A.2.7.	Hot water tank	2,5	-	4	0,54	3 x 2,5 + TT x 4	16
A.2.8.	Water cooler	2,5	-	4	0,60	3 x 2,5 + TT x 4	16
A.2.9.	Air compressor	2,5	-	4	0,07	3 x 2,5 + TT x 4	16
A.2.10.	Air conditioning	2,5	-	4	0,20	3 x 2,5 + TT x 4	16
A.2.11.	CIP station	2,5	-	4	0,78	3 x 2,5 + TT x 4	16

Table 26: Secondary panel 2 sections.

S.P.3.							
Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.3.1.	Single-phase lighting	2,5	2,5	4	1,87	3 x 2,5 + 1 x 2,5 + TT x 4	16
A.3.2.	Emergency lighting	2,5	2,5	4	0,59	3 x 2,5 + 1 x 2,5 + TT x 4	16
A.3.3.	Ground floor power outlets	6	6	6	3,91	3 x 6 + 1 x 6 + TT x 6	20
A.3.4.	First floor power outlets	16	16	16	1,22	3 x 16 + 1 x 16 + TT x 16	32
A.3.5.	Auxiliary panel	6	6	6	0,02	3 x 6 + 1 x 6 + TT x 6	20
A.3.6.	Auxiliary exterior panel	2,5	2,5	4	0,25	3 x 2,5 + 1 x 2,5 + TT x 4	16

Table 27: Secondary panel 3 sections.

A.P.							
Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.3.5.1.	Three-phase lighting 1	2,5	-	4	0,06	3 x 2,5 + TT x 4	16
A.3.5.2.	Three-phase lighting 2	2,5	-	4	0,05	3 x 2,5 + TT x 4	16
A. 3.5.3.	Three-phase lighting 3	2,5	-	4	0,03	3 x 2,5 + TT x 4	16
A.3.5.4.	Single-phase power outlets (PA)	2,5	2,5	4	2,41	3 x 2,5 + 1 x 2,5 + TT x 4	16
A.3.5.5.	Three-phase power outlets (PA)	2,5	2,5	4	1,06	3 x 2,5 + 1 x 2,5 + TT x 4	16

Table 28: Auxiliary panel.

A.E.P.							
Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.3.6.1.	Three-phase exterior lighting	2,5	-	4	0,28	3 x 2,5 + TT x 4	16
A.3.6.2.	Exterior lighting control	2,5	-	4	0,00	3 x 2,5 + TT x 4	16

Table 29: Auxiliary exterior panel sections.

It should be noted that since, the industrial unit has an alimentary purpose, it has been decided to use trays and tubes for conductor channelling. In this way, they would be more protected from rodents, insects ...

1.8. Protections

It would be necessary that the present installation is provided with protections against the different faults that could be caused in it, so full safety is achieved, from the point of view of the conductors and machinery and from the point of view of people. In addition, the current regulations that define how these protections should be, would be fulfilled at all times. It is contained in ITC-BT-22 (overcurrent protection), ITC-BT-23 (overvoltage protection), ITC-BT-24 (protection against direct & indirect contacts).

1.8.1. Protective elements

1.8.1.1. Circuit breakers

The circuit breaker is an electromechanical device in charge of limiting the current. This device is responsible for protecting the different receivers against overcurrents, that may cause machinery damage. In addition, it limits by two types of breaking:

- Magnetic breaking
    - It is the part intended to protect against short-circuits, intervening when the current exceeds between 3 and 20 times the rated current. It should be noted that this breaking is faster than the thermal one.

- Thermal breaking

    - It is the part destined to protect against overcurrents that are not high enough for magnetic breaking. It is formed by a bimetallic sheet that deforms by joule effect and stops the current flow.

These types of breakers are characterized by their tripping curves, which are described by the electric current value and the opening time, in an approximate way, in which the breaker would cut off the current. For the present installation, it has been decided to use C-curve circuit breakers for lighting and power outlets, and D-curve for machinery.

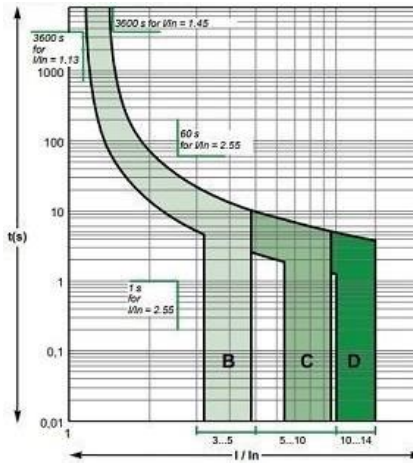

Figure 11: Example of circuit breaker curves.

The activation of these devices can be manual or automatic, however, they have a manual reset option.

1.8.1.2. Residual current device (RCD)

The residual current device is an electromechanical device in charge of protecting people from current leaks, regardless their origin, and from direct or indirect contacts. When a current leak occurs (caused by a failure in the conductors' insulation, for example), the metallic parts of the installation are subjected to voltage. If the installation does not have grounding, when a person touches a metallic element, the current would flow through it. At that moment, there is a voltage loss in the circuit, being a difference between the incoming current through the device and the return one, so the RCD opens.

This device is installed upstream, so it is very important to define its sensitivity. For the present installation, the following have been used:

- 30 mA sensitivity for lighting and power outlets.

- 300 mA sensitivity for machinery.

With the objective that, in case of failure, the device opened is the nearest one to the problem, not the upstream one, it must be ensured that the sensitivity of the upstream element is greater than the sensitivity of the downstream element.

1.8.2. Solution adopted

The circuit breakers and RCD obtained are shown below. It is important to note that for the circuit breakers, only the main of each panel has been calculated; the rest of them (observable in planes) have been obtained by considering constant the short-circuit current in each panel.

Note: The justification of the results obtained can be found in the document **Calculations**.

1.8.2.1. Main circuit breaker

The following table shows the results obtained from the calculation of the main circuit breakers:

Panel	Name	$I_{Calculation}$ (A)	$I_{Max.\ Adm.}$ (A)	Is-c (kA)	$BP_{Standarised}$	Curve	Polarity
L.V.P.	QF LVP	275,68	448,0	13,41	22	D	IV
T.C.A.P.	QF TCAP	2,56	26,0	4,04	4,5	C	II
G.D.P.	QF0	273,12	448,0	13,17	22	D	IV
S.P.1.	QF1	90,21	153,0	10,84	22	D	III
S.P.2.	QF2	48,34	84,0	5,92	6	D	III
S.P.3.	QF3	134,57	188,0	11,39	22	C	IV
A.P.	QF3.1	23,44	44,0	10,48	22	C	IV
A.E.P.	QF3.2	1,80	26,0	0,75	4,5	C	III

Table 30: Main circuit breakers summary.

1.8.2.2. Residual current device (RCD)

The adopted solution of the residual current device in each electric panel is shown below:

- Low Voltage Panel

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD LVP	275,68	1000

Table 31: Residential current device L.V.P.

- Transformation Center Auxiliary Panel

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD TCAP	2,56	30

Table 32: Residual current device T.C.A.P.

- General Distribution Panel

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 1	90,21	500
RCD 2	48,34	500
RCD 3	134,57	300
RCD 4	105,53	300

Table 33: Residual current devices G.D.P.

- Secondary Panel 1

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 1.1	90,21	300

Table 34: Residual current device S.P.1.

- Secondary Panel 2

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 2.1	13,17	300
RCD 2.2	14,74	300
RCD 2.3	8,61	300
RCD 2.4	11,82	300

Table 35: Residual current devices S.P.2.

- Secondary Panel 3

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 3.1	8,52	30
RCD 3.2	37,80	30
RCD 3.3	63,00	30
RCD 3.4	23,44	300
RCD 3.5	1,80	300

Table 36: Residual current devices S.P.3.

- Auxiliary Panel

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 3.5.1	1,56	30
RCD 3.5.2	10,80	30
RCD 3.5.3	11,09	30

Table 37: Residual current devices S.P.

- Auxiliary Exterior Panel

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 3.2.1	1,73	30
RCD 3.2.2	0,07	30

Table 38:Residual current devices A.E.P.

1.9. Grounding installation

The grounding is the union of all the metallic parts of an installation, without fuses or other protection systems, by an adequate section bare conductor, and one or more electrodes buried in the ground.

The main purpose of a grounding installation is to limit the voltage that, with respect to ground, the metallic masses could present at a given moment, ensure the action of the protections and eliminate or reduce the risk of a breakdown in the electrical materials of the installation.

Due to the industrial unit location and the type of soil (wet), the current regulations require that the maximum voltage difference between masses and ground must be 24V. In addition, as it is a building without lightning rod, the grounding resistance must be lower than 37Ω, however, in order to ensure the maximum difference of 24 V between masses and ground, it has been decided to be more restrictive by imposing a grounding resistance lower or equal than 10Ω.

Three grounding installations are distinguished, independent among them:

- Industrial unit protection installation.
- T.C. protection installation.
- Service ground installation.

Note: All the results shown in the “grounding installation” section are justified in the document **Calculations.**

1.9.1. Industrial unit grounding installation

After carrying out the pertinent calculations, it can be concluded that with the connection of a pike per electrical panel and joining them using a bare copper conductor of 35 mm^2 section, a resistance of 6.82Ω is obtained.

Note: It is recommended that for a better understanding of the installation, the following plans in the document **Plans** be consulted:

- Plan 14: Industrial unit grounding installation.

1.9.2. T.C. grounding installation

This installation would be the same as the industrial unit one, the objective is to protect the T.C. Therefore, after carrying out the pertinent calculations, it has been concluded that 4 pikes would be necessary, 2 pikes for the electrical panels and another 2 to obtain a resistance lower than 10Ω. The pikes would be connected by a 35 mm^2 section bare copper conductor. The resistance obtained is 7.69Ω.

Note: It is recommended that for a better understanding of the installation, the following plans in the document **Plans** be consulted:

- Plan 15: T.C. grounding installation

1.9.3. Service grounding installation

The service ground installation consists on connecting the neutral of the transformer to ground, in such a way, a reference to 0V is connected to the transformer (necessary for its operation).

This installation must be located 15 meters from the transformation center (on E street) and would consist of 4 joined pikes, as in the previous cases, with a 35 mm^2 section bare copper conductor. The resistance obtained is 10 Ω.

Note: It is recommended that for a better understanding of the installation, the following plans in the document **Plans** be consulted:

- Plan 15: T.C. grounding installation

1.10. Power factor compensation

Due to the phase difference between voltage and current (angle α), produced by a reactive power consumption of certain machinery, a full use of the power is not achieved. Therefore, it has been decided to install a capacitor bank that is capable of injecting reactive power. This would produce a compensation in the power factor to 1 (active power equal to apparent), and, with it, an optimization of the installation. It would be connected to the G.D.P. and would inject reactive power in stages.

In addition, power factor correction has numerous advantages:

- Cost reduction of electrical energy. Reactive power consumption is penalized by electrical companies increasing the tariffs costs.
- By not circulating reactive power, the circulation of reactive current is reduced in the same way.
- Higher quality supply, since, a low power factor produces an increase in current circulation through the lines, and, therefore, an increase on the conductors temperature.
- Increase of the installation useful life.

1.10.1. Solution adopted

The chosen capacitor bank is: 75 kVAr from Cisar (Reference: P135007540), which is capable of injecting the power in 5 electrical steps:

Step	1	2	3	4	5
Power (kVAr)	5	10	20	20	20

Table 39: Reactive power injection, Capacitor Bank.

Note: The justification for these calculations can be found in the document **Calculations**.

1.11. Transformation center

This electrical installation is responsible for receiving medium voltage energy and delivering it at low voltage for its use in the industrial unit. It is located on the outside of the industrial unit, being a specific transformer hut for this purpose. In it there are all the elements necessary to condition the supply, such as the cells (line, protection and measurement), electrical panels and the transformer.

Note: For a better understanding of the situation and connection of the transformation center, it is recommended to see the following plans in the document **Plans**:

- Plan 11: Transformation center
- Plan 12: T.C element distribution
- Plan 13: Electric panels distribution

1.11.1. Solution adopted

The transformation center used in this installation is a prefabricated transformation center from ORMAZABAL. Specifically, it is the PFU-4 model, located on E street.

The PFU-4 hut is a monoblock made of concrete plus a removable cover. Access to it is done through a lockable door located on the front, only qualified people can access to it. In the back it has a natural ventilation grille. In addition, thanks to the presence of the

transformation center auxiliary panel, it has 2 luminaires, 1 emergency luminaire and 2 single-phase power outlets.

The 13.2 kV connection is underground and at a frequency of 50 Hz by the supplier company, Iberdrola.

The medium voltage equipment used is CGMCOSMOS, also from ORMAZABAL.

In the hut there would also be the transformer, which would be in charge of conditioning the voltage for the correct operation of the installation (230 / 400V). In this case, it has been decided to use a conventional transformer from ORMAZABAL. This choice has been made based on the following points:

- Total power of the installation.
- Future extensions.
- Transformation relation 13,2/0,4 kV

Thus, the characteristics of the chosen transformer are detailed in the following images:

Características eléctricas			24 kV A_0 B_K										
Potencia asignada [kVA]			50	100	160	250	400	630	800	1000	1250	1600	2000	2500*
Tensión asignada (Ur)	Primaria [kV]		< 24											
	Secundaria en vacío [V]		420											
Grupo de Conexión			Dyn11											
Pérdidas en Vacío - P_0 [W]		Lista A_0	90	145	210	300	430	600	650	770	950	1200	1450	1750
Pérdidas en Carga - P_k [W]		Lista B_k	875	1475	2000	2750	3850	5400	7000	9000	11000	14000	18000	22000
Impedancia de Cortocircuito (%) a 75°C			4					6						
Nivel de Potencia Acústica LwA [dB]		Lista A_0	39	41	44	47	50	52	53	55	56	58	60	60
Caida de tensión a plena carga (%)		cosf=1	1,81	1,54	1,32	1,17	1,04	0,93	1,05	1,08	1,06	1,05	1,08	1,06
		cosf=0,8	3,57	3,43	3,31	3,22	3,13	3,06	4,35	4,37	4,35	4,35	4,37	4,35
Rendimiento (%)	Carga 100%	cosf=1	98,11	98,41	98,64	98,79	98,94	99,06	99,05	99,03	99,05	99,06	99,04	99,06
		cosf=0,8	97,64	98,02	98,30	98,50	98,68	98,82	98,82	98,79	98,82	98,83	98,80	98,83
	Carga 75%	cosf=1	98,47	98,72	98,90	99,02	99,14	99,24	99,24	99,23	99,24	99,25	99,23	99,25
		cosf=0,8	98,10	98,40	98,63	98,78	98,93	99,05	99,05	99,04	99,06	99,06	99,04	99,07

Figure 12: Electric characteristics of the transformer.

Dimensiones [mm]	24 kV A_0 B_K											
Arrollamientos de Aluminio												
Núcleo ferromagnético de material acero magnético de grano orientado												
Potencia asignada [kVA]	50	100	160	250	400	630	800	1000	1250	1600	2000	2500
A (Largo)	910	940	1046	1276	1426	1526	1706	1776	1996	1940	1960	2060
B (Ancho)	643	733	743	876	876	936	1046	1106	1256	1180	1160	1320
C (Alto a tapa)	759	767	873	932	1032	1133	1163	1163	1208	1540	1760	1810
D1 (Alto a MT con Porcelana MT)	1144	1152	1258	1317	1417	1518	1548	1548	1593	1925	2145	2195
D3 (Alto a MT Borna enchufable MT)	849	857	963	1022	1122	1223	1253	1253	1298	1630	1850	1900
D2 (Alto a BT con Palas)	919	927	1033	1166	1266	1394	1496	1496	1541	1910	2130	2240
F (Separación MT)	275	275	275	275	275	275	275	275	275	275	275	275
H (Separación entre BT)	80	80	80	150	150	150	150	150	150	200	200	200
J (Distancia entre ruedas)	520	520	520	670	670	670	670	670	820	820	820	1070
K (Ancho rueda)	40	40	40	40	40	40	40	40	70	70	70	70
Ø (Diámetro rueda)	125	125	125	125	125	125	125	125	200	200	200	200
L (Rueda)	110	110	110	110	110	110	110	110	165	165	165	165
Distancia entre ganchos para poste	530	530	530	–	–	–	–	–	–	–	–	–
Peso núcleo magnético (kg)	230	360	480	530	700	1000	1070	1350	1650	1850	1950	2200
Peso conductores (kg)	70	90	150	200	250	330	440	500	550	550	580	600
Peso aceite (kg)	117	126	181	255	320	375	486	495	588	833	1012	1173
Volumen Aceite (Litros)	138	148	213	300	377	441	572	582	692	980	1190	1380
Peso total (Kg)	486	572	753	1075	1389	1817	2233	2342	2826	4120	4970	5830
Otras dimensiones bajo pedido. (*) Por favor, contacte con **Ormazabal** para valores técnicos superiores a 2500 KVA o para otros modelos con características técnicas específicas.												

Figure 13: Constructive characteristics of the transformer.

1.12. Budget summary

Below it could be seen a budget summary, the breakdown of it could be seen in document No.5: **Budget**.

Chapter 1	26.602,24 €
Chapter 2	16.311,12 €
Chapter 3	8.908,20 €
Chapter 4	1.855,30 €
Chapter 5	21.713,58 €
Chapter 6	1.488,99 €
Chapter 7	1.794,75 €
Material execution budget	**78.674,18 €**
General expenses	10.227,64 €
Industrial benefits	4.720,45 €
Contract execution budget (without VAT)	**93.622,27 €**
Fees and project writing rights	11.801,13 €
Construction management team	11.801,13 €
Basic health and safety study	1.573,48 €
Total budget (without VAT)	**118.798,00 €**
VAT application (21%)	24.947,58 €
Total Budget	**143.745,59 €**

Therefore, the total budget of the installation is “ONE HUNDRED AND FORTY THREE THOUSAND SEVEN HUNDRED FORTY FIVE EUROS WITH FIFTY-NINE CENTS”.

Pamplona. June 1, 2020

Sgd. Javier Urdániz Viejo

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Low voltage electrical installation of a craft beer brewery with transformation center

Document No.2: Calculations

Javier Urdániz Viejo

June 1, 2020

INDEX

TABLE INDEX

2.1. Loads forecast

The installed machinery would suppose an important part of the total power consumption, that is the reason why it is convenient to foresee the power that they are going to consume. The following table shows the different parameters taken into account:

Machine	Manufacturer	Model	Voltage (V)	I_{Rated} (A)	P_{Rated} (W)	$P_{Calculation}$ (W)	S_{Rated} (VA)
Malt mill	Czech Brewery System	MM-283 EWR	400	3,18	2200	2750	2588
Screw conveyor	Czech Brewery System	SCR-40	400	2,02	1400	1750	1647
Wort brew machine	Czech Brewery System	Brewox tritank 1000	400	8,66	6000	7500	7059
Fermentation tanks	Czech Brewery System	CCT-1000CSQ	400	9,24	6400	8000	7529
Bottler	Czech Brewery System	BFSA4-250	400	0,53	370	462,5	425
Bottle labeling machine	Czech Brewery System	BLM-BM1202	400	0,29	200	250	230
Hot water tank	Czech Brewery System	HWT-1000	400	3,18	2200	2750	2529
Steam generator	Czech Brewery System	EWG-120	400	72,17	50000	62500	57471
Water cooler	Czech Brewery System	GCU-25	400	3,32	2300	2875	2556
Air compressor	Czech Brewery System	ACO-2M	400	0,53	370	462,5	411
Air conditioning	Riello	AARIA ECO AMK 35P	400	1,59	1100	1375	1222
CIP station	Czech Brewery System	CIP-51	400	6,13	4250	5312,5	4722
TOTAL				110,84	76790	95988	88390

Table 1: Machinery information.

These loads are treated as motors, so it is necessary to oversize 25% each machine power. Therefore, the power worked with when dimensioning the following elements (conductors, protections ...) would be the calculation power, that is, 95988W.

However, these are not the only loads of the installation, it would also be necessary to take into account the lighting and the power outlets. These elements would be calculated in the following sections, in order to obtain the total power of the installation.

2.2. Industrial unit lighting

2.2.1. Interior and exterior lighting

The calculations corresponding to the lighting have been carried out using DIALux, which calculates the illuminance level of a specific area once the lamps, their height… has been specified. These calculations could have been done by hand; however, it is more laborious, and the results obtained are less accurate. Likewise, the results obtained are the following:

Zone	E_m (LUX)	Lamp model	Power (W)	PF	Quantity	$E_{obtainesd}$ (LUX)	P_{Rated} (W)
Production area	300	BY480P LED170S/840 PSD WB GC SI	120,00	0,90	9	349	1080
Raw materials warehouse							
Secondary materials warehouse	200	BY121P G4 LED200S/865 PSU WB	138,00	0,90	1	264	138
Stoke hold	100	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	3	245	70,5
Male changing room	200	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	239	23,6
Female changing room	200	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	239	23,6
Dining room	200	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	3	434	70,5
Male WC	200	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	279	23,6
Female WC	200	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	279	23,6
Big WC	200	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	3	285	35,4
Qualtity and R&D room	1000	BY121P G4 LED200S/865 PSU WB	138,00	0,90	3	1279	414
Acclimatised room	300	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	3	397	70,5
Tasting & workshops room	500	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	5	525	117,5
Tasting & workshops WC	200	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	271	23,6
Office & meeting room	500	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	6	596	141
Shop	500	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	10	694	235
Corridors	150	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	3	217	70,5
Pallet truck	100	SM53C LED34S/940PSD PI5 L1130 ALU	23,50	0,90	1	165	23,5
T.C.	150	DN570B LED 12S/830 PSE-E C WH	11,80	0,90	2	195	23,6
Exterior	20	AOK-OT-200W-T4	200,00	0,90	6	81	1200
TOTAL							3808

Table 2: Luminaires results per zone.

2.2.2. Emergency lighting

As with interior and exterior lighting, DIALux has been used with emergency lighting to determine the number of luminaires required. These luminaires would be placed above the doors of each room. In the production area and primary materials warehouse, they would be suspended from the ceiling and attached to the wall. This way, at least between 2 and 5 Lux are achieved.

Zone	Lamp model	Flux (Lumen)	Power (W)	PF	Quantity	P_{Rated} (W)
Production area	Luxiona PT-300C Plat	290	12	0,90	16	192,00
Raw materials warehouse						
Secondary materials warehouse	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Stoke hold	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Male changing room	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Female changing room	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Dining room	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Male WC	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Female WC	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Big WC	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Quality and R&D room	Luxiona PT-300C Plat	290	12	0,90	2	24,00
Acclimatised room	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Tasting & workshops room	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Tasting & workshops WC	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Office & meeting room	Luxiona PT-300C Plat	290	12	0,90	1	12,00
Shop	Luxiona PT-300C Plat	290	12	0,90	2	24,00
Corridors	Luxiona PT-300C Plat	290	12	0,90	4	48,00
Pallet truck	Luxiona PT-300C Plat	290	12	0,90	1	12,00
T.C.	Luxiona PT-300C Plat	290	12	0,90	1	12,00
TOTAL						456,00

Table 3: Emergency luminaires results per zone.

Finally, as a summary, the total powers are shown in the following table:

Lighting	Power (W)
Interior	2584,4
Exterior	1200,0
Emergency	456,0
T.C.	23,6
TOTAL	4264

Table 4: Lighting powers summary

Therefore, the total consumption of the lighting would be 4264W, moreover, since all the luminaire used is LED, it would not be necessary to increase their power for other calculations.

2.3. Section calculation

The conductors used in the installation would be multipolar copper wires with XLPE insulation, except for the cables from the L.V.P to the G.D.P. which would be unipolar wires with XLPE insulation. The chosen installation is underground cables for the latter and in trays under tube for the multipolar ones.

The cable sections are determined by the UNE-HD-60364-5-52. On the other hand, the neutral section would be determined according to the ITC-BT-07.

Regarding the protection conductor, its section is defined in Table 2 of the ITC-BT-19, with a minimum section of 4 mm^2.

The tubes section for the channelling would be determined by ITC-BT-21.

It should be remembered that some loads have been increased, in case of the motors it has been 25%. Luminaires has not been necessary this increase as all of them are LED.

Thus, the equations used to carry out these calculations are:

- Thermal limit (determines the maximum current that can flow through the conductor without damaging it):
  - Single-phase installation:

$$I_{Calculation} = \frac{P_{Calculation}}{V \cos(\varphi)}$$

  - Three-phase installation:

$$I_{Calculation} = \frac{P_{Calculation}}{\sqrt{3} \cdot U \cdot \cos(\varphi)}$$

- Voltage drop (determines the maximum admissible voltage drop in the conductors, with a maximum of 4.5% for lighting and 6.5% for other devices):
  - Single-phase:

$$S = \frac{2 \cdot P_{Calculation} \cdot L}{\gamma \cdot e \cdot V}$$

  - Three-phase:

$$S = \frac{P_{Calculation} \cdot L}{\gamma \cdot e \cdot U}$$

  Where:
  - γ = Conductivity: $56 \frac{m}{\Omega \cdot mm^2}$ (Copper)
  - e = Voltage drop (V)
  - L = Conductor length (m)
  - S = Conductor section (mm^2)

In this way, the results obtained are as follows:

- Low Voltage Panel
  - Thermal limit:

Line	Element	Voltage (V)	$P_{Calculation}$ (W)	PF	$I_{Calculation}$	Installation	$S_{Phase}/S_{Neutral}$ (mm^2)
A	G.D.P.	400	133601	1,00	273,12	Underground	240 / 240
B	T.C.A.P.	230	588	1,00	2,56	Tray	1,5 / 1,5

Table 5: Thermal limit results L.V.P.

  - Voltage drop:

Line	Element	Voltage (V)	V drop $_{Max.}$ (V)	L (m)	$P_{Calculation}$ (W)	PF	Installation	S_{Phase} (mm^2)
A	G.D.P.	400	26	15	133601	1,00	Underground	3,44
B	T.C.A.P.	230	14,95	5	588	1,00	Tray	0,03

Table 6: Voltage drop results L.V.P.

  - Solution adopted:

Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A	G.D.P.	240	240	120	0,09	3 x 240 + 1 x 240 + TT x 120	-
B	T.C.A.P.	1,5	1,5	4	0,13	1 x 1,5 + 1 x 1,5 + TT x 4	16

Table 7: L.V.P. sections.

- General Distribution Panel
  - Thermal panel:

Line	Element	Voltage (V)	$P_{Calculation}$ (W)	PF	$I_{Calculation}$	Installation	$S_{Phase}/S_{Neutral}$ (mm^2)
A.1.	Secondary panel 1	400	62500	1,00	90,21	Underground	50
A.2.	Secondary panel 2	400	33488	1,00	48,34	Underground	16
A.3.	Secondary panel 3	400	37613	1,00	134,57	Underground	70 / 70
A.4.	Capacitors bank	400			105,53	Tray	50

Table 8: Thermal limit results G.D.P.

  - Voltage drop:

Line	Element	Voltage (V)	V drop $_{Max.}$ (V)	L (m)	$P_{Calculation}$ (W)	PF	Installation	S_{Phase} (mm^2)
A.1.	Secondary panel 1	400	26	32	62500	1,00	Underground	3,43
A.2.	Secondary panel 2	400	26	33	33488	1,00	Underground	1,90
A.3.	Secondary panel 3	400	26	36	37613	1,00	Underground	2,33
A.4.	Capacitors bank	400	26	6		1,00	Tray	0,00

Table 9: Voltage drop results G.D.P.

  - Solution adopted:

Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.1.	Secondary panel 1	50	-	25	0,45	3 x 50 + TT x 25	-
A.2.	Secondary panel 2	16	-	16	0,77	3 x 16 + TT x 16	-
A.3.	Secondary panel 3	70	35	35	0,22	3 x 70 + 1 x 35 + TT x 35	-
A.4.	Capacitors bank	50	-	25	0,00	3 x 50 + TT x 25	50

Table 10: G.D.P. sections.

- Transformation Center Auxiliary Panel
  - Thermal limit:

Line	Element	Voltage (V)	$P_{Calculation}$ (W)	PF	$I_{Calculation}$	Installation	$S_{Phase}/S_{Neutral}$ (mm^2)
B.1.	Single-phase lighting	230	24	1,00	0,10	Tray	1,5 / 1,5
B.2.	Emergency lighting	230	12	1,00	0,06	Tray	1,5 / 1,5
B.3.	Power outlets	230	552	1,00	2,40	Tray	1,5 / 1,5

Table 11: Thermal limit results T.C.A.P.

  - Voltage drop:

Line	Element	Voltage (V)	V drop $_{Max.}$ (V)	L (m)	$P_{Calculation}$ (W)	PF	Installation	S_{Phase} (mm^2)
B.1.	Single-phase lighting	230	10,35	5	24	1,00	Tray	0,00
B.2.	Emergency lighting	230	10,35	5	12	1,00	Tray	0,00
B.3.	Power outlets	230	14,95	3	552	1,00	Tray	0,02

Table 12: Voltage drop results T.C.A.P.

  - Solution adopted:

Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
B.1.	Single-phase lighting	1,5	1,5	4	0,01	1 x 1,5 + 1 x 1,5 + TT x 4	16
B.2.	Emergency lighting	1,5	1,5	4	0,00	1 x 1,5 + 1 x 1,5 + TT x 4	16
B.3.	Power outlets	1,5	1,5	4	0,07	1 x 1,5 + 1 x 1,5 + TT x 4	16

Table 13: T.C.A.P. sections.

- Secondary Panel 1
  - Thermal limit:

Line	Element	Voltage (V)	$P_{Calculation}$ (W)	PF	$I_{Calculation}$	Installation	$S_{Phase}/S_{Neutral}$ (mm^2)
A.1.1.	Steam generator	400	62500	1,00	90,21	Tray	25

Table 14: Thermal limit results S.P.1.

  - Voltage drop:

Line	Element	Voltage (V)	V drop $_{Max.}$ (V)	L (m)	$P_{Calculation}$ (W)	PF	Installation	S_{Phase} (mm^2)
A.1.1.	Steam generator	400	26	13	62500	1,00	Tray	1,40

Table 15: Voltage drop results S.P.1.

  - Solution adopted:

Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.1.1.	Steam generator	25	-	16	0,36	3 x 25 + TT x 16	32

Table 16: S.P.1 section.

- Secondary Panel 2
  - Thermal limit:

Line	Element	Voltage (V)	$P_{Calculation}$ (W)	PF	$I_{Calculation}$	Installation	$S_{Phase}/S_{Neutral}$ (mm^2)
A.2.1.	Malt mill	400	2750	1,00	3,97	Tray	1,5
A.2.2.	Screw conveyor	400	1750	1,00	2,53	Tray	1,5
A.2.3.	Wort brew machine	400	7500	1,00	10,83	Tray	1,5
A.2.4.	Fermentation tanks	400	8000	1,00	11,55	Tray	1,5
A.2.5.	Bottler	400	462,5	1,00	0,67	Tray	1,5
A.2.6.	Bottle labeling machine	400	250	1,00	0,36	Tray	1,5
A.2.7.	Hot water tank	400	2750	1,00	3,97	Tray	1,5
A.2.8.	Water cooler	400	2875	1,00	4,15	Tray	1,5
A.2.9.	Air compressor	400	462,5	1,00	0,67	Tray	1,5
A.2.10.	Air conditioning	400	1375	1,00	1,98	Tray	1,5
A.2.11.	CIP station	400	5312,5	1,00	7,67	Tray	1,5

Table 17: Thermal limit results S.P.2.

  - Voltage drop:

Line	Element	Voltage (V)	V drop $_{Max.}$ (V)	L (m)	$P_{Calculation}$ (W)	PF	Installation	S_{Phase} (mm^2)
A.2.1.	Malt mill	400	26	14	2750	1,00	Tray	0,07
A.2.2.	Screw conveyor	400	26	10	1750	1,00	Tray	0,03
A.2.3.	Wort brew machine	400	26	11	7500	1,00	Tray	0,14
A.2.4.	Fermentation tanks	400	26	30	8000	1,00	Tray	0,41
A.2.5.	Bottler	400	26	26	462,5	1,00	Tray	0,02
A.2.6.	Bottle labeling machine	400	26	29	250	1,00	Tray	0,01
A.2.7.	Hot water tank	400	26	44	2750	1,00	Tray	0,21
A.2.8.	Water cooler	400	26	47	2875	1,00	Tray	0,23
A.2.9.	Air compressor	400	26	36	462,5	1,00	Tray	0,03
A.2.10.	Air conditioning	400	26	33	1375	1,00	Tray	0,08
A.2.11.	CIP station	400	26	33	5312,5	1,00	Tray	0,30

Table 18: Voltage drop results S.P.2.

  - Solution adopted:

Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.2.1.	Malt mill	2,5	-	4	0,17	3 x 2,5 + TT x 4	16
A.2.2.	Screw conveyor	2,5	-	4	0,08	3 x 2,5 + TT x 4	16
A.2.3.	Wort brew machine	2,5	-	4	0,37	3 x 2,5 + TT x 4	16
A.2.4.	Fermentation tanks	2,5	-	4	1,07	3 x 2,5 + TT x 4	16
A.2.5.	Bottler	2,5	-	4	0,05	3 x 2,5 + TT x 4	16
A.2.6.	Bottle labeling machine	2,5	-	4	0,03	3 x 2,5 + TT x 4	16
A.2.7.	Hot water tank	2,5	-	4	0,54	3 x 2,5 + TT x 4	16
A.2.8.	Water cooler	2,5	-	4	0,60	3 x 2,5 + TT x 4	16
A.2.9.	Air compressor	2,5	-	4	0,07	3 x 2,5 + TT x 4	16
A.2.10.	Air conditioning	2,5	-	4	0,20	3 x 2,5 + TT x 4	16
A.2.11.	CIP station	2,5	-	4	0,78	3 x 2,5 + TT x 4	16

Table 19: S.P.2. sections.

- Secondary Panel 3
  - Thermal limit:

Line	Element	Voltage (V)	$P_{Calculation}$ (W)	PF	$I_{Calculation}$	Installation	$S_{Phase}/S_{Neutral}$ (mm^2)
A.3.1.	Single-phase lighting	230	1504	1,00	6,54	Tray	1,5 / 1,5
A.3.2.	Emergency lighting	230	456	1,00	1,98	Tray	1,5 / 1,5
A.3.3.	Ground floor power outlets	230	8694	1,00	37,80	Tray	6 / 6
A.3.4.	First floor power outlets	230	14490	1,00	63,00	Tray	16 / 16
A.3.5.	Auxiliary panel	400	11244	1,00	23,44	Tray	6 / 6
A.3.6.	Auxiliary exterior panel	400	1225	1,00	1,80	Tray	1,5 / 1,5

Table 20: Thermal limit results S.P.3.

  - Voltage drop:

Line	Element	Voltage (V)	V drop $_{Max.}$ (V)	L (m)	$P_{Calculation}$ (W)	PF	Installation	S_{Phase} (mm^2)
A.3.1.	Single-phase lighting	230	10,35	46	1504	1,00	Tray	1,04
A.3.2.	Emergency lighting	230	10,35	48	456	1,00	Tray	0,33
A.3.3.	Ground floor power outlets	230	14,95	40	8694	1,00	Tray	3,61
A.3.4.	First floor power outlets	230	14,95	20	14490	1,00	Tray	3,01
A.3.5.	Auxiliary panel	400	26	1	11244	1,00	Tray	0,02
A.3.6.	Auxiliary exterior panel	400	26	46	1225	1,00	Tray	0,10

Table 21: Voltage drop results S.P.3.

  - Solution adopted:

Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.3.1.	Single-phase lighting	2,5	2,5	4	1,87	3 x 2,5 + 1 x 2,5 + TT x 4	16
A.3.2.	Emergency lighting	2,5	2,5	4	0,59	3 x 2,5 + 1 x 2,5 + TT x 4	16
A.3.3.	Ground floor power outlets	6	6	6	3,91	3 x 6 + 1 x 6 + TT x 6	20
A.3.4.	First floor power outlets	16	16	16	1,22	3 x 16 + 1 x 16 + TT x 16	32
A.3.5.	Auxiliary panel	6	6	6	0,02	3 x 6 + 1 x 6 + TT x 6	20
A.3.6.	Auxiliary exterior panel	2,5	2,5	4	0,25	3 x 2,5 + 1 x 2,5 + TT x 4	16

Table 22: S.P.3. sections.

- Auxiliary Panel
  - Thermal limit:

Line	Element	Voltage (V)	$P_{Calculation}$ (W)	PF	$I_{Calculation}$	Installation	$S_{Phase}/S_{Neutral}$ (mm^2)
A.3.5.1.	Three-phase lighting 1	400	360	1,00	0,52	Tray	1,5
A.3.5.2.	Three-phase lighting 2	400	360	1,00	0,52	Tray	1,5
A. 3.5.3.	Three-phase lighting 3	400	360	1,00	0,52	Tray	1,5
A.3.5.4.	Single-phase power outlets (PA)	230	2484	1,00	10,80	Tray	1,5 / 1,5
A.3.5.5.	Three-phase power outlets (PA)	400	7680	1,00	11,09	Tray	1,5 / 1,5

Table 23: Thermal limit results A.P.

  - Voltage drop:

Line	Element	Voltage (V)	V drop $_{Max.}$ (V)	L (m)	$P_{Calculation}$ (W)	PF	Installation	S_{Phase} (mm^2)
A.3.5.1.	Three-phase lighting 1	400	18	37	360	1,00	Tray	0,03
A.3.5.2.	Three-phase lighting 2	400	18	29	360	1,00	Tray	0,03
A. 3.5.3.	Three-phase lighting 3	400	18	21	360	1,00	Tray	0,02
A.3.5.4.	Single-phase power outlets (PA)	230	14,95	36	2484	1,00	Tray	0,93
A.3.5.5.	Three-phase power outlets (PA)	400	26	31	7680	1,00	Tray	0,41

Table 24: Voltage drop results A.P.

- Solution adopted:

Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.3.5.1.	Three-phase lighting 1	2,5	-	4	0,06	3 x 2,5 + TT x 4	16
A.3.5.2.	Three-phase lighting 2	2,5	-	4	0,05	3 x 2,5 + TT x 4	16
A. 3.5.3.	Three-phase lighting 3	2,5	-	4	0,03	3 x 2,5 + TT x 4	16
A.3.5.4.	Single-phase power outlets (PA)	2,5	2,5	4	2,41	3 x 2,5 + 1 x 2,5 + TT x 4	16
A.3.5.5.	Three-phase power outlets (PA)	2,5	2,5	4	1,06	3 x 2,5 + 1 x 2,5 + TT x 4	16

Table 25: A.P. sections.

- Auxiliary Exterior Panel
  - Thermal limit:

Line	Element	Voltage (V)	$P_{Calculation}$ (W)	PF	$I_{Calculation}$	Installation	$S_{Phase}/S_{Neutral}$ (mm^2)
A.3.6.1.	Three-phase exterior lighting	400	1200	1,00	1,73	Tray	1,5
A.3.6.2.	Exterior lighting control	24	25	1,00	0,07	Tray	1,5

Table 26: Thermal limit results A.E.P.

  - Voltage drop:

Line	Element	Voltage (V)	V drop $_{Max.}$ (V)	L (m)	$P_{Calculation}$ (W)	PF	Installation	S_{Phase} (mm^2)
A.3.6.1.	Three-phase exterior lighting	400	18	53	1200	1,00	Tray	0,16
A.3.6.2.	Exterior lighting control	24	1,56	0	25	1,00	Tray	0,00

Table 27: Voltage drop results A.E.P.

  - Solution adopted:

Line	Element	S_{Phase} (mm^2)	$S_{Neutral}$ (mm^2)	S_{Ground} (mm^2)	V drop (%)	Wire chosen	ϕ Tube chosen (mm)
A.3.6.1.	Three-phase exterior lighting	2,5	-	4	0,28	3 x 2,5 + TT x 4	16
A.3.6.2.	Exterior lighting control	2,5	-	4	0,00	3 x 2,5 + TT x 4	16

Table 28: A.E.P. results.

Summary:

Line	Wire	ϕ Tube	Line	Wire	ϕ Tube
A	3 x 240 + 1 x 240 + TT x 120	-	A.3.1.	3 x 2,5 + 1 x 2,5 + TT x 4	16
B	1 x 1,5 + 1 x 1,5 + TT x 4	16	A.3.2.	3 x 2,5 + 1 x 2,5 + TT x 4	16
A.1.	3 x 50 + TT x 25	-	A.3.3.	3 x 6 + 1 x 6 + TT x 6	20
A.2.	3 x 16 + TT x 16	-	A.3.4.	3 x 16 + 1 x 16 + TT x 16	32
A.3.	3 x 70 + 1 x 70 + TT x 35	-	A.3.5.	3 x 6 + 1 x 6 + TT x 6	20
A.4.	3 x 50 + TT x 25	50	A.3.6.	3 x 2,5 + 1 x 2,5 + TT x 4	16
B.1.	1 x 1,5 + 1 x 1,5 + TT x 4	16	A.3.5.1.	3 x 2,5 + TT x 4	16
B.2.	1 x 1,5 + 1 x 1,5 + TT x 4	16	A.3.5.2.	3 x 2,5 + TT x 4	16
B.3.	1 x 1,5 + 1 x 1,5 + TT x 4	16	A.3.5.4.	3 x 2,5 + 1 x 2,5 + TT x 4	16
A.1.1.	3 x 25 + TT x 16	32	A.3.5.5.	3 x 2,5 + 1 x 2,5 + TT x 4	16
A.2.1.	3 x 2,5 + TT x 4	16	A.3.6.1.	3 x 2,5 + TT x 4	16
A.2.2.	3 x 2,5 + TT x 4	16	A.3.6.2.	3 x 2,5 + TT x 4	16
A.2.3.	3 x 2,5 + TT x 4	16			
A.2.4.	3 x 2,5 + TT x 4	16			
A.2.5.	3 x 2,5 + TT x 4	16			
A.2.6.	3 x 2,5 + TT x 4	16			
A.2.7.	3 x 2,5 + TT x 4	16			
A.2.8.	3 x 2,5 + TT x 4	16			
A.2.9.	3 x 2,5 + TT x 4	16			
A.2.10.	3 x 2,5 + TT x 4	16			
A.2.11.	3 x 2,5 + TT x 4	16			

Table 29: Sections summary

2.4. Protections

2.4.1. Circuit breakers

The choice of the circuit breakers is done based on three variables:

- Breaking power
- Calibre
- Tripping curve

To determine them, it is necessary to know the maximum short-circuit currents that could flow through each line. Moreover, as already mentioned in the **Memory** document, the tripping curves would be C for lighting and power outlets and D for motors / machinery.

2.4.1.1. Short-circuit current calculation

The short-circuit current is calculated with the following expression:

$$I_{sc\ máx} = \frac{U_s}{\sqrt{3} \cdot Z_t}$$

Where:

- I_{sc} = Short-circuit current (A)
- U_s = Phase-to-phase no-load voltage in the transformer secondary (V)
- Z_t = Total impedance, per phase, of the upstream grid of the fault (Ω)

Therefore, Z_t is made up of the following impedances

1. Impedance before the transformer

   This impedance is calculated with the following expression:

$$Z_a = \frac{U^2}{S_{cc}}$$

   Where:
   - U = Phase-to-phase no-load voltage in the transformer secondary (V).
   - S_{cc} = Shor-circuit power (VA). This value is given by the electric company and is around 400MVA.
   - Z_a = Impedance before the transformer (Ω).

2. Impedance of the transformer

   This impedance is calculated with the following expression:

$$Z_{Trafo} = \frac{U^2}{S} \cdot \frac{U_{cc}}{100}$$

Where:

- U = No-load voltage between phases (V).
- U_{cc} = Short-circuit voltage in %. This value is provided by transformer manufacturer.
- S = Apparent power (VA). This value is provided by the transformer manufacturer.
- Z_{Trafo} = Transformer impedance (Ω).

3. Conductors impedance

This impedance is calculated with the following expression:

$$R = \rho \cdot \frac{L}{S}$$

Where:

- R = Conductor resistance (Ω).
- ρ = Copper resistivity (0,0171 $\Omega \frac{mm^2}{m}$).
- L = Conductor length.
- S = Phase conductor section.

4. Automatisms impedance

The automatisms have an impedance that must be considered. Those located upstream from the point where the calculation is being carried out. It is calculated with the following expression:

$$Z_{automatism} = X_{automatism} = 0{,}00015 \cdot N_{automatism}$$

Where:

- 0,00015: automatism impedance(Ω).
- $N_{automatism}$ = Number of automatisms placed upstream.

Finally, once all these impedances have been calculated, Z_T is obtained as follows:

$$Z_T = \sqrt{Z_{Real}^2 + Z_{Imaginary}^2}$$

2.4.1.2. Circuit breaker choice

Once the short-circuit current (maximum) in each line has been calculated and the type of the circuit breaker curve has been decided (as mentioned in the **Memory** C document for lighting and power outlets and D for motors / machinery), the breaking power would be determined.

The breaking power must always be greater than the maximum short-circuit current, since, this way, the circuit opening is guaranteed in case of failure.

$$BP > I_{sc\ máx}$$

In addition, it should be noted that, it has been decided that the break of these circuit breakers is omnipolar.

2.4.1.3. Results obtained

After performing the operations defined in the previous section, the results obtained are shown in the following tables.

2.4.1.3.1. Circuit breakers

For the calculation of these circuit breakers, it has been considered a constant short-circuit current in each panel. This way only the first circuit breaker of each panel is shown. The rest (observable in planes) would be obtained with the corresponding short-circuit current of the panel, the rated current of the line, the curve and the number of poles required.

Panel	Nombre	Name	Z_a (Ω)	Z_{Trafo} (Ω)	R_{Wire} (Ω)	N Automatisms	Z_t (Ω)	Is-c (kA)
L.V.P.	QF L.V.P.	275,68	0,0004	0,0176	0,0001	0	0,0181	13,41
T.C.A.P.	QF T.C.A.P.	2,56	0,0004	0,0176	0,0571	2	0,0600	4,04
G.D.P.	QF0	273,12	0,0004	0,0176	0,0011	2	0,0184	13,17
S.P.1.	QF1	90,21	0,0004	0,0176	0,0121	5	0,0224	10,84
S.P.2.	QF2	48,34	0,0004	0,0176	0,0364	5	0,0410	5,92
S.P.3.	QF3	134,57	0,0004	0,0176	0,0099	5	0,0213	11,39
A.P.	QF3.1	23,44	0,0004	0,0176	0,0128	8	0,0231	10,48
A.E.P	QF3.2	1,80	0,0004	0,0176	0,3246	8	0,3251	0,75

Table 30: Main circuit breakers short-circuit currents.

Panel	Name	$I_{Calculation}$ (A)	$I_{Max.\ Adm.}$ (A)	Is-c (kA)	$BP_{Standarised}$	Curve	Polarity
L.V.P.	QF LVP	275,68	448,0	13,41	22	D	IV
T.C.A.P.	QF TCAP	2,56	26,0	4,04	4,5	C	II
G.D.P.	QF0	273,12	448,0	13,17	22	D	IV
S.P.1.	QF1	90,21	153,0	10,84	22	D	III
S.P.2.	QF2	48,34	84,0	5,92	6	D	III
S.P.3.	QF3	134,57	188,0	11,39	22	C	IV
A.P.	QF3.1	23,44	44,0	10,48	22	C	IV
A.E.P.	QF3.2	1,80	26,0	0,75	4,5	C	III

Table 31: Main circuit breakers adopted solution.

2.4.2. Residual current devices (RCD)

Knowing the rated (and calculation) currents of each load and the sensitivity that each downstream RCD must have (as detailed in the **Memory** document), it only remains the sensitivity determination of the upstream RCD to ensure selectivity. The results obtained are the following:

- Low Voltage Panel

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD LVP	275,68	1000

Table 32: Residual current device L.V.P.

- General Distribution Panel

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 1	90,21	500
RCD 2	48,34	500
RCD 3	134,57	300
RCD 4	105,53	300

Table 33: Residual current devices G.D.P.

- Transformation Center Auxiliary Panel

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD TCAP	2,56	30

Table 34: Residual current device T.C.A.P.

- Secondary Panel 1

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 1.1	90,21	300

Table 35: Residual current device S.P.1.

- Secondary Panel 2

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 2.1	13,17	300
RCD 2.2	14,74	300
RCD 2.3	8,61	300
RCD 2.4	11,82	300

Table 36: Residual current devices S.P.2.

- Secondary Panel 3

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 3.1	8,52	30
RCD 3.2	37,80	30
RCD 3.3	63,00	30
RCD 3.4	23,44	300
RCD 3.5	1,80	300

Table 37: Residual current devices S.P.3.

- Auxiliary Panel

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 3.5.1	1,56	30
RCD 3.5.2	10,80	30
RCD 3.5.3	11,09	30

Table 38: Residual current devices A.P.

- Auxiliary Exterior Panel

Name	$I_{Claculation}$ (A)	Sensitivity (mA)
RCD 3.2.1	1,73	30
RCD 3.2.2	0,07	30

Table 39: Residual current devices A.E.P.

2.5. Grounding installation

In this section the calculations for the different grounding installation would be realized. However, first the following considerations must be taken into account:

- Maximum voltage difference between ground and masses: 24 V
- Ground resistivity: 150 Ω · m
- Desired resistance: 10 Ω

Therefore, the equations used are:

$$\frac{1}{R} = \frac{1}{R_{Bare\ conductor}} + \frac{N_{Pike}}{R_{Pike}}$$

$$R_{Bare\ conductor} = \frac{2 \cdot \rho}{L_{Bare\ conductor}}$$

$$R_{Pike} = \frac{\rho}{L_{Pike}}$$

Where:

- R = Resistance (Ω)
- ρ = Ground resistivity (Ω · m)
- $L_{Bare\ conductor}$ = Bare conductor length (m)
- L_{Pike} = Pike length, 2 meters (m)
- N_{Pike} = Number of pikes

This way, the obtained results are:

Industrial unit grounding installation						
Ground resistivity	L_{Pike}	N_{Pike}	R_{Pike}	$L_{Bare\ Conductor}$	$R_{Bare\ conductor}$	$R_{Obtained}$
150	2	6	75	20	15	6,82

Table 40: Insutrial unit grounding installation results.

T.C. grounding installation						
Ground resistivity	L_{Pike}	N_{Pike}	R_{Pike}	$L_{Bare\ Conductor}$	$R_{Bare\ conductor}$	$R_{Obtained}$
150	2	4	75	23	13,04	7,69

Table 41: T.C. grounding installation resutls.

Service grounding installation						
Ground resistivity	L_{Pike}	N_{Pike}	R_{Pike}	$L_{Bare\ Conductor}$	$R_{Bare\ conductor}$	$R_{Obtained}$
150	2	4	75	14	21,43	10,00

Table 42: Service grounding installation results.

2.6. Capacitor bank

As mentioned in the **Memory** document, it has been decided to correct the power factor to a unitary one, in order to benefit from the improvements that this entails. For this, the reactive power of each receiver has been calculated and the total reactive power to be corrected has been obtained:

Element	$P_{Active,Calculation}$ (W)	PF	$S_{Calculation}$(VA)	$Q_{Calculation}$ (VAr)
Malt mill	2750	0,85	3235	1704
Screw conveyor	1750	0,85	2059	1085
Wort brew machine	7500	0,85	8824	4648
Fermentation tanks	8000	0,85	9412	4958
Bottler	462,5	0,87	532	262
Bottle labeling machine	250	0,87	287	142
Hot water tank	2750	0,87	3161	1558
Steam generator	62500	0,87	71839	35420
Water cooler	2875	0,90	3194	1392
Air compressor	462,5	0,90	514	224
Air conditioning	1375	0,90	1528	666
CIP station	5312,5	0,90	5903	2573
Total lighting	3808	0,90	4231	1844
Total emergency lighting	456	0,90	507	221
Total power outlets	33900	0,90	37667	16419
Total	134151,5	-	152892	73117

Table 43: Total reactive power, capacitor bank.

Therefore, it has been decided to use a 75 kVAr capacitor bank.

Pamplona. June 1,2020

Sgd. Javier Urdániz Viejo

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Low voltage electrical installation of a craft beer brewery with transformation center

Document No.3: Plans

Javier Urdániz Viejo

June 1, 2020

PLANS INDEX

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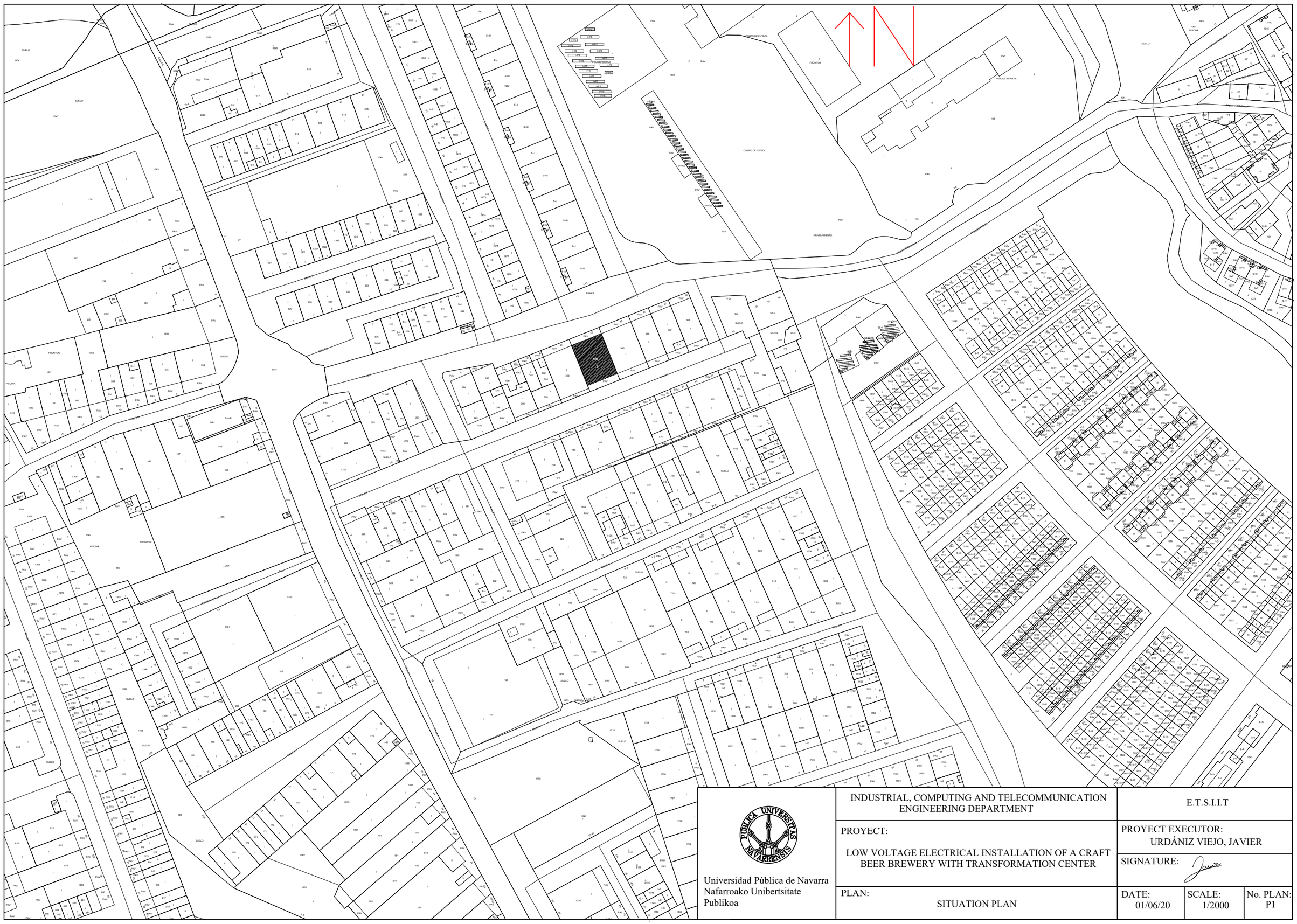

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INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT

E.T.S.I.I.T

PROYECT:

LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER

PROYECT EXECUTOR:
URDÁNIZ VIEJO, JAVIER

SIGNATURE:

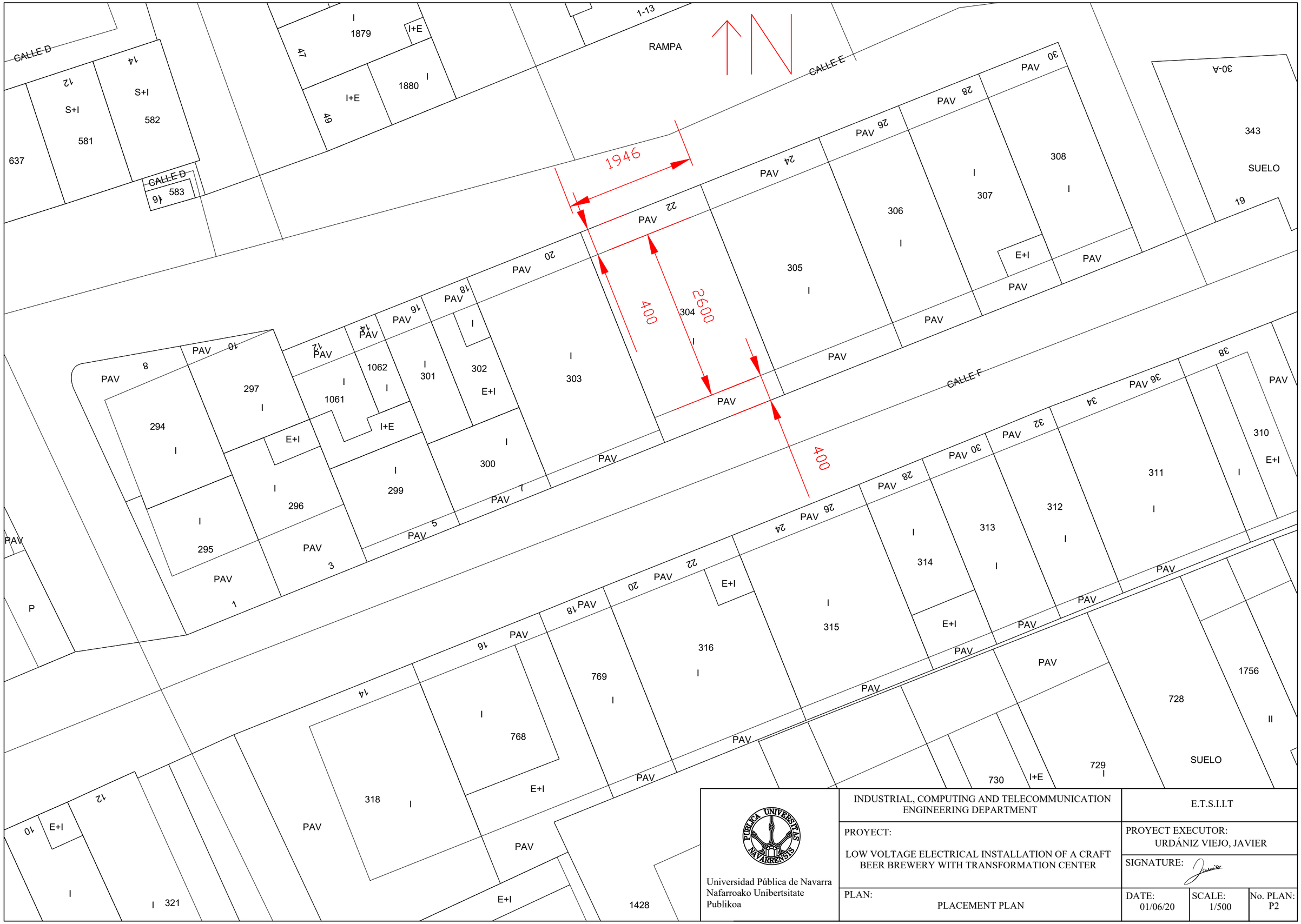
PLAN:
SITUATION PLAN

DATE: 01/06/20

SCALE: 1/2000

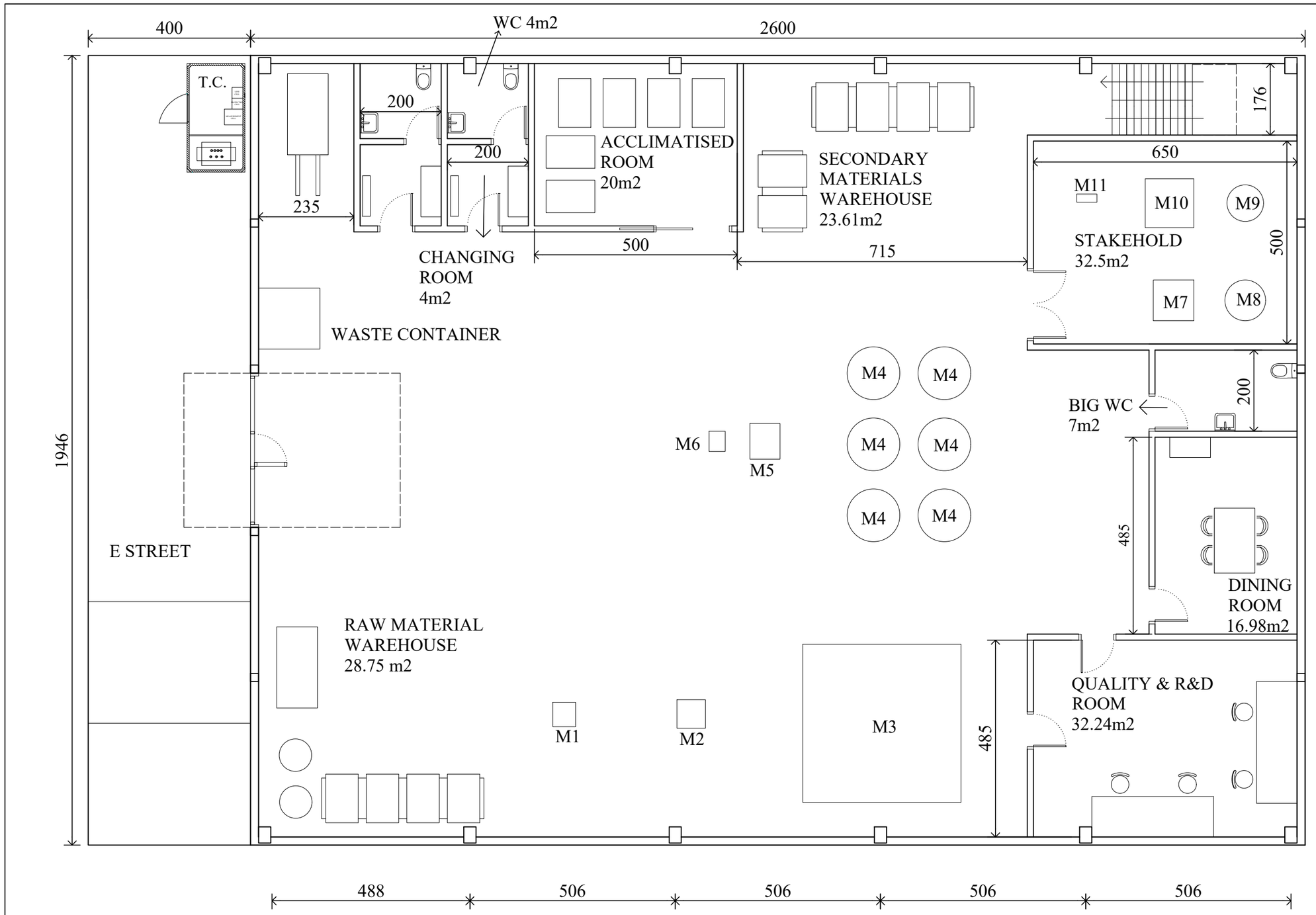
No. PLAN: P1

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

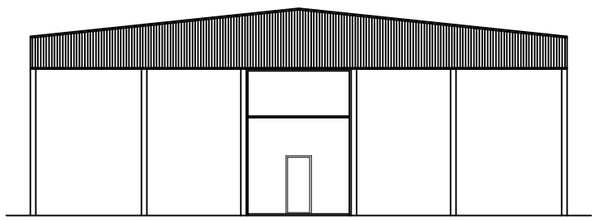


Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER SIGNATURE:
	PLAN: PLACEMENT PLAN	DATE: 01/06/20 · SCALE: 1/500 · No. PLAN: P2

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK



INFORMATION			
	MACHINE	P (W)	PF
M1	Malt mill	2200	0,85
M2	Screw conveyor	1400	0,85
M3	Wort brew machine	6000	0,85
M4	Fermentation tanks	6400	0,85
M5	Bottler	370	0,87
M6	Bottle labelling machine	200	0,87
M7	Steam generator	50000	0,87
M8	Hot water tank	2200	0,87
M9	CIP station	4250	0,90
M10	Water cooler	2300	0,90
M11	Air compressor	370	0,90

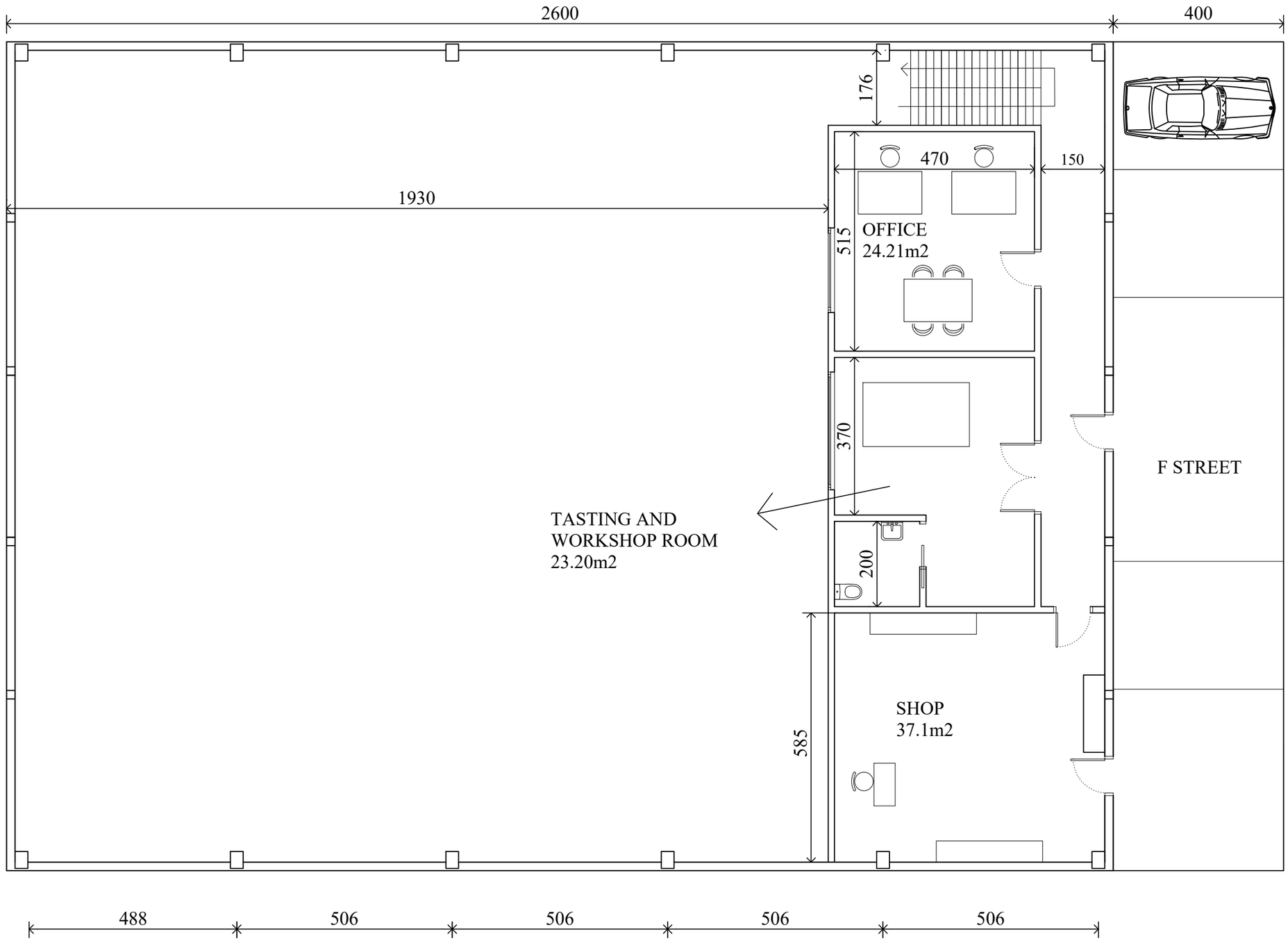


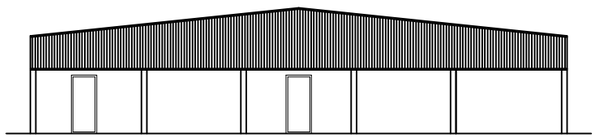
FRONT VIEW E STREET

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T	
PROYECT: LOW VOLTAGE ELECTIRICAL INTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
	SIGNATURE:	
PLAN: GROUND FLOOR LAYOUT	DATE: 01/06/20	SCALE: 1/100
		No. PLAN: P3

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK



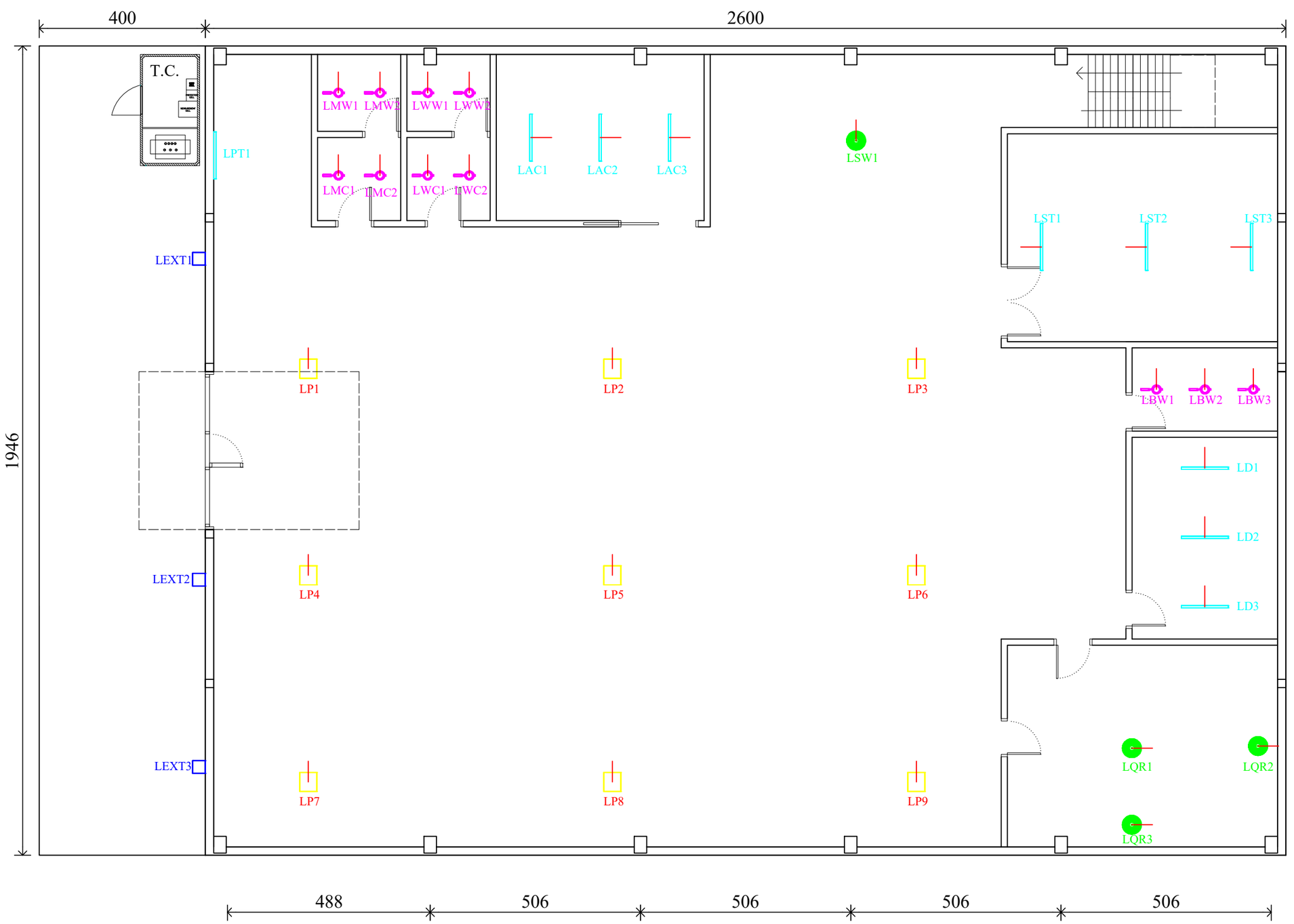


FRONT VIEW F STREET

Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BEWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER SIGNATURE:
	PLAN: FIRST FLOOR LAYOUT	DATE: 01/06/20 / SCALE: 1/100 / No. PLAN: P4

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

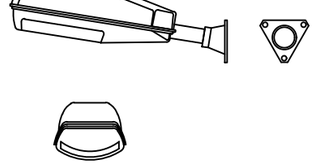
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK



INFORMATION			
	No.	P (W)	MODEL
	9	120	BY480P LED170S/840 PSD WB GC SI
	4	138	BY121P G4 LED200S/865 PSU WB
	11	11,8	DN570B LED 12S/830 PSE-E C WH
	10	23,5	SM53C LED 34S/940PSD PI5 L1130 ALU
	3	200	LED AREA LIGHT AOK T4

* Philips is the manufacturer of all the luminaires except the exterior ones that is AOK.

ATTACHMENT OF EXTERIOR LUMINAIRES



NOTE:

In the production area and secondary material warehouse the luminaires have a height of 5.5 meters from the floor.

The other areas have a height of 3 meters and the luminaires are attached to the roof.

In the pallet truck parking the luminary is attached to the wall an has a height of 3 meters.

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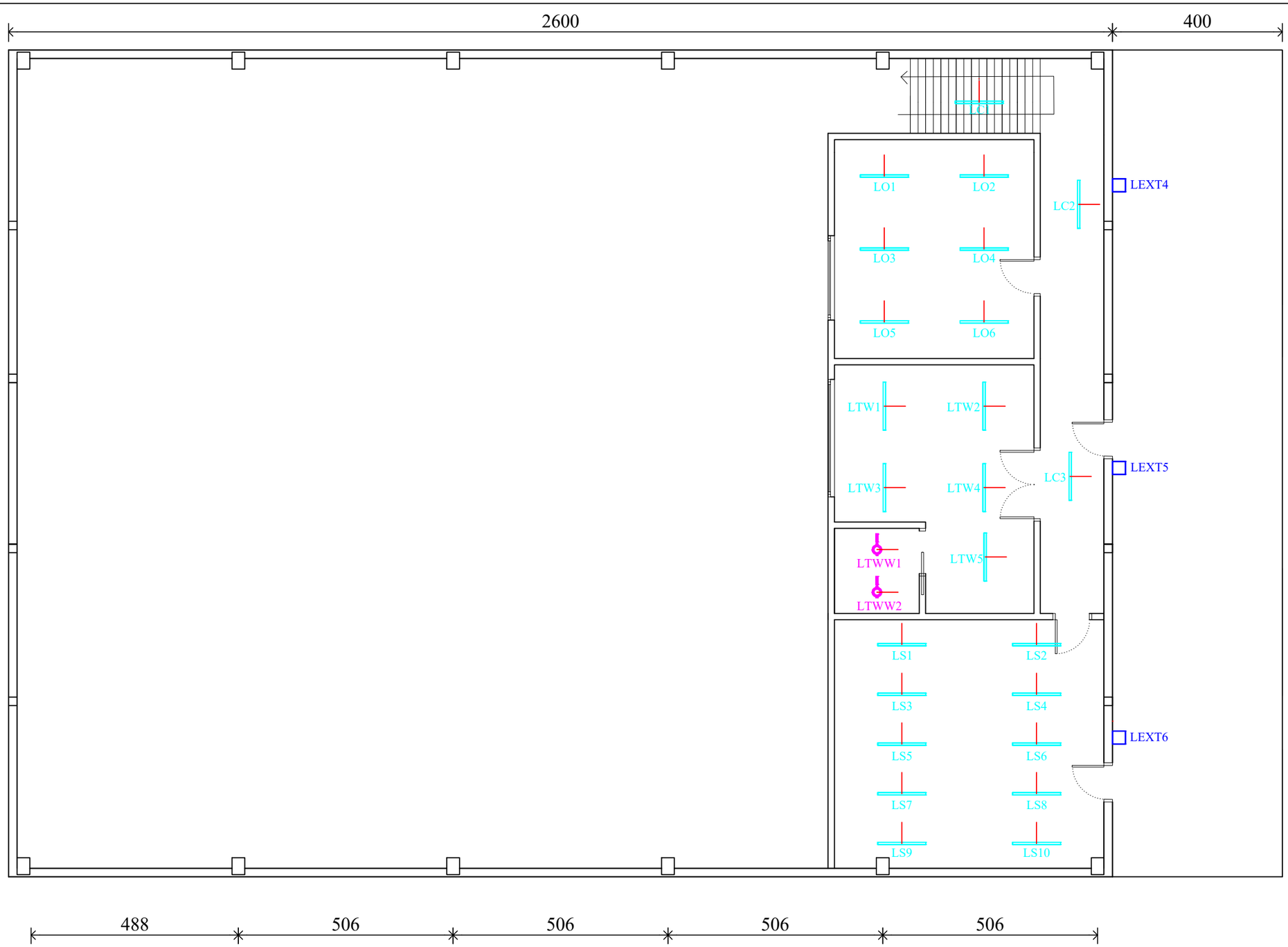
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER SIGNATURE:
	PLAN: GROUND FLOOR LIGHTING DISTRIBUTION	DATE: 01/06/20 / SCALE: 1/100 / No. PLAN: P5

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK



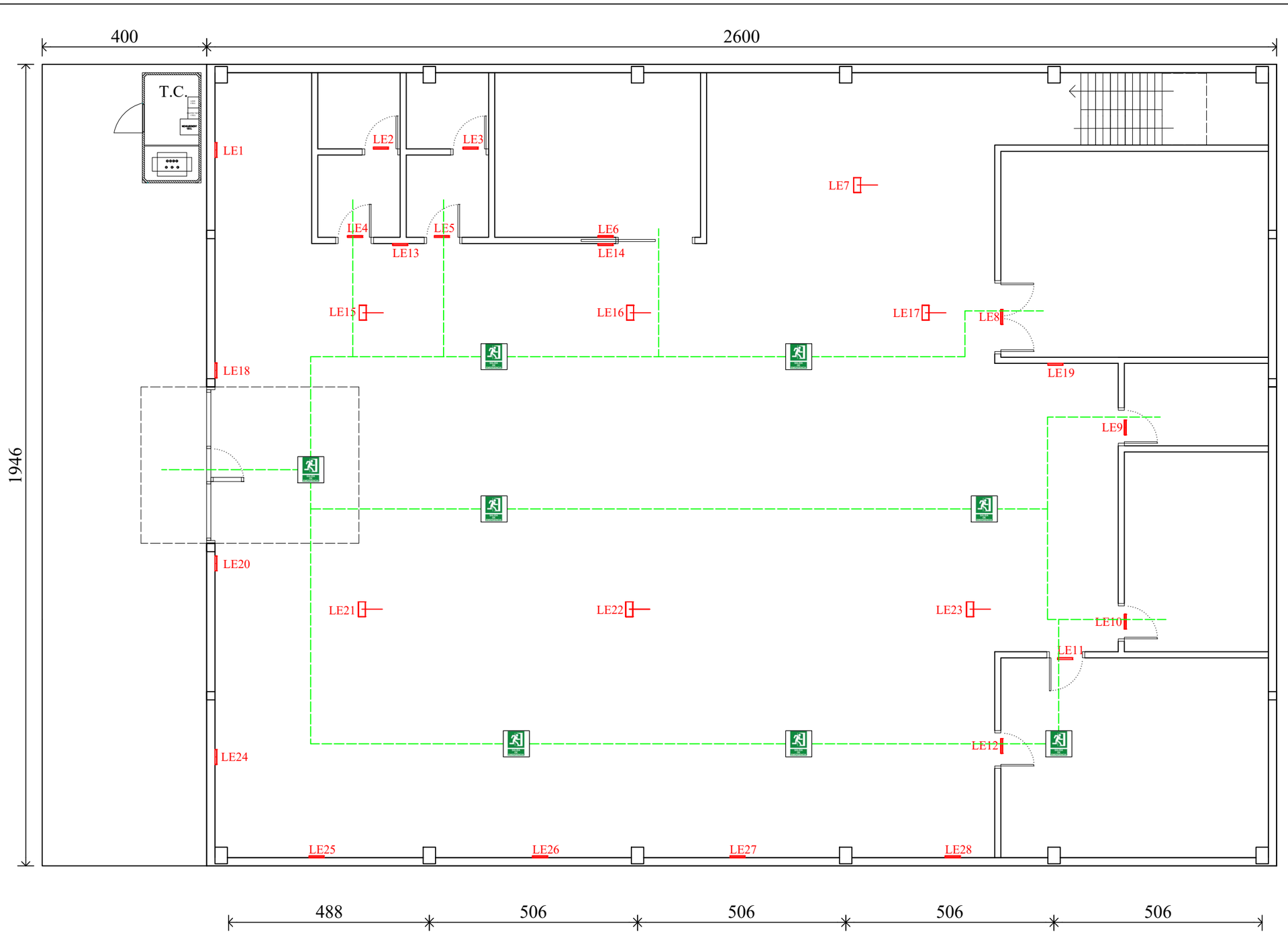
INFORMATION			
	No.	P (W)	MODEL
	2	11,8	DN570B LED 12S/830 PSE-E C WH
	24	23,5	SM53C LED 34S/940PSD PI5 L1130 ALU
	3	200	LED AREA LIGHT AOK T4

NOTE:

In the corridors and stairs the luminarires have a height of 3 meters from the floor

The rest of rooms have a height of 3 meters and the luminaires are attached to the roof

Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T	
	PROYECT: LOW VOLTAGE ELECTRICAL INTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
		SIGNATURE:	
	PLAN: FIRST FLOOR LIGHTING DISTRIBUTION	DATE: 01/06/20	SCALE: 1/100
			No. PLAN: P6



INFORMATION			
	No.	P (W)	MODEL
▭	28	12	Luxiona PT-300C Plat
- - -	Emergency exit route		

COLOCATION:

Horizontal position (attached to the wall)

Vertical position (suspended from the roof)

NOTE:

In the production area and secondary material warehouse the luminaries suspended from the roof have a height of 5.5 meters from the floor.

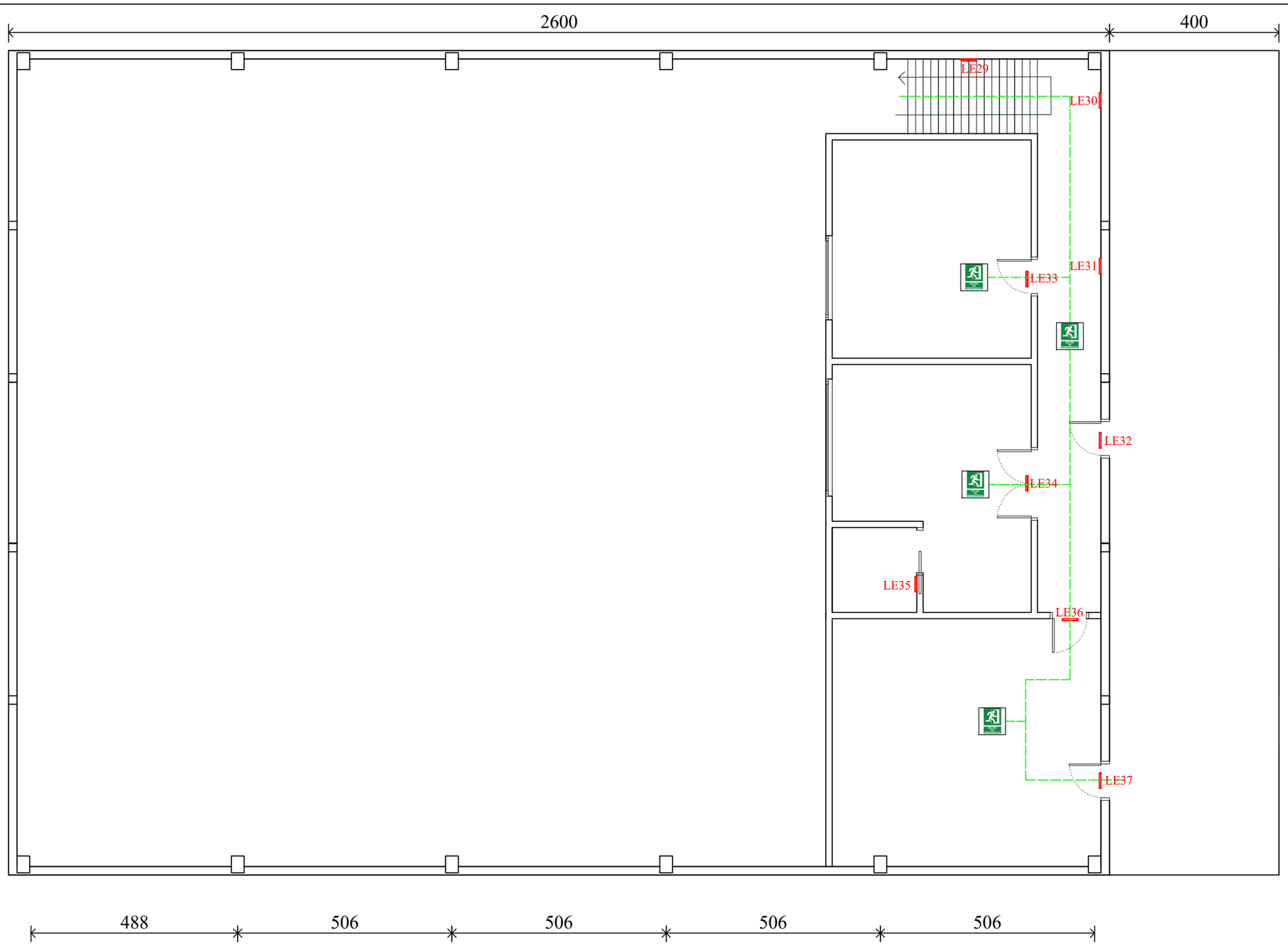
In the production area the luminaries attached to the wall have a height of 2.5 meters from the floor.

The other areas the luminairers are attached to the wall over the doors with a height of 2.3 meters.

Next to every luminaire there will be a sign indicating the nearest exit.

Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT		E.T.S.I.I.T	
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER		PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
			SIGNATURE:	
	PLAN: GROUND FLOOR EMERGENCY LIGHTING DISTRIBUTION		DATE: 01/06/20	SCALE: 1/100
				No. PLAN: P7

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK



INFORMATION			
	No.	P (W)	MODEL
▭	9	12	Luxiona PT-300C Plat
- - - -	Emergency exit route		

COLOCATION:

▭ Horizontal position (attached to the wall)

Vertical position (suspended from the roof)

NOTE:

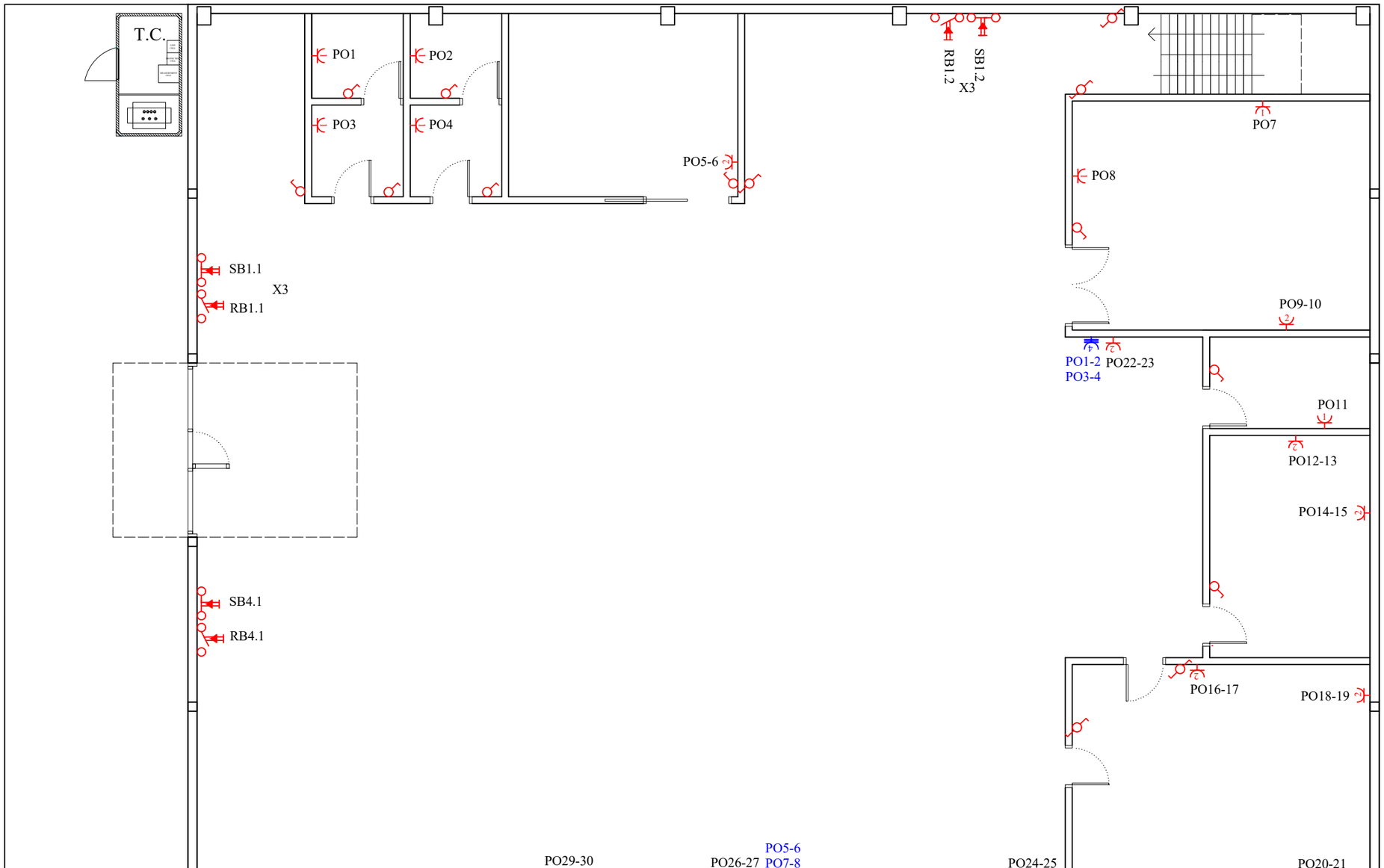
In the corridor and stairs the luminaries are attached to the wall have a height of 2.5 meters from the floor.

The other areas the luminairers are attached to the wall over the doors with a height of 2.3 meters.

Next to every luminaire there will be a sign indicating the nearest exit.

Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T		
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER		
		SIGNATURE:		
	PLAN: FIRST FLOOR EMERGENCY LIGHTING DISTRIBUTION	DATE: 01/06/20	SCALE: 1/100	No. PLAN: P8

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK



INFORMATION		
	No.	DESCRIPTION
	7	1 single-phase PO (16A)
	9	1 power strip with 2 single-phase PO (16A)
	1	1 power strip with 3 single-phase PO (16A)
	2	1 power strip with 4 three-phase PO (32A)
	9	Single switch
	5	Toggle switch
	7	Button NO to run luminaires
	8	Button NC to stop luminaires

* PO = power outlet

NOTE:

In the production area the power outlets would have a height of 1,6 meters from the floor. Moreover, they would be grouped with a special box.

In the other zones the height of the power outlets would be 35 cm.

All the switches would have a height of 1,5 meters over the floor.

There are 12 switches for the interior three-phase luminaires

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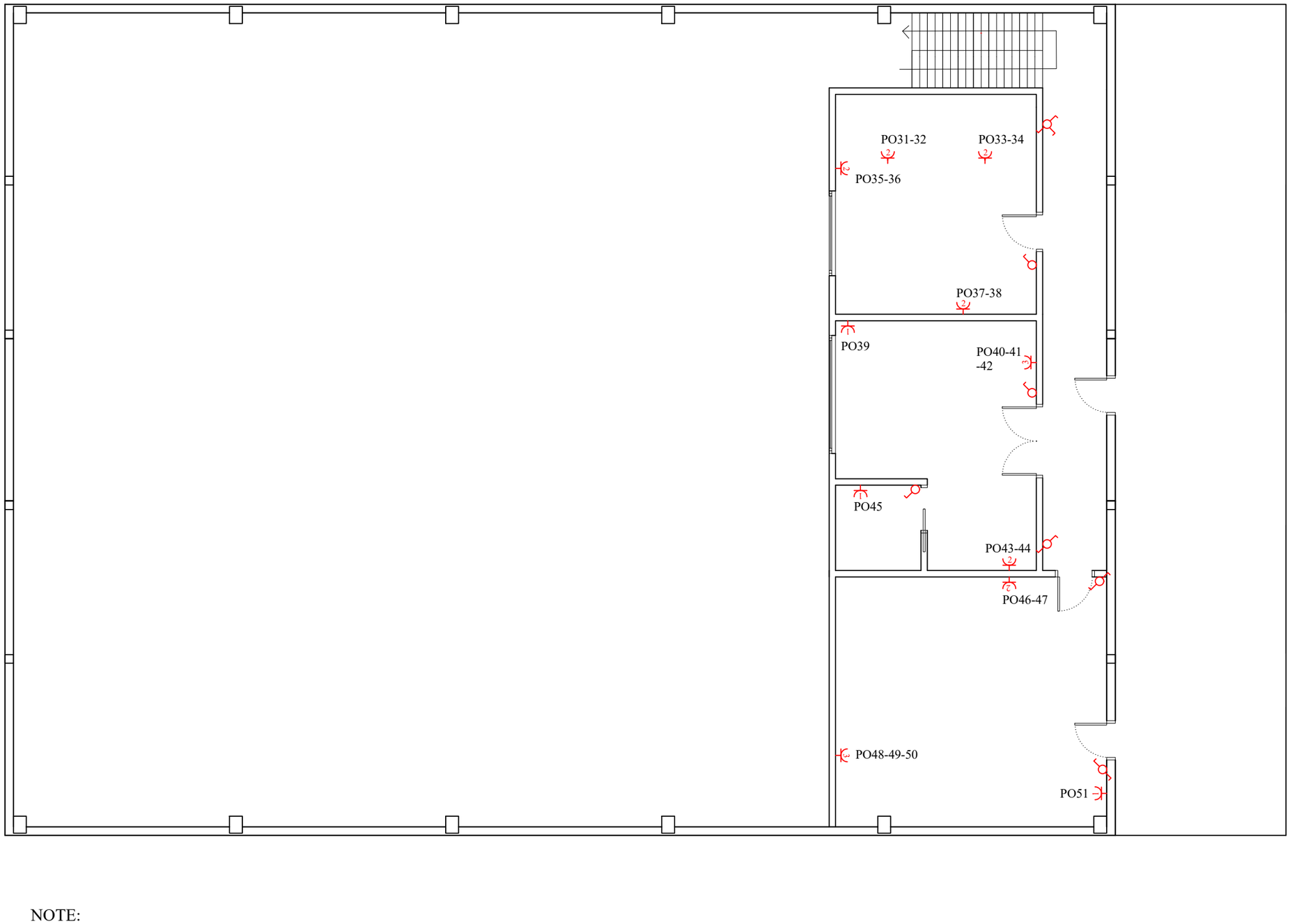
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
		SIGNATURE:	
	PLAN: GROUND FLOOR POWER OUTLETS DISTRIBUTION	DATE: 01/06/20	SCALE: 1/100
			No. PLAN: P9

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK



INFORMATION		
	No.	DESCRIPTION
	3	1 singlephase PO (16A)
	6	1 power strip with 2 singlephase PO (16A)
	2	1 power strip with 3 singlephase PO (16A)
	3	Single switch
	3	Toggle switch
	1	Crossing switch

* PO = power outlet

NOTE:

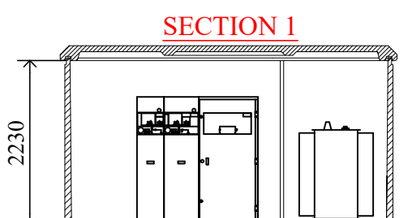
The height of the power outlets wouldl be 35 cm.

All the switches would have a height of 1,5 meters over the floor.

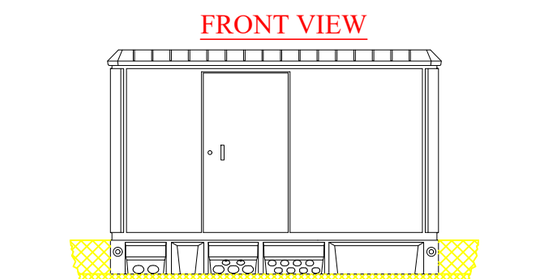
Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T	
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
		SIGNATURE:	
	PLAN: FIRST FLOOR POWER OUTLETS DISTRIBUTION	DATE: 01/06/20	SCALE: 1/100
			No. PLAN: P10

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

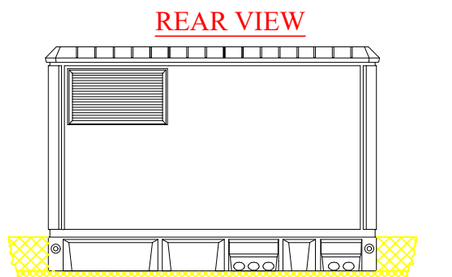
SECTION 1



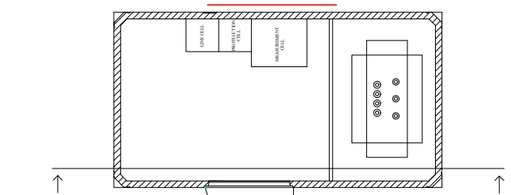
FRONT VIEW



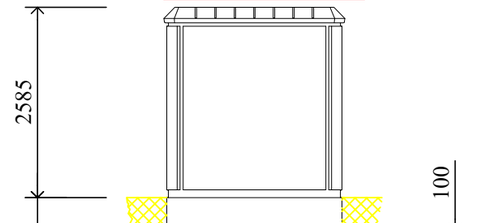
REAR VIEW



TOP VIEW



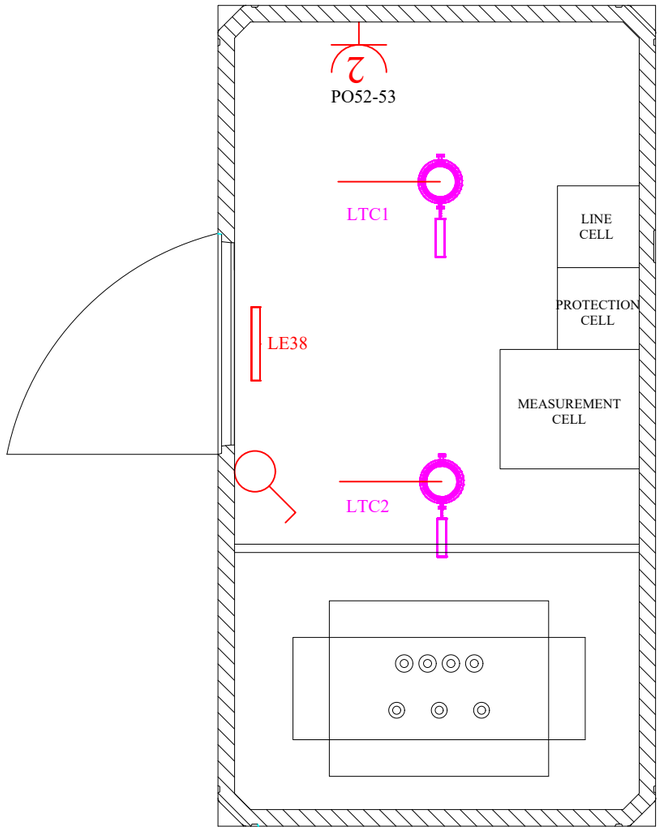
LATERAL VIEW



NOTE:

The transformation center has natural ventilation through the grille

Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER
		SIGNATURE:
	PLAN: TRANSFORMATION CENTER	DATE: 01/06/20 / SCALE: 1/50 / No. PLAN: P11



INFORMATION			
	No.	P (W)	DESCRIPTION
	2	11,8	DN570B LED 12S/830 PSE-E C WH
	1	12	Luxiona PT-300C Plat
	1	1 power strip with 2 singlephase power outlers (16A)	
	1	1 single switch	

NOTE:

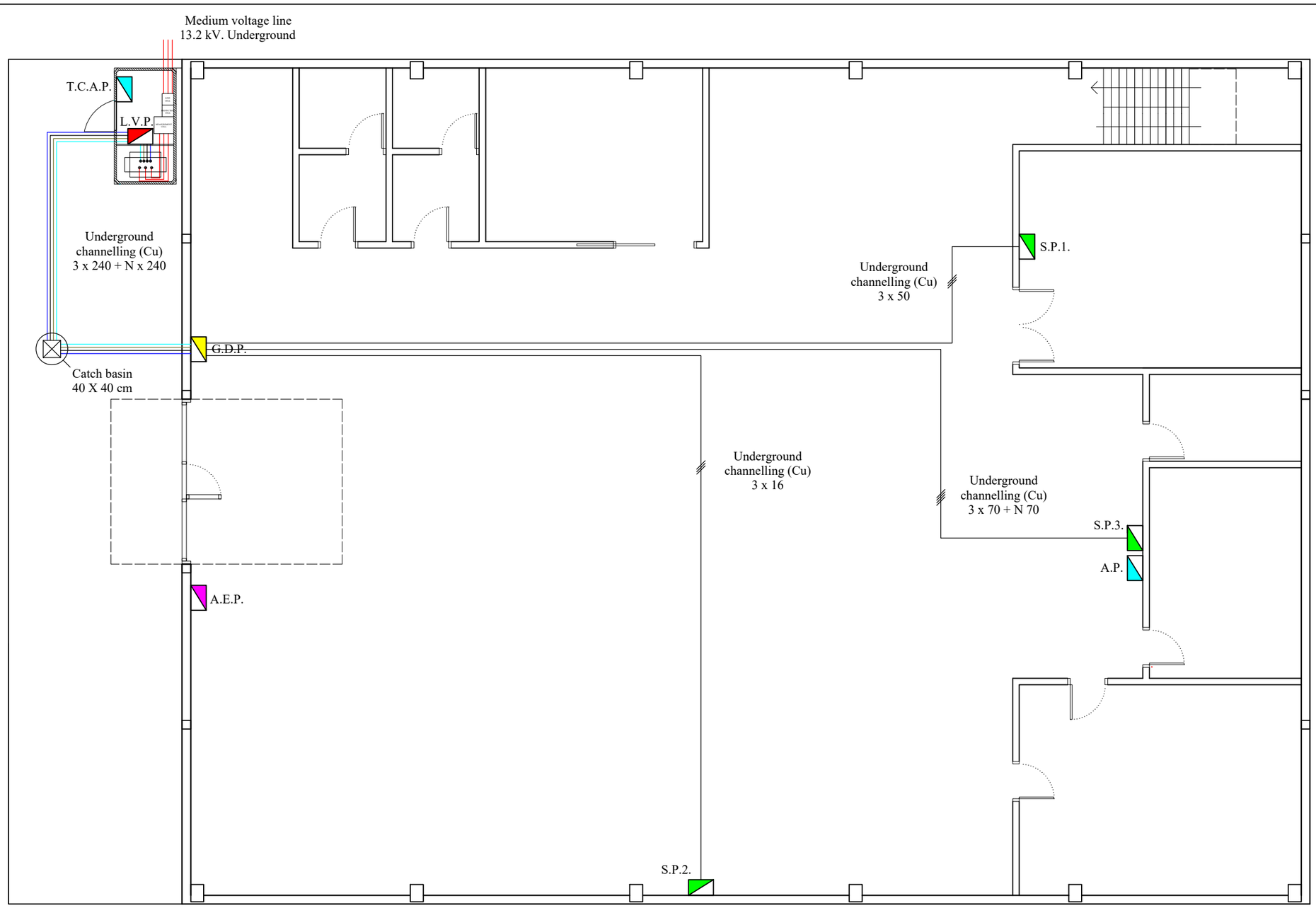
The height of the power outlets would be 35 cm from the floor.

The switch would have a height of 1,5 meters over the floor.

The luminaires would be attached to the roof with a height of 2,5 meters.

The emergency luminaire would be attached to the wall over the exit door, in horizontal position.

Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT		E.T.S.I.I.T	
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER		PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
			SIGNATURE:	
	PLAN: T.C. ELEMENTS DISTRIBUTION		DATE: 01/06/20	SCALE: 1/20	No. PLAN: P12



INFORMATION		
	No.	DESCRIPTION
	1	Low voltage panel
	1	General distribution panel
	3	Secondary panel
	2	Auxiliary panel
	1	Auxiliary exterior panel

NOTE:

The electric panels would be attached to the wall with a height of 1,5 meter from the floor.

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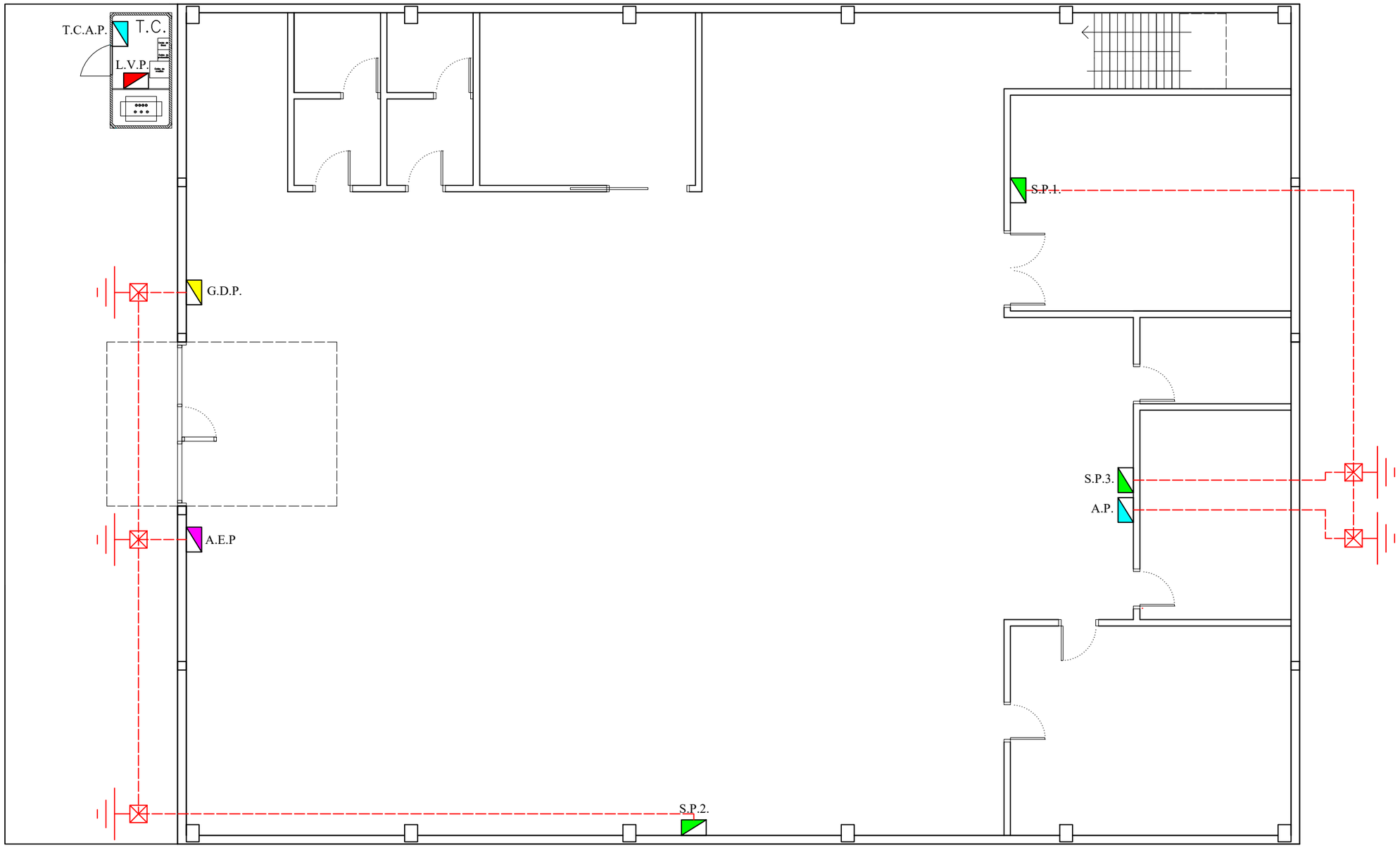
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER		PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
			SIGNATURE:	
	PLAN: ELECTRIC PANELS DISTRIBUTION	DATE: 01/06/20	SCALE: 1/100	No. PLAN: P13

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

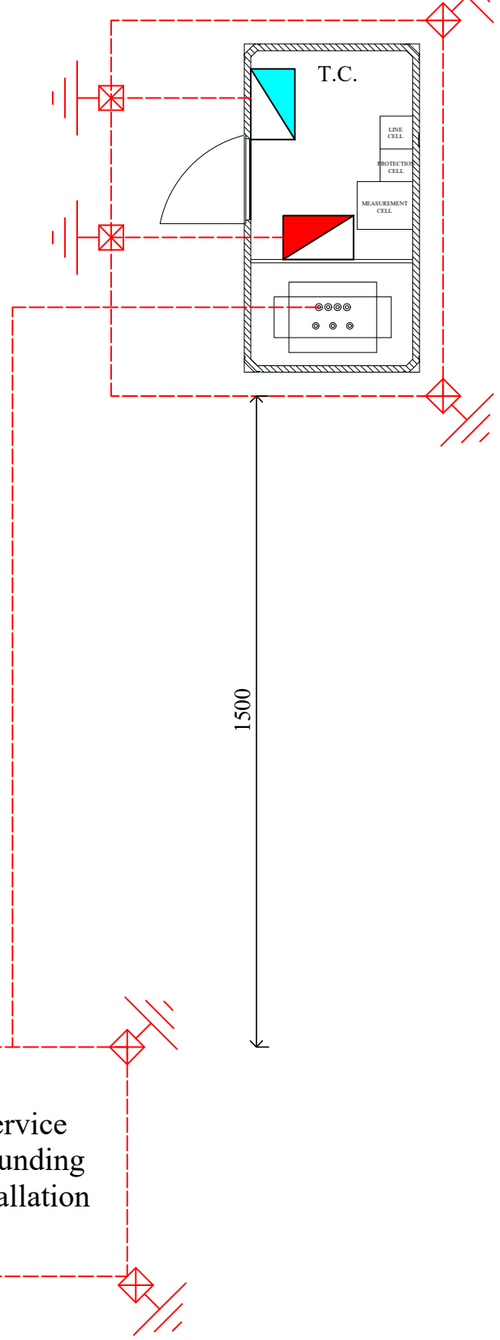


INFORMATION	
	DESCRIPTION
⊠	Catch basin
⏚	Pike

NOTE:

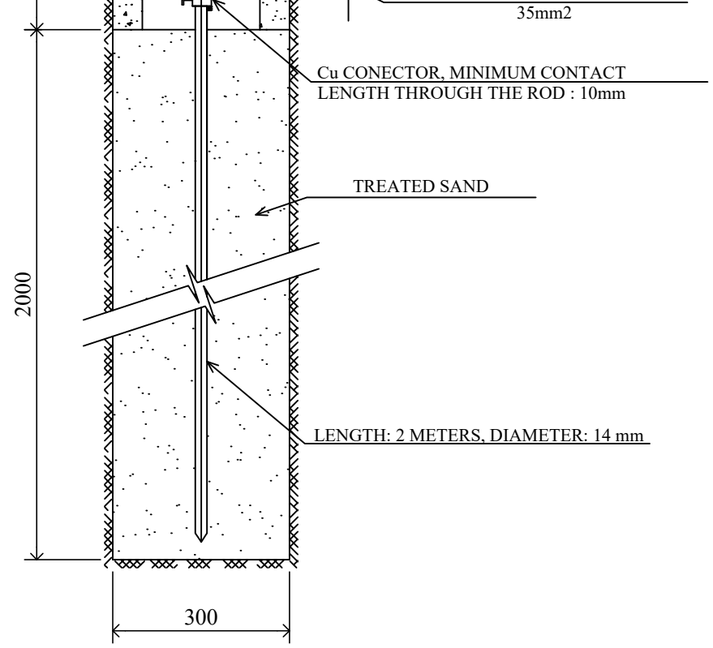
The section of the cable that goes through all the pikes is 35 mm2

Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T	
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
		SIGNATURE:	
	PLAN: INDUSTRIAL UNIT GROUNDING INSTALLATION	DATE: 01/06/20	SCALE: 1/100
			No. PLAN: P14



T.C. grounding installation

DETAIL OF THE INSTALLATION OF THE PIKE 1/1



INFORMATION	
	DESCRIPTION
⊠	Catch basin
⏚	Pike

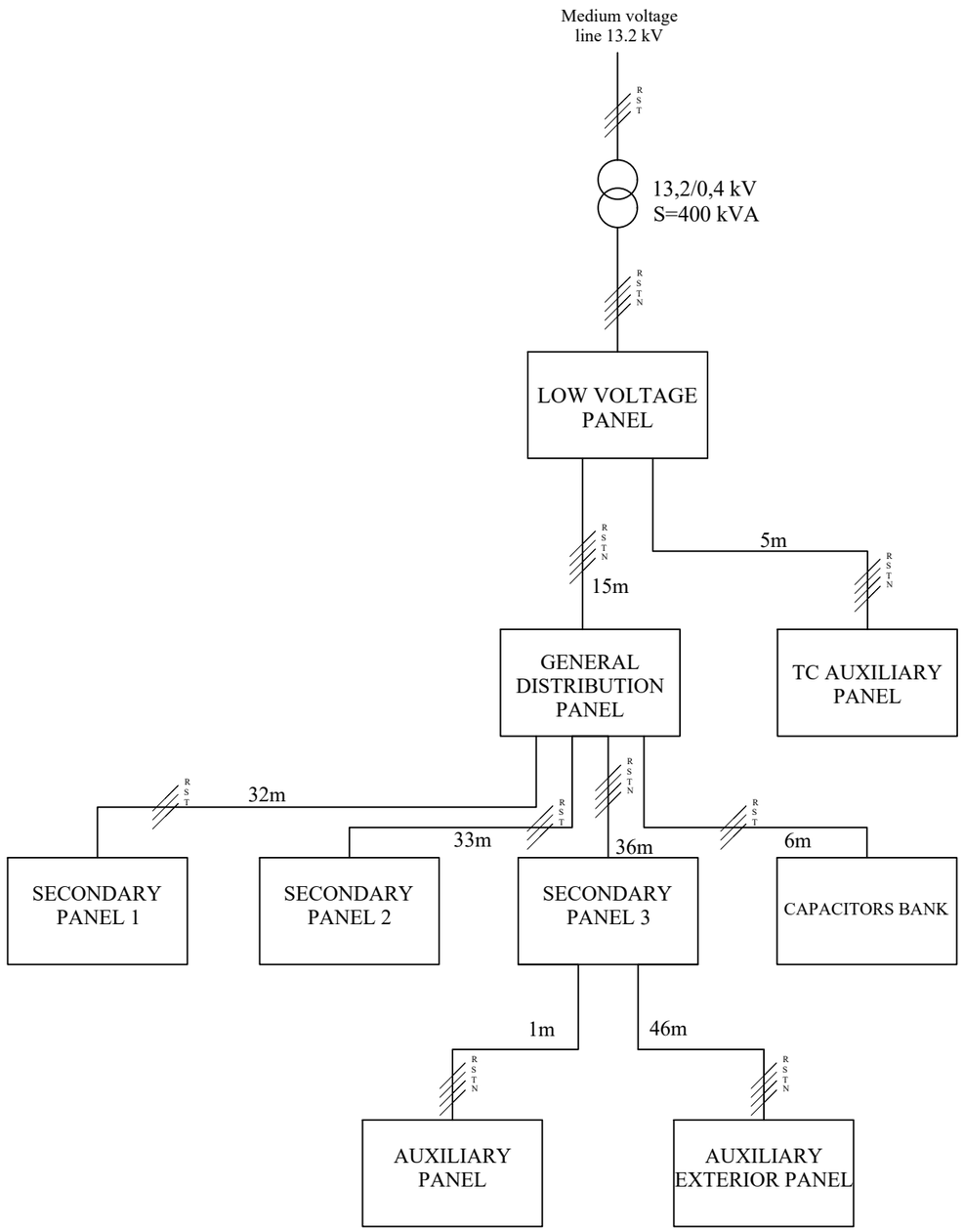
NOTE:

The section of the cable that goes through all the pikes is 35 mm2

Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT		E.T.S.I.I.T	
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER		PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
			SIGNATURE:	
	PLAN: T.C. GROUNDING INSTALLATION	DATE: 01/06/20	SCALE: 1/50	No. PLAN: P15

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

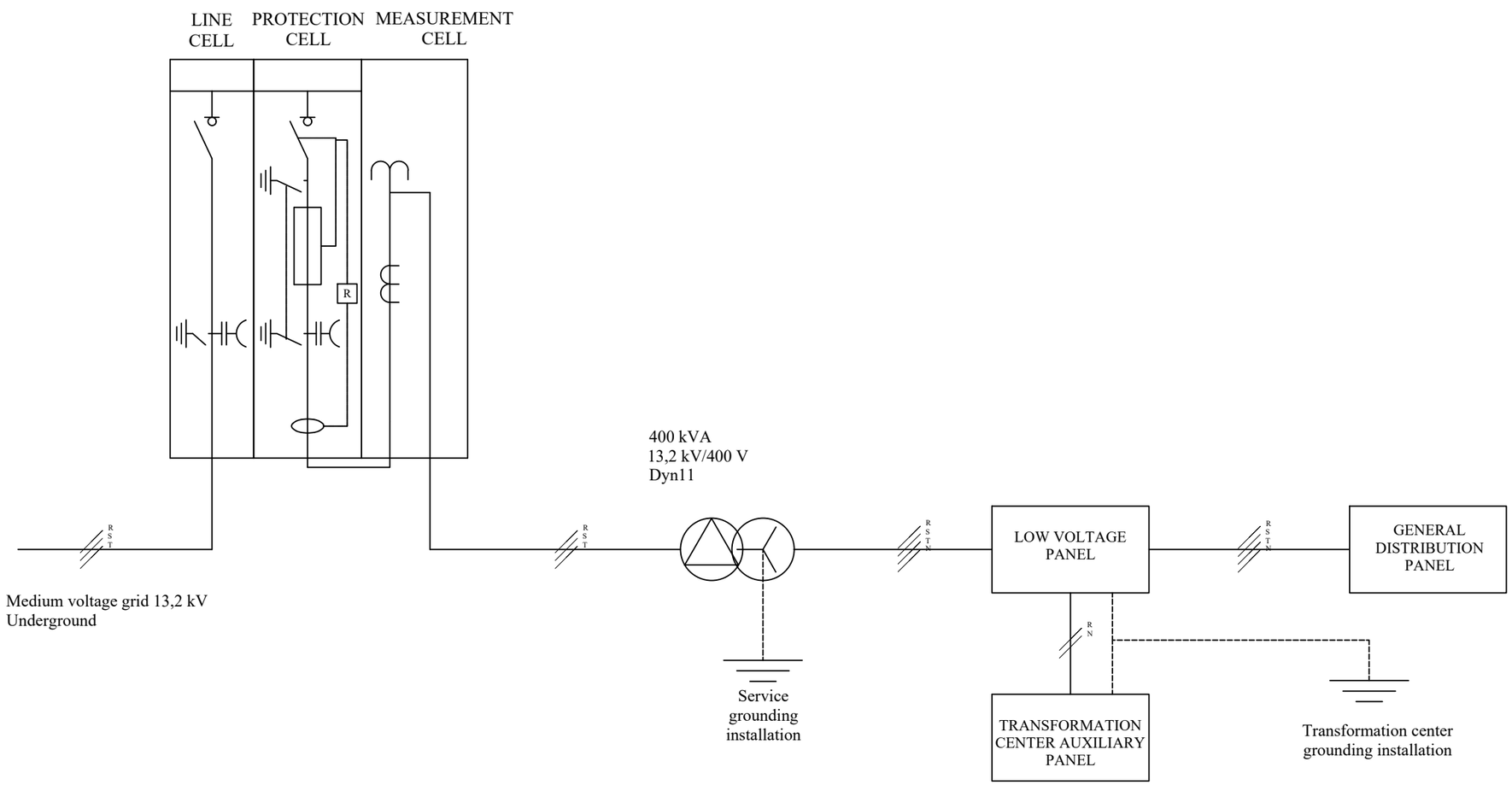
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK



Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T		
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION PANEL	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER		
		SIGNATURE:		
	PLAN: GENERAL DIAGRAM	DATE: 01/06/20	SCALE: -	No. PLAN: P16

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK



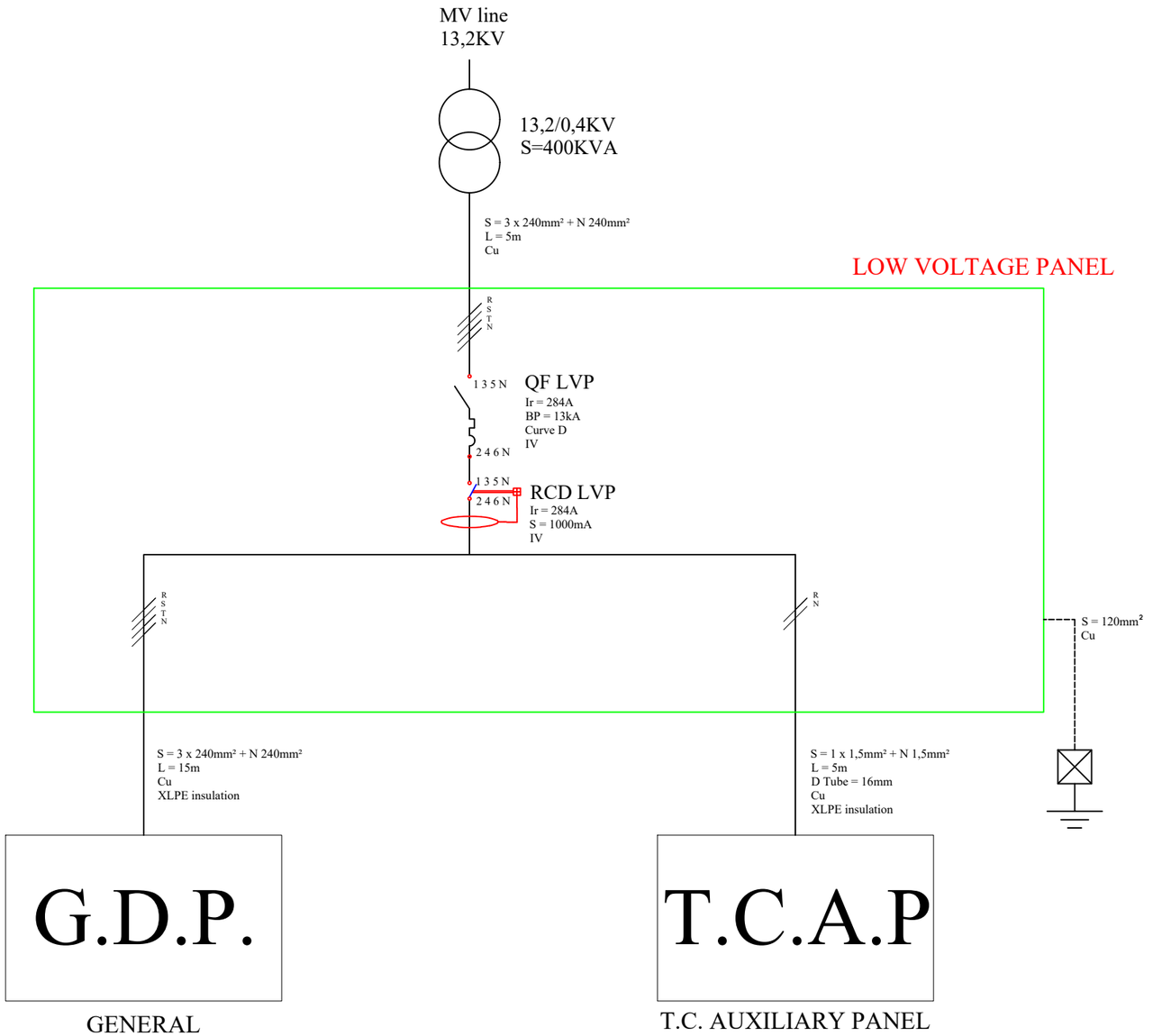
CELLS MAIN CHARACTERISTICS

Line cell	Ur= 24KV, Ir= 400A Rotatory-switch disconnector. Short-circuit current:16KA-20KA Breaking power: 40KA
Protection cell	Ur= 24KV, Ir= 400A Rotatory-switch disconnector. Short-circuit current:16KA-20KA Breaking power: 40KA Fuses: 3x63A
Measurement cell	Ur=24KV 3 Current transformer15-30/5A Class 05 Insulation 24KV. 3 Voltage transformer13,2-220/0,11KV Class 05 Insulation 24KV.

INFORMATION	
	Disconnector switch
	Automatic cut-off switch with fuse
	Transformer
	Grounding disconnector
	Voltage presence indicator
	Voltage transformer
	Current transformer

Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T	
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
		SIGNATURE:	
	PLAN: T.C. SINGLE LINE DIAGRAM	DATE: 01/06/20	SCALE: -	No. PLAN: P17

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK



Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T	
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
		SIGNATURE:	
	PLAN: L.V.P. SINGLE LINE DIAGRAM	DATE: 01/06/20	SCALE: -	No. PLAN: P18

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
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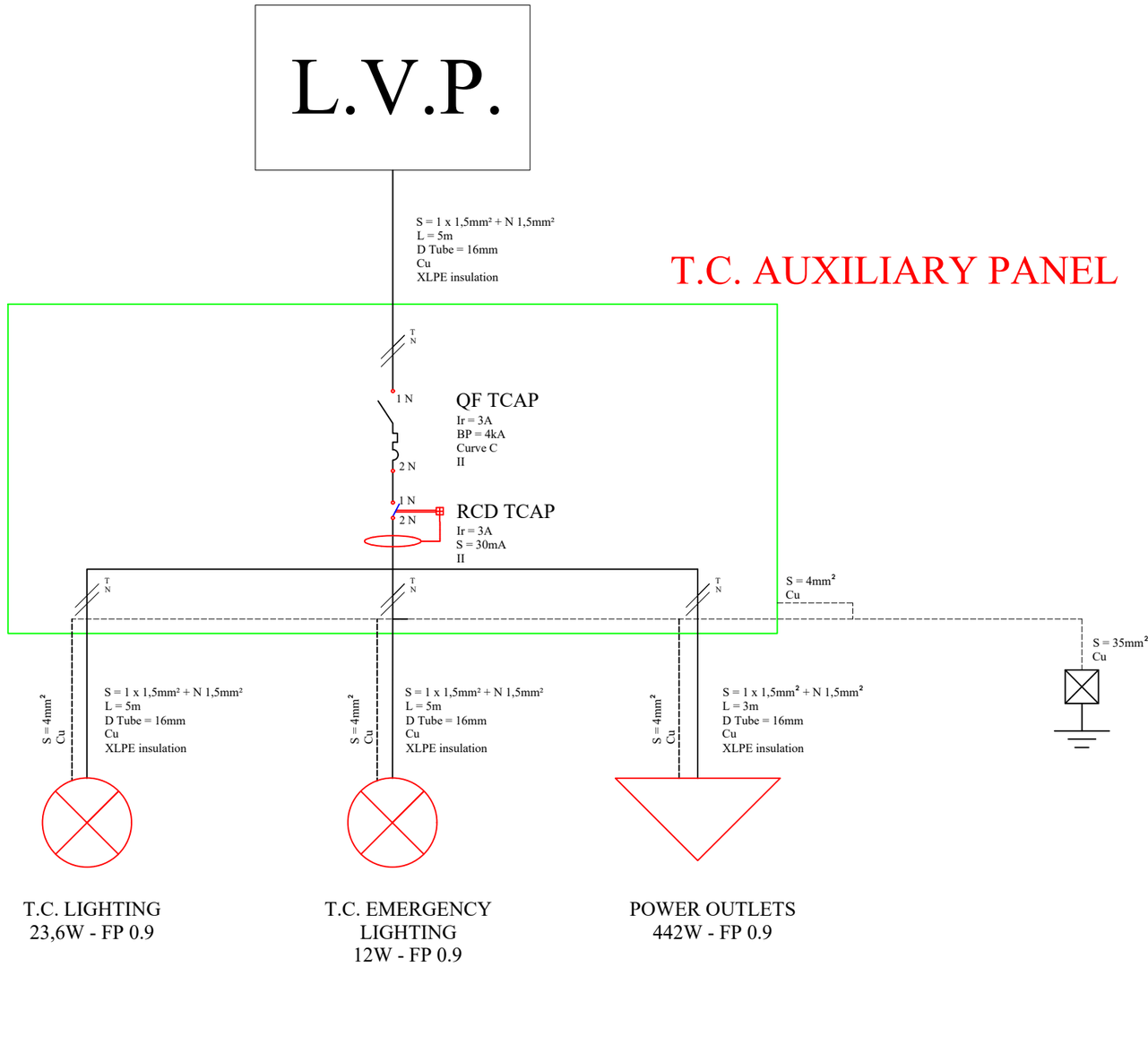

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	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
		SIGNATURE:	
	PLAN: T.C.A.P. SINGLE LINE DIAGRAM	DATE: 01/06/20	SCALE: -	No. PLAN: P19

L.V.P.

S = 35mm²
Cu

S = 3 x 240mm² + N 240mm²
L = 15m
Cu
XLPE insulation

GENERAL DISTRIBUTION PANEL

S = 120mm²
Cu

R S T N

1 3 5 N **QF0**
Ir= 281A
BP = 13kA
Curve D
IV
2 4 6 N

QF 0.1
1 3 5
Ir = 91A
BP = 13kA
Curve D
III
2 4 6

RCD 1
1 3 5
2 4 6
Ir = 91A
S = 500mA
III

R S T

S = 3 x 50mm²
L = 32m
Cu
XLPE insulation

S.P.1.

QF 0.2
1 3 5
Ir = 52A
BP = 13kA
Curve D
III
2 4 6

RCD 2
1 3 5
2 4 6
Ir = 52A
S = 500mA
III

R S T

S = 3 x 16mm²
L = 33m
Cu
XLPE insulation

S.P.2

QF 0.3
1 3 5 N
Ir = 138A
BP = 13kA
Curve C
IV
2 4 6 N

RCD 3
1 3 5 N
2 4 6 N
Ir = 139A
S = 500mA
IV

R S T N

S = 3 x 70mm² + N 35mm²
L = 36m
Cu
XLPE insulation

S.P.3

QF 0.4
1 3 5
Ir = 106A
BP = 13kA
Curve C
III
2 4 6

RCD 4
1 3 5
2 4 6
Ir = 106A
S = 300mA
III

R S T

S = 3 x 50mm²
L = 6m
D Tube = 50mm
Cu
XLPE insulation

S = 25mm²
Cu

CAPACITOR BANK
5 STEPS
-5 kVAr
-10 kVAr
-3x20 kVAr

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		SIGNATURE:	
	PLAN: G.D.P. SINGLE LINE DIAGRAM	DATE: 01/06/20 / SCALE: -	No. PLAN: P20

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
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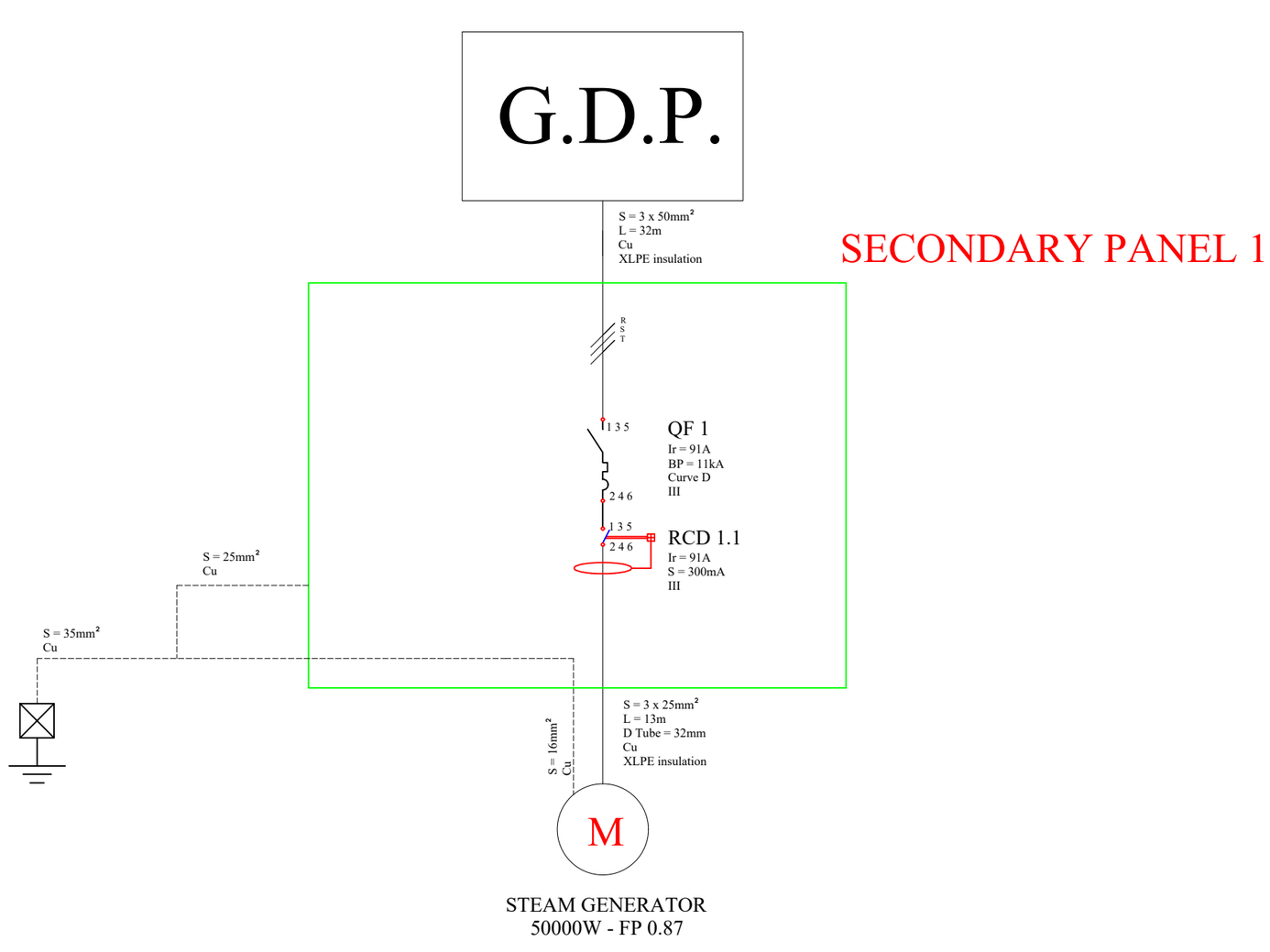

STEAM GENERATOR
50000W - FP 0.87

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	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER		
		SIGNATURE:		
	PLAN: S.P.1. SINGLE LINE DIAGRAM	DATE: 01/06/20	SCALE: -	No. PLAN: P21

G.D.P.

S = 35mm²
Cu

S = 16mm²
Cu

S = 3 x 16mm²
L = 33m
Cu
XLPE insulation

SECONDARY PANEL 2

R S T

1 3 5
2 4 6

QF2
Ir = 52A
BP = 6kA
Curve D
III

RCD 2.1 Ir = 14A S = 300mA III	RCD 2.2 Ir = 16A S = 300mA III	RCD 2.3 Ir = 9A S = 300mA III	RCD 2.4 Ir = 13A S = 300mA III	
QF 2.1 Ir = 11A BP = 6kA Curve D III	QF 2.2 Ir = 1A BP = 6kA Curve D III	QF 2.3 Ir = 2A BP = 6kA Curve D III	QF 2.4 Ir = 12A BP = 6kA Curve D III	QF 2.5 Ir = 1A BP = 6kA Curve D III
QF 2.6 Ir = 3A BP = 6kA Curve D III	QF 2.7 Ir = 4A BP = 6kA Curve D III	QF 2.8 Ir = 4A BP = 6kA Curve D III	QF 2.9 Ir = 1A BP = 6kA Curve D III	QF 2.10 Ir = 5A BP = 6kA Curve D III
QF 2.11 Ir = 8A BP = 6kA Curve D III				

S = 4mm² Cu	S = 4mm² Cu	S = 4mm² Cu	S = 4mm² Cu	S = 4mm² Cu
S = 3 x 2,5mm² L = 11m D Tube = 16mm Cu XLPE insulation	S = 3 x 2,5mm² L = 29m D Tube = 16mm Cu XLPE insulation	S = 3 x 2,5mm² L = 33m D Tube = 16mm Cu XLPE insulation	S = 3 x 2,5mm² L = 30m D Tube = 16mm Cu XLPE insulation	S = 3 x 2,5mm² L = 26m D Tube = 16mm Cu XLPE insulation
S = 4mm² Cu	S = 4mm² Cu	S = 4mm² Cu	S = 4mm² Cu	S = 4mm² Cu
S = 3 x 2,5mm² L = 10m D Tube = 16mm Cu XLPE insulation	S = 3 x 2,5mm² L = 14m D Tube = 16mm Cu XLPE insulation	S = 3 x 2,5mm² L = 44m D Tube = 16mm Cu XLPE insulation	S = 3 x 2,5mm² L = 36m D Tube = 16mm Cu XLPE insulation	S = 3 x 2,5mm² L = 47m D Tube = 16mm Cu XLPE insulation
S = 4mm² Cu	S = 4mm² Cu	S = 4mm² Cu	S = 4mm² Cu	S = 4mm² Cu
S = 3 x 2,5mm² L = 33m D Tube = 16mm Cu XLPE insulation				

M	M	M	M	M
WORT BREW MACHINE 6000W FP 0.85	BOTTLE LABELLING MACHINE 200W FP 0.87	AIRE CONDITIONING 1100W FP 0.9	FERMENTATION TANKS 6400W FP 0.85	BOTTLER 370W FP 0.87
M	M	M	M	M
SCREW CONVEYOR 1400W FP 0.85	MALT MILL 2200W FP 0.85	HOT WATER TANK 2200W FP 0.87	AIR COMPRESSOR 370W FP 0.9	WATER COOLER 2300W FP 0.9
M				
CIP STATION 4250W FP 0.9				

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Nafarroako Unibertsitate Publikoa

INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT

E.T.S.I.I.T

PROYECT:
LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER

PROYECT EXECUTOR:
URDÁNIZ VIEJO, JAVIER

SIGNATURE:

PLAN:
S.P.2. SINGLE LINE DIAGRAM

DATE: 01/06/20

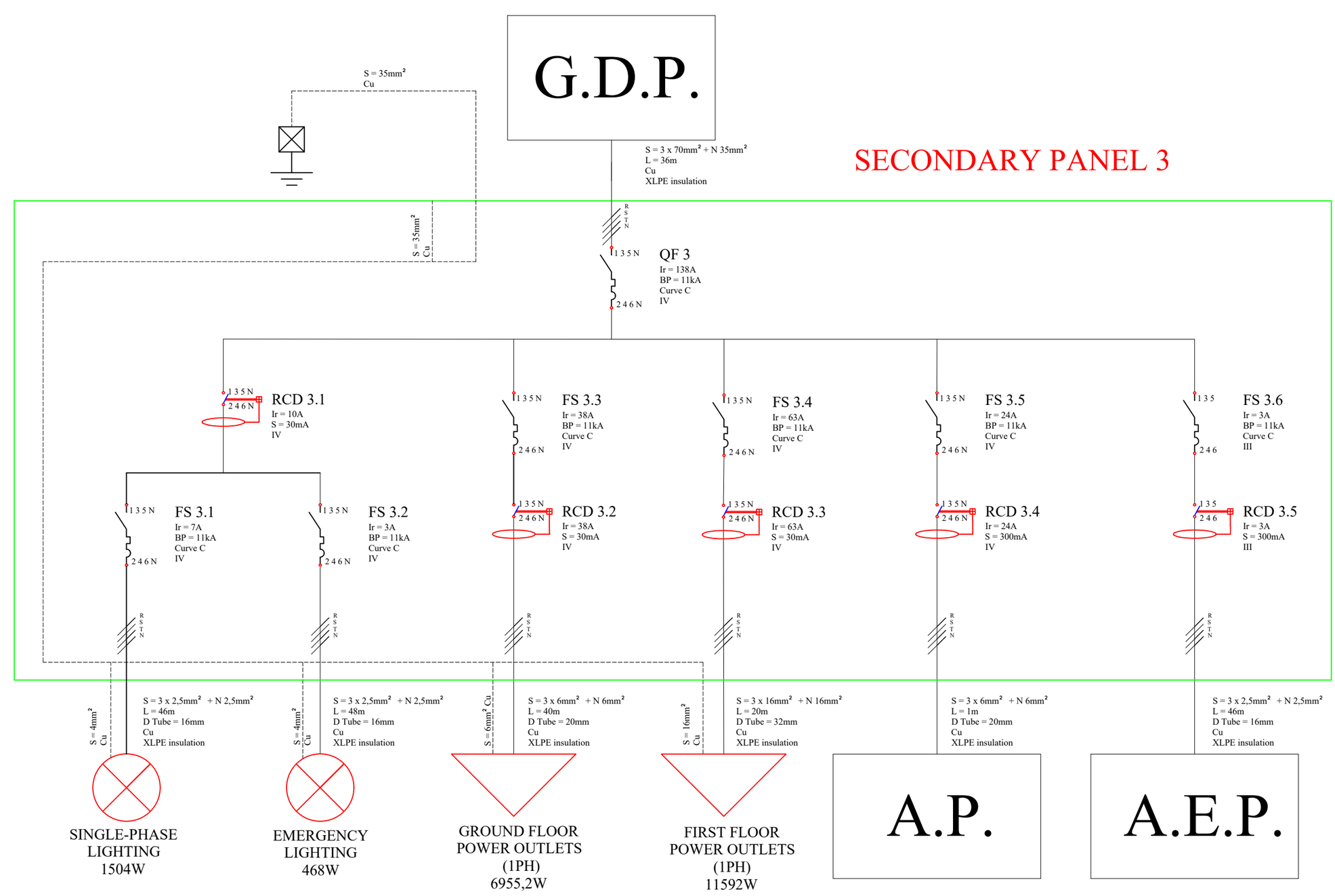
SCALE: -

No. PLAN: P22

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

SECONDARY PANEL 3

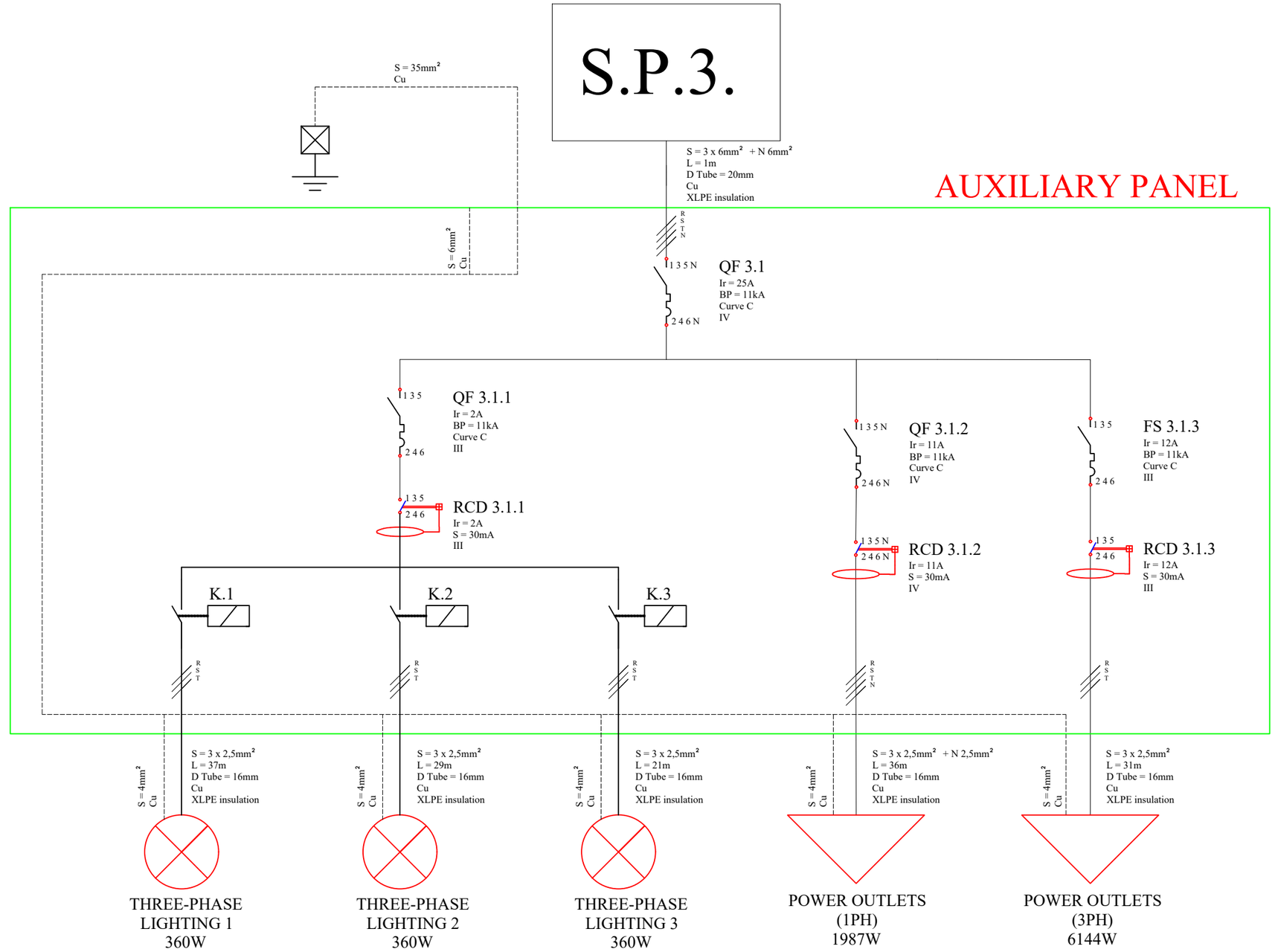


Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER
		SIGNATURE:
	PLAN: S.P.3. SINGLE LINE DIAGRAM	DATE: 01/06/20 / SCALE: - / No. PLAN: P23

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

S.P.3.

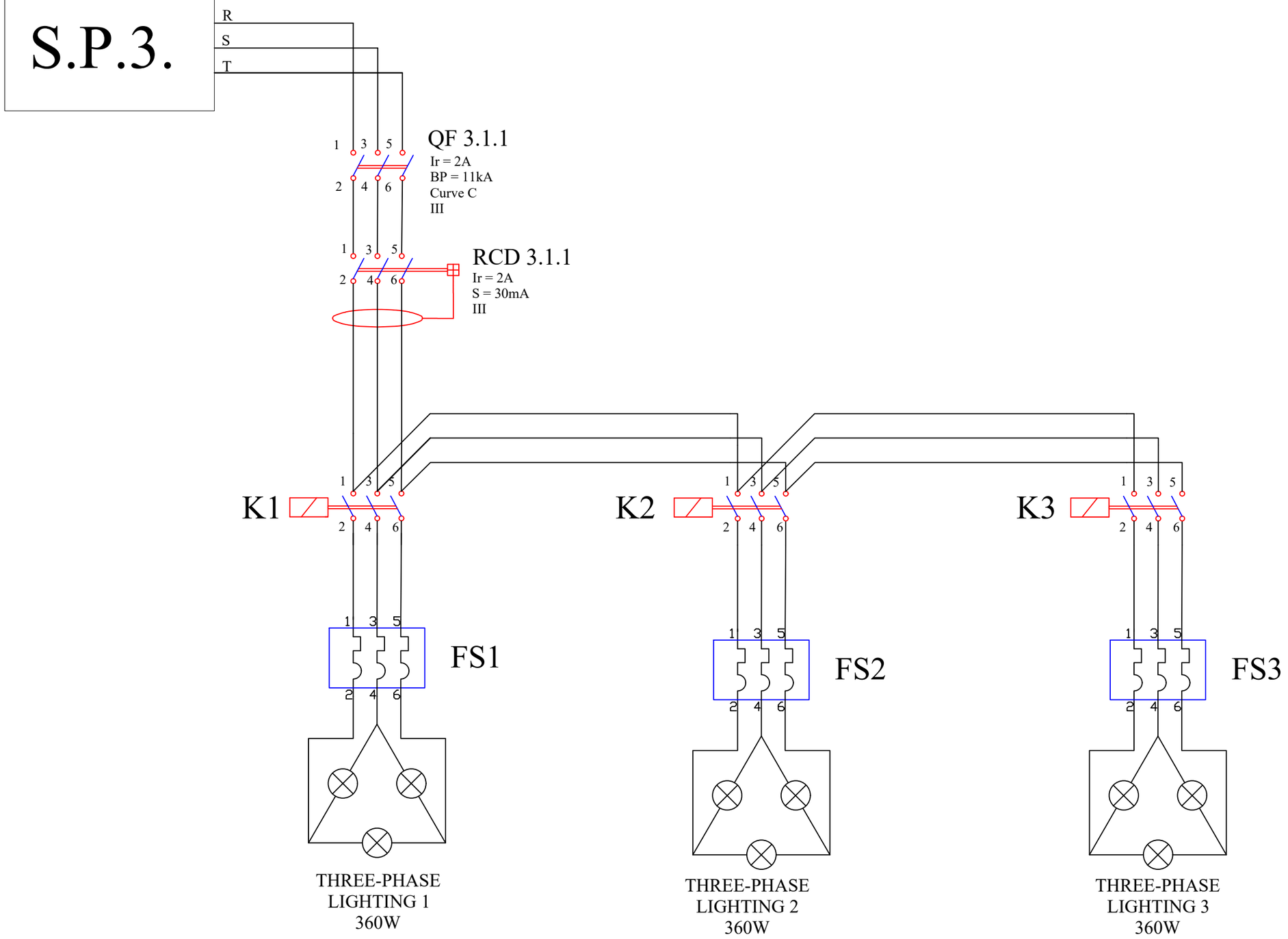
AUXILIARY PANEL



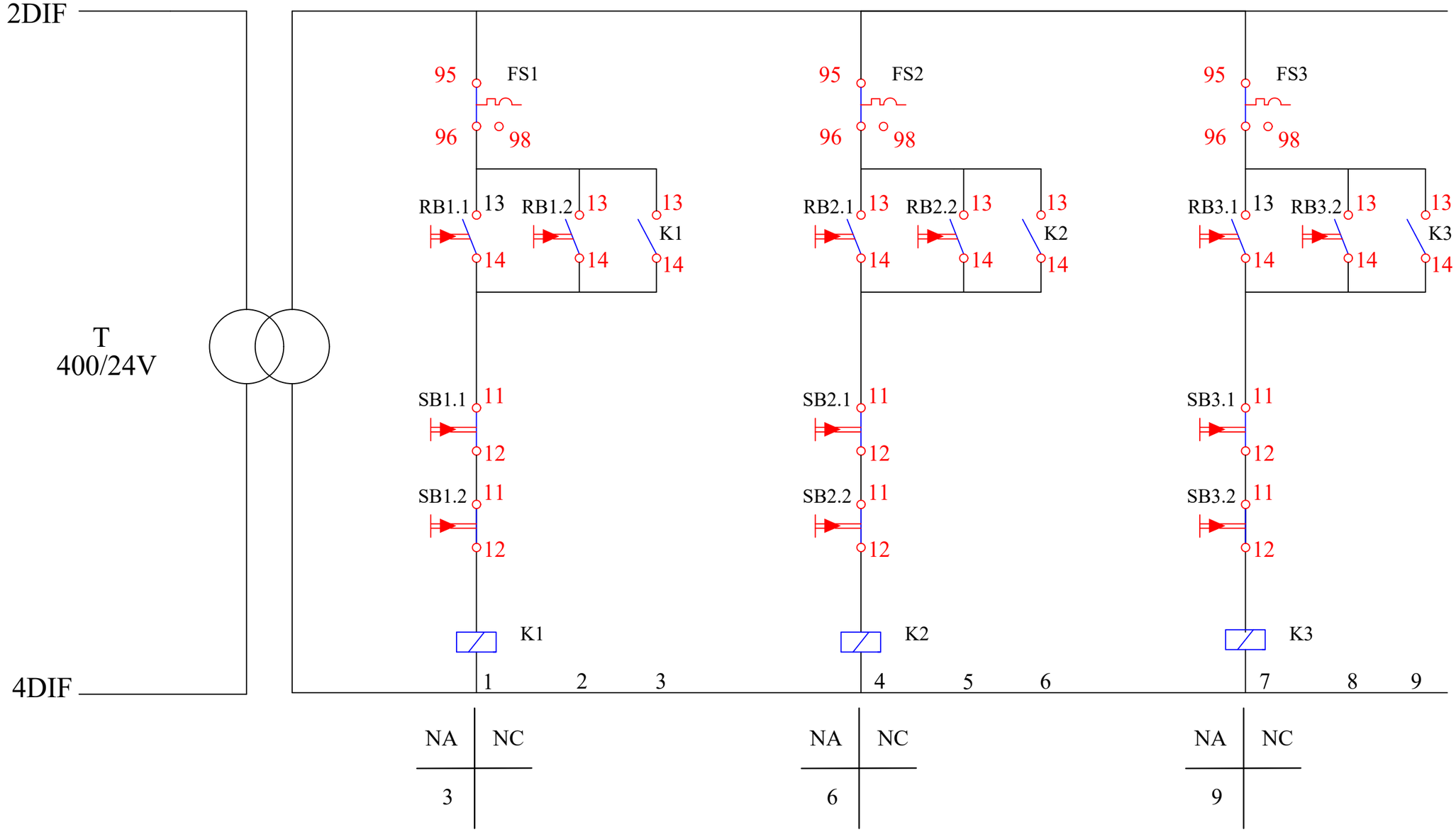
Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T	
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
		SIGNATURE:	
	PLAN: A.P. SINGLE LINE DIAGRAM	DATE: 01/06/20	SCALE: -	No. PLAN: P24

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

S.P.3.



Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T	
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
		SIGNATURE:	
	PLAN: A.P. MULTIPLE LINE POWER DIAGRAM	DATE: 01/06/20	SCALE: -	No. PLAN: P25



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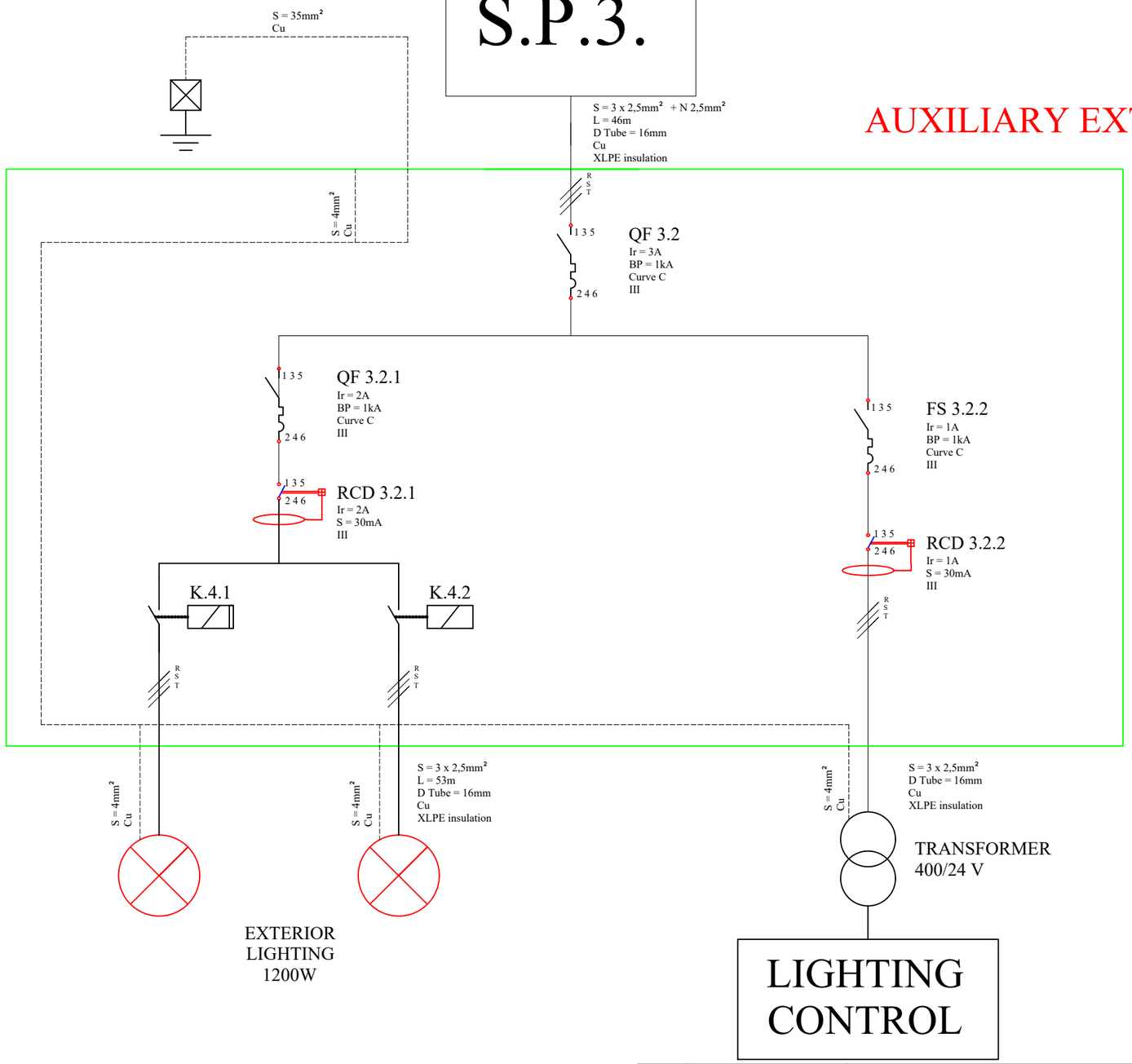
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER
		SIGNATURE:
	PLAN: A.P. MULTIPLE LINE CONTROL DIAGRAM	DATE: 01/06/20 / SCALE: - / No. PLAN: P26

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

S.P.3.

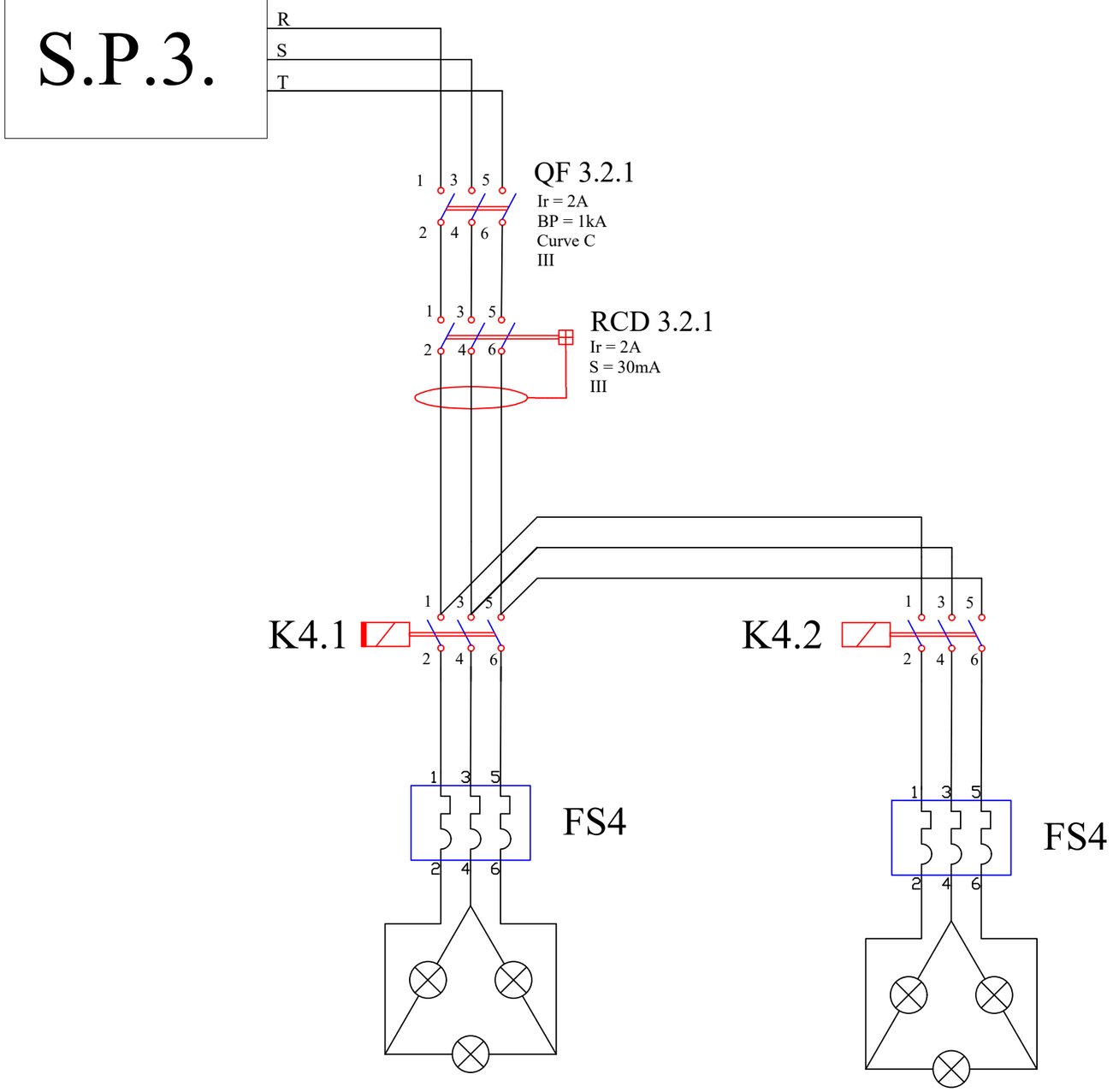


AUXILIARY EXTERIOR PANEL

Universidad Pública de Navarra Nafarroako Unibertsitate Publikoa	INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T	
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
		SIGNATURE:	
	PLAN: A.E.P. SINGLE LINE DIAGRAM	DATE: 01/06/20	SCALE: -	No. PLAN: P27

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK

S.P.3.



EXTERIOR LIGHTING
1200W

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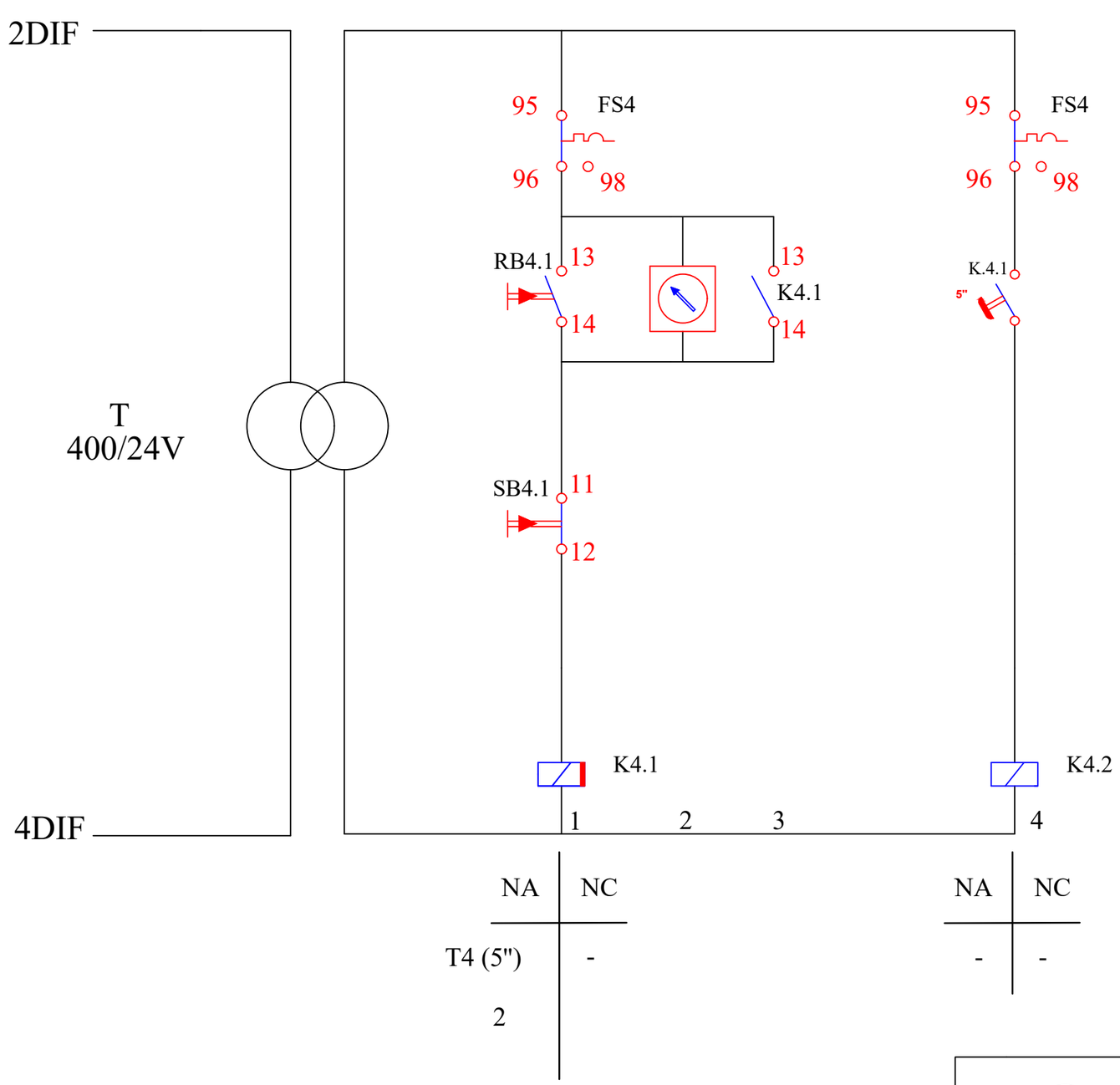
	PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
		SIGNATURE:	
	PLAN: A.E.P. MULTIPLE LINE POWER DIAGRAM	DATE: 01/06/20	SCALE: -	No. PLAN: P28

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK



NA	NC
T4 (5")	-
2	

NA	NC
-	-

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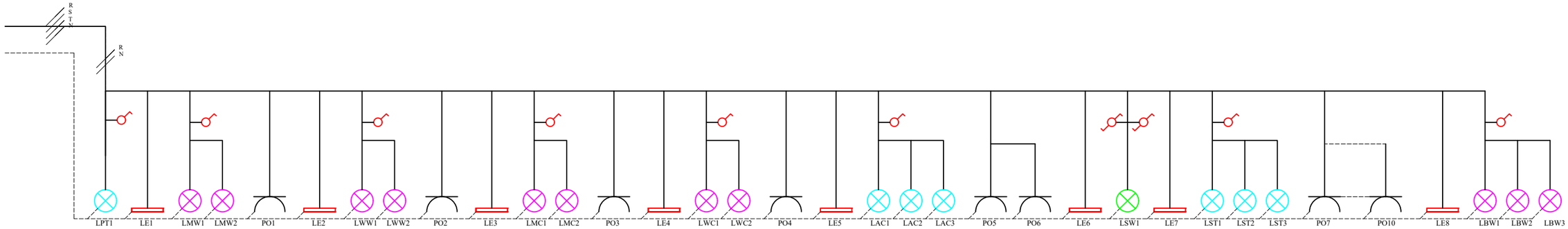
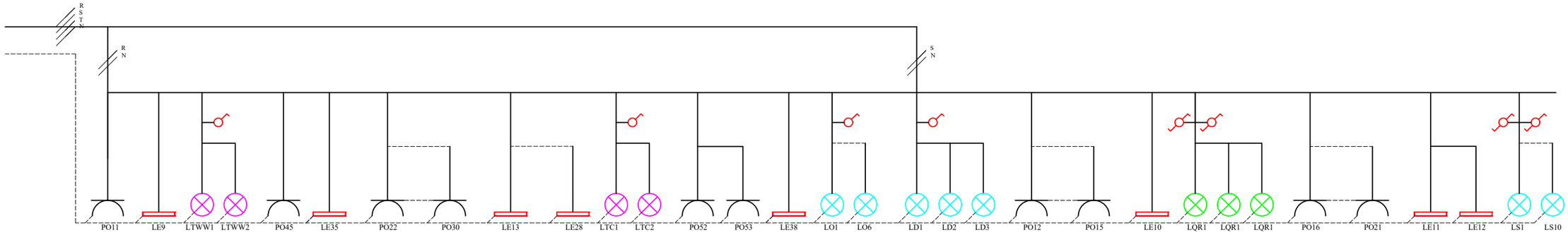
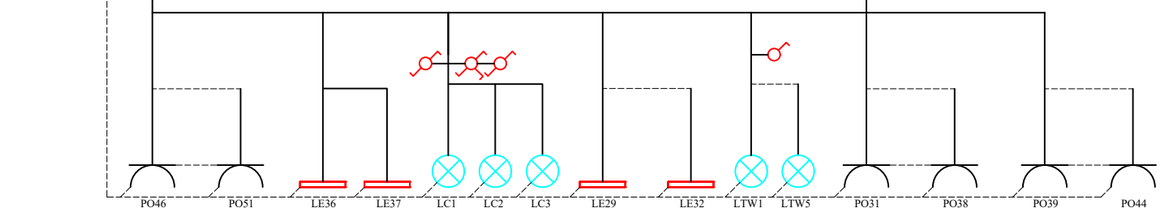
		SIGNATURE:	
	PLAN: A.E.P. MULTIPLE LINE CONTROL DIAGRAM	DATE: 01/06/20	SCALE: -	No. PLAN: P29

CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK
CREADO CON UNA VERSION PARA ESTUDIANTES DE AUTODESK







INFORMATION					
	Nº	MODEL		Nº	MODEL
⊗	4	BY121P G4 LED200S/865 PSU WB		51	Single phase power outlet
⊗	13	DN570B LED 12S/830 PSE-E C WH		12	Single switch
⊗	19	SM53C LED 34S/940PSD PI5 L1130 ALU		8	Toggle switch
▭	37	Luxiona PT-300C Plat		1	Crossing switch

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INDUSTRIAL, COMPUTING AND TELECOMMUNICATION ENGINEERING DEPARTMENT	E.T.S.I.I.T	
PROYECT: LOW VOLTAGE ELECTRICAL INSTALLATION OF A CRAFT BEER BREWERY WITH TRANSFORMATION CENTER	PROYECT EXECUTOR: URDÁNIZ VIEJO, JAVIER	
	SIGNATURE:	
PLAN: PHASE DISTRIBUTION DIAGRAM	DATE: 01/06/20	SCALE: -
		No. PLAN: P30

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Nafarroako Unibertsitate Publikoa

Low voltage electrical installation of a craft beer brewery with transformation center

Document No.4: Specification sheet

Javier Urdániz Viejo

June 1, 2020

INDEX

4.1. General specification sheet

4.1.1. Objective

The present specification sheet establishes the requirements that must be met by the materials, assembly and construction of the low voltage electrical installation, with transformation center, of an industrial unit dedicated to craft beer brewing.

The industrial unit is located in the smallholding 304, unit UC12MB of the NNSS of Aranguren, Navarra.

4.1.2. Area of application

Everything exposed in the present specification sheet would be applied in the works of supply and placement of every piece or work unit, necessary to properly carry out the electrical installation of the industrial unit previously described.

4.1.3. General disposition

All the installations carried out in the development of this project must comply with the precepted in the Low Voltage Electrotechnical Regulations, as well as the complementary regulations, and the Electrotechnical Regulations for Transformation Centers of the supplying company, in this case, Iberdrola.

For its part, the installer is obliged to comply with the corresponding Labor Regulations, the contracting of compulsory insurance, familiar and old age subsidy, health insurance, and all the current social regulations. In particular, it must comply with the dispositions of standard UNE 2402 "Construction Contracting. General Conditions", as long as it is not modified in this document.

4.1.4. Facultative conditions

The project installations would be governed by what is specified in the following regulations:

- Royal Decree 8442/2002, approving the Low Voltage Electrotechnical Regulation.
- Royal Decree 363/2004 by which the administrative procedure for the Low Voltage Electrotechnical Regulation application is regulated.
- Royal Decree 314/2006, by which the Technical Building Code is approved.
- Specific rules and standardization of the electric power supplier (Iberdrola Standards).
- Royal Decree 1955/2000, regulating transport, distribution, commercialization, supply activities and authorization procedures for electric power installations.

- Royal Decree 486/1997 Annex IV: Regulation of lighting in workplaces.
- Royal Decree 2267/2004, on fire safety in industrial establishments.
- Royal Decree 1942/1993, Regulation of fire protective installations.
- Royal Decree 3275/1982, on technical conditions and safety guarantees in power plants, substations and transformation centers.
- LAW 31/1995, on occupational risk prevention.
- Royal Decree 1627/1997, on minimum dispositions for safety and health in constructions.
- Royal Decree 485/1997, on minimum dispositions on safety and health signaling at work.
- Royal Decree 1215/1997, on minimum health and safety dispositions for the use of work equipment by workers.
- Royal Decree 773/1997, on minimum health and safety dispositions related to the use of personal protective equipment by workers.

4.1.5. Job security

The installer would comply with the conditions indicated in Law 31/1995, of November 8, on occupational risk prevention. Likewise, it must provide whatever is necessary for machines maintenance, tools and materials, in safe conditions.

The construction manager may require the installation company to cease the work of any employee or worker who, due to reckless imprudence, is capable of producing accidents that endanger the physical integrity of the worker or his companions. In addition, it may demand all kinds of social security supporting documents to be presented in the legally established manner.

During the manipulation of circuits, equipment with voltage or in its proximity, the operators would wear clothing without metallic accessories and would avoid the unnecessary use of metal objects. Tools or equipment would be carried in bags and insulating footwear would be used.

The installer staff is obliged to use all the personal protection devices, tools and safety clothing, required to eliminate or reduce professional risks such as helmets, glasses, insulating shoes, gloves ...

4.1.6. Public security

The installer must take all the precautions in operations and uses of equipment to protect people and devices from occupational risks and would take responsibility for any accidents that may occur.

The installation company would maintain an insurance policy that sufficiently protects him and his employees. It may protect against damages liability and civil liability that may be incurred for the installer or for third parties, as a consequence of the work execution.

4.1.7. Work organization

The installer would organize the works in the most efficient way for their perfect execution and the constructions would always be carried out following the instructions of the construction manager and the conditions detailed in the following points:

4.1.7.1. Construction data

A copy of the plans, memory and specifications sheet of the project would be given to the installer, as well as any data needed for the complete construction execution. It may take note or make a copy, at his own expense, of the budget and annexes of the project, as well as second copies of all documents.

The installer would be responsible for a good preservation of the original documents where the copies are obtained, which, would be returned to the construction manager after their use. The installer would not make alterations, corrections, omissions, additions or substantial variations in the project data, except with the prior written approval of the construction manager.

4.1.7.2. Work staking

The construction manager, once the installer is in possession of the project and before beginning the works, must reconsider them, paying special attention to the singular points, giving the installer the references and data necessary to completely set their location.

A certificate would be drawn up in duplicate, clearly stating the data delivered and signed by the construction manager and the installer representative. These staking costs would be borne by the installer.

4.1.7.3. General conditions

The installer must supply all the equipment and materials indicated in the plans, according to the number, characteristics, types and dimensions.

In case of quantity discrepancies between plans and budget, what is indicated in the plans would prevail. In case of quality discrepancies, this document would take precedence over any other. In case of doubts about the technical interpretation of any project document, the construction manager criteria would prevail.

The complementary materials of the installation, usually omitted in plans and budget, but necessary for the proper operation of the same, such as electrodes, paints, bushings, flanges, screws, nuts, etc., should be considered as included in the works to be carried out.

All the materials and equipment supplied by the installer must be new and of the required quality by this document, except when the use of used material is specified

in another part of the project. The offer would include the transportation of the materials on site, as well as the workforce for the assembly of materials and equipment and for the reception tests, equipped with the appropriate tools, utensils and measuring instruments.

The project management team reserves the right to ask the installation company to replace a responsible technician, without claiming justifications.

4.1.8. Planning and coordination

Within fifteen days of the award of the work, the installer must present the deadlines for the execution of the following main items:

- Definitive plans, material gathering and stakeout.
- Assembly and partial tests of the power supply, electricity and fire protection grids.
- Assembly of electrical panels, control equipment, lighting and power elements, and electrical energy management.
- Adjustments, start-ups and final tests.

Before the installation start, the installer would collaborate with the project management team to assign dates to the different construction phases. Coordination with other installers would be the responsibility of the project management team.

4.1.9. Materials gathering

According to the construction plan, the installer would store in a pre-established place all the materials necessary to carry out the construction, according to its needs. The materials would be protected against blows, mistreatment and weather phenomena, depending what their constitution or economic value requires.

The installer would be responsible for monitoring the materials during storage and assembly, until provisional reception. The project management team would have free access to all the work points and to the places of materials storage for their previous recognition, being able to be accepted or rejected according to their quality and condition, if the quality does not meet the requirements set in this document.

When any equipment, device or material offers doubts regarding its origin, quality, condition and aptitude for the function, the project management team would have the right to collect samples and send them to an official laboratory, to carry out the pertinent tests at expense of the installer. If the certificate obtained is negative, all unsuitable material would be rejected and replaced, at the installer expense, with material of the required quality.

The project management team would be able to order the opening of an act when it suspects the existence of hidden vices in the installation, being on account of the installer all the expenses caused.

4.1.10. Inspection and pre-assembly measures

Before starting the assembly works, the installer must carry out the stakeout of each and every installation element, equipment, devices and conductions.

In case that there are discrepancies between the measures carried out in the construction and those that appear in the plans document, which prevent the correct performance of the works in accordance with current regulations, the installer must notify the anomalies to the project management team for rectifications.

4.1.11. Plans, catalogues and samples

The project plans should not be considered with an executive character, but only indicative of the general disposition of the mechanical system and the scope of work included in the contract. For the exact location of devices, equipment and channellings, the installer must carefully examine the plans document.

The installer must verify that the equipment situation and the channellings layout do not interfere with other installers elements. In case of conflict, the decision would be the one that the project management team considers.

No equipment or devices may be delivered on site without obtaining the written approval of the project management team. The installer must submit the detail plans, catalogs and samples to the approval of the project management team with sufficient time so that the progress of the installation itself or of the other installers is not interrupted.

The approval by the project management team of plans, catalogs and samples does not exempt the installer from his responsibility regarding the correct installation operation.

4.1.12. Project variations

The installer may propose, at the time of presenting the offer, any variant on this project that affects the system and / or the specified materials, duly justified. The approval of such variants is at the discretion of the project management team, which would approve them only if they present a greater economic benefit without reducing the installation quality.

The project variations requested by the project management team that imply changes in quantities, qualities or the dismantling of a construction part already carried out, must be made by the installer.

4.1.13. Cooperation with other installers

The installer must fully cooperate with other companies, under the supervision of the project management team, providing all the necessary documentation so that the works would proceed without interference or delay.

4.1.14. Protection

The installer must protect the materials or equipment from flaws and damages during storage on site. In particular, should prevent the insulating materials from getting wet or damp.

The connection openings of all the devices and machines must be suitably protected during transport, storage and assembly, until they are joined.

The protections must have the appropriate shape and resistance to prevent foreign bodies and dirt from entering the device, as well as mechanical damage that could suffer the coupling surfaces of flanges, threads, sleeves ...

If the oxidation of the mentioned surfaces is feared, these should be covered with antioxidant paint, which should be removed at the time of coupling. Special care would be taken towards fragile and delicate materials, such as insulating materials, control equipment, measurement, etc., which must be specially protected.

The installer would be responsible for his materials and equipment until the provisional construction reception.

4.1.15. Construction cleaning

During assembling the installations, the installer must evacuate all the surplus materials, conductors, insulating materials, etc.

Likewise, at the end of the construction, all terminal units must be thoroughly cleaned of any dirt.

4.1.16. Scaffolding and rigging

The installer must supply the workforce and equipment, such as scaffolding and rigging, necessary for the movement of light materials from the storage site to the placement site.

The movement of heavy and / or bulky material, from the truck to the final location site, would be carried out by means of the contracting company, under the supervision and responsibility of the installer.

4.1.17. Electric power and water

All the expenses related to the consumption of electrical energy and water by the installer for carrying out the assembly works and for the partial and total tests would be borne by the activity concerned (the client), except when the contrary is indicated in other document.

The installer would disclose his electrical power needs to the client before taking possession of the construction.

4.1.18. Noises and vibrations

All machinery must operate, under any load condition, without producing noise or vibrations that may be considered unacceptable or that exceed the maximum levels allowed by municipal ordinances.

The corrections that, are eventually introduced to reduce noise and vibrations must be approved by the project management team and conform with the equipment manufacturer recommendations.

4.1.19. Accessibility

The installer would inform the project management team, with enough time, of the space and time needed for the assembly of its materials and devices. In this regard, the contractor must cooperate with other installers, since the works to be carried out are carried out in the same environment.

The expenses caused by the works of reopening false ceilings, skids, etc., due to the failure of making its needs known in time, would be borne by the installer. The measurement, control, protection and maneuvering elements must be removable and installed in visible and accessible places.

The installer must place all the equipment that needs periodic maintenance operations in a location that allows full accessibility to all of its parts, observing the most demanding minimum requirements among those set by current regulations and recommended by the manufacturer.

4.1.20. Channellings

Before its colocation, all the channels must be recognized and cleaned of any foreign body, such as burrs, oxides, dirt ...

The alignment of the channels in joints, changes of direction or section and branches would be carried out with the corresponding accessories or special pieces, centering the axes of the channels with those of the special pieces, without forcing the channel. For tubes, in particular, the necessary precautions would be taken so they retain, once installed, their circular section. The tubes must be beared in such a way that the thermal insulation is never interrupted.

In order to reduce the possibility of vibrations transmission, formation of condensation and corrosion, a flexible non-metallic material must be interposed between tubes and metal supports. In any case, the support cannot prevent the free expansion of the tube.

The buried tubes would bring the adequate protection to the environment in which they are immersed, which in no case would prevent free expansion.

4.1.21. Bushing sleeves

The installer must supply and place all the sleeves to be installed on the masonry or structural construction before these constructions are built. The installer would be responsible for the damages caused by not expressing his needs in time or indicating a correct location of the sleeves.

The space between the sleeve and the conduit must be filled with a plastic putty, approved by the project management team, which completely seals the passage and allows free conduction expansion. Furthermore, when the sleeve passes through a fire protection element, the fire resistance of the filler material must be at least equal to that of the structural element.

The sleeves would be made of 6 / 10mm thick galvanized steel sheet or galvanized steel pipe, with sufficient dimensions to allow the conduction to pass comfortably with its thermal insulation. On the other hand, the slack may not be more than 3 cm in length from the perimeter of the conduction.

There may be no connections inside the bushings sleeves.

4.1.22. Moving parts protection

The contractor shall provide protections to all types of moving machines with which accidental contact may take place. The protections must be of removable tube to facilitate operations on the move.

4.1.23. Elevated temperatures protection

Any surface at elevated temperature, with which accidental contact may take place must be protected by thermal insulation, calculated in such a way that its surface temperature does not exceed 60 Celsius degrees.

4.1.24. Electric panels and lines

The installer would supply and install the electrical panels for protection, maneuver and control of all the equipment of the installation.

The installer would also supply and install the power lines between the mentioned panels and the motors of the installation, the protection tubes, trays, junction boxes, joints, etc., as well as the wiring for control and interconnections, except when another document indicates otherwise.

The electrical installation would comply with the requirements established by the Low Voltage Electrotechnical Regulations. The electrical supplier company would be responsible for the electrical supply to all the panels, which would consist on 3 phases, neutral and ground. The connection between these wires and the panels would be in charge of the installer.

The installer must supply the electrical supplier company the necessary information for the connections to the panels, such as the exact location of their installation, the maximum absorbed power and, when necessary, the maximum absorbed current and the admissible voltage drop in the transitional regime.

Except when the contrary is expressed in the project report, the characteristics of the power supply would be the following: three-phase voltage at 400V and single-phase voltage 230V, with a frequency of 50 Hz.

4.1.25. Identification

All the devices, equipment and electrical panels must be marked with an identification plate, on which the name and number of the device would be indicated. The writing must be indelible and could be replaced by an engraving. The characters shall have a height, at least, of 50 mm.

In the electrical panels, all the output terminals must have an identification number that would correspond to the one indicated in the command and power scheme.

All the important equipment and devices of the installation, particularly those that consume energy, must be factory-equipped, in compliance with current regulations, with an identification plate, indicating their main characteristics, as well as the manufacturer name, model and type. The specifications of each device or equipment shall indicate the characteristics that, at least, must appear on the identification plate. The plates shall be fixed by means of a rivet or welding or adhesive material, to ensure their immobility, they shall be placed in a visible place and shall be written in clear characters and in the official Spanish language or languages.

4.1.26. Partial tests

The installer would make available all the human and material resources necessary to carry out the partial and final tests of the installation, carried out as indicated below for the partial tests and, for final tests, in other chapters of this specification sheet.

The partial tests are preceded by a verification of the materials at the time of their reception on site. When the material or equipment arrives on site with an origin certificate, which certifies compliance with the regulations in force, national or foreign, its reception would be carried out checking only its apparent characteristics.

When the material or equipment is installed, it would be verified that the assembly complies with the requirements set in the respective specification. Subsequently, each material or equipment would also participate in partial and total tests of the entire installation.

4.1.27. Final tests

Once the installation is completed, in accordance with the project specifications, and it has been adjusted and balanced according to the indications of the UNE standards, the final tests of the entire installation must be carried out, according to the instructions of the project management team when required.

4.1.28. Provisional reception

Once the constructions are completed, at the request of the installer, the provisional reception would be made by the contractor, requiring the presence of the project management team and the installer representative, drawing up the corresponding certificate, in which the conformity with the work done would be stated, if this is the case.

The certificate would be signed by the project management team and the installer representative. The construction would be considered as received if they have been carried out correctly, in accordance with the specifications given in the technical specifications sheet and in the corresponding project, therefore, the guarantee period would then begin to count.

At the moment of provisional reception, the installer must deliver the following documentation to the project management team:

- A reproducible copy of the final plans, duly updated, including, at least, the principle diagram, the control and safety diagram, the electrical diagram, the location plans for the control and electrical panels and the unit plans, where the route of the distribution conductions of the installations must be indicated.
- A memory of the installation, which includes the project bases and the criteria adopted for its development.
- A list of all the materials and equipment used, indicating manufacturer, brand, model and operating characteristics.
- Instruction manuals.
- The certificate of the installation presented to the Ministry of Industry and Energy of Navarra.
- The maintenance book.
- List of recommended spare parts and complete exploded views of each unit.

The project management team would deliver the mentioned documents to the owner of the installation, together with the compilation sheets of the results of the partial and final tests and the reception certificate, signed by the project management team and the installer.

If the construction is not in the state of being received, it would be stated in the certificate and the installer would be given precise and detailed instructions to remedy the defects observed, setting a deadline for execution. Once this period has expired, a new recognition would be made.

The repair works would be on account and in charge of the installer. If the installer does not comply with these requirements, the contract may be declared terminated with the deposit loss.

4.1.29. Guarantee periods

The guarantee period would be the one indicated in the contract and would start counting from the date of approval of the reception certificate. Until the final reception takes place, the installer is responsible for the construction conservation, with repairs due to defects in execution or poor quality of materials being at its own expense.

During this period, the installer would guarantee the contractor against any third-party claim, founded on cause and occasion of the construction execution.

4.1.30. Final reception

At the end of the guarantee period indicated in the contract or, failing that, six months after provisional acceptance, the constructions would be definitively received, with the concurrence of the construction manager and the representative of the installer, drawing up the corresponding certificate, in duplicate (if the constructions are in accordance), which would be signed by the construction manager and the installer representative and ratified by the contractor and the installer.

4.1.31. Licences

The installer, with the project management team, must manage with all the competent official organisms (national, autonomous, provincial and municipal) the obtaining of the permits related to the installations of the present project, including the writing of the necessary documents, endorsed by the corresponding official college and presence during inspections.

4.1.32. Training

The installer must adequately teach, in the operation and in the maintenance of the installations, the personnel designated by the property in number and qualification.

For it, during a period not lower than what is indicated in another document and before leaving the construction, the installer would specifically assign the appropriate personnel from its staff to carry out the training, in accordance with the present program and which must be approved by the project management team.

4.1.33. Spare parts, tools and specific supplies

The installer would incorporate into the equipment the spare parts recommended by the manufacturer for the period of operation indicated in another document, in accordance with the list of materials supplied with the offer.

4.1.34. Subcontracting of constructions

Unless the contract provides the contrary, or that, from its nature and conditions it is deduced that the work must be carried out directly by the awardee, it may be arranged with third parties to carry out certain construction units.

The conclusion of subcontracts would be subjected to the compliance of the following requirements:

- Give written notice to the project management team of the subcontract to be concluded, indicating the construction parts to be carried out and their economic conditions in order for the former to authorize it previously.

- The construction units that the awardee contract with third parties do not exceed 50% of the total budget for the main construction.

4.1.35. Risks

The constructions would be carried out, in terms of cost, time and art, at risk of the installer, without being, therefore, rights to compensation for loss, prejudice or breakdown. The installer may not allege ignorance of the situation, communications, construction characteristics, etc.

The installer would be responsible for damages caused to facilities and materials in the case of fire, theft, any kind of atmospheric phenomena, etc., and must cover these risks through insurance.

Likewise, the installer must also have civil liability insurance against third parties, for the damages that, directly or indirectly, due to omission or negligence, may be caused to people, animals or property as a result of the work carried out on it or for the performance of its staff or subcontracted.

4.1.36. Contract termination

The dissolution, suspension of payments or bankruptcy of the installer would be causes for termination of the contract, as well as seizure of the goods destined for the construction or used in it. Repeated non-compliance of technical conditions, delay in the delivery of the construction for a period exceeding three months and manifest disobedience in the execution of it would also be causes for termination.

The assessment of the circumstances listed in the previous paragraph would correspond to the project management team. In the cases provided for in the preceding paragraph, the property may unilaterally end the contract without payment of any compensation and request compensation for damages and prejudices, which would be determined in the arbitration practiced.

The installer would have the right to terminate the contract when the constructions is completely suspended and for a period of time greater than three months. In this case, the installer would have the right to demand compensation of five percent of the construction amount pending of realization, apart from full payment of all the construction carried out and of the materials located on site.

4.1.37. Construction payment

The payment for the construction carried out would be made at the end of it. If it is extended for a period of more than 30 days, the monthly certifications of the same would be paid.

Said certifications would only contain fully completed construction units that would have been carried out within the period to which they refer. The valued relationship that appears in the certifications, would be made according to the established prices, reduced in a 10% and with the location, plans and references necessary for its verification.

The installer would be responsible for the necessary operations to measure hidden or buried units, if the construction manager has not been warned in a timely manner for its measurement, the costs of stakeout, inspecting and settling them, in accordance with

current dispositions, and the expenses arising from inspection and facultative surveillance, when the technical management team deems it necessary to establish it.

The verification, acceptance or objections must be completed by both sides within a maximum period of fifteen days.

The construction manager would issue the certifications of the executed works that would have the character of provisional documents on good account, rectifiable by the final settlement or by any of the following certifications, not assuming, on the other hand, approval or receipt of the works executed and included in said certifications.

4.1.38. Collection of collected materials

When, in the opinion of the construction manager, there is no danger that the materials collected and recognized as useful would disappear or deteriorate, it would be paid according to the decomposed prices of the award.

Said material would be indicated by the construction manager, who would reflect it in the certificate of construction receiving, indicating the delivery deadline in the places previously indicated. The installer would be responsible for the damages that occur in the loading, transportation and unloading of this material. In case of delay in its restitution, deterioration or loss, the installer would also be responsible for any additional expenses that may result.

4.1.39. Final disposition

Attendance at any auction, contest or contest-auction whose project includes this general specification sheet, presupposes full acceptance of each and every one of its clauses.

4.2. Technical specification sheet

4.2.1. Generalities

The contractor would undertake to use the materials with the characteristics and brands specified in the project, if for any reason the contractor wants to use materials or devices different than those specified in the project, these must be of similar characteristics and would need to have the relevant authorization of the project manager engineer to use these new materials.

Once the construction have started, they must continue without interruption, unless expressly indicated by the construction manager. The contractor would have adequate technical and human resources for a proper and rapid execution of it.

4.2.2. Receivers

The receivers installed would have to meet the requirements of correct use and security. During their operation, they must not cause disturbances in public distribution grids or communications.

The receivers would be installed according to their destination (local class, location, use, etc.) with the foreseeable mechanical efforts and, in the ventilation conditions necessary so that no dangerous temperature, for the installation itself and for nearby objects, may occur in operation. They would withstand the influence of external agents to which they are subjected in service: dust, humidity, gases ...

4.2.2.1. Lighting

It is strictly forbidden to hang the armatures of the lamps using the conductors that carry the current. The armatures would be attached to the ceilings by means of screws or a similar system.

For the installation of lamps suspended on public roads, the MIE-BT-09 instruction of the Low Voltage Electrotechnical Regulation would be followed.

4.2.2.2. Motors

The motors would be installed in such a way that the approach to their moving parts cannot be the cause of an accident. They would never be in contact with easily combustible materials, keeping the following safety distances:

- 0.5 meters if the power is lower or equal to 1 kW.
- 1 meter if the power is greater than 1 kW.

4.2.3. Electric installations

All the electrical installations of the present project must follow, at all times, the specifications that are detailed in this document, following the guidelines of the following sections:

4.2.3.1. General & individual devices

The height at which the general and individual control and protection devices for the circuits would be located, measured from ground level, would be between 1 and 2 meters, as dictated in the plans document.

The enclosures of the panels would comply the UNE 20.451 and UNEEN60.439-3 standards, with a minimum degree of protection of IP 30 according to UNE20.324 and IK07 according to UNE-EN 50.102.

The installer would permanently attach a plate, printed in indelible characters, on the electric panels. Stating its name or trademark, the date the installation was carried out, as well as the intensity assigned by the main general circuit breaker. In case that more than one residual current device are installed in series there would be a selectivity between them.

All the masses of electrical equipment protected by the same protection device must be interconnected and joined by a protection conductor to the same grounding.

4.2.3.2. Indoor installation

The conductors section used would be determined by the thermal and voltage drop criteria.

The voltage drop between the origin of the installation and any point in the installation would be 4.5% for lighting and 6.5% for other uses.

The maximum admissible currents of the conductors would be governed in their entirety by the indicated in the UNE-HD-60364-5-52 standard.

4.2.3.3. Protective devices

All circuit breakers would be able to cut the maximum current of the circuit in which they are placed without allowing the formation of permanent arcs. Opening and closing circuits, without the possibility of taking an intermediate position. They would have the ability to manual reset.

Its breaking capacity for short-circuit protection would be in accordance with the short-circuit current that may occur at the point where they are installed.

A circuit breaker would be installed for each circuit and its rated operating current and rated operating voltage would be marked on it.

The residual current devices would be able to protect one or several circuits at the same time, causing the opening of the circuit or circuits that protect when fault currents occur in any of them.

4.2.3.4. Conductors identification

The conductors of the installation must be easily identifiable, especially with regard to the neutral conductor and the protective conductor. This identification would be made by the colors presented in their insulation.

When there is a neutral conductor in the installation, it would be identified with the colour blue. The protective conductor would be identified with the colours green and yellow. All phase conductors would be identified with the colours brown, black or grey.

4.2.3.5. Installations subdivisions

The installations would be subdivided so that, the disturbances caused by faults occurred at one point of the installation, affect only certain parts of the installation, or certain machines. This way the protection devices of each circuit would be adequately coordinated and selective with the general protection devices situated downstream.

Every installation would be divided into several circuits, according to the needs, in order to:

- Avoid unnecessary interruptions of all the circuit and limit the consequences of a failure.

- Facilitate verifications, tests and maintenance.

- Avoid the risks that could result from the failure of a single circuit that can be divided, for example if there were only one lighting circuit.

4.2.3.6. Insulation resistance and dielectric rigidity

The dielectric rigidity would be such that, disconnecting the utilization devices, it resists for 1 minute a voltage test of 2U + 1000V at the installer frequency, with U being the maximum service voltage expressed in volts, with a minimum of 1500 V.

The leakage currents shall not exceed the sensitivity of the installed residual current devices as protection against indirect contacts.

4.2.3.7. Electric connexions

Conductor connections by simple twisting or winding would not be allowed, they must always be carried out using individually mounted connection terminals, constituting connection blocks or strips or by using connection flanges. They should always be carried out in junction and / or derivation boxes.

In the case of multipolar wires, the connections would be made in such a way that the current is distributed through all the wires.

For the receivers, they can be connected to the channels directly or through a movable conductor. When this connection is made directly to a fixed channel, the receivers would be located in a way their operation can be verified, their maintenance can be carried out and its connection could be controlled. If the connection is by means of a movable conductor, this would include the number of conductors required, and if applicable, the protective conductor.

In any case, the conductors at the entrance to the devices would be protected against risks of traction, torsion, abrasion, excessive folding, etc., by means of appropriate devices made of insulating materials. It is not allowed to knot the conductors or tie them to the receiver. The protective conductors shall be of such a length that, in case of failure of the traction preventing device, they are only subjected until they have supported the supply conductors.

In heat producer receivers, if the parts of the same that could touch its power supply conductor reach more than 85ºC of temperature, the outer envelope of the conductor would not be made of thermoplastic material.

The connection of movable conductors to the power supply installation would be made using:

- Power outlets
- Connection boxes

4.2.3.8. Isolated conductors under protective tubes

The wires used would have a voltage insulation at least of 450 V. The tubes would be metallic, rigid or flexible, with the following characteristics:

- Compressive strength: Strong

- Impact resistance: Strong.
- Minimum service installation temperature: -5ºC.
- Maximum service installation temperature: +60ºC.
- Bending resistance: Rigid / Curvable.
- Electrical properties: Electrical continuity / Insulator.
- Resistance to penetration of solid objects: Against objects 1mm of diameter
- Resistance to water penetration: Against drops falling vertically when the tube system is inclined 15º.
- Corrosion resistance of metal and composite tubes: Medium interior and exterior protection.

The minimum external diameter of the tubes, depending on the number and section of the conductors, would be obtained from the tables indicated in the ITC-BT-21, as well as the minimum characteristics according to the type of installation.

For the channelling execution under protective tubes, the following general requirements would be taken into account:

- The channelling layout would be made following vertical and horizontal or parallel lines to the edges of the walls that limit the place where the installation is made.
- The tubes would be joined together by means of appropriate accessories to their class that ensure the continuity of protection they provide to the conductors.
- The bends in the tubes would be continuous and would not cause inadmissible section reductions.
- It would be possible to easily insert and remove the conductors in the tubes after placing them and fixing them and their accessories, providing for this the registers that are considered convenient, which in straight sections would not be more than 15 meters separated. The number of angled curves located between two consecutive registers shall not exceed 3.
- The records may only be intended to facilitate the introduction and removal of conductors in tubes or serve at the same time as junction or derivation boxes.
- The connections between conductors shall be made inside appropriate boxes of insulating material and non-flammable. If they are metallic, they would be

protected against corrosion. The dimensions of these boxes would be such that they can comfortably accommodate all the conductors they must contain.

4.2.4. Ground grid

The ground grid must always follow the following specifications:

4.2.4.1. Conductors

The employed conductors in the grid are:

- Bare, of copper and with 35mm^2 of minimum section, in the situation of being part of the ground grid.
- Insulated by means of 450/750 V voltage cables, with green-yellow coating, 4 mm^2 copper conductor with a minimum section for underground grids.

4.2.4.2. Grounding resistance

The value of the grounding resistance would be such that any mass cannot give rise to contact voltages greater than:

- 24 V in local or conductive location
- 50 V in other cases

If the installation conditions are such that they can give rise to contact voltages higher than the values indicated above, the rapid elimination of the fault would be ensured by means of suitable breaking devices.

4.2.5. Transformation center

The installer must follow the specifications regarding the transformation center.

4.2.5.1. High voltage devices

The cells used would be prefabricated by ORMAZABAL, with a metal envelope and SF_6 insulation. Modular cells would be used, so that, in case of failure, it is possible to remove only the damaged cell.

4.2.5.2. Transformer

The installed transformer in the transformation center would be three-phase and with the characteristics specified in the project report.

4.2.5.3. Transformation center grounding

The groundings would be carried out strictly in the manner indicated in the project.

There would be two separate grounding circuits:

T.C. grounding

To which it would be connected:

- H.V. masses
- L.V. masses
- H.V. auto valves
- Metal wire wraps or screens
- Protection screens
- Ground terminals of the voltage detectors
- Interior metal reinforcements of the building
- Metallic transformer tank

Service grounding

To which it would be connected:

- Transformer neutral

The neutral ground line would be isolated throughout its path with an insulation level of 10 kV at power frequency for 1 minute and 20 kV at 1.2 / 50 µs wavelength pulse.

4.2.5.4. Commissioning & disconnection of the T.C.

To carry out the commissioning of the transformation center, it would be done in the following order:

1. Disconnector connection.
2. High voltage circuit breaker.
3. Low voltage main circuit breaker

To disconnect, it would be done in the following order

1. Disconnection of the low voltage main circuit breaker
2. Disconnection of the high voltage circuit breaker
3. Disconnection of the disconnector

This order would be followed so that when the load disconnectors are operated, no electric shocks occur between the ends near to the disconnector.

4.2.5.5. Use, maintenance & security conditions

The transformation center would be kept closed at all times to prevent access by people foreign the service, in accordance with the High Voltage Regulations. It must be complied with the regulations regarding the minimum width of the corridors to allow the extraction of the installed cells and any other type of object.

Any item that does not belong to the installation cannot be stored. In addition, the electrical installation must be properly marked to prevent errors in maneuvers, accidental contacts with live elements or other accidents. The procedures necessary to perform first aid in the event of an accident would be posted in a visible place.

The cells would carry a distinctive plate with their characteristics:

- Manufacturer
- Year of production
- Type of device and manufacturing number
- Rated current
- Short duration rated current
- Rated frequency

4.2.6. Emergency lighting

The emergency lighting would follow the following guidelines:

- When the decrease in voltage reaches 70% of its rated value, the emergency lighting would automatically activate. The lighting would be fixed and would have an independent power supply.
- The lighting would maintain its function for at least one hour from its activation
- It would maintain a minimum illumination of 5 lux at ground level on evacuation routes.

Pamplona. June 1, 2020.

Sgd. Javier Urdániz Viejo

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Universidad Pública de Navarra
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Low voltage electrical installation of a craft beer brewery with transformation center

Document No.5: Budget

Javier Urdániz Viejo

June 1, 2020

INDEX

5.1. Material Execution Budget

5.1.1. Chapter 1: Transformation center

Item	Description	Quantity	Unit	Price (€/U.)	Total (€)
	Materials				
1.1.	Ground preparation for the placement of the prefabricated hut. Including the required devices. Excavation:4,6 m long, 2,5m wide and 0,6m deep	1	Unit	950,00	950,00
1.2.	Prefabricated hut Manufacturer: ORMAZABAL Model: PFU-4 Dimensions: 4460 x 2380 x 3045 mm	1	Unit	6.492,63	6.492,63
1.3.	Three-phase transformer Manufacturer: ORMAZABAL Power: 400kVA, Voltage 13,2/0,4kV, Connection: Dyn11 Dimensions: 1276 x 876 x 876 mm	1	Unit	8.591,11	8.591,11
1.4.	Line cell (CML-24) Manufacturer: ORMAZABAL Vr = 24kV, Ir = 400A Dimensions: 370 x 1800 x 850 mm	1	Unit	1.245,00	1.245,00
1.5.	Protection cell (CMP-F-24) Manufacturer: ORMAZABAL Vr = 24kV, Ir = 400A Dimensions: 420 x 1800 x 850mm	1	Unit	4.050,00	4.050,00
1.6.	Measurement cell (CMM-24) Manufacturer: ORMAZABAL Vr = 24kV Dimensions: 800 x 1800 x 1025mm	1	Unit	4.960,00	4.960,00
				Subtotal Materials	26.288,74
	Equipment & machinery				
1.7.	2 ton crane rental	4	Hours	15,00	60,00
				Subtotal Equipment & machinery	60,00
	Workforce				
1.8.	Officer 1 construction	4	Hours	18,50	74,00
1.9.	Construction assistant	4	Hours	17,50	70,00
1.10.	Officer 1 electrician	3	Hours	19,00	57,00
1.11.	Electrician assistant	3	Hours	17,50	52,50
				Subtotal Workforce	253,50
				TOTAL	26.602,24

5.1.2. Chapter 2: Protections

Item	Description	Quantity	Unit	Price (€/U.)	Total (€)
	Fuse box				
2.1	Fuse box Seller: ADAJUSA Dimensions: 600 x 600 x 250 IP 66 Key lock	4	Unit	87,11	348,44
2.2.	Fuse box Seller: ADAJUSA Dimensions: 1000 x 800 x 300 IP 66 Key lock	3	Unit	173,13	519,39
2.3.	Fuse box Seller: ADAJUSA Dimensions: 800 x 600 x 250 IP 66 Key lock	1	Unit	54,60	54,60
				Subtotal Fuse box	922,43
	Circuit breakers				
2.4.	Circuit breaker MC 400A Manufacturer: AAB BP: 36kA, Curve D, 4 Poles Reference: 1SDA054325R1	2	Unit	1.197,05	2.394,10
2.5.	Circuit breaker MC 100A Manufacturer: DELIXI BP: 25kA, Curve D, 3 Poles Code: BA0110 Reference: CDM7-125L/3/100A	2	Unit	162,60	325,20
2.6.	Circuit breaker MC 63A Manufacturer: DELIXI BP: 25kA, Curve D, 3 Poles Code: BA0108 Reference: CDM7-125L/3/63A	1	Unit	140,30	140,30
2.7.	Circuit breaker MC 160A Manufacturer: AAB BP: 25kA, Curve D, 4 Poles Reference: 1SDA066821R1	2	Unit	244,79	489,58

2.8.	Circuit breaker MC 125A Manufacturer: DELIXI BP: 25kA, Curve C, 3 Poles Code: BA0111 Reference: CDM7-125L/3/125A	1	Unit	269,45	269,45
2.9.	Circuit breaker 6A Manufacturer: DELIXI BP: 4,5kA, Curve C, 2 Poles Code: AA2006 Reference: DZ47/2/6C	1	Unit	19,90	19,90
2.10.	Circuit breaker 63A Manufacturer: DELIXI BP: 6kA, Curve D, 3 Poles Code: ACD363 Reference: CDB7/3/63D	1	Unit	159,30	159,30
2.11.	Circuit breaker 16A Manufacturer: DELIXI BP: 6kA, Curve D, 3 Poles Code: ACD316 Reference: CDB7/3/16D	2	Unit	90,25	180,50
2.12.	Circuit breaker 1A Manufacturer: DELIXI BP: 6kA, Curve D, 3 Poles Code: ACD301 Reference: CDB7/3/1D	3	Unit	110,50	331,50
2.13.	Circuit breaker 3A Manufacturer: DELIXI BP: 6kA, Curve D, 3 Poles Code: ACD303 Reference: CDB7/3/3D	2	Unit	110,50	221,00
2.14.	Circuit breaker 6A Manufacturer: DELIXI BP: 6kA, Curve D, 3 Poles Code: ACD306 Reference: CDB7/3/3D	3	Unit	96,65	289,95
2.15.	Circuit breaker 10A Manufacturer: DELIXI BP: 6kA, Curve D, 3 Poles Code: ACD310 Reference: CDB7/3/10D	1	Unit	90,20	90,20

2.16.	Circuit breaker MC 12,5A Manufacturer: DELIXI BP: 35kA, Curve C, 4 Poles Code: BB0121 Reference: CDM7-125M/4/12,5A	3	Unit	251,90	755,70
2.17.	Circuit breaker MC 40A Manufacturer: DELIXI BP: 35kA, Curve C, 4 Poles Code: BB0126 Reference: CDM7-125M/4/40A	1	Unit	251,90	251,90
2.18.	Circuit breaker MC 63A Manufacturer: DELIXI BP: 35kA, Curve C, 4 Poles Code: BB0128 Reference: CDM7-125M/4/63A	1	Unit	251,90	251,90
2.19.	Circuit breaker MC 25A Manufacturer: DELIXI BP: 35kA, Curve C, 4 Poles Code: BB0124 Reference: CDM7-125M/4/25A	2	Unit	251,90	503,80
2.20.	Circuit breaker MC 12,5A Manufacturer: DELIXI BP: 25kA, Curve C, 3 Poles Code: BA0101 Reference: CDM7-125L/3/12,5A	3	Unit	140,30	420,90
2.21.	Circuit breaker 6A Manufacturer: DELIXI BP: 6kA, Curve C, 3 Poles Code: ACC306 Reference: CDB7/3/6C	1	Unit	54,10	54,10
2.22.	Circuit breaker 3A Manufacturer: DELIXI BP: 6kA, Curve C, 3 Poles Code: ACC303 Reference: CDB7/3/3C	1	Unit	81,75	81,75
2.23.	Circuit breaker 1A Manufacturer: DELIXI BP: 6kA, Curve C, 3 Poles Code: ACC101 Reference: CDB7/1/1C	1	Unit	35,05	35,05
				Subtotal Circuit breakers	7.266,08

	Residual current devices				
2.24.	Opening relay Manufacturer: ABB Reference: 1SDA066325R1	2	Unit	71,54	143,08
2.25.	Toroidal relay Manufacturer: ABB Reference: P119411200000	2	Unit	131,11	262,22
2.26.	Toroidal transformer Manufacturer: ABB Reference: P101541200000	1	Unit	120,50	120,50
2.27.	Residual current device 125A 500mA 4Poles Manufacturer: ABB Reference: 2CSF204201R4950	1	Unit	2.731,03	2.731,03
2.28.	Residual current device 63A 500mA 4Poles Manufacturer: ABB Reference: 2CSF204201R4630	1	Unit	328,50	328,50
2.29.	Toroidal transformer Manufacturer: ABB Reference: P101521200000	1	Unit	145,82	145,82
2.30.	Residual current device 125A 300mA 4Poles Manufacturer: ABB Reference: 2CSF204201R3950	2	Unit	535,49	1.070,98
2.31.	Residual current device 16A 30mA 2Poles Manufacturer: ABB Reference: 2CSF202592R1160	1	Unit	568,69	568,69
2.32.	Residual current device 25A 300mA 4Poles Manufacturer: ABB Reference: 2CSF204101R3250	6	Unit	221,91	1.331,46
2.33.	Residual current device 25A 30mA 4Poles Manufacturer: ABB Reference: 2CSF204101R1250	6	Unit	124,46	746,76

2.34.	Residual current device 40A 30mA 4Poles Manufacturer: ABB Reference: 2CSF204101R1400	1	Unit	272,07	272,07
2.35.	Residual current device 63A 300mA 4Poles Manufacturer: ABB Reference: 2CSF204101R3800	1	Unit	301,82	301,82
				Subtotal Residual current device	7.721,11
	Workforce				
2.36.	Officer 1 electrician	11	Hours	19,00	209,00
2.37.	Electrician assistant	11	Hours	17,50	192,50
				Subtotal Workforce	401,50
				TOTAL	16.311,12

5.1.3. Chapter 3: Conductors & tuber

Item	Description	Quantity	Unit	Price (€/m.)	Total (€)
	Conductors				
3.1.	Wire 2x1,5 mm^2 Insulation a 0,6/1kV Model: RZ1-K Manufacturer: GENERAL CABLE	22	Meters	0,41	9,02
3.2.	Wire 3x2,5 mm^2 Insulation a 0,6/1kV Model: RZ1-K Manufacturer: GENERAL CABLE	544	Meters	1,02	554,88
3.3.	Wire 4x2,5 mm^2 Insulation a 0,6/1kV Model: RZ1-K Manufacturer: GENERAL CABLE	248	Meters	1,56	386,88
3.4.	Wire 4x6 mm^2 Insulation a 0,6/1kV Model: RZ1-K Manufacturer: GENERAL CABLE	49	Meters	2,01	98,49
3.5.	Wire 3x16 mm^2 Insulation a 0,6/1kV Model RZ1-K Manufacturer: GENERAL CABLE	40	Meters	5,14	205,6

3.6.	Wire 4x16 mm^2 Insulation a 0,6/1kV Model: RZ1-K Manufacturer: GENERAL CABLE	24	Meters	10,1	242,4
3.7.	Wire 3x25 mm^2 Insulation a 0,6/1kV Model: RZ1-K Manufacturer: GENERAL CABLE	16	Meters	10,47	167,52
3.8.	Wire 1x50 mm^2 Insulation a 0,6/1kV Model: RZ1-K Manufacturer: GENERAL CABLE	138	Meters	5,76	794,88
3.9.	Wire 1x70 mm^2 Insulation a 0,6/1kV Model: RZ1-K Manufacturer: GENERAL CABLE	172	Meters	8,08	1.389,76
3.10	Wire 1x240 mm^2 Insulation a 0,6/1kV Model: RZ1-K Manufacturer: GENERAL CABLE	72	Meters	26,28	1.892,16
3.11.	Bare conductor TT 4mm^2 Manufacturer: BRONMETAL	814	Meters	1,72	1.400,08
3.12.	Bare conductor TT 6mm^2 Manufacturer: BRONMETAL	49	Meters	2,38	116,62
3.13.	Bare conductor TT 16mm^2 Manufacturer: BRONMETAL	79	Meters	2,85	225,15
3.14.	Bare conductor TT 25mm^2 Manufacturer: BRONMETAL	46	Meters	2,54	116,84
3.15.	Bare conductor TT 35mm^2 Manufacturer: BRONMETAL	43	Meters	2,87	123,41
3.16.	Bare conductor TT 120mm^2 Manufacturer: BRONMETAL	18	Meters	3,25	58,5
				Subtotal Conductors	7.782,19
	Tubes				
3.17.	PVC flexible tube Diameter: 16mm Manufacturer: AISCAN	814	Meters	0,12	97,68

3.18.	PVC flexible tube Diameter: 20mm Manufacturer: AISCAN	49	Meters	0,14	6,86
3.19.	PVC flexible tube Diameter: 32mm Manufacturer: AISCAN	40	Meters	0,15	6,00
3.20.	PVC flexible tube Diameter: 50mm Manufacturer: AISCAN	7	Meters	0,21	1,47
				Subtotal Tubes	112,01
	Trays				
3.21.	Metal tray Dimensions 100x400 mm Manufacturer: AISCAN	50	Meters	12,98	649,00
				Subtotal Trays	649,00
	Workforce				
3.22.	Officer 1 electrician	10	Hours	19,00	190,00
3.23.	Electrician assistant	10	Hours	17,50	175,00
				Subtotal Workforce	365,00
				TOTAL	8.908,20

5.1.4. Chapter 4: Grounding

Item	Description	Quantity	Unit	Price (€/U.)	Total (€)
	Materials				
4.1.	Electrode, 2 meters long and 14mm diameter	14	Unit	18,00	252,00
4.2.	Bare copper conductor, 35mm^2	80	Meters	2,81	224,80
4.3.	Staple for hook connection	14	Unit	1,00	14,00
4.4.	Polypropylene catch basin with manhole cover 40 x 40 cm	14	Unit	74,00	1.036,00
				Subtotal Materials	1.526,80
	Workforce				
4.5.	Officer 1 electrician	9	Hours	19,00	171,00

4.6.	Electrician assistant	9	Hours	17,50	157,50
				Subtotal Workforce	328,50
				TOTAL	1.855,30

5.1.5. Chapter 5: Lighting

Item	Description	Quantity	Unit	Price (€/U.)	Total (€)
	Three-phase lighting				
5.1.	PHILIPS BY480P LED170S/840 PSD WB GC SI	9	Unit	400,00	3.600,00
5.2.	AOK-OT-200W-T4	6	Unit	176,00	1.056,00
				Subtotal Three-phase lighting	4.656,00
	Single-phase lighting				
5.3.	PHILIPS BY121P G4 LED200S/865 PSU WB	4	Unit	425,00	1.700,00
5.4.	PHILIPS SM53C LED34S/940PSD PI5 L1130 ALU	34	Unit	189,00	6.426,00
5.5.	PHILIPS DN570B LED12S/830 PSE-E C WH	15	Unit	203,00	3.045,00
				Subtotal Single-phase lighting	11.171,00
	Emergency lighting				
5.6.	LUXIONA PT-300C Plat	38	Unit	65,25	2.479,50
5.7.	Exit signs	38	Unit	29,95	1.138,10
				Subtotal Emergency lighting	3.617,60
	Equipment & machinery				
5.8	Elevator rental	8,5	Hours	75,85	644,73
				Subtotal Equipment & machinery	644,73
	Workforce				
5.9.	Officer 1 electrician	44,5	Hours	19,00	845,50
5.10.	Electrician assistant	44,5	Hours	17,50	778,75
				Subtotal Workforce	1.624,25
				TOTAL	21.713,58

5.1.6. Chapter 6: Power outlets, push buttons & automatisms

Item	Description	Quantity	Unit	Price (€/U.)	Total (€)
	Power outlets				
6.1.	Single-phase power outlet 16A Manufacturer: SCHNEIDER ELECTRIC Reference: MTN2300-0325	34	Unit	7,99	271,66
6.2.	Single-phase power outlet with protective cover 16A Manufacturer: SCHNEIDER ELECTRIC Reference: MTN2414-0414	9	Unit	24,61	221,49
6.3.	Three-phase power outlet with protective cover 32A Manufacturer: SCHNEIDER ELECTRIC Reference: PKY16F435	8	Unit	13,19	105,52
6.4.	2 modules flush mounting box	15	Unit	5,72	85,80
6.5.	3 modules flush mounting box	3	Unit	7,86	23,58
6.7.	4 modules flush mounting box	2	Unit	8,94	17,88
				Subtotal Power outlets	725,93
	Push buttons				
6.8.	Single switch 10A 230V Manufacturer: Simon Reference: 27101-65	12	Unit	1,83	21,96
6.9.	Toggle switch 10A 230V Manufacturer: Simon Reference: 75201-39	8	Unit	3,43	27,44
6.10.	Crossover switch mechanism Manufacturer: Simon Reference: 75251-39	1	Unit	7,57	7,57
6.11.	Green button NO Seller: ADAJUSA	7	Unit	1,22	8,54
6.12.	Red button NC Seller: ADAJUSA	7	Unit	1,74	12,18
6.13.	1 module flush mounting box	21	Unit	0,15	3,15
				Subtotal Push buttons	80,84

	Automatisms				
6.14.	NO three-phase contactor Manufacturer: SCHNEIDER ELECTRIC Reference: LC1 D09P7	5	Unit	18,00	90,00
6.15.	Timer 0.1-30 seconds for contactor connection delay Seller: ADAJUSA Reference: LA2-DT2	1	Unit	8,83	8,83
6.16.	Programmable time switch Manufacturer: THEBEN Reference: 1600001	1	Unit	24,90	24,90
6.17.	Transformer 230/24V 8VA Manufacturer: NAVARIS Reference: B07J2NWYC4	1	Unit	10,99	10,99
				Subtotal Automatisms	134,72
	Workforce				
6.18.	Officer 1 electrician	15	Hours	19,00	285,00
6.19.	Electrician assistant	15	Hours	17,50	262,50
				Subtotal Workforce	547,50
				TOTAL	1.488,99

5.1.7. Chapter 7: Capacitor bank

Item	Description	Quantity	unit	Price (€/U.)	Total (€)
	Capacitor bank				
7.1.	Capacitor bank Manufacturer: CISAR 75kVAr 5+10+3x20 710x754x258	1	Unit	1.740,00	1.740,00
				Subtotal CB	1.740,00
	Workforce				
7.2.	Officer 1 electrician	1,5	Hours	19,00	28,50
7.3.	Electrician assistant	1,5	Hours	17,50	26,25
				Subtotal Workforce	54,75
				TOTAL	1.794,75

5.1.8. Summary MEB

Chapter	Description	Material (€)	Renting (€)	Workforce (€)	Total (€)
1	Transformation center	26.288,74	60,00	253,50	26.602,24
2	Protections	15.909,62	0,00	401,50	16.311,12
3	Conductors y tubes	8.543,20	0,00	365,00	8.908,20
4	Grounding	1.526,80	0,00	328,50	1.855,30
5	Lighting	19.444,60	644,73	1.624,25	21.713,58
6	PO & push buttons	941,49	0,00	547,50	1.488,99
7	Capacitors bank	1.740,00	0,00	54,75	1.794,75
	TOTAL	74.394,45	704,73	3.575,00	78.674,18

The Material Execution Budget (MEB) is “SEVENTY-EIGHT THOUSAND SIX HUNDRED AND SEVENTY-FOUR EUROS WITH EIGHTEEN CENTS”.

5.2. Contract execution and total budget

Material execution budget	**78.674,18 €**
General expenses (13% over EMB)	10.227,64 €
Industrial benefit (6% over EMB)	4.720,45 €
Contract execution budget (without VAT)	**93.622,27 €**
Basic health and safety studio (2% over EMB)	1.573,48 €
Engineer job fees (15% over EMB)	11.801,13 €
Construction management team (15% over EMB)	11.801,13 €
Total budget (without VAT)	**118.798,00 €**
VAT application (21%)	24.947,58 €
Total budget	**143.745,59 €**

The total budget of the installation is “ONE HUNDRED AND FORTY THREE THOUSAND SEVEN HUNDRED FORTY FIVE EUROS WITH FIFTY-NINE CENTS”.

Pamplona. June 1, 2020

Sgd. Javier Urdaniz Viejo

upna

Universidad Pública de Navarra
Nafarroako Unibertsitate Publikoa

Low voltage electrical installation of a craft beer brewery with transformation center

Document No.6: Basic health and safety study

Javier Urdániz Viejo

June 1, 2020

INDEX

6.1. Precedents and general data

6.1.1. Objective & author

This basic health and safety study is written as the construction does not fulfill the minimum requirements (budget greater than 450 thousand euros, project duration greater than 30 laborious days and more than 50 workers) , according to article 4 of Royal Decree 1627/1997, of October 14, which oblige the realization of a complete health and safety study.

Therefore, the following document is written to comply with the mentioned Royal Decree, by which the minimum health and safety dispositions in construction works are established, within the framework of Law 31/1995 of November 8, on occupational risk prevention.

In accordance with article 3 of the R.D. 1627/1997, if the construction involves more than one company or a company and self-employed workers, or more than one self-employed worker, the developer must designate a coordinator in health and safety matters during the construction execution. This designation must be the subject of an express contract.

This basic health and safety study tries to define the security measures to be adopted during the electrical installation. It should contemplate the identification of, the occupational risks that could be avoided, indicating the technical measures necessary for this and the occupational risks that cannot be eliminated, specifying the preventive measures and technical protections aimed at controlling and reducing these risks and evaluating their effectiveness.

If project modifications are made and they influence health and safety conditions, an annex to the BHSS must be made and it should be approved by the safety and health coordinator.

The corresponding commission order designates the engineer Javier Urdániz Viejo as editor-in-charge of the basic health and safety study.

6.1.2. Site and construction description

The smallholding is located in the Mutilva Baja industrial estate, 10 minutes away from the city center (by car). It is the industrial unit number 22, located on E street (smallholding 304, unit UC12MB of the NNSS of Aranguren, Navarra).

The access of trucks and machinery would be made through E street, pedestrians would be able to access through this street or through F street. As building has several accesses, access construction signs would be placed at all entrances.

Works to be done:

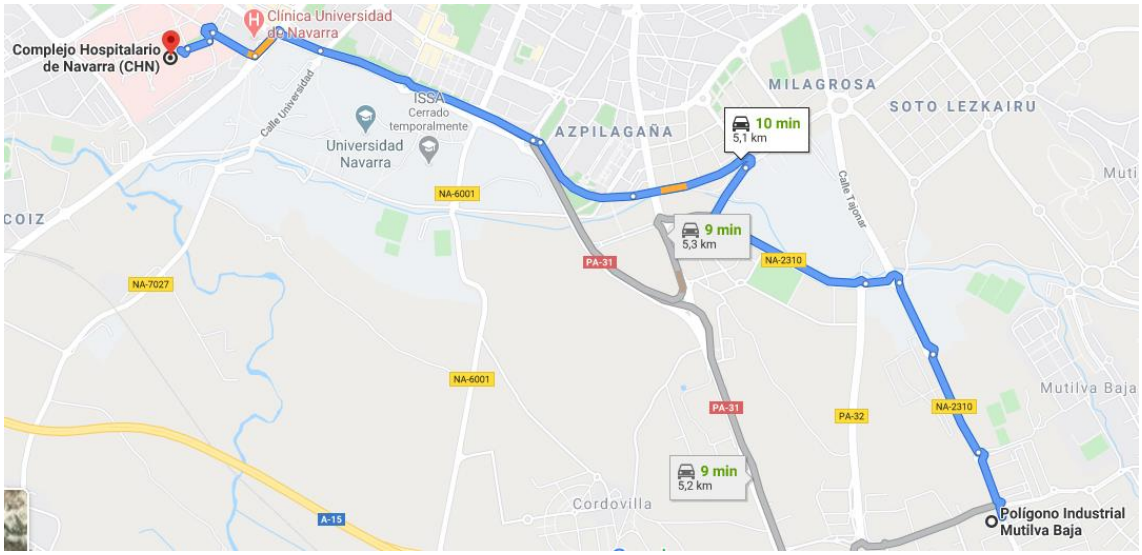
Stakeout	Marking the land of the constructions indicated in this project
Electric installation	Installation of lighting, electrical panels and channellings
Ending	Installation tests

The contractor would accredit to the construction management team the adequate formation and training of all the construction personnel in prevention and first aid matters.

6.1.3. Actions in emergencies

There would be a first-aid kit with the necessary material for a first aid action, however, depending on the severity of the accident, transfer to the hospital would be necessary.

Nearest hospital: Hospital de Navarra.



- **Burns**

  Every burn requires medical action, except if it is a superficial burn of less than 2 cm.

  If it is a burn produced by chemicals or boiling liquids, immediately remove impregnated clothing.

  If the burn is extensive, cover it with towels, handkerchiefs, sheets, that are CLEAN and urgently transfer it to a health center.

  Cool burn immediately by placing the affected area under a stream of cold water, for a minimum of 10 minutes. Do not apply any commercial or homemade product on the burn.

- **Foreign bodies on the eyes**

  <u>If it is small and free (speck of dust)</u>

  Explore with good light.

  Invert the upper eyelid if necessary.

  Eye wash with physiological serum or, failing it, with abundant water.

  Drag with a gauze or moistened cotton swab.

  Never rub your eyes or use eye drops.

  <u>If it is interlocked or metallic (shaving)</u>

  Do not touch.

  Cover both eyes with a sterile dressing.

  Transfer to a health center.

- **Fractures**

  The injured person must not be moved without first immobilizing the fracture.

  The fracture is immobilized in the same position in which we found it, encompassing the bone or broken bones and the adjacent articulations.

  If the fracture is open, cover it with dressings before immobilizing it.

  If we suspect a fracture in the spine, the injured person cannot be moved. Requires urgent transfer.

- **Luxation and sprains**

  Immobilize the area using a compression bandage or sling.

  If no more than 48 hours have passed, apply cold.

  Maintain rest, elevate the affected area and go to a health center.

- **Wound**

  If is a bleeding wound, press directly on it to stop the hemorrhage.

  Carefully wash your hands to clean the wound.

  Clean the wound with saline if possible, drying it with gauzes from the center of the periphery. Brush it with a non-colored antiseptic.

  If the wound needs to be saturated or looks very dirty, only clean it, cover it with clean dressings, hold them and go to a health center.

Do not forget the vaccination against tetanus.

Never use cotton, tissues or napkins, alcohol, iodine or bleach on wounds.

- **Haemorrhage**

  Apply pressure with the hand, directly on the wound, constantly for 10 minutes.

  Get medical help.

- **Electrocutions**

  Apply basic resuscitation measures and transfer the injured person to the nearest hospital.

- **Never**

  NEVER move an injured person without first noticing its injuries.

  NEVER touch and / or delve in wounds.

  NEVER take off the remains of dresses stuck on the burned skin or open the blisters.

  NEVER give food or liquids to unconscious or belly injured workers.

  NEVER put tourniquets, if it is not absolutely essential.

  NEVER put pillows, raise the head or incorporate those who suffer from fainting.

  NEVER touch the part of the gauze that should be in contact with the wounds.

6.2. Frequent risks

The main risks that can occur on the industrial unit are:

- Direct or indirect contacts.
- Falls of people in height.
- Falls of people at the same level.
- Run overs or collisions.
- Knocks and cuts with tools or machinery.
- Tread on sharp objects.
- Projection of particles to the eyes.

- Overexertion.

6.3. General principles of the preventive action

Taking into account article 15 of ORP Law 31/1995:

- The employer would apply the measures that integrate the general prevention duty in accordance with the following general principles:
    - Avoid risks.
    - Evaluate the risks that cannot be avoided.
    - Combat risks at the source.
    - Take into account the technique evolution.
    - Substitute the dangerous for what involves little or no danger.
    - Plan prevention, looking for a coherent set that integrates technique, work organization, working conditions, social relations and the influence of environmental factors at work.
    - Adopt measures that involve collective protection before individual protection.
    - Give proper instructions to workers.
- The employer would take into account the professional capacities of workers in safety and health matters when entrusting them with tasks.
- The employer would take the necessary measures to ensure that only workers who have received sufficient and adequate information can access the areas of serious and specific risk.
- The effectiveness of preventive measures must foresee distractions or non-reckless imprudences that the worker could commit. For its adoption, the additional risks that certain preventive measures may entail would be taken into account. Those could only be adopted when the magnitude of its risks is substantially lower than those intended to control and there are no safer alternatives.
- Insurance operations may be arranged in order to guarantee the coverage of risks arising from work. The company with respect to its workers, the self-employed with respect to themselves and cooperative societies with respect to their partners whose activity consists of rendering of their personal work.

The principles of the preventive action set in the mentioned Occupational Risk Prevention Law would be applied during the construction execution and, in particular, in the following tasks or activities (article 10 RD 1627/1997):

- The maintenance of the construction in good order and cleanliness.
- The choice of the location of the jobs and working areas, taking into account their access conditions, and the determination of the routes or zones of movement or circulation.
- The handling of different materials and the use of auxiliary means.
- Maintenance, prior control to commissioning and periodic control of the facilities and necessary devices for the construction execution, in order to correct defects that could affect the safety and health of workers.
- The delimitation and conditioning of the storage and deposit areas for the different materials, particularly if they are dangerous materials or substances.
- The collection of the hazardous materials used.
- The storage and removal or disposal of waste and debris.
- The adaptation, depending on the evolution of the construction, of the effective period of time that would have to be dedicated to the different jobs or work phases.
- Cooperation between contractors, subcontractors and self-employed workers.
- Interactions and incompatibilities with any other type of work or activity that is carried out on the construction site or near the construction site.

6.4. Protection equipment

During the construction course, protective equipment, individual and collective, would be available to eliminate or minimize risks.

6.4.1. Individual protection equipment

The equipment used for individual protection is:

- Safety helmet: It would be used at all times.
- High visibility clothing in the presence of mobile work teams: It would be used at all times.
- Safety footwear with reinforced toe cap and anti-perforation sole: It would be used at all times.
- Anti-cut gloves: When handling elements with edges or tools with sharp parts.
- Insulating gloves: During the manipulation of electrical material.

- Anti-projection goggles: Those jobs in which particles are released, such as jobs with radial, chipping hammer ...
- Hearing protection headpods: In those jobs whose noise level is higher than 80dB.
- Protection against burns: Protective screen and thermal protective gloves or sleeves would be used in welding works.
- Safety harness: In the use of a lifting platform, and in the absence of collective protection against falls.

6.4.2. Collective protection equipment

The equipment used for collective protection would be:

- Railings
- Safety scaffolding
- Protection of moving parts of machines
- Material download platforms
- Auxiliary stairs
- Safety distance
- Evacuation route in case of fire or accident

Signage is not part of collective protection, but it would be necessary for risks that cannot be avoided or sufficiently limited through collective protection technical means or through measures, methods or procedures of work organization.

6.5. Safety measures in electrical installations

The proposed preventive measures for risk control during the electrical connection are:

- The electrical connections would be done in the absence of voltage. In those operations in which voltage can be suppressed before start working:
  - Device disconnection.
  - Prevent any possible feedback through a consignment or blocking procedure.
  - Verify the voltage absence.
  - Grounding and short-circuit position.

    - Protect against nearby elements with voltage and establish a safety signage to delimit the working area.

- The assembly of electrical devices would always be carried out by electrician personnel, in prevention of risks of an incorrect assembly.

- The tool used would be protected with standard insulating material against contacts with electrical energy. Tools whose insulation is deteriorated would be removed and replaced by another in good condition, immediately.

- To avoid accidental connection to the mains, the wiring from the general distribution panel to the low voltage panel would be carried out the last one, keeping the necessary mechanisms for connection until the moment of use in a safe place.

- The operational tests would be communicated to the construction manager to take the appropriate prevention measures and notify the rest of the staff in order to avoid accidents.

- Before loading the installation, the connections of mechanisms, protections, and connections of the electrical panels would be thoroughly checked, always under the technical control responsible of the installation.

- There would be dry chemical powder fire extinguishers and a first aid kit.

6.6. Fire safety measures

The preventive and fire safety measures are detailed below:

- The “NO SMOKING” sign would be respected. Where smoking is allowed, the butts and matches would not be deposited in garbage cans or containers where there may be flammable materials.

- If the material is combustible, only the material for a day or shift should be stored in the working area.

- Residues and garbage (boxes, paper, cardboard ...) must be frequently removed to the containers (metal drums) disposed for storage.

- At the end of the working day all the elements would be left without voltage.

- When handling electric tools, combustible materials should be removed.

- Reserve the safest places for combustible materials, away from heat sources and from electrical panels and equipment.

- If any suspicious odour or hot surface is detected, the superior would be notified immediately.

- There would be fire extinguishers next to the doors of the storage areas that contain flammable products.

- Workers would be instructed in fire extinguisher handling and fire prevention.

6.7. Safety signs

Where and what sings would be placed is described in the following table:

Sign location	Sign type and meaning	
In dangerous substances warehouses doors		General waring sign
		Danger toxic products
		Danger flammable products
In fire danger zones		Smoking and lighting a fire are forbidden
		Fire extinguisher location
On the evacuation routes		Signalling of the routes according to the Annex III of R.D. 485/97
In the emergency kit		First aid kit location
In the different machines		Stickers with the warning danger signs of the corresponding protections, according to the catalog of risks and specific preventive measures of each machine
In the access of people to the construction		Access to people foreign the construction is forbidden
		Danger in general
		Use of helmet is mandatory
In the pedestrians and machinery accesses		The access to pedestrians is forbidden
Once personal access has been surpassed		Falling objects
		Suspended loads
		Falls at the same level
		Use of safety shoes is mandatory
		Use of security gloves is mandatory

In the vehicles and machinery exit		Mandatory stop
At the construction office and changing rooms		Indicative panel with telephones and addresses of interest for prevention (emergency number, ambulances, hospital…)
At the electric panels		Risk of electric energy contact
In the areas with danger of height falling		Fall at different level danger
		Mandatory use of security harness

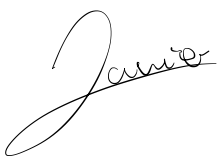
6.8. Applicable regulations

The regulations that apply to this installation are:

- Royal Decree 1627/2997 of October 24, which establishes the minimum health and safety dispositions.
- Law 31/1995 of November 8, on Occupational Risk Prevention.
- Workers statute.
- Electrical Low Voltage Regulation.
- Royal Decree 2291/1985 of November 8, which approves the Regulation of lifting devices and their maintenance.
- Royal Decree 1316/1989, on noise.
- Royal Decree 486/1997 of April 14, about minimum dispositions regarding occupation health and safety signs.
- Royal Decree 773/1997 of May 30, on minimum health and safety dispositions related to the use of personal protective equipment by workers.
- Royal Decree 1215/1997 of July 18, which establishes the minimum safety and health measures for the use of work equipment.
- Royal Decree 2267/2004, of December 3, which approves the regulation of fire safety in industrial establishments.

Pamplona. June 1, 2020

Sgd. Javier Urdániz Viejo



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Low voltage electrical installation of a craft beer brewery with transformation center

Document No.7: Bibliography

Javier Urdániz Viejo

June 1, 2020

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Low voltage electrical installation of a craft beer brewery with transformation center

Document No.8: Annexes

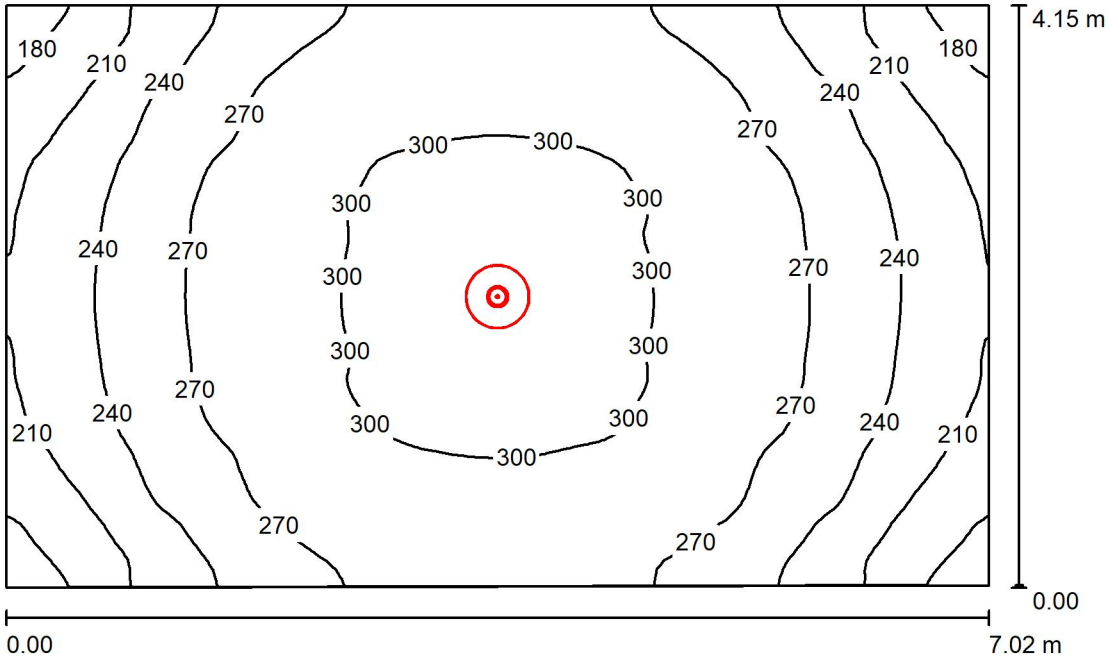
Javier Urdániz Viejo

June 1, 2020

DIALux
19.03.2020

Proyecto elaborado por
Teléfono
Fax
e-Mail

Almacen materias secundarias / Resumen



Altura del local: 7.000 m, Altura de montaje: 6.795 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:54

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	264	167	311	0.633
Suelo	20	207	167	228	0.807
Techo	70	59	39	73	0.655
Paredes (4)	50	137	44	357	/

Plano útil:

Altura:	1.200 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	PHILIPS BY121P G4 PSU 1 xLED200S/865 WB (1.000)	20000	20000	138.0
			Total: 20000	Total: 20000	138.0

Valor de eficiencia energética: 4.75 W/m² = 1.80 W/m²/100 lx (Base: 29.05 m²)

DIALux
25.03.2020

Proyecto elaborado por
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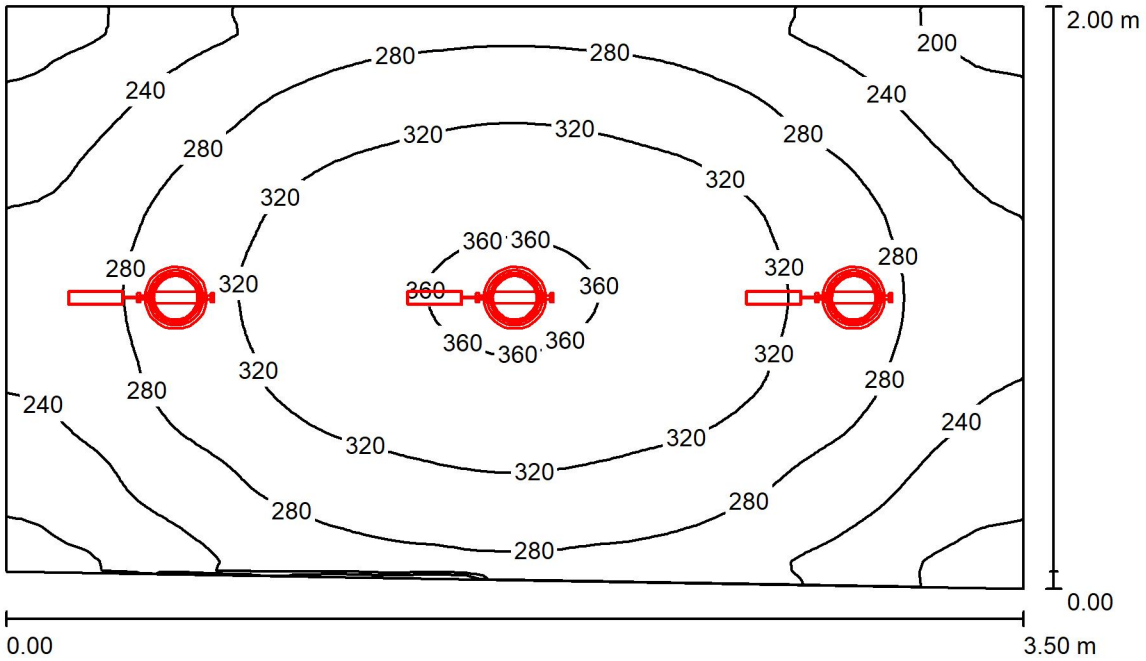
Aseo grande / Resumen



Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:26

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	285	178	366	0.626
Suelo	20	207	153	245	0.741
Techo	70	53	38	61	0.715
Paredes (4)	50	121	37	315	/

Plano útil:

Altura:	0.850 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	3	PHILIPS DN570B PSE-E 1xLED12S/830 C (1.000)	1350	1350	11.8
			Total: 4050	Total: 4050	35.4

Valor de eficiencia energética: 5.13 W/m² = 1.80 W/m²/100 lx (Base: 6.89 m²)

DIALux
25.03.2020

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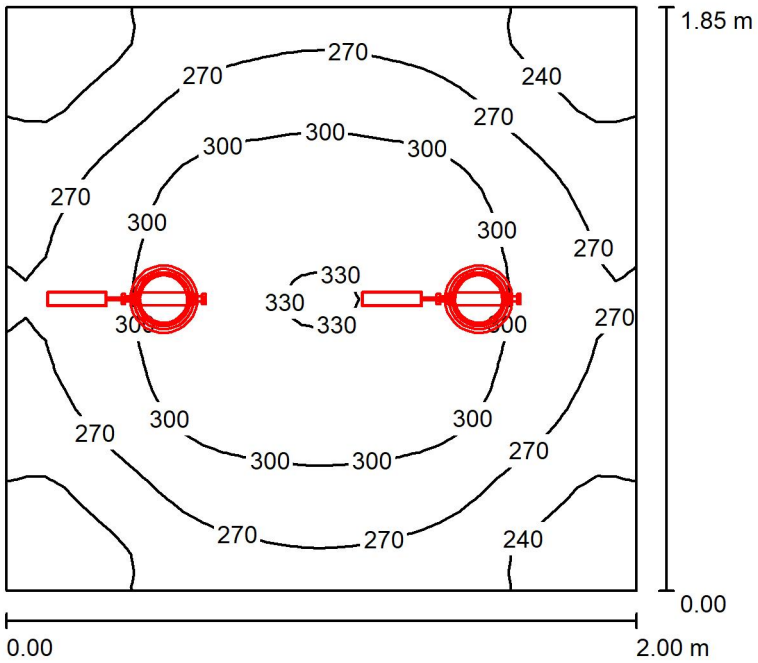

Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:24

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	279	209	332	0.749
Suelo	20	183	153	203	0.836
Techo	70	61	42	72	0.691
Paredes (4)	50	133	43	420	/

Plano útil:

Altura:	0.850 m
Trama:	32 x 32 Puntos
Zona marginal:	0.000 m

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	2	PHILIPS DN570B PSE-E 1xLED12S/830 C (1.000)	1350	1350	11.8
			Total: 2700	Total: 2700	23.6

Valor de eficiencia energética: 6.38 W/m² = 2.29 W/m²/100 lx (Base: 3.70 m²)

DIALux
25.03.2020

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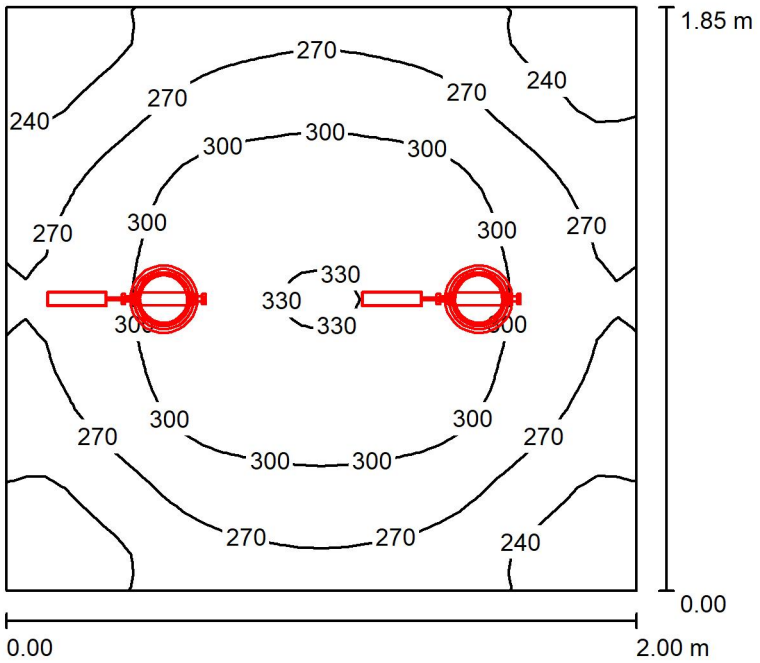

Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:24

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	279	209	332	0.749
Suelo	20	183	153	203	0.834
Techo	70	61	42	72	0.688
Paredes (4)	50	133	43	420	/

Plano útil:

Altura:	0.850 m
Trama:	32 x 32 Puntos
Zona marginal:	0.000 m

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	2	PHILIPS DN570B PSE-E 1xLED12S/830 C (1.000)	1350	1350	11.8
			Total: 2700	Total: 2700	23.6

Valor de eficiencia energética: 6.38 W/m² = 2.29 W/m²/100 lx (Base: 3.70 m²)

DIALux
19.03.2020

Proyecto elaborado por
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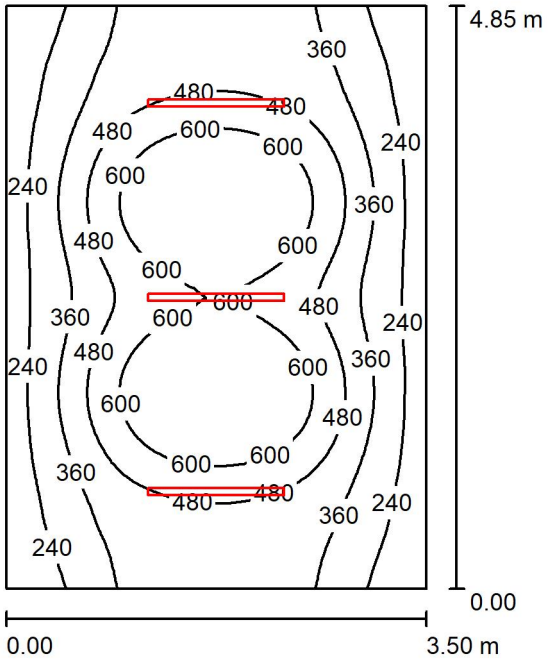

Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:63

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	434	138	721	0.319
Suelo	20	366	199	529	0.543
Techo	70	56	41	66	0.725
Paredes (4)	50	115	41	410	/

Plano útil:

Altura:	0.850 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

UGR

	Longi-	Tran	al eje de luminaria
Pared izq	18	18	
Pared inferior	18	18	

(CIE, SHR = 0.25.)

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	3	PHILIPS SM530C PSD L1130 1 xLED34S/940 OC (1.000)	3400	3400	23.0
			Total: 10200	Total: 10200	69.0

Valor de eficiencia energética: 4.06 W/m² = 0.94 W/m²/100 lx (Base: 16.97 m²)

DIALux
28.04.2020

Proyecto elaborado por
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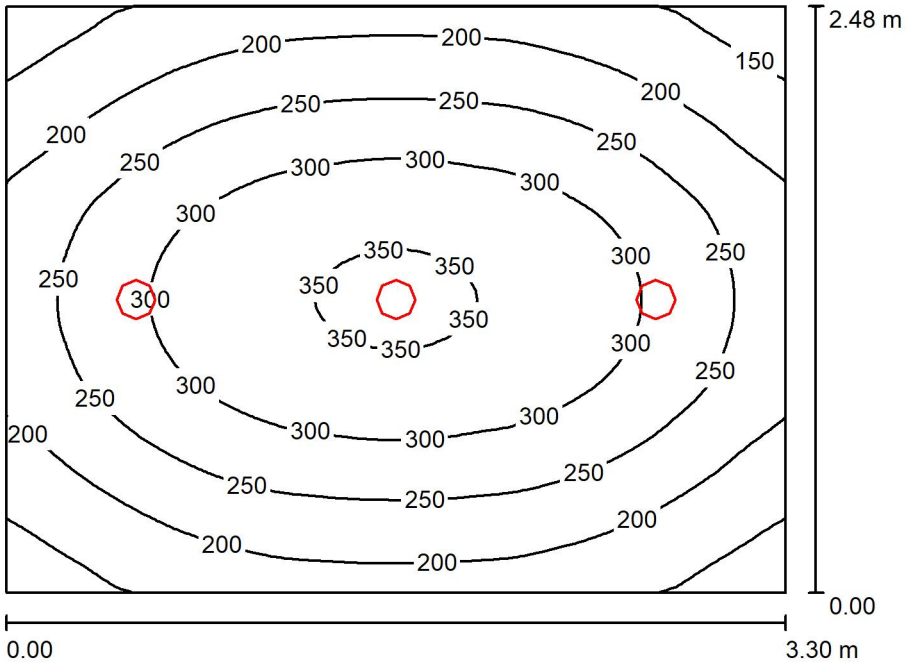

Altura del local: 2.800 m, Altura de montaje: 2.800 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:32

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	249	117	359	0.470
Suelo	20	185	127	228	0.687
Techo	70	39	27	45	0.704
Paredes (4)	50	89	27	298	/

Plano útil:

Altura:	0.850 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

UGR

	Longi-	Tran
Pared izq	21	21
Pared inferior	21	21

(CIE, SHR = 0.25.)

al eje de luminaria

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	3	PHILIPS DN560B 1xLED12S/830 F PG (1.000)	1150	1150	11.2
			Total: 3450	Total: 3450	33.6

Valor de eficiencia energética: 4.11 W/m² = 1.65 W/m²/100 lx (Base: 8.18 m²)

DIALux
19.03.2020

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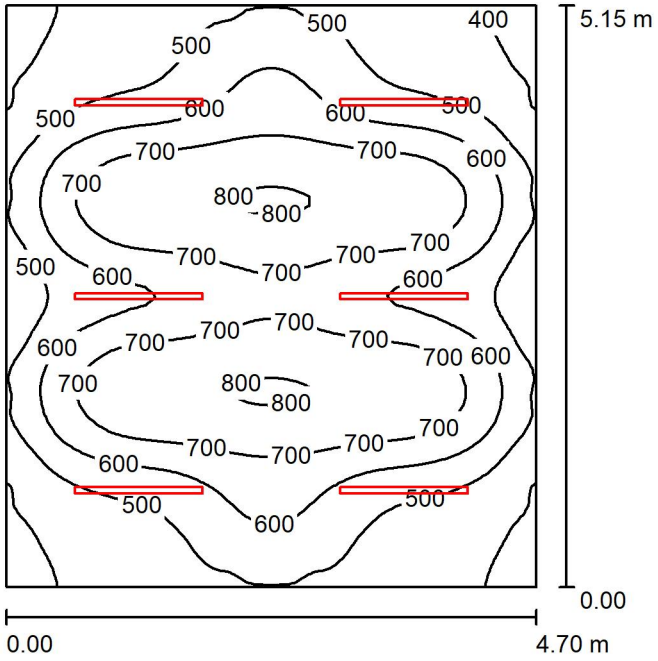
Oficina y sala de reuniones / Resumen



Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:67

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	596	331	810	0.555
Suelo	20	516	284	770	0.551
Techo	70	91	66	104	0.725
Paredes (4)	50	189	68	416	/

Plano útil:

Altura:	0.850 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

UGR

	Longi-	Tran	al eje de luminaria
Pared izq	18	18	
Pared inferior	18	18	

(CIE, SHR = 0.25.)

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	6	PHILIPS SM530C PSD L1130 1 xLED34S/940 OC (1.000)	3400	3400	23.0
			Total: 20400	Total: 20400	138.0

Valor de eficiencia energética: 5.70 W/m² = 0.96 W/m²/100 lx (Base: 24.20 m²)

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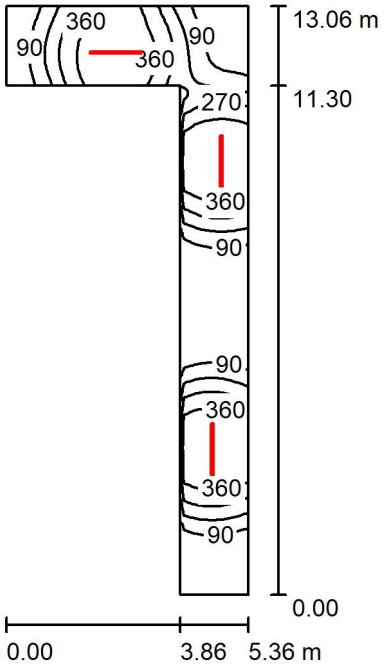
Pasillos / Resumen



Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:168

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	217	17	423	0.080
Suelo	20	168	25	287	0.149
Techo	70	33	14	55	0.439
Paredes (6)	50	78	15	601	/

Plano útil:

Altura:	0.850 m
Trama:	128 x 64 Puntos
Zona marginal:	0.000 m

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	3	PHILIPS SM530C PSD L1130 1 xLED34S/940 OC (1.000)	3400	3400	23.0
			Total: 10200	Total: 10200	69.0

Valor de eficiencia energética: 2.62 W/m² = 1.20 W/m²/100 lx (Base: 26.38 m²)

DIALux
19.03.2020

Proyecto elaborado por
Teléfono
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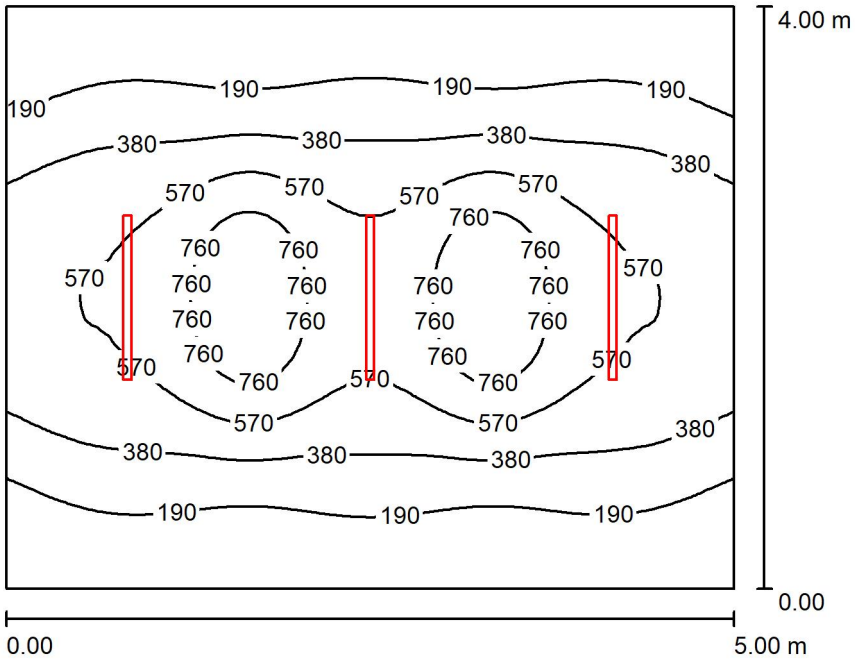
e-Mail

Sala aclimatada / Resumen



Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:52

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	397	52	956	0.131
Suelo	20	331	152	514	0.457
Techo	70	50	35	58	0.707
Paredes (4)	50	94	38	386	/

Plano útil:

Altura:	1.200 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

UGR

	Longi-	Tran	al eje de luminaria
Pared izq	18	18	
Pared inferior	18	18	

(CIE, SHR = 0.25.)

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	3	PHILIPS SM530C PSD L1130 1 xLED34S/940 OC (1.000)	3400	3400	23.0
			Total: 10200	Total: 10200	69.0

Valor de eficiencia energética: 3.45 W/m² = 0.87 W/m²/100 lx (Base: 20.00 m²)

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19.03.2020

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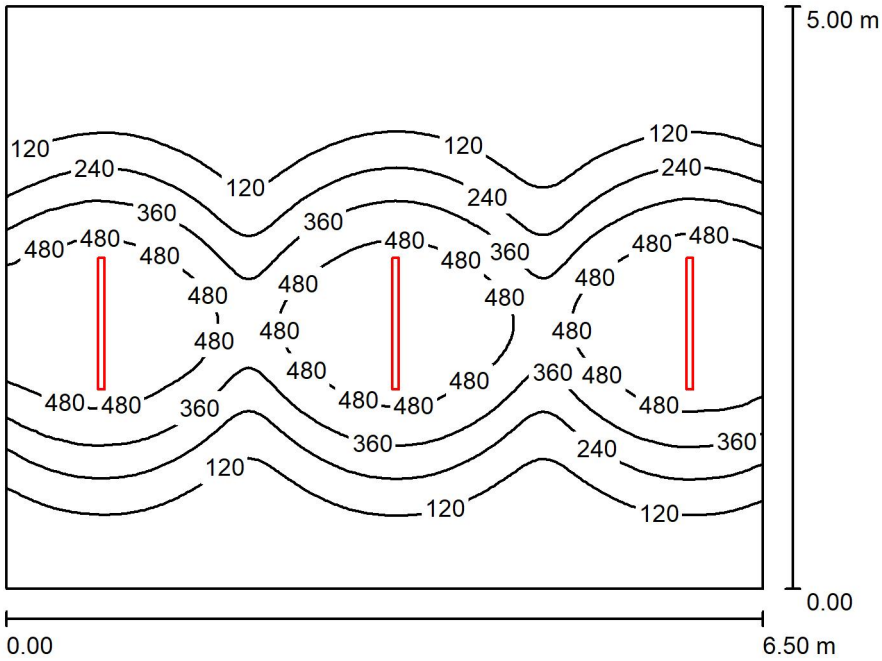
Sala calderas / Resumen



Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:65

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	245	24	577	0.100
Suelo	20	216	51	367	0.235
Techo	70	36	23	48	0.643
Paredes (4)	50	62	24	554	/

Plano útil:

Altura:	1.200 m
Trama:	128 x 128 Puntos
Zona marginal:	0.000 m

UGR

	Longi-	Tran	al eje de luminaria
Pared izq	18	18	
Pared inferior	18	18	

(CIE, SHR = 0.25.)

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	3	PHILIPS SM530C PSD L1130 1 xLED34S/940 OC (1.000)	3400	3400	23.0
			Total: 10200	Total: 10200	69.0

Valor de eficiencia energética: 2.12 W/m² = 0.87 W/m²/100 lx (Base: 32.50 m²)

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19.03.2020

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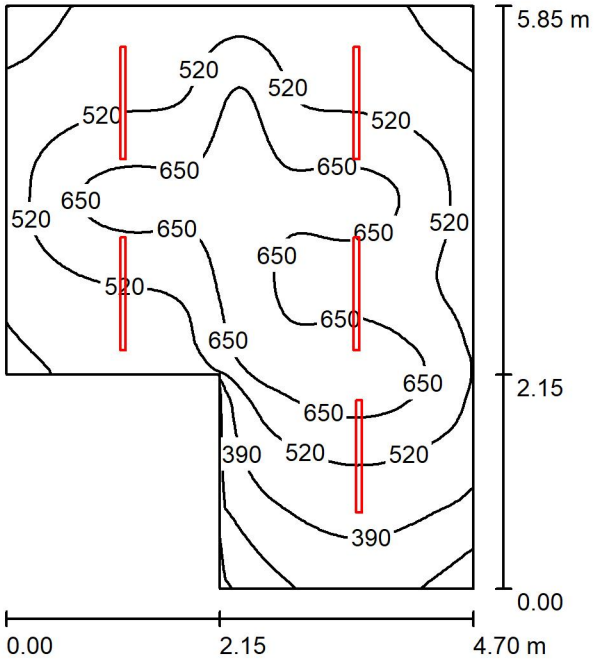
Sala de catas y talleres / Resumen



Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:76

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	525	117	718	0.223
Suelo	20	440	212	702	0.482
Techo	70	76	48	96	0.628
Paredes (8)	50	157	47	520	/

Plano útil:

Altura:	0.850 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	5	PHILIPS SM530C PSD L1130 1 xLED34S/940 OC (1.000)	3400	3400	23.0
			Total: 17000	Total: 17000	115.0

Valor de eficiencia energética: 5.03 W/m² = 0.96 W/m²/100 lx (Base: 22.87 m²)

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19.03.2020

Proyecto elaborado por
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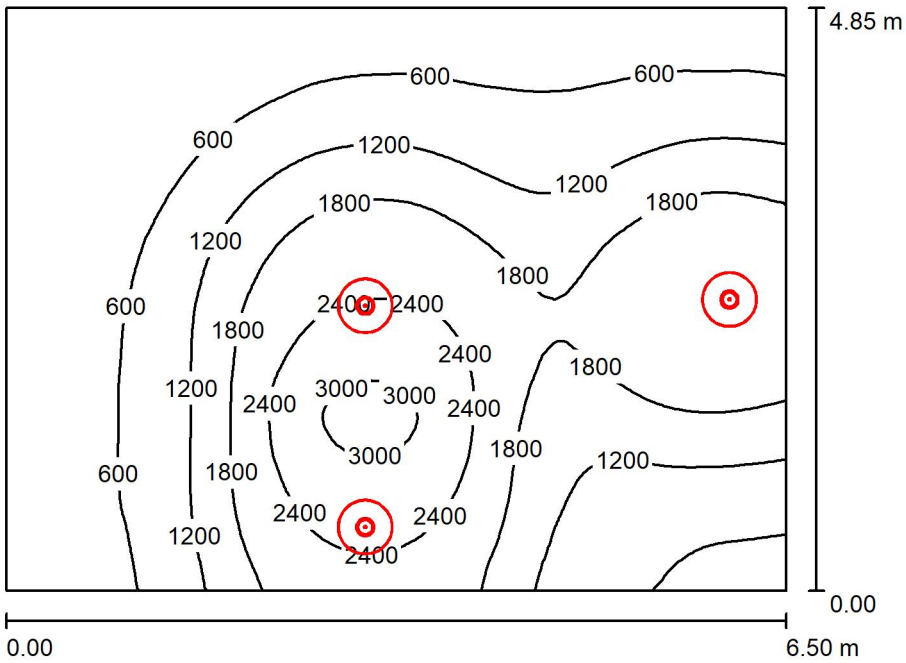
Sala I+D y calidad / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.945 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:63

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	1279	196	3164	0.154
Suelo	20	1129	249	1998	0.221
Techo	70	248	125	523	0.505
Paredes (4)	50	504	147	5778	/

Plano útil:

Altura:	0.850 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	3	PHILIPS BY121P G4 PSU 1 xLED200S/865 WB (1.000)	20000	20000	138.0
			Total: 60000	Total: 60000	414.0

Valor de eficiencia energética: 13.13 W/m² = 1.03 W/m²/100 lx (Base: 31.52 m²)

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19.03.2020

Proyecto elaborado por
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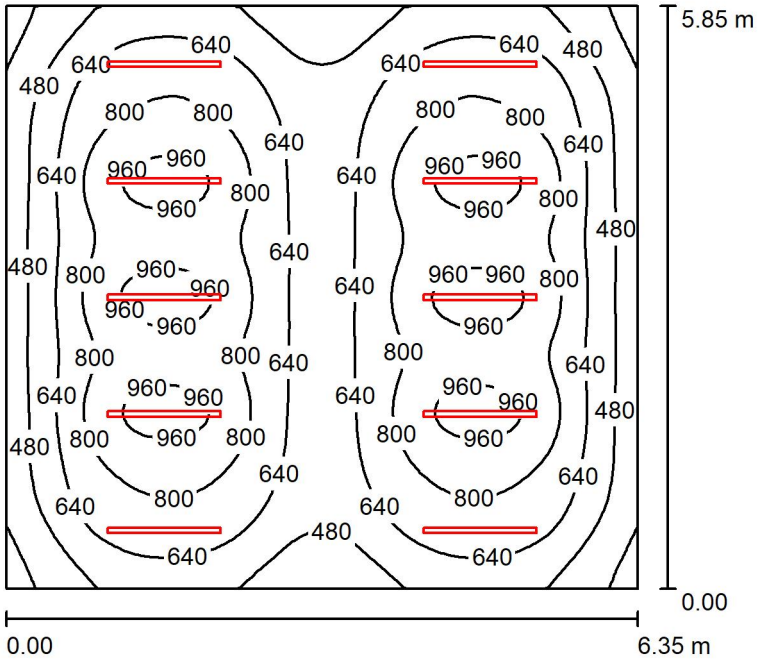
Tienda / Resumen



Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:76

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	694	257	1036	0.370
Suelo	20	621	332	850	0.534
Techo	70	107	76	121	0.705
Paredes (4)	50	202	80	672	/

Plano útil:

Altura:	0.850 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

UGR

	Longi-	Tran	al eje de luminaria
Pared izq	18	18	
Pared inferior	17	18	

(CIE, SHR = 0.25.)

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	10	PHILIPS SM530C PSD L1130 1 xLED34S/940 OC (1.000)	3400	3400	23.0
			Total: 34000	Total: 34000	230.0

Valor de eficiencia energética: 6.19 W/m² = 0.89 W/m²/100 lx (Base: 37.15 m²)

DIALux
19.03.2020

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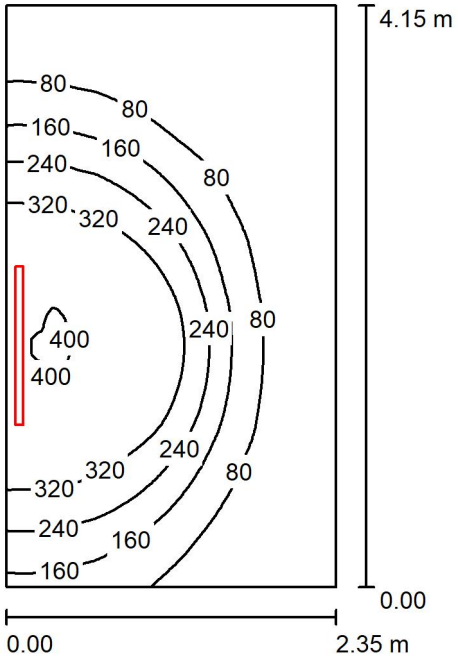
Toro / Resumen



Altura del local: 7.000 m, Altura de montaje: 2.938 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:54

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	165	19	403	0.117
Suelo	20	144	25	208	0.173
Techo	70	8.61	7.27	10	0.844
Paredes (4)	50	34	4.98	4019	/

Plano útil:

Altura:	0.850 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

UGR (Longi- / Tran al eje de luminaria)

Pared izq	18	18
Pared inferior	18	18

(CIE, SHR = 0.25.)

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	PHILIPS SM530C PSD L1130 1 xLED34S/940 OC (1.000)	3400	3400	23.0
			Total: 3400	Total: 3400	23.0

Valor de eficiencia energética: 2.36 W/m² = 1.43 W/m²/100 lx (Base: 9.75 m²)

DIALux
25.03.2020

Proyecto elaborado por
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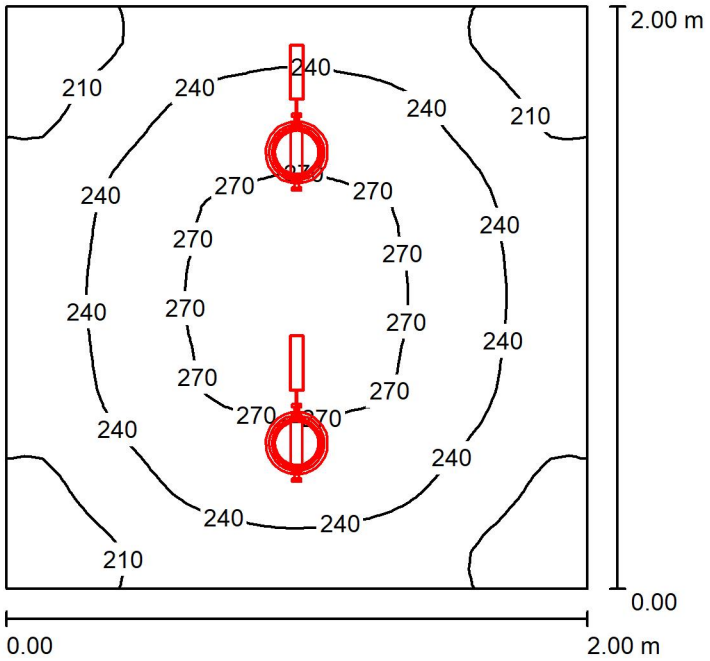
Vestuario hombres / Resumen



Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:26

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	239	178	278	0.747
Suelo	20	180	148	201	0.822
Techo	70	57	39	68	0.692
Paredes (4)	50	126	39	417	/

Plano útil:

Altura:	0.600 m
Trama:	32 x 32 Puntos
Zona marginal:	0.000 m

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	2	PHILIPS DN570B PSE-E 1xLED12S/830 C (1.000)	1350	1350	11.8
			Total: 2700	Total: 2700	23.6

Valor de eficiencia energética: 5.90 W/m² = 2.47 W/m²/100 lx (Base: 4.00 m²)

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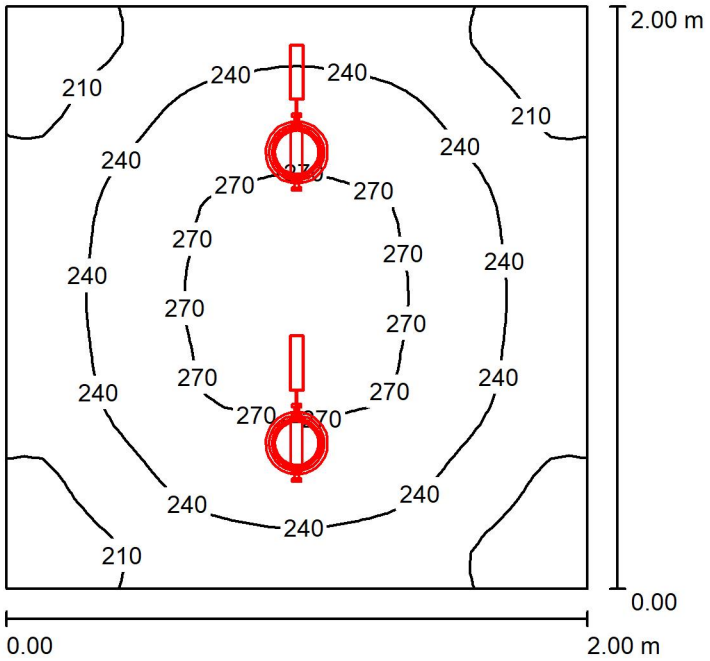
Vestuario mujeres / Resumen



Altura del local: 3.000 m, Altura de montaje: 3.000 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:26

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	239	178	278	0.747
Suelo	20	180	149	201	0.827
Techo	70	57	39	69	0.680
Paredes (4)	50	126	41	418	/

Plano útil:

Altura:	0.600 m
Trama:	32 x 32 Puntos
Zona marginal:	0.000 m

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	2	PHILIPS DN570B PSE-E 1xLED12S/830 C (1.000)	1350	1350	11.8
			Total: 2700	Total: 2700	23.6

Valor de eficiencia energética: 5.90 W/m² = 2.47 W/m²/100 lx (Base: 4.00 m²)

Proyecto elaborado por
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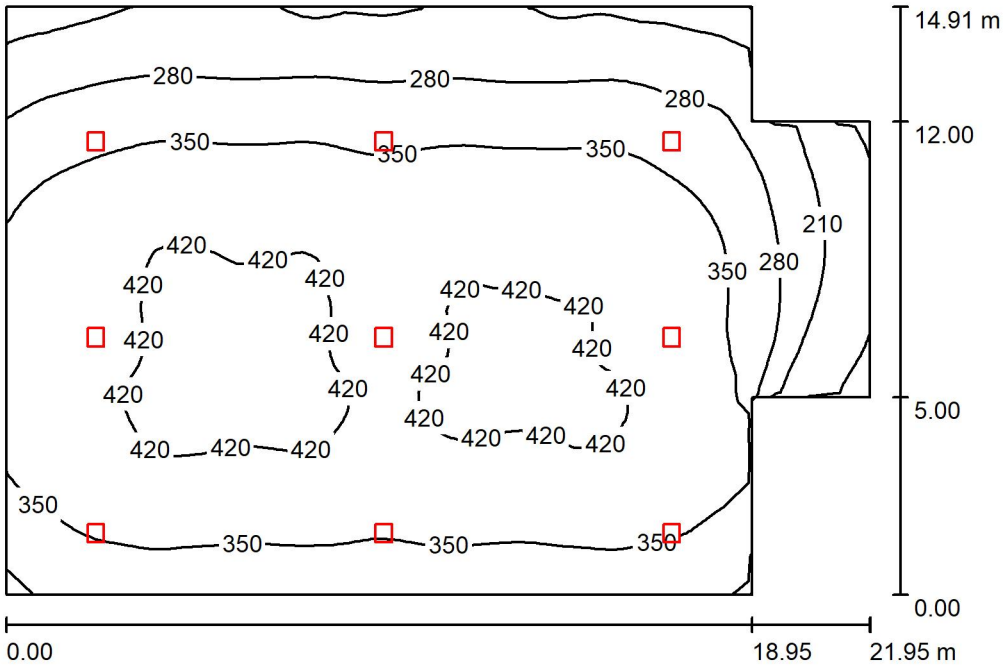
Zona Produccion + almacen MP / Resumen



Altura del local: 7.000 m, Altura de montaje: 6.780 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:192

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	349	115	433	0.330
Suelo	20	328	143	428	0.437
Techo	70	66	39	84	0.585
Paredes (10)	50	140	36	606	/

Plano útil:

Altura:	1.200 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	9	PHILIPS BY480P PSD 1 xLED170S/840 WB (1.000)	17000	17000	106.0
			Total: 153000	Total: 153000	954.0

Valor de eficiencia energética: 3.14 W/m² = 0.90 W/m²/100 lx (Base: 303.54 m²)

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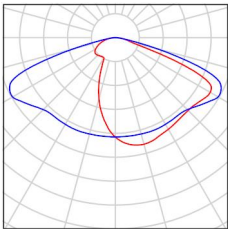
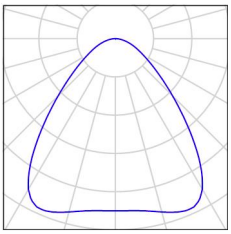
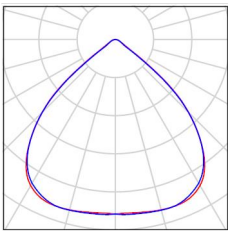
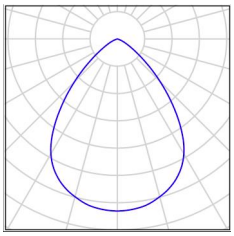
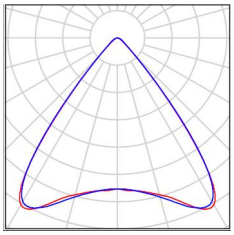
Planta baja / Lista de luminarias

3 Pieza	AOK LED Area Light AOK-OT-200W-T4 N° de artículo: LED Area Light Flujo luminoso (Luminaria): 32620 lm Flujo luminoso (Lámparas): 32620 lm Potencia de las luminarias: 200.1 W Clasificación luminarias según CIE: 100 Código CIE Flux: 34 65 95 100 100 Lámpara: 1 x AOK-200WoT (Factor de corrección 1.000).		
4 Pieza	PHILIPS BY121P G4 PSU 1 xLED200S/865 WB N° de artículo: Flujo luminoso (Luminaria): 20000 lm Flujo luminoso (Lámparas): 20000 lm Potencia de las luminarias: 138.0 W Clasificación luminarias según CIE: 100 Código CIE Flux: 66 90 98 100 100 Lámpara: 1 x LED200S/865/- (Factor de corrección 1.000).		
9 Pieza	PHILIPS BY480P PSD 1 xLED170S/840 WB N° de artículo: Flujo luminoso (Luminaria): 17000 lm Flujo luminoso (Lámparas): 17000 lm Potencia de las luminarias: 106.0 W Clasificación luminarias según CIE: 100 Código CIE Flux: 69 98 100 100 100 Lámpara: 1 x LED170S/840/- (Factor de corrección 1.000).		
13 Pieza	PHILIPS DN570B PSE-E 1xLED12S/830 C N° de artículo: Flujo luminoso (Luminaria): 1350 lm Flujo luminoso (Lámparas): 1350 lm Potencia de las luminarias: 11.8 W Clasificación luminarias según CIE: 100 Código CIE Flux: 76 97 100 100 100 Lámpara: 1 x LED12S/830/- (Factor de corrección 1.000).		
10 Pieza	PHILIPS SM530C PSD L1130 1 xLED34S/940 OC N° de artículo: Flujo luminoso (Luminaria): 3400 lm Flujo luminoso (Lámparas): 3400 lm Potencia de las luminarias: 23.0 W Clasificación luminarias según CIE: 100 Código CIE Flux: 89 98 100 100 100 Lámpara: 1 x LED34S/940/- (Factor de corrección 1.000).	Dispone de una imagen de la luminaria en nuestro catálogo de luminarias.	

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19.03.2020

Proyecto elaborado por
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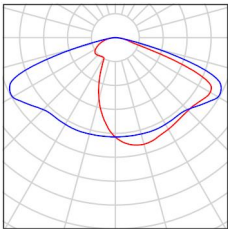
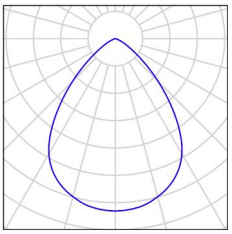
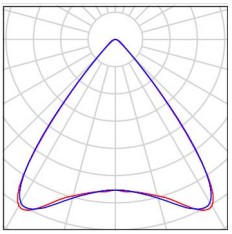
Planta primera / Lista de luminarias

3 Pieza	AOK LED Area Light AOK-OT-200W-T4 N° de artículo: LED Area Light Flujo luminoso (Luminaria): 32620 lm Flujo luminoso (Lámparas): 32620 lm Potencia de las luminarias: 200.1 W Clasificación luminarias según CIE: 100 Código CIE Flux: 34 65 95 100 100 Lámpara: 1 x AOK-200WoT (Factor de corrección 1.000).		
2 Pieza	PHILIPS DN570B PSE-E 1xLED12S/830 C N° de artículo: Flujo luminoso (Luminaria): 1350 lm Flujo luminoso (Lámparas): 1350 lm Potencia de las luminarias: 11.8 W Clasificación luminarias según CIE: 100 Código CIE Flux: 76 97 100 100 100 Lámpara: 1 x LED12S/830/- (Factor de corrección 1.000).		
24 Pieza	PHILIPS SM530C PSD L1130 1 xLED34S/940 OC N° de artículo: Flujo luminoso (Luminaria): 3400 lm Flujo luminoso (Lámparas): 3400 lm Potencia de las luminarias: 23.0 W Clasificación luminarias según CIE: 100 Código CIE Flux: 89 98 100 100 100 Lámpara: 1 x LED34S/940/- (Factor de corrección 1.000).	Dispone de una imagen de la luminaria en nuestro catálogo de luminarias.	

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19.03.2020

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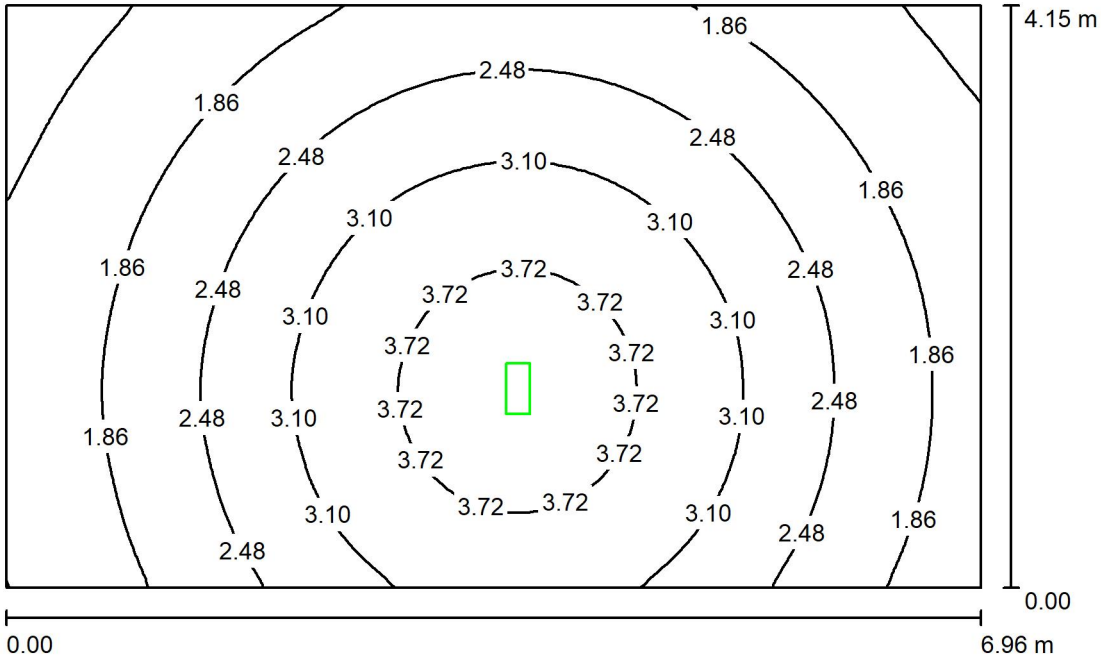
Almacen materia secundaria / Escena de luz 1 / Resumen



Altura del local: 7.000 m, Altura de montaje: 5.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:54

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	2.52	0.92	4.02	0.364
Suelo	20	2.01	0.91	2.87	0.453
Techo	70	0.00	0.00	0.00	0.000
Paredes (4)	50	1.12	0.00	12	/

Plano útil:
Altura: 0.850 m
Trama: 64 x 64 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 0.42 W/m² = 16.52 W/m²/100 lx (Base: 28.88 m²)

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19.03.2020

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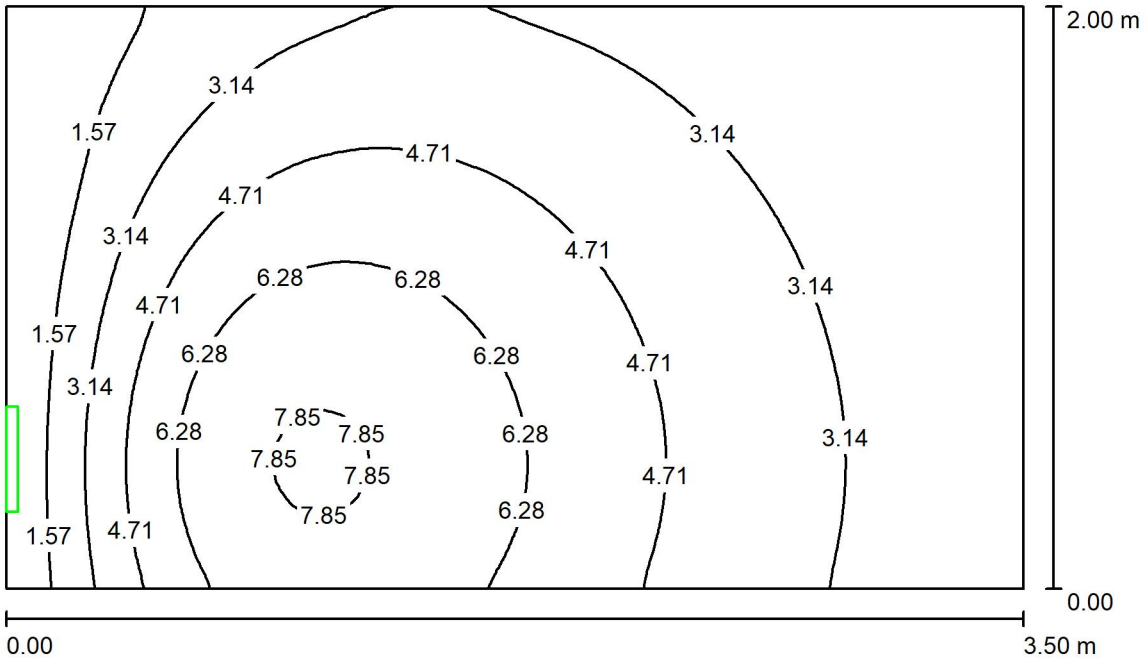
Aseo grande / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:26

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	4.02	0.18	8.02	0.044
Suelo	20	2.27	0.10	3.50	0.043
Techo	70	9.87	0.20	83	0.021
Paredes (4)	50	4.46	0.00	130	/

Plano útil:
Altura: 0.850 m
Trama: 64 x 64 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 1.71 W/m² = 42.59 W/m²/100 lx (Base: 7.00 m²)

DIALux
19.03.2020

Proyecto elaborado por
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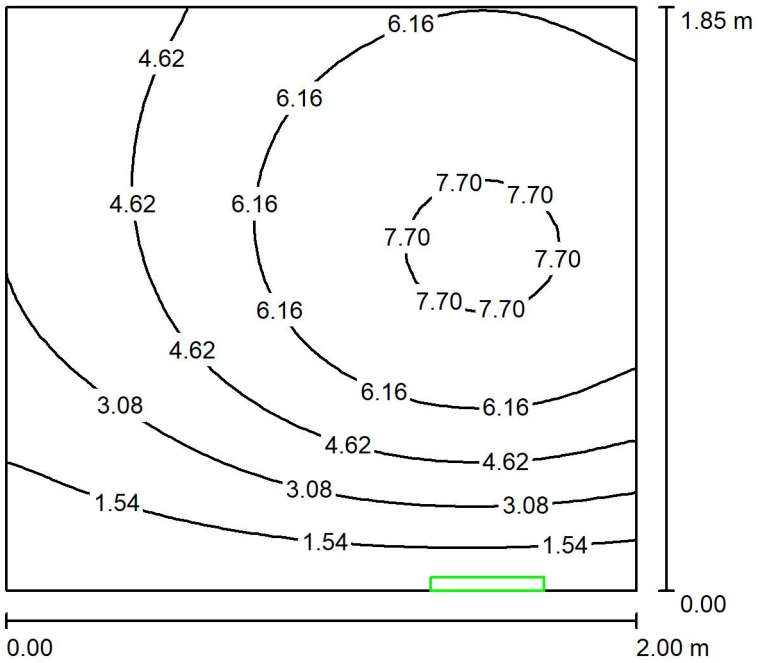
Aseo hombres / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:24

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	4.80	0.26	7.96	0.055
Suelo	20	2.11	0.15	3.48	0.069
Techo	70	17	0.21	83	0.012
Paredes (4)	50	6.95	0.00	107	/

Plano útil:

Altura:	0.850 m
Trama:	32 x 32 Puntos
Zona marginal:	0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 3.24 W/m² = 67.57 W/m²/100 lx (Base: 3.70 m²)

DIALux
19.03.2020

Proyecto elaborado por
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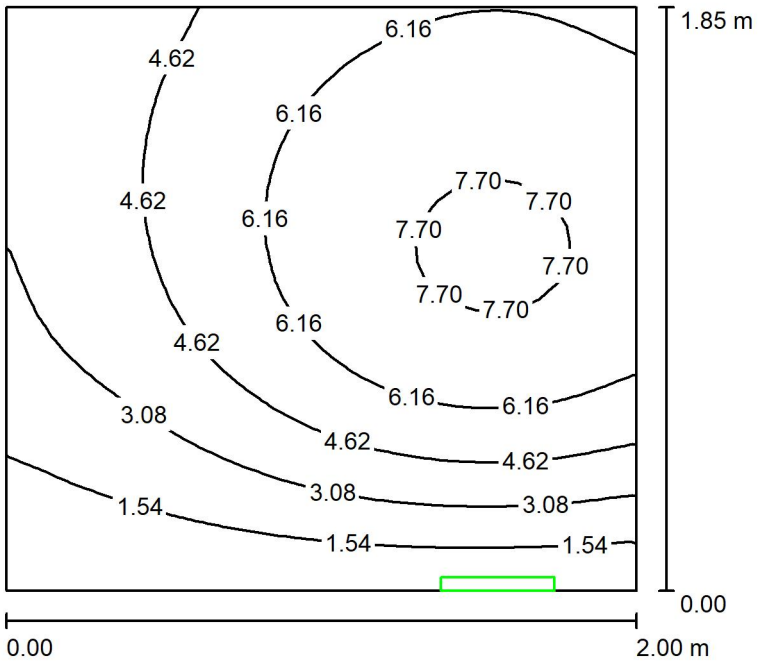
Aseo mujeres / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:24

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	4.75	0.26	7.97	0.055
Suelo	20	2.10	0.14	3.48	0.068
Techo	70	17	0.21	83	0.012
Paredes (4)	50	7.00	0.00	126	/

Plano útil:
Altura: 0.850 m
Trama: 32 x 32 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 3.24 W/m² = 68.29 W/m²/100 lx (Base: 3.70 m²)

Proyecto elaborado por
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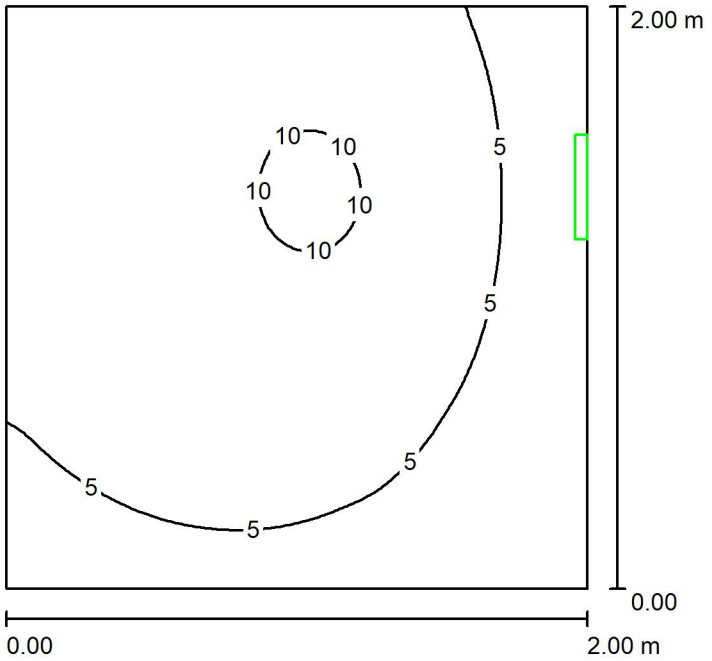
Aseo sala de catas y talleres / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.300 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:26

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	6.13	0.25	10	0.041
Suelo	20	2.67	0.20	4.11	0.074
Techo	70	14	0.35	44	0.025
Paredes (4)	50	6.93	0.00	60	/

Plano útil:

Altura:	0.850 m
Trama:	64 x 64 Puntos
Zona marginal:	0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 3.00 W/m² = 48.90 W/m²/100 lx (Base: 4.00 m²)

DIALux
19.03.2020

Proyecto elaborado por
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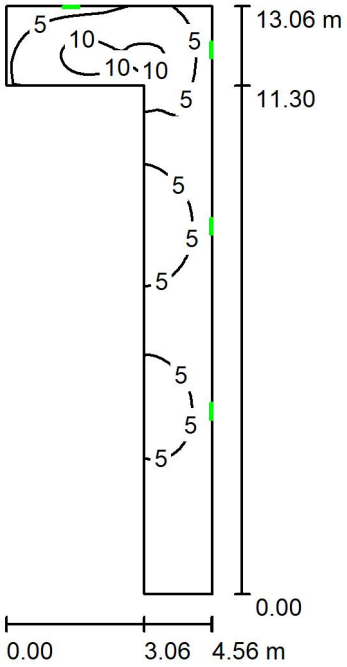
Pasillo / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:168

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	4.68	0.04	11	0.009
Suelo	20	2.52	0.05	6.03	0.018
Techo	70	13	0.02	84	0.001
Paredes (6)	50	5.22	0.00	39	/

Plano útil:
Altura: 0.850 m
Trama: 64 x 128 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	4	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 1160	Total: 1160	48.0

Valor de eficiencia energética: 1.92 W/m² = 41.07 W/m²/100 lx (Base: 24.98 m²)

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19.03.2020

Proyecto elaborado por
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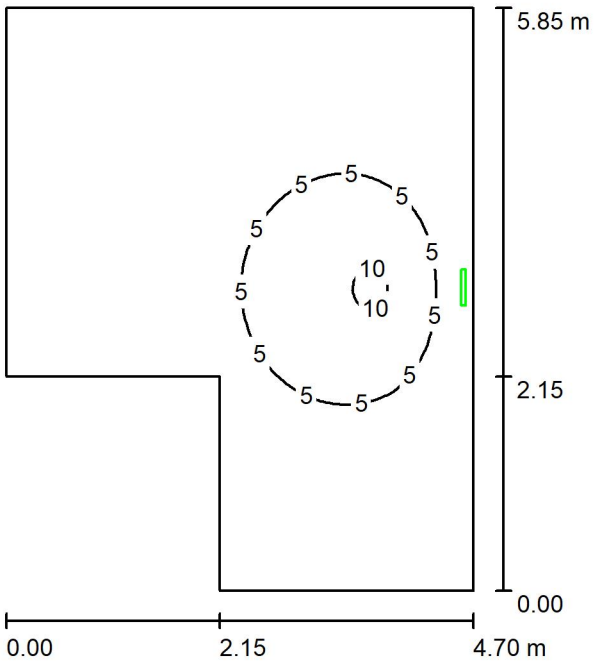
Sala de catas y talleres / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.300 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:76

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	2.71	0.01	10	0.002
Suelo	20	1.79	0.01	4.11	0.003
Techo	70	3.84	0.00	44	0.001
Paredes (6)	50	1.64	0.00	11	/

Plano útil:
Altura: 0.850 m
Trama: 128 x 128 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 0.52 W/m² = 19.33 W/m²/100 lx (Base: 22.87 m²)

DIALux
19.03.2020

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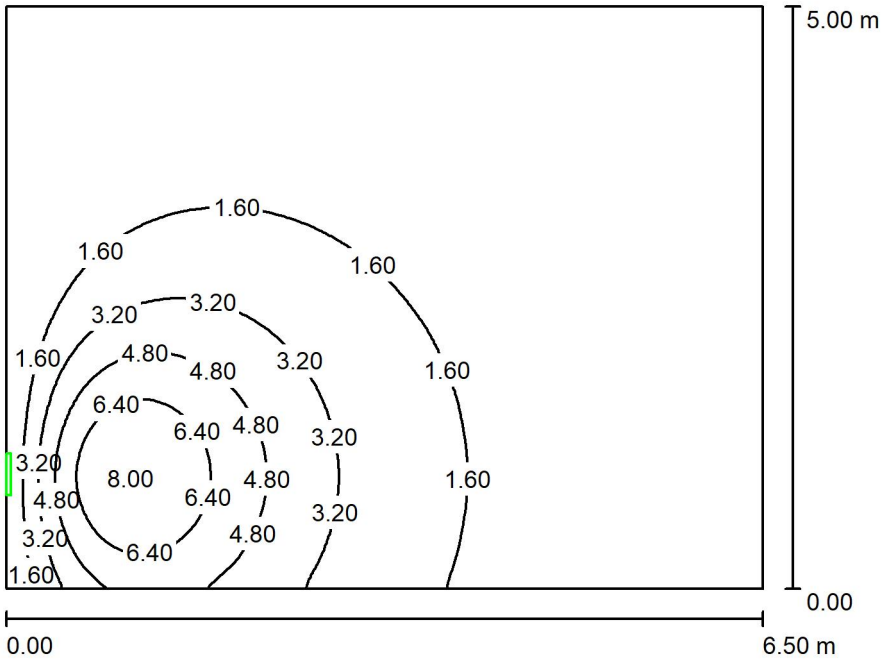
Sala calderas / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:65

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	1.71	0.02	8.02	0.015
Suelo	20	1.25	0.02	3.50	0.018
Techo	70	2.81	0.01	83	0.004
Paredes (4)	50	1.46	0.00	24	/

Plano útil:

Altura:	0.850 m
Trama:	128 x 128 Puntos
Zona marginal:	0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 0.37 W/m² = 21.63 W/m²/100 lx (Base: 32.50 m²)

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19.03.2020

Proyecto elaborado por
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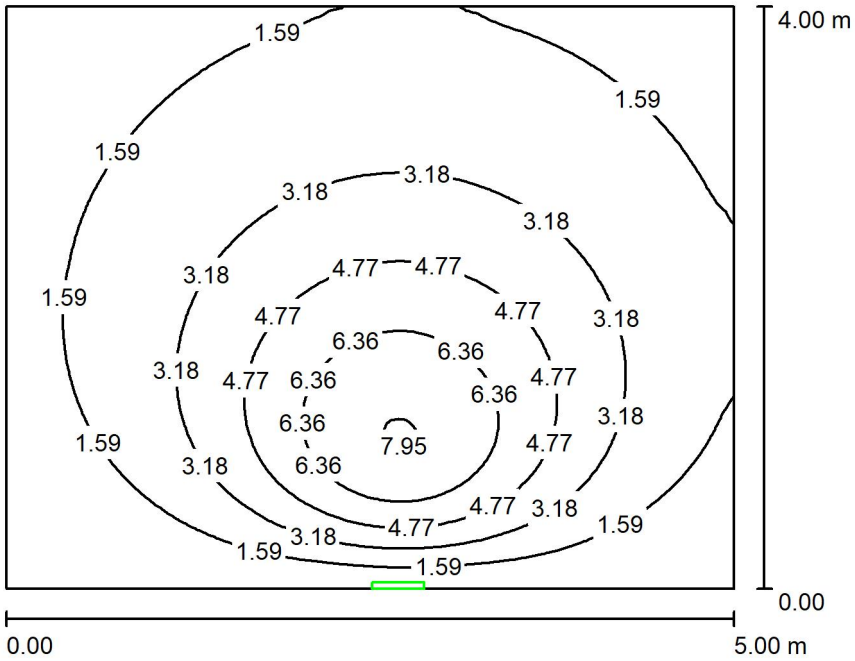
Sala aclimatada / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:52

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	2.78	0.06	8.02	0.021
Suelo	20	1.80	0.05	3.50	0.026
Techo	70	4.77	0.03	83	0.007
Paredes (4)	50	1.87	0.00	5.43	/

Plano útil:
Altura: 0.850 m
Trama: 128 x 128 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 0.60 W/m² = 21.61 W/m²/100 lx (Base: 20.00 m²)

DIALux
19.03.2020

Proyecto elaborado por
Teléfono
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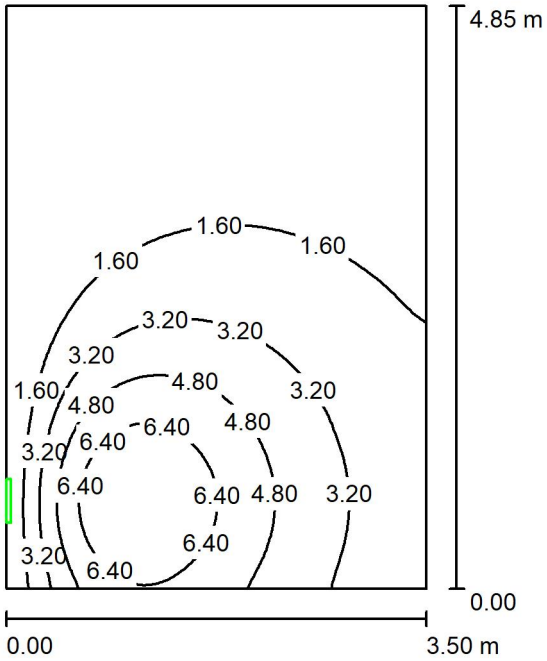
Comedor / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:63

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	2.40	0.01	8.02	0.006
Suelo	20	1.51	0.01	3.50	0.010
Techo	70	4.85	0.01	83	0.001
Paredes (4)	50	2.48	0.00	45	/

Plano útil:
Altura: 0.850 m
Trama: 64 x 64 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 0.71 W/m² = 29.40 W/m²/100 lx (Base: 16.97 m²)

DIALux
19.03.2020

Proyecto elaborado por
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Fax
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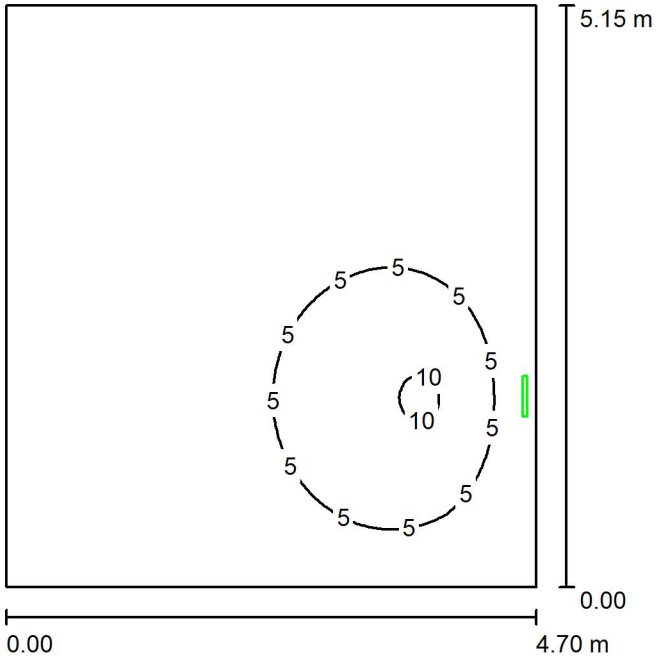
Oficina y sala de reuniones / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.300 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:67

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	2.58	0.00	10	0.002
Suelo	20	1.74	0.00	4.11	0.003
Techo	70	3.61	0.00	44	0.001
Paredes (4)	50	1.73	0.00	8.16	/

Plano útil:
Altura: 0.850 m
Trama: 128 x 128 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 0.50 W/m² = 19.21 W/m²/100 lx (Base: 24.20 m²)

DIALux
19.03.2020

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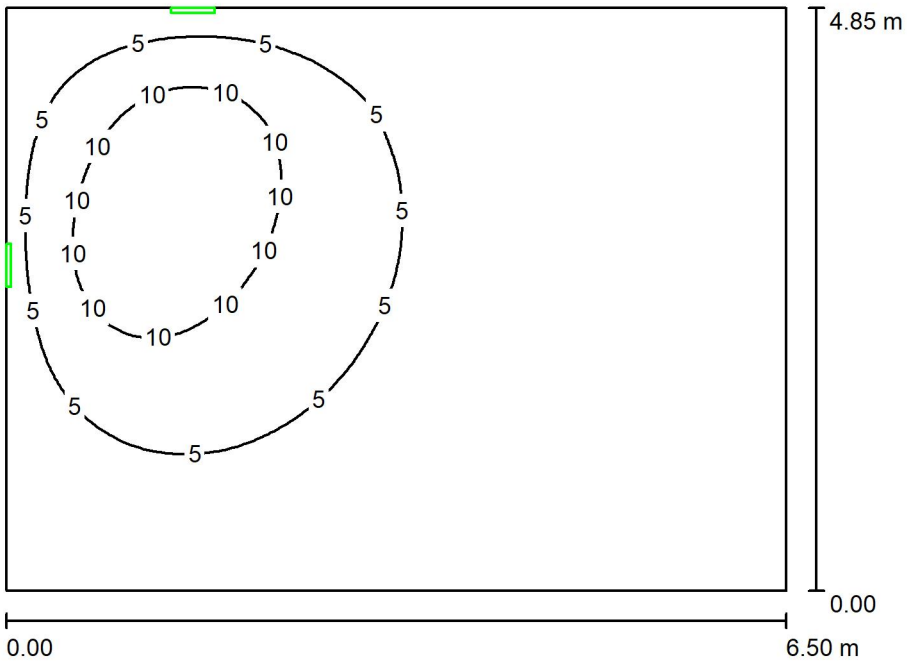
Sala I+D y calidad / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Factor mantenimiento: 0.80 — Valores en Lux, Escala 1:63

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	3.92	0.22	13	0.056
Suelo	20	2.79	0.13	6.85	0.048
Techo	70	6.17	0.14	85	0.023
Paredes (4)	50	2.67	0.05	9.09	/

Plano útil:
Altura: 0.850 m
Trama: 128 x 128 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	2	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 580	Total: 580	24.0

Valor de eficiencia energética: 0.76 W/m² = 19.44 W/m²/100 lx (Base: 31.52 m²)

DIALux
19.03.2020

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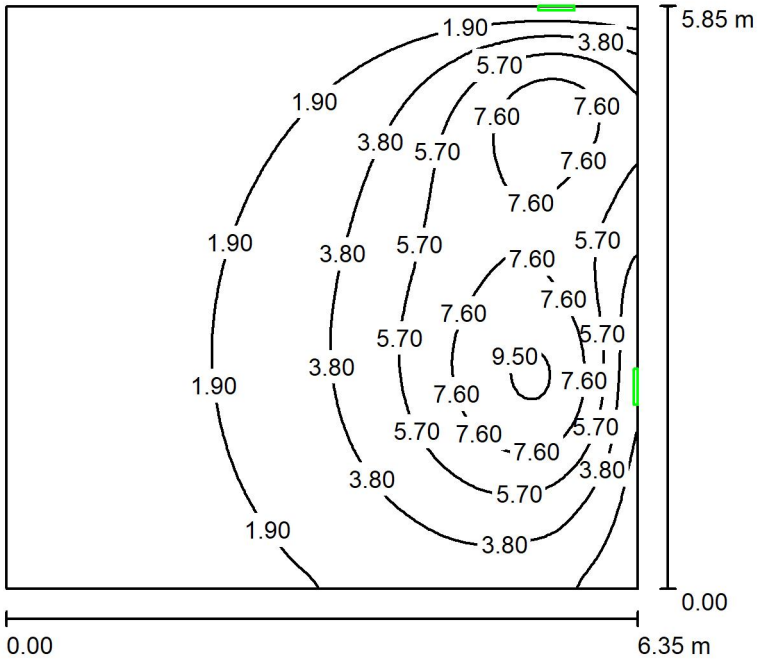
Tienda / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:76

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	3.23	0.27	9.75	0.085
Suelo	20	2.38	0.20	5.27	0.082
Techo	70	5.05	0.09	84	0.019
Paredes (4)	50	2.57	0.04	36	/

Plano útil:
Altura: 0.850 m
Trama: 128 x 128 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	2	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 580	Total: 580	24.0

Valor de eficiencia energética: 0.65 W/m² = 20.03 W/m²/100 lx (Base: 37.15 m²)

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19.03.2020

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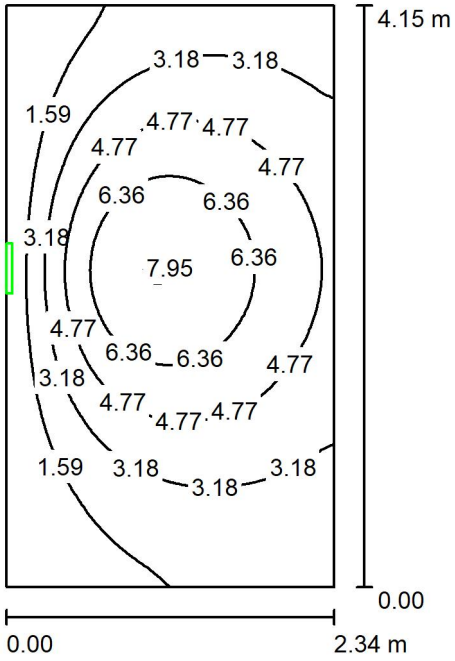
Toro / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:54

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	3.74	0.09	8.02	0.024
Suelo	20	1.96	0.06	3.50	0.029
Techo	70	8.83	0.07	83	0.008
Paredes (4)	50	3.28	0.00	16	/

Plano útil:
Altura: 0.850 m
Trama: 64 x 64 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 1.24 W/m² = 33.11 W/m²/100 lx (Base: 9.70 m²)

DIALux
19.03.2020

Proyecto elaborado por
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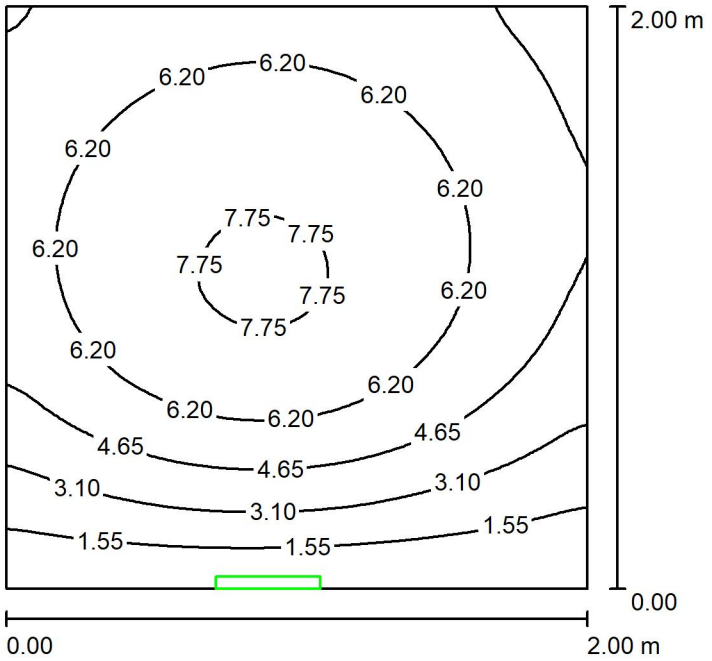
Vestuario hombres / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:26

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	5.16	0.19	7.96	0.037
Suelo	20	2.28	0.15	3.48	0.068
Techo	70	18	0.34	83	0.019
Paredes (4)	50	6.31	0.00	29	/

Plano útil:
Altura: 0.850 m
Trama: 64 x 64 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 3.00 W/m² = 58.10 W/m²/100 lx (Base: 4.00 m²)

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19.03.2020

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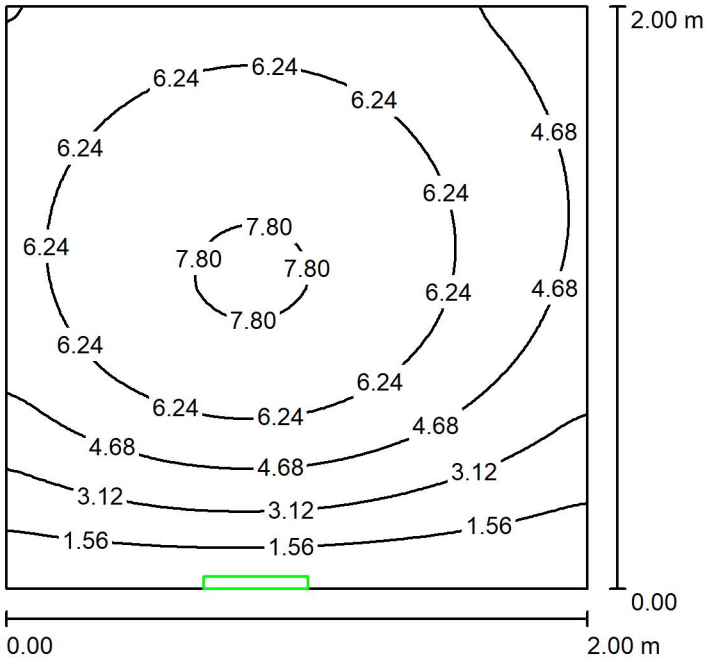
Vestuario mujeres / Escena de luz 1 / Resumen



Altura del local: 3.000 m, Altura de montaje: 2.500 m, Factor mantenimiento: 0.80

Valores en Lux, Escala 1:26

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	5.14	0.18	7.96	0.035
Suelo	20	2.28	0.15	3.48	0.066
Techo	70	18	0.37	83	0.021
Paredes (4)	50	6.32	0.00	32	/

Plano útil:
Altura: 0.850 m
Trama: 64 x 64 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

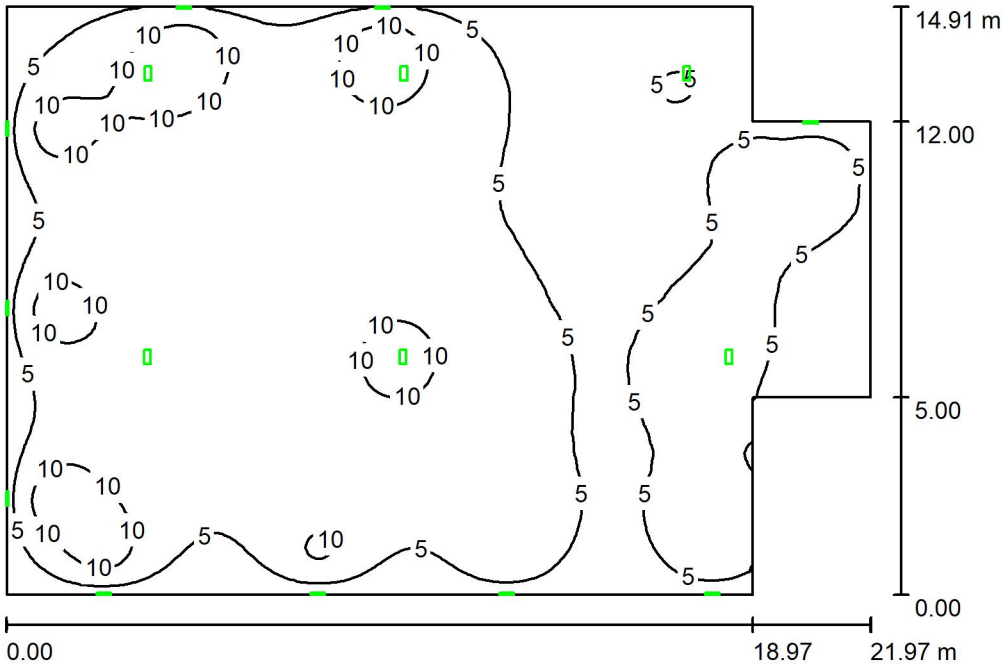
Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	1	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 290	Total: 290	12.0

Valor de eficiencia energética: 3.00 W/m² = 58.31 W/m²/100 lx (Base: 4.00 m²)

Proyecto elaborado por
Teléfono
Fax
e-Mail

Producción + almacen MP / Escena de luz 1 / Resumen



Altura del local: 7.000 m, Factor mantenimiento: 0.80 — Valores en Lux, Escala 1:192

Superficie	ρ [%]	E_m [lx]	E_{min} [lx]	E_{max} [lx]	E_{min} / E_m
Plano útil	/	6.54	0.82	14	0.126
Suelo	20	5.93	0.78	9.40	0.131
Techo	70	1.98	0.25	3.39	0.129
Paredes (9)	50	2.99	0.29	24	/

Plano útil:
Altura: 0.850 m
Trama: 128 x 128 Puntos
Zona marginal: 0.000 m

Escena de alumbrado de emergencia (EN 1838):
Sólo se calcula la luz directa. No se tiene en cuenta la acción de las luces reflejadas.

Lista de piezas - Luminarias

N°	Pieza	Designación (Factor de corrección)	Φ (Luminaria) [lm]	Φ (Lámparas) [lm]	P [W]
1	17	Luxiona PT-300C Plat (1.000)	290	290	12.0
			Total: 4930	Total: 4930	204.0

Valor de eficiencia energética: 0.67 W/m² = 10.28 W/m²/100 lx (Base: 303.68 m²)