BIALYSTOK UNIVERSITY OF TECHNOLOGY (BUT)

Project of electrical low voltage installations in the industrial building

Bialystok University of Technology

Escuela de Ingeniería y Arquitectura (EINA)

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ELECTRICAL ENGINEERING

PROJECT FINAL

Titular: SERGIO HARO ALCALDE

INDEX

1. INTRODUCTION

1.1 Definition and purpose of the project

The purpose of the project is to perform calculations and studies required for the design of electrical supply to different receiver power and lighting of a warehouse energy, whose activity consists in treating metals, so that the planned facilities allow carry out the production process.

The electrical needs of the company in terms of which the electrical installation will be projected, defining the technical and security features, and gathering the minimum conditions and guarantees required by current regulations, in order to obtain administrative authorization will be studied competent bodies for commissioning.

It is undertake the design and calculation of the electrical installation for industrial building for a business of metallurgy.

1.2 Scope of the project

The study covers from the end of the rush of the electricity distribution company to connect with receptors inside installation, including the network of lands and authorizations.

The contract for electricity supply will negotiate with the distribution company Endesa Distribución Eléctrica, S.L.

The power supply for the facilities belonging to the present project will be carried out at low voltage, the voltage being calculation and distribution between phases and 400V between phase and neutral 230 and a frequency of 50 Hz.

1.3 Situation

The facility object of this project is located on a plot of the sector 88 of the Industrial EMPRESARIUM in Barrio de la Cartuja Baja (Zaragoza) 6 km from the city.

1.4 Activity

The domain of our business is the manufacture of metal containers, consisting of a metal machining process, performed by appropriate machinery by direct treatment of the raw material, changing forms.

In this case the starting materials are iron and metal bars, which through the process that they undergo on this ship will be transformed into finished products: metal containers.

This activity would fall under the heading 2410 "Manufacture of basic iron and steel and ferroalloys" according to NACE Code and is classified as annoying, unhealthy, harmful and dangerous activity, because of the production of noise, Decimal Classification number 342-15. Metal machining is classified as industrial activity Decimal Classification No. 357-1, being a qualified as unhealthy activity (NACE Code no. 28.4 Treatment of Metals).

1.5 Land and buildings

It is already built a warehouse with a floor space of 680 m^2 and the following features:

Parcel area	680 m^2
Length of the ship	36,64 m
Width of building	18,47 m
Heigth of pillars	5 m
Cover	Fibrocement thermally insulated
Pavement	Concrete treated with anti-slip

The surface of the ship is distributed on one level that comprise the office area, common services for staff and the actual production area, where he will proceed to the transformation of parts and storage to delivery to the customer. The distribution of the surface will be:

Wardrobe.....	12 m^2
WC.....	19 m^2
Office.....	100 m^2
Boiler room.....	5m^2
Compressor room.....	5 m^2
Stock.....	129 m^2
Workshop.....	500 m^2

The structure is made of iron, protected fire to send a type one hundred eighty minutes (UNE-EN 13501-1: 2002, in which we observe classification behavior of materials subjected to reaction to fire tests).

Its structure is configured with mortar mineral fibers, projected on a metal mesh so that at any time can be exposed, silica to expand by heat, or that its deformation resistance or loss occurs due to the temperature.

1.6 Applicable regulations

To obtain the necessary licenses for the operation of our industry, it is necessary to invoke the Spanish legislation, and if the regional and local levels those are applicable, without forgetting that must comply with European directives in each subject. We quote the most relevant:

Spanish legislation:

- Law 21/1992 Industry (Safety and Industrial Quality)
- Royal Decree (RD) 1644/2008 marketing standards for service and commissioning of the machines
- RD 1435/1992 Machines, safety components "CE"
- Law 31/1995 Prevention of occupational hazards
- RD 485/1997 Provisions minimum in the field of signaling safety and health at work
- RD 486/1997 laying down minimum health and safety requirements set out in the workplace
- RD 614/2001 Provisions minimum for the protection of the health and safety of workers against the risk of electric
- RD 773/1997 Minimum requirements for safety and health concerning the use by workers of individual protective equipment
- RD 1942/1993 Regulation of facilities of protection fire
- RD 2267/2004 Fire Safety Regulations in industrial establishments
- Decree 1618/1980 regulation of heating, cooling and domestic hot water in order to rationalize their consumption
- Law 37/2003 of noise 17-11-2003
- RD 286/2006 on the protection of the health and safety of workers from the risks related to exposure to noise
- Decree 2414/1961 Regulation inconvenient, unhealthy, harmful and dangerous
- Law 34/2007 Air Quality and Atmospheric Protection
- Regulation 42/1975 Waste Act and Hazardous Waste
- Law 54/1997 on Electricity Sector Regulation
- RD 1955/2000 Regulates activities of transport, distribution, marketing, supply and installations of electricity authorization procedures
- RD 842/2002 Low Voltage Electrotechnical Regulations (REBT) and Complementary Technical Instructions (ITC) BT 01 to BT 51, and more specifically:

- ITC-BT 10 in terms of load forecast
- ITC-BT 11 as for rush
- ITC-BT 12 as for link facilities
- ITC-BT 15 in terms of individual referrals
- ITC-BT 17 control and protection devices
- ITC-BT 18 earthing of the installation
- ITC-BT 19 in terms of general rules
- ITC-BT 20 in terms of installation systems
- ITC-BT 21 protective pipes and channels
- ITC-BT 22 protections against intensities
- ITC-BT 23 protection against over voltages
- ITC-BT 24 protections against direct and indirect contacts

- D 363/2004 Regulates administrative procedure for application of the low voltage electro-technical regulation
- UNE and recommendations that apply UNESA
- Internal Rules of the Endesa group
- RD 235/2013 on energy efficiency in buildings
- Legislation local level: regional, municipal ordinances and other

European legislation:

- Directive 2006/42 / EC of 17 May 2006 on machinery (Industrial Security)
- Directive 2002/49 / EC of 06.25.2002 on the assessment and management of environmental noise
- Directive 2003/10 / CE of 06-02-2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise)
- Directive 2012/27 / EU of 10.25.2012 on energy efficiency

2 INDUSTRIAL PROCESS

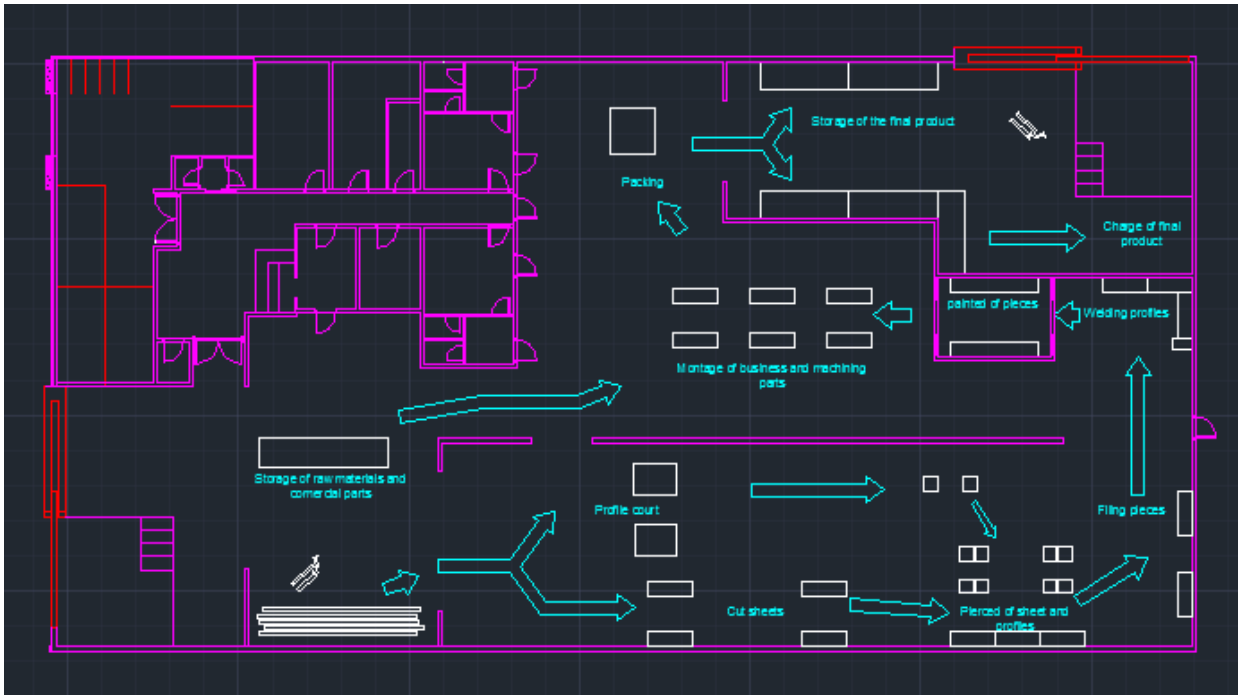
2.1 Description of the process

As noted above, the activity in our company is the manufacture of metal containers, which can be closed or open and with different dimensions to the market demands.

The metal is received in sheets and rods of different thicknesses and diameters and local undergo different operations to achieve the finished product:

- Operations cut to precise measurements
- Formed by plastic deformation
- Screwed
- Soldier
- Assembly and over.
- Boiler
- Compressor

All these operations require the appropriate machinery, indicated below, which is necessary to complete the production process of this industry.



2.2 Classification of the building

According to the ITC-28 Low Voltage Electrical Regulations it stipulates that a local public audience is if occupancy is 300 people or more, setting the following condition: the planned occupation of the premises will be calculated as 1 person per 0,8 m^2 floor space, except for the hallways and bathrooms.

In our case for being a factory in the metal sector it would limit a maximum capacity of 100-150 people in the days of full occupancy process.

We can conclude that our company will never have an occupation of more than 300 people and thus be out of the category of local public concurrence and well as the conditions that implies.

2.3 Equipment

Machinery used for production processes are:

Equipment	Quantity	Power (W)	Tension (V)
Milling machine	1	0,9	230
Guillotine cutter	2	7,5(15)	400
Universal cylindral grading	1	3	400
Lathe	1	2	400
Radial cutter	1	1,5	230
Compressor	1	15	400
Sharpener	1	1,5	230
Welding equipment SMAW	1	20	400
Welding equipment MIG-MAG	1	14	400
Drill	2	2,2(4,4)	400
Chamfering	1	0,85	400

We will present the main characteristics of the machines used in the followings chapters:

2.3.1 Milling machine

Router Bosch GOF 900 CE		
Maximun distance of tray		50 mm
Rotational speed in vacuum		12.000-24.000 rpm
Power consumption		900 W
Tool holder		6/8 mm
Rip fence with fine adjustament		-
Includes	Collet nut	8 mm
	Socket copying	17 mm
	Centiring pin	8 mm
	Wrench	1
	Suction fitting	-

2.3.2 Guillotine cutter

Type	6×2500
Thickness able to cut	6
Width able to cut	2500
Travel (times / min)	20-40
Rear block distance (mm)	750
Cutting angle (º)	0,5-1,5
Throat Depth (mm)	80
Main motor power (Kw)	7,5
Machine weight (kg)	6500
Dimensions (L×W×H) (mm)	3000x2075x1920

2.3.3 Cylindrical griding

In our workshop we will use a Vertical Precision Grinding Machine-T170S as a cylindrical griding with these features:

Maximum diameter of rectification ¢	170 mm
Maximum deeper of rectification	400 mm
Maximum diameter of perforation ¢	30 mm
Shaft rotation speed	80/860 r/min
Shaft powe	810 mm/min
Fast moving speed shaft	590 mm
Transportation shaft	0-500 mm
Distance between the axis and the work table	330 mm
Maximum longitudinal travel of worktable	1100 mm
Latitudinal maximum travel of the worktable	80 mm
Size of worktable (width x length)	400x1250 mm
Number of Slots T worktable	3
Dimension of precisión	H7
Rough drilling	Ra 2,5 µm
Main motor power	3 kw
Dimensions (Length x width x height)	2100x1430x2010 mm
Packaging dimension (length x width x height)	1820x1770x2190 mm
Net / Gross Weight	2500 kg/2800 kg

2.3.4 Lathe

We will use a Proteo TL 25 which meaning features are:

Maximum diameter bar	25 mm
Distance maximum torque	150 mm
Fast alimentation	40.000 mm/min
Scheduled alimentation	10.000 mm/min
Motor spindle	2 kw-s1
Motor axis	0,75 kw
Maximum speed milling	7000 rpm
Motor milling unit	0,75 kw
Proportions	1600x1400x1700 mmm
Weight	1400 kg
Power of the 3 phases + neutral	400/50 V/Hz

2.3.5 Sharpener

Bosch GSM 600	
Width disk	-
Grind	25 mm
Diameter of disk Ø	175 mm
Weight	14,3 kg
Positioning	The resistance for the toughest applications
Absorb power: 1500 W	1500 W
Disk Drill grind	32 mm
Grain size	36 + 60
Type of product	Double grinder
Nominal speed of rotation: 2.840 r.p.m.	2840 rpm
Package (L/A/A): 430 x 300 x 280 mm	430x300x280 mm
Standard specifications : Sanding Disc normal granulated	Grain 36
Sanding Disc normal grain	Grain 60

2.3.6 Welding equipment SMAW

Voltage AC power supply	380+/-10% V/50~60 Hz
Capacity of the power supply	17,8 KVA
Rated input current	26 A
Duty cycle	60%
Range of the output current	20-400 A
Cosϕ (η)	0,95
Protection class	IP 21 S
Insulation Grade	B
Weight	35,2 Kg
Dimensions (mm)	575x325x460

2.3.7 Drill base

FWJDCD2	
Core drill	-
Voltage	230 V/50 Hz
Power	1360 W
No-load speed	1900 r/min
Maximum Diameter Drilling	1200 mm
pc/CTN	1
Carton size (mm)	760x260x210

2.3.9 Compressor

Screw Air Compressor	JR - 20 A
Outdoors delivery / discharge pressure (m^3/min/Mpa)	-2,5 / 0,7 -2,3 / 0,8 -2,1 / 1,0 -1,9 / 1,2
Power (KW/HP)	15/20
Compression stage No.of	single stage
Room temperature (0º C)	-5 - + 45
Model Cooling	Air cooling
Discharge temperature (0 ºC)	T + 15 environment
Lubricant (L)	18
Noise Level (DB)	64 ± 2
Drive method	Multivee belt
Electricity (V/ph/Hz)	380/3/50
Dimensions: L xWxH (mm)	950 × 800 × 1130
Weight (kg)	450
Pipe diameter air outlet (inch/mm)	3/4"

2.4 Personal and necessary work regime

The staff required at the beginning of our industry life will consist of:

- 1 administrative
- 1 shop teacher
- 2 skilled workers
- 2 assistants laborers

The workday is 8 hours per day, five days a week, then 40 hours. Therefore, the annual day will be the total number of hours per year, considering that the year has 52 weeks:

$$52 \times 5 \times 8 = 2.080 \text{ hours}$$

2.5 Environmental report

It has conducted an investigation into the environmental impact to determine the degree of influence of the activity of the workshop environment. For this reason we have taken into account the law of environmental protection and bylaws of the city of Zaragoza.

Law 27/2006 of Environmental Responsibility, which arises from the transposition of Directive 2004/35 / EC, includes an administrative liability regime and unlimited target based on the principles of prevention and polluter-pays basis. Companies whose activities are included in this law are required to adopt and implement the measures of prevention, avoidance and repair of environmental damage and to cover their costs, whatever their level, when they are responsible for them. It also requires them to immediately inform the competent authority if the existence of environmental damage or imminent threat of such damage, that have caused or may cause.

The activities within the scope of this legislation are listed in Annex III, all activities in the event of negligence, fault or fraud and all activities they are reasonable measures of prevention and harm avoidance.

The elements that may constitute environmental hazards in our company is first determined, considering both its facilities and its environment, then the risk is assessed from the probability of occurrence and severity of the consequences.

Constantly businesses, including the metal sector, carry out activities that affect the environment, causing pollution and causing negative impacts on the environment.

The impacts may be associated with:

- Air pollution at global and local level:
    - Acid rain
    - Greenhouse
    - Destruction of the ozone layer
    - Ambient air pollution
- Water contamination
    - Reduction of the oxygen content of the water
    - Appearance of sediments or deposits of solids and sludge from different mineral or organic nature
    - Emergence of pathogenic microorganisms
    - Nutrient inputs causing massive algae growth and lead to eutrophication.
    - Inhibition of biological processes due to toxic or inhibitory.
    - Reducing the chances of further use: industrial, agricultural or recreational.
- Waste generation
    - Conditions on the ground by direct contact of contaminated waste
    - Conditions to waters
    - Scenic conditions accumulation of waste
    - Conditions to the natural environment of the area

Some of the characteristics of the wastewater generated in the metal sector activities are:

- Oily water: as a result of the cleaning of the premises and machinery
- Degreasing used in detergents and cleaning found in the discharge as a contaminant more.
- Cooling waters
- Acidic wastewater metals
- Wastewater with phosphates

In relation to urban or municipal waste the employer must comply with the regulations of local authorities for collection, since it is forbidden abandonment, dumping or

uncontrolled disposal. In the case of hazardous waste it is necessary to have authorization as a producer of hazardous waste and manage them properly:

- Separate and do not mix
- Package and label
- Not stored for more than six months
- Keep records
- Delivered to a waste manager
- Report in case of disappearance, loss or theft
- Annual report and statement

In this company, in addition to monitoring compliance with all the rules on the exposed impacts, we estimate that the most significant risk is the noise pollution.

Regulation of Annoying, unhealthy, harmful and dangerous activities (RAMINP) is approved in order to prevent the installations, establishments, activities, industries or stores whether public or private, public or private, general activities, produce discomfort, alter the normal conditions of health and hygiene of the environment and cause damage to public or private funds or involve serious risks to people or property.

In the nomenclature of this regulation the activities of the metal sector, in particular the manufacture of metal containers within annoying, because of the noise they cause are included.

Of environmental damage, noise pollution is probably where citizens perceive singled out a form. The noise and vibrations are a constant presence in any human activity.

This makes the European institutions have acted firmly on this issue and after a Green Paper of the European Commission on future policy to combat noise, Directive 2002/49 / EC on the assessment was approved and management of environmental noise, which has a first transposed into our law 37/2003 Noise Law, supplemented by Royal Decree 1513/2005, by which develops the Law regarding the assessment and management of environmental noise and Royal Decree 1367/2007, by which develops the Law regarding acoustic zoning, objectives of acoustic and acoustic quality issuers. The autonomous regions have participated in this regulatory process governing the subject.

In the case of our company it is governed by Law 7/2010 of 18 November on the protection against noise pollution of Aragon, which aims to collaborate effectively in the ongoing task of defending the environment and health of people against attacks that may represent noise and vibration, its intensity was placed in the limits permitted by law. Its purpose is to prevent, monitor and reduce noise pollution to prevent and reduce damage arising to human health, property or the environment in the

Autonomous Community of Aragon, through the establishment of levels, objectives and acoustic quality indices. In particular, it defines and regulates issues such as sound quality, acoustic areas, noise maps, the relationship with infrastructure and buildings, noise assessment, prevention and correction instruments of noise pollution and noise protection zones special among others.

For the purposes of this Act, two types of acoustic areas are considered: exterior and interior. According to the definition given in Annex I, types of external acoustic areas are:

- Natural areas
- High acoustic sensitivity areas (health and cultural practices, teachers).
- Residential areas
- Tertiary use areas
- Recreation areas and outdoor entertainment
- Areas of industrial use
- Areas of use of infrastructures and equipment

The acoustic type for indoor areas, defined in terms of their uses, is:

- Health and care use
- Private residential uses
- Public residential uses
- Educational and cultural uses
- Administrative and office uses

The areas of industrial applications sectors delimit the territory of very low acoustic sensitivity and, therefore, do not require special protection against noise pollution, including areas with a predominance of land for industrial use and complementary uses of the same.

The law acoustic transmitters in de article 15 are classified as:

- Vehicles
- Railways
- Aircrafts
- Road infrastructure
- Rail infrastructure
- Airport infrastructure
- Machinery and equipment
- Construction of buildings and civil engineering

- Industrial activities
- Commercial and service activities
- Sports and recreation and leisure activities

The acoustic evaluation is articulated in this Act through the processes of calculation, prediction, measurement and evaluation of acoustic indices set out in Annex IV. The overall objectives of the evaluation are:

- Objectively evaluate the acoustic quality of the interior and exterior spaces
- Assess the effects of noise on people, property and the environment
- Consider the acoustic quality of homes and buildings as a factor affecting the quality of life of people and the environment

Acoustic correction programs are self-acoustic programs adopted by the acoustic emitters both voluntarily and in compliance with the requirements of the competent authority, and whose purpose is to minimize noise pollution generated by them.

For the application of this Act the following intervals are established daily schedules by default:

Interval schedule	Time delimitation	Duration (h)
Morning	7:00-19:00	12
Evening	19:00-23:00	4
Night	23:00-07:00	8

The acoustic quality objectives for noise applicable to different types of external acoustic areas are defined by the no exceedance of the relevant noise immission rates Ld, Le and Ln set out in Table 1, to be considered as limiting values and they will be evaluated according to the criteria set out in Annex IV. These indexes are weighted noise levels to long term and obtained from the average of all corresponding to the reference time periods day, evening and night of the year being evaluated daily rates.

Table 1: Acoustic quality objectives applicable to existing urbanized areas

Type of acoustic area		Noise indices		
		L_d	L_e	L_n
a	Natural areas	Regulated in paragraph 1f)		
b	Areas of high acoustic sensitivity	60	60	50
c	Residential areas	65	65	55
d	Areas of tertiary use	70	70	65
e	Areas of recreation and entertainment	73	73	63
f	Areas of industrial use	75	75	65
g	Areas of use of infrastructures and equipment	Regulated in paragraph 1e)		

NOTE: The quality objectives applicable to acoustic areas are referenced to a height of 4 m.

Be deemed to acoustic quality objectives established in Table 1 is satisfied when, for each of the indexes of noise immission values evaluated according to the procedures set out in Annex IV meet, in the period of one year:

- No value exceeds the corresponding values set in Table 1.
- 97% of all daily values do not exceed 3 dB the values set in the corresponding Table 1.

3. FIRE PREVENTION

3.1 Applicable normative

The reference document is Royal Decree 2267/2004 of 3 December approving the Fire Safety Regulation was adopted in industrial establishments, in order to establish and define the requirements and conditions to be fulfilled by establishments and facilities for industrial safety in case of fire, to prevent their occurrence and to respond appropriately should they occur, to cancel or reduce the damages or losses that the fire may occur to persons or property.

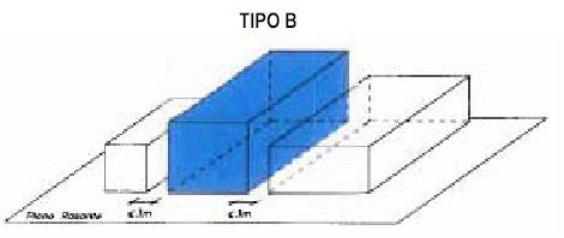
The development of the RD 2267/2004 occurs in two Technical Prevention Notes (NTP). In the first NTP criteria characterizing establishments (Annex I of RD) and the requirements of fire protection facilities (Annex III) and the second set of legislation and standards it is included to consider the application DR. It has also consulted the NTP 599 "Evaluation of the risk of fire", Criteria and NTP 831 and 832 on passive protection, evacuation and fire protection facilities.

For the implementation of the activity on the ship you will be required to submit to the competent body of the autonomous community of Aragon certificate attesting compliance with the technical requirements established by this Regulation, specifying levels of risk.

3.2 Local classification

The conditions and requirements to be met by industrial establishments in relation to fire safety, will be determined by the configuration and location in relation to its environment and its level of intrinsic risk, fixed as set out in Annex I.

- Depending on your configuration and location in relation to the environment this is a purpose-built B as fully occupies a building that is attached to one or other buildings, or at a distance equal to or less than three meters from one or other buildings.



Depending on the configuration, one or more sectors of fire, defined as building spaces enclosed by fire resistant elements is constituted. In our case is one area of fire.

- The level of inherent risk in the sector is assessed by the formula:

$$Q_s = \frac{\sum_1^i G_i \, q_i \, C_i}{A} R_a \; (MJ/m^2) \; o \; (Mcal/m^2)$$

Where

Q_s = charge density weighted and corrected fire
Gi = mass in kg of fuel
Qi = calorific value of each fuel
Ci = dimensionless coefficient that weights the degree of danger of fuels
Ra = dimensionless coefficient that corrects the degree of danger of industrial activity

We understand that the object of this work is not necessary to go into detailed calculation and going to consider that, for the materials are handled, the Qs < 200 Mcal/m^2 and therefore the resulting risk is medium. Nor are we in a qualified special risk industry.

3.3 Construction requirement

Annex II of the Fire Safety Regulations in industrial establishments corresponds to the Passive Fire Protection whose function is to prevent the occurrence of fire, prevent or delay its spread and facilitate both the firefighting and evacuation.

Next, the conditions and construction requirements for industrial establishments in relation to fire safety, which depend mainly on the relationship between the configurations of the building where the sector is described, the surface of the sector and the level of risk intrinsic.

Our ship has facade accessible as their holes that allow access from outside the staff of firefighting service. The approach road to the front and the room for maneuver meet the regulations.

The materials used in construction are:

- Cover..... Thermally insulated Slate
- Pavement..... Concrete treated with anti-slip
- Structure ..... Iron, protected fire to send a type one hundred eighty minutes

The structure is set mortar mineral fibers, projected into a metal mesh so that at any time can be exposed silica to expand by heat, or cause deformation or loss of strength due to the temperature.

All these materials are included as construction products and building elements defined by Royal Decree 312/2005 of March 18 by which the classification of construction products and building elements based on its reaction is approved and resistance against fire and have passed the test report and classification according to UNE EN 13501-1: 2002, thus meeting the conditions and building requirements to ensure fire safety in terms of its reaction and resistance before the fire.

3.4 Outputs and dimensions

According to the CTE Basic Document "Safety in case of fire" (SI) the ship can have a single plant output to meet the requirements: The occupation does not exceed 100 people, no more than 50 people need to save upwards evacuation height greater than 2 m and the length of the evacuation routes to the direct access to outer space insurance does not exceed 50 m. Despite this we have two exits, with direct access to outside insurance for safety of workers.

We follow the parameters established in the norm NBE-CPI-91 7.4 Article 7 to size doors, steps and walkways. Production teams are willing respecting a corridor of 0,80 m wide, regulatory when the number of employees is 10. The maximum width of any door leaf should not be less than 0,60 m or exceed 1,20 m, so that the workshop doors 0,90 m are placed on a single sheet.

3.5 Protection systems

Protection systems to be installed depend on the relationship between building type, the level of risk inherent in the sector and the area of the fire sector. All devices, equipment, systems and components facilities fire protection install and design, implementation, commissioning and maintenance of their facilities, meet the provisions in the Rules of facilities fire protection, approved by Royal Decree 1942/1993, of 5 November and the Order of April 16, 1998, on the rules of procedure and development.

The characteristics of the installation the law does not require the installation of fire alarm systems or by water or sprinkler systems. However, the law states that portable fire extinguishers are installed in all fire sectors of industrial establishments.

The location of portable fire extinguishers allow them to be easily visible and accessible, will be located next to the points where more likely to start a fire is

considered and its distribution is such that the maximum horizontal travel, from any point of the fire sector to extinguisher does not exceed 15 m.

According to the UNE 23010 they were chosen extinguishers ABC (multipurpose) powder. Fire extinguishers are placed on the surface of the wall, at a height of 1,20 meters from the ground for comfortable when use 5 extinguishers under the rules of pressure vessels and their complementary technical instruction MIE-AP5 be placed.

3.6 Marking and lighting

According to paragraph 7 "signaling means of escape" section SI 3 CTE Basic Document "Safety in case of fire" (SI) evacuation signals defined in UNE 23034/1988 is used.

Although the occupants are linked to the activity that takes place in the building and exits that are easily visible from all parts of the plant, we will use established signaling:

- An output is intended for emergency exit we will indicate as such marked "Emergency Exit" and the other is intended for regular use, so you will be marked with the label "OUT".
- Direction signs indicative of the routes visible from throughout the premises
- The means of fire protection manual operation (extinguishers) should be marked by signs defined in UNE 23033-1.

Signs must be visible even in case of failure of the normal lighting supply so we'll use photoluminescent whose light emission characteristics must comply with the provisions in UNE 23035-4/2003.

As there is a special risk premises it is not mandatory emergency lighting in the evacuation routes. It could have opted for the normal lighting system that would provide at least the same levels of illumination set out in Article 21 for the installation of emergency lighting, according to Article 12, Section 12.3 of Chapter 2 of the NBE CPI- 91, however we decided to equip it with an emergency lighting as noted in Article 21, paragraph 21.1 of Chapter 5 of the NBE CPI-91. The emergency facility will provide an illuminance of 0,2 lux minimum in the ground in the evacuation routes. The installation is performed with automatic autonomous teams.

The characteristics required of these devices will be established in UNE-20062-73 (autonomous devices for emergency lighting) and UNE 20392-75 (autonomous devices for emergency lighting with fluorescent lamp).

4. STUDY OF SAFETY AND HEALTH

4.1 Prevention of occupational hazards

4.1.1 Introduction

Law 31/1995, of November 8, 1995, Risk Prevention Work aims at determining the basic body of guarantees and responsibilities necessary to establish an adequate level of protection health workers from the risks arising from conditions work.

As law establishes a legal framework within which the rules will be regulatory setting and specifying the technical aspects of the preventive measures.

Those rules are summarized below:

- Minimum safety and health in the workplace
- Minimum requirements concerning safety signs and health the work
- Minimum safety and health for the use by workers work equipment
- Minimum safety and health at construction sites
- Minimum safety and health requirements for the use by workers of personal protective equipment.

4.1.2 Rights and obligations

4.1.2.1 RIGHT TO PROTECTION AGAINST THE RISKS LABOR

Workers have a right to effective protection in safety and health at work.

To this end, the entrepreneur made the prevention of risks labor by taking all necessary measures for the protecting the safety and health of workers, with the specialties as set out in the following articles on risk assessment, information, consultation, participation and training of workers, action emergency and serious and imminent risk and health surveillance.

4.1.2.2 PRINCIPLES OF PREVENTIVE ACTION

The employer shall implement appropriate preventive measures under the following general principles:

- Avoid Risks
- Assess the risks cannot be avoided

- To combat the risks at source
- To adapt the work to the individual, in particular as regards the conception of the jobs, the organization of work, working conditions, social relationships and the influence of environmental factors at work
- Adopt measures that put collective protection to the individual
- Giving appropriate instructions to workers
- Take the necessary measures to ensure that only workers who have received sufficient and appropriate to access to areas of serious and specific danger
- Provide distractions or rash actions that could commit the worker

4.1.2.3 RISK ASSESSMENT

Preventive action in the company will be planned by businessman from an initial assessment of the risks to safety and health Workers to be held, in general, taking into account the nature of the activity, and in relation to those who are exposed to special risks.

Same assessment should be made during the election working equipment, substances or chemical preparations and conditioning workplaces.

Somehow they could classify the causes of hazards in the following categories:

- Insufficient professional qualification of senior staff, team leaders and workers.
- Use of machinery and equipment in jobs that do not correspond to the purpose for which they were conceived or their possibilities.
- Negligence in the management and conservation of plant and machinery. Poor control on the farm.
- Insufficient training of personnel security. Relating to machine tools, the risks that may arise when handle can be summarized in the following points: It may cause an accident or damage a machine if put in up without knowing its mode of operation.
- Poor lubrication leads to premature wear so that manual lubrication points should be greased regularly.
- There may be some risks if you handle the machine is not in position.
- The result of a job can be little accurate if the guides machines wear, and therefore must be protected against the introduction of chips.
- There may be mechanical risks pertain primarily the various movements that make the parts of a machine and can cause the operator:

- Contact with any part of the machine or be trapped between it and any structure fixed or materials.
- Sea hit or dragged by any party movement machine.
- Being hit by machine parts that are projected.
- Being struck by other materials designed for the machine.
- There may be no mechanical risks such as those arising from the use electricity, chemicals, generation of noise, vibration, radiation, etc.

Hazardous machine movements are classified into four groups:

- Rotational motion. Those movements about an axis regardless of the inclination of same and even when rotated slowly. Are classified into the following groups:
  - Elements considered in isolation such as shafts, stems, bits, couplings.
  - Points of entrapment between rotating gears and shafts and other fixed or equipped with lateral displacement thereto.
- Alternative and translational movements. The danger point is in the where the piece provided such other approaches movement fixed or mobile and exceeds piece.
- Translational and rotational movements. Connections of rods and rods with wheels and steering wheels are some of the mechanisms that are generally equipped with this type of movement.
- Movements of oscillation. The movements provided parts generate point pendulum swing "scissors" between them and other fixed parts.

Prevention activities should be modified if it appears by the employer as a result of Periodic checks the preceding paragraph, its inadequacy for the purpose of protection required.

4.1.2.4 WORK TEAMS AND MEANS OF PROTECTION

When the use of work equipment may pose a risk specific to the safety and health of workers, the employer takes the necessary measures in order that:

- Use of work equipment is restricted to those responsible for such use
- Repairs, modifications, maintenance or conservation

They are carried out by specifically trained for such work. The employer must provide their workers team personal protection equipment suitable for the performance of their functions and ensure the effective use thereof.

4.1.2.5 INFORMATION, CONSULTATION AND PARTICIPATION WORKERS

The employer shall take appropriate measures so that workers receive all the necessary information regarding:

- The risks to the safety and health of workers at work
- The measures and activities of protection and prevention applicable to risks

Workers are entitled to make proposals to the employer, and as the competent bodies in this area, aimed at improving levels of protection of safety and health in the workplace, in signaling matter therein, in terms of use by the workers work equipment in construction and as to use by workers of personal protective equipment.

4.1.2.6 TRAINING OF WORKERS

The employer shall ensure that each worker receives training theoretical and practical sufficient and appropriate, in prevention.

4.1.2.7 EMERGENCY MEASURES

The businessman, considering the size and activity of the company, and the possible presence of people outside it, you must analyze possible emergencies and adopt the necessary measures first aid, firefighting and evacuation workers, designating for that personnel responsible for implementing these measures and checking periodically, if necessary, correct operation.

4.1.2.8 SERIOUS AND IMMINENT RISK

When workers are exposed to a serious and imminent risk at its work, the employer shall:

- Inform as soon as possible to all the workers concerned about the existence of that risk and the measures taken for the protection.
- Give instructions for that in the event of serious danger, imminent and inevitable, workers can stop work and also be in a position, given their knowledge and technical means at their disposal, to take the necessary measures to avoid the consequences of such danger.

4.1.2.9 HEALTH SURVEILLANCE

The employer shall ensure their workers monitoring service periodic their state of health according to the risks inherent in the work, opting for carrying out those examinations or tests that cause minor aches worker and proportionate to the risk.

4.1.2.10 DOCUMENTATION

The employer shall develop and maintain available to the authority work the following documentation:

- Assessment of the risks to safety and health at work, and planning of preventive action.
- Protection and prevention measures to be taken.
- Results of periodic inspections of working conditions.
- Practice Controls health of workers.
- List of accidents and occupational diseases that caused workers incapacity than one day of work.

4.1.2.11 COORDINATION OF BUSINESS ACTIVITIES

When the same workplace develops activities workers of two or more companies, they should cooperate in implementing the regulations on the prevention of occupational hazards.

4.1.2.12 WORKERS PROTECTION ESPECIALLY SENSITIVE TO CERTAIN RISKS

The employer shall ensure, assessing risks and adopting necessary preventive measures, protection of workers, for their own personal characteristics or known biological condition, including those that have recognized the state of physical, mental disability or sensory, are specifically sensitive to the risks arising from work.

4.1.2.13 MATERNITY PROTECTION

The risk assessment shall include the determination of the nature, extent and duration of exposure of workers in pregnancy or a recent delivery, agents, processes or working conditions that may adversely affect the health of the workers or fetus, adopting, where appropriate, the necessary measures to avoid exposure to such risk.

4.1.2.14 PROTECTION OF MINORS

Before joining the work of young people under eighteen years, and prior to any significant changes to their conditions work, the employer must make an assessment of the jobs to play by them, to determine the nature, extent and duration of exposure taking into account the risks arising from their lack of experience, immaturity to assess risks existing or potential and their still incomplete development.

4.1.2.15 RELATIONS OF TEMPORARY WORK DURATION SET AND TEMPORARY EMPLOYMENT

Workers with temporary work relationships or duration determined, as well as those employed by temporary employment agencies, they should enjoy the same level of protection and security the remaining health workers of the company in providing its services.

4.1.2.16 DUTIES OF WORKERS ON HEALTH AND SAFETY

It is up to each worker to ensure, according to their possibilities and through compliance with preventive measures in each case be adopted for their own safety and health at work and by those other people it might affect his business, because of its acts or omissions at work in accordance with their training and instructions of the employer.

The workers, in accordance with their training and following the instructions entrepreneur, in particular:

- Use properly according to their nature and risks predictable, machinery, apparatus, tools, dangerous substances, transportation equipment and, in general, any other means by which develop their activity.
- Using the media correctly and protective equipment provided by the employer.
- Do not put out of operation and correctly use the devices existing security.
- Immediately report a risk to safety and health workers.
- To contribute to the fulfillment of the obligations established by the competent authority.

4.1.3 Prevention services

4.1.3.1 PROTECTION AND PREVENTION OF PROFESSIONAL RISKS

On duty to prevent occupational risks, employer shall designate one or more workers to carry out such activity, constitute a prevention service or arrange said service a specialized entity outside the company.

The workers designated must have the necessary capacity, have adequate time and the necessary means and be sufficient in number, taking into account the size of the company and the risks are exposed workers.

In companies with fewer than six workers, the employer may personally assume the functions outlined above, provided that regularly develops its activity in the workplace and have capacity needed.

The employer who has not agreed with the Prevention Service an unrelated company specialized entity must submit your system prevention control of an external audit or evaluation.

4.1.3.2 PREVENTION SERVICES

If the appointment of one or more workers is insufficient for conducting prevention activities, depending on the size company, of the risks to which workers are exposed or dangerousness of the activities, the employer shall enlist one or more services in their own or other prevention to the company, collaborate when necessary.

Service shall be construed as preventing the media set human and materials needed to carry out preventive activities to ensure adequate protection of the safety and health of workers, advice and assistance to employer thereof workers and their representatives and the specialized representation bodies.

4.1.4 Consultation and participation of workers

4.1.4.1 CONSULTATION OF WORKERS

The employer must consult workers, with due advance the adoption of decisions:

- The planning and organization of work in the company and introduction of new technologies, in everything related to the consequences they may have for the safety and health of workers.

- The organization and development of the activities of health protection and prevention of occupational risks in the company, including the designation of workers engaged in such activities or the use of a service external prevention.
- The designation of the workers responsible for measures emergency.
- The design and organization of training in prevention.

4.1.4.2 RIGHTS OF PARTICIPATION AND REPRESENTATION

Workers have the right to participate in the company in the issues related to the prevention of risks at work.

In companies or workplaces where there are six or more workers, their participation will be channeled through their representatives and the specialized representation.

4.1.4.3 SAFETY REPRESENTATIVES

Prevention Delegates are representatives of workers specific in terms of risk prevention at work functions. They shall be appointed by and among the staff representatives in accordance with the following scale:

- From 50 to 100 workers: 2 Prevention Delegates.
- From 101 to 500 workers: 3 Prevention Delegates.
- From 501 to 1000 employees: 4 Prevention Delegates.
- From 1001 to 2000 workers 5 Prevention Representatives.
- From 2001-3000 employees: 6 Prevention Delegates.
- From 3001-4000 workers 7 Prevention Delegates.
- From 4001 onwards 8 Prevention Delegates.

In companies with up to thirty workers, the Chief Prevention will be the Chief of Staff. In companies of thirty one to forty nine workers Prevention will be a delegate to be elected by and among the delegates.

4.2 Minimum safety and health in the workplace

4.2.1 Introduction

Law 31/1995, of November 8, 1995, Risk Prevention Labor is the legal standard that the basic body is determined guarantees and responsibilities required to establish an

adequate level of health protection of workers from risks arising from the working conditions.

According to Article 6 of the Act, will be the standards regulations which set and materialize the more technical aspects of the preventive measures, through minimum standards to ensure adequate protection of workers. Among these are necessarily to ensure the safety and health at work, so that its use is no risk to workers arising.

Given the above, Royal Decree 486/1997 of April 14, 1997 lays down minimum safety and health rules for the workplaces, defined as areas of the workplace, built or not, in which workers must remain or that because they can access their work, not including construction temporary or mobile.

4.2.2 Obligations of the employer

The employer shall take the necessary measures to ensure that the use of the workplace does not cause safety hazards and health of workers.

In any case, workplaces must meet the minimum requirements laid down in this Royal Decree in their construction conditions, order, cleanliness and maintenance, signage, facilities protection service, environmental conditions, lighting, welfare facilities for rest, and local material and first aid.

4.2.2.1 CONSTRUCTION CONDITIONS

The design and construction features of the workplace must provide security against the risks of slips and falls, shock or blows against landslides or falling objects and materials on workers, for which the pavement constitute a homogeneous whole, plain smooth and seamless, consistent material are not slippery or be capable of using and easy to clean, the walls must be smooth, trimmed or painted in clear tones that can be washed and bleached and ceilings should protect workers from the inclement weather and be consistent enough.

The design and construction features of the workplace they should also facilitate the monitoring of emergency situations in especially in case of fire, and enabling, when necessary, rapid and safe evacuation of workers.

All structural or service (foundation, pillars elements, floors, walls and stairs) should have the solidity and resistance to support the loads or stresses to which they are subjected.

The dimensions of the workplaces should allow workers to perform their work without risk to their safety and health and acceptable ergonomic conditions, adopting a free

floor area over 2 m² per worker, increased volume to 10 m^3 per worker and height minimum from floor to ceiling of 2,50 m. The areas of workplaces where there is a risk of falling, falling objects or contact or exposure aggressive elements shall be clearly marked.

The floor must be fixed, stable and not slippery, no irregularities or dangerous slopes. The openings, slopes and stairs will be protected by handrails 90 cm.

Workers must be able to safely perform operations opening, closing, or adjustment setting windows, and in any situation they present a risk for them.

Traffic routes must be used according to its use provided, easily and safely. The minimum width of the exterior doors and corridors should be 100 cm.

The evacuation routes and exits must remain clear and they will lead to the outside. The number, distribution and dimensions of the routes they must be sized to evacuate all workplaces quickly providing emergency lighting those that require it.

The electrical installation should present no risk of fire or explosion, for it will be sized considering all the circuits predictable overcurrent and drivers and other will be provided electrical switchgear of an adequate standard of insulation.

To prevent direct electrical contact system will be used separation distance or away from live parts to an area not accessible by the employee, interposition of obstacles and / or barriers (cabinets for electrical panels, caps for switches, etc.) and coating or isolation of live parts.

To prevent indirect electrical contact system will be used to start land mass (protective conductors connected to the housings electrical loads, lines with land and artificial electrodes) and cutting devices fault current (differential switches appropriate to the type of local sensitivity, terrain features and constitution artificial electrodes).

4.2.2.2 ORDER, CLEANING AND MAINTENANCE. SIGNALS

The walkways, exits and passageways of the workplace and, especially, exits and roads planned for evacuation emergency, must remain free of obstacles.

The characteristics of the floors, ceilings and walls shall be such that allow such leaning and maintenance. They quickly removed the waste grease stains, waste and hazardous substances other waste products that can cause accidents or contaminate work environment.

The workplace and, in particular, its facilities should be subject to regular maintenance.

4.2.2.3 ENVIRONMENTAL CONDITIONS

Exposure to environmental conditions in the workplace not should jeopardize the safety and health of workers. In indoor workplaces local conditions must be met following:

- The temperature of the premises where work is carried sedentary own office or similar will be between 17 and 27° C. In light premises where work is carried out will be between 14 and 25° C.
- The relative humidity is between 30 and 70 per 100, except in premises where there are risks of static electricity in which the lower limit shall be 50 per 100.
- Workers shall not be exposed frequently or continued to drafts whose speed exceeds the following limits:
    - Work in hot environments no: 0,25 m/s
    - Sedentary work in hot environments: 0,5 m/s
    - Not sedentary work in hot environments: 0,75 m/s.
- The minimum air renewal workplaces is 30 m3 clean air per hour and worker in the case of sedentary work no hot or contaminated by smoke snuff and 50 m3 in environments other cases.
- Unpleasant odors are avoided.

4.2.2.4 LIGHTING

The lighting will be natural with glass doors and windows, supplemented by artificial lighting during the hours of visibility poor. The jobs also take individual points of light, in order to obtain significant visibility. Light levels minimums established (lux) are:

- Areas or premises for occasional use: 50 lux
- Areas or premises in common use: 100 lux
- Traffic routes occasional use: 25 lux.
- Traffic routes commonly used: 50 lux.
- Working areas with low visual requirements: 100 lux.
- Working areas with moderate visual requirements: 200 lux.
- Working areas with high visual requirements: 500 lux.
- Working areas with very high visual requirements: 1000 lux.

Lighting specified above must have an adequate uniformity by uniformly distributing luminaire, avoiding direct glare by teams of high luminance.

It will also install the appropriate emergency lighting and signaling in order to illuminate escape routes in case of general lighting failure.

4.2.2.5 WELFARE FACILITIES REST

In the local drinking water is available in sufficient quantity and easily accessible by the workers.

Changing rooms shall be provided when workers should wear clothing special work, equipped with seats and lockers or individual lockers lockable, with sufficient capacity to store clothing and footwear. If the costumes were not necessary, hangers or lockers should be provided to put clothes.

There will be toilets with mirrors, toilets with automatic flushing and toilet paper and sinks with running hot water, if necessary, soap and individual towels or other drying system with sanitary guarantees.

Also will have power showers, hot and cold water, when usually made dirty, or contaminants that originate high work sweating. They take tiling the walls to a height of 2 m. the floor, glazed white ceramic tile. The flooring will continuous and waterproof, slip formed by rugged sandstone slabs.

If work is regularly interrupted, spaces will be arranged where workers can stay during such interruptions, differentiated spaces for smokers and nonsmokers.

4.2.2.6 MATERIAL AND LOCAL FIRST AID

The workplace will have material for first aid of accident, it must be suitable in respect of quantity and characteristics, the number of workers and the risks to which they are exposed.

At least it is available, rather reserved, yet easy access of a portable kit, containing at all times, water hydrogen, 96 alcohol, tincture of iodine, mercurochrome, sterile gauze, cotton wool, water bag, tourniquet, sterile gloves and disposable syringes, kettle, needles, clinical thermometer, gauze, tape, adhesive bandages, scissors, tweezers, antispasmodics, analgesics and bandages.

4.3 Minimum on signaling health and safety at work

4.3.1 Introduction

Law 31/1995, of November 8, 1995, Risk Prevention Labor is the legal standard that the basic body is determined guarantees and responsibilities required to establish an adequate level of health protection of workers from risks arising from the working conditions.

According to Article 6 of the Act, will be the standards regulations which lay down the minimum measures to be taken to adequate protection of workers. These include the designed to ensure that workplaces there is adequate health and safety signage, provided that the risks can't be avoided or sufficiently limited by technical means of collective protection.

Given the above, Royal Decree 485/1997 of April 14, 1997 It lays down minimum provisions on safety signs and health at work, that is, those signs that relating to an object, activity or situation, provide one information or instructions on safety and health at work by a signal in the form of panel, a color, a light or buzzer, a verbal communication or a hand signal.

4.3.2 General obligations of the employer

The type of signal and the number and location of signals or signaling devices to be used in each case be carried out in so that the signaling as efficient as possible, taking into account:

- The characteristics of the signal
- The risks, elements or circumstances which are to be signaled
- The extent of the area to cover
- The number of workers affected

For signaling slopes, obstacles or other items originating risk of people falling, impact or blows, as well as for signaling electrical hazards, presence of flammable materials, toxic, corrosive or biological risk, may opt for a warning sign triangular shape, with a characteristic black pictogram of color on background yellow and black borders.

Traffic routes for vehicles must be delimited clearly by continuous strips of white or yellow color. The fire protection equipment must be red.

Signaling to the location and identification of pathways evacuation and rescue teams and relief (portable kit) is performed by a signal of square or rectangular shape, with a characteristic white pictogram on green background.

Signaling directed to alert workers or third parties of the emergence of a hazard and the consequent urgent need to act in a certain way or to evacuate the danger zone are

It will be made by a light signal, an audio signal or communication verbal.

The media and signaling devices must be cleaned, maintained and checked regularly.

4.4 Minimum safety and health for use by workers of equipment work

4.4.1 Introduction

Law 31/1995, of November 8, 1995, Risk Prevention Labor is the legal standard that the basic body is determined guarantees and responsibilities required to establish an adequate level of health protection of workers from risks arising from the working conditions.

According to Article 6 of the Act, will be the standards regulations which lay down the minimum measures to be taken to adequate protection of workers. These include the aimed at ensuring that the presence or use of equipment work made available to workers in the undertaking or establishment work no risks to health or safety arising thereof.

Given the above, Royal Decree 1215/1997 of July 18, 1997 lays down minimum safety and health requirements for the use by workers of work teams, meaning such any machine, apparatus, tool or installation used in the work.

4.4.2 General obligations of the employer

The employer shall take the necessary measures to ensure that equipment work that is made available to workers are appropriate to work to be carried and properly adapted to it, so to ensure the safety and health of workers using these equipment.

Equipment should only be used to meet any provision law or regulation that apply to them.

For the choice of work equipment the employer shall take into consider the following factors:

- The conditions and specific characteristics of the work to develop
- The risks to the safety and health of workers in the Workplace
- Where appropriate, the necessary adaptations for use by workers disabled

It shall take the necessary measures, through maintenance appropriate work equipment is kept for all time use under appropriate conditions. All operations maintenance, adjustment, unlock or repair of equipment work will be performed after the team stopped or disconnected. These operations shall be entrusted to specially trained staff for it.

The employer must ensure that workers receive training and information appropriate to the risks arising teams work. The information provided preferably in writing, shall contain at least the information regarding:

- The conditions and correct use of work equipment, taking into account the manufacturer's instructions, as well as situations or abnormal and dangerous forms of use that can be expected.
- The conclusions that, where appropriate, may be obtained from experience gained in the use of work equipment.

4.4.2.1 GENERAL MINIMUM REQUIREMENTS APPLICABLE TO WORK TEAMS

The controls of a team that have any impact on safety must be clearly visible and identifiable and shall not carry risks as a result of involuntary manipulation. Each team must be provided with a body drive it to a complete stop safely.

Work equipment involving risk of falling objects or projections must be fitted with suitable protection devices those risks.

Work equipment involving risks due to gas emissions, vapors or liquids or dust emission must be fitted with devices Suitable capture or removal near the emitting source corresponding.

If necessary for the safety or health of workers, Work equipment and its components shall be stabilized by clamping or other means.

When the moving parts of a team may involve risk of accident by mechanical contact, must be equipped with guards or devices to prevent access to dangerous areas. Areas and points of maintenance work or a team they must be suitably lit in line with the tasks to be performed.

The parts of a team that reach high temperatures or very low when applicable shall be protected against the risks of contact or proximity of the workers.

All work equipment must be appropriate to protect the exposed workers against the risk of direct or indirect contact electricity and risk involving noise, vibration or

radiation you must have suitable protection devices or to limit, in the As far as possible, the generation and propagation of these physical agents.

Hand tools should be constructed of materials resistant and unity among its components should be firm, so that avoid breakage or projections thereof.

The use of these devices can't be made in contradiction with the instructions provided by the manufacturer, comprobing before starting the task that all safety devices and conditions of use are appropriate. The necessary measures should be taken to avoid entrapment hair, clothing or other objects work worker, avoiding any appropriate, submit to equipment overload, overpressure, speeds or overstress.

4.4.2.2 ADDITIONAL MINIMUM REQUIREMENTS APPLICABLE TO WORK EQUIPMENT

Equipment with ride-on workers should avoid contact they wheeled and crawler and trapping by. For that provided with a protective structure that prevents the team tilt more than a quarter turn or a structure that guarantees a space enough around the ride-on workers if the team can tilted more than a quarter turn. These structures are not required protection when the team is stabilized during its employment.

Forklifts must be adapted by installation of an enclosure for the driver, a structure that prevents the dump truck, a structure that ensures that in the event of a rollover, left enough for the worker between the ground and certain parts of space said truck and a structure restraining the workers on the seat driving in good condition.

Propelled work equipment must have devices braking and stopping, with devices to ensure proper visibility and with an acoustic warning signal. In any case, yours driving it shall be reserved for workers who have received information specific.

4.4.2.3 ADDITIONAL MINIMUM REQUIREMENTS APPLICABLE TO MACHINE TOOL

Machine tools shall be protected electrically by double insulation and electric motors are protected by the housing, which will have the capacity to cut through the protected disk antiprojections housing.

Those used in flammable or explosive environments are protected by flameproof enclosures. The use of machines is prohibited powered by liquid fuels indoors or insufficient ventilation working on flooded places is prohibited, to avoid risks falls and electrical.

For all tasks have adequate lighting, around 100 lux.

Prevention of risks from inhalation of dust, will be used in road wet the tools to produce.

Tables circular saw, cutting of ceramic and saws Manual drive will not be placed at distances of less than three meters from the edge of forged, with the exception of those that are clearly protected (networks or railings, parapets auction, etc.). Under no circumstances will retire the protection of the blade, used at all times goggles spray-particle. As a general rule, you should extract nails or metal parts driven into the item to be cut.

With fixed-nail guns not inclined shots will be taken, it should be verify that there is no one on the other side of the object on which it is triggered, will prevent sticking on hollow brick factories and ensure the balance of the person before making the shot.

For the use of portable drills and power chasers will be chosen Always drill bits and drilling material suitable discs will prevent conduct holes in a single operation and inclined holes or scratches and freehand will try not overheat drill bits and disks.

In the tasks of arc welding the welding helmet is used or screen hand, did not look directly at the arc, is not played the welded recently was welded in a ventilated, parts, verify the absence of people in the vertical workplace environment, not will leave the clip directly in the ground or on the grid, will choose the electrode suitable for the cord being performed and the jobs will be suspended welding upper winds at 60 km/h weather with regime showers.

In gas welding (oxyfuel) shall not be mixed gas bottles different, they are transported on trays vertically and caged tied not be located in the sun or in an inclined position and lighters are return valves fitted with flame. If paint is arising work with protective mask and will be outdoors or in a local ventilated.

4.5 Minimum safety and health related the use by workers of equipment individual protection

4.5.1 Introduction

Law 31/1995 of 8 November on Prevention of Occupational Risks, determines the basic body of guarantees and responsibilities required establishing an adequate level of protection of the health of workers against the risks of working conditions.

So are the implementing provisions which should set the minimum measures to be taken for proper protection workers. These include those designed to ensure the use by workers at work personal protective equipment that adequate protection from

those risks to their health or safety can´t be avoided or sufficiently limited using means of collective protection or organizational measures in the work.

4.5.2 General obligations of the employer

Make mandatory the use of personal protective equipment that then they develop.

HEAD PROTECTION

- Helmets security, non-metallic, class N, insulated low tension, to protect workers from possible shocks, impacts and electrical contacts
- Hearing protectors attachable to helmets
- Spectacles against impact and dust
- Dust mask with protective filters
- Screen protection for autogenous and electric welding

PROTECTIVE HANDS AND ARMS

- Gloves against mechanical stresses (drilling, cutting, vibrations)
- Thin rubber gloves, for operators who work with concrete
- Gloves dielectric for B.T.
- Welder gloves
- Wristbands
- Mango protective insulating tools

PROTECTIVE FEET AND LEGS

- Footwear sole and fitted with safety toe against attacks mechanical
- Dielectric boots B.T.
- Boots waterproof protection
- Leggings welder
- Knee

BODY GUARDS

- Protection cream and ointments

- Vests, jackets and leather aprons for protection from attacks mechanical
- Waterproof overalls
- Seat belt, fastening and fall, class A
- Seat belts and vibration
- Pole B.T.
- Class I insulation bench for maneuver B.T.
- Single Lantern situation
- Voltage tester

4.6 Occupational health and safety in the metallurgical sector

4.6.1 Frequently occupational hazards

Economic and employment characteristics of the sector determine the working conditions of the same, and therefore, more frequent risks and prevention.

Security risks

- Bumps and collisions with objects or tools: The risk of strikes against metal objects and tools is very common in the sector. It is favored by the small size of the posts due to the size of the machines, which are usually larger and have phones, parts accentuated by the lack of order and cleanliness. If they not clearly defined machinery ends by signs, beacons,... bumps and bruises these may occur. Furthermore, the use of hand tools can cause bruises and cuts on the hands and upper extremities. To avoid this, a correct choice of tools is necessary, and that they take into account ergonomic aspects.
- Overexertion: The MHL is a very common activity in the metallurgical sector. The loads handled are variables, but sometimes they move through major distances without mechanical assistance of any kind. This causes musculoskeletal problems, back pain, accidents, etc. There are also frequent sustained awkward postures to work in confined spaces that hinder the natural movements of the human body, producing significant physical load situations.
- Stacks: If the stacks and storage are not performed correctly, these can collapse, trapping the workers who are nearby.
- Obstruction of corridors, routes and exits: Poor housekeeping can cause a risk of facing possible evacuations, and produce striking objects and falls.

- Cuts: They are very common in some operations, especially during finishing and handling of hand tools or sharp parts. In cutting tools mainly cuts and lacerations on his hands and arms may occur.
- Entrapment machines and moving parts: the sector machines usually have a particularly large. Entrapments often have serious consequences, such as amputations, crushing, etc. The risk of entrapment is especially high in certain operations, such as the work presses, and there are the upper limbs, hands and arms the most affected.
- Projection of particles and / or fragments: Work on cutting machines can result in projecting metal particles that reach the face or eyes, causing serious injury to themselves, especially eye injuries.
- Falls on the same and different level: Falls on the same level normally produced by slip or stumble caused by a poor conditions of order and cleanliness in the workplace, where there are waste materials spills, etc. Falls at different levels can be caused by poor signaling the slopes or to higher levels of unsafe or making a wrong use of them.
- Electrical contacts: electrical contacts may occur in some circumstances, such as in electric welding operations, or other electrical equipment where there is poor.
- Fire risk: The risk of fire in the steel industry is important for the characteristics of the production process, so that appropriate measures should be viewed prevention. The most common causes of fire are: static electricity, which causes friction surface and can accumulate and be discharged as a spark; machinery, generating heat during operation, and which may further have fuel or coolant; overloading of the leads of the electric current; spontaneous combustion of combustible materials or chemicals, high temperatures reached in the production process.
- Thermal contacts: occur when hot surfaces or under heating, such as in welding. They can cause burns of various kinds. Thermal contacts can also be caused by flying sparks and glowing particles.

Risks of Hygiene and Working Environment

- Noise: Noise is one of the most common contaminants in all workplaces, especially in the metallurgical sector, where machinery and operations are particularly noisy. The concentration of these noisy machines in the workplace produces a high level of environmental noise. In certain transactions, such as presses, in assembly, etc., noise levels reached are very high. Noise, and produce in continuous decline of hearing exhibitions - occupational deafness -

can also be the cause of accidents, by not allowing communication or acoustic warning signals, the concentration to perform the task, discomfort, etc. Occupational exposure to noise is regulated by Royal Decree 1316/1989 of 27 October.

- Vibrations: The vibrations are also common in the workplace. They are generated by the operation of the machinery itself. Prolonged exposure to vibration can cause musculoskeletal problems, especially in the spine and lumbar region of the back, and joints of the upper limbs (wrists, elbows,...). The vibrations are the cause of occupational diseases.
- Chemical contaminants: In operations such as welding, lots of smoke, gases, toxic substances and particles that can be inhaled to produce changes in health are generated. Besides the toxic potential for airway may also have irritation to the mucous membranes (eyes) or skin (allergies). If contact with these agents is long enough can cause poisoning. There are many effects that can cause chemical agents, but the most common are allergies, acute poisoning by inhalation, originating boxes nervous system depression, dizziness, headaches, dizziness, etc. In addition to the pollutants generated in welding, other products might be used for cleaning and degreasing machinery. Both the correct labeling as chemical safety data sheets should be required to the manufacturer. It is important not to change from one container to another, to avoid confusion. Other chemicals used are those applied in painting operations. These products are usually applied with guns or sprayers, resulting in the potential for inhalation of such substances.
- Radiation: are generated in welding operations, as the electric arc produces lots of lamps and ultraviolet radiation. Exposure to radiation of this type can cause eye problems such as conjunctivitis, temporary blindness, irritation, and skin burns.

Ergonomic and psychosocial risks

- Inadequate working postures: They generate a physical stress on workers, who sometimes have to maintain awkward postures or difficult position for some time. They can damage the spine and extremities.
- Eyestrain: Some tasks require special attention in character accuracy. When this visual fixity is prolonged can cause fatigue, accompanied by headaches, eye irritation, and blurred vision.
- Rhythms of forced labor: The rhythms of work are often too high. This sector usually works in chain and to a rate imposed by the production process followed. The high rates are a major cause of accidents, because it causes tiredness and fatigue workers, loss of resilience and oversights.

- Limited information and specific training sector workers perceive that they are given little training regarding methods of work and lack of information regarding the risks of the sector to which they are exposed, even though the Law on Prevention of Risks Labor recognizes both aspects as basic workers 'rights and employers' obligations explicit. The time spent in learning is high, and that the work takes place watching the older peers, which often spread this way incorrect work habits.

4.6.2 Most common diseases in the area

The metallurgical sector is a particularly aggressive sector, which can cause a multitude of changes on the health of workers. In addition to accidents, we have seen above, there are other types of health losses, such as diseases caused by work.

The most common diseases that occur in this sector are respiratory diseases. At work multiple emission of gases and particles that can be inhaled by workers they occur. Some of these gases are toxic and irritating; others can cause suffocation. Inhaling these gases usually causes both acute type, acute poisoning, manifested by dizziness, headache, nervous system depression, difficulty breathing, etc. These tables usually disappear when removed the affected from contaminated atmosphere. However, inhalation of certain pollutants from a repeatedly over a long time can cause severe disturbances in the form of chronic poisoning or occupational diseases.

Handling and moving loads (metal parts, plates, etc.), can cause musculoskeletal and joint problems. When heavy loads are handled frequently or when it is not done properly, damage may occur, especially in the spine, lower back and extremities.

Sector workers, are exposed to high noise levels, so the machinery used as the operations performed, which can cause hearing loss and occupational deafness. This hearing loss is progressive and is characterized by loss occurs generally in both ears equally.

The noise levels are very high in the vicinity of machinery or handling, and are also high in the rest of the workplace.

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4.6.3 Risk by the use of machinery

As we have seen, most of the risks generated in this sector from the use of machines, using hand tools and cutting tools and use of welds.

The risks generated could be classified as:

- Risks in manual handling and mechanical objects and materials
- Risk management tools and machines
- Electric welding risks
- Fire and explosion risk
- Electric risk
- Noise and location of the equipment

The technical conditions required of equipment and machines must comply with the provisions of Royal Decree 1215/97 regarding the use of work equipment and security measures that must be met.

We ensure that all machines have the CE mark, which ensures compliance with all legal requirements by manufacturers and importers (Royal Decree 1435/97).

4.6.4 Preventive measures

It is necessary and required by law that workers know the risks involved with their work to minimize accidents and for taking appropriate measures to prevent them.

The best way to prevent accidents is the training and information of employees in the proper handling of equipment and materials and awareness of the importance of the use of collective and individual protection.

All tools used machines have their instructions and is located in near the job site. This manual gathers the information necessary to perform all operations that allows the machine and in the best safety conditions for workers.

The uses of protections in the areas of operation are critical to risk reduction. Also is especially important to avoid accidents the order and cleanliness of the workplace.

Work clothes should be appropriate and as a general rule, machine operators must be protected with safety shields or goggles and protective footwear, not being advisable to wear gloves when handling the operator tools or machines with moving parts (lathes, drills , milling), because it increases the risk of entrapment and drag hand.

Whenever possible, the operating point of the machine must be protected by physical screens or light that impede access to the tool for the duration of the process. In addition, you must install a device or emergency stop button, which should be within immediate reach of the operator.

To prevent accidents and even fires using portable electric drive tools (drills, saws, hammers, lamps, ...) we made sure to properly size the electrical installation, with appropriate safety devices (RCD cutting high sensitivity and overcurrent protection devices).

General measures

- Training and specific information on working methods and the risks to which workers are exposed in each job. Training and training should be conducted periodically and updated way, paying special attention to workers entering for the first time to work.
- Right Labour Organization, which makes impact on the coordination of work, avoid temporary changes, establishment of regular rest breaks.
- Continuous improvement, as the technological possibilities, equipment, reaching full mechanization of some processes.

To avoid overexertion

- Teach courses on manual handling and working postures.
- Comprehensive information on the operation of the equipment and tools.
- Mechanize as much as possible the process of cargo handling and lifting weights or using auxiliary devices for moving loads.
- Optimal maintenance of equipment to facilitate where possible the drag and manipulating them.
- Establishing regular rest breaks to allow the rest of the body.

To prevent entrapments

- Comprehensive information on the operation of the equipment.
- Proper maintenance of all teams.
- Protection of the moving parts of vehicles and other machinery.
- Proper safety signs in the vicinity of the moving parts of machinery, rollers, belts, etc.

To avoid falls and different at the same level

- Using the right footwear, rubber-soled boots or rubber to prevent slipping.
- Providing the correct maintenance ladders that are used to access higher levels.
- At all times maintain order and cleanliness in the workplace, avoiding the accumulation of waste and obstruction of corridors, routes and exits with materials or objects.
- Unevenness signal conveniently there in the workplace.

To prevent poisoning with chemicals

- Isolate, whenever possible, the source generating smoke, dust or particles, enclosing the process.
- If isolation is not possible, install local exhaust systems to extract pollutants (vapors, powders, particles) as they go forming and removing them from the environment preventing breathing.
- Require all information concerning the product or products used by the two appropriate elements for this: first the correct labeling of products marketed; on the other, the safety data sheets containing and extend all the information relating to the constituents and must be distributed by the manufacturer chemicals.
- Replacing products that are especially dangerous for others who are not, and have similar characteristics to carry out the procedure.
- Comply with specific legislation, if any, for handling chemicals and for evaluation and control.
- Training and specific information on the handling of chemicals and work procedures.
- Use of appropriate personal protective equipment.

To prevent damage from exposure to noise

- Choice of less noisy machinery. When purchasing machinery, the employer must choose to choose the less noisy machinery. This is particularly important in this sector where machinery is very expensive, and the pace of technological change is rapid, which requires heavy investment in machinery.
- Compliance with the specific regulations on noise: Royal Decree 1316/89, which specifies the measures to be taken when noise levels are high.
- Proper maintenance of equipment, periodic reviews of the mechanical components, the operation may produce noise.

- Isolating noisy machines, such as by enclosures, using absorbent material.
- Withdrawal from the operators of the machines that emit high levels of noise.
- Use of hearing protectors considering that this should be the last option, and in any case a temporary measure until more effective measures to reduce noise levels are taken.

To prevent fires

- Check periodically and kept in perfect condition all electrical maintenance and installation teams.
- Make sure there are no combustible materials near heat sources, such as near welds.
- Dispose of fire containment methods, such as fire extinguishers, fire hydrants equipped in the workplace.
- Train workers on the use of fire extinguishers and the status of these.
- Emergency implement plans that contemplate the possible declaration of a fire, and engage them to all workers.

To avoid projected particles

- Purchase machinery at the time of purchase with the appropriate security measures to projections.
- Install devices resistant shielding and protection projections, and transparent to allow visibility to the operator.
- Use appropriate personal protective equipment: goggles, screens, ...

To avoid eyestrain

- Adequate to the requirements of the task lighting.
- Periodic breaks for recovery.

To avoid exposure to radiation

- Use special screens to prevent the arrival of radiation to the worker.
- Use appropriate personal protective equipment and clothing appropriate protection.

5. ELECTRICAL INSTALLATION

5.1 Objective

The study and definition contained in this Annex we describe the technique and system functions that provide for electrical power required workshop for operation and patenting the supporting calculations that led to the selection of the elements that need to be dimensioned such as conductors and protection of the installation.

5.2 Overview

5.2.1 Power Supply

The electrical energy required for the installation of the project will be provided by the company Endesa Distrubución Eléctrica, S.L., inside the building are available overall enclosure, before the centralization of accountants and general protections, preparing a line of division of Cu (1000 V) to the general distribution box located inside the premises, in place appropriate and protected by closures Special door and fireproof material.

5.2.2 Voltage

The supply voltage to the facility will be 400 volts between phases and 230 V between phase and neutral, with a frequency of 50 Hz, for receiving power and lighting.

5.3 Installation items

5.3.1 Rush

It is part of the installation of the distribution network that feeds the overall enclosure or equivalent functional unit (CGP). Drivers will be copper or aluminum. This line is regulated by the ITC-BT-11.

According to its layout, the installation system and network characteristics, Rush may be:

- Air, perched on facade:

  The cables will be isolated, rated voltage 0,6/1 kV, and its installation should preferably be under closed conduits or protective channels. For crossings of

roads and undeveloped areas, the cables may be installed directly tied at both ends. The minimum height of the streets and roads in no case be less than 6 m.

- Air, stretched over poles:

  Be insulated cables, rated voltage 0,6/1 kV, and may be installed suspended from a cable or latch using latch neutral conductor. When the cables cross on public roads or areas of potential road traffic, the minimum height on streets and roads shall in no case be less than 6 m.

- Groundwater:

  The cables will be insulated, rated voltage 0,6/1 kV, and may be installed directly buried, buried pipe or galleries, sewers or reviewable channels.

- Aero-ground:

  He fulfills the conditions mentioned in the previous sections. In step ground rush to air or vice versa, the cable must be secured from the measured depth to a minimum height of 2,5 m above ground level, through rigid conduit of the following characteristics:

  - Impact resistance: Strong (6 joules)
  - Minimum temperature of installation and service: - 5° C
  - Maximum temperature Installation and Service: + 60° C
  - Electrical properties: electrical / insulation continuity
  - Resistance to penetration of solid objects: D> 1 mm
  - Resistance to corrosion (metal conduit)
  - Resistance to flame propagation: retardant

Finally, note that Rush will be part of the installation consists of the Company Supplier therefore its design must be based on the particular rules of it.

5.3.2 Facilities link

5.3.2.1 SAFETY PROTECTION AND MEASUREMENT

In the case of supplies to a single user, the absence general line of food, be placed in a single element the overall enclosure and measurement equipment; that element enclosure and measure called. Consequently, the safety fuse located before the counter matches the fuse including a CGP.

They should preferably be installed on the exterior walls of buildings, places of free and permanent access. Their situation is fixed by agreement between the property and the supplier.

It will always be installed in a niche wall, which is closed with a preferably metal door, degree of protection IK 10 according to UNE-EN 50.102, externally coated according to the characteristics of the environment and be protected against corrosion, having a lock or lock normalized by the supplier. The reading devices measuring equipment be situated at a height of between 0,70 and 1,80 m.

In the niche leave provided the necessary holes to accommodate the inlet Rush.

When the front boundary with no public roads, the overall box will be placed on the boundary between public and private property.

The enclosures and measure to use correspond to one of the types listed in the technical specifications of the supplier that have been approved by the competent public authority, depending on the number and nature of supply. Within the same breaker fuses installed in all or polar phase conductors, with breaking at least equal to the short-circuit current at the point of installation.

The enclosures and comply measure everything on the subject indicated in the UNE-EN 60439-1, will flammability as indicated in UNE-EN 60439-3, once installed will have a degree of protection IP43 according to UNE 20.324 and IK 09 according to UNE-EN 50.102 and be sealable.

The envelope must have the necessary internal ventilation, ensuring no formation of condensation. The transparent material for the reading will be resistant to the action of ultraviolet rays.

The general provisions for this type of box are included in the ITC-BT-13.

5.3.2.2 INDIVIDUAL DIVERSION

It is part of the installation, starting from the enclosure and measurement, supplies electricity to a user installation, includes safety fuses, the set of measurement and general control and protection devices. It is regulated by the ITCBT-15.

The individual taps shall comprise:

- Insulated conductors embedded inside tubes
- Insulated conductors inside buried pipes

- Insulated conductors inside surface mounting tubes
- Insulated conductors inside the lid only protective channels you can open with the help of a tool
- Busbar trunking which shall meet standard UNE-EN 60439-2
- Insulated conductors inside closed duct work
- Factory designed and constructed for this purpose

Drivers will use copper or aluminum, isolated and usually unipolar, with its rated voltage 450/750 V minimum. In the case of multiconductor cables or leads for individual inside buried pipes, the insulation of the conductors is of rated voltage 06/1 kV. The minimum section is 6 mm² for polar cables, neutral and protective and 1,5 mm² for control wire (for application of different rates), which will be red.

The cables are fire retardant and smoke emission and reduced opacity. The cables equivalent to those of the standard features UNE 21.123 Part 4 or 5 or the UNE 211002 fulfill this requirement.

The maximum voltage drop will be, for the case of single-lead supplies for a single user that there is no general line of food, 1,5%.

5.3.3 Indoor Facilities

5.3.3.1 SELECTION OF ELECTRICAL EQUIPMENT

The category of equipment (excluding cables and conductors) to atmosphere gases and vapors shall be as indicated below:

Equipment category	Zones that are supported
Category 1	0,1 and 2
Category 2	1 and 2
Category 3	2

Where:

Category 1: Devices designed so that they can operate within the operational parameters established by the manufacturer and ensuring a very high level of protection.

Category 2: Devices designed to function in the operating parameters established by the manufacturer and ensuring a high level of protection.

Category 3: Devices designed to function in the operating parameters established by the manufacturer and ensuring a normal level of protection.

If the expected ambient temperature is not in the range between -20° C and +40° C, the equipment shall be marked to work in the relevant temperature range.

As far as possible, the electrical equipment will be located in non-hazardous areas. If this is not possible, the installation will take place where there is less risk.

5.3.3.2 DRIVERS

Wires and cables used in the facility should be of copper or aluminum and will always be isolated. The rated voltage not less than 450/750 V. Section drivers to use is determined so that the voltage drop between the origin of the indoor facility and any point of use is less than 3% for lighting and 5% for other uses.

The value of the voltage drop may be offset between the inner installation (3-5%) and of the individual branch (1,5%), so that the total voltage drop is less than the sum of the values limits for both (4,5-6,5%). For installations that feed directly into high voltage by a transformer itself, it is considered that the low voltage installation interior has its origins in the transformer output and is also in this case the maximum allowable voltage drops 4,5% for lighting and 6,5% for other uses.

Eligible drivers, maximum intensities shall be governed entirely by as indicated in the UNE 20.460-5-523 and its National Annex. In areas with risk of fire, the ampacity must be reduced by 15%.

Indoor facilities to consider the harmonic currents caused by nonlinear loads and possible imbalances, unless justified by calculation, the section of the neutral conductor shall be at least equal to that of the phases. One neutral conductor for various circuits will be used.

Protective conductors shall have a minimum diameter equal to the set in the following table:

Section conductive phase (mm^2)	**Conductors Protection Section (mm^2)**
$Sf \leq 16$	Sf
$16 < Sf \leq 35$	16
$Sf > 35$	Sf/2

5.3.3.3 IDENTIFICATION OF DRIVERS

Drivers installation must be easily identifiable, especially with regard to the neutral conductor and the conductor. This identification is performed by the colors present their isolates. Where there neutral conductor in the installation or expected for a subsequent phase conductor neutral conductor passes, they will be identified by the light blue color. Protective conductor will be identified by its yellow-green color.

All conductors, or where appropriate, those for which there is expected later shift to neutral, be identified by the brown, black or gray colors.

5.3.3.4 BRANCH FACILITIES

The facility is subdivided so that the disturbances caused by faults that may occur at a point of them, affect only certain parts of the facility, eg a sector of the building, to a plant, to one location, etc., for which protection devices for each circuit shall be properly coordinated and be selective with general protection devices preceding them.

Complete plant is divided into several circuits, as necessary, to order:

- Avoid unnecessary interruptions at the circuit limit consequences of failure.
- Facilitate verification, testing and maintenance.
- Avoiding risks that could result from failure of a single circuit that could divide, such as if there is only one lighting circuit.

5.3.3.5 LOAD BALANCING

For the greatest possible balance in loading drivers that are part of an installation is maintained, ensure that this remains divided between phases or polar drivers.

5.3.3.6 INSULATION RESISTANCE AND DIELECTRIC STRENGTH

Facilities must submit an insulation resistance least equal to the values shown in the following table:

Rated viltage DC	Test voltage installation (Y)	Insulation resistance (M)
MBTS o MBTP	250	≥ 0,25
≤ 500 V	500	≥ 0,50
> 500 V	1000	≥ 1,00

The dielectric strength is such that, disconnected devices use (receptors) for 1 minute withstand voltage test 2U + 1000 V power frequency, where U is the maximum voltage service in volts and at least 1500 V.

Leakage currents shall not exceed, for the whole installation or for each of the circuits in that it can be divided into effects of its protection, to sensitivity submit switches differential fitted as protection against indirect contact.

5.3.3.7. CONNECTIONS

In no event will enable wire bonding through connections and / or referrals by simple twisting or winding each other drivers, but should always be done using terminals mounted individually or forming blocks or terminal blocks; may also be possible, the use of connection flanges. Always must be performed inside boxes splicing and/or shunt. If it is multiple wiring conductor wires, the connections will be made so that the current is shared by all components wires.

5.3.3.8 INSTALLATION SYSTEMS

5.3.3.8.1 General prescriptions

Several circuits can be in the same tube or in the same compartment channel if all conductors are insulated rated voltage higher.

If proximity to electrical pipes other than electric must be designed so that between the outer surfaces of both a minimum distance of 3 cm is maintained. If proximity to heating ducts, hot air, steam or smoke, electrical cables shall be such that they can´t reach a dangerous temperature and therefore will remain separated by a suitable distance or through heat-proof screens.

The busbars not be placed below other pipes that can lead to condensation, such as those for driving steam, water, gas, etc., unless the necessary steps are taken to protect electrical cables against the purpose of these condensations.

The pipes must be arranged to facilitate their operation, inspection and access to their connections. The busbars shall be such that by appropriate identification of circuits and elements can proceed at any time repairs, alterations, etc.

Throughout the stride length pipes through building elements such as walls, partitions and ceilings, no cable splices or taps shall be provided, to be protected against mechanical damage, chemical actions and the effects of moisture.

The covers, lids or envelopes, knobs and buttons maneuver mechanisms devices such as switches, bases, regulators, etc., installed in wet areas or wet, be of insulating material.

The inputs of the cables and pipes to electrical appliances are made in accordance with the intended mode of protection. The holes for electrical equipment for cable entries or tubes that are not used must be closed by parts consistent with the protection mode to be provided such equipment.

At the point of transition from a busbar from one area to another, or dangerous to other non-hazardous location, you must prevent the passage of gases, vapors or liquids. That may require the sealing of ditches, tubes, trays, etc., adequate ventilation or backfilling with sand.

5.3.3.8.2 Insulated conductors under protective tubes

The cables used shall be of not less than rated voltage 450/750 V, insulated with thermoplastic or thermosetting mixtures. The tubes are metal, rigid or flexible, with the following characteristics:

- Compressive strength: Strong.
- Impact resistance: Strong.
- Minimum temperature of installation and service: -5º C.
- Maximum temperature of installation and service: +60º C.
- Resistance to bending: Rigid / bendable.
- Electrical properties: electrical / insulation continuity.
- Resistance to penetration of solid objects: objects Contra D 1 mm.
- Resistance to water penetration: Contra water drops falling vertically when the pipe system is tilted 15º C.
- Corrosion resistance of metal and composite tubes: Protection inner and outer half. The minimum outside diameter of the tubes, depending on the number and section of drivers to drive, be obtained from the indicated tables ITC-BT-21, and the minimum requirements by type of installation.

For the execution of the pipelines under protective tubes are take into account the following general requirements:

- The layout of the pipes will be along vertical lines and horizontal or parallel to the edges of the walls which limit the local where the facility is effected.
- The tubes are bonded together by appropriate fittings to class to ensure continuity of the protection afforded to conductors.

- The bendable rigid heat insulating tubes may be hot assembled together, covering the joint with a tail especially when a seal is required.
- The curves practiced in the tubes shall be continuous and must not cause unacceptable reductions section. The minimum radius of curvature for each class of pipe shall be specified by the manufacturer according to UNE-EN.
- It can be easy insertion and removal of the wires in the after placing tubes and fixed them and their accessories, providing for it records deemed appropriate, in sections righteous are not spaced more than 15 meters. The number of angle bends located between two consecutive records will not be greater than 3. Drivers are normally housed in the tubes after them placed.
- Records may be intended solely to facilitate the insertion and removal of the wires in the tubes or serve the same time as junction boxes or referral.
- Connections between conductors are made inside boxes proper insulation and flame retardant. If they are metal shall be protected against corrosion. Size these boxes should be such that comfortably accommodates all drivers should contain. Its depth is at least equal to diameter of the larger pipe plus 50% thereof, with at least 40 mm. Or minimum inner diameter side is 60 mm. When entries want to make watertight tubes in connection boxes, glands or suitable connectors must be used.
- In the metallic tubes without interior insulation, will take into account the possibility of water condensation occurring within, for which conveniently choose the layout of your installation, providing evacuation and establishing adequate ventilation in the inside the tubes by suitable system, as may be, for example, using a "T" of which one arm is not employed.
- The metal tubes must be grounded. Your electrical continuity must be properly secured. In the case of using tubes flexible metal, it is necessary that the distance between two earthing straight tubes does not exceed 10 meters.
- Metal pipes as protective conductors or neutro. When tubes installed in surface mount not be used
- The tubes are placed adapting to the surface on which install, bending or using the necessary accessories.
- In straight alignment, the deviations of the tube axis with respect to the line connecting the endpoints are not greater than 2100.
- There should tubes, whenever possible, at a height minimum of 2,50 meters above the ground, in order to protect any mechanical damage. When the tubes are placed wardrobes, are taken into account, in addition, the following requirements:

- In the installation of the pipes inside the elements of the construction, chases not jeopardize the safety of the walls or ceilings that are practiced. The dimensions of the chases are sufficient for the remaining tubes coated with a layer of 1 centimeter thick, minimum. In the angles, the thickness of this layer can be reduced to 0,5 centimeters.
- Shall not be located between forged and coated tubes for the electrical installation of the lower floors.
- For the installation in the plant itself, only may be installed between forged and casing, tubing to be coated with a layer of concrete or mortar 1cm thick, at least besides the coating.
- In the direction changes, the tubes shall be adequately curved or fitted elbows or "T" appropriate, but in the latter If only provided with manholes be accepted.
- The tops of the records and be accessible junction boxes and removable once the work. The records shall boxes flush with the outer surface of wall cladding or ceiling when not installed inside a closed housing and practicable.
- In the case of pipes embedded in walls used, it is convenient having horizontal runs 50 centimeters at most and floor or ceiling at a distance of vertical angles corners not more than 20 centimeters.

5.3.3.8.3 Insulated conductors laid directly on the walls

These facilities will be established with assigned tension cables not less than 0,6 / 1 kV, equipped with insulation and jacket, constructed to have a mechanical protection (mineral insulated cables and plating or armored cables with galvanized steel wire and non-metallic) outer shell.

For the implementation of the pipes the following shall be considered:

- They fixed on the walls by means of flanges, clamps, or collars so as not to impair covers them.
- In order that the cables are not susceptible to bending effect of its own weight, the fixing points thereof are sufficiently close. The distance between two successive points of fixation does not exceed 0,40 meters.
- When the cables must have mechanical protection by and installation conditions on which it is made, armored cables are used. Failure to use these cables, additional mechanical protection on them will be established.
- It will prevent bending the wires with a radius too small and unless stipulated against fixed in the UNE for the cable used, this radius not less than 10 times the outer diameter of the cable.

- Cables crossings with no electrical conduits may be made by the front or back to them, leaving a minimum DISTANCE of 3 cm between the outer surface of the non busbar and cable cover when the crossing is made by the front part thereof.
- The ends of the cables shall be watertight when the characteristics of the premises or locations so require, using for this purpose boxes or other appropriate devices. The tightness can be secured with the help of stuffing.
- The splices and connections will be made through boxes or equivalent devices fitted removable covers that ensure both continuity of mechanical protection provided, isolation and inaccessibility of connections and allowing verification if necessary.

5.3.3.8.4 Insulated conductors under protective channels

The protective channel is a setting material comprising a perforated wall profile or not, intended to accommodate wires or cables and closed by a removable cover.

The cables used shall be of not less than rated voltage 450/750 V, insulated with thermoplastic or thermosetting mixtures. The channels are metal, with the following characteristics:

- Impact resistance: Strong.
- Minimum temperature of installation and service: +15ºC L ≤ 16 mm and -5º C L > 16 mm carcasses.
- Maximum temperature of installation and service: +60º C.
- Electrical properties: Insulation channels L ≤ 16 mm and electrical/insulation channels L > 16 mm Continuity.
- Resistance to penetration of solid objects: Grade 4 channels L ≤ 16 mm and not less than 2 channels L > 16 mm.

The protective channels will have a degree of protection IP4X and will be classified as "channel access cover that can only be opened with tools." Inside you can put mechanisms such as switches, sockets, commands and control devices, etc., provided they are fixed in accordance with the manufacturer's instructions. May also be drivers in your joints and connections to the inner mechanisms. The protective channels for non-routine applications must have a minimum performance impact resistance of minimum and maximum temperature of installation and service, resistance to penetration of solid objects and resistance to water penetration, appropriate to the site conditions to which it is intended; also the channels will not propagate the flame. These characteristics shall conform to the standards of the series UNE-EN 50,085.

The layout of the pipes will preferably along vertical and horizontal or parallel to the edges of the walls that limit the room where you are installing lines.

The electrically conductive channels should be connected to the ground network, its electrical continuity will be suitably insured.

The top of the channel will always accessible.

5.3.3.8.5 Insulated conductors in tray or tray support

These facilities will be established with assigned tension cables not less than 0,6 / 1 kV, equipped with insulation and jacket, constructed to have a mechanical protection (mineral insulated cables and plating or armored cables with galvanized steel wire and non-metallic) outer shell.

5.4 Protection against overcurrent

All circuits shall be protected against the effects of overcurrents that may arise therein, for which the interruption of this circuit will be held at a convenient time or be sized for the foreseeable overcurrent.

Overcurrent may be motivated by:

- Overload due to equipment use or defects high impedance isolation
- Shorts
- Atmospheric electric shocks

Protection against overload: The current limit of allowable current in a conductor must in any case be guaranteed by the protection device used, considering that the allowable current in the conductors should be decreased by 15% over the corresponding value to a conventional installation. The protective device may be constituted by a multi-pole circuit breaker with thermal curve cutting, fuses or circuit breakers calibrated proper operational characteristics.

Protection against short circuits: At the root of all circuit device protection circuit court whose ability to agree with the short-circuit that may arise at the point of connection is established. It is recognized, however, that in the case of one main branch circuits, each of these branch circuit overload protection available, while a single overall device can ensure short circuit protection for all branch circuits. It allowed as circuit protection devices calibrated fuses proper operational characteristics and circuit breakers pole breaking system.

UNE 20,460-4 to 43 covers all aspects required for protective devices. UNE 20,460-4 to 473 defines the application of protective measures set out in the UNE 20,460-4 to 43 as due to overload or short circuit, indicating in each case their location or omissions.

5.5 Surge protection

5.5.1 Categories surges

The categories indicate the voltage withstand the shock wave surge that must have the equipment, determining, in turn, the maximum value of residual stress should allow different devices to protect each zone to avoid possible damage to the equipment.

Four different categories, indicating in each case the level impulse withstand voltage in kV, according to the nominal voltage of the system are distinguished.

Rated voltage installation		**Impulse withstand voltage 1,2/50 (kV)**			
Systems III	Systems II	Category IV	Category III	Category II	Category I
230/400	230	6	4	2,5	1,5
400/690	1000	8	6	4	2,5

Category I

It applies to very sensitive equipment to overvoltages and are intended to be connected to the electrical fixture (computers, sensitive electronic equipment, etc.). In this case, protective measures are taken off the equipment to be protected, either in the fixed installation or between the fixed installation and equipment, in order to limit overvoltages to a specific level.

Category II

It applies to equipment intended for connection to fixed wiring (appliances, portable tools and similar equipment).

Category III

It applies to the equipment and materials that are part of the permanent electrical installation and other equipment for which a high level of reliability (cabinets, busbars, switchgear is required, switches, switches, sockets, etc., pipelines and accessories:

cables, junction box, etc., electric motors with permanent connection, elevators, industrial machines, etc.

Category IV

It applies to the equipment and materials that connect the source or very close to the origin of the installation upstream of the switchboard (energy counters, telemetry equipment, main overcurrent protection devices, etc.).

5.5.2 Measures to control surges

You can have two different situations:

- Natural situation: when it is not necessary protection against surges, as envisaged a low risk of surges in the system (because it is fed by an underground network as a whole). In this case it is considered sufficient resistance to surge teams indicated in the table of categories, and no additional protection is required against transient surges.
- Controlled situation: when it is necessary protection against surges in the installation source because installation is fed by, or include, an airline with bare or insulated conductors.

It is also considered controlled situation that natural situation where it is desirable to include protection devices for added security (continuity of service, economic value of equipment, irreparable losses, etc.).

Protective devices against lightning overvoltages must be selected so that the protection level is lower than the voltage impulse with stand category of equipment and materials that are expected to be installed.

The arresters are connected between each of the conductors, including the neutral or compensator and the facility ground.

5.5.3 Selection of installation materials

The equipment and materials must be chosen so that its impulse withstand voltage not less than the withstand voltage prescribed in the above table, according to their category.

The equipment and materials that have a withstand voltage lower than indicated in Table pulses can be used, however:

- In natural situation, when the risk is acceptable.
- In controlled situation, if the overvoltage protection is appropriate.

5.6 Protection against direct and indirect contacts

Protection by insulation of live parts

The active parts must be covered with insulation that can´t be eliminated rather than destroying it.

Protection by barriers or enclosures

It is also considered controlled situation that natural situation where it is desirable to include protection devices for added security (continuity of service, economic value of equipment, irreparable losses, etc.).

Protective devices against lightning overvoltages must be selected so that the protection level is lower than the voltage impulse with stand category of equipment and materials that are expected to be installed.

The arresters are connected between each of the conductors, including the neutral or compensator and the facility ground.

5.7 Grounding

The grounding was primarily established to limit the voltage with respect to ground, can present at any given time the metal frames, ensuring the performance of protection and eliminate or reduce the risk posed by a fault in the electrical equipment used.

The start or grounding is direct electrical connection without fuses or some protection, a part of the electrical circuit or a conductive part does not belong to it, by an earth with an electrode or group of electrodes buried in the ground.

By installing grounding should get you on the set of facilities, buildings and near ground surface do not appear dangerous potential differences and at the same time, allows the passage earth fault currents or discharge of atmospheric origin.

The choice and installation of materials to ensure the development land should be such that:

- The value of resistance grounding conforms with the standards of protection and operation of the facility and maintained in this way over time.
- The earth fault currents and leakage currents can move safely, particularly from the point of view of thermal, mechanical and electrical stresses.
- The strength or mechanical protection is assured regardless of the estimated conditions of external influences.
- Contemplate the possible risks due to electrolysis that could affect other metal parts.

5.7.1 Ground unions

Grounding

For the ground can be used electrodes formed by:

- Bars, tubes
- Plates, bare conductors
- Plates
- Rings or mesh made of the above elements or combinations thereof
- Buried concrete armor
- Other buried structures that are shown to be appropriate

Copper conductors are used as electrodes building and electrical resistance class 2 according to UNE 21.022.

The type and depth of burial of the earth connections must be such that the potential loss of soil moisture, the presence of ice or other climatic effects, do not increase the resistance of the ground above the predicted value. The depth will never be less than 0,50 m.

Grounding conductors

The section of grounding conductors, when they are buried, must agree with the values given in the table below. The section not less than the required minimum protection for drivers.

Type	**No mechanically protected**	**Mechanically protected**
Protected	Equal protection drivers sec. 7.7.1	Galvanized Steel 16 mm2 against corrosion
Not protected	25 mm^2 Cu	25 mm^2 Cu
Agains corrosion	50 mm^2 Fe	50 mm^2 Fe

The corrosion protection can be obtained by an envelope.

During execution of the connections between ground conductors and ground electrodes should Extreme care to make them electrically correct. Care must be taken, in particular, that the connections do not harm or drivers or grounding electrodes.

Earthing terminals

In any grounding installation should have its main earth terminal, which must join the following drivers:

- Ground conductors.
- Drivers of protection.
- The main equipotential bonding conductors.
- Drivers functional ground, if needed.

Provision should be made on the ground conductors and accessible place, a device for measuring the resistance of the cable system is grounded. This device may be combined with the main earth terminal must necessarily be removable by means of a tool, must be mechanically safe and must ensure electrical continuity.

Protective conductors

Protective conductors serve to electrically connect the masses of an installation with earth terminal in order to ensure protection against indirect contact.

Protective conductors shall be at least equal to the fixed section in the following table:

Section conductive phase (mm^2)	**Conductors Protection Section (mm^2)**
$Sf \leq 16$	Sf
$16 < Sf \leq 35$	16
$Sf > 35$	Sf/2

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

- 2,5 mm2 if protective conductors have a mechanical protection.
- 4 mm2 if protective conductors do not have a mechanical protection.

As protective conductors may be used:

- Wires in the multiconductor cables
- Bare or insulated conductors having a common enclosure with live conductors, or
- Bare or insulated conductors separated.

No device shall be inserted in the conductor. The masses of equipment to be connected to protective conductors should not be connected in series in a circuit protection.

5.7.2 Equipotential conductors

The main equipotential must have not less than half the protective conductor larger section of the installation section with a minimum of 6 mm². However, the section may be reduced to 2,5 mm² if copper.

Additional equipotential bonding may be secured either by conductors not removable such as removable metallic structures, or by additional conductors, or by a combination of the two elements.

5.7.3 Resistance of earthing

The value of earth resistance shall be such that any mass can´t lead to higher contact stresses:

- 24 V in local or driver location
- 50 V in other cases.

If the installation conditions are such as to give rise to touch voltages higher than the values listed above, the rapid elimination of the fault is ensured by cutting devices appropriate to the current service.

The resistance of an electrode depends on its size, its shape and resistivity of the soil in which it is established. This resistivity varies frequently from one point to another terrain, and also varies with depth.

5.7.4 Independent land tomes

Grounded upon another is considered separately, when one of the grounding, no scope, on a point of zero potential, a voltage exceeding 50 V when the other circulates the maximum fault current planned land.

5.7.5 Spacing between the grounding of the masses facilities use and masses of a transformer

Verify that the masses were grounded in a facility utilization and protective conductors associated with these masses or mass protection relays are not attached to the rounding of the masses of a transformer, for avoid during the evacuation of an earth fault in the substation, the masses of utilization facility may be subject to dangerous touch. If control of independence indicating above (50 V) between the grounding of the masses facilities use regarding grounding protection or mass of the transformer, it does it will be considered that the earthing are electrically independent when all are met and each of the following conditions:

- There conductive metallic conduit (metal cable cover uninsulated especially piped water, gas, etc.) than a land area of the transformer to the area where the devices are used.
- The distance between the earth connections of the transformer and grounding or other conductive buried in local usage is at least equal to 15 meters of land whose resistivity is not high (<100 ohm x m). When the ground is very poor conductor, the distance must be calculated.
- The processing center is located in an insulated enclosure for local use or if the adjoining premises or interior.de use thereof is set so that its metallic elements are not connected electrically metallic elements to the constructive utilization of the premises. You can only attach the grounding of the utilization facility (building) and grounding protection (mass) of the transformer, if the resistance value of single grounding is low enough that there is in the case of evacuating the maximum expected value of the earth fault current (Id) in the center of transformation, the value of the fault voltage (Vd = Id x Rt) is less than the maximum contact stress applied.

5.7.6. Review of the grounding

Given the importance that offers, from the point of view of safety any grounding installation shall be compulsorily checked by the Director of the Work or Authorized Installer at the time of registering the facility for commissioning or operation. Technically competent staff will perform the installation testing ground, at least annually, at the time when the soil is drier. To do this, the earth resistance is measured and urgently repaired the defects found.

In places where the soil is not favorable to the preservation of the electrodes, these drivers and linking them to the point of grounding, will become exposed for examination at least once every five years.

5.7.7 Receivers lighting

The fittings shall conform to the requirements of standards UNE-EN 60598 series.

The mass of suspended luminaires exceptionally flexible cable must not exceed 5 kg.

The drivers, who must be able to support this weight, should not show intermediate joints and effort shall be made on a different element of the terminal.

Accessible metal parts of luminaires than Class II or Class III shall have a connecting element for grounding, which will be connected reliably and permanent conductor of the circuit.

The uses of gas discharge lamps to high voltage (neon, etc.) are permitted where your location is outside the volume of accessibility or when separating barriers or enclosures are installed.

In lighting installations discharge lamps made on premises where work machines with reciprocating or rotary quickly, you should take steps to prevent the possibility of accidents caused by optical illusion caused by the strobe effect.

The power circuits are provided to carry the load due to the receptors themselves, their partners and their harmonic components and starting currents. For receivers with discharge lamps, the minimum load specified in volt-amperes will be 1,8 times the wattage of the lamps. For single phase distributions, the neutral conductor will have the same section as those of phase. Be acceptable for a different coefficient calculating the conductor cross section, as long as the power factor of each receiver is greater or equal to 0,9 and if the burden associated with each of the elements is known lamps and starting currents that they and those may occur. In this case, the coefficient shall be the result.

In general, the engine power exceeding 0,75 kW must be provided with starter resistors or equivalent devices that do not allow the current ratio between the starting period and normal gait that matches your full load, according to characteristics of the engine must indicate your plate exceeds that indicated in the following table:

0,75 kW to 1,5 kW	4,5
1,5 kW to 5 kW	3
5 kW to 15 kW	2
More than 15 kW	1,5

6.MATHEMATICAL FORMULAS USED TO CALCULATE

We will use the following formulas:

Three-phase system:

I = Pc / 1,732 x U x $\cos\varphi$ x R = amp (A)

e = (L x Pc / k x U x n x S x R) + (L x Pc x Xu x $\sin\varphi$ / 1000 x U x n x R x $\cos\varphi$) = voltios (V)

Single Phase system:

I = Pc / U x $\cos\varphi$ x R = amp (A)

e = (2 x L x Pc / k x U x n x S x R) +
(2 x L x Pc x Xu x $\sin\varphi$ / 1000 x U x n x R x $\cos\varphi$) = volts (V)

Where:

Pc = Computing power in watts
L = Calculate length in meters
e = Voltage drop in Volts
K = Conductivity
I = Current in Amps
U = Service Voltage in Volts (three phase or single phase)
S = Conductor cross section in mm²
$\cos\varphi$ = Cosine of φ x Power Factor
R = Performance (for lines motor)
n = Number of conductors per phase
Xu = Reactance per unit length in mΩ/m

Formula Electrical Conductivity

K = 1/ρ

$\rho = \rho_{20}$ [1+ρ (T-20)]

T = T0 + [(Tmax-T0) (I/Imax)]

Being,

K = Conductor conductivity at temperature T

ρ = Electrical resistivity at temperature T

ρ_{20} = Electrical resistivity at 20° C

Cu = 0,018

Al = 0,029

α = Temperature coefficient:

Cu = 0,00392

Al = 0,00403

T = Conductor temperature (ºC)

T0 = Environment temperature (ºC):

Cables buried = 25

Cables air = 40

Tmax = Maximum permissible conductor (ºC) Temperature:

XLPE, EPR = 90ºC

PVC = 70ºC

I = Intensity provided by the driver (A)

Imax = Maximum ampacity of the conductor (A)

Formulas Overload

$Ib \leq In \leq Iz$

$I2 \leq 1{,}45\ Iz$

Where:

Ib= intensity used in the circuit.

Iz= ampacity of the pipeline in accordance with standard UNE 20-460/5-523.

In= rated current of the protective device. For adjustable protective devices, In is the chosen intensity regulation.

I2= intensity that effectively ensures the operation of the protection device. In practice I2 is taken as:

- The operating current in the conventional time for circuit breakers (In 1,45 max).
- The intensity of fusion in the conventional time for fuses (1,6 in).

Reactive power compensation formulas

Cos Ø = P/$\sqrt{}$ (P + Q)

Tg Ø = Q/P

Qc = Px (tgØ1-tgØ2)

C = Qcx1000/U x ω (Single Phase - Three phase star connection)

C = Qcx1000/3xU x ω (Three phase delta connection)

Being:

P = Active power installation (kW)
Q = Reactive power installation (kVAr)
Qc = Reactive power compensation (kVAr)
Ø1 = Phase angle uncompensated installation
Ø2 = Phase angle you want to achieve
U = phase voltage(V)
ω = 2xPixf; f = 50 Hz
C = capacity capacitors(F); cx1000000 (µF)

Short formulas

IpccI = Ct U /$\sqrt{}$ 3 Zt

Being,

IpccI= continuous current DC start line in kA
Ct= Voltage coefficient
U= Phase voltage in V
Zt= Mohm total impedance in upstream point cc (excluding the line or circuit under study).

IpccF = Ct UF / 2 Zt

When,

IpccF= Continuous current of DC end of line in kA
Ct= Voltage coefficient
UF= Phase voltage in V

Zt= In mohm total impedance including the own line or circuit (therefore is equal to the impedance of the conductor itself more or source line)

The total impedance to the short-circuit point will be:

$$Zt = \sqrt{(Rt^2 + Xt^2)}$$

Being,

Rt= R1 + R2 + ...+ Rn (sum of the resistances of the lines to the point upstream of cc)
Xt= X1 + X2 +.....+ Xn (chokes sum lines to the point upstream of cc)
R = L · 1000 · CR / K · S · n (mohm)
X = Xu · L / n (mohm)
R= Line resistance in mohm
X= Line reactance in mohm
L= Line length in m
CR= Resistivity coefficient
K= Conductivity of metal
S= Line section in mm²
Xu= Line reactance in mohm per meter
n= Nº. of conductors per phase

tmcicc = Cc S² / IpccF²

When,

tmcicc= Sg maximum time that a driver supports a Ipcc
Cc= Constant depending on the type of conductor and insulation
S= line section in mm²
IpccF= Continuous current of DC in order to line A

tficc = cte. fuse / IpccF²

Being,

tficc= melting time of a fuse for a given fault current
IpccF= Continuous current of DC end of line in A

$$Lmax = 0{,}8\ UF / 2\ IF5 \sqrt{\ } (1{,}5 / K\ S\ n) + (Xu / n\ 1000)$$

Being,

Lmax= Maximum length conductor shielded DC (m) (for protection by fuses)
UF= Phase voltage (V)
K= Conductivity
S= Section of the conductor (mm^2)
Xu= Reactance per unit length (mohm/m). Usually insulated conductors in 0,1
n= nº of conductors per phase
Ct= 0,8: It is the voltage coefficient
CR = 1,5: Is the resistance coefficient
IF5 = Intensity melt amp fuse in 5 seconds

Curves valid (for protection breakers equipped with electromagnetic relay)

CURVE B IMAG = 5 In
CURVE C IMAG = 10 In
CURVE D Y MA IMAG = 20 In

Busbars formulas electrodynamic calculation

$$\sigma \text{ max} = Ipcc\ L / (60\ d\ Wy{\cdot}n)$$

Being,

σ max= Maximum voltage on the plates (kg/cm^2)
Ipcc= Continuous current DC (kA)
L= Spacing between supports (cm)
d= Separation between plates(cm)
n= nº of plates per phase
Wy= Modulus at deck y- axis and (cm^3)
σ adm= Permissible voltage equipment (kg/cm^2)

Checking for thermal stress shorts

$$Icccs = Kc\ S / (1000 \cdot \sqrt{\ } tcc)$$

Being,

Ipcc= Continuous current of DC (kA)

Icccs= Intensity DC supported by the driver during the duration of cc (kA)

S= The total section of plate (mm^2)

tcc= Short duration(s)

Kc= Constant Driver: Cu = 164, Al = 107

7. UNIFILAR

	P. Calculo (W)	Dist.Calc (m)	Section (mm)	I. Calculo (A)	I. Adm (A)	C.T.Parc (%)	C.T.Total (%)	Dimensions (mm) Tube, channel, band
GB	177936	2	150	256,82	320	0,1	0,02	150
GP1	9684	2	4	13,977	16	0,21	0,05	16
GP2	168252	11	150	242,85	250	0,55	0,55	150

	P. Calculo (W)	Dist.Calc. (m)	Section (mm)	I. Calculo (A)	I. Protec. (A)	C.T.Parc (V)	C.T.Total (%)	Dimensions (mm) Tube, channel, band
GP1	9684	2	4	13,977	16	0,21	0,05	16
C13	84	20	1,5	0,36	10	0,1739	0,0756	16
C1	1400	19,25	1,5	6,08	10	2,789	1,21	16
C6	1300	14,3	1,5	5,65	10	1,92	0,835	16
C2	3450	19,25	2,5	15	16	2,929	1,273	16
C7	3450	14,3	2,5	15	16	3,06	1,332	16

	P. Calculo (W)	Dist.Calc. (m)	Section (mm)	I. Calculo (A)	I. Protec. (A)	C.T.Parc (%)	C.T.Total (%)	Dimensions (mm) Tube, channel, band
GP2	168252	11	150	242,85	250	0,55	0,137	150
C13	54	29,15	1,5	0,234	16	0,16	0,07	16
C1	540	23,65	1,5	2,3479	10	1,32	0,574	16
C6	504	26,95	1,5	2,19	10	1,4	0,6113	16
C2	3450	23,65	4	15	16	3,16	1,377	16
C7	3450	25,85	4	15	16	3,46	1,505	16
C12	504	26,95	1,5	2,19	10	1,4	0,61	16
C14	3450	25,85	4	15	16	3,46	1,505	16
C15	3000	8,8	4	15	16	1,02	0,44	20
C16	8800	22	10	13,04	40	3	1,3	25
C17	1800	22	4	7,82	10	1,53	0,66	20
C18	30000	16,5	70	130,04	140	1,09	0,477	50
C19	28000	22,55	50	121,7	16	1,96	0,85	50
C20	40000	22,55	95	173,9	25	1,474	0,64	63
C21	1700	27,5	4	7,39	10	1,81	0,789	20
C22	3000	27,5	4	13,04	16	3,2	1,39	20
C23	30000	19,8	10	43,3	63	2,65	0,66	32
C24	4000	24,2	4	5,77	10	1,08	0,27	20
C25	6000	24,2	4	8,66	10	1,62	0,405	20

8. PLANS

Below are attached the following plans:

- Distribution plant
- Fabrication process
- Fire prevention
- Work area
- Power plug installation
- Lighting distribution
- Evacuation plan