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MASOL CONTINENTAL BIOFUEL S.R.L.
STABILIMENTO DI LIVORNO

MASOL CONTINENTAL BIOFUEL S.R.L.
PLANT LIVORNO

PROGETTO ESECUTIVO

REALIZZAZIONE NUOVO IMPIANTO DI PRETRATTAMENTO OLI,

SPLITTING E DISTILLAZIONE DEGLI ACIDI GRASSI

EXECUTIVE PROJECT

NEW PLANT FOR OIL PRE-TREATMENT, SPLITTING AND

DISTILLATION OF FATTY ACIDS

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01) PROJECT TECHNICAL REPORT

01.01) GENERAL

The subject of this description are the works to be carried out to feed the Acids and Fats plant serving line 3 and the power supply to the new waste water purification plant for the production of Biodiesel at the MASOL s.r.l. plant. located in Livorno in via Leonardo da Vinci, 35 / A and precisely:

- New 1600kVA MV / LV transformer to replace the existing 800kVA transformer;
- Extension of the existing QEGBT800 switchboard, adding two 600mm columns to house the new 4x2500A main switch and the 4x2000A starting switch to power the general switchboard serving the new QE-GBT FAP denominated acid and fatty SKID;
- QE-MCC FAP Distribution Board;
- QE-SERV FAP Services Panel;
- Power supply of the New Purification Plant via a dedicated electric line connected to an existing switch in the QBT-1600 panel, currently in reserve.
- Upgrade of the existing line that feeds the Q-COOLING SYSTEM Panel (cooling towers);
- Extension of the Q-COOLING SYSTEM panel (cooling towers) to power the users serving the new acid and fat SKID;
- Acid and Fat SKID Utility Distribution System serving the BIO 3 line;
- Integration and partial reconstruction of the ground and Equipotential network;
- Normal and Emergency Light System Acid and Fat SKID for the BIO 3 line;
- Check atmospheric discharges.

01.02) REFERENCE STANDARDS

- It is agreed to apply to the contract all the laws and regulations in force on the subject of public works, and more precisely:
- The technical standards issued for the plant in question by the competent Bodies and Associations (Fire Brigade - CEI ex ENPI-UNEL- etc...).
- The following in particular must be observed:
- The plant and all electrical components installed shall be made in a workmanlike manner in accordance with the dictates of the new Ministerial Decree 37 of 22/01/2008 as well as the old Laws 186/68 and 46/90 abrogated by the new decree. In particular, all the components and materials employed shall have CE Marking or other comparable European marks.
- They shall also have characteristics of suitability for the installation environment and conform with the Legal Standards and Regulations in force for general use, in particular with the CEI Regulations and related variants with regard to electrical plant.
- Decree 37 of 22/01/08, “Regulations concerning implementation of Article 11- quaterdecis, sub-paragraph 13, letter a) of Law N° 248 of 2 December 2005, bearing the reordering of provisions on the subject of plant installation within buildings”.

- Legislative Decree N° 81 of 9 April 2008, “Implementation of Article 1 of Law N° 123 of 3 August 20076, on the subject of safeguarding health and ensuring safety in the workplace”.
- Old Presidential Decree N° 547 of 27/04/55, Rules for the prevention of accidents at work;
- Old Law N° 186 of 1 March 1968, Provisions concerning the production of materials, apparatuses, machinery and the installation of electrical and electronic plant (workmanship);
- Law N° 791 of 18/10/1977 “Implementation of CEE directive N° 73/23 regarding the guarantee of safety required of electrical material to be used within determined voltage limits”.
- Ministerial Decree of 10/4/1984, “Elimination of radio interference”.
- Law N° 818 of 7/12/1984 “Provisional authorisation for activities subject to fire prevention checks”.
- Ministerial Decree of 08/03/1985, urgent directives for fire prevention.
- Old Law 46/90, standards for plant safety.
- Old Legislative Decree 626/96; implementation of directive 93/68/CEE concerning CE marking of electrical material to be used within certain voltage limits.
- Old Legislative Decree 494/96, “Implementation of directive 92/57/CEE concerning the minimum prescriptions of health and safety to be effected on temporary or mobile sites”.
- Presidential Decree N° 302 of 19/03/1956 “General standards of hygiene at work”.
- Presidential Decree N° 320 of 20/03/1956, “Standards for the prevention of accidents and for hygiene when working underground”.
- Law N° 615 of 13/07/1966 “Provisions against atmospheric pollution” and implementation of the regulations in force.
- Home Secretary Circular N° 31 of 31/08/1982, “Safety regulations for the installation of internal combustion engines coupled with electricity generators or operating machinery”.
- Ministerial Decree of 26/06/1984 “Classification of reaction to fire and homologation of materials with view to fire prevention”.
- Ministerial Decree Public Works of 12/12/1985 “Technical standards for piping”.
- Law N° 447 of 26/10/1995, “Framework law on noise pollution”.
- Ministerial Decree of 10/03/1998, “General criteria for safety against fire and for emergency management in the workplace”.
- Legislative Decree N° 615 of 12 November 1996, (implementation of European directive 89/536 CEE – Electromagnetic Compatibility).
- Ministerial Decree N° 519 of 15 October 1993, “Regulations bearing authorisation of the Higher Institute of prevention and safety at work to carry out homologated activities of first or new plant for earthing and protection against atmospheric discharges”.
- Legislative Decree N° 626 of 19 September 1994, + LD N° 242 of 18 March 1996, “...implementation of directives 89/391/CEE regarding improvement of workers’ safety in the workplace”.
- Legislative Decree N° 496 of 14 August 1996, “Safety and/or health signs in the workplace”.
- Ministerial Circular N° 7938 of 06/12/1999 from the former Ministry of Public Works, published in the Official Bulletin N° 57 of 09/03/2000.
- UNI 13201 “Lighting technique requirements for roads with motorised traffic”.
- I.E.C. Standards (International Electrotechnical Commission).
- UNEL unification tables.
- C.E.I. standards (Italian Electrotechnical Committee).
- In particular the electric lighting system has been designed and will be built in conformity with the following CEI standards:
- CEI 0-2: guide for the definition of design documentation of electrical systems.
- Standard CEI 3-1, ”Graphic signs for electrical diagrams; elements of graphic signs, distinctive graphic signs and signs for general use”.
- Standard CEI 3-15, “Graphic signs for diagrams; conductors and connection devices”.
- Standard CEI 3-18 “Graphic signs for diagrams; production, transformation and conversion of electricity”.
- Standard CEI 3-19 “Graphic signs for diagrams; apparatuses and command and protection devices”.
- Standard CEI 3-20 “Graphic signs for diagrams; measuring instruments, lamps and signalling devices”.
- Standard CEI 3-23 “Graphic signs for diagrams; diagrams and architectural and topographical installation plans”.
- Standard CEI 3-25 “Graphic signs for diagrams; general”.
- Standard CEI 3-32 “General recommendations for preparation of electrical diagrams”.

- CEI EN 61936-1 (Classification CEI 99-2): electrical plant with voltage greater than 1 kW in AC;
- CEI EN 50522 (Classification CEI 99-3): Earthing of electrical plant with voltage greater than 1 kW in AC.
- Standard CEI 11-17 Plant for production, transmission and distribution of electricity. Lines in cable.
- Standard CEI 11-25 “Calculation of short circuit currents in three-phase AC networks”, which is the guide for calculation of short circuits in LV networks supplied by MV or by generators;
- Standard CEI 11-28 “Application guide for calculation of short circuit currents in low voltage radial networks”, which is the guide to application of the directives contained in the previous Standard in the case of a LV network supplied by a public MV distribution network;
- Standard CEI 11-35 edition 10/1996 “Guide to the execution of end-user electrical substations”.
- Standard CEI 11-37 “Guide for the execution of industrial premises earthing plant for systems of I, II and III category” where not replaced by the standards CEI 11-1 mentioned above;
- Standard CEI 17-5 “Automatic switches for alternate current and nominal voltage not greater than 1000 V and for direct current and nominal voltage not greater than 1200 V”.
- Standard CEI 17-6 “Prefabricated equipment with metal sheath for voltages from 1 to 72.5 kV”.
- CEI EN 61439-1 (CEI 17-113) Assembled equipment of protection and control for low voltage (LV switchboards) - Part 1: General rules
- CEI EN 61439-2 (CEI 17-114) Assembled equipment of protection and control for low voltage (LV switchboards) - Part 2: Power boards
- Assembled equipment of protection and control for low voltage non standard (ANS).
- Standard CEI 20-14 “Cables insulated with polyvinyl chloride, R2 quality with degree of insulation greater than 3 (for systems with nominal voltage from 1 to 20 kV)”.
- Standard CEI 20-19 “Cables insulated with rubber with nominal voltage not greater than 450/750 V”.
- Standard CEI 20-20 “Cables insulated with polyvinyl chloride with nominal voltage not greater than 450/750 V”.
- Standard CEI 20-22 “Fire-retardant cables”.
- Standard CEI 20-29 “Conductors for insulated cables”.
- Standard CEI 20-32 “Cables with concentric neutral insulated with hard ethylene propylene rubber, for AC systems with voltage not greater than 1 kV”.
- Standard CEI 20-37 “Electrical cables: tests on gases emitted during combustion”.
- Standard CEI 20-38 “Cables insulated with fire-retardant rubber with low development of toxic and corrosive fumes and gases; part I – nominal voltage not greater than 0.6/1 kV”.
- Standard CEI 20-40: guide for the use of low voltage cables
- Standard CEI 20-45 “Fire resistant cables insulated with elastomeric mixture with nominal voltage Uo/U not greater than 0,6/1 kV”.
- Standard CEI 23-3 “Automatic overload switches for domestic and similar uses (for AC not greater than 415 V”.
- Standard CEI 23-8 “Rigid protective tubing in polyvinyl chloride and accessories”.
- Standard CEI 23-11 “Switches and commutators for domestic and similar apparatus”.
- Standard CEI 23-12 “Plug sockets for industrial uses”.
- Standard CEI 23-14 “Flexible protective tubes in PVC and their accessories”.
- Standard CEI 23-18 “Differential switches for domestic and similar uses and differential switches with overload cut-outs incorporated for domestic and similar uses”.
- Standard CEI 23-25 “Tubing for electrical installations; general prescriptions”.
- Standard CEI 23-28 “Tubing for electrical installations - part II: special standards for tubing – section metal tubing”.
- Standard CEI 23-29 “Tubing in rigid plastic material for underground cable ducts”.
- Standard CEI 23-31 ”Systems of metal channels and accessories for use as cable carriers and trunking for apparatus”.
- CEI 23-51: prescriptions for the creation, verification and testing of distributions boards for fixed installations for domestic and similar use..
- Standard CEI 31-30: Electrical constructions for atmospheres explosive due to the presence of gas. “Guide to the classification of dangerous places”.
- Standard CEI 31-33: Electrical constructions for atmospheres potentially explosive due to the presence of gas. “Electrical systems in place with danger of explosion due to the presence of gas”.
- Guide CEI 31-35 – 31-35 A – “Guide to Classification of dangerous places”;
- Standard CEI 33-5: “Static power factor improving capacitors of the self-healing type for AC electrical plant with nominal voltage less than or equal to 660 V”.

- Standard CEI 34-21 “Lighting apparatus. Part I; general prescriptions and tests”.
- Standard CEI 34-22 “Lighting apparatus. Part II; special requirements: emergency lighting apparatus”.
- Standard CEI 34-23 “Lighting apparatus. Part II; special requirements: fixed apparatus for general use”.
- Standard CEI 64-8: “End-user electrical systems with nominal voltage up to 1000V AC and 1500V DC.
- CEI 64-12 “Guide for the execution of earthing systems in buildings for residential and tertiary use” with regard to ground plates.
- Standard CEI 64-14 Guide to verification of users’ electrical systems.
- Standard CEI C.T. 70 Protective sheathing. (Equipment constructional references).
- CEI UNEL 35023: “Electrical cables insulated with rubber or thermoplastic material with a degree of insulation not greater than 4 – Voltage drops”.
- CEI UNEL 35024/1: “Electrical cables insulated with elastomeric or thermoplastic material for nominal voltages not greater than 1000 V AC and 1500 V DC. – Ampacity for overhead installation”.
- CEI UNEL 35024/2: “Electrical cables with mineral insulation for nominal voltages not greater than 1000 V AC and 1500 V DC. – Ampacity for overhead installation”.
- Moreover the following Regional Law N° 000037 of 21/03/2000 must be observed:
  Law of the Tuscany Regional Administration on light pollution:

01.03) BRIEF DESCRIPTION OF THE PREMISES

This is the Acids and Fats plant serving line 3 for the production of Biodiesel at the MASOL s.r.l. plant. located in Livorno in via Leonardo da Vinci, 35 / A consisting of:

- New 1600kVA MV / LV transformer to replace the existing 800kVA transformer;
- Supply and installation of 4x2500A busway between the secondary of the new 1600kVA transformer and the expansion of the existing QEGBT800 switchboard to which two 600mm columns will be added to house the new 4x2500A main switch and the 4x2000A start to power the general switchboard at the service of the new SKID for acids and fats called QE-GBT FAP;
- Supply and installation of 4x2000A busbar to power the new QE-GBT FAP switchboard;
- Power supply of the New Purification Plant via a dedicated electric line connected to an existing switch in the QBT-1600 panel, currently in reserve.
- Realization of MCC Distribution Panel to supply the users of the ACID and FAT SKID called QE-MCC FAP;
- Realization of QE-SERV FAP Services Framework;
- Upgrade of the existing line that feeds the Q-COOLING SYSTEM Panel (cooling towers);
- Extension of the Q-COOLING SYSTEM panel (cooling towers) to power the users serving the new acid and fat SKID;
- Acid and Fat SKID Utility Distribution System serving the BIO 3 line;
- integration and partial reconstruction of the ground and Equipotential network;
- Normal and Emergency Light System Acid and Fat SKID for the BIO 3 line;
- Check atmospheric discharges.

The cables supplying the end-uses in the skid will be laid, after the work process, in a new dedicated channel in galvanised steel next to the existing ones.

The maximum size of the area is:
- Length: 31 m.
- Width: 27 m.

Maximum height of Skid line 3 Biodiesel
Height: 53 m.

The absolute altitude of the plant is:
100 metres above sea level.

The number of people simultaneously envisaged in the various spaces is:

Production premises : 3 persons permanent
: 3 persons occasionally
For a total of : 3 persons permanent
: 3 persons occasionally.

01.04) LIST OF PROJECT DRAWINGS

For list of project drawing see report in document **IT-06-14-01001**

01.05) CLASSIFICATION OF ENVIRONMENTS

01.05.01) TECHNOLOGICAL ROOMS

These rooms contain apparatus, conduits and machinery.
Access is allowed only to authorised and suitably trained personnel.
Considering the structural features of the rooms in question, the classification of “restricted places” is excluded as per Standard CEI 64-8/6.

01.05.02) DEGREE OF PLANT PROTECTION

The degrees of protection of sheathing and plant, in conformity with the prescriptions of standards CEI 70-1, must be suitable for the environment and typology of the place where the plant is installed. The minimum degrees of protection for individual components and for overall plant in function of the environments considered are indicated below:

- Electrical switchboards (Doors closed) : IP 40/IP 55
- Electrical systems : IP 55
- External electrical systems : IP 55

01.06) CLASSIFICATION OF ELECTRICAL SYSTEMS

The systems will be supplied in MV by the existing plant:
MV supply : 15 kV. by ENEL
LV supply : 400 V.
Icc. Medium voltage : 16 kA.

Distribution in LV is done through a category I system (400/230 V.) of the type TN-S, derived from new Transformer da 1600 kVA - with an Icc Value = 36 kA.

01.07) EARTHING SYSTEM

The existing general earthing system consists of 50 sq.mm copper plait, interred, which links cross-shaped galvanised steel earthing rods measuring 50x50x5 mm, length 2,5 m, and the main metal structures at various points of connection.
With the refurbishment of the Acids and Fats skid serving line 3, it is necessary to check the perimeter earthing system in the intervention area, making new connections at the corners of the structure with 50 sqmm bare copper rope.
New connections must also be made between the external dispersing plant and the new switchboard room.
Close to the user units there will be copper BTM connected to the general earthing network.
From these BTM all the equipotential plants of the metal masses and electrical end-uses will be derived.
The electrical end-uses will be moreover connected to earth by means of the earth conductor internal to the supply cable connected to the earthing rod in the supply switchboard.

The earthing system will be sized in such a way as to respect the following rapport:
Rt = 50/Is
in which:
Rt = maximum value of resistance in Ohms
Is = maximum value of earth fault current in Amperes
The various electrical circuits will be further protected by differential relays coordinated with the earthing system.
The following elements will be connected to the general earthing system:

- all the metal parts of electrical equipment not normally under tension;
- the star-point of the transformer;
- tubing, tanks, supports etc.;
- iron reinforcements of load bearing columns;
- service stairs and gangways in metal;
- metal door and window frames;
- all other large metal masses not expressly listed.

01.08) ATMOSPHERIC DISCHARGE PROTECTION SYSTEM

For the atmospheric discharge protection system see report in document **IT-06-14-01005**

01.09) GENERAL PROTECTION

01.09.01) CABLE SIZING AND PROTECTION COORDINATION

CABLE SIZING CRITERIA
The purpose of this chapter is to define the general and design criteria for sizing the electrical protection regarding the main supply lines, setting out from the switchboards.
All the cables employed correspond to what is shown in the UNEL tables and to the building standards established by the CEI. In particular, the following types of cables shall be used for the creation of electrical systems:

- Cables with conductor in red copper flexible plait, single-core, without fire-retardant type sheathing FS17 with insulation level 450/750V, insulation in XLPE quality G16, for electrical circuits with voltage up to 230/400V;

- Cables with flexible rounded plait of annealed red copper type FG16(O)R16, single or multi-core, insulated with high modulus HEPR rubber, special PVC Rz quality sheathing, degree of insulation 0.6/1kV for electrical circuits up to 230/400V;

The cable sections have been sized in conformity with:

- Current in transit in the cable under normal conditions of use;
- Reduction coefficient of capacity with regard to the laying conditions;
- Voltage drop which must not exceed 4% of nominal voltage of the circuit (under nominal load) with regard both to cables supplying driving power and lighting.

The voltage drop considered is that measured between the general electrical switchboard and the most distant end-user.

Calculation of the Section of the conductors in function of circulating current

The section of the conductors is a function of the operating current (In) (circulating) which must never exceed the maximum capacity at steady state of the cable that conveys it (Iz).

The operating current (In) is the value which may flow in an ordinary service circuit, while maximum capacity in steady state (Iz) means the maximum current that the conductor can tolerate without, by Joule effect, the temperature reaching such values as to compromise the intactness and duration of the insulations.

The maximum tolerable temperature does not have a fixed value valid for all the cables but depends on the type of insulation used for sheathing the conductors (from 80° C for economical insulation to more than 200° C for special insulation).

For sizing of the conductors employed in the attached project, the table CEI UNEL 35024/1 and 35024/2 was used.

The maximum capacities of the conductors (Iz) and the related sections obtained were checked by the simplified formula below:

$$S \geq \frac{I_n}{a}$$

where

S is the section of the conductor in mm²;

In is the operating current that may involve a circuit in ordinary service;

a is the density of current referred to the conductor of unitary section equal to:
- 10 A/mm² for conductors in conduit beneath plaster,
- 12 A/mm² for surface mounted conductors,
- 13 A/mm² for well ventilated conductors.

Capacity reduction coefficients – Coefficients K1 and K2

The value of Iz (capacity of the conductor in normal service conditions) was moreover determined on the basis of declassing due to various correction coefficients depending on temperature of use, type of laying and the number of conductors in a single conduit.

The correction factors taken into consideration, which contribute to the reduction of nominal capacity, are substantially two:

Factor K1, which takes account of the surrounding temperature in which the cable is laid,

Factor K2 which takes account of the proximity of other cables.

The reference tables containing factors K1 and K2 can be found in the abovementioned literature.

Factor K2 is applied in the hypothesis in which the cables of the bunch or layer have similar sections, which is to say contained within the three unified adjacent sections; contrarily, factor K2 becomes

$$K_2 = \frac{1}{\sqrt{n}}$$

Calculation of the minimum section in function of the effective short-circuit current

The section of the conductors was defined on the basis of the nominal current of the conductor under normal service conditions (Iz), declassed as mentioned in the previous paragraph.

It must be checked that the said section is never less that what is produced by the following relation

$$S = \frac{I \cdot \sqrt{t}}{k}$$

where:

S	is the section in mm²;
t	is the duration in seconds of the short-circuit;
I	is the effective short-circuit current in Amperes expressed in RMS;
k	is a constant equal to: 115 for copper cable insulated with PVC (160°C) 135 for copper cable insulated with rubber (220°C) 143 for copper cable insulated with rubber G7 (250°C)

Verification of voltage drop

Over and above the foregoing, the cables have been verified also in function of voltage drop in such a way that between the origin of the plant and any end-user apparatus it never exceeds 4% of nominal voltage.

Higher voltage drops have been considered for conductors supplying electric motors during the starting period, or for other electrical components that require higher current absorption, with the condition that it is ensured that the voltage variations remain within the limits indicated in the relevant CEI Standards.

Voltage drops were verified with the following formula:

$$\Delta \mathbf{V} = 2\, I_b\, l\, (R \cos\varphi + X \operatorname{sen} \varphi) \text{ per i circuiti monofasi e}$$
$$\Delta \mathbf{V} = 1{,}73\, I_b\, l\, (R \cos\varphi + X \operatorname{sen} \varphi) \text{ per i circuiti trifasi}$$

where:

ΔV = is the drop in Volts projected on the phase vector;
Ib is the working current of the line in Amperes;
φ is the angle of phase shift between current Ib and the phase voltage;
R is the resistance per metre in Ω/m;
X is the reactance per metre in Ω/m;
l is the length of the conductor in km.

The values of resistance and reactance were taken from the table UNEL 35023-70.

GENERAL CRITERIA FOR SIZING OF PROTECTION DEVICES

The sizing of all protection devices was determined by taking account of the following reference currents:

- In (Nominal current)
  current referred to by all the constructional prescriptions of the apparatus and which represents the unitary value of the intervention characteristic;
- Inf (Non-functioning current)
  maximum value of overcurrent that does not trip the protective device within the prearranged time;
- If (Functioning current)
  minimum value of overcurrent that definitely trips the protective device within the prearranged time.

Protection against overload currents

Protection against overload, as indicated by Standard CEI 64-8, is guaranteed for the following conductors:
mainline feeding derived end-uses with simultaneity coefficients less than 1;
line feeding motors and end-uses which in their functioning may determine overload conditions;
line feeding socket and plug;
line feeding end-uses positioned in places subject to explosion or fire hazard;
The characteristics of the devices protecting the apparatus against overloads were sized by observing the following conditions:

$$\mathbf{I_b \leq In \leq I_z}$$

$$I_f \leq 1.45\ I_z$$

Protection against overload currents

Protection against overload, as indicated by Standard CEI 64-8, is guaranteed for the following conductors:
mainline feeding derived end-uses with simultaneity coefficients less than 1;
line feeding motors and end-uses which in their functioning may determine overload conditions;
line feeding socket and plug;
line feeding end-uses positioned in places subject to explosion or fire hazard;
The characteristics of the devices protecting the apparatus against overloads were sized by observing the following conditions:

Protection against short-circuit currents

The presumed short-circuit current at a point of an end-user plant is the current there would be in the circuit if at the point in question there was a connection with negligible impedance between the conductors under tension.
The interruption power of a protective device must not be less than the presumed short-circuit current at the installation point.
The value of the short-circuit current, for which the protective devices are sized, has been calculated with the following relation:

$$I_{cc} = \frac{c \cdot V}{k \cdot Z_{cc}}$$

In which:
c = voltage factor listed in the Standards
Zcc = short-circuit impedance
K = 1 or $\sqrt{3}$ depending on the type of breakdown under consideration
V = voltage value
The minimum value of the short-circuit current (at the end of the line) when the neutral is not distributed was calculated with the following relation:

$$I_{cc\min} = \frac{0.8\,U \cdot S}{1.5\,\rho\,2 \cdot l}$$

where:
U is the phase-to-phase voltage in Volts;
S is the section in mm²;
ρ is the resistivity at 20° C of the material of the conductors in Ωmm²/m;
l is the length of the line.

With the neutral conductor distributed the previous relation becomes:

$$I_{cc\min} = \frac{0.8\,U_0 \cdot S}{1.5\,\rho\,(l+m)}$$

where:
Uo is the voltage:
m is the relationship between the resistance of the neutral conductor and the resistance of the phase conductor.

It was further verified that the short-circuit protective device has a power of interruption greater than the maximum value of the presumed short-circuit current in the section of the plant where the device itself is installed, and that the (specific)

electricity allowed to pass by the apparatus is not greater than the maximum passing electricity tolerable by the conductors installed downstream. The whole translates into the following relations:

$$I_{ccmax} \leq P.d.I.$$
$$I^2t \leq K^2S^2$$

where:

Iccmax = maximum short-circuit current.
P.d.I. = protective device power of interruption.
I²t = value of the specific passing electricity read on the curve I²t of the protective device in correspondence to the short-circuit currents.
K²S² = specific passing electricity supported by the conductor, where:
K = coefficient of cable type (115,135,143 etc. in accordance with CEI 64-8/4 point 434.3.2).
S = conductor section.

01.09.02) SECTIONING AND CONTROL

For sectioning and non-automatic local and remote control, special sectioning will be utilised with view to avoiding and/or suppressing dangers connected with electrical systems, with apparatuses or with electrically powered machinery.

Each circuit will be sectioned from the feed supply.
Sectioning must take place on all active conductors.

- Interruption for non-electrical maintenance

When non-electrical maintenance may involve risks to persons, power supply switch-off must be envisaged.

- Mechanical electrically powered apparatus means not only rotating machinery but also any heating systems and/or electromagnetic equipment.

Suitable provisions must be made to avoid electrically powered mechanical apparatus being accidentally reactivated during non-electrical maintenance, if the interruption devices are not under the continuous control of the maintenance workers.

These protective devices may consist of one or more of the following measures:

- Mechanical blocking of the interruption device.
- Writing or other signs.
- Positioning of interruption devices within a room and/or an enclosure under lock and key.

For the envisaged end-uses of this plant there will be a system of switching off for non-electrical maintenance by means of buttons and key selectors which interrupt the control circuits and which will be placed close to the end-user apparatus not visible from the supply switchboards.
For the rest of the end-uses a lockable intermediate control will be installed on the front panel which acts on the motor protector of each end-use.

01.10) LOW VOLTAGE SWITCHBOARDS (LV Distribution)

These switchboards will be built in self-standing sheet steel, finely painted after antirust treatment, or in self-extinguishing resin, depending on their places of installation.
Maximum protection against indirect contacts of the outgoing will be guaranteed through the installation of suitable fuses in the switchboards.
The switch-off power was chosen in function of the maximum presumed value of the short-circuit current.
The external dimensions of the switchboards as shown in the technical documents should be understood as approximate, which is to say not as strictly binding.
All the electrical apparatus will be contained in cabins in sheet steel, stove enamelled with epoxy resins following phosphate conversion coating, and/or in containers of self-extinguishing resin.
The switchboards are closed by hinged front doors with lock and key.
Execution is modular with units interconnected with galvanised nuts and bolts; all the front panels of access to the apparatus and terminal boards are closed by triangular lock and/or bolts.
Also when inspection from the rear is envisaged, the apparatuses are completely visible and manoeuvrable from the front and installed on guides and panels that are solid with the frame of the switchboard.
Each switchboard is supplied with an earth rod in bare copper which runs its whole length.
All the metal parts of the switchboard, even where no electrical parts are contained, are connected to the earth rod by means of derived collectors.
The lines are connected to a wide section terminal board, ordered in such a way that that it need not bear the weight of the conductors which, to this end, are suitably anchored.
The wirings within the switchboards will be carried out with fire-retardant conductors (standards CEI 20-22) and the remaining non-metallic materials are of the self-extinguishing type.
Each power and/or auxiliary conductor will be identified by an appropriate marker in such a way as to facilitate recognition and service.
Each conductor in the switchboard will be protected against short-circuit as envisaged by the standards CEI 64-8.
Should this not be possible, especially in short runs (< 3 m.) the conductors must be sized for the maximum (I)^2 x t that may occur at that point, and in any case all the connections deriving from the main bars will have a minimum section of 6 sq. mm.
Each switchboard will also be complete with the electrical power and functional diagram and the test certificate carried out by the manufacturer on the basis of CEI standards.
The trials carried out will be:
- Verification of constructional features (conformity with design)
- Applied voltage tests
- Verification of mechanical functioning
- Verification of electrical functioning
- Verification of protective devices and the electrical continuity of the protection circuit.

Reference standards
- CEI EN 61439-1 (CEI 17-113)
- CEI EN 61439-2
- CEI 11.26
- CEI 17-43
- DPR 547
- EN 60 439-1

Mechanical interlocks with keys
Sheet metal thickness 15-20-25/10 mm.
External painting with epoxy powders

Degree of protection	IP3x (doors closed) IP2x (doors open)

Quadro QE-GBT FAP

Electrical characteristics

–	Insulation voltage:	:	440 V.
–	Working voltage:	:	400 V.

- Frequency: : 50 Hz.
- Short-time current: : 30 kA.
- Rated busbar current: : 2500 A.
- Barring in bare copper :
- Earthing system : TN-S
- Type : Distribution switchboard
- Form : 3A

Quadro QE-MCC FAP

Electrical characteristics
- Insulation voltage: : 440 V.
- Working voltage: : 400 V.
- Frequency: : 50 Hz.
- Short-time current: : 30 kA.
- Rated busbar current: : 2000 A.
- Barring in bare copper :
- Earthing system : TN-S
- Type : MCC extractable drawers

Quadro QE-SERV FAP

Electrical characteristics
- Insulation voltage: : 440 V.
- Working voltage: : 400 V.
- Frequency: : 50 Hz.
- Short-time current: : 16 kA.
- Rated busbar current: : 160 A.
- Barring in bare copper :
- Earthing system : TN-S
- Type : Distribution switchboard
- Form : 2B

01.11) CONDUCTORS AND LAYING METHOD

01.11.01) CONDUCTOR TYPES AND SECTIONS
All cables and conductors will be from leading manufacturers, corresponding to constructional provisions established by CEI standards and bearing IMQ marking.

For the type of premises it is obligatory to use single-pole cables insulated with rubber and/or PVC with fire-retardant sheathing CEI 20-22 II type FS17 and/or FG16 (CPR).

01.11.02) ELECTRICAL CABLE TYPES

The cables employed will be of the fire-retardant type in accordance with standards CEI 20-20, 20-22, and more precisely:

- **Cables FS17**

Responding to the Construction Products Regulation CPR
Colouring: black, brown, grey, blue, yellow/green

Electrical characteristics:
- Nominal voltage : 450-750 V.
- Test voltage : 2.5 kV in AC
- Maximum working temperature : 70 °C

- **Cables FG16OR16 / 0,6-1**

Responding to the Construction Products Regulation CPR
Single-pole and/or multipolar.

Colour of core:
- Single-pole : black
- Multipolar : blue, brown, black, Yellow/green.
- External sheathing grey

Electrical characteristics:

- Nominal voltage : 0.6-1 kV.
- Trial voltage : 4kV in AC.
- Maximum working temperature : 90 °C

Recommendations for laying:
- Minimum range of curvature : 4D
- Maximum traction force during laying : 6 kg/sq.mm of copper section.

01.11.03) VOLTAGE DROPS

The main distribution lines will be sized to contain the value of the voltage drop within the limits indicated below of the percentage value of voltage drop DV%.

-FM Lines :DV%max=4%
-Lighting lines :DV%max=4%
-End-use supply lines :DV%max=4%

01.11.04) COEFFICIENT OF UTILISATION

The coefficient of utilisation adopted at each point of sampling of the electrical system, defined as the relation between the effective maximum absorbed current and the nominal capacity of the end-user, is as follows:

- Motors : 0,9
- F.M. Sockets : 0,4
- Lighting systems : 1

01.11.05) SIMULTANEITY COEFFICIENT

The simultaneity coefficient, understood as the relationship between the maximum power drawn simultaneously from the supply lines with regard to the deliverable power for the various types of end-use is as follows:

- Motors : 1
- F.M Sockets : 0,2
- Lighting systems : 1

01.11.06) INSULATION RESISTANCE

The insulation resistance to earth and between the conductors belonging to different phases is no less than:

- 1500 Kohm For nominal voltage systems to earth greater than 50 V.
- 1000 Kohm For nominal voltage systems to earth less than or equal to 50 V.

01.11.07) PRESCRIPTIONS CONCERNING NEW INSTALLATION CIRCUITS

The phase cables, the neutral and the protection conductor (earth) may be distinguished as indicated in CEI standards, and in particular the following conditions must be observed:

- Phases : black, brown, grey.
- Neutral : blue.

All cables entering or leaving a switchboard are connected to special modular terminals set on DIN guides except for the lines supplying the switchboard.
All the lines are distinguished from the start, in the junction boxes and in arrival, by special labels with indelible writing indicating the circuits served..

01.11.08) LAYING IN UNDERGROUND CONDUITS

The plant will include underground PVC conduits; in foot traffic areas these conduits are coated with concrete.
This type of laying envisages only the use of double insulation cables.

01.11.09) LAYING IN TUNNELS

In tunnels the cables are simply laid on the bottom.
This type of laying envisages only the use of double insulation cables.

01.11.10) LAYING IN CABLE TRAYS

Cables in trays are fixed thereto by clips that keep the cables fixed in position, especially in the vertical and/or inclined stretches (in the vertical stretches the trays will be covered).
This type of laying envisages only the use of double insulation cables.

01.11.11) LAYING IN VISIBLE CONDUIT

The internal dimensions of the conduits are such as to assure easy insertion and extraction of the cables they contain.
The internal surface of the tube is sufficiently smooth to avoid damaging the insulating sheathing.

This type of laying envisages the use of single and double insulated cables.

01.11.12) FILLING OF CHANNELLING

The filling coefficient of the channels, understood as the ratio between the total theoretical external section of the conductors and the net internal section of the channelling, must have the maximum values specified below:

- Cable trays : 0.5
- External and underground conduits : 0.5

01.11.13) JUNCTION BOXES

The junction boxes are the only device in which junctions and derivations of cables have been implemented.
The boxes will be in aluminium alloy complete with terminal boards for derivation of lighting systems and motive power; they will be positioned in places where they are protected against accidental impact.

01.12) CHANNELLING

01.12.01) CABLE TRAYS AND PROTECTIVE TUBING

Channelling will be in galvanised steel following a work process of suitable sizing, installed on appropriate brackets complete with all assembly accessories such as bends, derivations, joints and covers.
Tubing will be wall mounted and/or mounted on the structures and complete with boxes installed at such a distance as to allow easy insertion of the cables.
The terminal stretches of the tubing and end-uses will be carried out with protective sheathing.
The plant will be executed in observance of the regulations in force with regard to the Zone in which it is installed.

01.13) F.M. SYSTEMS

01.13.01) FM SYSTEMS.

All the systems will be created with cables possessing the general characteristics and those of the project diagrams and will be laid in the channels described above.

The cables used in this plant will be double insulated type.

01.13.02) FM SOCKETS SYSTEM.

The installation of service socket groups is envisaged, comprising:
- N° 1 socket CEE 2P+T of 16A – 220V;
- N° 1 socket CEE 3P+T of 16A – 400V;
- N° 1 socket CEE 3P+T of 32A – 400V;

These groups are:
- of the interlocking type and for industrial use;
- individually protected by fuses;
- with minimum degree of protection IP65.

All the socket groups are protected by differential switch with I_d 0,03A.

01.14) INTERNAL AND EMERGENCY LIGHTING

All the systems will be created with apparatus possessing characteristics similar to those described in the design.

The cables will be of single or double insulation type.

An internal lighting system will be created for the working premises.
The type of lighting installed has been selected on the basis of the height and on the lighting to be guaranteed within the premises in question.

Minimum lighting is:

1)	Skid	100 lux.
2)	Electrical cabins	180.....200 lux.
6)	Emergency exits	150…200 lux

Minimum emergency lighting is:

1)	Skid	2…5 lux.
2)	Electrical cabins	5...10 lux.
3)	Emergency exits	3…5 lux

Ravenna 29 Ottobre 2021

Il Progettista

Ing. Franco Casadio