



# TECHNICAL REQUIREMENTS

## ELECTRICAL

Document No. OL-TR-ER-000

## GENERAL ELECTRICAL ERECTION PROCEDURES

Document No. OL-TR-ER-036

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00	Final Issue	29-Sep-14	D <sup>2</sup> RT' <i>engineering</i>	ORLEN Lietuva	ORLEN Lietuva
Rev.	Revision description	Date	Prep. by	Check. by	Appr. by

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## 1. SCOPE

- 1.1 The aim of these procedures is to define and establish the system for controlling and correctly performing erection works.
- 1.2 Do not use some part of that document or part of technical requirements if that type of equipment or activity not used in your project or not included in scope of work.
- 1.3 Safety requirements included into this document shall be established for all type activities in OL where the portable electrical tools, lights or welding are used.
- 1.4 Procedures shall be followed by all employees of the Contractors as well as Sub-contractors that perform works in the territory of the ORLEN Lietuva company.
- 1.5 **Requirements in actual revision of instruction BE-2 shall be used when works are perform in OL.**
- 1.6 **Welding procedures shall be in accordance with OL-TR-MR-001.**

## 2. REFERENCES

The actual (newest) revision of documents shall be used.

### 2.1 Local Law and Regulations

#### 2.1.1 General

*Elektrifikuotų mechanizmų, rankinių elektros prietaisų ir įrankių, buitinių elektros prietaisų, rankinių ir kilnojamųjų šviestuvų eksploatavimo instrukcija BE-2*

*Saugos eksploatuojant elektros įrenginius taisyklės*

*Elektros įrenginių bandymo normos ir apimtys*

*Apšvietimo elektros įrenginių įrengimo taisyklės*

#### 2.1.2 Transformers

*Elektros įrenginių įrengimo bendrosios taisyklės*

*Skirstyklų ir pastočių elektros įrenginių įrengimo taisyklės*

*Elektros įrenginių relinės apsaugos ir automatikos įrengimo taisyklės*

*Specialiųjų patalpų ir technologinių procesų elektros įrenginių įrengimo taisyklės*

*Elektros įrenginių bandymo normos ir apimtys*

#### 2.1.3 Cable and Termination

*Elektros įrenginių įrengimo bendrosios taisyklės*

*Elektros linijų ir instaliacijos įrengimo taisyklės*

*Galios elektros įrenginių įrengimo taisyklės*

*Specialiųjų patalpų ir technologinių procesų elektros  
įrenginių įrengimo taisyklės*

*Elektros įrenginių bandymo normos ir apimtys*

## 2.2 OL Specifications

OL-TR-GR-000 *General Requirements*

OL-TR-CR-014 *Civil. Corrosion Protection and Lining. Cathodic Protection*

OL-TR-ER-000 *Electrical. General*

## 3. TERMS AND DEFINITIONS

**Additional insulation:** Refers to insulation that is used in addition to the main insulation for the purpose of protection against dangerous shock caused by electric current which may be sustained after the main insulation has been damaged.

**Double insulation:** Means an insulation system composed of main and additional insulations. Symbol [..] is used to mark double insulation.

**Reinforced insulation:** Refers to total insulation used on the equipment parts that induce electric current to ensure the same degree of protection as with double insulation.

**Protective grounding:** Means electric circuit connection between conductive shells/structural elements and a ground system.

**Protective neutral connection:** Means electric circuit connection between conductive shells/ structural elements and a grounded neutral conductor.

**Electrotechnical staff:** Refers to persons with adequate electrotechnical background that have been certified as per established procedures and issued authorization certificates for electrotechnical work. Any other persons referred to in this procedure are not part of the electrotechnical staff.

**Cable routing card:** See Table 2.

**Connection card:** See Table 3.

**Welding Qualification:** All the welders must be qualified for the type of welding that they intend to carry out.

For general terms, definitions and abbreviations see:

OL-TR-ER-000 *Electrical. General*

## 4. GENERAL

4.1 In case of any uncertainty in respect of classification of a specific piece of electric equipment or premise, electrotechnical staff should be addressed for advice.

- 4.2 Any technical maintenance and repair of the electric equipment must be done by the electrotechnical staff only.
- 4.3 Switches installed on electric equipment must be in a good technical condition. It is prohibited to use switches hanging off of the connecting wires.
- 4.4 Electric equipment must be switched on/off in a reliable way (not automatically), comply with safety rules and norms, be free of open voltage areas.
- 4.5 The design of plug connections used for power sources of up to 50 V must be different from plug connections designed for higher voltages. They must have a record indicating the level of voltage. Plugs intended for up to 50 V must not be fit for a connection to a higher voltage network.
- 4.6 Wires and cables use for the connection of electric equipment should hang where possible. Wires and cables must be prevented from a direct contact with hot or oily surfaces.
- 4.7 In case of electric equipment failure or equipment user sustaining any level of electric shock, works must be terminated immediately and accident reported to the electrotechnical personnel.
- 4.8 Electric equipment must be operated in strict observance of operational instructions issued by equipment manufacturers. If there are any requirements set forth in the operating instructions of the manufacturer, the present regulations should not override such requirements of equipment manufacturer.
- 4.9 Measurements shall be done by certificated company and staff.
- 4.10 Persons, using electrified mechanisms, manual electric machinery and tools, portable lights, reducing transformers and frequency converters, are responsible for their timely delivery for the performance of measurements.
- 5. WORKS WITH ELECTRIFIED MECHANISMS, MANUAL POWER EQUIPMENT AND TOOLS**
- 5.1 It is prohibited to use manual power equipment and tools of Classes 0 and 0I in very dangerous, dangerous premises and outdoor environments.
- 5.2 In dangerous premises can be used only manual power equipment and tools of Classes I, II and III.
- 5.3 Use in very dangerous premises and outdoor use is allowed for manual power equipment and tools of Classes I, II and III only when such are connected via isolating transformers, frequency converters and residual current protection units. Connection of the equipment and tools via isolating transformers, frequency converters and residual current protection units can be done only by persons having the electric protection category of no less than VK. Where isolating transformers, frequency converters or residual current protection units are connected to a power source using plug-and-jacket connections, connecting may be done by users of such equipment.
- 5.4 It is prohibited to bring isolating transformers, frequency converters or tripping devices inside metal vessels, tanks and very dangerous premises.
- 5.5 Only one power equipment or tool can be connected to the isolating transformer, frequency converter or tripping device.

- 5.6** It is prohibited to connect 50 V power equipment and tools to the common power grid, using an autotransformer.
- 5.7** Before using power equipment employees must be undergo safety trainings.
- 5.8** During work breaks or power supply interruptions, electrified machinery, manual power equipment and tools must be disconnected from power supply sources.
- 5.9** Prior to each use of electrified machinery, manual power equipment and tool, the following shall be checked up:
- a) If voltage and frequency meet the electric grid parameters;
  - b) If work tools (drills, abrasive discs and other components) have been securely mounted/installed;
  - c) Condition of cables and plugs (visual inspection);
  - d) Condition of grounding devices;
  - e) Reliability of switch;
  - f) Run of equipment in idle mode.
- 5.10** The length of electrical cable shall be sufficient not to stretch the cable and not to loosen contacts of plug connection.
- 5.11** Electrified mechanisms, manual electric machinery and tools connected to electric network cannot be left unattended on the scaffolding, supports or hanged on ladders.
- 5.12** While working, drills, milling cutters and other tools shall be monitored for bends.
- 5.13** While working with electrified mechanisms, manual electric machinery and tools the following is forbidden:
- a) Measuring of the part being machined.
  - b) Cleaning of shavings and sawdust and lubrication of the tool;
  - c) Adjustment or replacement of the tool;
  - d) Gripping of the rotating holder and efforts to stop it;
  - e) Holding onto a wire or cable of the electric tool;
  - f) Use of tools in an open place during rain or snow;
  - g) Any repairs to any power machinery/tools, their cables or wires;
  - h) Working on a lean-to ladder;
  - i) Leaving tools connected to electric network unattended.
- 5.14** Working with electrified mechanisms, manual electric machinery or tools it is forbidden when:
- a) Plug connection, cable and its protective tube are damaged;
  - b) Brush holder cover is damaged;
  - c) The switch operation is unreliable;
  - d) Header brushes sparkle and a ring of fire occurs on the surface;
  - e) Lubricant leaks from a reducer;
  - f) Smoke or smell typical to burning insulation appears;
  - g) Extraneous sounds and vibration occur;
  - h) Cracks appear on the casing of the tool.

*NOTE: In case such evidence of a breakdown is noticed, an electrified mechanism, manual electric machinery or tool must be disconnected from electric network and an immediate superior shall be notified.*

- 5.15** Upon completion of work with an electrified mechanism, manual electric machinery or tool the following shall be done:

- a) Disconnection from electric network;
- b) Cleaning of the work site;
- c) Removal of dirt, lubricant and dust, wiping of corrosion-prone parts with cloth moistened with lubricant;
- d) Wiping of wires and cable with dry cloth and rolling into a tidy roll.

## **6. WORKS WITH PORTABLE LIGHTS**

- 6.1** Portable lights should not have open voltage areas that can be accidentally contacted; lights must have protective glass shades, steel grids, mesh.
- 6.2** The ends of cable and wire jackets shall be safely fixed inside electric lights or plug connections.
- 6.3** Voltage of portable lights shall not exceed 50 V; when performing works in the extremely hazardous environment - voltage shall not exceed 12 V. Use of portable lights, voltage of which is 230 V, is also permitted provided that they are connected via residual current protection units.
- 6.4** Use of transformers, generators, converters and accumulators as power sources for portable lights is permitted. Use of autotransformers for this purpose is forbidden.
- 6.5** Plug connections are used for connection of portable lights to the power grid.
- 6.6** Technical condition of portable lights shall be inspected prior to the commencement of works. In case of any breakage or fault (damaged cable insulation, bare cable core, cable jacket not fixed inside the light or plug, damaged construction of the light, etc.) use of the light is forbidden.

## **7. OPERATION OF ELECTRIC WELDING EQUIPMENT**

- 7.1** During operation of electric welding equipment, in addition to the requirements herein, it is necessary to follow the requirements established in the Operating Manual of electrical welding machine issued by the manufacturer.
- 7.2** Only certified primary PK electrical safety category possessing and specially trained persons are allowed to do electric welding works.
- 7.3** Testing and measurements of electric welding equipment shall be performed following valid norms and manufacturer Operating Manuals. If manufacturer in the Operating Manual does not provision periodicity of testing and measurements, then resistance of welding transformer and current converter winding insulation shall be measured after every maintenance of such machine, but at least once per 12 months.
- 7.4** Maintenance, testing and measurements of electric welding equipment in the Company shall be performed by electrotechnical personnel.
- 7.5** The results of insulation resistance measurements of welding transformers and current converters and testing shall be recorded in a special logbook.
- 7.6** A label indicating inventory number and next insulation resistance measurement date shall be placed on the casing of electrical welding machine.
- 7.7** Prior to commissioning of a newly purchased electrical welding machine the following shall be executed:



- a) The copy of electrical welding machine Operating Manual shall be submitted to Electrical Shop;
- b) Measurement of electrical welding machine insulation resistance.

- 7.8** Head of Division/Department (in charge of particular electrical welding machine) shall be responsible for technical conditions of electrical welding machine and its timely delivery for measurements.
- 7.9** Electric welding equipment, except connected via switchgears or plug-and-jack, can be connected and disconnected only by electrotechnical employees possessing secondary VK electrical safety category.
- 7.10** Only special units shall be used as welding current sources for all types of outside welding.
- 7.11** It is prohibited to use home-made electrode holders.
- 7.12** Flexible, insulated welding cables with coating from fire-resistant insulating materials shall be used from hand welding current source to electrode holder.
- 7.13** Welding cables shall be connected by way of pressing, welding, soldering or using special joint boxes. Welding cables shall be connected to the welding machines using soldered or pressed lugs.
- 7.14** In place of the reverse conductor connecting the welded item and the current source, any profile steel bus, welding table or the welded item may be used, provided their cross section is sufficient based on the allowable heating up for welding current.

*NOTES:*

- (1) Individual elements used instead of the reverse conductor shall be connected using bolts, lugs or any other reliable methods.*
- (2) It is prohibited to use building metal structures, communications, process units, local railway, grounding or nullification network, initial communication conductor and buses of distribution network instead of the reverse conductor.*

- 7.15** When using movable (portable) electric welding equipment and during welding works in fire, explosive atmospheres, the reverse conductor shall be insulated in the same way as the direct one.

- 7.16** Electric welding equipment power supply main and secondary circuit cables shall be laid so that they are protected against mechanical damage.

*NOTE: It is prohibited to lay the welding cables together with other cables or have them in contact with the cable lines and the piping containing flammable gas or liquids.*

- 7.17** Switching (disconnection) and safety electrical devices shall be installed in the primary power circuit of electrical welding machine.

*NOTE: Electric welding equipment with multioperator welding current source shall be equipped with source protection against overload (automatic circuit-breaker, fuses) and switchgear and protective electrical device for every power supply line to welding station.*

- 7.18** Movable (portable) electrical welding machine shall be placed at a particular distance from switchgear unit so that connection cable was not longer than 10 meters.

*NOTE: This requirement shall not apply when electrical welding machines are connected to power supply via trolley lines and in cases when different cable length is provisioned in the machine Operating Manual. Power supply shall be disconnected during relocation of electrical welding machines.*

- 7.19** Electrical welding machines shall be grounded prior to connection to power grid.
- 7.20** Flexible cable shall be used for power supply to electrical welding machine, and PE cord shall be directly connected to welding transformer casing and grounding busbar (terminal) of power supply point.

*NOTE: Grounding busbar of power supply point shall be connected with line PE wire, if not available – with specially installed grounding bar.*

- 7.21** When electrical welding works are executed in confined spaces the requirements of work related regulatory normative acts and Company procedures shall be followed.
- 7.22** When electrical welding works are executed inside tanks, work place shall be illuminated with suitable illuminators installed outside the tank, or portable 12 V voltage electric illuminators. Transformer connected to portable illuminator shall be installed inside the tank. It is forbidden to connect portable illuminator via autotransformer.

## **8. ERECTION PROCEDURES**

### **8.1 Purpose**

- 8.1.1** The purpose of the present Erection Procedures about the electrical erection in the ORLEN Lietuva company is to set the scope of the works to be performed by Contractor.
- 8.1.2** The scope of this document is not to describe the assembly procedures in great detail, but only to provide the most important information and the main guidelines. The details are under the responsibility of Contractor, which has to carry out the works by the most advanced techniques and according to the good engineering and erection practices in order to achieve optimum quality levels.

### **8.2 Medium Voltage Cabinets**

#### **8.2.1 Medium Voltage Switchgears**

- 8.2.1.1** Each cubicle has to be thoroughly leveled by small steel shims and fixed to the concrete floor by stud bolts. Position of the cubicles must be marked thoroughly according to drawings because the MV busducts have little position tolerance.
- 8.2.1.2** The transportation of the cubicles will be arranged so that the first ones introduced in the building is the ones to be installed furthest from the entrance point.
- 8.2.1.3** To move the cubicles inside the building have be used appropriate rollers.
- 8.2.1.4** When pushing or pulling the modules, the force has to be applied on their structural frames, never on weak points like the centre of the external metal covers.
- 8.2.1.5** All contact surfaces between busbars will be layered with contact grease before screwing them together by the corresponding tightening torque. It must be checked that all the screws in the same joint are of the same hardness.

**8.2.1.6** Not any tools or materials storage inside the cubicles.

**8.2.1.7** Immediately after the installation the cubicles have to be properly grounded according to drawings.

## **8.2.2 Medium Voltage Busduct**

**8.2.2.1** Relative positions of MV cubicles and existing 6.6 kV busbars have to be verified according to the manufacturer drawings, because the busducts have small tolerances. Any discrepancy between the site condition and the positions indicated in the drawings need to be solved before starting the erection.

**8.2.2.2** Before starting with the installation all the boxes have to be opened and the materials inside checked and recognized. Any discordance between the expected materials and the boxes content will be communicated to the Client. All the supplied sections have to be arranged in accordance to their final position along the busduct.

## **8.2.3 Supports**

**8.2.3.1** Before installation, all support positions have to be marked to ensure that there is not any hinder, including the position of all the anchors.

**8.2.3.2** All supports need to be aligned with the other according to the tolerances shown in Table 1.

*Table 1. Support Tolerances*

<b>Description</b>	<b>Tolerance</b>
Alignment	± 5 mm
Horizontal levelling	± 2.5 mm
Vertical levelling	± h/1,000 mm (h = height of support)
Minimum distance between supports	1-3 m, but not less than length of cable tray piece

**8.2.3.3** Supports will be fixed to concrete ceilings, walls or floors using anchor bolts. To fix to metallic structure they will be welded on a previously polished surface.

**8.2.3.4** Any damage inflicted to the galvanized supports will be touched up with high content of zinc paint (minimum 90% once dried).

## **8.2.4 Busduct**

**8.2.4.1** After the installation and alignment of the supports all the busbar sections will be put on them and joined together by the supplied hardware and copper plates, but the tightening torque is not going to be applied yet. All nuts need to be accessible for adjustment.

**8.2.4.2** Contact grease will be applied on all the contact surfaces before joining them together.

**8.2.4.3** After placing and joining together all the sections, they have to be perfectly aligned by means of the junction tolerances. After achieving a good alignment, the final tightening torque will be applied according to the manufacturer's instructions and any left junction plate installed. Every tighten nut has to be marked in order to allow an easy visual check.

- 8.2.4.4** While doing the final alignment it must be checked that the copper braids to be installed later between the busduct ends and the terminals of end equipment fit correctly without forcing or twisting them.
- 8.2.4.5** Once all the sections have been aligned it is necessary to do a preventive complete check of the electrical insulation by megger in order to detect and clear any fault before starting with the installation of the enclosure. The minimum insulation values are usually provided by the manufacturer in their quality documentation.
- 8.2.4.6** After the preventive test it is time to install the space heaters system, if applicable.
- 8.2.4.7** Then, a complete cleaning by cloths has to be done and the enclosures installed. It is very important to check thoroughly before closing the busduct that nothing had been left behind inside the duct, as this could lead to a catastrophic failure in operation.
- 8.2.4.8** Then, all the bonding jumpers between sections have to be installed as well as every other external accessory, like condensation drains (if applicable).
- 8.2.5 Coupling Boxes**
- 8.2.5.1** Once all the previous works had been completed the coupling boxes to the cubicles will be assembled following the manufacturer's piece detail drawings.
- 8.2.5.2** Before assembling the coupling boxes all the surfaces that will be included inside them and the boxes pieces themselves need to be thoroughly cleaned.
- 8.2.5.3** Coupling boxes have an associated IP and have to accomplish with the designed waterproof protection, so it is very important to install properly every gasket, mastic or other sealing method provided by the manufacturer. Before installing the sealing accessories it is important to clean the metallic surfaces that will be in touch with them.
- 8.2.6 Testing and Finalization**
- 8.2.6.1** Once all previous works had been completed, a second insulation test will be done. It has to be followed by a hi-pot test. This hi-pot test is going to be supervised by a vendor's representative that must be present.
- 8.2.6.2** All the grounding system must be finished before proceeding with the final tests.
- 8.2.6.3** Once the hi-pot test has been done, it is necessary to do a second insulation test by megger.
- 8.2.6.4** After successful tests it is time to install all the terminal connections to the end equipment, applying the corresponding tightening torque and contact grease.
- 8.2.6.5** Before closing the coupling boxes it is important to verify thoroughly that there is not any object left behind. In case some dirty or dust had entered the box, it is necessary to carry out a last cleaning by clothes.
- 8.2.6.6** Any damage inflicted to the surface of the metallic parts has to be repaired now using the spare paint supplied by the manufacturer.
- 8.3 Shelters and Containers**
- 8.3.1** Before placing the shelter on its final location it is necessary to mark exactly its position by consulting the corresponding layout drawings.

- 8.3.2** Shelter can be handled by a forklift or placed by a crane.
- 8.3.3** The shelter has to be thoroughly leveled by small steel shims and fixed to the concrete floor by epoxy anchor bolts.
- 8.3.4** After the shelter is placed it is time to assembly all the parts delivered detached from the shelter because of transport reasons, as the two-pitched roof or the bottles grating and rack.
- 8.3.5** Once the assembly of the shelter is finished it has to be earthed according to the applicable drawings.
- 8.3.6** Finally the space heaters have to be powered in order to protect the equipment against the humidity. In case the final earthing connection is not available, the shelter has to be earthed temporarily before powering on the heaters. This is not applicable if the shelter is weather sealed.
- 8.4 Transformers**
- 8.4.1 Dismantling and Removal of Old Transformers**
- 8.4.1.1** At first, it has to disconnect all the secondary, primary and ground connections, remove the transformer carefully and transport it to the place indicated by Client within the limits of the existing plant.
- 8.4.1.2** Then it has to take special care to not damage the transformer, their support structure or the primary links, as they are going to be used for the three new transformers.
- 8.4.1.3** The old secondary cabling and ground connections have to be removed and either threw away or transported to the place indicated by Client's supervisors.
- 8.4.2 Installation of New Transformers**
- 8.4.2.1** The current transformers must be transported to the erection site inside their crates.
- 8.4.2.2** In case the support structure had been supplied along with the transformers, it has to be placed on the foundation taking care about the position of the junction boxes, cable ducts and etc.
- 8.4.2.3** All pieces have a specific tightening torque indicated by the assembly instructions. This tightening torques will be observed carefully.
- 8.4.2.4** Each transformer will be completely assembled at ground level.
- 8.4.2.5** Before lifting the current transformers to their final position, the following precommissioning tests have to be done:  
a) Continuity (multimeter);  
b) Insulation between windings and from windings to earth (megger);  
c) Polarity (multimeter + battery).
- 8.4.2.6** Finally, the whole piece will be lifted onto the support structure taking into account the polarity (mixed polarities are now allowed) and the manufacturer instructions, especially those related to the way the slings must hold the transformer.

- 8.4.2.7** After the transformer is fixed, it is time to install the cabling from there to the transformer terminals, including those windings that are set as spare.
- 8.4.2.8** Special care must be taken to not left any loose connection or open winding. The entire spare windings have to be short circuited tight in the junction box. An open winding could result on a catastrophic failure in case the current transformer would be put in service under this condition. This is why every wire must be carefully checked for continuity.
- 8.4.2.9** In case there was an unused capacitive voltage terminal, it has to be grounded.
- 8.4.2.10** Once all the connections to ground have been done, it is time to connect the primary to the line by the corresponding terminals.
- 8.4.2.11** It is forbidden to connect aluminum to copper terminals and/or conductors, as this would result in galvanic corrosion. If it were unavoidable to do this, proper bimetallic pieces have to be used.

## **8.5 Cable Trays**

- 8.5.1** Before starting the works the whole tray route will be inspected to assure that there is not any interference with pipes, structures, equipment, etc. which had not been considered in the drawings. The future rock wool insulation of pipes has to be taken into account because in no case is going to be allowed a tray or support embedded, even little, in that insulation.
- 8.5.2** If there were any interference this will be discussed with Client supervision, in order to come into an agreed solution. Depending on the importance of the modification Client can order either to directly proceed with the alternative route or wait for an engineering response.
- 8.5.3** A visual inspection will be done at the warehouse in the moment of the reception of the materials in order to make sure about their integrity and suitability. In case the trays or supports showed signs of deterioration or there were any obvious discrepancy between their characteristics and the ones that they should have according to the project specifications, the material will be rejected and Client's overseers will be warned immediately.
- 8.5.4** Before the installation all the positions of the supports have to be marked to ensure that there is not any hinder, including the position of all anchor bolts if they are going to be fixed by them.
- 8.5.5** All supports need to be aligned with the other supports in line, as well as vertical and horizontal leveled, according to the tolerances shown in Table 1.
- 8.5.6** Supports will be fixed to concrete ceiling, walls or floor using expansion anchor bolts. To fix to metallic structure or embedded plates they will be welded on a previously polished surface.
- 8.5.7** It is forbidden to fix supports to removable structures (like handrails or gratings), equipment, other minor supports or pipes.
- 8.5.8** The straight sections are going to be supplied in lengths of 1.5, 3, 6 m, so Contractor have to cut these sections to the required length, drill the corresponding fastening holes and repair the galvanization in the cut area.



- 8.5.9** To cut or pierce cable trays cannot be used blow torches, but appropriate drilling and grinding machines. Any sharp edge or chip has to be smoothed after cutting to avoid future damages either on cables or people.
- 8.5.10** Special care must be taken to install in each position the accessory that matches with the bend radius specified in the drawings, because failing to do this will result on problems when pulling cables.
- 8.5.11** It is forbidden to join together two cable trays, or one cable tray to its supports, by welding. Only the supplied jointing accessories can be used.
- 8.5.12** Grounding of cable trays have to be done previously to cable pulling, fixing the bare copper cable along the external side of the most visible flange of the top tray.
- 8.5.13** After the end of the erection every object or debris on the trays has to be removed.
- 8.5.14** The screws used to connect the ladders have to be installed with the head on the internal surface of the tray, in order to avoid future damages to the cables. Screw must be mushroom type.
- 8.5.15** The corresponding tightening torque has to be applied at every screw. This torque has to be reviewed after the installation to make sure that there is not any loose junction left.
- 8.5.16** All cutting and piercing areas have to be touched up, when cool, with high content of zinc paint (90% once dried), as well as any area showing a damaged galvanized coating.
- 8.5.17** After the cable pulling is finished, Contractor has to install a cover on all the cable trays that run outdoors and run alone or is in the top position of a trays rack.
- 8.5.18** All the cable trays rising from a floor or ground opening have to be covered up to a height of 2 m.
- 8.6 Cabling**
- 8.6.1** The required cable routing cards have to be available, as well as all the corresponding cable routing drawings.
- 8.6.2** All cable drums specified in the cable routing cards must be available and have cable enough rolled around them.
- 8.6.3** The cable route has to be clean and free of any obstacle.
- 8.6.4** The whole cable route has to be finished and both end equipment must be installed. It is forbidden to pull cables along unfinished cable ways or if the terminal equipment are not in place.
- 8.6.5** The cable route has to be fully identified (even temporarily) so that there was no chance of confusion when pulling the cables.
- 8.6.6** The cable drums must not show any sign of deterioration. In case of damage, the spoilt cable section will be removed from the drum and its length will be informed, so that the cable stock can be conveniently keep up to date. Then, the cable drum will be tested.

- 8.6.7** In order to avoid pulling the same cable twice, there will be just one controlled copy of the cable routing card in site. This card will be handed over to Client once the cable had been pulled and the required data wrote down (like real length, used cable drum, etc.).
- 8.6.8** The cable length to be cut from the cable drums have to be always checked measuring along the cable ways. Theoretical length stated in the cable routing cards or cable list are just for reference.
- 8.6.9** Every unavoidable sharp edge along the cable way has to be covered or softened to avoid damages on cables.
- 8.6.10** The cable drums will be lifted using two jacks and a shaft, in order to allow it to turn freely. The cable has to be uncoiled from the upper part of the cable drum.
- 8.6.11** It is forbidden to pull cables using vehicles. To pull heavy cables will be used always a machine equipped with a pull strength limitation device.
- 8.6.12** The following types of cables never can be mixed or pulled along the same cable tray:
- a) Medium voltage cables;
  - b) Power low voltage cables;
  - c) Control cables;
  - d) Instrumentation cables;
  - e) Communications cables;
- 8.6.13** Sometimes control cables can run along the same tray with low voltage, instrumentation or communications cables, but only if a metallic separator has been installed. The same is applicable to instrumentation and communications cables. Client's authorization is compulsory to proceed like this.
- 8.6.14** It is forbidden to put on cables heavy or sharp objects.
- 8.6.15** Cable trays never will be used as scaffolds while pulling cables.
- 8.6.16** It is strictly prohibited to carry out cable splices, with the exception of exceptional conditions and always after the authorization of Client's supervisors.
- 8.6.17** When pulling one-core medium voltage cables, all three phases will be put together forming triads. Each triad will be separated one cable diameter from the next one and medium cable diameter from the cable tray flange. The special holders should be used for triads forming.
- 8.6.18** When pulling one-core power cables through a buried duct the duct have to hold all the three phases in order to prevent induction of currents in the slab framework.
- 8.6.19** Before to start pulling, the first cable end will be identified using indelible means by its KKS code. After cutting, the second end will be identified at the moment in the same way.
- 8.6.20** Both ends of pulled cables will be protected against humidity using proper insulating tape.
- 8.6.21** Minimum bending radius will be always observed according to the manufacturer's specifications and, in absence, following this general criteria:
- a) For shielded and armored cables, between 10 and 15 times the external diameter of the cable;



- b) For the rest of cables, between 7 and 10 times the external diameter of the cable.

**8.6.22** Extra length to be left at the entrance of boards or equipment for connection will be the maximum of the following numbers:

- a) 1.5 times the internal length to the furthest connection point inside the equipment;
- b) 2 meters.

**8.6.23** Cables will be fastened to the cable trays using black nylon ties indoors and special UV, low temperature service (-40°C) and weather resistance ties (polyamide, stainless steel, etc.). After finishing cable pulling, the spare length of the ties has to be cut. The following fastening criteria has to be followed:

- a) Immediately above the floor when the cable rises from an opening;
- b) Near the termination points;
- c) Every half a meter when the cable runs vertically;
- d) Every two meters when the cable runs horizontally;
- e) At every bend.

**8.6.24** All cables will run in parallel perfectly arranged in layers along the cable trays, and are not allowed cables crossing on other cables. High power cables never will be arranged in more than one layer.

**8.6.25** All cables will be identified with its KKS by plastic labels fastened to the cable using black nylon ties, according to the following criteria:

- a) Next to the termination points;
- b) Inside every manhole;
- c) At a height of 1.5 m in vertical sections on every floor;
- d) In both sides of every wall crossing;
- e) Each 50 meters along horizontal sections;
- f) Immediately after a diversion from the main route in a "T" or "X" branch.

**8.6.26** Marking system must be durable, indelible and oil and moist resistant, like engraving. Labels background must be light but text dark.

## **8.7 Termination**

**8.7.1** The required connection cards must be available.

**8.7.2** The cable which is going to be connected has to be fully pulled and both ends must be available in both terminal equipment.

**8.7.3** The cable insulation must have been tested successfully.

**8.7.4** The cable size must match the one specified in the connection card. In case of discrepancy, this will be communicated to Client's supervisor at once and the connection of the cable will be held.

**8.7.5** The terminal blocks in the destination equipment must be suitable for the size of the wires. In case of discrepancy this will be advised to Client's supervisor and the connection of the cable held.

**8.7.6** All cable glands must be suitable for the cable diameter, according to the tables of correspondence. It is not allowed cables passing loose through a cable gland.

**8.7.7** For armored cables, it has to be used cable glands specifically designed for this kind of cables. The same is applicable for hazardous (ATEX) areas.

- 8.7.8** The crimp terminal size has to match exactly the diameter of the wires.
- 8.7.9** The termination has to be done soon after pulling and in both tails. It is forbidden to connect a cable in one end and leave the other one disconnected.
- 8.7.10** All control and medium voltage cable shields and armours have to be connected to ground in both ends. The connection will be braided from the shield, so when removing the cable sheath must be taken into account the necessary length for these braids. Then, the braid will be covered by a green-yellow plastic sleeve and connected to ground using a cable lug. In case of copper foil cable shields, a yellow-green cable will be welded to the shield by solder and then connected normally.
- 8.7.11** Instrumentation cable shields and armours have to be connected to ground only in one end. Usually, cable shields are connected to the instrumentation grounding bar, while pair shields are connected to specific terminal blocks. Special care must be taken to connect these cable shields to the instrumentation grounding busbar, not to the general one. All braids have to be sheathed by a green-yellow plastic sleeve.
- 8.7.12** Spare conductors never will be cut, but arranged inside the panel canalizations and labelled as “Rez.”.
- 8.7.13** All conductors have to be labelled by concave shape markers or similar in both tails. Text on markers have to be indelible, durable and oil and moist resistant. Markers must be light, but text dark. Black text on yellow marker is preferable.
- 8.7.14** Every marker must include the name of the origin and destination terminals. Besides, all power cable conductors have to include in the marker the identification of the corresponding phase in color (Yellow, Green, Red, Blue, Yellow/Green) or text (L1, L2, L3, N, PEN).

## **8.8 Motor Control Centers (MCC)**

- 8.8.1** It is under the scope of Contractor to assemble the MCC until it is fully operational, jointing all the detached parts, connecting all the jumpers and busbars, grounding the set according to specifications and etc.
- 8.8.2** While assembling the motor control centers it must be taken into account what is specified under the para. 8.2.
- 8.8.3** Besides, once the erection is finished and before connecting any cable to the MCC, Contractor has to carry out the insulation test on the busbars (1,000 volts). Each busbar has to be tested between it and the other two and ground.

## **8.9 Cathodic Protection System**

- 8.9.1** Contractor has to install the totality of this system in all the outdoor locations in which it is necessary, that are all the systems will be galvanic type ones, external assembly.
- 8.9.2** Contractor has to install the anodes, the reference electrodes, the test boxes and all the interconnections.

For details see OL specifications:

**OL-TR-CR-014**

*Civil. Corrosion Protection and Lining. Cathodic Protection*

**OL-TR-ER-023**

*Electrical. Cathodic Protection Systems*

## **8.10 Control and Protection System**

- 8.10.1** Within this classification is included the DCS panel, that must be considered a sensitive electronic equipment.
- 8.10.2** It is going to be installed in the electronic room of the circulating water pumps house. This room is at ground level and is about 150 m away from the power plant, on the lake shore.
- 8.10.3** It is under the scope of Contractor to pull and terminate all the power, control, communications and instrumentation cables that are connected to these panels.
- 8.10.4** When assembling these cabinets should be taken into account the applicable guidelines under the para **8.2** plus the following additional ones:
- 8.10.4.1** Electronic cabinets are dust sensitive. This is why their installation has to be done only inside closed rooms. While installing the panels, mainly if their doors have to be opened, will be avoided in the proximities any activity that could produce dust, like cutting, grinding or sweeping. After their complete installation, the cabinets will be immediately covered by a canvas or any other suitable protection.
- 8.10.4.2** Electronic cabinets are heat and coldness sensitive. In no case the crates containing the panels will be left outside exposed to direct sun or under the night sky.
- 8.10.4.3** It must be taken into account that this kind of electronic panels usually have got two grounding busbars: one for electrical protection and other for instrumentation. It is very important to correctly identify both grounding strips before making the ground connections, in order to avoid mixing instrumentation and electrical protection grids. Inside the building there must be two independent grounding strips to carry out both connections.

## **8.11 Panels and Junction Boxes**

### **8.11.1 Standing Panels**

- 8.11.1.1** The scope of Contractor is the usual one: to install and level the bedplate and the cabinet, grounding, pulling and termination of all the cables that are connected to the equipment and every task needed to complete the installation.
- 8.11.1.2** For the installation of the electrical boards must be taken into account the guidelines related under the para. **8.2**, while for the installation of the electronic panels have to be considered the additional ones under the para. **8.2**.
- 8.11.1.3** Panel mounting will be:
- Before entering the cabinets in the room it is necessary to install the bedplates. Their position will be always checked to assure that the parts are not swapped or upside-down;
  - The entire bedplate has to be thoroughly levelled by small steel shims and fixed to the concrete floor by stud bolts. In case of raised floor it will be fixed on the real floor by appropriate legs, never on the raised floor frame;
  - The transportation of the panelboards will be arranged so that the first ones introduced in the building are the ones to be installed furthest from the entrance point;
  - To move the panelboards inside the building Contractor has to use appropriate rollers. It is not allowed dragging the cells directly on the floor;

- e) When pushing or pulling the boards the force has to be applied on their structural frames, never on weak zones like the center point of the external metal enclosures
- f) Before installing each panelboard it must be checked that the floor openings intended to pull the cables through them match the required ones. If there would be any obvious discrepancy, like absence of openings, the installation has to be stopped and Client's overseer warned;
- g) After installing the modules on their bedplate the horizontality and alignment has to be checked again. If despite the former bedplate levelling the cubicles showed some misalignment this has to be rectified by steel shims before fastening them;
- h) It is forbidden to storage tools or materials inside the panels;
- i) Every panelboard has to be properly grounded before entering any cable inside;
- j) Electronic and control cabinets are dust sensitive. This is why their installation has to be done only inside closed rooms. While installing the panels, mainly if their doors have to be opened, will be avoided in the proximities any activity that could produce dust, like cutting, grinding or sweeping. The cabinets will be covered by a canvas or any other suitable protection immediately after their complete installation;
- k) Electronic cabinets are heat and coldness sensitive. In no case the crates containing the panels or the panels themselves will be left outdoors exposed to direct sun or under the night sky;
- l) It must be taken into account that electronic and control panels could have two grounding busbars: one for electrical protection and the other for instrumentation. It is very important to correctly identify both grounding tapes before making the ground connections in order to avoid mixing instrumentation and electrical protection grids. Inside the building there must be two independent grounding bars to carry out both connections.

## **8.11.2 Surface Mounted Panels**

**8.11.2.1** All these panels are of small size and wall mounted type, so they have to be fixed on an appropriate concrete wall, metallic structure or standing support. As usual the support and all the fixation accessories are under the scope of Contractor.

**8.11.2.2** We can mention the following ones:

- a) Junction boxes linked to the instrumentation of the technological units;
- b) Junction boxes corresponding to the all electrical connections;
- c) Junction boxes enclosing galvanic separators around ATEX areas;
- d) Junction boxes related to the local level indicators;
- e) Junction boxes, thermostats of heat tracing;
- f) Electrical and instrumentation junction boxes related to the medium voltage and low voltage pumps and their motors;
- g) Cable size reduction boxes. Sometimes the incoming low voltage power cables are too big to be fitted in the terminal boxes of some motors. In order to solve this problem the cable is connected to an interconnection box installed next to the motor in order to pull a suitably sized jumper from there;
- h) Safety switches installed next to the motors of all pumps and fans;
- i) Emergency stop and local start push buttons linked to all kind of pumps and motors all over the plant. This buttons will be installed mostly on standing supports.

**8.11.2.3** In the case of the cable size reduction boxes it is under the scope of Contractor the full assembly of the box, including either DIN rail and terminal blocks or insulators and copper plates depending on the size of the incoming cables.

- 8.11.2.4** Although the sizes of these boxes are very variable we can say that most of them are medium and small sized, between 300x200x400mm and 600x300x800mm, with the exception of the push buttons that obviously is much smaller.
- 8.11.2.5** As usual all the cabling that is connected to these boxes and their grounding is under the scope of Contractor.
- 8.11.2.6** While assembling a wall mounted type panel or junction box the following erection guidelines have to be observed:
- a) All supports need to be vertical and horizontal levelled, according to the tolerances shown in Table 1.
  - b) Supports will be fixed to concrete walls or floor using expansion bolts. To fix to metallic structure, they will be welded on a previously polished surface;
  - c) It is forbidden to fix supports to removable structures, like handrails;
  - d) Before installing the support or frame it will be checked that its size matches the dimensions of the junction box;
  - e) Supports can never difficult the accesses to any equip or device, like valves, other panels, instruments, pumps, motors, ventilation openings, monkey ladders, etc. In case this happened in the set position, installation has to be hold and Main Contractor's supervisors warned.

### **8.11.3 Junction Boxes**

While assembling a junction box the following erection guidelines have to be observed:

- a) Before installing the junction box, it will be checked that their identification coincides with the one in the drawing in the same location;
- b) All steel sheet type junction boxes installed outdoors have to be hot dip galvanized and painted according to the project specifications. Minimum ingress protection is IP-55;
- c) All junction boxes installed indoors need to have a minimum ingress protection of IP-54;
- d) The door of the junction box has to open in its final location at least 90°. On the contrary Contactor's supervisors will be warned in order to define an alternative location;
- e) The specification for the junction box levelling is the same that for its support;
- f) All junction boxes will be properly grounded before terminating any cable inside;
- g) When drilling to install the cable glands extreme caution will be taken to avoid damaging the internals by the driller. If the junction box has got a detachable bottom blind plate, it will be removed to drill and install the glands. All cable glands belonging to each junction box must be installed at the same time and previously to the connection of the first cable;
- h) When re-installing the bottom blind plates they have to be correctly fastened and tightened to avoid breaking the IP protection of the junction box;
- i) Once finished the installation, the key of the box will be fastened using a wire or a cable to avoid it's lost and the door will be locked;
- j) It is not allowed to store materials or tools inside the junction box;
- k) It's prohibited to drill at site the ATEX certified boxes, without necessary permits and instructions of box's manufacturer;
- l) Avoid tension of wires and cables terminated into the boxes;
- m) Avoid water pass into boxes from outside cables loops. Cables should go from down to up.

### **8.12 Lighting and Sockets**

It is under the scope of Contractor the full installation of the equipment, perforated cable trays, conduit and cables necessary to make fully functional this system, including any necessary grounding.

This system includes lots of derivation and junction boxes, as every lamp and socket will be connected to the main power grid through one of them.

#### **8.12.1 Lighting Fixtures**

**8.12.1.1** Contractor has to install all the lighting fixtures of the plant and all the secondary power distribution boards.

**8.12.1.2** The erection can be recessed in suspended ceiling, suspended from threaded rods, steel cables or chains, directly fixed on surface, fixed on surface with intercalated supports, installed on pole, etc. All the options are showed in the corresponding typical erection details.

#### **8.12.2 Lighting and Auxiliary Power Panel Boards**

**8.12.2.1** Contractor is going to install the local power distribution boards that feed the lighting fixtures and the sockets. These panels are going to be mounted on wall or metallic surface or fixed on a specific standing support supplied, manufactured, sandblasted, painted and installed by Contractor.

**8.12.2.2** The final installation way depends on the site condition.

#### **8.12.3 Sockets**

**8.12.3.1** Contractor is going to install all the power sockets in the plant. This is the description of the sockets that Contractor has to install:

- a) Socket panels that combine within the same enclosure different kinds of 32 A and 16 A sockets. These panels can be installed on wall, metallic surface or specific support manufactured by Contractor;
- b) Flush boxes that include various 16 A sockets and RJ-45 connectors. These boxes are installed recessed on the tiles of a raised floor;
- c) Single 63 A sockets surface mounted;
- d) Single 25 A sockets installed recessed on the wall or surface mounted;
- e) Single 16 A sockets installed recessed on the wall or surface mounted.

**8.12.3.2** These plug receptacles are fed from the same panels than the lighting fixtures and are showed in the same layout drawings.

#### **8.12.4 Switches and Other Accessories**

**8.12.4.1** Contractor has to install the local switches linked to the diverse lighting circuits. We can mention the following types:

- a) Push buttons;
- b) Single pole, single throw switches (one-way);
- c) Single pole, double throw switches (two-way);
- d) Four-way switches (intermediate).

**8.12.4.2** All of them can be installed recessed on the wall or surface mounted. There are different kinds depending on the required ingress protection. Some of them are designed to be installed in ATEX rated areas.



**8.12.4.3** Some lighting circuits could be controlled by photocells or timers which installation is as well under the scope of Contractor.

**8.12.4.4** Finally, Contractor will have to install several sizes of intermediate junction and derivation boxes 110x110x50 mm and 150x150x70 mm, die cast or metal sheet made. Some of the die cast 110x110x50 mm ones have to be installed in ATEX rated areas.

## **8.12.5 Luminaries**

Luminaries mounting will be:

- a) Previously to the installation of any luminary it is necessary to make sure that the rated power and the ingress protection level are exact the ones specified in drawings;
- b) Luminaries installed outdoors must meet a working temperature suitable for the expected winter conditions;
- c) The installation of a luminary includes the assembly of any accessory supplied detached, like ingress protection enclosures, lamps, signalization sticks, batteries and etc.;
- d) Contractor has to make sure that all the materials to be installed inside ATEX rated areas are suitable for this kind of locations. That includes luminaries, switches, cable glands and etc.;
- e) Every cable has to enter the luminaries through cable glands which ingress protection has to match or exceed the one of the luminary. These cable glands have to be made of polyamide in case of plastic enclosures and brass in case of metallic enclosures;
- f) The installation of any luminary has to follow the typical erection details and the manufacturer instructions. In case there was any contradiction this will be communicated at once to Client's supervisors;
- g) Not a single luminary will be installed in a position that, according to the manufacturer's brochures, could compromise its ingress protection level;
- h) The installation place has to be exactly the one indicated by the drawings, given that this is the location considered in the lighting study. In case it was necessary to move a luminary because of interferences it needs to be agreed with Client's supervisors;
- i) Luminaries will be fixed to concrete or walls by anchor bolts or rawl plugs. Fixation to metallic structure will be by metallic supports welded on a previously polished surface;
- j) In order to fix a luminary it is necessary to make use of the anchorage points provided by the manufacturer. In no case a luminary will be perforated in order to fix it;
- k) After their installation every luminary has to be cleaned outside and inside using dirt-free soft clothes in order to assure the correct illumination levels, mainly the reflectors and the optic covers;
- l) Lamps never will be installed before the installation, but once it has finished. This is to prevent them to break during the erection process. Contractor has to replace any broken lamp because of mishandling at their own expenses;
- m) All the lighting fixtures have to be cleaned by dirt-free soft clothes before the installation;
- n) In no case an installation method will be accepted if it causes the ATEX rate or the ingress protection to be compromised;
- o) All the distances between the base of the luminary and the floor have to be thoroughly observed. Subsequently the suspension devices (chains, rods, cables and etc.) have to be carefully dimensioned.

## **8.13 Control Room Equipment**

### 8.13.1 Cable Routing Card

For cable routing card see Table 2.

*Table 2. Cable Routing Card*

Cable No.	From	To	Conduit		Cable		Drum	Pulling data
			Size	Length	Type	Size		

### 8.13.2 Connection Card

For connection card see Table 3.

*Table 3. Connection Card*

Cable No.	From panel terminals, termination data			To panel terminals, termination data			Notes