

# EK 34. ELEKTRİK İŞLERİ MONTAJ PROSEDÜRÜ (ELECTRICAL INSTALLATION PROCEDURE) ÖRNEĞİ

## ELECTRICAL INSTALLATION PROCEDURE

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### **1.0 SCOPE**

This procedure defines requirements and installation methods for electrical installation works in the plant construction.

### **2.0 CODES, STANDARDS AND SPECIFICATIONS**

Below listed documents will be effective:

The applicable codes and standards, specifications, drawings referred in the Contract and reference data supplied by the Client.

Quality Manual,

Approved Health, Safety and Environment Plan,

Approved Quality Control Plan,

Approved Inspection & Test Plans,

Where there is contradiction between documents supplied by Client and the specified codes and standards or legal requirements, such contradiction shall be immediately transferred to Client to be clarified by the Client.

### **3.0 WORK IN HAZARDOUS AREAS**

- All Contractor supplied equipment, apparatus and materials intended for use in a hazardous area shall be selected, procured and installed in accordance with codes, standards and specifications with a type of protection appropriate to the risk zone. The risk zone shall be decided in accordance with the relevant Area Classification Drawing.

- The Contractor shall ensure that all electrical equipment to be used at the hazardous area will be certified, labelled or marked by the manufacturer with the correct "Ex" protection type, gas group and temperature classification.

- No instrument/equipment without valid certification shall be used or installed.

- All Contractor's personnel to be assigned to work in hazardous areas shall be fully competent and conversant with all necessary regulations and standards, relating to the working rules and installation of electrical equipment within the hazardous areas.

One senior person thoroughly familiar with the class and character of the work, shall be present at the hazardous work site during all working hours.

#### **4.0 CABLE INSTALLATION**

During cable installation works, attention will be shown to below mentioned points.

- All cable routes shall be accurately measured prior to cutting any cables from cable drums.
- Where it is noted in the relevant drawings that routing to be left to the discretion of the site personnel, the Contractor shall cooperatively determine by inspecting the cabling requirements for equipment and the route conditions.
- Where practicable, common cable routes shall be established to minimize duplication of trenching and installation work.
- Cables of different voltages and services e.g. telecommunications, fire and gas cables shall be segregated to prevent interference between electrical power, control and instrumentation circuits.
- The minimum separation distance between power/control and electronic or inductive sensitive circuit cables shall be not less than 330 mm for 115/230 V, 660 mm for 230/400 V, 1250 mm for 6600 V.
- Where intersection between groups is unavoidable, the routing shall be arranged such that power/control and electronics/signal cables cross at right angles.
- All cables shall be left clear of process and service pipes. It should be noted that many process lines will be done later on and therefore clearances between cable runs and pipe runs should take this into account. There shall be a minimum distance of 400 mm between any cable and the process lines.
- With some below mentioned exceptions, as a general rule, each cable from origin to destination, shall run as a continuous length, without joints.
- The cables, which form the ring main for the high mast lighting columns, are too large to loop in/out of the 10 m. columns. In all this instances a "T - joint" is to be used. The joint is to be located as close as practicable to the base of the columns.
- Where cables pass vertically through floors, platforms, walkways, etc., protection against mechanical damage shall be provided as detailed on the drawings or shall be agreed with the Client.
- Cables passing through solid floors or walls must be sealed by use of an approved system or if the number of cables is small, by the use of individual cable glands.
- For the minimum-bending radius of any cable and wires, manufacturer's recommendations shall be followed.
- Where cable ends are coiled pending installation, the cables shall be coiled individually. The coils of each individual cable shall be strapped together firmly, using adhesive tape or rope to avoid mixing. Armouring wire shall not be used for this purpose.
- All cable ends shall be sealed to prevent the ingress of moisture. Coiled cables shall be protected to avoid damage.
- Each cable coil shall be clearly identified in a legible manner using non-corrodible material. Coils shall be arranged in sequence and for ease of accessibility for installation.
- When the ambient temperature is below 0° C, installation of thermoplastic cables shall not be carried out, to avoid the risk of damaging their insulation sheath.
- Cables shall be handled and installed in a manner, which does not cause damage by abrasion, or by excessive tension and shall be laid in smooth parallel formations. Twists, crossings or intertwining of cables is not acceptable.
- Cables installed on horizontal runs shall be strapped in convenient bundles at intervals of 900 mm, at each bend or change in direction and not more than 600 mm from a transit or gland position. For vertical runs, temporary ties may be utilised prior to the installation of permanent clamps.
- Cables equal to or larger than 3 or 4 cores shall be clamped individually. Smaller cables may be strapped together. 6 KV cables to be individually laid.
- Holding down straps, clamps or tie wraps shall be of non-corrosive, plastic covered and metallic material, compatible with the cable sheath and support steelwork. They will be at suitable dimensions that when tensioned, they do not damage the cable sheath.
- On vertical and horizontal runs, cables shall be strapped to the rack or tray at 500 mm intervals.

- All cables shall be so supported that no strain is placed upon the cable, cable gland or equipment. After pulling, each cable is to be cut back to within two meters of its final length and left for at least 24 hours before final glanding and terminating to allow redistribution of the tensile forces, to prevent armour/insulation shrink back.
- Motor control cables shall be laid alongside their respective motor power cable. Single core cables shall be run in clover formation, held in place by suitable strapping. Where metal-sheathed single core cables are used, the metal sheath shall be bonded at both ends.

## 5.0 CABLE SUPPORT SYSTEMS

Cable supporting systems can be cable trays, cable racks and conduits.

- Cable trays shall be adequately supported, hot dipped galvanized, heavy-duty perforated mild steel. Cable tray shall be cut along a line of plain metal and not through a line of perforations.
- Cable racks shall be hot dipped galvanized, heavy-duty perforated mild steel. Spacing of supports shall be as stated on the drawings but in no case they shall exceed the manufacturer's recommendation for the loading.
- Conduit support shall be in accordance with PUE (Power Usage Effectiveness). Spacing in cable tray shall be in accordance with PUE but not more than 450 mm.

General notes:

- Supports for site routed cable trays or racks shall be provided in accordance with the manufacturers recommended loading and span distances.
- All cable support metalwork shall be painted after site manufacturing.
- Every effort shall be made to keep all cable runs in accessible positions. The minimum height of cable supports, crossing structure walkways or other minor access ways shall be 2.2 m.
- The spacing between adjacent layers of support systems shall permit ready access during the initial laying of cables and for subsequent inspection or repair, with a minimum of 450 mm between the bottom face of any adjacent tray or rack.
- Burrs and sharp edges formed on cable trays or racks when cut, shall be removed to the extent that the exposed edge will not cause any damage to cables or personnel.
- Certified bends and tees of cable trays and supports shall be used where shown on the relevant drawings and on site run cable routes. Site fabrication of accessories shall only be allowed where absolutely necessary due to space limitations or equipment arrangements.

## 6.0 CABLES INSTALLED UNDER GROUND

Cables run underground, shall be either be laid with hot dip galvanized or concrete conduits or inside concrete cable trenches, or duct banks or directly laid and buried into excavated cable trenches. The method will be decided in accordance with contract conditions and specifications. Underground works shall not be covered until the visual inspection by the Client is done. Points to be considered are:

- The routing and arrangement of underground cables, particularly in areas adjacent to substations and control houses, shall be planned concurrently with main pipe routes and vehicle access ways, to give as far as possible, clear direct and safe routes.
- Spacing between continuous current carrying LV cables shall be minimum 100 mm from center to next cable's center. Spacing between HV and LV cables shall be minimum 150 mm from edge to next cable's edge.
- Cables shall be laid on 150 mm of sand bed and covered with 150 mm of sand. The sand shall be screened to remove sharp objects and hand compacted to eliminate damage risk.
- Warning marker tape and protection red brick shall be installed over the cables as indicated on the relevant drawings.
- If not given a different dimension, the **minimum** depth of cover from the cable to the finished grade shall be as following:
  - For street lighting and telephone cables: 70 cm
  - For power cables up to and including 1000 V and control cables: 70 cm
  - Power cables above 1000 V: 80 cm.
- The backfilling material over the sand is to be well-compacted and free from large stones or other injurious objects.
- Cables shall be installed using specially constructed cable rollers. The cables are to be installed by hand-up, manually, up to 40 mm diameter; above this size, cable pulling winch with tensioning device may be used.
- Proprietary cable marker posts on the ground shall identify cable routes in unpaved areas not more than 25 m intervals on straight runs and each change of direction.

- The installation of direct buried cables shall not commence until the entire route has been excavated, inspected and cleared of all stones and debris.
- Where cables are installed in concrete trenches over the sand bed, the backfilling is to be clean sand and special care shall be taken, when fitting the concrete covers to ensure that they are properly positioned and seated.
- Prior to cables are installed in concrete ducts, the duct line is to be proved clear of obstructions by the use of a wooden mandrel or by rodding.
- All ducts (sleeves) are to be sealed at both ends after the installation of the cables.
- Pulling lines (guide wire) shall be installed in all spare ducts.
- Where cables rise from below ground, they shall be protected for not less than 150 mm above grade by rigid metal/plastic pipe sleeves.
- No cables shall be run directly beneath pipes, which follow the same direction as the cables.
- Underground (direct buried) cable shall have a warning tape and ceramic tiles as per specification requirements, over the cables.

## 7.0 CABLE MARKERS

Cables are defined with their respective numbers as indicated on the cable schedule.

Cable markers shall be located at each end of the cable and at both side of the roads, walls, etc., and at regular intervals (max. 25 m) along the cable route and also where aboveground cables enter and leave cable trenches.

Cable markers shall be clearly visible from the direction in which the cables would be normally inspected.

The cores of cables shall be identified by the manufacturers. The marking can be black numbers on white colored core sheaths or self-colored core sheaths.

Core identification, shall be provided for all power and control circuit cables. Identification will be by means of color coded, numbered or lettered rings. All rings shall be positioned in such a way that they are easily readable.

## 8.0 CABLE TERMINATIONS

All cable terminations shall be compression type cable glands. Glands shall be manufactured in brass and shall be fitted with sealing washers as appropriate to installation conditions.

The correct size of lug and crimping tool shall be used to ensure good conducting properties and mechanical strength.

All glands installed externally on all hazardous area electrical equipment shall have suitable **EExd**, **EExde**, **Exe** or **Exd** certification, depend upon the contractual requirements. The installation requirements of the respective protection class and certificates shall be satisfied.

Where cables are terminated in increased safety (Exe) enclosures, suitable cable gland sealing components shall be provided as necessary to maintain a degree of protection IP54 of the terminal enclosure.

All cable panels shall be fitted with close fitting PVC covers. Voltage relief of terminations for high voltage cables shall be carried out in accordance with the cable manufacturer's recommendations. Suitable termination kits will be used for such installation.

Unless it is not possible due to equipment arrangement or space limitations, cable entry shall be under the apparatus. Where any entry has to be horizontal, a drip loops to be formed in the cable, immediately before the gland.

All unused cable entries in panel, shall be sealed by the use of the appropriate type of screwed plug. For hazardous area, certified compatible apparatus plugs shall be used.

Cable entry holes in Exd certified equipment shall not be drilled out or altered in any way. Where necessary, Exd certified adaptors shall be used with the approval of the Client.

Where cathodic protection is present and electrical equipment attached to the pipeline/structure is not insulated from the pipeline/structure, care should be take in the cable glanding/termination earthing arrangements so that effectiveness of the cathodic protection system is not impaired.

## 9.0 EARTHING

- The earthing of the installation shall be carried out in accordance with the relevant drawings, codes and standards.
- All non-current carrying metal parts of electrical equipment shall be effectively bonded to the earth network.

- Cable racking and cable trays shall have earth continuity throughout their lengths and shall be connected to the structural steelwork at approximately 20 m. intervals.
- Pipework, equipment and tanks shall be earthed by using earthing bosses supplied with the equipment. Above ground pipework shall be earthed, where pipework enters and exists hazardous areas.
- All cables glanded into clearance holes shall have their metal sheaths or armouring effectively bonded to earth, at both ends.
- Where module built units is added to structural steelwork, it shall be ensured that the module steel is effectively earthed to the structural steelwork. The method of attaching earthing cables to structural steelwork shall be by means of bolted lugs. Structural steel may be drilled to M12 studs.
- After completion, every earthing connection shall be fully covered with anticorrosion paste.
- Spare cores of glanded multicore cables shall be terminated and collectively earthed within the termination enclosure to prevent harmful induced voltages.
- If required, lightning protection shall be installed in accordance with construction drawings.
- Earthing cables shall have green/yellow colored sheaths.
- It shall be verified that the electrical earthing system does not have resistance more than 4 ohm to ground, as measured by the fall of potential method for the equipment and electrical power system and not more than 1 ohm to ground for the instrumentation system ground.
- All below grade work shall not be covered, until a visual inspection by Client is done.

## **10.0 LIGHTING**

- The exact location of luminaries and socket outlets shall be determined by the Contractor to ensure that they are both accessible for maintenance and does not cause obstruction to other services. In case the relevant drawings cannot be applied and major deviations to be done, the selected locations shall be subject to Client's acceptance.
- Welding or drilling of primary steelwork, equipment and tanks for lighting supports and brackets are not permitted, if it is not shown in drawings.
- It shall be ensured that the continuity of the cable armour is maintained where cables loop in and out of luminaries, socket outlets and junction boxes
- A red band shall identify emergency luminaries.
- Lighting and socket outlet distribution boards shall have their circuit identification cards permanently marked to indicate circuit and area distribution references.
- Lighting and low power cables shall run on main cable routes wherever possible.
- After the lighting system installation is completed, the following will be done at night time conditions:
  - Illumination level readings of the plant with the normal lighting system energised,
  - To prove adequacy, energize only the emergency lighting system,
  - Orientation of floodlight fittings shall be adjusted for maximum efficient use.

## **11.0 EQUIPMENT IDENTIFICATION**

All electrical equipment and materials shall be adequately labelled.

Labels shall have following information:

- a) Identification of equipment or material,
- b) Equipment rating,
- c) Safety/warning notices,
- d) Instructional notices.
- e) Labels shall be engraved with black characters on a white background and fixed with stainless steel screws.
- f) Warning labels shall have black characters on a yellow background.

## **12.0 INSPECTION, TESTING AND PRE-COMMISSIONING**

Installation, inspection and testing of electrical equipment shall be in accordance with the approved Inspection and Test Plans and/or manufacturers' recommendations.

Testing and commissioning of the equipment and the materials shall include the following:

- a) **MV Switchgear:** Inspections, insulation resistance, primary and secondary injection tests of current and voltage transformers and protection, relaying, instrumentation, operational/functional tests of closing, tripping alarm and indication systems control will be done. After the testing is satisfactorily completed, protection relays will be adjusted to the settings shown on the protection schedules.

- b) **Batteries & Chargers:** Inspection and testing to be done according to specifications and manufacturer recommendations.
- c) **Grounding system:** Main plant building and ground grids to be tested for maximum ground resistance in accordance with specifications and drawings.
- d) **Medium Voltage power cable:** Insulation, continuity and DC high potential test to be done in accordance with specifications and manufacturer recommendations.
- e) **Low Voltage Switchgear and Motor Control Centers:** Inspections, insulation, functional tests and protection relays settings to be done in accordance with specifications. After the testing is satisfactorily completed, design settings shown on the protection schedules will be applied.
- f) **Medium and Low Voltage Motors:** Inspection, insulation and (DC high potential test for medium voltage motors only) test to be done in accordance with specifications and manufacturer recommendations.
- g) **Transformers:** Inspection, insulation, continuity tests and correctness windings connection to be checked in accordance with specifications and manufacturer recommendations.
- h) **600 Volt wire and cables:** Insulation and continuity test to be done in accordance with specifications and manufacturer recommendations.
- i) **Uninterruptible Power Supplies (UPS):** Tests to be done in accordance with specifications and manufacturer's recommendations.