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TECHNICAL SPECIFICATION

HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

ELECTRICAL INSTALLATION IN CIVIL BUILDING

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0	05/04/2011	First Issue (as Spec 700/6)
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Table of Contents

REFERENCES DOCUMENTS

- Job Spec. DSF-SPC-ELE-004
[General Electrical Works]

- Job Spec. DSF-SPC-ELE-009
[Electrical Switchboards]

- Job Spec. DSF-SPC-ELE-019 [External Lightning Protection]

- Job Spec. DSF-SPC-ELE-020
[Internal Lightning Protection System]

- ELOT HD 384
[Erection of power installations with nominal voltages up to 1000 V]

- ELOT HD 60364
[Low-voltage electrical installations]

Νο Δ6/Β/14826, ΦΕΚ 1122, 17.06.2008 “Μέτρα για τη μείωση της ενεργειακής κατανάλωσης των κτιρίων"

All standards or codes mentioned in this specification are valid in their latest version or by the relative superseded edition.

1. SCOPE

This specification covers the general design, erection and testing criteria for electrical installations in civil buildings and similar premises.

2. GENERAL

This specification shall be read in conjunction with the Job Specification for General Electrical Works **Job Spec. DSF-SPC-ELE-004,** as far as applicable to the scope of work. Particular specifications, e.g. for equipment, listed in the General electrical specification shall also apply.

3. EU LEGISLATION. STANDARDS AND REGULATIONS

Chapter 3 of the Job Spec. No. 700/5 shall apply.

4. ENGINEERING DOCUMENTS

4.1 ENGINEERING DOCUMENTS BY MANUFACTURER/VENDOR

The following documentation shall form part of the electrical engineering work and shall be furnished as a minimum but not be limited to:

- one-line diagrams for D.C. and A.C. power circuits, including metering & protective relaying,
- electrical equipment specifications and material requisitions (MR),
- schematic diagrams (if any),
- canalizations and wiring diagrams, cable schedules, cable layouts,
- load data list and load computation for normal and emergency conditions,
- short circuit calculations, including motor contribution to short circuit,
- relay co-ordination study,
- lighting layouts and wiring diagrams,
- layouts of electrical rooms,
- layouts and wiring diagrams of communications,

- layouts and wiring diagrams of fire alarm system,
- earthing drawings,
- list of bulk material,
- classification of hazardous locations (if any),

4.2 GENERAL REQUIREMENTS FOR ENGINEERING DOCUMENTS

Para 4.2 of the **Job Spec. DSF-SPC-ELE-004**shall apply.

5. BASIC DESIGN DATA

Chapter 5 of the Job Spec. DSF-SPC-ELE-004shall apply.

6. CLASSIFICATION OF ENVIRONMENTS

Chapter 6 of the Job Spec. DSF-SPC-ELE-004shall apply. In addition the following paragraphs shall be considered.

6.1 CLOSED CIVIL ROOMS

Dry closed civil rooms shall include:

- administration offices,
- cafeteria,
- corridors and lobbies,
- filing and mailing rooms, and alike, lavatories.

In this type of rooms the following conditions are to be considered

- temperature : 5- 40°C
- humidity : negligible,
- no presence of wetness, moisture, and dust.

Wet and or moist closed civil rooms shall include:

- laundries,
- kitchen and alike,
- bath and shower bath rooms.

In these types of rooms, the following conditions are to be considered

- temperature : 5 - 40°C,
- humidity : 80- 100%,
- wetting : up to 1,0 (*)

6.2 OPEN PROTECTED CIVIL PREMISES

Open protected civil premises shall include:

- open sided buildings,
- porticoes

In these types of rooms, the same temperature and humidity as outdoor shall be considered.

Exposure to water shall be considered with relation to actual installation conditions.

(*) Wetting due to dew and precipitation expressed in percentage of occurrence.

7. CLASSIFICATION OF HAZARDOUS LOCATIONS

Chapter 7 of the Job Spec. DSF-SPC-ELE-004shall apply. In addition the following shall be considered.

7.1 CLASSIFIED LOCATIONS WITHIN CIVIL BUILDINGS

Laboratories, garages, warehouses, battery rooms, central heating stations and alike shall be classified as hazardous locations in accordance with the **ELOT HD 384.**

8. ENCLOSURES AND TYPE OF MECHANICAL PROTECTION OF MATERIALS, EQUIPMENT AND MACHINERY

Chapter 8 of the Job Spec. DSF-SPC-ELE-004 shall apply. In addition the following paragraphs shall be considered.

8.1 ENCLOSURES FOR USE IN CIVIL ROOMS

Use in dry civil rooms

Enclosures shall be with protection against contacts with live or moving parts and with protection against ingress of foreign bodies.

Mechanical protection degree shall be at least corresponding to IP 4X, where the X represents the degree of protection against water, if any.

Use in wet or moist civil rooms or ambient

Enclosures shall be with protection against entrance of water: mechanical protection degree at least corresponding to IP 44.

9. SELECTION OF MATERIAL. EQUIPMENT AND MACHINERY WITH REGARD TO ENVIRONMENT AND HAZARDOUS LOCATIONS - SELECTION OF TYPE OF INSTALLATION

Chapter 9 of the Job Spec. DSF-SPC-ELE-004 shall apply. In addition the following paragraphs shall be considered.

9.1 CLOSED CIVIL ROOM

Dry closed room

Enclosures shall be with protection degree not less than IP 4X.

Wet and or moist rooms, open protected civil premises, laboratories, garages, warehouse, central heating stations and alike.

Enclosures shall be with protection degree not less than IP 44, unless a higher degree of protection is required by area classification.

9.2 OPEN PROTECTION CIVIL AMBIENT

Enclosures shall be with protection degree not less than IP44.

Exceptions may be considered for ceiling mounted luminaries, provided the adopted degree of protection is suitable for the particular application and Owner's approval is obtained.

9.3 TYPE OF INSTALLATION

The installation methods to be considered shall be

a) with canalization and relevant fittings embedded in the masonry wall, floor or ceiling;

b) with canalization clipped to wall or ceiling and relevant fittings projecting mounted: cables in surface PVC light gauge conduit or in closed PVC trucking;

c1) cables in plastic PVC conduits with fire non-propagating characteristics and assuring a degree of protection not less than IP 40;

c2) armored cables. (Flame retardant type).

For c1) and c2) junction boxes shall have mechanical protection degree not less than IP 44, unless a higher protection degree is required by the classification of the location.

Dry closed civil rooms **(para 6.1)** Canalizations shall be type a). Wet and/or civil rooms and alike **(para 6.1, 6.2)**

Canalizations shall be type b).

Classified locations (see **para 7.1**) Canalizations shall be type c1) or c2), unless otherwise required by the safety's sake consideration.

10. CLASSIFICATION OF ELECTRICAL USERS IN RELATION TO THE OPERATIVE CONDITIONS

Definitions given in **chapter 10 of Job Spec. DSF-SPC-ELE-004**shall apply.

Unless otherwise specified, all electrical users of civil buildings shall be classified as "normal loads", with exception of the following "priority loads".

- safety lighting (see **para 12.7**)
- telecommunication systems.
- electronic data processing systems.

11. DISTRIBUTION SYSTEM DESIGN

11.1 POWER SUPPLY

The power supply to civil buildings shall be single radial via step down transformer, with secondary winding 400- 230 V, three phase, four wire, with direct earthed neutral. The power supply may be from plant substation located near the building or from building sub-station,

depending on economics.

Auxiliary power supplies for priority loads (D.C. stationary batteries and relevant equipment) shall be provided as required.

11.2 BUILDING SUBSTATION

The building substation snail include:

- step-down transformer, directly connected to the incoming medium voltage cable,
- main distribution switchboard, power center type, or power-motor control center type,
- power sub-distribution switchboards,
- lighting distribution switchboards.

Requirements set for in the **Job Spec. DSF-SPC-ELE-004** for substation room, substation layout, and for substation equipment and apparatus shall apply.

Particular equipment specifications shall also apply.

11.3 SUBSTATION LAY-OUT

Generally, the substation shall be installed at the ground floor of the building, at a height of not less than 500 mm above ground level.

If the length of power distribution cables from substation to secondary switchboards exceeds 150 m, the installation of more than one substation shall be considered from an economical and installation point of view.

11.4 SWITCHBOARDS

For main distribution and sub-distribution switchboards the Job Spec. DSF-SPC-ELE-009 shall apply.

Standardized boards and cabinets shall be adopted.

12. LIGHTING

The principal purpose of the lighting installation shall be to provide:

a) Adequate visibility so that task can be performed with required standards of speed and accuracy;

b) Lighting levels that will permit one to work with minimum effort that will result in maximum safety and absence of visual discomfort and visibility.

Chapter 17 of the Job Spec. DSF-SPC-ELE-004 shall apply.

In addition, the following paragraphs shall be considered. Detail information about lighting shall be shown on architectural drawings.

12.1 ILLUMINATION LEVELS

The average horizontal illumination level on the working plane (at 1 m above grade), when the illuminating source is at its lowest output and when the luminaries is at its dirtiest condition, shall comply at least with the following:

Area Designation	Illumination Level in Lux
Drawing office	600
Administration and technical	300-500
offices	400-1000
Laboratories and alike	100200-
Cafeteria and kitchen	300
Workshops	

Generally, the lowest illumination value at any point on the task plane shall not be less than one-third of the average value; a higher uniformity degree shall be achieved in drawing offices and in administration and technical offices.

Lighting intensity calculation shall consider the causes of light loss:

- lamp output depreciation,
- aging of luminary finish and material,
- luminary dirt depreciation,
- surface reflectance,
- accumulation of dirt on room surfaces.

The maintenance factor (product of lamp luminous flux depreciation factor multiplied by luminary dirt depreciation factor) to be applied shall not be higher than 70% for wet or moist rooms and shall not be higher than 80% in dry clean rooms.

It shall be responsibility of Contractor to determine actual reduction factors, when the said factors should not be correct for the particular application.

The following table shall apply:

Operation	Interval	Remarks
Cleaning of luminary Relamping 50%	6 months {24 months {24 months	In wet, most, dust rooms {In dry, clean rooms {Fluorescent type lamps

12.2 DISTRIBUTION OF THE LIGHT FLUX

Proper distribution of the light flux from luminaries in one of the essential factors in efficient and uniform lighting.

From technical and economical point of view (installation cost and energy cost) the installation's parameters shall be selected in order to achieve a comfortable balance, particularly in the offices, or similar locations. It is desirable and practical to limit luminance ratio between areas of appreciable size from normal view point as follows:

- 1 to 1/3 between task and surroundings,
- 1 to 1/10 between task and more remote darker surfaces,
- 1 to 10 between task and more remote lighter surfaces,
- 2 to 1 between task (or fenestration) and surfaces adjacent to them,
- 40 to 1 anywhere within the normal field of view.

These ratios are recommended, as maximum reductions are generally beneficial.

12.3 TYPE OF LUMINARIES

Interior lighting systems may be included in one of the following:

a) indirect;

b) semi-indirect;

c) general diffuse and direct-indirect;

d) semi-direct;

e) direct and ceiling area lighting.

These classifications, made by CIE, (*) are in accordance with the percentage of total luminary output emitted above and below horizontal plane passing adjacent or through the luminary.

(*) CIE = Commission International de l' Eclairage

The architectural criteria, concerning the physical organization of human activities and the problem of providing pleasant and optimization of environments, shall be considered in selecting the type of light diffusion.

12.4 TYPE OF LAMPS

Generally incandescent filament-lamps and fluorescent type lamps shall be adopted in interior lighting; other types of lamps, such as fluorescent high-pressure mercury lamps, high pressure sodium lamps and other specialized lamps, may be considered for matching better some particular working conditions and for the high efficiency required in interior big spaces.

Due to the best efficacy (lumen/watt) fluorescent tube lamps will be largely preferred against the incandescent lamps, unless otherwise specified further fluorescent tube lamps of preheating starting type are recommended for interior lighting, since no big temperature variations are expected.

Generally, color rendering of light source shall be close to the daylight color, as far as possible and in some cases the color selection shall be compatible with the color characteristic of the particular task.

The type of lamps shall be in accordance to No Δ6/Β/14826, ΦΕΚ 1122, 17.06.2008.

12.5 LUMINARIES INSTALLATION

The luminary shall be provided with all fittings needed to locate and to easily fasten it; the following mounting system may be considered:

a) suspended: hung from the ceiling by supports;

b) flush or recessed: mounted above the ceiling, or behind a wall or other surface, with the opening of the luminary level with the surface;

c) surface mounted on ceiling or on wall;

d) bracket mounted on wall.

The light source can be shielded above the luminous ceiling (continuous surface of transmitting material) or louvered ceiling (multicell louvers) and shielded with other systems to achieve some particular architectural effects.

12.6 LIGHTING DISTRIBUTION CIRCUITS

Power sources and distribution circuits

The power requested to supply lighting circuits of various locations shall be drawn from main lighting distribution switch-boards, to be installed in the building substation or to the nearest electrical substation.

Secondary lighting distribution panels shall be provided to supply separately circuits belonging to the same floor or circuits grouping rooms based on their services or vicinity.

Each circuit shall not be loaded over 10 A and shall be single phase and balanced on the three-phase supply system.

Sizing and installation of distribution circuits

General requirements for conductor selection and sizing shall comply with chapter 22 of **Job specification DSF-SPC-ELE-004.**

Voltage drop shall not exceed the following figures:

- main circuits (from main lighting distribution board) 1%,
- sub-distribution circuit (from secondary panels luminaire) 3%

In any case the total voltage drop shall not exceed 4% and joule losses 6%.

12.7 SAFETY LIGHTING

Safety lighting system shall be provided to supply illumination essential to safety of life in the event of failure of the normal supply. Generally, safety lighting shall be connected to independent, sure power source, such as a stationary lead acid battery, emergency generating set or any other power source which is affected by general shortage occurred on main power supply system.

Unless otherwise specified, the luminaries belonging to safety lighting will have an individual built-in inverter-charger and battery system, suitable to one-hour autonomy.

Luminaries shall be located at strategic points such as:

- rooms in which more than ten persons can permanently work,

- corridors (at distances not exceeding 50 m),
- exit doors,
- staircase-landing.

Safety lighting shall be switched on automatically at power failure; supply circuits shall be common with normal lighting and energized by the same photocell switches.

12.8 CONTROL OF LIGHTING CIRCUITS

Normal and safety lighting circuits relevant to corridors, staircases, lobbies, porticoes and alike shall be controlled by photocell; manual switching-on shall be possible by overriding the automatic control.

Lighting circuits in all other rooms shall be switched by means of manual switches located near open side of ingress door.

13. POWER AND CONVENIENCE SOCKET OUTLETS

Chapter 18 of **Job Spec. DSF-SPC-ELE-004** shall apply. In addition, the following paragraphs shall be considered.

13.1 TYPES OF SOCKETS

The welding, power and lighting socket shall conform to the requirements of the **Job Spec. DSF-SPC-ELE-004.**

13.2 LOCATION OF OUTLETS

Welding sockets shall be located at least at the following points:

- staircase,
- lift shaft,
- kitchen,
- laundries,
- central heating station
- at any point specified in architectural drawings.

Power sockets (three-phase or single-phase) shall be located in accordance with architectural drawings; at least one single-phase socket shall be provided in each room wall (or every 5 meters).

Lighting sockets shall be provided in offices and similar rooms only, unless otherwise specified on architectural drawings.

Safety extra voltage socket shall generally not be provided in civil buildings, unless otherwise specified.

13.3 SOCKET-OUTLETS

13.3.1 SOCKET - OUTLETS

Socket-outlets shall be rated for 250V, 16A, 1 phase 2 wires and ground.

13.3.2 SAFETY EXTRA LOW VOLTAGE SOCKET-OUTLETS

Chapter 18 para 18.2.2 of **Job Spec. DSF-SPC-ELE-004**shall apply.

13.4 DISTRIBUTION CIRCUITS

Welding socket-outlet circuits shall be connected to the main distribution switchboards. Power socket-outlet circuits shall be connected to sub-distribution switchboards.

Socket-outlet (single-phase) circuits shall be connected to lighting sub-distribution panels.

Cables shall be sized in accordance with paragraph 16; voltage drop shall not exceed 5%.

Sockets shall be arranged in-groups of no more than eight outlets for each circuit. The size of the supply feeder shall be based on a 0,4-demand factor.

14. CANALIZATION

Chapter 19 of the **Job Spec. DSF-SPC-ELE-004**shall apply. In addition, the following paragraphs shall be considered.

14.1 GENERAL

Canalization shall be effected with metallic and/or nonmetallic PVC tubing, conduit, duct, trucking or channels, surface mounted or embedded or formed in a building structures together with protection devices, distribution, control and outlet boxes, and shall be selected in order to minimize the dangers arising from mechanical damage. The floor dorsal circuits consisting of system branches between sub-distribution board of floor and the last distribution box can be

installed at ceiling, at wall or at floor as indicated on the architectural drawings or as per Contractor's decision: However, circuits shall be installed in a manner that junction and other boxes are located in free, easily and permanently accessible location, in preference along corridors or aisle.

In case of ceiling dorsal the boxes shall be applied to wall or beam elements, with vertical disposition. Direct ceiling mounting may be admitted only for lighting or auxiliary system boxes.

In case of floor dorsal the boxes shall be readily accessible without interference with normal passage and normal work; the floor rough thickness, floor finishing and the projection on plane of prefabricated walls shall be considered.

The relevant boxes given on to single utilization points, shall be arranged in a manner to be allowed the suitable apparatus for socket outlet or for connection of the different users (offices machines, desk lamps, telephones, electric cookers, etc.) with respect, to the particular requirements of the minimum distances indicated in **para 15.**

For all canalization that shall be embedded into the structures particularly attention is drawing for under floor canalization, to the adequate space provision for the bends, and thickness for carry-out of the crossing at difference levels, specially near the distribution panel or cabinet and the connection to feeder-line and near other technological services.

All material and apparatus employed for auxiliary and electrical systems, cover by this specification shall be ensured that they possess adequate resistance to any mechanical shock, corrosive actions, thermal and damp actions.

All materials and apparatus shall conform to requirements of the codes indicated in para 3 of **Job Spec. DSF-SPC-ELE-004.**

14.2 CONDUIT

Chapter 20 of the **Job Spec. DSF-SPC-ELE-004** shall apply. In addition, the following paragraphs shall be considered.

Rigid metallic conduit

Where applicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action.

In wet locations supports, bolts, straps, screws, etc., shall be of corrosion resistant material or protected by corrosion resistant materials.

Where a conduit enter a box or other fitting, a bushing or adapter shall protect the wire from abrasion, unless the design of the box or fitting in such as to afford equivalent protection.

Rigid non-metallic conduit (PVC) and non-metallic fittings

Conduit shall conform to the requirements of the: **IEC Recommendation – ELOT EN Standard**.

Conduit and fittings of suitable nonmetallic material which is resistant to moisture shall also be flame retardant and mechanically strong.

All point between lengths of conduit, and between conduit and couplings, fittings and boxes shall be supported and fixed at distances not exceeding 1 m.

Where a conduit enters a box or other fitting, a bushing or adapter shall be provided to protect the wire from abrasion, unless the design of the box or fitting is such as to provide equivalent protection.

Conduit and fittings shall be installed as follows:

a) Direct earth burial not less than 450 mm below surface or, if less than 450 mm, encased in concrete curb with a minimum cover not less than 50 mm; Conduit shall also be suitable to withstand continued loading which is likely to be encountered after installation.

b) Surface mounted on walls or ceiling.

c) Embedded in plaster, or masonry, or concrete wall, or floor.

Installation of conduit system (rigid metallic and nonmetallic type)

In wet or moist locations, the entire conduit system, including boxes and fittings, shall be so installed and equipped as to prevent water from entering the conduit. All supports, bolts, straps, screws etc., shall be of corrosion resistant materials or protected by corrosion resistant materials.

The entire system shall be mounted so that there is at least 10 to 15 mm air space between it and the wall or supporting surface.

In locations subject to severe corrosive influence and where subject to chemicals, proper materials shall be used.

Under floor trucking, ducts or conduits in offices occupancies

This canalization system shall be used only in open space offices and in removable wall offices.

Under floor trucking or ducts or conduits be installed beneath the surface of concrete or other flooring material.

Ferrous or nonferrous metallic under floor trucking or ducts and fittings shall not be installed in concrete, or in areas subject to severe corrosive influences, unless corrosion protection for the condition is provided.

Flat top trucking or ducts shall be laid flush with the floor surface. Flat top covering trucking not over 100 mm in width shall have not less than 20 mm of concrete cover and trucking not over 200 mm in width less than 30 mm.

Under floor trucking, ducts or conduits shall be laid so that relevant junction boxes are aligned.

Canalization material shall be firmly held in place to prevent disturbing alignment during construction.

14.3 BUS-DUCTS OR / AND BUS-BAR TRUCKING

Bus-ducts and/or bus-bar trucking systems are considered as complete factory-built assemblies, which should comply with the relevant applicable standards and with installation instructions, by manufacturer.

Bus-ducts and/or bus-bar trucking may be used only in dry ambient.

15. WIRING BOXES AND FITTINGS

Chapters 19, 20 and 21 of the **Job Spec. DSF-SPC-ELE-004** shall apply. In addition, the following paragraphs shall be considered.

15.1 BOXES AND FITTINGS EMBEDDED IN MASONRY, OR CONCRETE WALL OR CEILING

15.1.1 ALL CIRCUITS

Requirements for boxes shall also apply to all other fittings with removable covers.

Boxes and fittings embedded in noncombustible material shall be so installed that the front edge of the box and fitting will not be back of the finished surface more than 2 mm and shall be securely and firmly held in place during construction.

Nonmetallic boxes shall be used only with nonmetallic conduit, which shall be secured to boxes and fittings according to manufacturer's instructions. Conduit shall extend from the last support and shall be run into the box.

Unused openings in boxes and fittings shall be effectively closed with plug or plate.

Boxes shall be provided with a cover, unless a fixture canopy is used. Metallic or non-metallic covers and plates may be used with non-metallic boxes and fittings. Metallic covers or plates shall be conveniently earthed.

Unless otherwise shown on architectural drawings, wall boxes housing devices, such as switches or sockets, shall be located at 1200 mm high (from finished floor level to horizontal centerline of the device). Lighting switches shall be installed on corridors on the opening side of the doors.

Unless otherwise shown on architectural drawings, socket outlets boxes located on the baseboard or on floor columns shall have the bottom generatrix of the plug at a distance of 40 mm minimum from finished floor level.

Unless otherwise shown on architectural drawings, in a room containing a fixed bath and/or shower bath, every switch or other means of control or adjustment, shall be so situated as to be out of arm's reach of a person in contact with a bath (refer to figure 18.1.1). No provision shall be made for use of portable appliances.

15.1.2 TELEPHONE CIRCUITS

Unless otherwise shown on architectural drawing telephone wall boxes shall be installed with the lower edge not higher than 250 mm from the finished floor level.

Rosettes for inter room and special apparatus shall be installed with the lower edge not higher than 250 mm from the finished floor.

15.2 UNDER FLOOR EMBEDDED BOXES AND FITTINGS

Boxes and fittings shall be metallic.

Junction boxes and inserts shall be leveled to floor finished grade and sealed against entrance of water. Inserts set in or on fibber or plastic trucking or ducts before the floor is laid shall be mechanically secured; if set after the floor is laid, they shall be screwed into the trucking or ducts.

Continuity of earthing of junction boxes and inserts used with metallic trucking, ducts or conduit shall be assured by construction or by suitable junctions.

15.3 SURFACE MOUNTED BOXES AND FITTINGS

Boxes and fittings shall b securely and rigidly fastened to the surface.

16. CABLES AND CORES

16.1 CABLES AND CORES FOR POWER, LIGHTING AND TELESIGNALLING SYSTEMS

Chapter 22 of the **Job Spec. DSF-SPC-ELE-004** shall apply. In addition, the following paragraphs shall be considered.

Generally single cores (*) shall be used for installation in trucking, ducts, or conduits. Single cores may be used, provided that suitable provisions prevent damaging of insulation during installation. Cables shall be used for installation on trays.

Insulation degree of cores shall be not less than 3 kV for all circuits less than 1 kV, except for extra safety low voltage circuits.

Cables and cores for safety lighting, lifts, controls and alarms circuits, shall be made with fire-resistant sheath and/or insulation.

Any flexible cable or flexible cord operating at a voltage exceeding 250 V between lines or to earth shall be protected against mechanical damage. Any metal braid or flexible metallic sheaths used for this purpose shall not form the sole protective conductor.

Cable for extra low-voltage circuits, such as fire alarm circuits, watch control circuits, electric clock circuits etc. shall be classified according to CEN standards as 0 (zero) category systems with maximum 50 V A.C. or max. 75 V D.C. Insulation degree shall not be less than 1 kV.

16.2 CABLES FOR INTERNAL AND/OR PRIVATE TELEPHONE AND INTERCOM SYSTEMS

Soft-annealed copper conductors shall have minimum diameter of 0,5 mm and thermostatic insulation with a test-voltage not less than 1 kV.

Telephone cables for internal network connected to Public Telephone system, shall

comply with local regulation and Public Telephone Company recommendations.

16.3 TERMINATION AND JOINTS

At a termination the insulation shall be removed no further than is necessary for compliance with the manufacturer's instructions.

Where joints in cables are required, they shall be mechanically and electrically sound, and they shall be made by means of mechanical clamps, which shall securely retain all the wires of the conductor.

The resistance of a jointed conductor shall not exceed that of an unjointed conductor.

(*) Cable (twin or multicore): Combination of two or more electrically separate cores bound together mechanically, generally under one or more protective covers (sheath, braid, metal sheath, etc.)

Single core (sheathed) cable: Core covered with a sheath.

Core: Combination of the conductor and its insulation.

Conductor: Metal part which carried the current. It is composed either of solid wire or of several wires twisted together.

Insulation: Layer of insulating material surrounding the conductor. (Definitions according to CENELEC in the Harmonization Documents).

17. CABLE INSTALLATION

Chapter 23 of the **Job Spec. DSF-SPC-ELE-004** shall apply. In addition, the following paragraphs shall be considered.

17.1 ADDITIONAL REQUIREMENTS FOR CIVIL BUILDING INSTALLATION

Wiring material shall be so selected and installed as to prevent, during and after laying damages to cables due to sharp edges or abrasive surfaces.

Pulling in conduits or ducts of wires and cables shall be by considering manufacturer's recommendations.

No petroleum and grease shall be used for lubricating cables with neoprene or equivalent jackets.

Cable of A.C. system installed in metal conduit shall be so bunched that cores of all phases and neutral (if any) are drawn in the same conduit.

Cable for extra low voltage circuits or for telecommunication circuits shall be separated or segregated from other cables in order to minimize dangers arising from the latter in case of fault.

Where a common trucking or raceway is used to contain cables insulated for the two categories of above mentioned circuits, these shall be effectively segregated, by means of rigidly fixed screens or partitions, or separate by spacing the cables of the two categories by more than 100 mm, of by using for circuits other than extra low voltage or telecommunication, cables provided with a metallic covering, surrounding all the live conductors of the cable, and having an equivalent cross sectional area not lower than that prescribed for the protective conductor of the circuit.

Cables and/or wires shall have single length between their terminal connections, as far as possible.

In circuits with rated voltage not higher than 500 V, splices (if any) shall be made with compression type connectors and with restoring of complete insulation.

Splices for wires and cables inside conduits, ducts and trucking are not allowed.

Underground splices shall have cast-iron or die-cast resin protective houses with entrance glands.

Armor clamp shall be provided for armored cables at the entry to metal boxes. Armoring shall be earthed at least at one side.

Splices on cable trays and similar cable supporting systems shall be placed in

accessible locations along the cableway and shall be housed in enclosures having the required mechanical protection degree.

Mechanical tightening type terminals shall be used. Terminals shall have steatite body. For flexible conductor's suitable compression type lugs or pins shall be used.

Cables shall not be brought in to lighting fixtures, accessories or appliances where, under normal working conditions, owing to the transfer of heat, the cores are likely to exceed the maximum permitted temperature.

18. PROTECTION EARTHING AGAINST SHOCK FOR INDIRECT CONTACTS. LIGHTNING AND ELECTROSTATIC ELECTRICITY

Chapter 24 of the **Job Spec. DSF-SPC-ELE-004**shall apply. In addition, the following paragraphs shall be considered.

18.1 USE OF DIFFERENTIAL CIRCUIT BREAKERS

All lighting socket circuits installed in wet and/or moist ambience shall be provided with ground fault interrupter (G.F.I).

18.2 PROTECTIVE CONDUCTORS

In general, protective conductors shall be run in the same wiring system as the live conductors (phase and neutral, if any).

Where more than one circuit is laid in the same conduit, trucking or duct, a common protective conductor may be used, provided it complies with the individual requirements of each of the circuits involved.

In the case that the protective conductor does not form part of the supply wiring, it shall be properly protected against chemical and mechanical damages as per **para 14.2.**

Minimum cross-sectional area of protective conductors shall be as per specified in the **ELOT HD 60364.**

Use of extraneous conductive parts as protective conductors. Extraneous conductive parts such as metallic structures, machine enclosures, frames of hoist may be used as a protective conductors, if they satisfy the three following requirements:

a) Their electrical continuity shall be assured, either by construction or by suitable connections, in such a way as to be protected against mechanical, chemical or electrochemical deterioration;

b) Their conductance shall be at least equal to that required by CEN standards.

c) Removal of such conductive part can be done only after removal or dismantling of the electrical equipment connected to them.

Metal raceways and metal enclosed busbar trucking systems (bus ways) may be used as protective conductors, if they simultaneously satisfy the following requirements:

a) Their electrical continuity shall be achieved by construction or by means of suitable connections in such a manner as to ensure protection against mechanical, chemical or electrochemical deterioration;

b) Their conductance shall be at least equal to that required by CEI standards.

Cable armors may be used as protective conductors if their conductance is at least equal to that required by IEC and if the use as protective conductor is foreseen by cable manufacturer.

Rigid, heavy duty threaded metallic conduits may be used as protective conductors, if their conductance is as least equal to that required by IEC report as per above sub clause 18.2.1.

Electrical continuity shall be assured at connection with enclosures, fittings etc., by removing of any nonconductive paint, enamel, or similar coating at threads, contact joints and contact surfaces or by means of fitting so designed as to make such removal unnecessary.

18.3 BONDING

In each building the following conductive parts (extraneous conductive parts) shall be interconnected by main bonding conductors:

- main water pipes,
- main gas pipes,
- central heating risers,
- building metal structures (metallic frame work or concrete reinforcing steels),
- bath and shower-bath rooms, kitchens, metallic sinks and ail exposed metal pipes.

The main bonding conductors shall have a cross sectional area not less than or earthing leads, with a minimum of 25 mm^2 copper.

The main bonding conductors shall be connected to earthing bus bars.

All extraneous conductive parts which are accessible to contact by a person (refer to figure 18.1.1), shall be bonded.

Cross sectional area of bonding conductors shall be not less than 16 mm^2 copper.

The bonding conductors shall be directly connected to earthing bus-bars or to main bonding conductors.

Supplementary bonding conductors shall be provided when the safety conditions specified for touch voltages **(Job Spec. DSF-SPC-ELE-004,** chapter 24) cannot be full filled.

Supplementary bonding must include all simultaneously accessible parts, whether they are exposed conductive parts of fixed apparatus or extraneous conductive parts.

Cross sectional area of supplementary bonding conductors shall be at least one half that of the protective conductor of the appliance having the highest rating included in the supplementary bounding, with a minimum of 25 mm copper.

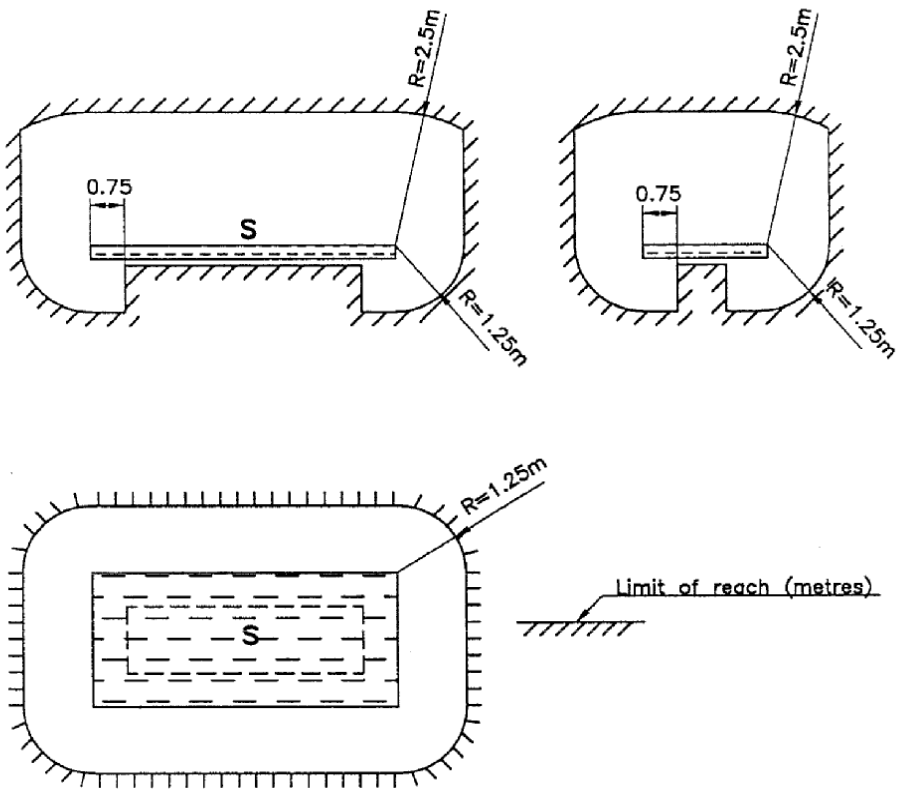
In hazardous locations, regardless of the touch voltage in case of faults the electrical continuity and the equality of potentials achieve by means of supplementary bonding against of dangerous arcs, or sparks or surface temperatures.

Bonding for lightning protection purposes. Metallic parts inside and outside buildings which can be jeopardized by side flashes shall be bonded to down conductors or to earthing electrodes.

Earthing leads and earthing bus-bars foreseen for other protection purposes shall serve also for lightning protection.

Note: For ensure electrical continuity of metallic conduit raceways shall be used grease Croue-Hinds's type "STL" or equal.

FIGURE 18.1.1



S=surface expected to be occupied by persons or walking surface

NOTE: Limits of reach: a zone extending from the standing surface of locations to be occupied by persons to the limits which a person can reach with his hand. In places where bulky or long conducting objects are normally handled, the distances given in the figure 1 shall be increased accordingly.

18.4 BUILDING METAL STRUCTURES AND CONCRETE REINFORCED STEEL

To improve equality of potential through- out the entire building, the metal structures and the steel used in reinforced concrete of columns beams and slabs shall be bonded to the earthing system.

At least at any floor and in correspondence with main pillars of beams the metallic structure or reinforcing steel be made accessible by means of a steel conductor welded or bolted to the steel work.

These terminal points shall be bonded to an earthing bus-bar or to a main bonding conductor.

Bonding and supplementary bonding conductors of extraneous conductive parts may be connected to terminal points of the building metal structure.

18.5 CONNECTIONS TO EQUIPMENT AND TO FITTINGS

Electrical continuity between earthing conductors, protective conductors and bonding conductors, earthing bus bars and equipment or fittings shall be by means of lugs, pressure connectors, clamps or other suitable means.

Continuity between a metallic box (e.g. outlet box) and their metallic support shall be by means of a jumper between the earthed support and the box.

Jumper shall not be required if the box is surface mounted, direct metal to metal contact between the box and the earthed support, or if fixing screws are designed to establish metallic continuity.

Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact joints and contact surfaces or be connected by means of fittings so designed as to make such removal unnecessary.

Jumpers shall be of copper or other corrosion resistant material.

18.6 STAR POINT EARTHING OF BUILDING DISTRIBUTION TRANSFORMERS

The star point of the distribution transformers installed in the building shall be directly earthed by connecting the star point to the substation earthing bus bar. The earth wire coming from MV substation shall be connected to the same bus-bars.

Earthing of transformers star point may be also in the main distribution switchboard.

18.7 PROTECTION AGAINST STATIC ELECTRICITY

In hazardous location protection against static electricity shall be provided as indicated in para 25.3 of **Job Spec. DSF-SPC-ELE-004.**

19. EARTHING

19.1 EARTHING ELECTRODE

Earth electrode of buildings shall consist of foundation earth electrodes, i.e. concrete steel reinforcing steel of foundations and of any structural part in contact with the ground.

To this scope concrete steel reinforcing bars shall be connected together and made accessible by means of an iron bar welded or bolted to the steel work.

In case of a building steel frame, the connection point may be at foundation anchoring bolts.

No earthing electrode wires and roads shall be installed underneath the building.

Connection points of foundation earth electrode shall be connected to earthing bus bars, suitably located throughout the building (mainly at main pillars or beams).

Bus bars shall be bonded together via main bonding conductors (sub-clause 18.3.1).

Ring electrodes installed around the building for the purpose of lightning protection (see **Job Spec. DSF-SPC-ELE-019** and **Job Spec. DSF-SPC-ELE-020)** shall be connected to the above said earthing bus bars.

Earthing conductors (or earth electrode wires if bare) for connection of the building electrode to the general plant earth electrode shall be terminated at earthing bus bars; to the same bus bars shall terminate earthing wires laid along supply cables trenches.

19.2 EARTHING FOR PROTECTION AGAINST LIGHTNING

Refer to **Job Spec. DSF-SPC-ELE-019**and **Job Spec. DSF-SPC-ELE-020.**

20. ELECTRICAL FIELD TEST

Chapter 29 of the **Job Spec. DSF-SPC-ELE-004** shall apply. In addition, the following paragraphs shall apply.

20.1 GENERAL CHECK AND ELECTRICAL TEST PROCEDURES

Before the electrical facilities are placed in operation, sub-contractor (*) shall make suitable tests to establish that all equipment, devices, and canalizations have been correctly installed, are in satisfactory working condition, and will operate as intended.

Tests, which are necessary to retain the manufacturer's guarantee, shall be carried out in accordance with instruction from the manufacturer of electrical equipment.

In the absence of specific manufacturer's instructions, electrical field test shall be carried out as hereinafter specified for the various material and equipment.

The results of all test described in this specification shall be recorded on forms provided by the subcontractor.

Test results shall be submitted to the Owner's engineer before circuits or equipment are energized.

Subcontractor by carrying out tests shall take every precaution to prevent accidents to personnel, equipment and property.

(*) Sub-contractor means Erection Company.

20.2 POWER TRANSFORMERS TESTS

Transformer nameplate data and item reference shall be checked to ensure correspondence with engineering documents.

A visual check shall be made for housing damage, terminal bushing or insulator damage and, in case of liquid filled, for leaks.

For liquid units, a check of liquid level shall be made.

Insulation test shall be performed by measuring insulation resistance between the winding and the housing, and between the two windings.

The transformer tank and all fittings shall be inspected for adequate sealing to prevent leakage of insulating liquid before the transformer is energized.

Joints, connections and gaskets snail be checked with chalk dust to detect leaks.

Completely assembled transformers shipped complete with insulating liquid, successfully passing the preliminary dielectric strength test without filtering, may be put into service after inspection, if the cold coil insulation resistance between windings and between windings and earth exceed 6 megaohm. In the event the insulation resistance value falls below 6 megaohm, the transformer coils must be dried.

Coils of transformers failing the preliminary dielectric strength test (before filtering) must undergo an out-of- liquid short-time "megger" test for insulating resistance to earth and to other windings at temperature between 60 to 70°C.

In the event drying results necessary, the transformer coils shall be heated to a

temperature consistent with insulation class, by short circuiting either windings (MV or LV) and impressing percent of rated voltage (at normal frequency) across the other.

The following precautions should be taken before placing the transformer in service:

a) check liquid level;

b) check tap changers to be sure they are in operating condition;

c) check operation of Buchholz relay and of temperature alarm;

d) check operation of cooling fan relay and circuit (if provided);

e) check earthing of transformer.

The readings should compare favorably with values measured in the manufacturer's workshop.

Any test required in relevant specification and/or MR prior to start up, shall be completed.

20.3 TEST OF SWITCHGEARS, SUB-DISTRIBUTION SWITCHBOARDS AND CONTROL PANELS

A visual check shall be made for possible damage to the enclosure and devices mounted on the enclosures.

A visual check shall be made, inside the enclosure, for possible damage to insulators, barriers, bus bars, measuring transformers and devices etc.

A close inspection shall be made of all connection of bus bars, current devices, voltage devices, fuse clips and fuses.

All plug-in devices shall be checked for proper alignment condition of disconnecting devices and easy plug- in/plug-out operation.

Circuit breakers, switches, motor starters, contactors and alike shall be checked for proper rating and tagging in accordance with engineering documents.

Before energizing the switchgear, circuit breakers and motor starters tested as follows, with breakers or contractors in test position, if provided:

a) close and trip the breaker or contractor with its control switch;

b) manually trip the breaker or contractor;

c) close and trip the breaker or contractor from any remote control position;

d) check of the relevant mechanical and electrical position of local and remote indicators, if any.

Check of relays, fuses and any other adjustable device for proper rating and tagging in respect to

the engineering documents.

Check of setting and calibration in respect to the relay co-ordination study.

Check of operation of protective and auxiliary relays (with power circuits deenergized), of automatic devices, alarms and monitoring devices, with installation not running and simulating opening and closing of contacts.

Where the switchgear is arranged for a secondary selective or dual supply system with automatic transfer scheme, the transfer circuit shall be tested by simulated fault and under voltage conditions.

Check of indicating recording and metering apparatus for polarities, ratios, and removal of any secondary short-circuiting devices. Check operation.

Control devices and alarms shall be checked for correct type and proper operation. A continuity and sequence of operation check shall be made on control wiring.

Insulation resistance check shall be made after the switchgear is placed in final position, but before the outside electrical connections are made.

Insulation value shall give favorable results comparing with values measured in the manufacturer's workshop.

External wiring shall be checked for proper tagging.

Any test required in relevant specification and/or M/R prior to start up shall be completed.

20.4 TESTS OF ROTATING MACHINES

Nameplate data and item reference shall be checked to ensure correspondence with engineering documents.

A visual check shall be made for cracks in housing, chipped housing, damaged bearing, seal rings and junction boxes, and for bearing lubrication.

Prior to energizing the machine, all foreign objects between the rotor and the stator field coils shall be removed.

Brushes must move freely in their holders, making a firm and even contact with collector rings.

All bearings must be properly filled with oil or grease.

Machine shafts (rotors) shall be checked for alignment and rotation before being coupled to other machinery.

Three phase machines with only three leads brought out shall have the insulation resistance measured with all three leads connected together.

Three phase machines with all six leads brought out shall have the insulation resistance of each phase measured separately with the other two phases earthed. The observed resistance of each phase shall be divided by two to obtain a value, which after correction for temperature, can be compared with the recommended minimum value of insulation resistance.

During the machine-test-run inspection shall be done for smoke, unusual noises, vibration and over-heating.

Operating conditions shall be checked and corrective action shall be taken when the total temperature (ambient-plus-rise) exceeds the normal values.

20.5 CHECKS OF INSTALLATION GENERAL MATTERS

Checks of the correspondence of the electrical installation to the applied standards and to the engineering documents, checks of correspondence of nameplate and of item reference.

Check of the exact location and orientation of lighting fixtures, outlets, switches, and of equipment in general, in connection with the engineering drawings.

Check of the best orientation of the covers of the junction boxes, in accordance with the possibility of their inspection.

Check of the good execution of the splices of the electrical wires and of the terminal connections to the equipment.

Check of the greasing of all the covers of the explosion-proof boxes, of the breathers and drains fittings.

Check of the appropriate execution of all sealing fittings.

Check of connections of earth electrode, earth conductors and earth bus bars.

Check of connections of protective conductors and bonding conductors and of the connection of the transformer star point to the earthing bus bar.

Check of connections to earth bus bar of the conductors for protection against static charges.

Check of earthing and bonding of all extraneous conductive parts, which are not forming part of the electrical installation, such as cable trays, steel conduits, steel ducts, steel raceways, stairs, railings, window and door frames, supports, gas and water pipes, structural metal work of the building, non-insulating floors and walls.

20.6 INSULATION RESISTANCE TESTS

Before energizing any circuit, insulation resistance testing (Megger tests) shall be accomplished by use of D.C. Megger, correctly calibrated.

Records of all specified Megger tests shall be properly dated, identified by circuit number, drawing number and/or equipment description.

Equipment under Megger testing shall be disconnected from any other electrical device, which may be damaged by such tests.

20.7 CABLE TESTS

High potential tests shall be carried out as per applicable standards.

Before any high potential test, a Megger test shall be made on equipment until obtaining a satisfactory reading.

Cable considered as part of a system installation with rated voltage above 1000 V, shall be tested for current leakage using a suitable D.C. testing device. The cable shall be gradually stressed to minimized harmful surge current.

The following procedures, apply for this testing:

a) leakage currents shall be observed during voltage build-up;

b) faulty installations will cause leakage values to steadily rise after thirty seconds;

c) final test voltage shall be sustained for five minutes. A steady leakage current indicates a satisfactory installation;

d) cables failing the leakage current test shall be considered as inadequate and must be corrected or replaced.

After potential test and before circuit energization, another megger test shall be made to verify that the equipment insulation has not been damaged.

20.8 CABLE TESTS

High potential tests shall be carried out as per applicable standards.

Before any high potential test, a Megger test shall be made on equipment until obtaining a satisfactory reading.

Cable considered as part of a system installation with rated voltage above 1000 V, shall be tested for current leakage using a suitable D.C. testing device. The cable shall be gradually stressed to minimized harmful surge current.

The following procedures, apply for this testing:

e) leakage currents shall be observed during voltage build-up;

f) faulty installations will cause leakage values to steadily rise after thirty seconds;

g) final test voltage shall be sustained for five minutes. A steady leakage current indicates a satisfactory installation;

h) cables failing the leakage current test shall be considered as inadequate and must be corrected or replaced.

After potential test and before circuit energization, another megger test shall be made to verify that the equipment insulation has not been damaged.

20.9 EARTHING SYSTEM TESTING

Earth continuity tests shall be made by use of a heavy-duty earth megger. Earth resistance tests shall be carried out on each earth electrode.

Test values shall not exceed those indicated in the engineering documents by Contractor. Touch or/and step voltage shall not exceed the values given in the **Job Spec. DSF-SPC-ELE-004** para 24.1.

Where fuses or overload circuit breakers are used in connection with earthing for the protection against indirect contacts, each complete installation and, if possible, each final sub-circuit shall be tested to ensure that the impedance of the earth-fault loop with permit compliance with the requirements.

The method for testing shall give a direct indication of the maximum permissible setting of the fuse or circuit-breaker, or an indication whether a fuse or circuit breaker of a given rating will operate satisfactory under fault conditions.