

SECTION 3

RACEWAY SYSTEM

3.1 CONDUITS

3.1.1 PVC Conduits

3.1.1.1 Conduit specifications

Heavy gauge P.V.C. plastic conduits shall be of the high impact, high temperature, class "A" type having the following basic characteristics :

- a) Softening 75 deg. C.
- b) Specific gravity 1.35 to 1.45.
- c) Self extinguishing in accordance with DIN 49016.
- d) Coefficient of linear expansion $(6 \times \text{Exp.}^{-5})$ per Degree C.
- e) Dielectric strength 400-450 volts/mil.
- f) Heavy gauge P.V.C. plastic Conduit shall be to DIN 49016 and VDE 0605.

Flexible rubbed P.V.C. plastic conduits shall have a working temperature range between 40 Degree C and + 100 Degree C and suitable for heavy mechanical Stresses.

Conduits shall be comply with DIN 49018 .

3.1.1.2 CONDUIT FITTINGS

Conduit fittings such as couplings, expansion couplings, clips, saddles, elbows, glands, adapters reducers and the like shall be specially designed and suited to the type, size and installation equipment of the conduit in question.

Conduit fittings shall comply with DIN 49018.

3.1.1.3 BOXES

GENERAL

Boxes and covers used with plastic conduit systems shall be molded plastic provided with means for securely terminating the conduits.

Outdoor boxes shall be of the outdoor type provided with gaskets to ensure water tightness.

Outlet boxes

Outlet boxes shall be of size and design to suit the devices to be fitted thereto, such as telephone or socket outlets of the systems concerned.

Junction , pull , splice and terminal boxes

Junction and splice boxes shall be provided where indicated on the drawings, or as required to distribute from main cables to the various outlets.

All boxes shall be fitted with brass earthing terminals, and brass inserts.

Boxes used for all lighting outlets shall be fitted with steel insert clips to provide additional support for heavy pendants and allow for heat conduction where totally enclosed fittings are used.

Termination in junction boxes, distribution boxes and outlet boxes shall be of screwed type. Termination shall comply with NEC Article 110 .

3.1.2 Steel conduits

3.1.2.1 General

Heavy gauge galvanized steel conduits shall be used throughout for all power and low current system wiring as indicated in the drawings.

- a) An expansion joint shall be installed wherever a conduit run crosses an expansion joint in the structure to which it is attached, or in the case of straight conduit run exceeds 6 meters in length.
- b) Exposed or surface mounted conduits, shall be saddled at 1 m intervals, minimum. Conduits shall not cross pipe shafts or vent ducts.
- c) Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of two quarter bends (180 total).
- d) Conduits shall be properly capped until the wiring conductors are finally drawn in.
- e) Sleeves for conduits passing through outside walls shall be of cast iron with intermediate integral flange with internal diameter 50 mm larger than the outside diameter of the conduit. Sleeve length shall correspond to the wall thickness.
- f) The remainder of the sleeve shall be packed with plastic compound or lead and held in place by heavy escutcheon plates at both faces of the wall. The sleeve shall be secured to wall with set screws.
- g) Conduit hangers and supports shall be hot dip galvanized cast iron malleable straps or structural steel with hot dip galvanized bolts and nuts.

Expansion joints for steel conduits shall consist of a sleeve with fittings to provide telescoping of one of the conduit ends into the sleeve. Movable conduits shall be fitted with insulating bushings and all joints shall be weatherproof. Joints shall be made of malleable iron with a corrosion resistant gasket. A bonding jumper or earth clamp shall connect electrically on the two sides of every joint.

3.1.2.2 Application

Install flexible conduit in lieu of rigid conduit for service to individual recessed fixtures, 12 mm minimum size, and for final connection to distribution transformers and other equipment subject to vibration or movement. Use liquid-tight type of flexible conduit lieu of nonjacketed flexible conduit in damp or wet locations and for final connections to all motors.

Install conduit systems as indicated, as required by the NEC, and as specified. install conduit sizes as indicated. Where conduit sizes are not indicated, install sizes per NEC requirements, except do not use conduit sizes smaller than 3/4 inch unless otherwise specified.

Structural exposed conduit runs parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Keep conduit at least 150 mm away from parallel runs of high temperature surfaces, such as steam or hot water pipes and do not run conduit directly under cold water lines.

Group conduit for common support where indicated, as practicable, or as directed the Engineer.

Do not install crushed or deformed conduits and avoid trapped runs in damp or wet locations. Take care to prevent the entrance of water and the lodging of concrete, plaster, dirt or trash in conduit, boxes, fittings and equipment during the course of construction. Free conduit of obstructions or replace the conduits. Where conduit joints occur in concrete slabs, or in damp or wet locations, make joints watertight by applying an approved compound on the entire thread area before assembling. Draw up all conduit joints as tightly as possible. Cap exposed empty conduits which do not terminate in outlets, panels, cabinets, etc. With standard galvanized plumbers pipe caps. Plug empty conduits which terminate flush with floors or walls with flush coupling and brass plug.

Terminate conduit stubbed up through concrete floors for connections to free standing equipment with a coupling flush with finish floor, and extend rigid conduit to equipment, except that where required, use flexible conduit from a point 150 mm above the floor.

Make changes in direction of runs with symmetrical bends, fittings or pull boxes. Do not use bends around outside corners, use fittings for same. Install elbows, bends and offsets having a minimum radius of curvature of 600 mm for 2 inch and 2-1/2 inch conduit, and 900 mm for 3 inch and larger conduit. Except where conduit runs are shown in exact detail, install pull points at not greater than 60 meter intervals in straight runs. Where bends are included between pull points,

reduce this maximum permissible 60 meter separation between pull points by 15 meter for each 90 degree bend and 7.6 meter for each 45 degree bend. Figure deductions for all other angle bends on a similar basis. When bends are made in the field, make bends with an approved hickey or conduit bending machine. Make bends in 1-1/4 inch and larger conduits with standard conduit ells where possible.

Provide conduit nipples with two independent sets of threads. Do not use running threads on any part of the conduit system. Where conditions require joining two fixed conduits into a continuous run, use a conduit union, in place of running threads and coupling.

Use one hole malleable iron galvanized pipe straps for support of single conduits, or clevis- type hangers. Support groups of conduit on trapeze hangers. Use threaded rod or pipe for hanger support. Do not use perforated strap or wire for conduit or hanger support. Use beam clamps or malleable iron or wrought steel with hook rods to grip the beam flange for conduit or hanger support, do not use C-clamp type fittings. Support exposed conduit at least every 2.4 meter if smaller than 2 inches, and every 3 meter if 2 inches and larger, unless otherwise noted.

Conduit shall not be supported from architectural ceiling hangers wires or mechanical equipment. Electrical trades shall provide all required support for their work.

Support boxes independent of conduit and secure rigidly in place. Install boxes used for fixture support such that they are capable of carrying 50 kg.

Above suspended ceilings, support boxes independent of the ceiling fasten boxes to an independent support system by bar hanger or other approved support.

3.1.2.3 Outlet , switch , junction and pull boxes

Outlet Boxes for use with Rigid Steel Conduit : Cast or malleable iron in exposed, or damp or wet locations.

Gaskets : Provide cover gaskets for boxes in damp or wet locations.

Pull and Junction Boxes for Use with Each Type of conduit : As specified for outlet boxes for each conduit type under above paragraphs.

Install boxes in the wiring or raceway systems as required for pulling of wires, making connections, and mounting of devices and fixtures.

Install outlets for wall switches controlling lighting on the latch side of door where possible.

3.2 CABLE TRAYS

Cable trays shall be of galvanized steel, bordering shall be with edge protection. If cable trays with rungs are used instead of those with a perforated continuous bottom, the rung distance may not exceed 300 mm. The minimum load capacity shall be:

200 mm - 150 kg/m.

300 mm - 200 kg/m.

400 mm - 200 kg/m.

500 mm - 230 kg/m.

600 mm - 240 kg/m.

The regular supporting distance shall be 1500 mm. Elbows, T- and X- connectors shall be of the same manufacture.

3.3 Installation of raceways

3.3.1 Conduits

Exposed conduit shall be installed parallel or perpendicular to the building walls and ceilings, with right-angle bends, fittings or boxes.

Conduits supports shall be spaced not more than 1.50 m apart. The supports shall be galvanized wall brackets ceiling trapezes or pipe strap hangers with solid anchorage into concrete.

Exposed conduit shall be mounted with a clear space between conduit and wall.

Conduit systems shall be complete with all necessary pull boxes, junction boxes, fittings, couplings and outlet boxes. For conduit embedded in concrete floor slabs and installed in the form work before pouring concrete, the Contractor shall provide positive wire fastening of the conduit to the reinforcing rods at the proper distance from the concrete face, so that buoyancy of conduit does not lift it up to the surface.

All conduits shall be installed with 2 mm galvanized pull wire. All conduits gauge PVC, interior conduits above ceiling and in furred walls shall be rigid PVC conduit. Joints of PVC conduits shall be solvent-welded in accordance with the recommendations of the manufacturer.

Conduit fittings and elbows shall be provided from the same manufacturer. flexible conduits shall be provided where necessary, and fitted to the rigid conduits used and their fittings. Conduit sleeves shall be installed in advance of construction of slabs or construction of walls.

Conduit expansion joints shall be installed at each expansion joint of the building structure. Conduits shall be installed at least 300 mm from steam or hot water piping in parallel runs and at least 150 mm in cross runs. They shall be at least 75 mm from cold-water piping in parallel runs and in cross runs.

Not more than two bends shall be installed in conduit systems between pull or junction boxes.

All conduits in connection with ceiling outlets for exposed visible concrete ceilings shall be embedded in the concrete (recess-mounted).

Where conduit runs occur in spaces having ceilings, conduits shall be installed above the suspended ceiling and not in the floor slab or fill.

Conduits shall be reamed after being threaded. Ends shall be cut square and shall butt solidly into coupling's connectors and hubs.

3.3.2 Cable trays

Cable trays shall be installed within suspended ceilings or in other areas where visual aspects are of no importance. It shall be provided at a maximum distance of 1500 mm. Elbows, T or X connections shall be provided where necessary and shall be of the same manufacture. Only cables or insulated and sheathed multicore wiring may be installed on cable trays.

A minimum of 25% space for future cable installation shall be provided.

3.3.3 Filling of raceways with wires or cables

The following table shall apply only to complete raceway systems and is not intended to apply to short sections of raceways used to protect exposed wiring from physical damage.

When conduit nipples, having a maximum length not exceeding 600 mm, are installed between boxes, cabinets, and similar enclosures, the nipple shall be permitted to be filled to 60% of its total cross-sectional area.

The following table shows the allowable percentage of raceway fill

Number of conductors	1	2	3	4	>4
Raceway fill (all conductor types)	53%	41%	40%	40 %	40 %

The attached table indicates the permitted number of conductors in various conduit sizes.

A multiconductor cable of two or more conductors shall be treated as a single conductor cable for calculating percentage raceway fill.

3.3.4 Boxes

Pull and junction boxes

Pull and junction boxes shall be provided in the wiring or raceway systems wherever required for pulling of wires, making connections, and mounting devices or fixtures.

Boxes shall be suitable for use with the selected raceway system. In partitions of

light steel construction, suitable fastening devices, specially designed for this purpose shall be used to secure the boxes to the building structure. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required.

Boxes for use in masonry block or tile walls shall be square; cornered tile type, or standard boxes having square cornered tile covers.

Boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed.

Boxes and supports shall be fastened to wood with wood screws, with bolts and expansion shield on concrete or brick, with toggle bolts on hollow units and with machine screws or welded studs on steel work. In open overhead spaces, boxes threaded to raceways need not be separately supported except where used for fixture supports.

Boxes having threadless connectors always need to be supported from the building structure. If conduit runs exceed 45 m in length or exceed total bend limitations, pull boxes shall be provided at accessible locations.

Outlets

Outlets installed back-to-back in the same wall shall be offset from each other, 150 mm horizontally, to preclude noise transmission.

Outlet boxes

Outlet boxes shall be installed flush with the finished surface where outlets occur in concrete finished walls or columns.

Supports

Outlet boxes shall be supported to masonry or concrete construction by expansion anchors and to steel beams by clamps, bolts, etc.

END OF SECTION 3

SECTION 4

GROUNDING SYSTEM

4.1 General requirements

A complete and effective system of earthing shall be provided for the project. The system of earthing shall comply with the IEE wiring regulations and the recommendations stated in BS 7430, where the IEE wiring regulations and BS 7430 differ then the former shall take precedence.

The system mainly will consist of a number of earthing pits located at each distribution board to achieve the earthing resistance required (not more than 5 ohms), and to be connected together by copper conductor with cross-section as indicated in the drawings.

4.2 Earthing pit

Earthing points for the various electrical systems of each building shall each consist of one or more earth pits, constructed and equipped as herein specified and/or as per the B.S.S. and I.E.E. recommendations.

Each earthing pit shall contain at least one directly driven 3 m or more copper clad-steel earth rod with the necessary bolted-type cable connectors (the number of pits and length of rod shall be chosen to fulfill the required value of the earthing resistance). The earth rod may be extended by adding the necessary sections properly coupled not less than 185 mm².

4.3 Earthing connections

Equipment protective earthing shall consist of connecting all non-current carrying metallic parts of the electrical installation to the earthing sources.

Non-current carrying metal parts of the electrical installation shall include such items as metal conduit, raceways, outlet boxes, cabinets, exposed metal parts of apparatus, etc. as well as enclosures doors, grills, barriers, etc.

Earth continuity conductors other than metallic conduits trunking and cable armor shall consist of a special green colored insulated conductor of the same material and size of the associated branch circuit wiring.

Where there is a lightning conductor system for the building or structure, it shall be effectively bonded to the main earthing terminal in accordance with the requirements of BS 7430. A suitable label shall be provided adjacent to this bonding connection at the main earthing terminal indicating the purpose of connection.

Steel framed structures or metallic cladding shall be effectively bonded to the main earthing terminal.

The cross-sectional area of all earthing, bonding and protective conductors shall comply with the requirements of the IEE wiring regulations. Except where detailed otherwise in this specification or on the drawings all conductors for earthing shall be copper, manufactured in accordance with BS 1432, for strip and BS 4109, for cables.

Single-core cables forming part of the earthing system shall be of stranded copper, insulated to 450/750V standards with green/yellow PVC. These cables shall comply with BS 6004, table 1.

Bare protective conductors in twin and three core cables included in BS 6004, table 5 will be acceptable.

Mechanical joints between aluminium and copper shall have the joint faces lightly coated with an anti-corrosion compound before the connection is made.

Where conduits, or small glands for armoured cables, terminate on switch gear, distribution boards, starter panels on other apparatus then brass compression washers shall be used to ensure an effective earth connections .

Where connections are made between sections of trunking then the manufacturer's earth continuity links shall be installed across the joint. Connections made between trunking sections crossing a building expansion joints shall be made with a flexible copper braid .

Sections of cable tray shall be thoroughly cleaned before overlapping and securing with a minimum of two screwed fixings.

The remote ends of the cable tray shall be effectively bonded to the earthing system.

The armoring of plastic sheathed cables shall terminate in compression glands fitted with purpose made earth tags. A protective conductor shall connect the earth tag with the apparatus earthing terminal. The earth tags shall be manufactured from a high conductivity material compatible with the cable gland.

The armoring of metal sheathed cables shall be securely clamped to the gland at the cable termination with a purpose made bolted clamp. A protective conductor shall be installed to connect the armor clamp or gland fixing bolts to the apparatus earthing terminal. On outdoor terminations the cable gland shall be fitted with a weatherproof shroud to prevent corrosion.

Metal sheaths and/or armoring of multicore cables connected to a cubicle type switchboard shall be effectively connected to the switchboard earth bar as described in later clauses.

Where any metal sheathed and/or armoured cables of rating in excess of 100A terminated on an "Industrial type switchboard, a separate protective conductor shall connect the sheath and /or armoring to the switchboard earthing terminal.

Connections between earth bars, equipment frames, etc., and stranded copper cables shall be made by compression lug, bolt, washers, nut and lock nut. Contact surfaces shall be thoroughly cleaned and tinned prior to connection.

Connections between earth bars, equipment frames, etc., and copper strip shall be made with by bolt, washers, nut and lock nut. Contact surfaces shall be thoroughly cleaned and tinned prior to connection. The washers shall be of sufficient size to prevent any distortion of the copper strip.

The diameter of fixing holes shall not exceed one third the width of the earth bar or strip. Where a larger hole is required in an earth bar then connection shall be made to a copper flag welded to the bar. The weld shall be tested for continuity.

The earthing system shall be in full conformity with the requirements of the "Regulations" and the specification.

All materials used for earthing shall be specially manufactured for the purpose.

The complete earthing system shall be mechanically and electrically continuous to provide an independent fault current return path to the earthing source.

In every main earth lead a removable earth link should be fitted to enable the electrode system to be disconnected for testing purposes. The link should be installed in a conveniently accessible position and arranged to isolate the earth electrode system where open.

"Tee" and straight through joints in copper strip should be made either by riveting and sweating, welding or brazing.

Copper strip where used as a main earth lead to the earth electrodes or as earthing loop shall be 50 mm x 6 mm tinned copper strip. The copper strip should be fixed with either copper or brass saddles and/or brass or copper screws.

Where connections between dissimilar metals must be made, these should be protected by painting over with a moisture resisting bituminous paint or compound, by wrapping with a protective tape to exclude moisture.

The earthing resistance between any point in the earth continuity system and the main earth electrode shall not exceed 0.5 Ohm.

The neutral conductor shall be insulated throughout and shall not be connected at any point to the equipment earthing system.

4.4 Earthing of main distribution board :

- 4.4.1.** Main distribution board and panel boards shall be earthen by connecting an earth continuity conductor from the earth pit to the special earthing lug or bus bars provided inside the boards cabinets.

- 4.4.2. The earth continuity conductor for the above application shall be bare tinned copper strip having the following dimensions:

25 mm x 2 mm for boards protected by devices rated more than 200 amps. and
15 mm x 2 mm for 200 a and less.

4.5 Earthing distribution boards :

- 4.5.1. Panel boards shall be earthen by connecting an earth continuity conductor from the earthing lug or bus bar on the main distribution boards to the special earthing connector welded to the panel boards cabinets.
- 4.5.2. The earth continuity conductor shall be as shown on the drawings and/or required by the "Regulations".

Pay Item

10.4 Grounding system LS

END OF SECTION 4

SECTION 5

LIGHTING SYSTEM

5.1 Lamps and lamp-holders

5.1.1 Lamps

5.1.1.1 Tubular fluorescent lamps

Tubular fluorescent lamps shall comply with SSA 138, SSA 139, and IEC 81. Standard tubular fluorescent lamps for 20, 40 and 65 W with a tube diameter of approximately 38 mm shall be used. However, the low-energy type for 18, 36 and 58 W with a tube diameter of approximately 26 mm is preferred and shall be provided as far as possible.

Rapid-start tubes shall be provided.

5.1.1.2 Discharge lamps

High pressure mercury vapor lamps shall comply with IEC 188. These standards shall also be used for high-pressure vapor lamps as applicable.

The manufacturer's installation recommendations have to be followed. Instant restart lamps shall be installed for security lighting if specified in the Project Documents.

5.1.2 Lamp-holders

5.1.2.1 Lampholders for tungsten filament lamps shall comply with IEC 61 and 238. Lampholders shall consist of heat-resistant plastic or porcelain Edison screw. Type E 14, E 27 and E 40 are preferred.

5.1.2.2 Lamp-holder for tungsten filament lamps

Lampholders for tubular fluorescent lamps shall comply with IEC 400, and shall be for standard two-pin tubular lamps. The locking angle shall be approximately

30° to both sides.

Lampholders shall be of heat-resistant plastic.

5.2 Ballast and accessories

5.2.1 Ballasts

5.2.1.1 General

All ballasts shall be integrated power factor corrected with integral temperature protection.

5.2.1.2 Ballasts for fluorescent lamps

Ballasts for fluorescent lamps shall comply with IEC 82.

Ballasts shall be sheet metal enclosed with a protection code IP 20 and the coil shall be cast-resin impregnated.

The temperature rating shall be at least 130/55/125, which means:

130 = 130°C maximum coil temperature .

55 = 55 °C temperature rise of coil at normal operating conditions.

125 = 125 °C temperature rise of coil at abnormal operating conditions

5.2.1.3 Ballasts for high pressure discharge lamps

Ballasts for HP discharge lamps shall comply with IEC-188. Integrated ballasts shall be used for discharge lamps which include the ballast coil and the power factor correcting capacitor in a sheet metal enclosure with a protection code IP 53. The coil shall be cast-resin impregnated. The ballast shall have two or three taps for voltage adjustments. The temperature ratings shall be the same as before

5.2.1.4 Starters

Starters for fluorescent lamps shall comply with IEC-155.

Starters shall be provided in a plastic enclosure and shall be rated for an ignition temperature range from -20° to $+80^{\circ}$ C.

The universal type shall be provided to allow for start of lamps in the range of 20 W to 65 W.

5.2.2 Capacitors

Capacitors for lighting fixtures shall comply with IEC 566.

Capacitors shall be installed for fluorescent lamps for power factor correction to a cos. phi of approximately 0.95 to 1.0. The capacitor shall be provided in an aluminium enclosure and shall have a fastening bolt M 8 for installation at the lighting fixture. The terminals shall be for snap-type connectors.

High pressure sodium lamps shall comply with IEC 188.

The manufacturer's installation recommendations have to be followed. Instant restart lamps shall be installed for security lighting if specified in the Project Documents.

5.3 Flood light lighting fixtures

High-intensity floodlights shall have one discharge lamp. The housing construction shall be heavy-gauge cast aluminium designed for maximum head dissipation. The fixture shall be adjustable horizontally up to 35° and vertically up to 180° . The fixture reflector shall be extrude aluminium and shall be adjustable. The socket shall be made of a high-temperature, metal encased, spring-loaded porcelain.

Industrial type fixtures shall have a porcelain enameled seamless steel dome-like reflector having a ventilated hood and a wiring terminal outlet. Pendant and wall mounted fixtures shall have connectors for rigid steel conduit. Connectors shall contain a set screw or other approved method to prevent the fixture from turning on the conduit. Pendant-mounted fixtures shall be provided with a swivel suspension. Reflector provided with a swivel suspension. Reflector and socket shall be easily detachable as a unit without the use of tools, but shall be so arranged that the socket and reflector cannot come loose because of vibration. Ventilation openings in the neck

of the fixture shall be in accordance with the manufacturer's published standards. Fixtures shall be wired with not smaller than 1.5 mm² conductor having a minimum temperature rating 15°C.

5.4 Lighting fixtures and lighting poles.

5.4.1 General

Fixture parts shall be made of aluminum, brass, copper, steel or plastic. Metals shall be of composition and temper required by the manufacturing process involved and most suitable for the duty and function of the particular fixture part.

Materials and accessories, whether specifically mentioned or not, shall be of the highest grade of manufacture. Workmanship shall be first-class in every respect and shall produce lighting fixtures and lighting equipment of high character, equal in every respect to the highest commercial standard. All fixtures shall comply with IEC 598.

5.4.2 Fluorescent lighting fixtures

Surface-mounted lighting fixtures shall be suitable for wall or ceiling mounting.

Housing

The housing of surface-mounted lighting fixtures shall be either of sheet metal as described above or of rigid reinforced glass fiber plastic made from one piece, and solid along its entire length. The housing shall have sufficient knock-outs for convenient mounting by normal methods.

Protection code

Lighting fixtures for interior installation in dry locations shall have a protection code of at least IP-40, and lighting fixtures for installation in wet or outside locations shall have a protection code of at least IP 55.

5.4.3 Lighting poles

The complete assembly of the lighting fixtures consisting of a pole, luminaries and bracket arms shall be designed for dead loads imposed and theoretical dynamic loads of pressures developed by wind velocities

Height, shaft tube shape, and dimensions shall as indicated in the Project Documents. Poles shall be galvanized or painted (one coat primer and two finishing coats) steel.

Floodlight poles carrying more than two Lighting fixtures shall be provided with a suitable service platform including a safety basket.

Each pole shall be equipped with a cable connection box of protection code IP 55, for two incoming armoured cables up to 4X35 mm², Equipped with 2 fuse sockets for fuses up to 63 Amp. The cable boxes shall be installed inside the pole behind a lockable handhole opening which shall be located approximately 600 mm above F.F.L.

Each pole shall have an earthing lug above F.F.L. for the connection of a separate earthing conductor.

The base assembly of these poles shall consist of a base plate, a suitable dimension, welded to the shaft tube. A minimum of four hot-dipped galvanized high-tensile steel anchor bolts, with square leveling nuts, hexagonal hold-down bolts, flat and lock washers shall be capable of withstanding full bending moment of the shaft at its yield strength stress. The base plate shall have a 100 mm wide opening for cable penetration from the concrete foundation

5.5 Installation

All lighting fixtures shall be installed in an approved workmanlike manner. All straps, supports, hangers and other materials for proper installation shall be provided.

Upon completion of the installation, the lighting fixtures and lighting equipment shall be in first class operating order, in a perfect finished condition and free from defects. At the time of final inspection, all fixtures and equipment shall be completely lamped,

and be complete with the required glassware, reflectors, side panels, louvers or other components necessary to complete the fixtures.

Continuous rows of fixtures shall be installed so as to provide perfect alignment. Surface-mounted fixtures shall not have gaps between fixture items, trim and adjacent items.

Lighting Poles shall be aligned vertically and shall be properly fastened to their foundations. Earth embedded poles shall be provided with a corrosion protection tape at the point of earth penetration approximately 200 mm above and below ground level.

Brackets shall be positioned to point in the direction as indicated in the project documents. In addition to the design dimensions given in the project documents. The contractor must prove the foundation stability by a structural calculation

Pay Item

Lighting Fixtures

- | | | |
|--------|---|---------|
| 10.5.1 | Lighting Fixtures (sodium Lump) | Numbers |
| 10.5.2 | Lighting Fixtures (Flickering lighting fixtures) | Numbers |

Lighting poles

- | | | |
|--------|------------------------------|---------|
| 10.5.3 | Fixed on ground | Numbers |
| 10.5.4 | Fixed on the concrete bridge | Numbers |
| 10.5.5 | Fixed on the steel bridge | Numbers |

END OF SECTION 5

SECTION 6

INTERCOMMUNICATN SYSTEM

6.1. General

The Suez canal bridge is equipped with intercom system which, in case of emergency ensures link to the control center. The emergency service is realized by standard CB telephone sets and a special console located in the control center.

6.2- Function of the System

The main function of the intercom system is to allow the passengers crossing the bridge to contact the control center in case of emergency .

Each 500 m along the bridge (9 km length) is equipped with cabin telephone including a CB telephone set. (ref. to the DWG. enclosed)

The operator in the control center can visualize the calling subscriber on the relevant line LED blinking located on the front panel of a special console.

An caustic buzzer also advises of the incoming call.

When the operator in the control center is engaged in conversation, other incoming calls are signaled only the blinking of the relevant LED.

Control center console uses a full duplex connection with subscribers .

The maximum available number of telephone sets linkable to the control center console is 40.

The control center console receives incoming calls on a 2 watt loudspeaker. The operator can adjust the acoustic power by an audio frequency gain control located on

the front panel of the console.

The console has an enclosed microphone for transmission.

The connection with all the subscribers is point to point type and it is possible to take calls one at a time.

The operator in control center can call telephone sets by the use of dedicated keys.

6.3. Specific Requirements and Performance :

The system should be designed according to the major international standard CCITT, IEC.

The telephone set used in the system is standard CB (control battery) can be easily replaced by other types supplied by the market.

The telephone sets are heavy-duty type.

6.4. Equipment Description :

6.4.1 Control Center Console

This is the terminal used by the operator in the control center to handle the lines of the intercom system. The console can handle from 20 to 40 lines, its modularity can be easily configured (hardware and software). The terminal is connected to the lines through switching equipment, to handle the outgoing and incoming calls.

6.4.1.1 Main operating Functions:

Acoustic and optic signaling of calls.

Hands free or hand set operation.

Volume regulation on the loud speaker.

Power self test.
On line self test for data channel.

6.4.1.2 Key Board Features:

Keys monostable.
Key lighting LED (light emitting diode)
Key life time 1×10^6 operations.

6.4.2 Weather proof CB telephone set:

The telephone set has been designed to be used with the control center console, working in a voltage range from 24 to 60 V with the following features:

Housing in cast alloy light alloy case.
Hand set in anti shock resin, hermetically sealed.
Fully electronic.
Magnetic hook made with sealed reed relay.
Electronic ringing with high performances.
Built-in protection against high voltage on line .
Amplified dynamic microphone and receiving capsules.

6.4.2.1 Rated Voltage :

24/48/60 Vd.c.

6.4.2.2 Protection Degree

According to IEC recommendations.

6.4.3 Switching equipment:

The switching is equipped with MSS (Management and Service subrack) and TLS (Telephone line subrack)

6.4.3.1 Management and service subrack.

The management subrack, connected to the telephone console by means of a voice / data line, handles all the telephone connections, it handles also a service board used for reception and transmission of DC criteria from the field. Its functions, governed by microprocessor with program stored in the EPROM, consist of :

- * Reception of call criteria.
- * Dialing of calling or called line.
- * Generation of Line signaling.
- * Data link with the console.
- * Handle of services boards.

6.4.3.2 Telephone line subrack

This subrack contains the telephone lines boards and it is controlled by the management subrack.

The following board and signaling is used

Board type	2 Line exchange side.
Signaling type	CB (Central battery)

6.4.4 Power Supply requirements

The primary power supply is 220 Vac. 50 Hz

The power supply of switching equipment supplies 24/48/60 Vd.c needed for the equipment subrack and console, the power supply system should include a battery charger and battery has an Amp. hour capacity capable to operate the system for 8 hr in case of failure of the primary power supply.

6.5. Cable, Wiring And Conduits:

The type of cables, wires and conduits, will be as per international standards (IEC).

6.6. Environmental Requirements

6.6.1 The environmental requirements for switching equipment and console are :

Temp. range (operation)	0/50 °C
Rate of change	0/5 °C/min.
Humidity range	10% - 95%
Temp. range (Storage)	- 40 /+ 70 °C

6.6.2 The environmental condition for telephone sets are :

Temp. range (operation)	0/70 °C
Rate of change	0/5 °C/min.
Humidity range	10% - 95%
Temp. range (Storage)	- 40 /+ 70 °C

6.7. **Maintenance :**

The intercom system should offer optimum availability and exceptionally high quality standards.

Ease of maintenance is provided by.
The use of high reliable components .
System modularity one module /one function.
Optimization of maintenance kits.

Pay Item

Intercommunication system

10.6.1	main station	LS
10.6.2	slave stations	Numbers

Telephone cables

10.6.3	10 pairs telephone cable	Numbers
10.6.4	5 pairs telephone cable	Numbers

END OF SECTION 6

SECTION 7

TESTING

7.1. WIRES AND CABLES

An insulation resistance test shall be performed for direct buried cables prior to backfilling of trenches prior to energization, an insulation resistance test shall be executed for each circuit without a connection between the neutral and protective earth conductors. The following shall be measured:

- Neutral against line conductors.
- Line conductors against protective earth conductor.
- Neutral conductor against protective earth conductor.
- Line conductors against line conductors.

Motor feeders shall be tested when the motor is disconnected.

7.2. SWITCHBOARDS

An individual test shall be performed for each switchboard and panel prior to energization.

- Insulation resistance.
- lines against earth.
- lines against neutral and lines against each other shall be measured.
- Function of all switching equipment shall be tested. Each relay releasing device shall be tested for proper tripping and adjustment.

Factory tested equipment must also be tested on site. The actual setting-point of protective and time relays must be indicated on a separate label attached to the relay.

7.3. TRANSFORMERS

An insulation test shall be executed for each transformer, Line to neutral, line to earth,

lines to each other.

For oil-filled transformers, the dielectric strength and physical level of the cooling agent must be tested.

7.5. LIGHTING FIXTURES

In addition to the insulation resistance tests performed with the tests for the wiring system, lighting fixtures shall be observed after all lamps are inserted and energized for proper function and for completion.

7.6. RECEPTACLES AND SWITCHES

In addition to the insulation resistance tests performed with the tests for the wiring system, receptacles and switches shall be inspected for proper function and for completion.

7.7. CONTROL SYSTEMS

Control Systems shall be tested for their entire function, failure shall be simulated, and alarm indicators shall be checked.

7.8. COMMUNICATION SYSTEMS

Communication systems shall be tested in accordance with the manufacturer's instructions, for their entire function.

Failure and alarm conditions must be simulated, and all data and alarm indicators are checked. These systems are required to be tested and put into operation by a manufacturer's representative.

7.9. INSULATION TESTS

The insulation resistance of LV installations shall be at least 1000 ohm per volt, i.e.

127 V System - 127 000 Ohm

220 V System - 220 000 Ohm

380 V System - 380 000 Ohm

The test shall be with a Mergger-instrument for 500 V. High voltage installations shall be tested with a 5000 V Mergger and the minimum insulation resistance shall be 20 Megaohm.

7.10. ADDITIONAL TESTS

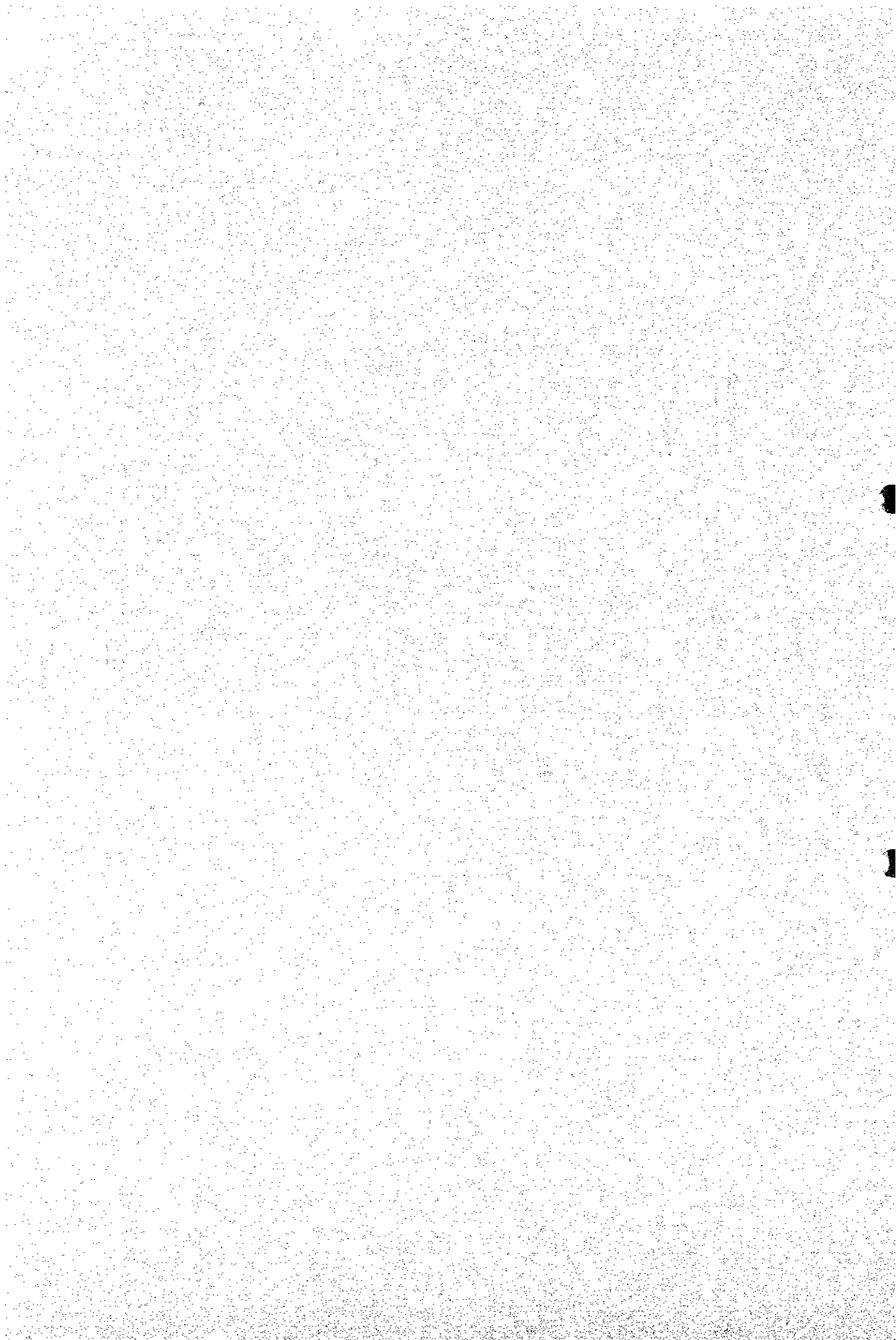
In addition to the above listed tests, the following checks shall be performed:

- (1) The protective earth, the earth, and the potential equalization conductors must be checked for proper size and connection and also for continuation through the entire system.
- (2) The proper labeling and identification of protective earth conductors shall be checked.
- (3) The protective earth contacts on receptacles shall be checked for proper functioning.
- (4) The tripping units of protective devices shall be checked for proper selectivity.

END OF SECTION 7

11.0 SUPPLEMENTARY WORKS

11.1	Lightning Lod	1
11.2	Air Hazard Warning Lights	2
11.3	Navigation Light	3
11.4	Seismic Meter	4
11.5	Wind Velocity Gauge	5
11.6	Suez Canal VTMS Remedial Measure	7
11.7	Microwave System Remedial Measures	10



11.1 Lightning Rods

11.1.1. Description

This work shall consist of installation of air terminals on tops of pylon shafts and earthing of copper boards into foundation ground, as indicated in Drawings.

11.1.2. Materials

The materials used for lightning rods shall be acceptable for BS6651-1985.

11.1.3. Basis of Payment

The amount of completed and actual lightning rod will be paid for at the unit price in the Bill of Quantities which rate shall be full compensation for supplying, fabricating, transporting, installing, and for materials, labour, equipment, tools and other items necessary for the proper completion of the work.

11.1.4. Items in the Bill of Quantities

11.1 Lightning Rod	Lump Sum
--------------------	----------

11.2. Air Hazard Warning Lights

11.2.1. Description

This work shall consist of installation of Air Hazard Warning Lights on tops of pylon shafts as shown in Drawings. The system shall consist of strobe light unit, power unit, control unit and environment lamination inspection unit.

11.2.2. Materials

Strobe Light : 200,000 cd or more, white light
Angle of Beam : 120 degree or more
Strobe Interval : 40 times per minute
Electric Power : 200 V
Case Steel : Stainless Steel (18 cr. 8 Ni)

11.2.3. Basis of Payment

The amount of completed and actual Air Hazard Warning Lights will be paid for at the unit price in the Bill of Quantities which rate shall be full compensation for supplying, fabricating, transporting, installing, and for materials, labour, equipment, tools and other items necessary for the proper completion of the work.

11.2.4. Items in the Bill of Quantities

11.2 Air Hazard Warning Lights Lump sum

11.3. Navigation Lights

11.3.1. Description

This work shall consist of installation of 3 navigation lights beneath the deck girder on each side indicating the navigation width of Suez Canal as shown in the Drawings. Light color shall be as follows;

Asian side	:	Green
Center	:	Yellow
African side	:	Red

11.3.2. Materials

Bulb	:	45 cd or more, 12 V, 25 W
Lantern	:	glass lens, acrylic filter

11.3.3. Basis of Payment

The amount of completed and actual Navigation Lights will be paid for at the unit in the Bill of Quantities which rate shall be full compensation for supplying, fabricating, transporting, installing, and for materials, labour, equipment, tools, and other items necessary for the proper completion of the Work.

11.3.4. Item in the Bill of Quantities

11.3 Navigation Lights	Lump Sum
------------------------	----------

11.4. Seismic Meter

11.4.1. Description

This work shall consist of installation of earthquake gauges inside deck girder and maintenance building.

11.4.2. Materials

The gauge shall equip the following capacities:

Recording elements : 2 horizontal accelerators
 1 vertical accelerator
Recording range : 0.1 ~ 1,000 gals
Range of period : 0.1 ~ 70 Hz
Recording method : IC cards, 1 MB or more

11.4.3. Basis of Payment

The amount of completed and actual Earthquake Gauges will be paid for at the unit price in the Bill of Quantities which rate shall be full compensation for supplying, transporting, installing, and for materials, labour, equipment, tools, and other items necessary for the proper completion of the work.

11.4.4. Item in the Bill of Quantities

11.4 Seismic Meter Lump sum

11.5. Wind Velocity Gauge

11.5.1. Description

This work shall consist of installation of wind speed gauge at center of main deck girder. The system shall consist of speed direction sensor unit, speed/direction indication unit and recording unit.

11.5.2. Materials

The characteristics of each unit shall be as below;

1) Sensor Unit

Type: Plastic bane

Measurement range:

Wind speed	0.5 m/s ~ 90 m/s
Wind direction	0 ~ 360°

Measurement accuracy:

Wind	10 m/s or less	±0.3 m/s
	10 m/s more	±3 %
Direction	±3° or less	

2) Indication Unit

Wind Speed : 3 different modes, 10 minutes average,
2 minutes average,
instant

Direction : instant wind direction

3) Recording Unit

2 pens type paper recorder.

Suez Canal Bridge 1977

11.5.3. Basis of Payment

11.5.4. Item in the Bill of Quantities

Wind Velocity Gauge

Lump Sum

11.6 Suez Canal VTMS Remedial Measures

11.6.1. Description

The Construction of Suez Canal Bridge will give influences against Suez Canal VTMS System which is now under operation to monitoring the vessels navigating on the Canal by radar system established along the Canal.

The construction of high elevated bridge interferes the monitoring operations by radars located in Qantara and Ismailia stations.

This work of Suez Canal VTMS Remedial Measures consists of the new construction of radar station at Ballah, adjustment work of radar station at El Cap, and transmission cable installation between both stations and Ismailia central station.

The work shall be completed before the erection of main pylon columns upto 30 m from the ground level, so as not to give any influences on existing VTMS system.

11.6.2. Materials

- 1) Tower : Foundation : concrete 210 kg/cm²
: Tower : Formed steel / HT Bolt
- 2) Equipment Room : Brick and Concrete
- 3) Radar Equipment : Raytheon MTR 50 kw - band MTR with LNFE
Raytheon MTR 18 × band array inclusive pedestal
- 4) Radar accessories and installation materials
 - Encoder 1024 PPR for array
 - MTR status Sense Kit for MTR
 - Dry Air Generator
 - Wave guide switch
 - Elliptical wave guide, 60 mtr.
 - Transformator for power supply

Suez Canal Bridge 1977

Power distribution between antenna starter and fuses

Power and signal cabling between the radar units.

5) VTS equipment

Remote control equipment and muxes VRC 500

6) Control room equipment

Uninterrupted Power supply

Air conditioner

7) Transmission

Fiber transmission

11.6.3. Construction Requirements

1) Tower erection

The Contractor shall carry out the new tower erection at Ballah and adjustment work at El Cap with close consultation with Suez Canal Authority.

2) Equipment room construction

Equipment room layout shall be confirmed by Suez Canal Authority.

3) Installation of radar system and equipment, and Testing

This work shall be carried out by KONGSBERG, NONCONTROL SYSTEM AS.

(P. O. Box 1024m N-3 194 Horten, Norway,

Tel 4733 03 2000

Fax 4733 04 5735)

4) Installation of transmission fiber

The Contractor shall carry out the work with close consultation with Suez Canal Authority.

5) Updating documentation

The operational and maintenance documentation shall be revised. This work shall be done by NONCONTROL SYSTEM AS.

6) Transfer of the new system to Suez Canal Authority.

The Contractor shall transfer the new established VTMS system to Suez Canal Authority by operational training of SCA staffs and with complete supporting documentation. The contractor shall receive transfer certification by SCA at the time of transfer.

11.6.4. Basis of Payment

The amount of completed and actual Suez Canal VTMS remedial measures will be paid for at the unit price in the Bill of Quantities which rate shall be full compensation for supplying , fabricating, transporting, installing, erecting and for materials , labor, equipment, tools and other items necessary for the proper completion of the work.

11.6.5. Bill of Quantities

11.6 Suez Canal VTMS remedial measures Lump Sum

11.7. Microwave System Remedial Measures

11.7.1. Description

The construction of approach viaduct of Suez Canal Bridge will give influence against the first frenel zone of Existing microwave communication system of Suez Canal Authority between Qantara and Ismailia.

This work of microwave System Remedial Measures consists of the adjustment of tower height at Qantara and installation of new antennas on both towers at Qantara and Ismailia.

The work shall be completed before the erection of super structure of approach viaduct at West Bank.

11.7.2. Materials

- 1) Tower Formed steel
- 2) Microwave Antenna 6 Ghz. same system as existing

11.7.3. Construction Requirements

- 1) Tower erection

The Contractor shall carry out this work with close consultation with Suez Canal Authority and shall pay careful attention not to disturb existing communication system during the work.

- 2) Installation of New Antennas

The antenna at Qantara site shall be installed at elevation of 75 meters and at Ismailia site at elevation of 67 meters.

- 3) Transfer of the new system to Suez Canal Authority

The contractor shall transfer the new microwave system to Suez Canal Authority after operational testing before SCA staff existence and complete supporting documentation for operation and maintenance.

11.7.4. Basis of Payment

The amount of completed and actual Microwave System remedial measures will be paid for at the unit price in the Bill of Quantities which rate shall be full compensation for supplying , fabricating, transporting, installing, erecting and for materials , labor, equipment, tools and other items necessary for the proper completion of the work.

11.7.5. Bill of Quantities

11.7	Microwave System Remedial measures	Lump Sum
------	------------------------------------	----------

10/10/10

10/10/10

1

2

1

2

3

JICA