

Section 1602

Telephone System

SECTION 16022**TELEPHONE SYSTEM****PART 1 - GENERAL****1.01 Work Included:****A. Related Work:**

Complete telephone distribution network and private telephone exchange system suitable for the project use, including, but not limited to the following:

Telephone distribution installations

Electronic private automatic branch exchange (PABX)

Main Distribution frame (MTTB) and main terminal cabinet (MTC)

PABX peripheral equipment

Operator's console(s)

Power supply equipment

Ancillary equipment.

1.02 Related Work:

A. Section 16010: Electrical General Provisions.

B. Section 16110: Raceway.

C. Section 16120: Wiring.

D. Section 16190: Supporting Devices.

1.03 Regulations and Standards: telephone installations are to comply with the requirements of local telecommunications authority and the relevant CCITT recommendations.

1.04 Submittals:

A. **Equipment Data:** Submit data for approval including complete technical data and manufacturer's catalogues for all equipment and materials.

1.04 Submittals: (cont'd)

- B. Tests: PABX and related equipment are to be tested at manufacturer's premises, and test certificates, certified by an official testing authority, are to be submitted to the Engineer before shipping and delivery to site.
- C. Shop and Construction Drawings: submit drawings for approval including, but not limited to, the following:

Detailed system schematic diagram

Exact routing and layout of all cabling and wireways

Exact composition of PABX cabinet(s), terminal boxes and other distribution boxes.

Type installation details of cabinet (s), boxes, and other equipment.

1.05 Approved Manufacturers:

Ericsson	Sweden
I.T.T.:	U.S.A.
N.E.C.:	Japan
Philips:	Holland
Siemens:	Germany

Or approved equal

PART 2 - PRODUCTS**2.01 Telephone Distribution Components:**

- A. Main Terminal Cabinet (MTC): is to be provided for terminating main lines. MTC is to be in compliance with the local requirements for telephone service entrance, and of capacity as shown on the Drawings.
- B. Telephone Distribution Cabinets and Boxes: Steel or metal alloy, general purpose enclosures, for surface or concealed mounting, of size and at location shown on the Drawings, dust-proof, IP 42 protection for indoor mounting and IP 55 for outdoor mounting, to IEC 144, with door and lock for sizes over 10 pair capacity, and with tamper - proof screwed covers for up to 10 - pair capacity.
- C. Terminal Blocks: screw or plug-in quick connect type in moulded high insulation resistance phenolic base, fixed by two captive screws, with doubled -ended nickel-plated brass connectors, and plug - in or set - screw terminals for connection of conductors with diameters between 0.5 and 1 mm.

- D. Conduits and Raceways are to be provided in accordance with Section 16110 of the specification.
- E. Telephone System Cable: two-pair and multi - pair cables for indoor cabling are to be polyethylene insulated, tinned solid copper conductors, twisted into pairs, color coded, with wrapping of aluminum polyester tape and gray PVC sheath. Minimum diameter of conductor is to be 0.6 mm Drain wire is to be provided in each cable, 0.4 mm diameter for 1 to 10 pair cables and 0.6 mm diameter for cables with more than 10 - pairs.
- F. Multi-Pair Cables for installation in duct banks, outdoor or directly buried are to be non - hygroscopic, Waterproof, polyethylene insulated, tinned solid copper conductors, minimum 0.6 mm diameter, twisted into Paris, color coded, with wrapping of aluminized polyester tape, PVC tape aluminum or copper sheath and PVC over-sheath.
- G. Cable Rating: cables are to be rated for maximum operating voltage of 150 V, with insulation resistance of 10,000 megaohm/km, and tested at 500 V d.c. applied core and core-earth.
- H. Telephone Outlets: are to have modular grid box and cover plates similar to other socket outlets and switches desecration Section 16140 of the Specification, with corgrip cover and fixed mounting set-screw terminal block in side box.

2.02: Electronic Private Automatic Branch:

- A. Design:
 - 1) Numbering: design is to permit station numbers to be assigned to lines at time of installation, in accordance with customer-desired numbering plan, and reassignment while in service to allow personnel moves without requiring number changes.
 - 2) Outward Call Restrictions: it is to be possible to assign to each extension, restriction for outward calls as follows:
 - non - restricted: having unrestricted access to external lines for outward calls either by direct dialing or through operator.
 - semi-restricted: having unrestricted access to external lines for outward calls either by direct dialing or through operate
 - restricted: having no access to external lines neither through direct dialing nor through operator.
 - 3) Segregation of External Line: it is to be possible to segregate external turn lines as follows:
 - lines for incoming calls directed to assigned stations
 - lines for outgoing calls accessible only by operators.
 - lines for outgoing calls accessible by operators and by all remaining non-restricted and semi-restricted extensions.

2.02: Electronic Private Automatic Branch: (cont'd)**B. Characteristics:**

1) Type:

PABX is to be fully electronic, digital stored program, microprocessor controlled with LSI switching circuits. Reed relays, mini-switches, cross-point switching and cross-point techniques are not acceptable. PABX is to be designed for use as a universal telephone exchange system for all applications. It is to be possible to connect any combination of DTMF and rotary dial telephones to the PABX, with the provision of manufacturer-made interface modules as necessary within the PABX and without the need to modify the assembly.

2) Capacity: is to be as follows:

- a- external lines as shown on the drawings.
- b- internal extensions: as shown on the drawings.
- c- operator's consoles: 1 with provision to one in future.

3) Grade of Service: is to be as follows:

- a- incoming traffic: $P = 0.01$
- b- outgoing traffic: $P = 0.01$
- c- internal traffic: $P = 0.001$
- d- traffic capacity per line: more than 0.19 erlang.

4) Characteristics: PABX is to be in accordance with Local Telecommunication Company recommendations and is to have at least the following characteristics:

- a- control : stored program
- b- control functions : performed by LSI micro-processors and mini-processors
- c- maximum loop resistance : 1300 ohms (including telephone set)
- d- insertion loss : less than 0.6 dB at 800 Hz, less than 1.5 DB between 300 and 3400 Hz
- e- CrossTalk Attenuation : more than 0.6 70 dB (in 200 to 3,200 Hz band)
- f- leakage impedance : more than 40 K ohms
- g- power supplies;
 - primary power 220 V (+/-15%)
 - battery 48 V d.c.
nominal (+/-12%)
- h- ambient room temperature : 40 deg. C
- i- relative humidity : 5% to 90 %
- j- compatible station : two - wire and/or three wire standard serial pulse or DTMF dialing.

2.02: Electronic Private Automatic Branch: (cont'd)**C. Systems Performance:****1) PABX Features:** are to include, but are not limited to, the following:

Station-to station calling: station user is to be able to directly dial other stations within PABX system without assistance of operator.

Direct Outward Dialing (DOD): non-restricted and semi-restricted station use is to be able to gain access to exchange network, without assistance of operator, by dialing an access code, receiving a second dial tone and then dialing desired network exchange number.

Executive override (break-in): station use is to be able to enter existing two-party busy station connection, this intrusion is to be preceded by a warning tone; if a person called releases his line he is automatically called back.

Camp on Busy: if internal extension called is busy, it is to be possible to dial a digit and to hang up, the two telephone stations are automatically called back as soon as they are simultaneously free.

Inquiry call: when telephone use is in conversation with the outside he is to be able to put his communication on hold, dial an internal number, consult privately, and then take back first communication.

Call Transfer: this is to enable any extension in the installation to directly divert and external communication to another extension without going throughout the operator.

Dial access to operator: station users within switching system are to be able to reach operator by dialing a single digit, and operator may complete these calls to trunk faculties or other stations.

Recall Dial Tone: this is to indicated to station user the successful use of the switch - hook flash when requesting a service feature during an established, call and without causing a re-origination to occur line lockout with warning: this gives 3-0 seconds warning tone and then holds the line out of service when a station line remains off - hook for longer than 10 seconds with out dialing, the hold out - of service is to be released when station goes on - hook.

Call forward: an internal extension is to be able to forward all incoming calls automatically to another selected telephone number.

Auto answer back: selected extension is to automatically answer on call after one ring.

Group Call: station use is to be able to establish an automatic conference between pre-designated group of stations.

Splitting: station use is to be able to consult privately with one party on a call without third party hearing.

2.02: Electronic Private Automatic Branch: (cont'd)**C. Systems Performance: (cont'd)**

Serial Call: operator is to be able to complete an incoming trunk call to two or more station lines in succession without requiring the outside party to recall operator.

Conference: stations are to be able to establish a conference of up to six parties (min) without operator assistance

Power failure transfer: this is to allow a limited number of pre-assigned stations to get access to or from the network in case of battery failure.

Call back queuing for trunks: this allows the used to wait for a trunk to be idle: when the trunk is idle, the exchange rings back, then waits for user to go off-hook and dial the number.

Direct distance dialing (DDD): this is to allow user to dial long-distance calls without intervention of operator.

Do not disturb (DND): operator is to be able to place individual extensions into a DND mode, such that to be appeared busy to all incoming calls.

Paging calls: selected extensions are to be able to send a paging call by dialing an access number followed by the called paging number.

2) Operator's Console Features: are to include at least the following:

- a- facility to check status of any individual trunk or extension line.
- b- ring-when-free facility for external calls transferred to a given busy extension.
- c- automatic return to operator if an extension does not answer an outside call within 15 seconds.
- d- time reminders: operator is to be automatically alerted after 30 seconds hen an internal or outside call on the console is waiting.
- e- calling number display: visual display of PABX station seeking attendant assistance.
- f- Transfer of incoming call to wanted extension made by push-button key set.
- g- Priority: operator is to be able to interfere in an established communication of special announcements or transfer of incoming calls, warning tone is to be sent to both conversing parties.
- h- Splitting: operator is to be able to consult private with one part on a call with out the other party hearing.

2.02: Electronic Private Automatic Branch: (cont'd)**C. Systems Performance: (cont'd)**

- i- Operator is to be able to connect any internal extension or outside trunk line with any other internal extension, operator is to be able to place an outgoing call for a station use without requiring the station user to hang up
- j- Call hold: calls that cannot immediately be extended, are to be placed in a hold buffer, when required extension becomes available, the call is to be retrieved from hold buffer and extended to extension.
- k- abbreviated dialing: operator is to be able to assign short dial codes for frequently called destinations.
- l- Automatic call supervision: if an unannounced extended call is not answered within a predetermined time, the call is to be automatically returned to the operator.
- m- Fault indication: any fault within the system is to be automatically detected and signaled by an alarm buzzer and an indicating lamp.
- n- Automatic and manual switch-over to night service: incoming CO trunk calls during night operation are to be routed to predetermined answering stations; routings are to be on a flexible basis by the attendant and are to remain in effect until changed.

D. System peripheral Equipment:

- 1) **PABX:** is to contain floppy disk for storage of all system and user data, to serve as back-up storage for protection of system configuration data and operating system software. Floppy disk processor is to be provided for this unit.
- 2) **Calls Detail Recording:** facilities are to be included in order that all trunk call information is to be automatically recorded for accounting purposes. Information is to be stored on floppy disk and printed on typewriter (or printer) upon request. Call reports are to be the full list of outward calls, with indication of number called, number on internal extension originating the call, date, time and duration of call or list of calls per certain extension.
- 3) **Paging System Interfacing:** Interfacing modules to the radio paging system are to be provided in coordination with the systems supplier/manufacturer.

2.02: Electronic Private Automatic Branch: (cont'd)**E. Construction:**

- 1) Cabinet: Exchange components are to be grouped in a modular, totally enclosed, sheet metal cabinet, with lockable front access doors, and whole assembly is to fit into one integrated form. Cabinet is to be dust and insect proof, an ventilation is to be provided as required for specified ambient conditions and air-conditioning facilities. Range of temperatures recommended for continuous operation of the system are to be submitted to the Engineer.
- 2) Plug - In Equipment: electronic circuits and components are to be plug-in card type, with solid state electronic components. Equipment is to be assembled neatly in tracks. Sensitive equipment is to have dust protection covers.

2.03 Other Equipment:**A. Operator's Console:**

- 1) Type: Desk-top, compact type, equipped to enable operator to provide all services required and have full control of system operation. As well as a busy lamp panel is to be included to show the condition of the extensions and public exchange lines.

B. Telephone Extension Sets:

- 1) Type: desk or wall type as shown on the Drawings. Dial is to be push button operated, dual tone multi-frequency type (DTMF) and pulse type, switch able.
- 2) Executive Set: is to be a multi-line type and is to have, but not limited to, and LCD display (2 lines x 40 characters min.), min. of 8 programmable keys, hands free operation, auto answer back, hold, release and hands free mute keys.
- 3) Construction: set is to be shock - resistant moulded plastic, of approved design and color, and appropriate for function intended. Set is to be dust and insect tight with bell and adjustable volume control. Serial number and other markings are to be large and legible. Base plate is to be engraved with year of manufacture, serial number, manufacturer and any other information required by the standards.
- 4) Connectors and Cord telephone sets are to have lock-in plug-ended connector cords not less than 2.5 m long, for connecting hand-set to telephone set base an for connection base to wall terminal box. Plugs are to snap-lock into mating connectors on hand-set base terminal box. Lock is to be released without special tools.
- 5) Receiver and Transmitter: capsule is to be protected by a click suppresser. Transmitter capsule is to be spit-proof type.
- 6) Impedance and Frequency response: set is to shown an optimum impedance adaptation to the extension lines in the band from 300 to 3,400 Hz. Frequency response curve for transmission is to be uniform and without sharp deviation within the band (30 to 3.400 Hz)
- 7) Insulation test: sets are t withstand an insulation test of 200 V , 50 Hz , for 30 seconds.

C. Main Distribution Frame (MTTB)

- 1) Size is to be suitable for ultimate capacity of PABX specified, cross-connection type with separate incoming and outgoing terminal blocks. All internal and external lines of PABX system are to be connected MTTB.
- 2) Protection against lightning and voltage surges on all trunk circuits is to be provided by protectors as recommended by the Manufacturer.
- 3) Terminals are to be identified by numbered tags corresponding to respective lines and extensions. Proposed numbering scheme is to be submitted for approval. Internal and external lines are to be connected by plugged twin terminals soldering will not be allowed.

D. Power Supply Equipment:

- 1) **Standby Power system:** rectifier-charger and batteries are to supply continuous d.c. power at specified voltage to the PABX. Capacity is to provide minimum eight hours continuous operation without loss of functions or reduction in system capacity after normal power supply failure. Batteries are to be floated on load side of rectifier and kept continuously fully charged
- 2) **Rectifier:** to be solid stage, with sufficient capacity to supply required power to PABX and maintain batteries in fully charged condition. Quality of output voltage is to be within required limits of PABX. Following restoration of normal power and full discharge of batteries, rectifier charger is to return batteries, rectifier charge is to return batteries to 90% full charge within 6 hours.
- 3) **Batteries:** lead-acid, sealed, maintenance free, stationary type. Necessary hardware and wiring are to be provided inside PVC conduit for interconnection. Suitable mounting rack is to be provided for battery installation.
- 4) **Maintenance Kit** is to be provided for servicing the battery.

PART 3 - EXECUTION**3.01 Installation**

- A. **Equipment Installation on Site:** is to be limited to fixation and inter-wiring of various items of the ready made equipment.
- B. **Cables:** are to be run concealed in underground ducts, on cable trunking, in walls or under floors in a manner to protect them from physical damage and excessive heat, and to permit ease of accessibility for servicing and modifications. Fixing accessories are to include two piece plastic clamps, galvanized screws, wall base-holders and fiber-plastic inserts of rawl-bolts, subject to the approval of the Engineer.
- C. **Operator's Console:** Install concealed wiring directly from main distribution frame via multi-pair cables to operator's console.
- D. **Conduits:** in accordance with section 16110 of the specification.

3.01 Installation

- E. **Tools:** use only proper tools for all installation work particularly in making connections.
- F. **Earthing:** provide interference-free earthing as necessary.
- G. **Super-intendance:** carry out installations under the direct supervision of a qualified technician, licensed by and trained at the factory.
- H. **Telephone sets:** install finally and only after obtaining approval from the Engineer.

3.02 Tests:

- A. **Test Plans:** PABX is to be tested in accordance with the contractor-developed and approved test plans. Test plans are to include insulation tests and system operation tests.
- B. **Phase I site testing:** Prior to system hand-over, it is to be demonstrated to the satisfaction of the Engineer that installed equipment meets the requirements of the Specification and is ready for hand-over. Test calls are to be made from stations selected at random, and a.c. power is to be disconnected to test reliability of emergency power system.
- C. **Phase II Site Testing:** System is to be tested under actual operating conditions for 30 days prior to acceptance. Tests are to demonstrate to the satisfaction of the Engineer that system is fully operational and compatible with the local telecommunication authority

END OF SECTION

Section 16050

Through-Penetration Firestop Systems

SECTION 16050**THROUGH-PENETRATION FIRESTOP SYSTEMS****PART 1 - GENERAL****1.1 Related Documents**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

- A. This Section includes through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:
 - 1. Floors.
 - 2. Roofs.
 - 3. Walls and partitions.
 - 4. Smoke barriers.
 - 5. Construction enclosing compartmentalized areas.
- B. Related Sections include the following:
 - 1. "Cast-in-Place Concrete" for construction of openings in concrete slabs and walls.
 - 2. "Building Insulation" for safing insulation and accessories.
 - 3. "Sprayed Fire-Resistive Materials."
 - 4. Division 15 Sections specifying duct and piping penetrations.
 - 5. Division 16 Sections specifying cable, cable trays and conduit penetrations.

1.3 Performance Requirements

- A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.
 - 1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
 - 2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
 - 3. Fire-resistance-rated floor assemblies.

1.3 Performance Requirements (cont'd)

4. Fire-resistance-rated roof assemblies.
- B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
 - C. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
 1. Penetrations located outside wall cavities.
 2. Penetrations located outside fire-resistive shaft enclosures.
 3. Penetrations located in construction containing fire-protection-rated openings.
 4. Penetrating items larger than 100-mm- (4-inch) diameter nominal pipe or 100 sq. cm (16 sq. in.) in overall cross-sectional area.
 - D. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 450, as determined per ASTM E 84.

1.4 Submittals

- A. Product Data: For each type of through-penetration firestop system product indicated.
- B. Shop Drawings: For each through-penetration firestop system, show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating item.
 1. Submit documentation that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
- C. Qualification Data: Includes lists of completed projects with project names and addresses, names and addresses of Engineers and Employers, and other information specified.
- D. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.
- E. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.5 Quality Assurance

- A. **Installer Qualifications:** An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. **Installer Qualifications:** An experienced installer who is qualified by having the necessary experience, staff, and training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its through-penetration firestop system products to Contractor or to an installer engaged by Contractor does not in itself confer qualification on buyer.
- C. **Source Limitations:** Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.
- D. **Fire-Test-Response Characteristics:** Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:
 - 1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is **UL, ITS**, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
 - 2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
 - b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
 - 1) UL in "Fire Resistance Directory."
 - 2) ITS in "Directory of Listed Products."

1.6 Delivery, Storage and Handling

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.

1.6 Delivery, Storage and Handling (cont'd)

- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 Project Conditions

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.8 Coordination

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- C. Notify Engineer at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until the Engineer, if required by authorities having jurisdiction, have examined each installation.

PART 2 - PRODUCTS**2.1 Products and Manufacturers**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A/D Fire Protection Systems Inc.
 - 2. 3M Fire Protection Products.

2.2 Firestopping, General

- A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

- B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 - 2. Temporary forming materials.
 - 3. Substrate primers.
 - 4. Collars.
 - 5. Steel sleeves.

2.3 Fill Materials

- A. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of Part 3 by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.

- B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

- C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

2.3 Fill Materials (cont'd)

- D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
- F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- H. Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- I. Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.
- J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- K. Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
 - 2. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
 - 3. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

2.4 Mixing

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION**3.1 Examination**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 Through-penetration Firestop System Installation

- A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

3.3 Through-penetration Firestop System Installation

- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 Identification

- A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
 - 1. The words: "Warning--Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Through-penetration firestop system designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Through-penetration firestop system manufacturer's name.
 - 6. Installer's name.

3.5 Cleaning and Protection

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

3.5 Cleaning and Protection (cont'd)

- B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

END OF SECTION

Section 16110

Raceways

SECTION 16110
RACEWAYS

PART 1 - GENERAL

1.1 Related Documents

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

This section specifies the furnishing and installation of electrical raceway systems.

1. Rigid metal conduit.
2. Rigid nonmetallic conduit.
3. Flexible metal conduit.
4. Liquid-tight flexible metal conduit.
5. Cable Tray.

1.3 Reference Standards

1. ANSI/ANSI C80.1 - Rigid Steel Conduit - Zinc-Coated.
2. ANSI/UL 1 - Flexible Metal Conduit.
3. ANSI/UL 360 - Liquid-tight Flexible Steel Conduit.
4. ANSI/UL 467 - Electrical Grounding and Bonding Equipment.
5. ANSI/UL 651 - Schedule 40 Rigid PVC Conduit.

1.4 Submittals

Submit manufacturer's literature and product data.

PART 2 - PRODUCTS**2.1 Conduit and Fittings**

1. Rigid Steel Conduit.
 - A. Conduit: Rigid hot-dipped galvanized steel (RGS) conduit with zinc-coated threads and an outer coating of zinc chromate.
 - B. Fittings: Threaded steel or malleable iron, either cadmium plated or hot-dipped galvanized.

2. Rigid Nonmetallic Conduit.
 - A. Conduit: Schedule 40 polyvinyl chloride (PVC).
 - B. Fittings: Solvent weld socket type.

3. Flexible Metal Conduit.
 - A. Conduit: Spiral-wound, square-locked, hot-dipped galvanized steel strip.
 - B. Fittings: One-screw and two-screw for 304.8mm (12 inches) and larger, double-clamp steel or malleable iron, either cadmium plated or hot-dipped galvanized.

4. Liquid-tight Flexible Steel Conduit.
 - A. Conduit: Spiral wound, square locked, hot dipped galvanized steel strip plus a bonded outer jacket of PVC.
 - B. Fittings: Compression type, malleable iron, with insulated throat, either cadmium plated or hot dipped galvanized.

PART 3 - EXECUTION**3.1 Conduit and Fittings**

1. Minimum Trade Size: 19.05mm (3/4 inch), except that 9.53mm (3/8-inch) flexible metal conduit may be used in lengths not exceeding 180cm for tap conductors supplying lighting fixtures.

3.1 Conduit and Fittings (cont'd)

2. Types According to Use: Use rigid steel conduit (RGS) throughout the project except as specified below.
 - A. Use PVC-coated RGS where exposed to rain, condensation, moisture, constant high humidity or corrosive atmospheres.
 - B. Use PVC in interior walls or ceiling spaces and where exposed when installed more than 2.5 meters above finished floor in open work areas, mechanical rooms or electrical rooms. Conduit which enters or leaves the top of panelboards or enclosures may be PVC, provided the top of the panelboards or enclosures are a minimum of 150cm above finished floor and such panelboards and enclosures are located in mechanical or electrical rooms.
 - C. RGS or rigid nonmetallic conduit 25.4mm (1 inch) and smaller may be embedded in slabs if the slab thickness is a minimum of 10cm thick.
 - D. Use RGS or rigid nonmetallic conduit encased in concrete with minimum 76.2mm (3-inch) thick walls, where installed below grade. Concrete encasement may be omitted when conduit is installed below floor slabs. All horizontal to vertical transitions shall be made using RGS elbows and RGS conduit stub-ups.
 - E. Connect all electrical equipment subject to vibration or movement with liquid-tight flexible metal conduit 60cm minimum length. Where the equipment is located in a duct or plenum used for environmental air, the length of conduit shall not exceed 12meters and the conduit shall be flexible metal conduit.
 - F. Transitions.
 - (1) Continue the heavier, more protective type conduit application not less than 101.6mm (4 inches) into the area where lighter, less protective type conduit is permitted.
 - (2) For below-grade to above-grade outdoor locations, extend concrete encasement around conduit 4 inches above finished grade and slope top away from conduit with a 15cm -per-foot slope.
 - (3) For below-grade to above-grade locations using PVC to metal conduit, make the transition from PVC to metal conduit before turning up with RGS elbow.

3.1 Conduit and Fittings (cont'd)

3. Preparation: Place sleeves in walls and floor slabs for the free passage of cables or conduits. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work. Seal all openings and voids around sleeves through floors and walls. Be sure that plugs or caps are installed before concrete placement begins.
4. Installation Requirements
 1. Metallic conduits must be continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc. The conduit must enter and be secured to enclosures so that each system is electrically continuous throughout. Where knockouts are used, provide double locknuts, one on each side. For rigid metallic conduits, provide nonmetallic insulating bushings for conductor protection. Where conduits 38.1mm (1-1/2 inches) and larger terminate in equipment having a ground bus, such as in switchgear, motor control centers and panelboards, provide conduit with an insulated grounding bushing and extend a suitable grounding wire to the ground bus.
 2. Have rigid nonmetallic conduit adequately solvent welded at joints to form a tight, waterproof connection.
 3. Run concealed conduit as directly and with the largest radius bends as possible. Run exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Unless otherwise shown, remaining conduit may be exposed. Provide chrome-plated floor and ceiling plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Select properly sized plates to fit the conduit when securely locked in place.
5. Installation Methods.
 1. Install each entire conduit system complete before pulling in any conductors. Clean the interior of every run of conduit before pulling in conductors to guard against obstructions and conduit omissions.
 2. Cut all joints square, then thread and ream smooth. Coat cuts, threads or scratches on steel conduit with an approved zinc chromate or with a 90 percent zinc paint. When dry, draw up tight.

3.1 Conduit and Fittings (cont'd)

3. Make bends with standard ells or conduit bent in accordance with the NEC. Make field bends using equipment designed for the particular conduit material and size involved. Bends must be free from dents or flattening. Use no more than the equivalent of three(3) 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.
4. Conduit bodies may be used in lieu of conduit ells where ease of installation and appearance warrants their use. Conduit bodies larger than 1 inch may be used only where approved.
5. Securely fasten and support conduit to structure or metal framing using hot-dipped galvanized, malleable iron pipe straps or other approved means. Wires of any type may not be used for securing conduits.
6. Provide a No. 30 nylon pulling line in conduits in which wiring is not installed under this work. Identify both ends of the line by means of labels or tags reading "Pulling Line-Telephone,"pulling line-Data@ ...etc.
7. Suitably cap conduit during construction to avoid water, dirt and trash entrance.
8. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceway systems.
9. With a coupling, terminate concealed conduit for future use at structural surfaces. Install a pipe plug flush with the surface.
10. Openings around electrical penetrations of fire-resistance rated walls, partitions, floors or ceilings shall be fire stopped to maintain the fire resistance rating using approved methods.

END OF SECTION

Section 16114

Cable Tray

SECTION 16114**CABLE TRAY****PART -1 GENERAL****1.01 Related Documents**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 Summary

Perforated hot-dipped galvanized after fabrication steel cable tray.

1.03 Related Work

- A. Section 16190: Supporting Devices
- B. Section 16125: Grounding and Bonding

1.04 Reference Standards

- A. BS 1767
BS 2989
- B. IEC 439
- C. NEC

1.05 SUBMITTALS

- A. Submit shop drawings and product data, including all dimensions and finishes for each type.
- B. Submit manufacturer's installation instructions.

PART 2 – PRODUCTS**2.01 Cable Tray**

- A. Cable tray shall be of the perforated type with return flanges for added rigidity and shall be manufactured from hot dip galvanized sheet steel. Minimum metal thickness shall be as follows:-
 - 1. 1.5 mm for cable tray up to 200 mm wide.
 - 2. 2.0 mm for cable tray above 200 mm wide.

2.01 Cable Tray (cont'd)

- B. Each length of cable tray shall be provided with heavy duty galvanized steel joint pieces and joint cover plates.
- C. Vertical runs of cable tray in electrical switch rooms and shafts shall be provided with clip-on type galvanized sheet covers.
- D. Provide cable tray complete with all necessary bends. Tees, crosses and risers, manufactured from hot dip galvanized sheet steel and manufactured by the same factory.
- E. All exposed cable trays shall be covered.

2.02 Tray Supports

- A. As recommended by the cable tray manufactured and indicated on the plans.

2.03 Approved Manufactures

Cables Trays and all necessary accessories

- BICC (U.K.)
- MONO Systems (U.S.A)
- DAVIS (U.K.) or equal and approved alternative

PART 3 – EXECUTION**3.01 Coordination**

- A. Co-ordinate layout of cable tray with other services to ensure that there is no conflict.
- B. Relocate cable tray as necessary to avoid building obstruction of other services.

3.02 Installation

- A. Install cable tray level and plumb according to manufacturer's written instructions, coordination drawings, original design and referenced standards.
- B. Remove burrs and sharp edges from cable trays.
- C. Fasten cable tray supports securely to building structure.
- D. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independently of fittings. Don not carry weight of cable tray on equipment enclosure.

3.02 Installation (cont'd)

- E. Install expansion connectors where cable tray across a building expansion joint and in cable trays runs that exceed 30 meter space connectors and set gaps as required.
- F. Make changes in direction and elevation standard fittings.
- G. Make cable tray connections using standard fittings.
- H. Install cable
- I. Seal penetrations through fire and smoke barriers according to Division 7 Section "Firestopping".
- J. Install cable trays with sufficient space to permit access for installing cables.

3.03 Cable Trays

On completion of cable tray installation, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes, including chips, scratches, and abrasions.

3.04 Protection

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, that ensure cable tray is without damage or deterioration at the time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.

3.05 Groundingt

- A. Provide a separate ground wire on all runs of cable tray bonded to the appropriate switch gear, cabinets, electrical equipment in accordance with the grounding specification section.
- B. Provide 10 sq. mm copper bonding jumpers across all joints.
- C. Test complete system for ground continuity.

END OF SECTION

Section 16120

Wiring

SECTION 16120**WIRING****PART 1 - GENERAL****1.01 Work Included**

- A. Single core and multicore 600 volt wiring, 10mm² and smaller.
- B. Fixture Wiring
- C. Signaling Systems Wiring
- D. Power Distribution wiring

1.02 Related Work

- A. Equipment Identification Section
- B. Grounding and Bonding Section

1.03 Reference Standards

- A. IEC 227
- B. IEC 228
- C. IEC 502, 540
- D. IEC 287
- E. BS 6004, 6231, 6346, 7629.

1.04 Submittals

- A. Submit product data and manufacturers literature
- C. Submit proposals for colour coding of insulation
- D. Submit completed test sheets.
- E. Sample of cable pulling lubricant.

Part 2 - PRODUCTS**2.01 Materials**

- A. Building Wiring: Concentric lay, uncoated copper with a normal maximum operating temperature of 85 C, 600V, PVC insulation.
- B. Power and Control wiring: Concentric lay, uncoated copper with a normal maximum operating temperature of 70 C. Insulation to be 600 V PVC with black PVC jacket. Provide white conductor insulation with indelible black numerals at 25mm intervals on control cables. Maximum conductor size to be 10 mm².
- C. Flame Retardant Power and control Wiring: Multi Strand, concentric lay, coated copper with a normal maximum operating temperature of 90 C and 600V flame retardant cross linked polyethylene insulation and overall cable jackets of chlorosulfonated polyethylene, all in accordance with Standards and Codes. Cable jacket to be applied over tape wrapped cable cores.
- D. Flame Retardant Alarm and instrument Cable : Multi strand, concentric lay, coated copper with a normal maximum operating temperature of 90 C and 600V flame retardant cross linked polyethylene insulation, cable assembly shield of combination aluminum/mylar tape and 7 strand 0.6 mm² minimum coated copper drain wire applied to achieve 100% cover over insulated conductors and chlorosulfonated polyethylene cable jacket. Twisted pair cables with 60 mm to 90 mm lay staggered. Each pair to be numbered.
- E. Fixture Wire: Standard round coated copper with a operating temperature of 200 C with 600V silicone rubber insulated and braided glass jacket, all in accordance with Standards and Codes.
- F. Fire alarm Signal Cable: shall be fire resistant multi-core cable to conform with civil defence regulations and manufacturer recommendations.
- G. Lighting/Power Cable: Multicore copper conductors 600V grade PVC insulation lighting cable minimum size is 2.5 mm² and power cable minimum size is 4 mm². Provide one (1) larger size lighting/power cable (lighting cable size is 4mm² and power cable size is 6mm²) if entire circuit length from Electrical panel board to the last lighting fixture/outlet is more than 30 meters long.
- H. Loudspeaker Cable : Single pair with solid copper conductor (1.25mm diameter) in flat configuration with polyethene insulation and PVC jacket. Conductors to have a maximum DC loop resistance at 20 C of 28 ohms per kilometer and a nominal capacitance of 91 picofarads per meter.

2.01 Materials (cobt'd)

- I. Microphone Cable: Single pair screened with stranded copper conductors (13/0.2mm) with PVC insulation lapped copper screen and PVC jacket. Conductors to have a maximum DC loop resistance of 45.7 ohms per kilometer and a nominal capacitance of 430 picofarads per meter.
- J. Attendant Call Cable: Minimum 2.5 mm² cable as described in Part 2.01A above.
- K. Slave Clock Cable: Minimum 1.5 mm² cable as described in Part 2.01A above.
- L. Control cable: Multicore 2.5 mm² cable as described in part 2.01A above.

2.02 Manufactures Recommended:

- Pirelli General Cable Works Ltd (UK)
- General Cable (U.S.A)
- BICC Pyrotex Ltd (U.K)
- or equal and approved alternative

Part 3 - EXECUTION**3.01 Installation**

- A. Ensure conductor lengths for parallel feeders are equal.
- B. Lace or clip conductor groups at switchgear panels, pullboxes, wireways, etc.
- C. Provide grounding conductors and straps in accordance with the grounding specification Section.
- D. Wiring in conduit only to be installed after concrete, masonry and plastering work is complete and all conduit has been cleaned out and dried.
- E. Splice cables at accessible junction or outlet boxes only.
- F. Color code all wiring insulation as per equipment identifications specification Section.
- G. Terminate cables in accordance with the manufacturers recommendations.

3.01 Installation

H.	Colour codes	:	220V System
	Phases	:	phase "A" red, phase "B", yellow, phase "C" blue.
	Neutral	:	Black
	Ground	:	Green / Yellow in combination or green

3.02 Field Testing

Field testing: Insulation resistance of all conductors shall be tested. Each conductor shall have its insulation resistance tested after the insulation is completed and all splices, taps and connections are made except connection to or into its source and point (or points) of termination. Insulation resistance of conductors which are to operate at 600 volts or less shall be tested by using a Biddle Megger of not less than 1000 volts d-c, insulation resistance of conductors rated at 600 volts shall be free of shorts and grounds and have minimum resistance phase-to-phase and phase-to-ground of at least 10 megohms. Conductors that do not exceed insulation resistance values listed above shall be removed at Contractor's expense and replaced and test repeated. The Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed, and shall forward copies of the test readings to the Engineer in accordance with Section 16010. These test reports shall identify each conductor tested, date and time of test and weather conditions. Each test shall be signed by the party making the test.

END OF SECTION

Section 16121

600 Volt Cable

SECTION 16121**600 VOLT CABLE****PART 1 GENERAL****1.01 Work Included**

Single and multi core insulated power conductors rated 600 volts, sized 10 mm² and greater.

1.02 Related Work

- A. Grounding and Bonding
- B. Wiring
- C. Equipment Identification

1.03 Reference Standards

- A. B.S. 6360, 6004, 6207, 6476, 6346, 5468
- B. IEC 502
- C. IEC 228
- D. IEC 287

1.04 Submittals

- A. Provide Product Data and manufacturers literature
- B. Provide Operation and Maintenance Data
- D. Submit completed factory any site test sheets
- E. Sample of cable pulling lubricant

PART 2 - PRODUCTS**2.01 General**

- A. Cables shall be one, three or four core consisting of 99% conductivity, bare annealed stranded copper conductors rated at a normal maximum operating temperature of 90 degrees
- B. Insulation for cables 10 mm² and greater shall be of extruded semi-conducting cross-linked polyethylene, meeting standards requirements. A semi-conducting tape may be used under the polyethylene.
- C. Provide a PVC overall jacket on all cables, with a durable marking on the surface of the jacket at intervals not exceeding 610mm. marking shall include manufacturers name, conductor size and voltage class of cable.
- D. Cable ampacity and electrical characteristics shall conform with specified codes and standards.
- E. Provide a ground wire with each circuit sized in accordance with the grounding specification Section. Ground wire shall be bare, concentric lay copper.
- F. Where armoring is required, it shall be steel strip armour on single core cables and galvanized steel or tape armour on multi-core cables.

2.02 Splices and Termination

- A. Cable splices and terminations shall be furnished in kit form and shall conform to the recommendations of the cable manufacturer. All material shall be furnished in factory sealed packages and shall not be opened until required for use.
- B. Splices shall be suitable for installation in manholes
- C. Terminal connectors shall be pressure; bolted clamp or compression type.

2.03 Cable Ties and Cable Markers

- A. Lacing material for site installed cable shall be non-releasing nylon ties.
- B. Tie-on cable markers shall be provided in accordance with equipment identification specification Section.

2.04 Wiring

Single core 600 volt cable of size 10 mm² and less is specified under different Section.

2.05 CU/XLPE/SWA/PVC:**A. CU/XLPE/SWA/PVC:**

1. To BS 5468, 1000V grade
2. Conductors : Plain annealed copper to BS 6360
3. Cables shall comprise of plain copper, stranded circular conductors insulated with an adequate thickness of extruded cross linked polythene (XLPE).
4. Conductors shall be laid up together and wormed circular with suitable pre-formed fillers and wormings, bound with polythene terephthalate (PTP) tape and covered with an extruded PVC sheath minimum 1.4 mm thick.
5. Multicore cables shall have steel wire or tape armouring, extruded sheath of black PVC.
6. Single core cables shall be unarmoured, unless otherwise specified, with an extruded black PVC outer sheath.
7. Outer sheath of single and multicore shall be at least 2.5mm thick.
8. Design electrical stress at any point in the insulation shall not exceed 3KV per mm.
9. Conductor screen: non-metallic comprising of either:
 - a. Semi-conducting tape; or
 - b. A layer of extruded semi-conducting material.
10. The electro-static screen over insulation shall comprise of a non-metallic layer of semi-conducting tape or extruded semi-conducting material applied over the insulation and in direct contact with it, followed by a layer of copper tape applied helically over the semi- conducting layer to ensure close contact throughout.

2.05 CU/XLPE/SWA/PVC: (cont'd)

11. Prevent void formation in insulation by careful control of its passage through the temperature graded water baths.

2.06 Approved Manufacturers

- A. Pirelli General Cable Works Ltd (U.K)
- B. General Cable (U.S.A)
- C. BICC Pyrotenax Ltd (U.K)
- D. or equal and approved alternative

PART 3 - EXECUTION**3.01 Internal Cable Installation**

- A. Support internal horizontal and vertical runs on cable tray using non-ferrous clamps at 1 meter intervals.
- B. Arrange multicore cables to run parallel on tray with a lateral spacing of the diameter of the largest cable.
- C. Arrange single core cables with phases in trefoil formation providing one cable diameter space between trefoil groups.
- D. Where cables are routed through walls or floors, the opening between the cables and the structure shall be sealed such that the fire resistance of the sealing barrier is at least as great as the surrounding structure.

3.02 External Cable Installation

- A. Immediately prior to the placement of each cable or cable group, the raceway route to be followed shall be inspected and ascertained to be complete in installation and free of all materials detrimental to the cable or its placement. All cables assigned to a particular duct or conduit shall be grouped and pulled in simultaneously, using cable grips or pulling eyes and acceptable lubricants.

All cables shall be carefully checked both as to size and length before being pulled into conduits or ducts. Cable pulled into the wrong conduit or duct or cut too short to rack, train, and splice as specified herein, shall be removed and replaced.

3.02 External Cable Installation (cont'd)

- B. Cable in manholes, Shafts,... etc.: Cable shall be supported at all times without short bends or excessive sags and shall not be permitted to lie on the manhole floor. Cable ends must not be submerged. Cable racks, saddle supports or trays shall be provided for permanent support. Temporary support required during placement shall be with rope slings, timbers, or alternate method acceptable to the Engineer.

Cable shall be located in manholes to provide minimum interference with other cables to be installed or installation of future cables in spare conduits.

- C. Cable Pulling: Pulling shall be done with nylon or rope recommended by cable manufacturer.
- D. Cable Grips: Factory installed pulling eyes shall be used for pulling cable where they are available. Woven wire cable grips shall be used to pull all single conductor cable, 70 mm² and larger. Pulling loops shall be used to pull single conductor cable smaller than 70 mm². When a cable grip or pulling eye is used for pulling, the area of the cable covered by the grip or seal plus 150 mm shall be cut off and discarded when the pull is completed.
- E. Inspection: The outside of each cable reel shall be carefully inspected and protruding nails, fastenings, or other objects which might damage the cable shall be removed. A thorough visual inspection for flaws, breaks, or abrasions in the cable sheath shall be made as the cable leaves the reel, and the pulling speed shall be slow enough to permit this inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged in any way during installation shall be replaced.
- F. Pulling Tension: The pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types used by the Contractor shall have the rated capacity in tons clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometers shall be used to show the tension on the cable and the indicator shall be constantly watched. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected.
- G. Sidewall Pressure: To avoid insulation damage from excessive sidewall pressure at bends in duct and conduit runs, the pulling tension in kilograms at a bend shall not exceed 450 times the radius of the bend in metres.
- H. Cable Bends: Extreme care shall be exercised during the placement of all cable to prevent tension and bending conditions in excess of the manufacturer's recommendations. The permanent radius of bend after cable installation shall be in accordance with the cable manufacturer's recommendations.

3.02 External Cable Installation (cont'd)

- I. **Supports:** All cable supports and securing devices shall have bearing surfaces located parallel to the surfaces of the cable sheath and shall be installed to provide adequate support without deformation of the cable jackets or insulation.

Final inspection shall be made after all cable is in place and, where supports, bushings, and end bells deform the cable jacket, additional supports shall be provided. Additional cable protection such as a wrapping of light rubber belting, friction tape, or similar materials shall be provided when required. Cable in vertical runs shall be supported by woven wire grips in accordance with the Code requirements.

- J. **Cable Identification:** The Contractor shall identify all cables in the locations specified in the equipment identification spec Section.

- K. **Moisture Seals:** Each cable shall be kept sealed except when termination and splicing work is being performed.

The ends of all cables shall be sealed with heat shrinkable caps. Cap sizes shall be as recommended by the cap manufacturer for the cable outside diameter and insulation. Caps shall contain sufficient adhesive that shrinkage of the cap during application results in formation of a positive watertight seal capable of withstanding complete immersion or total exposure without permitting the entrance of moisture.

Before and after pulling, the leading and seal of each length of cable shall be examined and repaired if necessary. All cut cable ends shall be promptly sealed after cutting except those to be spliced or terminated.

- L. **Crimping Tools:** Crimping tools used to secure conductors in compression type connectors or terminal lugs shall be those made for that purpose and for the conductor sizes involved. Crimping tools shall be a product approved by the connector manufacturer. The Contractor shall establish and maintain a tool certification program to ensure that crimping tools are kept in accurate operating condition.

- M. **Termination:** Cable shall be terminated in accordance with the following requirements.

- Train cable in place and cut squarely to required length. Avoid sharp bends.
- Install terminals or terminal connectors as required, ensuring a firm metal-to-metal contact.

3.02 External Cable Installation (cont'd)

- Insulate each connection of cable to an insulated conductor (whether cable, bus, or equipment bushing). The insulation shall cover all exposed surfaces of the conductors; the insulation voltage level of the completed termination shall be not less than the insulation voltage level of the connected conductors. Insulation of terminations shall be as specified in the following paragraphs.
- N. Insulation of Termination in 600 volt Cable: Terminations which require insulation in cable rated 600 volts or less shall be insulated in accordance with the following requirements:
- All exposed conductor and connector surfaces shall be covered with a minimum of three half-lapped layers of self-vulcanizing rubber insulating tape.
 - A minimum of three half-lapped layers of polyvinyl chloride electrical tape shall be applied over the rubber tape. The polyvinyl chloride tape shall extend a minimum of two cable diameters over the cable jacket and a similar distance over other conductor insulation or connector requiring insulation.

3.03 Field Testing

Insulation resistance of all conductors shall be tested. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps and connections are made except connection to or into its source and point (or points) of termination. Insulation resistance of conductors which are to operate at 600 volts shall be tested by using a Biddle Megger of not less than 1000 volts d-c. Insulation resistance of conductors rated at 600 volts shall be free of shorts and grounds and have a minimum resistance phase-to-phase and phase-to-ground of at least 10 megohms. Conductors that do not exceed insulation resistance values listed above shall be removed at Contractor's expense and replaced and test repeated. The Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed, and shall forward copies of the test readings to the Engineer in accordance with Section 1610. These test reports shall identify each conductor tested, date and time of test and weather conditions. Each test shall be signed by the party making the test.

END OF SECTION

Section 16122

Elevator Equipment Wiring

SECTION 16122**ELEVATOR EQUIPMENT WIRING****PART 1 - GENERAL****1.01. Work Included:**

- A. Elevators equipment wiring for
Passenger, patients and service elevators
- B. Elevator equipment wiring includes
 - 1. Elevator power service connections
 - 2. Telephone service connections
 - 3. Lighting and emergency lighting connections for car and elevator shaft.
 - 4. Connection for car-top receptacles
 - 5. Fire alarm system connection

1.02. Related Work:

- | | | |
|----|--------------------------|----------------|
| A. | Electrical elevators | Section: 14100 |
| B. | Wiring | Section: 16120 |
| C. | Fire Alarm System | Section: 16720 |
| D. | Wiring Devices | Section: 16140 |
| E. | Enclosed Safety switches | Section: 16490 |
| F. | Grounding and Bonding | Section: 16125 |

1.03. Work Covered Under Other Sections:

- A. The lighting, receptacles, telephone and fire alarm system installations shall be covered under the relevant sections of Division 16.

PART 2 - PRODUCTS**2.01: Components:**

- A. Provide the following switches in the respective elevator motor rooms:
- Elevator shaft lighting switch
 - Elevators motors rooms power switch
- B. For other wiring refer to the drawings and to elevators specification Section.
- C. Provide junction boxes complete with terminals in elevator motor rooms for:
- Service receptacle on top of cars
 - Lighting and emergency lighting in cars
 - Lighting in shaft
 - Telephone connections
 - Fire alarm connections

PART 3 - EXECUTION**3.01: Coordination:**

Coordinate location of lights, switches, receptacles, fire alarm sensors, machines, and junction boxes installed in elevator machine rooms and elevator pit with elevator system installer on site prior to installation.

3.02: Equipment wiring:

- A. Place elevator wall switches on lock side of door within elevator machine room.
- B. Provide lighting supply in elevator motor rooms for elevator car lighting and supply for elevator emergency lighting.
- C. Provide 220 volt single phase A/C supply in elevator motor rooms for elevator car top receptacles.

3.02: Equipment wiring:

- D. Provide provisions for telephone cabling connection in shafts for each elevator car.
- E. Provide signal cabling between elevator control panels and the fire alarm indicator/control panel.
- F. Terminate wiring in elevator motor room in junction boxes referred to above.

3.03: Tests:

All systems interfaced with elevator installation shall be tested in coordination with elevator system installation.

END OF SECTION

Section 16125

Grounding

SECTION 16125**GROUNDING****PART 1 - GENERAL****1.1 Related Documents**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

This section specifies the furnishing and installation of grounding and bonding equipment for electrical systems.

1.3 Reference Standards

1. ANSI/IEEE Std 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. ANSI/UL 467 - Grounding and Bonding Equipment.
3. BS 7430 and BS 7671

1.4 Submittals

1. Equipment Data: Prior to ordering materials, submit data for approval including, but not limited to, manufacturers catalogues for earth rods, connecting, clamps, earthing conductors, protective conductors, bonding conductors, connectors and other accessories, exothermic welding kits, and tools etc., and samples of conducts as requested.
2. Shop and Construction Drawings: submit drawings for approval including, but not limited to, the following:
 - (1) Exact location of earth pits, rods and details of installation and connections.
 - (2) Exact routing of buried earthing conductors with indication of cross-section, depth of laying and covering cross sectional area of all earthing, protective and bonding conductors.
 - (3) Layout and details of earthing provisions at substations, generator rooms, switch gear, distribution panel covering cross sectional area of all earthing, protective and bonding conductors.

PART 2 - PRODUCTS**2.1 Materials**

Earth Rod: Copper clad steel, 16mm diameter, 3m length, extendible as necessary to obtain required earth resistance. Earth rod is to be complete with couplings, head and bolted connector of sufficient size, and number of bolted clamps to connect all cables terminated thereto.

2.2 Buried Earth Conductors:

Bare annealed copper strip conductors 25x3mm, or annealed stranded copper conductors 70mm² cross-section.

2.3 Tape Mats:

Where earth rods are not likely to be used, earth electrode is to consist of parallel and perpendicular copper strip, 2.4 m apart, welded together by exothermic welds to form a grid. Tape is to be 25x3mm strip conductor.

2.4 Earth Pit:

Precast, square or circular section concrete handhole (minimum 450 mm internal diameter), with cast iron cover and extending to about 150 mm below top of earth rod. Earth pit is to be provided for each earth rod where connected to an earthing conductor. Cover is to have inset brass plate with inscription. Earth Pit-Do Not Remove, cover to have a recessed lifting hook.

2.5 Earthing:

Conductors: insulated or bare copper conductor as described in the specification for the particular application.

2.6 Testing joints (Test Links):

Copper or copper alloy, with bolted end connections, disconnectable by use of a tool, and suitably sized for earthing conductors or earth bar connection. Links are to be fixed to porcelain or other approved insulating supports. Contact surfaces are to be tinned.

2.7 Protective Conductors:

Single core stranded annealed copper, PVC insulated cables, having rated insulation grade compatible with circuit protected, or to be a conductor forming part of a multi-core cable, color coded.

2.8 Main Earthing Bar:

Hard drawn copper, 40x4 mm where formed into a closed loop, and 50x6mm where open ended. Earth bar is to be labeled AMain Earth Bar@ and is to be drilled, for connection of conductors, at a spacing not less than 75mm, and is to be supplied with copper alloy bolts, nuts and washers and wall mounting insulators.

2.9 Protective Bonding Conductors:

Bare copper strip conductor, annealed stranded copper cable or flexible strap (flexible braid) of cross-sectional area as described in sub-section 2.01 hereof.

2.10 Earthing Accessories:

Copper or copper alloy, purpose made, of approved design, compatible with points of connection, and of adequate cross-section and current carrying capacity. Connectors and clamps are to be bolted type. Bolts, nuts and washers are to be high quality phosphor bronze or copper silicon alloys.

PART 3 - EXECUTION**3.1 System Ground**

1. System Neutral: Where a system neutral is used, ground the system neutral as required by NEC Article 250. Ground the system neutral only at the point of service and isolate it from ground at all other points in the system.
2. Separately Derived Systems: Ground neutrals of separately derived systems such as generators, etc., in accordance with NEC 250-26.
3. Size: Size the system grounding electrode conductors to comply with NEC Table 250-94, unless shown larger.
4. Testing: Test the completed grounding system. If the resistance of the grounding system is less than 5 ohms, add ground rods to attain 5 ohms.

3.2 Equipment Ground

1. Manholes: Provide a No. 1/0 AWG bare stranded copper ground bus in all manholes. Mount bus 304.8mm (12 inches) above floor using one-hole pipe straps 914.4mm (3') on center. Connect bus to ground rod with a No. 1/0 AWG conductor. Bond all metallic components and electrical grounding conductors to the bus using lugs or clamps.

3.2 Equipment Ground (cont'd)

2. Switchgear Rooms: Provide a ground bus in switchgear room. Mount bus 304.8mm (12 inches) above finished floor and 1 inch from wall around perimeter of room. Connect bus by a grounding conductor with a cross-sectional area equivalent to the ground bus to an acceptable grounding electrode as described in NEC Article 250. Connect all noncurrent-carrying metallic parts of electrical equipment in the room to the bus.
3. Raceway Systems and Equipment Enclosures:
 - A. Ground cabinets, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, other electrical equipment and metallic enclosures: Ground equipment and enclosures to the continuous-grounded, metallic raceway system in addition to any other specific grounding shown.
 - B. Provide bonding jumpers and ground wire throughout to ensure electrical continuity of the grounding system.
 - C. Provide grounding-type insulated bushings for metal conduits 38.1mm (1-1/2 inches) and larger terminating in equipment enclosures containing a ground bus and connect the bushing to the ground bus.
 - D. Provide a green insulated equipment grounding conductor for each feeder and branch circuit.
4. Size: When grounding and bonding conductors are not sized on drawings, size the grounding conductors in accordance with NEC Table 250-95. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent grounding conductor as determined from NEC Table 250-95.

END OF SECTION