



TECHNICAL SPECIFICATIONS

FOR

ELECTRICAL WORKS

**PROPOSED MULTI-PURPOSE CENTER
CITY OF BORONGAN, EASTERN SAMAR**

SEPTEMBER 2015



PROPOSED MULTI-PURPOSE CENTER
City of Borongan, Eastern Samar

DIVISION 16 ELECTRICAL WORKS

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SECTION 16010 - GENERAL PROVISIONS

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SECTION 16010 - GENERAL PROVISIONS

1.0 GENERAL CONDITIONS:

All sections under this Division shall be subject to the requirements of the Architect's General Conditions - UAP Doc. 301 and Section 16010 of these Specifications.

2.0 GENERAL DESCRIPTION:

A. The work to be done under this Division of the Specifications consists of the fabrication, complete in all details, of the Electrical Work, at the subject premises, and all work and materials incidental to the proper completion of the installation, except those portions of the work which are expressly stated to be done by others. All work shall be in accordance with the governing Codes and Regulations and with the Specifications, except where same shall conflict with such Codes, etc., in which case, latter shall then govern. The requirements in regard to materials and workmanship specify the required standards for the furnishing of all labor, materials and appliances necessary for the complete installation of the work specified therein and indicated on the drawings. These specifications are intended to provide a broad outline of the required installation, but are not intended to include all details of design and construction.

B. The CONTRACTOR before submitting his proposal, shall examine all drawings relating to his work and verify all governing conditions at site and shall become fully informed as to the extent and character of the work required. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or work to be done, it being understood that the submission of a proposal is an agreement to all items and conditions referred to herein or indicated on the accompanying drawings and actual site conditions.

If specified equipment/instruments are not locally available, CONTRACTOR must immediately place an order as soon as project is awarded. Any exceptions, omission or substitutions shall be presented in writing with the CONTRACTOR's bid.

C. The CONTRACTOR, before commencing work, shall examine all adjoining areas on which this work is in any way dependent for perfect workmanship according to the intent of this specification and shall report to the Owner's representative any condition which will prevent the CONTRACTOR from performing first class work. No waiver of responsibility for defective work will be considered unless notice has been filed at the time the CONTRACTOR submits his proposal.

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- D. It is the intention of these Specifications and drawings to call for furnished work tested and ready for operation. Whenever the word "provide" is used, it shall mean "furnish and install, complete and ready to use". Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

3.0 WORK INCLUDED:

Under this Division of the Specifications, provide all materials and equipment and perform all the work necessary for the complete execution of all the Electrical Works as shown on the Electrical Drawings, and on the General Construction Drawings, as herein specified, or both, except as otherwise excluded, and which without excluding the generality of the foregoing, shall include but not be limited to the following principal items of work:

- A. Power distribution equipment including lighting panelboard and disconnect switches.
- B. A system of lighting and power wiring, switches and socket outlets including all feeders, branch circuits and connections to all lighting and power outlets.
- C. All general lighting fixtures and lamps.
- D. Complete grounding system for electrical power system.
- E. Lightning Protection System
- F. Battery Operated Fire Detection and Alarm System
- G. Complete testing and commissioning of all systems.
- H. Painting of electrical work and equipment.
- I. Grouting of openings in floors and walls after all conduits or pipes or ducts are in place and sealing of all such openings.
- J. Anything that has been omitted in any item of work or materials usually furnished, which are necessary for the completion of the electrical work.

4.0 CODES, INSPECTION, PERMITS AND FEES:

- A. The work under this contract is to be installed according to the latest requirements of the following:

SECTION 16010 - GENERAL PROVISIONS

Philippine National Building Code
Philippine Electrical Code
City of Borongan, Eastern Samar
Local Electric Utility

Nothing contained in these specifications or shown on the drawings shall be construed as to conflict with National and Local Ordinances or Laws governing the installation of Electrical Works, and all such laws and ordinances are hereby made part of these specifications. The Contractor is required to meet the requirements thereof.

- B. All construction permits and fees including construction plans and specifications required for this work shall be obtained by and at the expense of the CONTRACTOR. The CONTRACTOR shall furnish the OWNER and the CONSULTANT final certificates of inspection and approval from the proper government authorities after the completion of the work. The CONTRACTOR shall prepare all the shop or working drawings, as-built plans and all other paperwork required by the approving authorities.
- C. Approval from authorities of all plans for construction shall be secured by the CONTRACTOR.

5.0 RECORD DRAWINGS:

- A. The CONTRACTOR shall, during the progress of the work, keep a record of all deviations of the actual installation from that shown on the Contract Drawings and shall be available anytime upon request of the CONSULTANT.
- B. The CONSULTANT will furnish the CONTRACTOR at cost a complete set of electronic files on which he shall indicate all changes and revisions. Copies of these electronic files, indicating such changes and revisions, shall be submitted to the CONSULTANT together with the requests for progress billings.
- C. Upon completion of work, the CONTRACTOR shall submit three (3) copies of the as-built drawings, signed and dry-sealed by the Contractor's registered Professional Electrical Engineer, indicating the work as actually and finally installed, including new information not originally shown in Contract Drawings, to the CONSULTANT for approval as to conformance with the design concepts and compliance with pertinent Code provisions. The CONTRACTOR shall also submit three (3) sets of operating and maintenance instructions, equipment and parts lists for approval.

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After such approvals, the CONTRACTOR shall submit the CADD-generated as-built originals, three (3) sets of prints and two (2) sets of electronic files to the CONSULTANT, as well as three (3) sets of operating and maintenance instructions, equipment and parts lists, including addresses of manufacturers or suppliers of major equipment and materials.

- D. Approval of the as-built drawings by the CONSULTANT shall be a requirement for final acceptance of the completed works and of final payment.

6.0 SHOP DRAWINGS, SAMPLES AND OTHER SUBMITTALS:

- A. CONTRACTOR shall prepare and submit to the CONSULTANT for approval the following:
1. Dimensional layout and assembly drawings of all panelboards. Shop drawings shall contain bus bar sizes and spacing, lug sizes, circuit breaker arrangements, etc. of each of the panelboards.
 2. Shop drawing and sample of wireways for power and communications.
 3. Shop drawing of lightning protection mounting bracket.
 4. Sample of lighting fixtures.
 5. Samples and/or manufacturer's catalog sheets with complete technical data marked as necessary to indicate materials, devices and equipment being furnished for the following:
 - a. Circuit breakers
 - b. Fire detection and alarm system devices
 - c. All lighting fixtures
 - d. All wiring devices including plate covers
 - e. Lightning Protection System
 6. Detailed shop drawings for the following installations:
 - a. Lighting fixtures
 - b. Main feeder
 - c. Mounting of panelboard, pullboxes and gutters.
 7. Field test reports for the following:
 - a. Insulation resistance tests
 - b. Voltage level tests
 - c. Continuity test
 - d. Phase relationship
 - e. Earth-ground resistance tests

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8. List of miscellaneous materials proposed, including conduits, conductors, and accessories, identifying manufacturer and type.
 9. Such other shop drawings as indicated on the plans or as the CONSULTANT may require.
- B. All drawings should be signed and dry sealed by the Contractor's Registered Professional Electrical Engineer.
 - C. All drawings, etc. shall be submitted sufficiently in advance of field requirements to allow ample time for checking and no extension of the contract time will be granted this CONTRACTOR, by reason of his failure in this respect.

All submittals shall be complete and shall contain all required and detailed information.

7.0 COORDINATION:

- A. Coordinate timing of installation with work of other trades.
- B. Systems provided shall be complete and operable, and shall include required accessories, fastenings, and supports.
- C. Determine required location, arrangement, and quantities of equipment and materials from drawings, schedules and specifications.
- D. All equipment shall be installed in strict accordance with manufacturer's recommendations.
- E. Certain items of equipment specified in other contracts require electrical connections. Contractor shall provide such connections as required.

8.0 MINOR MODIFICATIONS:

The plans as drawn are based upon architectural plans and details and show conditions as accurately as it is possible to indicate them in scale. The plans are diagrammatical and do not necessarily show all fittings, etc., necessary to fit the building conditions. The location of outlets, apparatus and equipment shown on the plans are approximate. This CONTRACTOR shall be responsible for the proper location in order to make them fit with architectural details and instructions from the CONSULTANT's representative at the site.

9.0 GUARANTEE:

- A. The CONTRACTOR shall guarantee that the Electrical System is free from all grounds and from all defective workmanship and materials and

SECTION 16010 - GENERAL PROVISIONS

will remain so for a period of one (1) year from date of acceptance of the work. Any defects, appearing within the aforesaid period, shall be remedied by this CONTRACTOR at his own expense.

- B. The CONTRACTOR shall indemnify and save harmless the OWNER and the CONSULTANT from and against all liability for damages arising from injuries or disabilities to persons or damage to property occasioned by any act or omissions of the CONTRACTOR or any of his Subcontractors, including any and all expenses, legal or otherwise which may be incurred by the OWNER, or the CONSULTANT, in the defense of any claim, action or suit.

10.0 APPROVALS, SUBSTITUTIONS, ETC.:

Wherever hereinafter the words "for approval", or "approved" (make, type, size, arrangement, etc.) are used, especially in regard to manufactured specialties, etc., or wherever it is desired to substitute a different make or type of apparatus for that specified, all information pertinent to the adequacy and adaptability of the proposed apparatus, shall be submitted during the pre-bid conference(s) to the CONSULTANT and their approval secured before submitting the bid. No approvals or substitutions on specified items will be entertained unless requested by the OWNER after the Contract Award or during construction.

11.0 ACCEPTANCE TEST:

Field tests and adjustments as laid out in Section 16100 shall be performed prior to approval of work.

12.0 SUBCONTRACTS, ETC.:

This CONTRACTOR shall be held fully responsible for the work of any Subcontractor or manufacturer performing work for or supplying materials to him, as it is intended that the entire Electrical Work, when finally delivered to the OWNER, shall be ready in every respect for satisfactory and efficient operation.

13.0 WORKMANSHIP:

The work throughout shall be executed in the best and most thorough manner to the satisfaction of the CONSULTANT, who will interpret the meaning of the Drawings and Specifications and shall have the authority to reject any work and materials which in their judgment, are not in full accordance therewith.

This CONTRACTOR shall assume unit responsibility and shall provide the service of a qualified Engineer to supervise the complete installation of equipment and systems and who shall be available for conducting the final acceptance tests.

SECTION 16100 - BASIC MATERIALS AND METHODS

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SECTION 16100 - BASIC MATERIALS AND METHODS

1.0 REFERENCE:

Requirements of Section 16010 apply to all work under this Section.

2.0 GENERAL:

- A. Furnish and install all conduits, joint and outlet boxes, conductor and miscellaneous materials required for wiring, as specified herein and shown on drawings.
- B. Furnish and install all power and control wiring to all equipment, except as otherwise specified. Equipment includes motor, motor starter, and miscellaneous devices.

3.0 INTERMEDIATE METAL CONDUIT: (ALTERNATE: RIGID STEEL CONDUIT)

- A. General: NEMA Standard trade sizes, UL approved or equivalent to Pittsburg Standard's SeAH, Robroy, Youngstown, Panasonic, Maruichi, Korea or approved equal.
- B. Material: Mild steel, hot dipped galvanized.
- C. Size: 15mm (½") minimum.
- D. Couplings, unions and fittings: standard, threaded.
- E. Use limitation: As specified in the latest edition of PEC and/or NEC.
- F. Expansion fittings: Use for runs spanning expansion joints.
- G. Paint field cuts and repair damaged protective coating with zinc chromate. Conduit threads shall not be painted.

4.0 POLYVINYLCHLORIDE (PVC) CONDUIT:

- A. General: Standard trade sizes, heavy wall, manufactured to NEMA TC-2 Type 40, rated for 90°C cable as manufactured by Neltex, Moldex and Atlanta or approved equal.
- B. Material: Polyvinylchloride, extruded.
- C. Nominal Size: 20mm (¾") minimum.
- D. Couplings and Fittings: Standard joint by solvent weld process.

SECTION 16100 - BASIC MATERIALS AND METHODS

- E. Use Limitation:
 - 1. As specified in the latest edition of PEC and/or NEC.
 - 2. Not permitted where subject to mechanical damage.
 - 3. As indicated in the drawings.
- F. Pulling Hardwares: Flat fish tape with ball and flexible leader or polyethylene or Manila rope. Use of steel pulling cable not permitted.

5.0 FLEXIBLE GALVANIZED STEEL CONDUIT:

- A. General: Standard trade sizes, UL approved or equivalent.
- B. Material: Steel, galvanized.
- C. Size: 15mm (½") minimum.
- D. Fittings: Standard.
- E. Use Limitation:
 - 1. Between motor terminal boxes, or vibration producing devices and rigid conduit.
 - 2. Short lengths of concealed wiring to lighting fixtures (max. length - 1800mm).
 - 3. Other applications: only where approved or where shown on plans.

6.0 FLEXIBLE LIQUID TIGHT CONDUIT:

- A. General: Standard trade sizes. UL approved or equivalent.
- B. Material: Galvanized steel with outer liquid-tight plastic jacket.
- C. Diameter: 15mm (½")
- D. Fittings: Liquid-tight
- E. Use limitation:
 - 1. Short lengths to vibration producing devices situated in wet or potentially wet locations.
 - 2. Between motor terminal boxes or vibration producing devices and rigid conduit.

SECTION 16100 - BASIC MATERIALS AND METHODS

3. Other applications: Only where approved or where shown on plans.

7.0 CONDUIT INSTALLATION:

- A. General: Install in accordance with applicable codes and recognized standards of good practice.
- B. Location: Approximately as shown on drawings; actual routing subject to approval.
- C. Wall and floor sleeves:
 1. General: Provide for passage of conduits through walls, floors, or partitions. Set sleeves in masonry during construction; set sleeves through concrete before pouring begins.
 2. Material: Galvanized pipe, securely fastened in position.
 3. Sleeves through exterior building walls: Install conduit in center of sleeve, fill annular space with loosely packed oakum. Seal interior and exterior of packing with hot applied asphalt. Fit the conduit on each side of the wall with round galvanized steel flange fastened to conduit by two set screws to retain sealing compound.
 4. Sleeves through waterproof constructions: Flanged type.
 5. Opening required after footings, walls, floors, or ceilings are constructed shall be provided and patched at Contractor's expense in an approved manner.
- D. Embedded Conduit:
 1. General: Set before pouring of concrete begins. Route in as direct a line as possible and where a bend is required, turn with a long radius.
 2. Underground installation: Encase conduits with concrete, 75mm (3") from outer face of conduits.
 3. Conduit joints shall be half-wrapped with 3M Scotch Wrap #50 PVC Tape or approved equivalent.
- E. Joints: Make with approved couplings and unions to provide electrically continuous and moisture-tight system.

SECTION 16100 - BASIC MATERIALS AND METHODS

- F. Expansion joints: Use expansion fittings and bonding jumpers wherever conduit spans building expansion joints.
- G. Bends: Not more than the equivalent of three 90° bends between pulling joints.
- H. Wiring of fire related motors shall be embedded or encased in concrete.
- I. Field cuts and threads:
 - 1. Cut ends of conduit square with hand or power saw and ream to remove burrs and sharp edges. Do not use wheel cutter.
 - 2. Threads cut on job shall have same effective lengths, thread dimensions, and taper as factory cut threads.
 - 3. Carefully remove burrs from threads. Conduit threads shall not be painted.
 - 4. Apply coat of protective paint through conduits where protective coating is damaged.
- J. Supports:
 - 1. Manufacturer: Steel City, Unistrut or approved equal.
 - 2. Hangers, supports, or fastenings: Provide at each elbow and at end of every straight run terminating in a box or cabinet. Rigid fastenings spaced in accordance with the PEC.
 - 3. Clamps: Galvanized malleable iron one-hole straps, beam clamps, or other approved device with necessary bolts and expansion shields.
 - 4. Adjustable hangers:
 - a. Use to support horizontal runs only.
 - b. Trapeze hangers: For parallel runs of conduits. Install pipe clamps every third intermediate hanger for each conduit. Paint hangers one prime coat of red lead or zinc chromate, one finish coat of approved color. Hangers are not detailed but must be adequate to support the combined weights of conduit, conductors, and hangers.
 - 5. Submit shop drawings for approval.

SECTION 16100 - BASIC MATERIALS AND METHODS

- K. Concealing: Conceal conduits in all areas except mechanical equipment rooms and areas as specified. Run exposed conduits parallel with, or at right angle to, lines of buildings.
- L. Conduit ends:
 - 1. Cap conduit.
 - 2. Open conduit ends terminating in panels for enclosures where exposed to entrance of foreign material: Plug space around cables with commercial duct sealing compound.
 - 3. Cap conduit ends during construction to prevent entrance of foreign material.
- M. Cleaning: Clean inside by mechanical means to remove all foreign materials and moisture before wires or cables are installed.
- N. Conduit connections at panels and boxes: Double locknuts and bushings.

8.0 JUNCTION AND OUTLET BOXES:

- A. General: Provide junction boxes for pulling and splicing wires, and outlet boxes for installation of wiring devices as required, or as shown on drawings. As a rule, provide junction boxes in all runs of greater than 30 meters (100 ft.) in length. For other lengths, provide boxes as required for splicing or pulling. Boxes shall be in accessible locations.
- B. Construction: Welded sheet steel, galvanized finish. Provide removable covers attached with round head machine screws, minimum of 1.6mm MSG (Ga. 16). Concentric knockouts are not allowed.
- C. Support: Support boxes independently of conduits entering, by means of materials described in Section 16100, sub-section 7.0. J.
- D. Finish: Galvanized.

9.0 WIREWAY:

- A. General: Furnish and install wireway as indicated on drawings or as required.
- B. Size and arrangement: As indicated on drawings.
- C. Construction: Minimum 1.519mm (#16 MSG) thick galvanized steel sheet metal with snap-on cover or as shown on plans.

SECTION 16100 - BASIC MATERIALS AND METHODS

- D. All screws installed towards the inside shall be guarded to prevent wire insulation damage.
- E. Provide all necessary supports, fittings and miscellaneous materials for a complete installation.

10.0 CONDUCTOR:

- A. Manufacturer: UL listed, Phelps Dodge or approved equal.
- B. Material: Copper, annealed.
- C. Stranding: Standard stranding for 3.5 sq.mm and larger.
- D. Minimum sizes: 3.5 sq.mm THHN for lighting and power, 2.0 sq.mm for control wiring.
- E. Standards: ICEA or Philippine Electrical Code.
- F. Color Code:
 - 1. Color coding for all phase, ground and neutral conductors shall be as follows and in accordance with the Code:

	<u>Power</u>
Ground	Green
Neutral	White
Phase	Black

- 2. Color coding shall be maintained all throughout the installation.
- G. 600-Volt Class Conductors: Insulation:
 - 1. Feeders and general use conductors: THHN/THWN insulation.
 - 2. Fixture wires: In accordance with Philippine Electrical Code.

11.0 CONDUCTOR INSTALLATION:

- A. Place all wiring, in raceway of type or types indicated. Provide all required and indicated accessories for proper installation of all wiring.
- B. Bending radii: Not less than permitted by Philippine Electrical Code
- C. Supports in vertical runs: As prescribed by Philippine Electrical Code.

SECTION 16100 - BASIC MATERIALS AND METHODS

D. Splicing:

1. Permissible only in junction boxes or similar accessible locations. Number of splices held to absolute minimum.
2. Use solderless, compression-type wire terminators at devices. Use wire nuts with screws not bearing directly on the wires.

E. Insulation of splices or taps:

1. Three layers 20mm wide 3M Company "Scotch No. 33" or "Scotch No. 88", or approved equal, electrical tape, half lapped.
2. Use filler compound, "Scotchfil", or approved equal, at sharp edges to provide smooth surface before taping.
3. Use 3M #UG for .32/3C telephone.
4. Use 3M wire nut for splices in wireways.

F. Marking: Mark each end of every power or control cable with a plastic tag securely fastened to it bearing circuit use identification. Also mark cables in pull or junction boxes.

G. Connections:

1. Apparatus lugs: Solderless pressure-type lugs. Thoroughly clean lug conductor and coat with suitable oxidation inhibiting compound prior to connection.
2. Terminal blocks: Use retaining cup washers where solid wire is used. Use pressure type terminal lugs where stranded wire is used.
3. All feeder cable terminations shall be torqued and properly marked.

12.0 NAMEPLATES:

- A. General: provide and install nameplates wherever indicated as required in these specifications. Wording shall be approved prior to purchase of nameplates.
- B. Material: Red Bakelite engraving stock, white core.
- C. Lettering: Engraved, approximately 5.0mm high. Wording shall identify function of device to which nameplate is attached, or identify equipment served by device or as indicated in the plans.

SECTION 16100 - BASIC MATERIALS AND METHODS

- D. Installation (except for factory-installed nameplates): Attach with sheet metal screws after painting of equipment is completed.
- E. All receptacle outlets/switches, plates shall be identified with circuit and panel homerun numbers using tape labeller (do not use dymo).

13.0 FIELD TESTS AND ADJUSTMENTS:

- A. Test reports: Typewritten, listing equipment used, person or persons performing the tests, date tested, circuits tested, and results of tests.
- B. Insulation resistance tests, general:
 - 1. Perform insulation resistance tests on wires listed herein.
 - 2. Test Equipment: Furnished by CONTRACTOR; equal to Megger" as manufactured by James G. Biddle Company, motor driven or rectifier type with ranges of 500, 1000, and 2500 volts d-c.
 - 3. Resistance measured: Line to ground.
 - 4. Disconnect all solid state equipment before making wire or cable tests. CONTRACTOR is responsible for damage to any such equipment caused by these tests.
- C. Insulation resistance tests, wires.
 - 1. Test all 600 volt class power and lighting circuits at 1000-volt rating of "Megger" for one minute duration.
 - 2. Spot test control circuits with "Megger" as directed.
- D. Voltage level test:
 - 1. When performed: After all equipment is installed, ready for operation.
 - 2. CONTRACTOR shall measure voltage at five points in the system, as directed.
 - 3. Load conditions: No-load and full load, in so far as practicable.
 - 4. Test report: Required, as specified under Item "A".
- E. Continuity test: Test all socket outlet and control circuits to determine continuity of wiring and connections. Submit written statement that this test has been performed.

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F. Correction of defects:

1. If tests disclose any unsatisfactory workmanship, wiring or equipment furnished under this Contract, CONTRACTOR shall repair or replace, at his expense, such defects in an approved manner.
2. If any wiring or equipment is damaged by tests, CONTRACTOR shall repair or replace, at his expense, such wiring or equipment in an approved manner.

SECTION 16134 - PANELBOARDS

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SECTION 16134 - PANELBOARDS

1.0 REFERENCE:

Requirements of Section 16010 apply to all work under this Section.

2.0 GENERAL:

Furnish and install panelboards as listed in the "Panelboard Schedule" appended to this section.

3.0 TYPES AND RATINGS:

- A. Enclosure and internal elements shall be manufactured in accordance with NEMA Standards and PEC Rules and Regulations.
- B. All panelboards shall have a NEMA type enclosure and contain a single brand of molded case circuit breakers. All current carrying parts shall be made of electrical gage copper with non-corrosive protective coating on all contact surfaces. Terminal lugs shall be the same or equal to those supplied with the circuit breakers with sizes and type suitable for copper wires.
- C. All insulating materials shall be non-combustible, high-impact, non-tracking and non-hygroscopic.

4.0 PANEL AND BOX:

B.I. 1.984mm (#14 MSG) minimum box, plain steel front for indoor usage enclosure, complete with corrosion free hardware such as hinged door, polished metal catch and lock. All panels shall be keyed alike.

Paint and corrosion proofing shall be per manufacturer's standards and finishes. Repair any damage to finish in manner acceptable to CONSULTANT.

- A. Mounting: flush and surface as required.
- B. Cardholder on inside of door, with clear plastic cover and complete printed schedule of panel branch circuits. Leave "spare" circuits blank.
- C. Nameplate: required for each panel.
- D. Installation:
 - 1. Location: As shown. Maximum distance from floor to center line of highest breaker shall be 1.8m.

SECTION 16134 - PANELBOARDS

2. Provide required mounting materials; make connections specified or shown. Use collars around mounting bolts, or equivalent means, to provide air space between panels and wall for surface-mounted panels.
3. Provide extension troughs and pull boxes for column-type panels.

5.0 MOLDED CASE CIRCUIT BREAKERS:

- A. Panelboard shall contain a single brand of industrial type circuit breakers manufactured by General Electric/Fuji, Square D or approved equal.
- B. Voltages and full load amperes shall be UL and/or NEMA rated. Project requirements shall be as shown in the Panelboard Schedule.
- C. Breakers: "Plug-in" type molded case, thermal-magnetic protective, quick-make, quick-break, trip-free from handle, trip-indicating, number and size as shown in Panelboard Schedule. Internal common trip for 2- and 3-pole breakers.
- D. Breaker minimum interrupting capacities: based on NEMA and UL test procedures shall be as follows unless otherwise noted in the panelboard schedule:
 1. 230-volt breakers: 10,000 rms symmetrical amperes at 230VAC.
- E. Time-current characteristic coordination curves of circuit breakers in distribution boards and the corresponding downstream breakers shall be submitted prior to the purchase of subject breakers.

6.0 WARRANTY:

Warranty for a period of one (1) year shall be provided against failure of components resulting from normal use and/or factory defects.

7.0 QUANTITY AND IDENTIFICATION:

The Panelboard Schedule consisting of one (1) page appended to this section comprises the entire requirement of this project for panelboards. Where "space" is indicated in the Schedule, this shall mean that complete bus, insulators, etc., shall be included ready to accept future circuit breakers. Any inconsistency between the Panelboard Schedule and the Single Line Schematic Diagram, the panelboard with the greater number of branches and higher ampere ratings shall be considered.

PANELBOARD SCHEDULE

BUILDING FLOOR	ROOM	DESIGNATION	ENCLOSURE TYPE	VOLTS / PHASE / WIRE	CB AMP TRIP LUG-AMPACITY P-PHASE WIRE SIZE N-NEUTRAL WIRE SIZE	QTY	AMPERE TRIP			MINIMUM PANEL & BREAKERS (MAIN & BRANCHES KAIC RATING)
							1P	2P	3P	
LOWER LEVEL	GENSET ROOM	PP	NEMA 1	230 V 1-PHASE 2-WIRE	MAIN – 100 A P – 1-22mm ² THWN N – 1-22mm ² THWN G – 1-8mm ² THWN	11	15			10
						3	20			10
						2	60AF			

SECTION 16140 - WIRING DEVICES

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SECTION 16140 - WIRING DEVICES

1.0 REFERENCE:

Requirements of Section 16010 apply to all work under under this Section.

2.0 GENERAL:

Furnish and install wiring devices as listed in "Wiring Device Schedule", appended to this Section.

3.0 DEVICES AND PLATES:

- A. Wall Switches: Quiet type, spring operated. The type of switch shall be of tumbler operation. Rating as shown in wiring device schedule.
- B. General Purpose Receptacles: Flush mounting, type and ratings as shown in wiring device schedule.
- C. General Purpose Wall Plates: Type, color, plating and appearance of device plates shall be as selected by the CONSULTANT. Appropriate samples shall be submitted prior to the purchase of faceplates.
- D. Manufacturers: Panasonic, G.E., Bryant, Hubbel, AH & H, Slater, or approved equal.

4.0 INSTALLATION:

Connect wiring devices ground terminal to circuit ground wire.

5.0 LOCATIONS:

Indicated locations are approximate. Determine exact locations at site by reference to building drawings and in coordination with work of other trades. Receptacles for appliances shall be so located as to be accessible, but, not prominently displayed and upon coordination with the CONSULTANT.

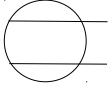
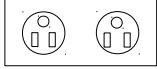
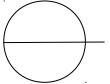

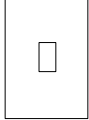
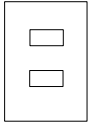
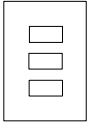
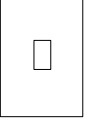
6.0 WARRANTY:

A warranty for a period of one (1) year shall be provided against failure of components resulting from normal use and/or factory defects.

7.0 WIRING DEVICE SCHEDULE:

The following "Wiring Device Schedule" consisting of one (1) page comprises the entire requirement of this project for wiring devices.

WIRING DEVICE SCHEDULE

ITEM NO.	SYMBOL	RATING	CONFIGURATION	DESIGNATION	DESCRIPTION
1		10A, 250V			DUPLEX CONVENIENCE OUTLET, PARALLEL SLOTS, GROUNDING TYPE, SIMILAR TO NATIONAL/PANASONIC BRAND WITH MODERN COVER PLATE OR APPROVED EQUAL. NOTE: WEATHERPROOF IF MARKED "WP"
2		10A, 250V			SINGLE CONVENIENCE OUTLET, PARALLEL SLOTS, GROUNDING TYPE, SIMILAR TO NATIONAL/PANASONIC BRAND WITH MODERN COVER PLATE OR APPROVED EQUAL. NOTE: WEATHERPROOF IF MARKED "WP" ; EMERGENCY LIGHT IF MARKED "E"
3	S	15A, 300V			SWITCH, STANDARD GRADE INTERCHANGEABLE LINE, 1-POLE ON-OFF QUIET TYPE SIMILAR TO NATIONAL WN5001-701 W/ MODERN COVER PLATE OR APPROVED EQUAL.
4	2S	15A, 300V			SIMILAR TO ITEM #3, EXCEPT WITH 2-LEVEL PLATE FOR TWO (2) SWITCHES.
5	3S	15A, 300V			SIMILAR TO ITEM #3, EXCEPT WITH 3-LEVEL PLATE FOR TWO (2) SWITCHES.
6	S3	15A, 300V			SIMILAR TO ITEM #3, EXCEPT THAT THE SWITCH IS THREE-WAY.

NOTE: ALL COVER PLATES ARE SUBJECT TO ARCHITECT'S APPROVAL.

SECTION 16400 - POWER DISTRIBUTION

SECTION INDEX

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2.0	General	1
3.0	Individually Enclosed Circuit Breakers	1
4.0	Installation	1
5.0	Shop Drawing	1
6.0	Warranty	1

SECTION 16400 - POWER DISTRIBUTION

1.0 REFERENCE:

Requirements of Section 16010 apply to all work under this section.

2.0 GENERAL:

- A. Furnish and install all equipment and materials shown on drawings or specified to provide complete and operable system.
- B. Refer to Section 16100 for conduit, conductor, and nameplate specifications and for field tests affecting equipment specified herein.
- C. Provide all excavation and backfill required for installation of underground circuits. Refer to Architectural/Structural Specifications for applicable excavation, backfill and compaction specifications.

3.0 INDIVIDUALLY ENCLOSED CIRCUIT BREAKERS:

- A. Ratings: 1, 2 or 3-pole, 230V, automatic or non-automatic, ampere ratings as shown on drawings. Requirements of Section 16134 shall be complied with. Lockable if indicated on drawings.
- B. Enclosure: NEMA1, unless noted. Use NEMA 3R for outdoors.
- C. Nameplates: Required to indicate equipment served or function of switch and voltage rating.
- D. Color: Manufacturer's standard. Repair any damage to finish in manner acceptable to Consultant.

4.0 INSTALLATION:

Furnish and install as shown on drawings.

5.0 SHOP DRAWINGS:

Submit shop drawings for approval.

6.0 WARRANTY:

A warranty for a period of one (1) year shall be provided against failure of components resulting from normal use and/or factory defects.

SECTION 16440 - GENERATING SET

SECTION INDEX

1.0	Reference	1
2.0	General	1
3.0	As-built Drawings	1
4.0	Coordination	1
5.0	Tools	2
6.0	Operating and Maintenance Instructions	2
7.0	Subcontracts	2
8.0	Guarantee	2
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SECTION 16440 - GENERATING SET

1.0 REFERENCE:

Requirements of Section 16010 apply to all work under this section.

2.0 GENERAL:

- A. Furnish and install all equipment and materials shown on drawings or specified to provide complete and operable system.
- B. Refer to Section 16100 for conduit, conductor, and nameplate specifications and for field tests affecting equipment specified herein.
- C. Provide all excavation and backfill required for installation of underground circuits. Refer to Architectural/Structural Specifications for applicable excavation, backfill and compaction specifications.

3.0 AS-BUILT DRAWINGS:

- A. Upon completion of work, the Contractor shall submit three (3) copies of the as-built drawings, signed and dry-sealed by the Contractor's registered Professional Electrical Engineer, indicating the work as actually and finally installed, including new information not originally shown in Contract Drawings, to the Consultant for approval as to conformance with the design concepts and compliance with pertinent Code provisions.

After such approvals, the Contractor shall submit the CADD-generated as-built originals (in sheets and DVD), three (3) sets of prints and two (2) sets of electronic files to the Owner and Consultant.

- B. Approval of the as-built drawings by the Consultant shall be a requirement for final acceptance of the completed works and of final payment.

4.0 COORDINATION:

- A. Coordinate timing of installation with work of other trades.
- B. System provided shall be complete and operable, and shall include required accessories, fastenings, and supports.
- C. Determine required locations, arrangements, and quantities of equipment and materials.
- D. All equipment shall be installed in strict accordance with manufacturer's recommendations and Contractor shall be deemed responsible to include all cost necessary to comply with such recommendations.
- E. The Contractor shall coordinate with other trades to ensure that all electrical layouts shall conform with the latest drawings and requirements for these works.

SECTION 16440 - GENERATING SET

5.0 TOOLS:

All special tools needed for proper operation, adjustment and maintenance of equipment shall be delivered to Owner.

6.0 OPERATING AND MAINTENANCE INSTRUCTIONS:

- A. Three (3) sets of operating and maintenance instruction manuals, covering completely equipment starting sequences, operation, maintenance, automatic controls and listing of all spare parts shall be furnished to Owner.
- B. Furnish a list of manufacturers (with names of local representatives) in order to expedite ordering of replacement parts.
- C. This Contractor shall provide operating and maintenance instruction for not more than eight (8) building operators with personal on-the-job instruction by an engineer representing the Contractor for eight (8) hours. This instruction shall be scheduled at time(s) convenient to the Owner's personnel. Instruction shall cover all equipment and system provided by this Contractor. The number of hours is a minimum requirement. Where additional hours are specified in other paragraphs of this Specifications, those hours shall be additive to the minimum above. Instruction shall be comprised of both classroom type and actual hands-on operating experience. Number of hours in each category to be arranged with the Owner directly.

7.0 SUBCONTRACTS:

Where Contract Documents require manufacturer's services, and wherever the staff of the trade performing the work of this Section cannot adequately perform such services, this trade shall stipulate such performance in its contracts with its Subcontractor or Sub-subcontractors, vendors, manufacturers, and the like, or else subsequently pay them any additional fees required therefor.

8.0 GUARANTEE:

- A. This Contractor shall guarantee that the System is free from all defective workmanship and materials and will remain so for a period of one (1) year from date of completion as certified by the Consultant. Any defects, appearing within the aforesaid period shall be remedied by the Contractor at his own expense.
- B. The Contractor shall indemnify and hold harmless the Owner, and the Consultant from and against all liability for damages arising from injuries or disabilities to persons or damage to property occasioned by any act or omissions of the Contractor or any of his Subcontractors, including any and all expenses, legal or otherwise which may be incurred by the Owner, or the Consultant, in defense of any claim, action or suit.

SECTION 16440 - GENERATING SET

9.0 CONSULTANT'S REVIEW:

A. The Consultant will review shop drawings and samples for conformance with the design concept of the project and the information contained in the Contract Drawings. The Consultant's review of shop drawings and samples is only for the convenience of the Owner in following the work and does not relieve the Contractor of responsibility for deviations from the requirements of the Contract Documents. The Consultant's review shall not be construed as a complete or detailed check of the work submitted, nor shall it relieve the Contractor of responsibility for errors of any sort in the shop drawings and samples, or from the necessity of furnishing any work required by the Contract Documents which may have been omitted from the shop drawing submittals. The review of a separate item shall not indicate review of the complete assembly in which it functions. Nothing in the Consultant's review of shop drawings and samples shall be considered as authorizing:

1. A departure from Contract Documents or Specifications;
2. Additional cost to the Owner; or
3. Increased time for completion of the work.

B. All shop drawings and samples shall be identified as follows:

1. Date of submittal.
2. Title of project.
3. Name of Contractor.
4. Name of Sub-contractor or supplier.
5. Number of submission.
6. Any qualification, departure or deviation from the requirements of the Contract.
7. Such additional information as may be required by the Specifications for the particular material being furnished.

C. Consultant's review is for general compliance with the design concept and Contract Documents. Markings or comments or the lack thereof shall not be construed as relieving the Contractor from compliance with the project plans and Specifications. The Contractor remains solely responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of

SECTION 16440 - GENERATING SET

construction, for performing his work in a safe manner, and for coordinating his work with that of other trades.

10.0 DIESEL ENGINE GENERATING SET:

- A. Furnish one (1) diesel generating set as specified herein.
- B. The standby duty diesel generating set shall be complete with diesel engine and auxiliary equipment, generator, residential type silencer, radiator, switchboard, battery charger, batteries, day tank and other standard accessories. Engine and generator shall be mounted on a common steel base with spring-type vibration isolators.
- C. The diesel generating set shall have the following features:
 - 1. Engine-generator speed shall be at 1800 rpm and designed for continuous duty, stationary service, with an efficiency (continuous KW output/shaft KW input) of at least 90% at full load.
 - 2. Generator shall be a 1-phase, 60-hertz, single bearing, brushless rotating field synchronous type built to NEMA standards.
 - 3. The generating set shall be rated at 10kW prime duty at 1.0 power factor, 230V, 1-phase, 60 hertz.
- D. CAPACITY
 - 1. The generating set shall be rated at 10kW at 1.0 power factor, 230V, 1-phase, 60 hertz.
 - 2. The ratings of both engine and generator must be substantiated with manufacturer's test certificates including oil and fuel consumption at 0, 1/2, 3/4 and full loads.
 - 3. Ratings must reflect the net power available after deducting all engine or motor driven accessories.
- E. ENGINE
 - 1. The generating set shall be rated at 10kW at 1.0 power factor, 230V, 1-phase, 60 hertz.
 - 2. The ratings of both engine and generator must be substantiated with manufacturer's test certificates including oil and fuel consumption at 0, 1/2, 3/4 and full loads.

SECTION 16440 - GENERATING SET

3. Ratings must reflect the net power available after deducting all engine or motor driven accessories.
 4. Fuel consumption shall not exceed 0.3 liters per KWH at any load between 50% to 100% of rated load.
- G. Manufacturer: Perkins, Kipor or approved equal.

SECTION 16450 - GROUNDING

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2.0	General	1
3.0	Materials	1
4.0	Installation	1
5.0	Tests	1

SECTION 16450 - GROUNDING

1.0 REFERENCE:

Requirements of Section 16010 apply to all work under this Section.

2.0 GENERAL:

Furnish all materials and labor required to ground the panelboards, motor frames, conduit systems, and all other electrical equipment.

3.0 MATERIALS:

- A. Ground Rods: Copper clad, 20 mm dia. x 3000 mm, detail as shown on drawings.
- B. Ground Cable: Stranded soft-drawn bare copper.
- C. Insulators and miscellaneous installation materials: As shown on drawings.

4.0 INSTALLATION:

- A. Raceway Grounding: Ground all conduit systems. Use double locknuts at all panels; use bonding jumpers if conduits are installed in concentric knockouts.
- B. Equipment grounding:
 - 1. Ground separately-mounted motor controllers, motor frames, distribution boards, switches and outlets through grounded conductor.
 - 2. Connect all receptacles to grounding conductor.
 - 3. All conduit systems shall be provided with a ground wire with THHN insulation sized per PEC.

5.0 TESTS:

- A. Ground rod-earth resistance test:
 - 1. Test each ground rod by single-test "Megger" method.
 - 2. Test equipment: To be furnished by CONTRACTOR, equal to "Megger".

SECTION 16450 - GROUNDING

- B. Test report: submit typewritten report, listing equipment used, person or persons performing the tests, date tested, circuits or equipment tested, and results of tests.

SECTION 16500 - LIGHTING

SECTION INDEX

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2.0	General	1
3.0	Lighting Fixtures	1
4.0	Coordination	2
5.0	Shop Drawings and Samples	2
6.0	Warranty	2
7.0	Lighting Fixture Schedule	2

SECTION 16500 - LIGHTING

1.0 REFERENCE:

Requirements of Section 16010 apply to all work under this Section.

2.0 GENERAL:

- A. Furnish, install and wire all equipment and materials required for complete lighting system, as specified and shown.
- B. See Section 16100 for conduit, conductor, and nameplate specifications.

3.0 LIGHTING FIXTURES:

- A. Lighting Fixtures: As designated in "Lighting Fixture Schedule" appended to this section.
 - 1. Housing: 22 gage, B.I. Sheet, Formed, screwed with machine or stove bolt and/or welded.
 - 2. Finish: Use two (2) coat primer. Powder coat, white acrylic paint.
 - 3. Lampholder: UL listed, locking type, springloaded bi-pin, push-in lead wire.
 - 4. Diffusers: Prismatic acrylic 3.0mm thickness or as listed in the "Lighting Fixture Schedule".
 - 5. Others: Per details on the plans.
- B. Provide fixtures complete with required accessories, including the following:
 - 1. Lamps:
 - a. General: Types and ratings as shown in "Lighting Fixture Schedule."
 - b. LED: as listed in "Lighting Fixture Schedule."
 - d. Manufacturer: Philips, G.E. or approved equal.
 - 2. Mounting Hardware, including any steel required to supplement building structure for support of fixtures.
 - 3. Support fixtures independently of suspended ceiling or as shown on details.

SECTION 16500 - LIGHTING

C. Wiring:

1. General: Fixture wiring shall comply with fixture manufacturer's recommendations and PEC requirements.

D. Location: Approximately as shown. Modify to avoid other equipment or structural components. Provide necessary conduit, wire, fittings and miscellaneous materials to locate fixtures in unobstructed locations.

4.0 COORDINATION:

- A. Coordinate installation of all lighting fixtures with work of other trades.
- B. Coordinate exact location of fixtures with respect to suspended ceiling layout to achieve uniformity.

5.0 SHOP DRAWINGS AND SAMPLES:

Prepare and submit for approval before manufacturing the following:

- A. Fabrication drawings.
- B. Sample of each fixture.


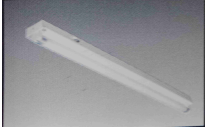
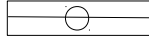
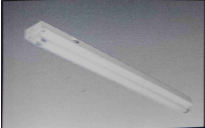
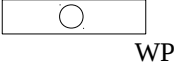

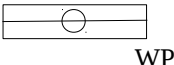







6.0 WARRANTY:

All fixture components shall be covered with a warranty for a period of one (1) year against any failure resulting from normal use and/or factory defects.

7.0 LIGHTING FIXTURE SCHEDULE:

The following "Lighting Fixture Schedule" consisting of one (1) page comprise the entire requirement of this project for lighting fixtures.

LIGHTING FIXTURE SCHEDULE

ITEM NO.	QUANTITY	TYPE	SYMBOL	DETAIL	DESCRIPTION
1					SURFACE MOUNTED SLIM BOX TYPE LINEAR LED LIGHTING FIXTURE (1200mm x 55mm), WITH 1x16W LAMP, 230 V, IP 20. ZINC PHOSPHATE STEEL SHEET HOUSING, WHITE POWDER COAT PAINT FINISH. FUMACO BRAND OR APPROVED EQUAL.
2					SAME AS ITEM NO. 1 EXCEPT WITH 2x16W LAMP.
3					SURFACE MOUNTED LINEAR LED LIGHTING FIXTURE (1200mm x 300mm), WITH 1x16W LAMP, 230 V, IP 54. ZINC PHOSPHATE STEEL SHEET HOUSING, WHITE POWDER COAT PAINT FINISH. FUMACO BRAND OR APPROVED EQUAL.
4					SAME AS ITEM NO. 3 EXCEPT WITH 2x16W LAMP.
5		ES/M/W5100			SURFACE MOUNTED LED EXIT LIGHT SINGLE SIDED (375mm x 270mm), WITH 2W LED STRIP LAMP TYPE, 230 V, IP 30. HIGH TEMPERATURE NICKEL CADMIUM BATTERY FOR 2 HOURS DURATION. HOUSING MADE OF ELECTRO-GALVANIZED STEEL WITH EPOXY POWDER COATING. FUMACO BRAND OR APPROVED EQUAL.
6		MAXSPID MR203L			WALL OR CEILING MOUNTED LED EMERGENCY LIGHT, WITH 2x1W LED LAMP, IP 50 CLASS 2. INJECTION MOULDED THERMOPLASTIC ABS; UL 94V-0 FLAME RATING, TWO FULLY ADJUSTABLE GLARE-FREE ROUND SHAPED HEADS. HIGH TEMPERATURE NICKEL CADMIUM, 2 HOURS DURATION. FUMACO BRAND OR APPROVED EQUAL.
7		FUMACO LED 1571 50W FLOODLIGHT			WALL MOUNTED 50W LED FLOODLIGHT WITH BUILT-IN LED DRIVER, 200-240V, IP 54, DAYLIGHT. DIE-CAST ALL ALUMINUM CONSTRUCTION, POWDER COAT FINISH HOUSING. HIGH PURITY ALUMINUM REFLECTOR WITH TEMPERED GLASS DIFFUSER. FUMACO BRAND OR APPROVED EQUAL.

NOTE: ALL LIGHTING FIXTURES ARE SUBJECT TO ARCHITECT'S APPROVAL

Division 16 Electrical

SECTION 16610 - LIGHTNING PROTECTION

SECTION INDEX

1.0	Reference	1
2.0	General	1
3.0	Materials	1
4.0	Manufacturer	3
5.0	Warranty	3

SECTION 16610 - LIGHTNING PROTECTION

1.0 REFERENCE:

Requirements of Section 16010 apply to all work under this Section.

2.0 GENERAL:

Furnish and install one (1) set lightning protection system complete in every respect as indicated in the plans and as specified herein.

The lightning protection system shall be one which conveys a lightning discharge to ground without electrification of its supporting mast or pole and nearby structures. A set of protection system shall consist of electrode, down conductor, ground rods, masts, fasteners and other miscellaneous mounting hardware.

3.0 MATERIALS:

A. Electrode (Air Terminal):

1. The electrode shall generate a current of free primary electrons coming from the air natural gradient, the potential of which rises in proportion with the approach of lightning and its charge.
2. It shall be non-radioactive and shall not require batteries or solar cells to perform its function. It shall have no moving parts.
3. The electrode shall be made of highly dielectric materials so that as soon as lightning strikes its tip, it enters into a sealed hole down to earth.
4. The construction of the electrode assembly shall be such as to prevent the occurrence of galvanic corrosion. Its down conductor terminal shall be insulated from the mast and support structure.
5. The electrode shall be mounted at least 3 meters above the highest point of the building. It shall provide a protective radius of 107 meters at ground level.

B. Down Conductor:

1. The down conductor shall be a two conductor coaxial cable with outside insulation; the insulation shall have basic impulse level rating of 200 KV.

Division 16 Electrical

SECTION 16610 - LIGHTNING PROTECTION

2. Each conductor shall have a minimum cross sectional area equivalent to 35 sq.mm of electrical grade copper.
3. The characteristic impedance of the coaxial cable shall not exceed 16 ohms when determined by the following formula:

$$Z = (L/C)^{1/2}$$

Where:

- Z = Characteristic impedance of coaxial cable.
- L = Inductance per meter of the inner conductor.
- C = Capacitance per meter between inner and outer conductor.

4. At the electrode end, the central conductor shall make a high current connection to the electrode terminal while the outer conductor shall remain insulated.
5. At the earth end, the central and outer conductors of the coaxial cable shall both bond to the grounding system in such a manner as to allow subsequent removal for electrical testing. Grounding system of any nearby electrical or telecommunication systems shall not be utilized.
6. The down conductor shall be secured in accordance with the manufacturer's instructions, and shall not be subject to bend less than 0.365 meter radius.
7. The coaxial cable, together with its accessories, shall be furnished by the electrode assembly manufacturer.

C. Grounding and Ground Rods:

1. The grounding system shall not exceed 10 ohms of static impedance.
2. The ground resistance shall be measured with an approved 3-electrode type test instrument.
3. Ground rod shall be as shown in the plan and as specified in Section 16450. Additional ground rods shall be driven if resistance exceeds 10 ohms.

SECTION 16610 - LIGHTNING PROTECTION

4. Where several ground rods are required, these shall be interconnected by buried copper wire of 100 sq.mm minimum cross sectional area.
 5. The ground rod shall be bonded to mast (or pole).
- D. Mast (or Pole):
1. Mast shall be made of steel, round, plain body, with an all-weather paint over primer, complete with base plate and anchor bolts.
 2. Mast shall be able to withstand a wind loading created by 320 kph wind velocity.
- E. The top of the mast supporting the electrode shall be fiberglass pipe with an inside diameter of not less than 70mm diameter, 4mm thick, 2 meters minimum length with electrode assembly bracket.

4.0 MANUFACTURER:

Lightning protection system shall be EF Lightning Control System or approved equal.

5.0 WARRANTY:

A warranty for a period of one (1) year shall be provided against failure of components resulting from normal use and/or factory defects.