

Color Coding: Provide for all low voltage feeder, branch, control, and signaling circuit conductors. Color shall be green for grounding conductors, and white for neutrals, except where neutrals of more than one system are installed in same raceway or box, the other neutral shall be white with a colored (not green) stripe. The color of the ungrounded conductors in different voltage system shall be as follows:

400/230 Volts, 3-Phase - Phase A - Black
Phase B – Red
Phase C – Blue

Wire Conformation: Provide wires and conforming to UL standards.

600 Volt Wires and Cables: Provide wires and conforming to UL 83 THW and TW as indicated. Only wires with "W" in the type designation shall be used in wet or damp locations.

a. Cables:

Connector and Terminals:

a. Wire Connectors and Terminals for use with Copper Conductors: UL 486A.

High Voltage Wires and Cables: Copper, cross-linked polyethylene (XLPE) insulated, 133 percent insulation level, shielded single conductor, polyvinyl jacketed conforming to NEMA WC7, rated 34.5 kV and 4.16 kV. Cable shall be single conductor, employing concentric, Class B, compact round stranded copper conductors.

High Voltage Cable Terminations: IEEE 48 Class 1. The manufacturer shall provide all components, materials and complete instructions for installation which shall include stress relief cones.

Pull Wire: Pull wire shall be hot-dip galvanized steel or plastic having a minimum tensile strength of 200 lbs. in each empty duct. Minimum 300 mm of slack shall be left at each end of pull wires.

Grounding and Bonding Equipment: Shall conform to UL 467.

3. EXECUTION

Concrete: Concrete for electrical requirements shall be at least 20.68 Mpa concrete with one-inch maximum aggregate.

Concrete: Concrete for electrical requirements shall be at least 20.68 Mpa concrete with one-inch maximum aggregate.

Underground Structures: Cast-in-place manholes. Cast-in-place concrete manholes shall have a smooth trowel finish for floors and horizontal surfaces. Manholes shall be the type noted on drawings and shall be constructed in accordance with the applicable details as indicated. Provide all necessary lugs, rivets and brackets. Set pulling-in irons and other built-in items before depositing concrete. A pulling-in iron shall be installed in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, shall be adequate to accommodate the cables in

manholes and cable trenches. The words "ELECTRICAL" shall be cast in the top face of all power manhole covers.

Underground Duct with Concrete Encasement:

Construct underground duct lines of individual conduits encased in concrete. Conduit shall be Schedule 40 PVC. Do not mix the kind of conduit used in any one duct bank. Ducts size shall be as indicated. The concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 75 mm of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 50 mm, except separate light and power conduits from control, signal, and telephone conduits by a minimum concrete thickness of 75 mm.

The top concrete envelope shall not be less than 457 mm below grade except that under roads and pavement it shall be not less than 610 mm below grade.

Duct lines shall have a continuous slope downward toward manholes and away from buildings with a pitch of not less than 1 mm in 400 mm. Except at conduit risers, accomplish changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, by long sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 457 mm for use with conduits of less than 80 mm in diameter and a minimum radius of 914 mm for ducts of 80 mm in diameter and larger.

Terminate conduits in end-bells where duct lines enter manholes. Separators shall be of precast concrete, high impact polystyrene, steel, or any combination of these. Stagger the joints of the conduits by rows and layers so as to provide a duct line having the maximum strength. During construction, protect partially completed duct lines from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs. As each section of a duct line is completed from manhole draw a brush through having the diameter of the duct, and having stiff bristles until the conduit is clear of all particles of earth, sand, and gravel; then immediately install conduit plugs.

Cable Trench: Construct cast-in-place cable trenches in accordance with details shown on drawings. Walls and bottom shall be of monolithic concrete construction. Provide cable racks, including rack arms and insulators adequate to accommodate cables.

Ground Rods: Provide 20 mm x 3.0 m copper-clad steel ground rods where shown on drawings driven into the earth.

GENERAL INSTALLATION REQUIREMENTS: Underground cable installation shall conform to ANSI C2 and PEC.

CABLES GENERAL REQUIREMENTS: The type of installation, sizes, and number of cables shall be as indicated. Each circuit shall be identified by means of fiber, laminated plastic, or nonferrous-metal tags, or approved equal, in each manhole, and at each terminal. Manufacturer's written recommendations shall be furnished for each type of splice and medium-voltage cable joint and termination, and for fireproofing application methods. Medium-voltage cable joints and terminations shall be the standard product of a manufacturer and shall be either of the factory preformed type or of the kit type containing tapes and other required parts. Compounds and tapes shall be electrical grade suitable for the cable insulation provided and shall use design materials technique per manufacturer. Maximum

length of cable pull and cable pulling tension shall not exceed the cable manufacturer's recommendation.

Duct Line Installations: Medium-voltage cables shall be installed in duct lines where indicated. Cable joints in medium-voltage cables shall be made in manholes only.

Cable Pulling: Thoroughly swab out duct lines to remove foreign materials before pulling of cables. Pull cables downgrade with the feed-in point at the manhole of the highest elevation. Use flexible cable feeds to convey cable thru the manhole opening and into the duct runs.

Cable pulling tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer.

Installation of Cables in Manholes: Do not install cables utilizing the shortest route, but along those walls providing the longest route and the maximum spare cable lengths. For all cables to closely parallel walls, not to interfere with duct entrances, and support on brackets/cable insulators.

Cable Terminating: Protect terminations of insulated power and lighting cables from accidental contact, deterioration of coverings and moisture by the use of terminating devices and materials.

Splices for 600 Volt Class and Medium Voltage Cables: Splice in underground systems only in accessible locations such as manholes using a compression type connector on the conductor and insulate suitable for continuous submersion in water and shall be made only in accessible locations in manholes. Splices in shielded cables shall include covering the entire spliced area with metallic type, or like material, to the original cable shield and by connecting it to the cable on each side of the splice.

Terminator, Modular Molded Rubber Type: IEEE 48 Class I. Terminator shall consist of a stress control, ground clamp, non-tracking rubber skirts, crimp-on connector, rubber cap and aerial lug.

Grounding: Non-current carrying metallic parts associated with electrical equipment shall have a maximum resistance to solid earth ground not exceeding the following values.

Grounding other metal enclosures of electrical operated equipment - 10 ohms

Grounded secondary distribution system neutral and non-current carrying metal parts associated with distribution system and grounds not otherwise covered – 10 ohms

When work in addition to that indicated or specified is directed in order to obtain the specified ground resistance, the provisions of the contract covering "Changes" shall apply.

Grounding electrodes shall be cone pointed driven ground rods driven full depth plus 150 mm, installed when indicated to provide an earth ground of the value before stated for the particular equipment being grounded.

Make grounding connections which are buried or otherwise normally inaccessible, and excepting specifically those connections for which access for periodic testing is required by exothermite type process or ground clamps. Make thermit welds strictly in accordance with the weld manufacturer's written recommendations. Welds which have "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. No mechanical connector is required at thermit weldments.

In lieu of an exothermic type process, a compression ground grid connector for a type which uses hydraulic compression tool to provide the correct circumferential pressure may be used. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

Grounding conductors shall be bare soft-drawn copper wire square mm size as indicated on plans.

Provide all empty conduits with a 2.0 mm (No. 14 AWG) zinc coated steel wire or a plastic rope having a breaking strength of at least 200 lbs. leave 610 mm of spare at each end of the pull.

FIELD TESTS: As an exception to requirements that may be stated elsewhere in the contract, the Engineer shall be given 3 working days' notice prior to each test.

Ground Rods: Test ground rods for ground resistance value before any wire is connected. Use a portable ground testing megger to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicated the ground value of the ground electrode under test. Provide one copy of the megger manufacturer's directions for use of the ground megger indicating the method to be used.

Medium-Voltage Cable Test: 34.5kV, 4.16kV and 600 volt cables shall be given high potential test (identify each cable & test result). Prior to making the test, the cables shall be isolated by opening applicable protective devices. The method, voltage, length of time and other characteristics of the test shall be in accordance NEMA WC 7

**ITEM 18 : PAD MOUNTED TRANSFORMER, SUBSTATION TRANSFORMER
AND SWITCHGEAR, EXTERIOR****1. GENERAL**

"Electrical General Requirements," applies to this section with additions and modifications specified herein.

SUBMITTALS:

Shop Drawings and Manufacturers' Data: GEAR

- a. Pad mounted transformer
- b. Substation transformer
- c. Switchgear, high voltage
- d. Separable insulated high voltage connectors
- e. Surge arresters
- f. Switchgear
- g. Vacuum circuit breakers

Shop Drawings and Manufacturer's Data: Submit shop drawings in compliance with the Local Power Company requirements for approval, two (2) copies to the Engineers and four

(4) Copies to the Power Company.

Drawings shall indicate but not be limited to the following:

- a. Overall dimensions, front view and section views
- b. Elementary diagrams and wiring diagrams with terminals identified, and indicating internal wiring for and interconnection between each item of equipment
- c. Bus arrangements including dimensions and ampere ratings of all bus bars
- d. Type and spacing of bus supports
- e. Maximum short circuit bracing
- f. Circuit breaker type, interrupting rating, trip setting

Certificates of Conformance or Compliance with IEC Standards: Before delivery of materials and equipment, submit certificates in triplicate.

Factory Test Reports: Submit in triplicate certified copies of reports of all tests required for the following:

- h. Switchgear
- i. Transformer Tests

2. PRODUCTS**INSULATING LIQUIDS:**

Mineral Oil: ASTM 3487, Type II, tested in accordance with ASTM 117.

High Fire Point Transformer Liquids: NFPA 70 and Factory Mutual Approval Guide for "less- flammable" liquids having a fire point not less than 300 degrees C tested per ASTM D 92 and dielectric strength not less than 33 kV tested per ASTM D 877 Insulating liquids containing Polychlorinated biphenyls (PCB's) and Tetracholoroethylene shall not be provided.

UNDERCOATING: Transformers, substations, switchgear and switchboards which have bases in contact with concrete shall have the underside of their bases coated with minimum 4 mils thick coating conforming to standards.

NAMEPLATES: Provide nameplates for each transformer, switchgear and devices.

WARNING SIGNS: ANSI Z35. 1. Provide warning signs for the enclosures of electrical substations, transformers and switchgear. Mount signs on fence if equipment is guarded by a fence. Provide metal signs having the legend "DANGER HIGH VOLTAGE" in two lines of letters of nominal 75mm height. Provide the number of signs required to be readable from each accessible side.

PAD MOUNTED TRANSFORMER ANSI C57.12.22 consisting of a high voltage incoming compartment, a transformer section and a low-voltage outgoing compartment separated by full height isolating barriers. Components shall be assembled and shipped by one manufacturer as a unit, completely weatherproof and tamperproof for mounting on a concrete pad without additional housing or enclosures. Unit shall conform to ANSI 12.26, modified as necessary to accommodate the components specified herein.

Compartments: Divide the high- and low-voltage compartments into sections with steel isolating barriers extending the full height and depth of the compartment.

High voltage compartment shall contain the incoming line, load-break switch handle and access to dry-well fuse holders, 6kV surge arresters, cable terminators, insulated phase barriers, tap changer, and transformer high voltage bushings.

- a. **Load-Break Switch:** Radial feed oil-immersed type rated at 60kV BIL with continuous, load break and make-and -latch amp ratings per standard based on kVA rating of each transformer.
- b. **Current limiting fuses:** ANSI C37.47. Provide fuses in air-insulated, oil-sealed, dead- front dry-well fuse holders and on the load side of the load-break switch. Interlock fuse holders with the load-break switch so that the fuses may be removed only when the switch is in the "Off" position. Size fuses to approximately 150 percent of the transformer ratings. Fuses shall have an interrupting rating of 40kA RMS asymmetrical amps at the system voltage specified.
- c. **Cable Terminators:** Provide modular molded rubber type as specified in Section 16301, "Underground Electrical Work."
- d. **Surge Arresters:** NEMA LAI, distribution valve-type rated 6 kV.

Low voltage compartment shall contain gauges, valves, thermometers, drains, cable lugs, low-voltage bushings, stainless steel transformer nameplate.

Transformer:

Oil insulated, two winding, 60hz, 65 degree C rise above 30 degree C ambient, self-cooled type. Tap changer shall be externally operated, manual type for changing tap setting when the transformer is deenergized. Accessories shall include drain and sampler valve, filter connection, liquid level gauge, lifting lugs, cover lifting eyes, provisions for jacking under base, diagrammatic nameplate, pressure relief valve, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator. The transformer shall have an insulated low voltage bushing with removable ground strap in both primary and secondary compartments with lugs for ground cable. Transformer ratings shall be as follows:

kVA :	750, 1000, 2500
Primary Voltage :	4160 volts, 3-phase, 3-wire
Secondary Voltage:	400Y/230 volts, 3 phase, 4-wire for 750 & 1000 kVA 460 volts, 3-phase, 3-wire for 2500 kVA
Phase :	3Ø
Frequency:	60 Hertz
Temperature Rise:	65 degrees C
BIL-Primary :	60kV
Secondary :	30kV
HV Taps :	Two (2), 2.5% above and two (2) 2.5% below normal voltage
Noise Level at Full:	61 db
Impedance :	5.75% nominal

PRIMARY SUBSTATION TRANSFORMER:

IEC 60076, NEMA C57.12.00. The transformer shall be oil-filled with online oil purification, conservator, online tap changer and other standard devices including provisions for future forced-air cooling components and brackets. Provide stainless steel or corrosion resistant diagrammatic nameplate and other standard maintenance devices.

Rating:

kVA :	3750KVA ONAN / ONAF
Primary Voltage:	34.5KV
Secondary Voltage:	4.16 KV, 3wire
Phase:	3Ø
Frequency:	60 hertz
Temperature Rise:	65 degrees C
BIL Primary:	150KV
Secondary:	60KV
HV Taps:	Two (2) 2.5% above and two (2) 2.5% below normal voltage
Nose level at full:	61 db
Impedance:	5.75% nominal

High-Voltage Terminations: The transformer primary shall be connected with 36 kV cables from high voltage switchgears.

Medium-Voltage Terminations: The transformer secondary shall have provision for 4160 volt, 2500A phase bus duct connections to medium voltage switchboard.

SWITCHGEAR: IEC 62271-200. Metalclad for vacuum circuit breaker and 30 kV lightning arresters, IP 45 outdoor enclosure.

The vacuum circuit breaker shall be electrically operated, three-pole, circuit interrupting device rated 1200 and 630 amperes at 34.5 kV and 150 kV BIL, with a short circuit capacity of not less than 25 kA amperes symmetrical as shown on drawings. Circuit breaker shall be draw-out mounted with position indicator, operation counter, auxiliary switches, and primary and secondary disconnect switches. Provide for manual charging of the mechanism and for slow closing of contacts for inspection or adjustment. The circuit breaker control voltage shall be 125 volts DC.

Conductor terminations shall be 1/C terminations arranged for conduits entering from below.

3. EXECUTION

INSTALLATION: ANSI C2, PEC, Conform to the manufacturer's shop drawing and mounting instructions including securing the transformer to the concrete slab with a minimum of four anchor bolts.

GROUNDING: PEC and ANSI C2, except that grounds and grounding system shall have resistance to solid earth grounds not exceeding the following values:

- For Grounding Substation 5
- For Grounding other metal enclosure of primary voltage electrical and electrically operated equipment 10
- For grounds not covered above 25

Provide additional interconnections as necessary to obtain the specified resistance to ground.

FOUNDATION FOR EQUIPMENT AND ASSEMBLIES:

Provide concrete foundation for mounting of substation equipment as shown on drawings, bolt substation to slab. The top of the concrete slab shall be approximately 100 mm above the finish grade. Slab edges above shall have 155 mm chamfer.

TOUCH-UP PAINTING:

Touch-up all surfaces as required with paint and procedures approved by the manufacturer.

TEST:

Perform factory testing on the following in accordance with the latest revision of ANSITest Code C56.12.90 and submit the results.

- a. Winding resistance
- b. Voltage ratio
- c. Polarity and phase
- d. Exciting current
- e. Impedance and load loss
- f. Temperature
- g. Applied potential
- h. Induced potential

GUARANTEE:

The manufacturer shall guarantee the transformers for workmanship, construction and operation for period of one (1) year after installation and acceptance.

ITEM 19 : DIESEL ENGINE GENERATOR SETS STANDBY**1. GENERAL**

Work under this Contract shall be in accordance with Diesel Engine Generator Sets of these Specifications and shall be applicable to this item, whether herein referred to or not.

SCOPE OF WORK:

The Work covered shall include but not be limited to all labor, materials, tools, equipment and incidentals necessary for the Contractor to furnish/provide diesel electric generating unit with accessories, auxiliary equipment, and associated work as specified and indicated.

APPLICABLE PUBLICATIONS:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition or the revised version of such codes and standards current at the date twenty eight (28) days prior to date of bid submission shall apply. During contract execution, any changes in such codes and standards shall be applied after approval by the Owner.

1. American Institute of Steel Construction (AISC):
 - AISC S335 Structural Steel Buildings Allowable Stress Design and Plastic Design
2. American National Standards Institute (ANSI):
 - ANSI C37.16 Switchgear-Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors-Preferred Ratings, Related Requirements, and Application Recommendations
 - ANSI C37.17 Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers
 - ANSI C39.1 Electrical Analog Indicating Instruments
3. American Society of Mechanical Engineers (ASME):
 - ASME B1.1 Unified Inch Screw Thread (UN and UNR Thread Form)
 - ANSI B1.1 Mechanical Power Transmission Apparatus
 - ASME B15.1 Cast Iron Pipe Flanges and Flanged Fittings
 - ASME/ANSI B16.1 Pipe Flanges and Flanged Fittings
 - ASME/ANSI B16.5
4. American Society For Testing and Materials (ASTM):
 - ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 - ASTM A 126 Gray Iron Casting for Valves, Flanges, and Pipe Fittings
 - ASTM A 181/ Piping A 181M Forgings, Carbon Steel, for General Purpose
 - ASTM A 193/ Alloy A 194M Steel and Stainless Steel Bolting Materials for High-Temperature Service

ASTM A 194/ Carbon and Alloy Steel Nuts for Bolts for High-Pressure and
A 194M High-Temperature Service

ASTM A 234/ Piping Fittings of Wrought Carbon Steel and Alloy Steel

A 234M for Moderate and Elevated Temperatures

ASTM A 307 Carbon steel Bolts and Studs, 60,000 psi Tensile Strength

ASTM D 975 Diesel Fuel Oils

5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

IEEE115 Synchronous Machines

IEEE 42.1 Definitions for Excitation Systems for Synchronous Machines

IEEE C37.2 Electrical Power System Device Function Numbers

ANSVIEEE Low Voltage AC Power Circuit Breakers Used Enclosures

C37.13

ANSVIEEE Instrument Transformer

6. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) :

NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches

NEMA MG 1 Motors and Generators

7. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA):

NFPA 30 Flammable and Combustible Liquids Code

NFPA 37 Installation and Use of Stationary Combustion Engines and Gas
Turbines

NFPA 70 National Electrical Code

8. UNDERWRITERS LABORATORIES INC. (UL):

UL 429 Electrically Operated Valves

UL 489 Molded Case Circuit Breaker and Circuit Breaker Enclosures

UL 508A Industrial Control Equipment

UL 1236 Battery Chargers for Charging Engine Starter Batteries

DEFINITIONS:

a. Intercooling- Cooling of charged air after it leaves turbocharger compressor.

b. IEEE Device Number s - Described in IEEE Standard IEEE C37.2.

c. Gross and Net Bkw Bhp Ratings of Engine - Gross rating shall be total rated power output before deducting power requirements of electric motor-driven equipment. Net ratings shall be equal to gross ratings minus total power requirements of electric motor driven accessories normally constituting part of "engine assembly."

SUBMITTALS:

Submit the following in accordance with section entitled "SubmittalProcedures."

Manufacturer's Catalog Data:

Engine-Generator Set Data: Submit the following data pertaining to each engine generator set.

- a. Manufacturer of engine
- b. Type or model of engine
- c. Gross bkw, bhp rating of engine
- d. Net bkw, bhp rating of engine
- e. Strokes per cycle
- f. Number of cylinders
- g. Bore and stroke, mm inches
- h. Engine speed, rpm
- i. Piston speed, m/s fpm
- J. BMEP at full load Pa (gage) (psig)
- k. kW rating of generator set at specified voltage and temperature rise per NEMA MG 1
- l. kVA rating of generator and power factor
- m. Induction method (naturally aspirated, turbocharged)
- n. Intercooler type (air-to-air or jacket water)
- o. Governor type, make and model
- p. Make and model of turbochargers
- q. Motor starting kVA of generator set at 35 percent dip specified

Engine-Generator Unit Guarantees:

Submit for the following. Fractional loads shall be calculated on basis of net ratings unless otherwise called for:

- a. Fuel consumption at 0.80 power factor (Joules Btu per net kWh):
 - (1) 1/2 load
 - (2) 3/4 load
 - (3) Full load
- b. Generator efficiency at 0.80 power factor (percent):
 - (1) 1/2 of net-rated load
 - (2) 3/4 of net-rated load
 - (3) Full net-rated load
- c. Radiator capacity at design conditions:
 - (1) Coolant shall be antifreeze mixture as specified under paragraph entitled "Cooling System."
 - (2) Engine jacket coolant flow (Lis) (GPM)
 - (3) Air flow through radiator (cubic meter/minute) (CFM)
 - (4) kW Btu/hour of heat exchange based on 40° ambient temperature.

Diesel Engine Data:

Submit the following data certified by the engine manufacturer:

- a. Approximate exhaust temperature degrees C F at full load
- b. Cubic meter/minute CFM of exhaust gas at full load
- c. Cubic meter/minute CFM of intake air at full load
- d. Total heat rejected to cooling system and to ambient air at full load at maximum ambient temperature (kW) (Btu per hr)
- e. Maximum jacket coolant temperature from engine degrees CF at full load
- f. Jacket coolant temperature from engine that will cause generator set shutdown for over-temperature, (Degrees C) (Degrees F)
- g. Lubricating oil consumption in liters gallons per hour at full load (estimated)
- h. Recommended grade and type of lubricating oil.

i. Maximum over speed limit

Generator and Exciter Data: Submit the following data certified by the generator manufacturer.

- a. Manufacturer and model number of generator
- b. Generator short circuit ratio

- (1) Synchronous reactance, X_d
- (2) Transient reactance, X_d'
- (3) Sub transient reactance, X_d''

- c. Generator over speed limit (percent)
- d. Generator flywheel effect (kg-m²) (lb-ft²)
- e. High Potential Test Voltage
 - 1. Generator Stator
 - 2. Generator Rotor
 - 3. Exciter
- f. Generator and exciter efficiency data
- g. Radio frequency interference data.

Drawings:

- a. Engine-generator unit and auxiliary equipment
- b. Engine-generator unit electrical drawings

Engine-Generator Unit and Auxiliary Equipment:

Submit drawings pertaining to the engine-generator set and auxiliary equipment, including the following:

- a. Certified outline, general arrangement (setting plan), and anchor bolt details. Show total weight and center of gravity of assembled equipment on the steel subbase.
- b. General arrangement and detail piping of exhaust and air intake piping systems
- c. General arrangement, size, and location of electrical interface points, and detailed elementary, schematic wiring, and interconnection diagrams of generator, exciter, governor, and other integral devices.
- d. Dimensional drawings or catalog cuts of exhaust and intake silencers, intake filters, starting equipment, and other auxiliary equipment not integral with the generator set.
- e. General arrangement or assembly drawings showing location of major auxiliary equipment in relation to the engine-generator set.
- f. Piping schematics for fuel oil and engine coolant showing pumps, gages, pipe sizes and valve locations.
- g. Engine-generator control panel.

Engine-Generator Unit Electrical Drawings: Submit complete electrical drawings including elementary, schematic, wiring, and interconnection diagrams for the generator switchboard and automatic transfer switches/low voltage switchboard.

Design Data:

- a. Torsional vibrations analysis for each unit

Statements

- a. Diesel engine generator successful operation

Diesel Engine Generator Successful Operation: Submit certificates within 30 calendar days after award certifying that not less than three engines of identical number of cylinders and cylinder size, identical or higher rotative speed, up to a maximum of 1,800 rpm, and identical or higher brake mean effective pressure (BMEP), and the same basic configuration (In-line or Vee) as the engine to be provided, have each driven generators which have produced, in satisfactory operation, not less than 250 kWh of electricity for each kW of generator nameplate capability within a 2-year period. Certificates shall include:

- a. A list of at least three engine-generator set installations meeting experience requirements in paragraph entitled "Experience Requirements."
- b. Owner and location of each installation.
- c. Date of initial operation of each installation.
- d. Number of kWh produced per kW of generator net rated capability of each engine installation.
- e. KW rating Horsepower rating, kW rating, and rotative speed of each set.
- f. BMEP rating of each engine.
- g. Design characteristics of each unit, such as bore and stroke, number of cylinders, and configuration (In-line or Vee).

Test Reports:

- a. Switchboard bus continuous current test.

Switchboard Bus Continuous Current Test: Certify that switchboard bus meets NEMA rated continuous current design test by listing bus size, bus quantity, bus material, rated amperes used, plus measured temperature rise and ambient temperature used during the test.

Factory Test Reports:

- a. Engine-generator set tests: Submit certified factory test report within 30 calendar days after completion of tests. Provide in accordance with requirements set forth in paragraph entitled "Source Quality Control."

Field Test Reports

- a. Piping tests
- b. Preliminary operation
- c. Phase relationship tests
- d. Control panel and switchboard tests
- e. Engine-generator set acceptance tests
- f. Auxiliary equipment test: Submit test and inspection reports for work required under paragraph, "Field Quality Control."

Records

- a. Posted operating instructions for diesel engine-generator set. Provide text for each piece of equipment according to paragraph, "POSTED OPERATING INSTRUCTIONS."

Operation and Maintenance Manuals

- a. Engine-generator unit and auxiliary equipment
- b. Engine speed governing system
- c. Engine-generator set voltage regulator
- d. Engine control panel
- e. Generator switchboard
- f. Automatic Transfer Switches

QUALITY ASSURANCE:

Experience Requirements:

Engines installed shall meet the following operating experience requirements:

- a. Only electric generation service is considered equivalent experience. Engines driving pumps, compressors, or those in marine propulsion or railroad service are not acceptable.
- b. Only experience on the same engine model is acceptable. Engine model is considered to be a given series or class of identical bore and stroke and of the same type of engine, such as In-line or Vee. In-line and Vee engines with identical bore and stroke are considered as two separate models.
- c. Only experience at identical or higher rotative speed as that specified is acceptable.
- d. Only experience at identical or higher BMEP as that specified is acceptable.
- e. Only experience with diesel-fueled engines is acceptable

Regulatory Requirements:

- f. Provide devices designed and installed to comply with the following requirements:
 - (1) Power Transmission Apparatus: Guard in accordance with ANSI/ASME B15.1.
 - (2) Electrical Installations: Conform to NFPA 70.
 - (3) Mercury: Use of mercury in instruments, contacts, and manometers is not permitted.

DELIVERY, STORAGE AND HANDLING:

Deliver equipment on pallets or blocking with each entire unit wrapped in heavy-duty plastic wrapping, sealed to protect unit from moisture and dirt. Plug and seal shut piping, conduit, exhaust, and air intake openings. Pack generator switchboard in shipping sections which can be handled and installed at the site. Protect and prepare batteries for shipment as recommended by battery manufacturer. Store equipment at the site in covered enclosures, protected from atmospheric moisture, dirt, and ground water. Properly label each package on exterior of wrapping to identify enclosed equipment, contract number, manufacturer, and purchaser. Manufacturer's standard practice in product protection and identification, meeting above requirements, is acceptable.

POSTED OPERATING INSTRUCTIONS:

Provide operating instructions laminated between matte-surface thermoplastic sheets suitable for placement adjacent to corresponding equipment. Install operating instructions where directed.

2. PRODUCTS**MATERIALS:**

Provide materials and equipment of manufacturers regularly engaged in production of such materials or equipment, and the manufacturer's latest standard commercial product that complies with specification requirements. Where two units of the same class of equipment are required, these units shall be products of a single manufacturer; however, component parts of the system need not be products of the same manufacturer.

ENGINE-GENERATOR SET:

Each set shall consist of a water cooled diesel engine direct- connected to an AC generator having a brushless excitation system, and shall be provided with necessary accessories, auxiliaries, appurtenances, control equipment, and cooling systems, resulting in a complete set and, except for external service connections, ready for operation. Mount each engine-generator set on a steel subbase sized to support the engine; generator-exciter, engine-generator control panel; lubricating oil filters, heat exchangers and pump; fuel oil filters and pumps; jacket coolant heat exchangers and pumps; and interconnecting piping and wiring. Engine generator set shall include electric starters, controls, and related wiring for electric starting. Batteries, battery racks and charger assembly may be mounted on the set subbase. Provide subbase with vibration isolators suitable for loads and lateral forces involved in seismic zone applicable. Isolators shall be as recommended by engine-generator set and isolator manufacturers to suit specific equipment involved. Make electrical and mechanical field connections with flexible connectors. When standard with the manufacturer, combustion air filter/silencer units and exhaust muffler units may be mounted separately from the set, and

connections made to engine with corrosion-resistant flexible connections. Factory align engines and generators on subbase and securely bolt into place in accordance with manufacturer's standard practice. Paint each set, after assembly, with manufacturer's standard paints and colors. After tests and before shipping, thoroughly clean each set and retouch paint as necessary to provide complete protection to the set. Arrange sets for automatic unattended starting in addition to manual start-and-stop by control panel switches. Each engine generator set shall be capable of automatically starting, coming up to synchronous speed, and ready to accept full rated power within 10 seconds after receipt of start signal.

Equipment Rating and Capability:

Each engine-generator set shall have a net standby rating capacity of not less than 2000 kW at 0.8 power factor and shall be designed to supply 4160 volts 3 phase, 60-Hz ac output. Auxiliary equipment shall be designed for continuous duty at 100 percent of rated net capacity of engine-generator set. Cooling system components and auxiliaries shall be properly sized relative to engine coolant specified under cooling system.

Torsional Vibrations:

Each complete engine-generator set shall be free of torsional vibrations that might endanger satisfactory operation of the set. Satisfactory operation will be considered endangered, when torsional vibration stresses exceed 34.45 MPa 5,000 psi within 10 percent above or below rated engine speed. Analysis of torsional vibrations shall be accomplished by calculations and by tests of a complete representative prototype of the engine-generator set. Results of the analysis shall be certified by a registered professional engineer.

Parallel Operation:

Each engine-generator set shall operate satisfactorily in parallel under this contract. Consider parallel operation satisfactory, when power pulsations between a new unit and the balance of the system do not exceed plus or minus 100 kW.

GENERATOR SET DESIGN AND CONSTRUCTION:

Isolate or shield rotating or reciprocating parts, or other parts that present a potential hazard to operating personnel.

DIESEL ENGINES AND ACCESSORIES:

Engines shall be four-cycle, naturally aspirated, turbocharged or turbocharged and intercooled; vertical in-line or vertical Vee type; water cooled; designed for continuous electrical duty, stationary service. Provide each engine designed and constructed to eliminate undue heating, vibration, and wear and be efficient and trouble free in operation. Engine shall be capable of operating on diesel fuel oil conforming to ASTM D 975, Grade 2-D

Construction:

Construct engine to withstand sudden changes from no load to rated load, and to preserve alignment of integral components under all conditions of operation. Design shall incorporate pressure lubrication of bearings and wrist pins, and bearing journals shall be hardened or chromium plated to provide a hard shock-resistant surface with ductile core. Counterbalance crankshafts to reduce vibration to a minimum. Crankshaft and connecting rod bearings shall be replaceable precision sleeve type. Provide cylinders with replaceable liners. Construct piston rings of heat-resisting alloy steel or chromium plated cast-iron. Camshafts shall be gear driven, and shall be high wear-resistant, at cams and journals. Clearly indicate timing marks on crankshaft and gears. Valves shall have removable or rebuildable stem guides and seat inserts. Flywheel shall be balanced, and capable of being rotated 50 percent above the maximum rated engine rotative speed without danger of breaking or exploding. Provide flywheel housing with a drain hole at the lowest point. Provide means for turning crankshaft manually. Turbocharger lubricating oil system shall not be a separate system, but shall be a part of engine lubricating oil system.

Assembly:

Completely factory-assemble each engine. Mount turbocharger or mechanically driven supercharger and intercooler and piping integral with the engine, on the engine.

Engine Speed Governing System, IEEE Device 65:

Provide each engine with a speed governing system and an independently driven over speed limiting engine shutdown device. Provide an adjustable isochronous governor, with suitable speed sensing. Governor shall be capable of either manually or automatically dividing the load when operating in parallel with other units having similar governors, and shall maintain specified stability without hunting, cycling, or other irregularities. Governor shall include provisions for adjusting speed droop and speed while the unit is in operation. Governor characteristics shall conform to the following:

- a. Minus 10 to plus 5 percent minimum range of speed changer expressed as a percent of rated speed.
- b. Steady-state governing speed band shall not exceed plus or minus 0.25 percent expressed as a percent deviation from rated speed.
- c. Transient speed deviation shall not exceed plus or minus 3.0 percent expressed as a percent of rated speed for any 50 percent load step, on or off.
- d. Time to return to limits of observed speed band shall not exceed 3 seconds after sudden load change of transient speed deviation.
- e. 0 percent to 5 percent minimum manual speed regulation range adjustment, expressed as a percent of rated speed.

Engine Protective Devices: Provide each engine with protective devices as follows:

- f. Engine Shutdown: Equip each engine with shutdown

devices listed. These devices shall shut down the engine by shutting off the fuel supply to fuel injectors. Shutdown devices shall be positive, direct in action and independent of the governor. Shutdown devices shall have factory-set fixed set points and shall be equipped with either auxiliary electrical contacts, relays or equivalent device for shutdown. Auxiliary contacts shall be suitable for starting battery voltage. Shutdown shall open the generator main circuit breaker. Provide the following shutdown devices:

- (1) Over speed device which operates when engine speed exceeds normal synchronous speed by 18 percent. Device shall require manual reset.
- (2) Pressure switch which operates when engine and turbocharger lubricating oil pressure drops below a preset value.
- (3) Temperature switch which operates when jacket coolant temperature exceeds a preset value.
- (4) Other shutdown devices as recommended or normally provided by engine manufacturer.

Electrical Interlocks and Alarms:

Equip starting mechanism with auxiliary contacts for interlocking with generator main breaker control circuit as determined by manufacturer. Auxiliary contacts shall be suitable for starting battery voltage.

Engine Alarm Contact Devices:

Equip each engine with alarm devices, relays, and auxiliary contacts, as required, to actuate alarm system on associated engine control panel. Auxiliary contacts shall be suitable for starting battery voltage. Alarm devices shall have factory-set fixed setpoints. Provide following alarm contact devices:

- a. Starting mechanism contacts or equivalent device operating to energize a portion of alarm system only when engine is running and not during cranking or shutdown.
- b. Pressure switch in engine and turbocharger lubricating oil system piping from engine to operate when pressure drops below a preset value due to failure of engine-driven lubricating oil pump.
In addition to alarm contacts, provide set of contacts to start an auxiliary oil pump, when such a pump is standard with engine manufacturer
- c. Temperature switch in jacket coolant discharge piping from engine to operate when temperature exceeds a preset value.
- d. Other alarm devices as recommended by engine manufacturer.

Engine Accessories:

Provide the following accessories for each engine-generator set as recommended by the manufacturer:

- a. Piping on engine-generator set to inlet and outlet connections, including nonstandard companion flanges.
- b. Foundation bolts, nuts, isolators, and sleeves for engine-generator

set.

- c. Leveling jack screws or shims, when applicable.
- d. Chocks and shims for installation and leveling of engine-generator set subbase, when applicable.
- e. Manually operated barring gear.
- f. Indicating thermometer or temperature indicator in accordance with manufacturer's standard for engine coolant.

Air Intake and Exhaust Systems:

Provide air intake and exhaust systems for each engine. Install field piping in accordance with manufacturer's requirements. Include piping, fittings, and expansion joints necessary to interconnect equipment with engines. Arrangement of air intake and exhaust systems shall be similar to that indicated and modified, as required, to suit engine furnished, subject to approval of the Owner and Engineers.

- a. Air intake filters: Provide heavy duty and dry type filter for each engine as standard with the engine manufacturer. Size filter to suit engine requirements at 100 percent of rated full load. Unit shall be designed to permit easy access to filter for maintenance purposes.
- b. Exhaust silencers: Provide a residential type exhaust silencer for each engine to reduce the exhaust sound. Silencer shall be complete with insulation and necessary brackets for supporting purposes. Sizing of silencer shall be in accordance with engine and silencer manufacturer's recommendations. Flanged inlet and outlet connections shall be provided.
- c. Expansion (flexible) joints: Provide sections of multiple corrugated stainless steel expansion joints with liners in the engine exhaust piping for each engine to absorb expansion strains and vibration in the piping. Flexible joints in exhaust piping shall be suitable for continuous operation at 93° C 200°F above the normal exhaust gas temperature at 100 percent load. Air intake expansion joints shall be as specified for exhaust piping or may be reinforced rubber type suitable for the service. Joints shall be of the same size as pipe and provided with flanged connections. Air intake expansion joints may be for plain end pipe.
- d. Air intake piping: Conform to manufacturer's recommendations for size, type, and connections.
- e. Exhaust piping: Provide piping for each engine complete with necessary fittings, flanges, gaskets, bolts, and nuts. Pipe shall be steel conforming to ASTM A 53. Exhaust piping shall be Schedule 40. Exhaust piping shall slope away from engine. Flanges shall be 667.5-N 150- pound slip-on forged steel welding flanges conforming to ASME/ANSI B16.5, with material in accordance with ASTM A 181/A 181M, Grade I. Fittings shall be butt-welding conforming to ASTM A 234/A 234M, with wall thickness same as adjoining piping. Built-up miter welded fittings may be used. Fittings shall be of same material as pipe. Miter angles of each individual section shall not exceed 0.393 rad 22.5 degrees total and not more than 0.196 rad 11.25 degrees relative to pipe axis at any one cut. Gaskets for piping shall be of high temperature asbestos-free material suitable for the service. Bolting material for exhaust flanges shall be alloy-steel bolt-studs conforming to ASTM A 193/A 193M, and alloy steel nuts conforming to ASTM A 194/A 194M. Bolts shall be of sufficient length to obtain full bearing on nuts and shall project not more than two full threads beyond the

nut.

GENERATORS AND EXCITATION AND VOLTAGE REGULATION SYSTEM:

Generator:

Provide 0.80 power factor, synchronous, ac, brushless-excited, revolving field, air-cooled, self-ventilated unit conforming to NEMA MG 1 and rated as specified in paragraph entitled "Equipment Rating and Capability." Enclosure frame shall be drip proof. Match generator speed to that of engine. Drive generator directly from engine crankshaft in a manner approved by both engine and generator manufacturers. Generator shall be capable of carrying at rated voltage and 0.8 power-factor, a load equal to net kW rating of the engine without exceeding temperature limits specified in NEMA MG 1 for standby duty. Winding insulation shall be Class For H. An amortisseur winding shall be provided and generator and flywheel shall have sufficient flywheel effect to meet requirements of regulation and parallel operation specified. Generator field voltage shall be manufacturer's standard voltage. Ground generator enclosure at two opposite mounting legs.

Excitation and Voltage Regulation Systems Comply with IEEE 421.1.

Exciter:

Integral with generator; synchronous, rotating armature, rotating rectifier, brushless or permanent magnet brushless type. Mount rotating rectifier assembly in a manner to provide ready access for inspection and replacement of rectifier diodes. Semiconductor rectifiers shall have minimum factor of safety of 300 percent for peak inverse voltage, and forward current ratings for operating conditions, including 100 percent generator output at 40° C ambient. Provide safety devices for protection of rectifiers against overload currents and voltages unless design provides this protection inherently. Acceptable ratio of exciter ceiling voltage to exciter nominal voltage shall be not less than three to two.

Voltage Regulator, IEEE Device 90:

Provide a solid state voltage regulator that automatically controls the generator field current through action on the exciter, and provides immunity from SCR tracking. Voltage regulator shall enable manual adjustment of set output voltage, while set is operating, by potentiometer adjustment at generator control panel. Voltage regulator shall enable parallel operation with like sets. Provide cross connection of voltage regulators of sets to enable operation in parallel with minimal voltage drop.

a. Operation:

Voltage regulator shall have characteristics and sensors which enable generator to operate alone or in parallel with other generators in isochronous load sharing mode and in conjunction with common solid-state control to operate isochronously with proportional load sharing mode. Provide a contact to short out the current transformer when a generator is not connected to its

output bus. Install instrument transformers and voltage regulator in the generator control panel along with a manual voltage setting control.

b. Regulation:

Voltage regulator/excitation systems shall be capable of voltage regulation within plus or minus 1 percent from no-load to full-load. A 5 percent variation in frequency and effects of field heating shall not affect units' regulation performance. System shall provide 300 percent rated generator current for at least 10 seconds to provide short-circuit current adequate to operate circuit breakers.

FUEL OIL DAY TANKS:

Provide tank with a minimum capacity of 2 hours of engine-generator set operation at full-rated load

Level Alarm Switches:

Provide tank-top mounted or external float cage, single-pole, single-throw type designed for use on fuel oil tanks. Arrange high level alarm switches to close on rise of liquid level, and low level alarm switches to close on fall of liquid level. Mount float cage units with isolating and drain valves. Contacts shall be suitable for starting battery voltage.

Tank Gages:

Provide tank gages for fuel oil day tanks. Gages for fuel oil day tanks shall be buoyant force type, with dial indicator not less than 100 mm⁴ inches in size and arranged for side mounting. Each dial or scale shall be calibrated for its specific tank to read from empty to full, with intermediate points of 1/4, 1/2, and 3/4.

Fuel Oil Filter: Provide manufacturer's standard.

Day Tank Makeup Control Valve: Solenoid valve shall be two-way, direct acting, normally closed, open when energized, closed when DE energized, with brass body and resilient seat material. Electrical rating shall be 230 volt, single-phase, 60-Hz. Body connections shall be same size as connecting piping.

LUBRICATING OIL SYSTEM:

Auxiliary Lubricating Oil Pumps: Where recommended by the engine manufacturer, provide one pump for each engine, each suitable for "before-and-after" lubricating and cooling service as required by the engine. Equip each pump with a bypass relief valve.

Lubricating Oil Filtration:

Provide each engine with a pressurized lubricating oil filtration system capable of filtering the full rate of oil flow from the oil pumps at maximum engine speed in accordance with standard practice of engine manufacturer. Provide means to ensure delivery of lubricating oil to vital wearing surfaces regardless of the condition of filters without removing engine from service. Filters shall provide means of automatically bypassing filter when filter becomes flow-restricting.

Provide throwaway type filter elements as recommended by engine manufacturer.

COOLING SYSTEM:

Jacket Coolant Pumps:

Provide one pump for each engine driven from engine crankshaft or camshaft. Each pump shall have ample capacity to circulate required flow of coolant specified through the system to remove total heat rejected from the engine and, where provided by design, from lubricating oil and intercoolers. Heat shall be rejected to jacket coolant to maintain optimum jacket coolant temperature leaving and entering engine as recommended by the engine manufacturer.

Radiators:

Provide one radiator unit for each engine-generator set. Provide engine unit-mounted radiators of the forced draft type horizontal air discharge, as standard with manufacturer.

- a. Design Conditions: Each radiator unit shall have ample capacity to remove not less than the total kW Btu per hour of heat rejected by its respective engine at 100 percent full-rated load to jacket coolant, to lubricating oil system, to air surrounding the engine on subbase-mounted radiator units and that necessary for turbocharger intercooler. Radiator capacity shall be rated at optimum temperature of coolant leaving engine and intercooler as recommended by the engine manufacturer, with a dry bulb air temperature of 43° C. Pressure drop through the radiator shall not exceed 41.34 kPa 6 psi when circulating maximum required coolant flow. Radiator air velocity shall be a maximum of 4.57 m/s 900 feet per minute. Coolant solution shall be a mixture of clean water and a commercial standard methoxy-propanol or ethylene glycol coolant. Mixture shall be to proportions recommended by the engine manufacturer to meet site conditions.
- b. Engine Unit-Mounted Radiator Construction: Radiator fan shall direct air flow from the engine outward through the radiator. Fan shall be V-belt driven directly from the engine crankshaft. Radiator shall have sufficient capacity to meet design conditions against a static restriction of 12.7 mm of water as may be imposed by louvers and ductwork. Cooling section shall have a tube and fin-type core consisting of copper or copper base alloy tubes with nonferrous fins. Engine-driven fans shall be the engine manufacturer's standard unit selected for quiet vibration-free operation. Provision shall be made for coolant expansion either by self-contained expansion tanks or separately mounted expansion tanks, as standard with the manufacturer. Provide suitable guards for each fan and drive.

Thermostatic Control Valves: When recommended and standard with engine manufacturer for proposed engine, provide a valve installed in the jacket coolant system for each engine to maintain a constant jacket coolant temperature from the engine. Valve shall be as specified in paragraph entitled "Thermostatic Control Valves." Valve shall be capable of passing coolant flow, as determined by the engine manufacturer.

ELECTRIC STARTING SYSTEM: Provide a 24 volt dc starting battery installation for starting of each engine-generator set utilizing an electric

cranking system. Electric cranking system shall be capable of rotating the engine at a speed sufficient for rapid starting in an ambient temperature of minus 7°C 20°F. Signal for starting shall come from engine-generator set control system.

Cranking: Energize electric cranking system from negative polarity grounded starting batteries. Provide heavy-duty type cranking motors with capacity to crank the engine continuously to start the engine. Drive mechanism for engaging starting motors with engine flywheel shall be designed to inherently engage and release without binding. When engine starts, starting gearing shall automatically disengage and starting motors shall shut down. Automatic cranking panel shall crank engine as specified under paragraph entitled "Engine Cranking Relay."

Starting Battery Installation: Provide maintenance free lead acid industrial engine cranking batteries designed for diesel engine starting of sufficient size and capacity in a fully charged condition to crank engine for four consecutive cycles of 30 seconds cranking followed by 120 seconds rest. Provide battery racks or enclosures, properly ventilated for the batteries and charger. Provide necessary cabling.

Starting Battery Charger: Provide enclosed, automatic, dual-rate, solid-state, constant voltage type battery charger having ac voltage compensation, dc voltage regulation, and current limiting. Charger shall employ transistor-controlled magnetic amplifier circuits to provide continuous taper charging. Charger shall have two ranges, float and equalize, with 0 to 24 hour equalizer time, dc cranking relay, silicon diode full-wave rectifiers, automatic surge suppressors, dc ammeter, dc voltmeter, and fused inputs and outputs. Charger shall have continuous rated output of not less than 10 amperes and conform to UL 1236.

ENGINE-GENERATOR SET CONTROLS:

Provide an engine generator control panel mounted on each engine generator set subbase and a separate generator switchboard. Manufacturer's standard electronic control panels may be provided in lieu of those specified below if they accomplish the same functions.

Engine Control Panel Provide an enclosed panel fabricated of not lighter than 14-gage sheet steel in compliance with NEMA 250, Type 1. Construct cabinet with angle iron framework, if required, for proper stiffness and support. Size cabinet to accommodate specified equipment when arranged in an orderly and approved manner. Factory-mount panel on engine unit subbase. Provide isolation mounting material between subbase and panel to isolate the panel from engine vibrations. Provide panel-mounted devices with nameplates of laminated black gloss-finished plastic with white engraved lettering. Provide connecting piping, tubing, and wiring installed in conduit where not otherwise enclosed.

Engine Control Panel Provide devices of the type standard with the manufacturer utilizing minimum 50-mm 2-inch nominal diameter gages. Provide instruments subject to rapid pressure surges with damping devices to give a steady reading. Provide the following panel-mounted devices as a minimum:

- a. **Engine Controls:** Install engine controls on generator control

panel, except provide an emergency stop switch on the engine control panel.

b. Engine Instrumentation :

- (1) Fuel oil pressure gage
- (2) Lube oil pressure gage
- (3) Coolant temperature gage
- (4) Elapsed time meter

c. Engine Safety Circuit Devices: Provide the following devices to stop engine-generator set and to simultaneously open its main circuit breaker. Stop switch may be connected to this safety circuit when recommended by the manufacturer. Source of energy for engine safety circuit devices shall be the starting battery, separate from the starting circuit.

- (1) Over cranking
- (2) Over speed
- (3) Excessive coolant temperature
- (4) Dangerously low lubricating oil pressure

Generator Control Panel:

Install controls in engine-generator control panel or in the generator switchboard generator panel as indicated. Provide microprocessor based communication and connection for remote monitoring of generator operation including all required interface devices and generator controls and instrumentation as follows:

a. Generator controls

- i. Voltage regulator and associated controls

b. Generator instrumentation and metering

- i. Voltmeter and control switch
- ii. Ammeter and control switch
- iii. Three current and three voltage (potential) transformers

c. Engine starting and stopping controls and protective equipment

- i. Engine starting switch
- ii. Engine cranking relay
- iii. Engine shutdown relay
- iv. Automatic transfer switch
- v. Automatic synchronizing and transfer circuitry

d. Local Alarm Panel: Provide manufacturer's standard local alarm panel suitable for operation on the starting battery voltage. Provide with shutdown alarms in accordance with NFPA 99. Panel shall be complete with interface devices and modules for connection to and monitoring, data gathering by a Building Management System. Provide the following alarms with pre- shutdown alarms only for temperature and pressure conditions and shutdown alarms for all conditions:

- i. High jacket coolant temperature
- ii. High lubricating oil temperature
- iii. Low lubricating oil pressure
- iv. Low fuel oil pressure
- v. Engine shutdown due to overspeed
- vi. Engine starting failure
- vii. Normal voltage supply failure
- viii. Restoration of normal supply voltage
- ix. Control battery summary alarm
- x. Other engine-generator set abnormal conditions as recommended by the manufacturer

Generator Switchboard:

Free-standing, self-supporting metal-enclosed, general-purpose, indoor, with internal steel barrier, hinged that doors for access to control, transformers and breaker compartments, standard powder coated smooth finish low-voltage switchboard rated for 400-volts, three-phase, four wire and provided with full-size neutral bus and continuous ground bus. Buses shall be copper. Interrupting and continuous ampere ratings as indicated.

Operation:

- a. The control switchgear shall be used for automatic operation of engine generator sets standby units.
- b. Automatic programming shall be interpreted to mean automatic starting, automatic paralleling and automatic load sharing system for the engine generator sets. The design of the control system shall also permit manual starting, stopping and paralleling of the station engine generator sets. Manual control of the individual generator sets speed and voltage shall also be provided. The automatic synchronizing and automatic load sharing circuits shall remain operative in the manual mode.
- c. Should an engine generator set fail to start, fail to automatic parallel or develop a critical running monitored fault, the control system shall cause the engine to automatically shut down with its circuit breaker automatically tripped open.

Generator Units:

Provide to switch and control electrical output of each engine-generator set.

Automatic Transfer Switch Tie Units:

Provide automatic tie units to switch and control each transfer switch tie.

Generator Control Panel Devices

Controls:

Provide microprocessor based generator sets power control system with functions of power load control, power metering, automatic synchronizing/paralleling, protective relaying and provide closed-loop control of real and reactive power output when units operate in parallel.

- Power control functions shall include the following:
 1. True RMS real power sensor for precise control
 2. Closed-loop control of generator power level
 3. Control outputs to be wired to the generator sets electronic speed control engine governor module
 4. Adjustable ramp time for soft loading and soft unloading of generator sets
- Power metering functions shall include the following:
 1. AC amperes, 3 phase
 2. AC voltage of each phase to phase
 3. AC kilowatts, 3 phase total
 4. AC kiloVARS (KVARs), 3 phase
 5. Frequency
 6. Power factor
 7. AC kilowatt hours, 3 phase total
 8. Generator set run time hours
- Automatic Synchronizing (paralleling) functions shall include the following:
 1. Automatic synchronizer, both speed (frequency) and voltage matching
 2. Synchronizing check function
 3. Failed to Parallel function
- Protective relay functions shall include the following:
 1. Over/under voltage, 3 phase, 27/59 function
 2. Over/under frequency, 81-O/U function
 3. Negative phase sequence-current, (current unbalance) 46 function
 4. Negative phase sequence-voltage, (voltage unbalance) 47 function
 5. Reverse reactive power/Loss of Excitation, 40 (32RV) function
 6. Reverse power, 32 function
- Operator Interface Module (OIM) shall include the following:
 1. 10.5" Colour Display
 2. Graphical representation of system status
 3. Analog and digital metering
 4. Alarm, shutdown, and status annunciation
 5. Access to control modes, timers, level adjustments, etc
 6. Manual Synchronizing Provisions

Generator Circuit Breaker, IEC 62271: Provide medium voltage circuit breaker using vacuum switching technology. Provide stored-energy closing mechanism for rapid and safe closing of circuit breaker against fault currents within the short-time rating of circuit breaker independent of operator's strength or effort in closing the handle. Size circuit breaker for the 100 percent full-load capacity of engine-generator set and provide lugs for indicated electrical connection.

- Circuit Breaker Type:
 1. Vacuum Circuit Breakers

- (a) IEC 62771-100, 630A 7.2kV, 60kV BIL, 25kA
rated short time withstand current draw-out type

- Circuit Breaker Support Structure
 2. Switchboard, IEC 62771-200

Instrument and Control Switches: Utilize rotary-enclosed, rear-mounted switches having positive means of maintaining contacts, which shall be silver-to-silver type, identifying escutcheon plates, and handle targets to indicate switch position. Utilize knurled handles for instrument switches, standard pistol grip handles for circuit breaker and governor control switches, and provide only two removable oval handles for synchronizing switches. Provide red and green indicating lights for circuit breaker control switches.

Indicating Lights: Provide front removable, low drain, push-to-test, indicating lights equipped with dropping resistors suitable for 120-vac service, as required and color caps as specified.

Instrument Transformers: Provide indoor, cast epoxy resin type conforming to IEC or ANSI/IEEE C57.13. Coordinate mechanical and thermal ratings with circuit breakers and other apparatus in the switchboard. Provide voltage transformers as shown or as required of the non-drawout type with current-limiting primary fuses and secondary fuses.

Engine Starting Switch: Four-position rotary, enclosed rear mounting, maintained position type. Switch positions shall be "Automatic," "Off," "Test," and "Manual" and connected to provide the following operation:

- In "Automatic" position, engine-generator set shall start automatically in response to loss of voltage, as described in paragraph "Automatic Controls."
- In "Off" position, engine-generator set starting circuits shall not function.
- In "Test" position, engine may be started and brought up to speed, but engine-generator set cannot be put on line.
- In "Manual" position, switch shall start and bring engine-generator set up to speed and then connect it to line.

Engine Cranking Relay: Provide to operate as follows:

- a. When actuated, device shall close contacts to actuate engine starting system.
- b. Should engine fail to start at once, cranking shall continue for 30 seconds (adjustable) after which a 120-second "off" period (adjustable) shall occur. Durations of cranking and "off" periods listed above may be modified in accordance with engine manufacturer's recommendations.
- c. Repeat above described cranking cycle for four starting attempts.
- d. If engine still fails to start, cranking device shall lock out further starting attempts until device is manually reset. When cranking

relay locks out, an alarm light shall be energized on the panel and remain lighted until relay is manually reset.

Engine Shutdown Relay Provide and actuate by engine protective devices as specified in paragraph "Engine Safety Circuit Devices." Shutdown relay shall disable engine starting circuits until manually reset. Provide reset pushbutton on switchboard.

Automatic Synchronizing and Transfer Circuitry: Provide engine-generator sets with relays, switching, and other devices and wiring necessary for fully automatic operation.

- a. Automatic Starting: When normal supply voltage in phase drops below a predetermined value, adjustable from 65 to 90 percent normal for a predetermined interval, adjustable from 0 to one minute, automatic operation shall begin. First, engine-generator set shall automatically start, accelerate to governed speed, and build up to regulated voltage. When engine-generator set voltage reaches approximately 90 percent normal, automatic transfer of load from normal source to engine-generator set shall occur. When load exceeds a predetermined value, adjustable from 50 to 100 percent of engine-generator set rating for a period of approximately 10 seconds, second engine-generator set shall automatically start, accelerate to governed speed, build up to regulated voltage, synchronize and be connected in parallel, dividing the load equally, with first set and so on for engine-generator sets provided.
- b. Automatic Synchronizing: Provide each engine-generator set with an individual three-phase automatic-synchronizing relay, IEEE Device 25, having fully redundant logic and circuit breaker closure circuitry. Provide relay complete with necessary auxiliary devices arranged to close each generator circuit breaker at the correct phase angle in advance of synchronism to effect closure of a circuit breaker main contacts at approximately the instant of zero phase angle between generator and bus voltages, when generator synchronizing selector switch is operated. Automatic synchronizing relay shall not permit closing of a generator breaker with abnormal voltage nor with a slip frequency greater than one-third Hz and shall automatically adjust governed speed of selected generator to match frequency of bus prior to closing generator circuit breaker. Relay shall contain a pulsing circuit to "force" phase correction when frequencies are matched but improper phase relation exists. Ensure that dead bus logic operates so that before one generator circuit breaker can close, remaining generator circuit breakers have been locked out. Provide a 10- to 20 millisecond time delay compatible with logic and closure circuits. Relay shall be equipped with surge protection either by suitable devices or by component rating.
- c. Automatic Stopping: When normal supply voltage is restored to a predetermined value, adjustable from 90 to 100 percent normal, for a predetermined time interval, adjustable from 0 to 2 minutes, load shall automatically transfer from engine-generator sets to normal supply, generator circuit breaker shall open, and engine-generator sets shall continue to run for a period of 5 minutes, adjustable, then automatically stop. Devices shall return to normal position, ready to repeat the automatic operation above. Complete facilities shall be provided for manual control, including test operation of each engine-generator set without load and manual operation of load transfer

devices. When engine-generator sets are not required to supply connected load, unneeded sets shall be shut down.

- d. **Selector Switch:** Provide one selector switch to permit selection of which engine-generator set first starts and permit selection of the sequential starting of other engine-generator sets.

Generator Switchboard Unit Equipment Details: Provide units with nameplates for front and rear identification and necessary auxiliary relays, small wiring, nameplates, control and instrument buses, fuses, terminal blocks, wire terminals, and accessories. Arrange cable compartments in switchboard for indicated entrance of power and control cables. For each free-standing section provide one set ground buses, splices, and connections. Buses shall be tin plated copper. Circuit breakers shall conform to paragraph "Generator Circuit Breakers."

MISCELLANEOUS ENGINE SYSTEM REQUIREMENTS:

Tank Construction: Construct tanks of not less than 4.76-mm 3/16-inch steel plate with welded joints and necessary stiffeners on exterior of tank. Provide a braced structural steel framework support. Weld tank top tight and provide an access opening with dustproof, removable 610-mm 24-inch cover.

Flange Connections: Where not otherwise indicated, provide piping connections in accordance with ASME/ANSI B16.1 for 556-N 125-pound flanges.

Thermostatic Control Valves: Valves shall be modulating type utilizing self-contained thermostats without the use of external bulbs, and equipped with three-way valve action. Provide valves with one or more interchangeable thermostatic elements. Thermostat shall be nonadjustable and operating temperature shall be factory-set at temperature recommended by engine manufacturer. Provide valve designed to fail-safe, permitting flow through engine.

WIRE AND CABLE: Provide wire and cable required for a complete electrical system as shown. Comply with requirements specified in Item, "Interior Distribution System."

VIBRATION ISOLATION SYSTEM: The isolation system shall reduce the vibration transmitted to the adjacent floor slab to a maximum of 0.038 mm 0.0015 inch total amplitude throughout the frequency range down to 65 CPS. The manufacturer shall certify that the vibration isolation system will reduce the vibration to the limits specified.

IDENTIFICATION OF EQUIPMENT: Each major component of equipment shall have the manufacturer's name, address, and model and serial number on a nameplate securely affixed in a conspicuous place; nameplate of the distributing agent will not be acceptable. Nameplates shall not be painted.

SOURCE QUALITY CONTROL: Perform and report on factory tests prior to shipment. Provide certified copies of manufacturer's test data and results. Notify Owner before performing tests. Test procedures shall conform to IEC,

ASME, IEEE, and ANSI Standards, and to SAE requirements on testing, as appropriate and applicable. Ensure that measuring and indicating devices are certified correct. Tests shall indicate satisfactory operation and specified performance. When satisfactory, equipment tested will be given a tentative approval. Equipment shall not be shipped before approval of factory test reports for the following tests:

Engine-Generator Set Tests: Perform customary commercial factory tests on each engine-generator set, including, but not necessarily limited to, the following:

- a. Perform hydrostatic test on engine water jackets and piping to ensure that water seals and water jackets are water tight. Test report shall indicate pressure at which test was made and the results.
- b. Place engine-generator set in continuous operation without stoppage for a period of not less than 8 hours. Operate not less than one hour at each load point, that is 1/2, 3/4, and full load. When stoppage becomes necessary during this period, repeat the 8-hour run. Record the following data for sets at the start, at 15-minute intervals, and at end of each load run: Fuel consumption (correct fuel consumption results to guarantee conditions); exhaust temperatures; engine coolant temperatures; lubricating oil temperatures and pressures; and any other data of importance.

Generator Tests: Ensure that temperature tests on one generator's windings are performed by manufacturer of generator in manufacturer's own plant. Temperature tests shall be in accordance with IEEE 115. Generator tests shall include insulation resistance and dielectric resistance. Prototype tests for generators that are physically and electrically identical to those provided under the Contract are acceptable. Calculations of sub transient reactance shall be included in the test report.

3. EXECUTION

PREPARATION: Use cribbing and shoring as required to protect construction from moving-in damage. Protect flooring and finished surfaces with heavy planking. Obtain approval of methods and materials from the Owner or the Engineer's authorized representative before moving equipment across shored floors.

INSTALLATION Installation shall be in strict accordance with manufacturer's instructions. Unload, move, and erect equipment under direct supervision of a competent and experienced erecting engineer. Provide labor, tools, equipment, and other necessities for erection and installation of equipment. After equipment has been installed, remove shoring and repair damage to floors and other parts of the building. Furnish the services of one or more Diesel-Generator representative or technicians, experienced in installation and operation of the type of systems being provided, to supervise the installation.

Installation of Engine-Generator Sets: Install engine-generator sets on a concrete foundation as indicated. Provide vibration isolators to isolate vibrations from engine-generator set to the foundation.

Equipment Supports and Installation Provide devices to support equipment not supported on engine-generator structural steel subbase as required. Fabricate required supports of structural steel sections, plates or rods, and arrange to provide rigid and sturdy support. Provide connections and fasteners required

between equipment supports and building structures.

- a. **Generator Switchboard:** Provide floor mounting channels, suitable for mounting above cable trenches and install on concrete floor pad in accordance with switchboard manufacturer's drawings and instructions and as indicated. Splice the main bus and insulate bus joints in accordance with switchboard manufacturer's recommendations. Connect control wiring as required at shipping splits.
- b. **Batteries and Chargers:** When batteries are to be stored during the construction period, follow manufacturer's instructions for charging and protection from environmental damage.

Instruction of Operators: After equipment is ready to be placed in service, Contractor and equipment manufacturer's representative shall fully instruct plant operators in operation and maintenance of the equipment. Posted operating instructions for diesel engine-generator set shall be provided adjacent to the unit.

Provisions for Expansion: Provide for expansion of piping subject to temperature change by using suitable flexible piping connectors, expansion joints, bends, ball joints, offsets, and loops in a manner that will prohibit development of excessive stresses between anchor points or at equipment connections. Provide bends, loops, and offsets wherever practical to prevent overstressing of piping systems due to thermal expansion and to provide adequate flexibility. A piping system may be cold sprung by an amount no greater than 50 percent of the total linear expansion to alleviate end thrusts and moments. Method of cold springing shall be as approved.

- **Reducing Fittings:** Provide for changes in pipe size except where taps are permitted. Use of bushings is prohibited. In horizontal mains containing liquids, provide eccentric reducers.
- **Unions or Flanges:** Provide where necessary to permit easy connection of piping and apparatus. Provide unions on valves with screwed ends. In long lines inside buildings, place unions or flanges not farther apart than 30 meters, except in pipe lines of welded construction where unions or flanges shall be placed as indicated.
- **Valves:** Install in positions accessible for operation and repair. Install stems preferably in a vertical position with hand wheels or operators on top, or install in a horizontal position. Do not install hand wheels on stop valves below the valve. Install globe valves with flow direction from below the disk.
- **Connections to Equipment:** Make piping connections to equipment shown and provide reducers, unions, and valves to make a complete installation. Make connections to equipment with unions or flanges. Provide valves the same size as piping in which they are installed.

Joints:

- a. **Flanged Joints:** Face pipe flanges true to line and thoroughly clean before assembly. Gasket faces shall be free of burrs or bruises. Make up flanged

joints prior to completing the last weld in connecting piping. Coat bolt threads with a mixture of equal parts of graphite and boiled linseed oil or with an approved commercial coating.

- b. Screwed Joints: Provide graphite pipe-joint compound; apply to male threads only. Piping shall be free of fins and burrs. Ream pipe ends or file out to size of bore; remove chips.

Pipe Sleeves:

Provide where pipes and tubing pass through masonry or concrete walls, floors, roofs, and partitions. Sleeves in outside walls above grade, in floor, or in roof slabs shall be steel pipe. Sleeves in floor slabs shall extend 75 mm above the finished floor. Firmly pack space between pipe or tubing and sleeve with oakum and calk on both ends of sleeve with elastic cement, except for sleeves in plant operating floors which shall be free of packing and elastic cement. Where piping passes through steel grating, band the opening with 25-by 3mm steel edge bands welded to the grating bars.

Anchors, Guides, and Supports:

Anchor and support piping in a manner such that expansion and contraction will take place in the desired direction. Prevent vibration by use of vibration dampers and prevent undue strains on equipment served. Hangers used for supporting piping 50-mm and larger shall be the type permitting adequate adjustment after erection while still supporting the load. Provide supports to adequately carry weight of lines and to maintain proper alignment. Provide inserts and sleeves for supports in concrete where necessary, and in new construction place inserts and sleeves before concrete is poured.

FIELD QUALITY CONTROL:

Perform and report on field tests and trial operations, and conduct field inspections, except final field inspection. Provide labor, calibrated and approved test equipment, and incidentals required for tests. Engineers will witness field tests and trial operations and will conduct final field inspections. Give Engineers 5 days' notice of dates and times scheduled for tests, trial operations, and inspections which require the presence of the Owner/Engineers. Rectify deficiencies and retest work affected by such deficiencies.

Preliminary Operation:

Align and adjust equipment to ensure proper operation as instructed by manufacturers of equipment. Lubricate equipment prior to operation in accordance with manufacturer's instructions. Upon approval by the Owner or the Owner's authorized representative, operate engine-generator sets at varying loads throughout the load range for a sufficient time to demonstrate that operation is proper and that pressures and temperatures are normal and within specified limits. Operate engines for a period of time sufficient to ensure that units are ready to carry test loads specified in paragraph "Engine-Generator Set Acceptance Tests" without damage to engine parts. During this preliminary operation, check operation and ensure proper functioning of auxiliary equipment. Make necessary adjustments to equipment to place auxiliary equipment in operating condition.

Electrical Equipment and Materials Tests Test procedures, inspections, and sampling shall be as specified and noted below:

- a. **Phase Relationship Tests:** Check connections to equipment for proper phase relationship. During such check, disconnect devices which could be damaged by application of voltage or reversed phase sequence.
- b. **Control Panel and Switchboard Tests:** Test and adjust meters and relays in accordance with applicable referenced specifications.
- c. **Insulation Resistance Tests:** Test field installed cables. Minimum acceptable values of insulation resistance of circuits shall be as recommended by the manufacturer.

Engine-Generator Set Acceptance Tests:

When installation is complete and in operating condition, notify the Owner and Engineers in writing that engine-generator sets and auxiliary equipment are ready for final field tests. The Owner or Engineer's authorized representative will witness final acceptance tests. Perform tests as necessary to make certain that equipment is functioning properly. Tests shall include the following:

- a. A test to determine generating unit speed regulation under a gradual change from zero to fullload.
- b. A test to determine generating unit instantaneous speed change with 50 percent load on or off.
- c. A test to ensure proper functioning of over speed trip.
- d. An individual test each alarm device.

Inspect auxiliary equipment including, but not limited to, pumps, fans, radiators, instruments, and special valves to ensure proper operation. Auxiliary equipment test shall be in accordance with the latest ASME and IEEE performance test codes, when applicable. Check oil after tests for presence of metal particles and water. Provide and install temporary instrumentation, piping, and electrical wiring and make electrical connections required for engine-generator set tests.

ITEM 20 : MEDIUM VOLTAGE SWITCHGEAR (INDOOR)

1. GENERAL

"Electrical General Requirements," applies to this section with additions and modifications specified herein.

SUBMITTALS:

Shop Drawings and Manufacturers' Data: GEAR

- a. Vacuum circuit breaker
- b. Medium voltage switchgear

Shop Drawings and Manufacturer's Data: Submit shop drawings in compliance with the Local Power Company requirements for approval, two (2) copies to the Engineers and four (4) Copies to the Power Company.

Shop drawings for switchgear shall indicate but not be limited to the following:

- a. Switchgear layout showing dimensions and clearances between equipment and walls
- b. Overall dimensions, front view, and sectional views of switchgear
- c. Bus arrangements including dimensions and ampere ratings of all bus bars
- d. Type and spacing of bus supports
- e. Maximum short circuit bracings
- f. Vacuum circuit breaker, interrupting rating
- g. Ratings and sizes of lugs, impedance, taps, and fans
- h. Elementary diagrams and wiring having their terminals identified, and indicating the internal wiring for each item of equipment and the interconnection between the items.

Certificates of Conformance or Compliance with IEC Standards: Before delivery of materials and equipment, submit certificates in triplicate.

Manuals: Manuals and final wiring drawings shall be furnished with the equipment.

Factory Test Reports: Submit in triplicate certified copies of reports of all tests required for the following:

- a. Switchgear

2. PRODUCTS

GENERAL REQUIREMENTS, MATERIALS: All equipment and materials shall be new unless indicated or specified otherwise.

INCOMING AND DISTRIBUTION SECTION: IEC 62271-200. The switchgear shall be rated for 4.16 kV, 2500 amperes main bus and shall consist of metal clad switchgear sections for connecting the incoming circuit from transformers and outgoing distribution feeders.

Incoming termination shall be from transformer bus duct connection and from single conductor cable terminations to generator switchgear as shown on drawings. Outgoing conductor terminations from distribution breakers shall be single conductor entering from below as shown on drawings.

The vacuum circuit breakers shall be electrically operated, three-pole, circuit interrupting device with amperes rating as shown on drawings, 7.2 kV 60 kV BIL, 60 hz. with a short circuit capacity of not less than 25 kA amperes symmetrical, 63 kA rated peak withstand current. Circuit breaker shall be drawout-mounted with position indicator, operation counter, auxiliary switches, and primary and secondary disconnect switches. Provide for manual charging of the mechanism and for slow closing of contacts for inspection or adjustment. The circuit breaker control voltage shall 125 volts DC.

Provide metering as shown on drawings and complete protective relay system, control transformers, battery and charger for 125 volts DC controls and earthing switch for incoming circuit breakers.

BUS BARS: Copper with silver plated contact surfaces, mounted on insulator supports of high impact, non-tracking, high quality insulating material, adequately braced to withstand the mechanical forces exerted during short circuit conditions.

ENCLOSURE: IEC 60529

Construction: Enclosure shall be constructed of structural or rolled sheet steel and welded into a solid framing. Each unit shall be adequately braced, with adequate venting to prevent conditions, which include short-circuits up to the specified rating. Metal enclosures shall be free-standing. Vent openings shall be provided with screens to prevent the entrance of rodents.

Suitable means for lifting the switchgear shall be provided.

Paint and Finish: Housing shall be chemically cleaned inside and out and then treated with a phosphoric acid to etch and clean the metal. All surfaces shall be finished in medium light grey (ANSI number 61) paint or per manufacturer's standard.

ACCESSORIES:

- a. Provision for padlocking
- b. Door interlock to prevent operation of vacuum circuit breaker when compartment is open
- c. Hazardous Danger Sign

NAMEPLATES: Provide laminated plastic nameplates for each switch and devices to identify its function, and where applicable, its position. Laminated plastic: 3.2 mm (1/8-inch) thick Melamine plastic white with black center core. Surface: matte finish; corners: square. Accurately align lettering and engrave into the black core. Size of nameplates:

50mm by 250 mm minimum; lettering: minimum 25 mm high normal block lettering. Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3. EXECUTION

TESTS:

The manufacturer shall supply, test results, to confirm that the rigidity and bus bracing.

GUARANTEES:

The manufacturer shall guarantee the complete switchgear for workmanship, construction, and operation for a period of one (1) year after installation and acceptance.

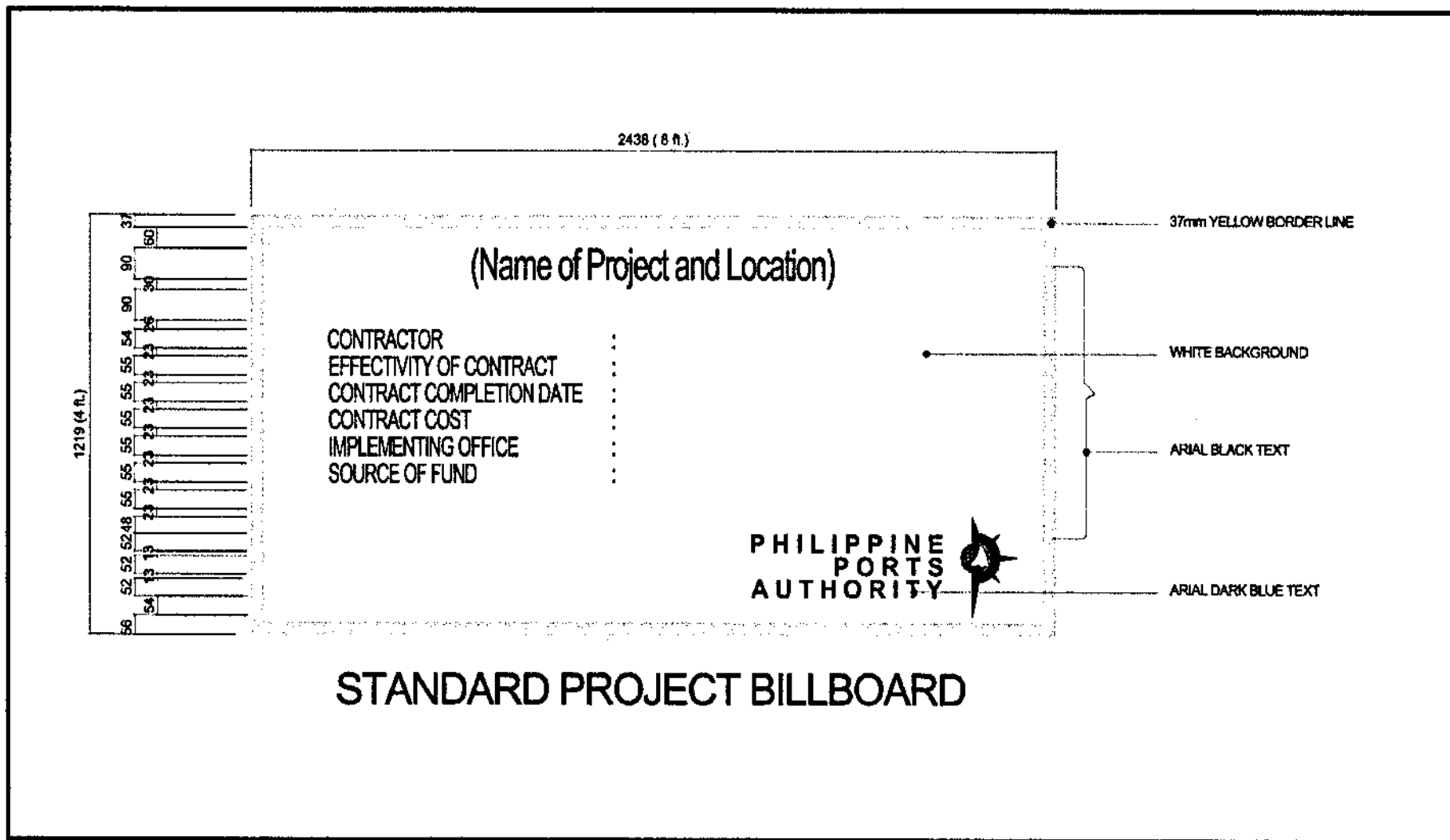
ITEM 21 : PROJECT BILLBOARD**SPECIFICATION**

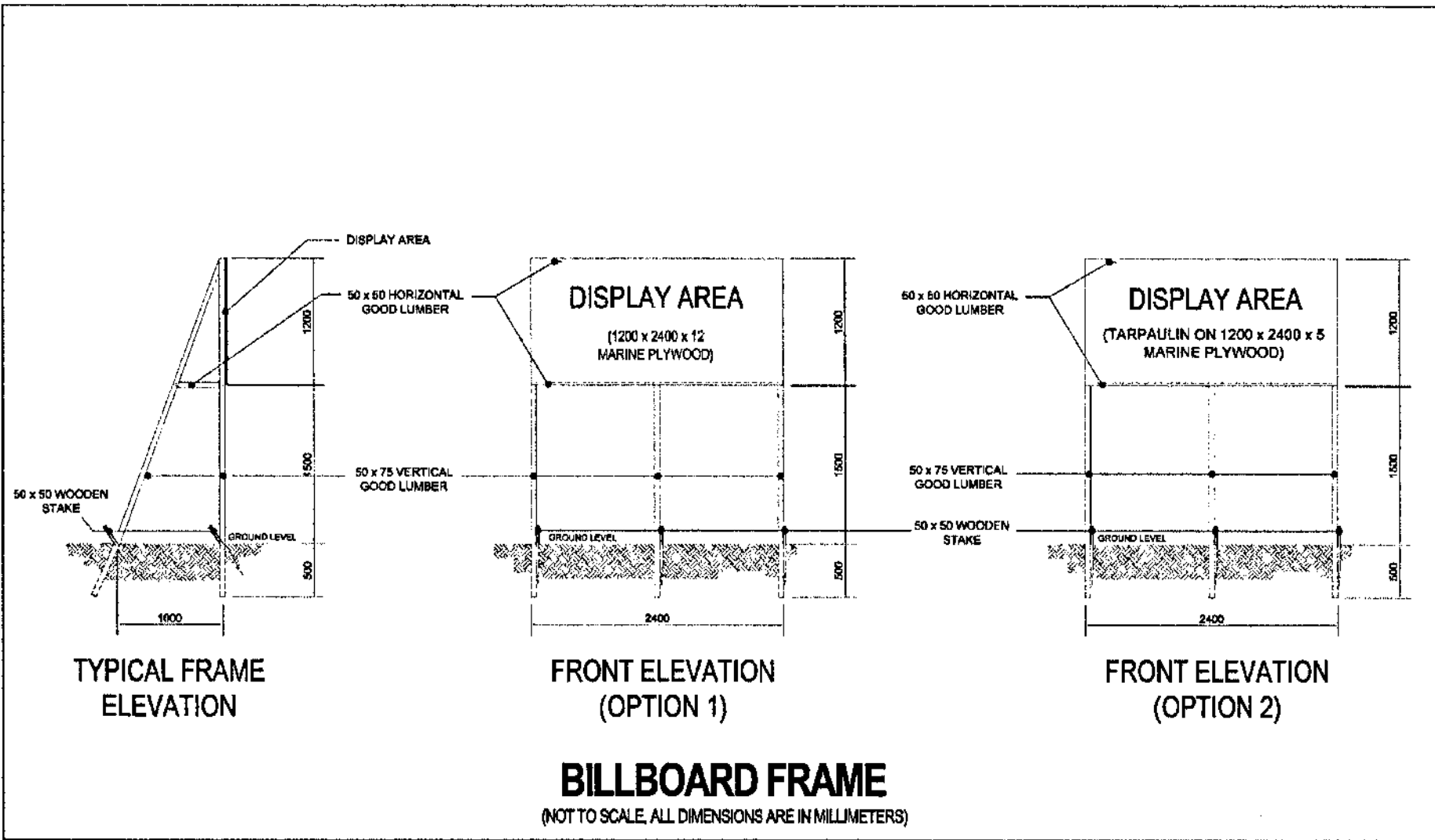
The Project Billboard shall be installed at location(s) designated by the Engineer.

The size and specifications of materials for the standard billboard shall be 4ft. x 8ft. (1,200mm x 2,400mm) using ½ inch (12mm) marine plywood or tarpaulin poster on 3/16 inch (5mm) marine plywood.

Project billboards shall not contain Name(s) and/or picture(s) of any personages.

See attached drawings for further details of the standard billboard.





“To all our contractors, suppliers, and service providers, all we ask is for you to

SPEED UP

your contracts and **FINISH**

AHEAD of schedule,

WITHOUT SACRIFICING

QUALITY

of work, and **REASONABLENESS**

OF COST agreed upon. Gawin niyo

‘yan at hindi tayo maghihiwalay ng landas (Do that and we will not part ways).”

A Message from
DOTr Secretary Arthur Tugade



 @DOTPH

 @DOTPH

www.dotr.gov.ph

ITEM 22 : SAFETY SIGNAGES AND BARRICADES

DESCRIPTION

This work includes the furnishing and installing of safety signages and barricades in accordance with the specifications and to the details shown below in the drawings, or as directed by the Engineer.

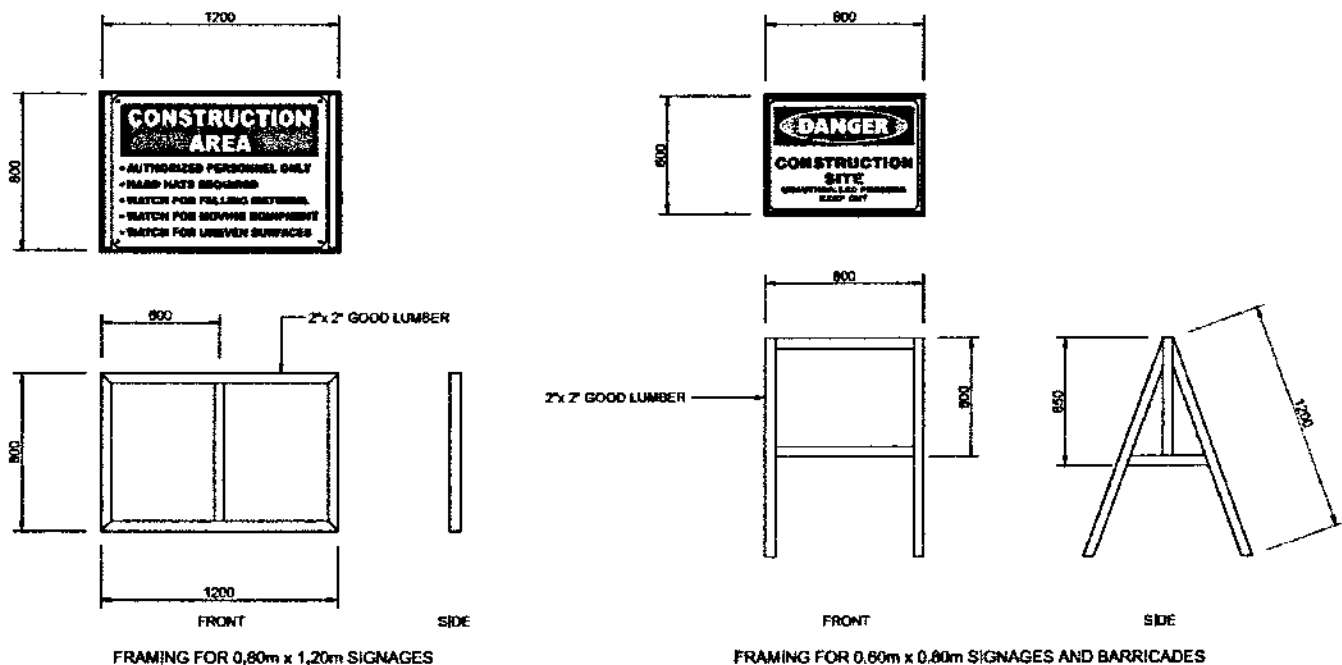
SPECIFICATION

The Signage's and Barricades shall be installed at location(s) designated by the Engineer.

The sizes of the standard signages shall be 2-2/3ft x 4ft (800mm X 1,200mm) for fixed type and 2ft x 2-2/3ft (600mm x 800mm) for mobile type. For barricade standard 2ft x 2-2/3ft (600mm x 800mm) shall be provided.

The materials to be used for signages and barricades are ½ inch (12mm) marine plywood or tarpaulin poster on 2" x 2" (50mm x 50mm) good lumber frame (see drawing below).

The printing or painting shall be the discretion of the Engineer.



STANDARD PLAN FOR SIGNAGES AND BARRICADES

SECTION VII

DRAWINGS
(APPROVED PLANS)

SECTION VII

DRAWINGS AND APPROVED PLANS

(SEE ISSUED APPROVED PLANS)

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A - 02 of 05	<ul style="list-style-type: none"> FLOOR PLAN LEGEND 	
A - 03 of 05	<ul style="list-style-type: none"> FRONT ELEVATION RIGHT SIDE ELEVATION REAR ELEVATION LEFT SIDE ELEVATION 	<ul style="list-style-type: none"> LEGEND (FINISHES) LONGITUDINAL SECTION CROSS SECTION
A - 04 of 05	<ul style="list-style-type: none"> REFLECTED CEILING PLAN ROOF PLAN 	
A - 05 of 05	<ul style="list-style-type: none"> TOILET BLOW - UP PLAN ELEVATION (TOILET) SCHEDULE OF DOORS AND WINDOWS 	

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E - 03 of 11	<ul style="list-style-type: none"> POWERHOUSE GENSET TRANSFORMER LAYOUT PLAN 	
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SECTION VIII

BILL OF QUANTITIES
and
ATTACHMENTS

BILL OF QUANTITIES
REHABILITATION/UPGRADING OF POWER SUBSTATION
Port of Cagayan de Oro, Cagayan de Oro, Misamis Oriental

NO. (1)	DESCRIPTION OF WORK (2)	UNIT (3)	QTY. (4)	UNIT PRICE (Pesos) (5)	AMOUNT (Pesos) (4) x (5)
BILL NO. 1	GENERAL EXPENSES				
1.01	Mobilization, demobilization and cleaning	lot	1		
1.02	Rental of temporary site office and residence for the Engineer and staff	mo.	12		
1.03	Maintain temporary site office and residence for the Engineer and staff	mo.	12		
1.04	Provide Construction Safety and Health Program in the execution of the project including stringent Covid-19 protocols per Engineering circular No. 01-2020, and Construction Guidelines for Project Implementation during the period of Public Health Emergency, PDCB and CIAP (as indicated in the Bid Documents)	mo.	12		
TOTAL FOR BILL NO. 1					

Bidder's Authorized Signature

BILL OF QUANTITIES
REHABILITATION/UPGRADING OF POWER SUBSTATION
Port of Cagayan de Oro, Cagayan de Oro, Misamis Oriental

NO. (1)	DESCRIPTION OF WORK (2)	UNIT (3)	QTY. (4)	UNIT PRICE (Pesos) (5)	AMOUNT (Pesos) (4) x (5)
BILL NO.	2 CONSTRUCTION OF POWER HOUSE BUILDING, SECURITY FENCE AND STEEL GATE				
2.01	Removal of existing structure including disposal of debris and turning-over of recovered materials with value to Authority	lot	1		
2.02	Removal of existing pavement including disposal of debris	sq.m.	1,696		
2.03	Scrape existing gravel base course up required elevation	sq.m.	929		
2.04	Excavation and backfilling works for building foundation, wall footing, concrete pad, septic vault, catch basin, chb fence & steel gate	lot	1		
2.05	Subgrade preparation	sq.m.	521		
2.06	Supply and apply soil treatment	sq.m.	521		
2.07	Supply, place and compact aggregate base course up to required elevation	cu.m.	98		
2.08	Supply, place and compact gravel bedding for building foundation, lamp post foundation, slab on grade, wall footing, septic vault and catch basin	cu.m.	64		
2.09	Supply & place 3,500 psi concrete for footings, columns, beams, genset concrete pad, transformer concrete pad, septic vault and catch basin	cu.m.	227		
2.10	Supply & install steel reinforcement for footings, columns, beams, genset concrete pad, transformer concrete pad, septic vault and catch basin	kg.	26,525		

Bidder's Authorized Signature

BILL OF QUANTITIES
REHABILITATION/UPGRADING OF POWER SUBSTATION
Port of Cagayan de Oro, Cagayan de Oro, Misamis Oriental

NO. (1)	DESCRIPTION OF WORK (2)	UNIT (3)	QTY. (4)	UNIT PRICE (Pesos) (5)	AMOUNT (Pesos) (4) x (5)
2.11	Supply and install structural steel members for trusses and roofing system including base plates, stiffeners and accessories	kg	20,214		
2.12	Construct 3,500 psi. concrete slab and ramp on grade including steel reinforcements	sq.m.	521		
2.13	Construct 150mm thick CHB wall including reinforcement	sq.m.	620		
2.14	Supply and place 13mm thick cement plaster finish (2,500 psi concrete)	sq.m.	1,847		
2.15	Supply and apply paint for concrete and dry-wall surfaces (2-coats)	sq.m.	2,137		
2.16	Supply and apply paint metal surfaces (2-coats)	sq.m.	1,524		
2.17	Supply and apply waterproofing	sq.m.	34		
2.18	Supply and place cement floor finish	sq.m.	468		
2.19	Supply and install 0.60m x 0.60m unglazed and non-slip ceramic floor tiles	sq.m.	29		
2.20	Supply and install tactile strip for ramp	sq.m.	6		
2.21	Supply and install 0.30m x 0.60m homogenous ceramic wall tiles	sq.m.	28		
2.22	Supply and install granite tile countertop including splash board	sq.m.	1		
2.23	Supply and install paving blocks in herringbone pattern	sq.m.	530		

Bidder's Authorized Signature

BILL OF QUANTITIES
REHABILITATION/UPGRADING OF POWER SUBSTATION
Port of Cagayan de Oro, Cagayan de Oro, Misamis Oriental

NO. (1)	DESCRIPTION OF WORK (2)	UNIT (3)	QTY. (4)	UNIT PRICE (Pesos) (5)	AMOUNT (Pesos) (4) x (5)
2.24	Supply and install aluminum clip-in perforated panel (0.60m x 0.60m x 0.70mm) including accessories for office and toilet	sq.m.	29		
2.25	Supply and install assorted type of doors and windows including accessories	lot	1		
2.26	Supply and install toilet fixtures including mirror and accessories	lot	1		
2.27	Supply and install water line pipes and fittings including accessories.	lot	1		
2.28	Supply and install sewerage pipes and fittings including accessories.	lot	1		
2.29	Supply and install drainage pipes and fittings including accessories	lot	1		
2.30	Supply and install roofing materials including accessories	lot	1		
2.31	Supply and install electrical system for power house	lot	1		
2.32	Construct CHB security fence with cyclone wire	lot	1		
2.33	Construct steel gate including accessories	lot	1		
2.34	Restore portland cement concrete pavement, (300mm thick)	sq.m.	489		
2.35	Supply and deliver office furnitures	lot	1		
TOTAL FOR BILL NO. 2					

Bidder's Authorized Signature

BILL OF QUANTITIES
REHABILITATION/UPGRADING OF POWER SUBSTATION
Port of Cagayan de Oro, Cagayan de Oro, Misamis Oriental

NO. (1)	DESCRIPTION OF WORK (2)	UNIT (3)	QTY. (4)	UNIT PRICE (Pesos) (5)	AMOUNT (Pesos) (4) x (5)
BILL NO.	3 ELECTRICAL AND MECHANICAL WORKS				
3.01	Excavation of fill materials for handholes, electrical manholes and duct banks	cu.m.	408		
3.02	Supply, place and compact gravel bedding for lamp post foundations, slab on grade, cable trench, wall footing and duct bank	cu.m.	82		
3.03	Supply & place 3,500 psi concrete for cable trench, lamp post and floodlight foundations, manhole, duct bank and hand hole	cu.m.	331		
3.04	Supply & install steel reinforcement for cable trench, lamp post and floodlight foundations, manhole, duct bank and hand hole	kg	37,549		
3.05	Supply, deliver and install primary service entrance devices including	lot	1		
3.06	Supply, deliver and install primary conduits and fittings including accessories	lot	1		
3.07	Supply, deliver and install primary cables including accessories	lot	1		
3.08	Supply and deliver to site switchgears assembly including accessories	lot	1		
3.09	Install switchgears assembly including accessories	lot	1		
3.10	Supply and deliver to site primary transformers including accessories	lot	1		

Bidder's Authorized Signature _____

BILL OF QUANTITIES
REHABILITATION/UPGRADING OF POWER SUBSTATION
Port of Cagayan de Oro, Cagayan de Oro, Misamis Oriental

NO. (1)	DESCRIPTION OF WORK (2)	UNIT (3)	QTY. (4)	UNIT PRICE (Pesos) (5)	AMOUNT (Pesos) (4) x (5)
3.11	Install primary transformers including accessories	lot	1		
3.12	Supply and deliver to site generator sets including accessories	lot	1		
3.13	Install generator sets including accessories	lot	1		
3.14	Supply and deliver to site distribution panels including accessories	lot	1		
3.15	Install distribution panels including accessories	lot	1		
3.16	Supply, deliver and install exterior underground distribution, conduits and fittings including accessories	lot	1		
3.17	Supply, deliver and install grounding including accessories	lot	1		
3.18	Supply, deliver and install lightning arrester including accessories	lot	1		
3.19	Testing and commissioning	lot	1		
TOTAL FOR BILL NO. 3					

Bidder's Authorized Signature

BILL OF QUANTITIES
REHABILITATION/UPGRADING OF POWER SUBSTATION
Port of Cagayan de Oro, Cagayan de Oro, Misamis Oriental

NO. (1)	DESCRIPTION OF WORK (2)	UNIT (3)	QTY. (4)	UNIT PRICE (Pesos) (5)	AMOUNT (Pesos) (4) x (5)
BILL NO. 4	REIMBURSABLE ITEMS				
4.01	Provide reimbursable items necessary in the implementation of the project as determined by the Authority				
	a) Office furnitures and appliances	lot	1		
	b) Computers and Accessories	lot	1		
TOTAL FOR BILL NO. 4					

Bidder's Authorized Signature

BASIS OF PAYMENT FOR WORK ITEMS INCLUDED IN THE PROPOSAL

The work items included in the proposal and the basis of payments are as follows:

BILL NO. 1

GENERAL EXPENSES

Item 1.01 Mobilization, demobilization and cleaning

The quantity to be paid for shall be the minimum equipment requirement enumerated in the bid documents mobilized, demobilized and cleaning of the site and accepted by the Engineer. The contract lump sum price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to mobilize and demobilize all the minimum equipment requirement enumerated in the bid documents including cleaning of the site. Fifty percent (50%) of the total amount shall be payable after the mobilization activity while the remaining (50%) payable after demobilization and cleaning.

Item 1.02 Rental of temporary site office and residence for the Engineer and staff

The quantity to be paid for shall be the actual rental for temporary site office and residence for the engineer and staff and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary for the provision of temporary site office and residence for the engineer and staff.

Item 1.03 Maintain temporary site office and residence for the Engineer and staff

The quantity to be paid for shall be the actual services rendered in maintaining the site office and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the maintenance of the temporary site office and residence as well as other expenses such as provision for electric power, telephone bill, potable water supply, janitorial and security services.

Item 1.04 Provide construction safety and Health Program in the execution of the project including stringent Covid-19 protocols per PPA Engineering Circular No. 01-2020 and PCR testing of all project personnel (as indicated in the bid documents)

The quantity to be paid for shall be the actual implementation of construction safety and health program and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the implementation of the Construction Safety and Health Program, as required and approved by the Department of Labor and Employment (DOLE).

BILL NO. 2

CONSTRUCTION OF POWER HOUSE BUILDING, SECURITY FENCE AND STEEL GATE

Item 2.01 Removal of existing structure including disposal of debris and turning over of recovered materials with value to the Authority

The quantity to be paid for shall be the actual lot of existing structure to be removed including disposal of debris and turning over of recovered materials with value to the Authority in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.02 Removal of existing pavement including disposal of debris

The quantity to be paid for shall be the actual area in square meter of existing pavement including disposal of debris in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.03 Scrape existing gravel base course up to required elevation

The quantity to be paid for shall be the actual area in square meter of existing gravel base course, scraped up to required elevation in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.04 Excavation and backfilling works for building foundation, wall footing, concrete pad, septic vault, catch basin, chb fence and steel gate

The quantity to be paid for shall be the actual lot of excavation and backfilling works for building foundation, wall footing, concrete pad, septic vault, catch basin, chb fence and steel gate in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.05 Subgrade preparation

The quantity to be paid for shall be the actual area in square meter of subgrade preparation in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.06 Supply and apply soil treatment

The quantity to be paid for shall be the actual area in square meter of soil treatment, supplied and applied in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.07 Supply, place and compact aggregate base course up to required elevation

The quantity to be paid for shall be the actual volume in cubic meter of aggregate base course to be supplied, set-in-place and compacted up to required elevation in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.08 Supply, place and compact gravel bedding for building foundation, lamp post foundation, slab on grade, wall footing, septic vault and catch basin

The quantity to be paid for shall be the actual volume in cubic meter of gravel bedding for building foundation, lamp post foundation, slab on grade, wall footing, septic vault and catch basin to be supplied, set-in-place and compacted in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.09 Supply and place 3,500 psi concrete for the footings, columns, beams, genset concrete pad transformer concrete pad, septic vault and catch basin

The quantity to be paid for shall be the actual volume in cubic meter of 3,500 psi concrete for the footings, columns, beams, genset concrete pad transformer concrete pad, septic vault and catch basin, supplied and set-in-place in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.10 Supply and install steel reinforcement for the footings, columns, beams, genset concrete pad transformer concrete pad, septic vault and catch basin

The quantity to be paid for shall be the actual weight in kilogram of reinforcing steel bars for the footings, columns, beams, genset concrete pad transformer concrete pad, septic vault and catch basin, supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.11 Supply and install structural steel members for trusses and roofing system including base plates, stiffeners and accessories

The quantity to be paid for shall be the actual weight in kilogram of structural steel members for trusses and roofing system including base plates, stiffeners and accessories to be supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.12 Construct 3,500 psi. concrete slab and ramp on grade including steel reinforcements

The quantity to be paid for shall be the actual area in square meter of 3,500 psi. concrete slab and ramp on grade including steel reinforcements, to be constructed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.13 Construct 150mm thick CHB wall including reinforcement

The quantity to be paid for shall be the actual area in square meter of 150mm thick CHB wall including reinforcement, constructed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.14 Supply and place 13mm thick cement plaster finish (2,500 psi concrete)

The quantity to be paid for shall be the actual area in square meter of 13mm thk. cement plaster finish (2,500 psi concrete), supplied and set-in-place in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.15 Supply and apply paint for concrete and dry-wall surfaces (2-coats)

The quantity to be paid for shall be the actual area in square meter of paint for concrete and dry-wall surfaces (2-coats) to be supplied and applied in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.16 Supply and apply paint for metal surfaces (2-coats)

The quantity to be paid for shall be the actual area in square meter of paint for metal surfaces (2-coats) to be supplied and applied in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.17 Supply and apply waterproofing

The quantity to be paid for shall be the actual area in square meter of waterproofing to be supplied and applied in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.18 Supply and place cement floor finish

The quantity to be paid for shall be the actual area in square meter of cement floor finish to be supplied and set-in-place in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.19 Supply and install 0.60m x 0.60m Unglazed and non-slip Ceramic Floor Tiles

The quantity to be paid for shall be the actual area in square meter of unglazed and non-slip ceramic floor tiles (0.60m x 0.60m), supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.20 Supply and install tact tile strip for ramp

The quantity to be paid for shall be the actual area in square meter of tact tile strip for ramp, supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.21 Supply and install 0.30m x 0.60m homogenous ceramic wall Tiles

The quantity to be paid for shall be the actual area in square meter of homogenous ceramic wall tiles (0.30m x 0.60m), supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.22 Supply and install granite tile countertop including splash board

The quantity to be paid for shall be the actual area in square meter of granite tile countertop including splash board, supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.23 Supply and install paving blocks in herringbone pattern

The quantity to be paid for shall be the actual area in square meter of paving blocks, supplied and installed in herringbone pattern in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.24 Supply and install Aluminum Clip-In Perforated Panel (0.60 x 0.60 x 0.70m) including accessories for office and toilet

The quantity to be paid for shall be the actual area in square meter of aluminum clip-in perforated panel including accessories for office and toilet (0.60 x 0.60 x 0.70m), supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.25 Supply and install assorted type of doors and windows including accessories

The quantity to be paid for shall be the actual lot of assorted type of doors and windows including accessories, to be supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.26 Supply and install Toilet Fixtures including mirror and accessories

The quantity to be paid for shall be the actual lot of toilet fixtures including mirror and accessories, supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.27 Supply and install water line pipes and fittings including accessories

The quantity to be paid for shall be the actual lot of water line pipes and fittings including accessories, supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.28 Supply and install sewerage pipes and fittings including accessories

The quantity to be paid for shall be the actual lot of sewerage pipes and fittings including accessories, supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.29 Supply and install drainage pipes and fittings including accessories

The quantity to be paid for shall be the actual lot of drainage pipes and fittings including accessories, supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.30 Supply and install roofing materials including accessories

The quantity to be paid for shall be the actual lot of roofing materials including accessories, supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.31 Supply and install electrical system for power house

The quantity to be paid for shall be the actual lot of electrical system for power house, supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.32 Construct CHB security fence with cyclone wire

The quantity to be paid for shall be the actual lot of CHB security fence, constructed with cyclone wire in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.33 Construct steel gate including accessories

The quantity to be paid for shall be the actual lot of steel gate including accessories, constructed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.34 Restore Portland cement concrete pavement (300mm thick)

The quantity to be paid for shall be the actual area in square meter of Portland cement concrete pavement (300mm thick), restored in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 2.35 Supply and deliver office furniture

The quantity to be paid for shall be the actual lot of office furniture to be supplied and delivered in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

BILL NO. 3

ELECTRICAL AND MECHANICAL WORKS

Item 3.01 Excavation of fill materials for handholes, electrical manholes and duct banks

The quantity to be paid for shall be the actual volume in cubic meter of fill materials to be excavated for handholes, electrical manholes and duct banks in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.02 Supply, place and compact gravel bedding for lamp post foundation, slab on grade, cable trench, wall footing and duct bank

The quantity to be paid for shall be the actual volume in cubic meter of gravel bedding for lamp post foundation, slab on grade, cable trench, wall footing and duct bank to be supplied, set-in-place and compacted in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.03 Supply and place 3,500 psi concrete for the cable trench, lamp post and floodlight foundations, manhole, duct bank and handhole

The quantity to be paid for shall be the actual volume in cubic meter of 3,500 psi concrete for the cable trench, lamp post and floodlight foundations, manhole, duct bank and handhole, supplied and set-in-place in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.04 Supply and install steel reinforcement for the cable trench, lamp post and floodlight foundations, manhole, duct bank and handhole

The quantity to be paid for shall be the actual weight in kilogram of reinforcing steel bars for the cable trench, lamp post and floodlight foundations, manhole, duct bank and handhole, supplied and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.05 Supply, deliver and install primary service entrance devices including accessories

The quantity to be paid for shall be the actual area in lot of primary service entrance devices including accessories, supplied, delivered and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.06 Supply, deliver and install primary conduits and fittings including accessories

The quantity to be paid for shall be the actual area in lot of conduits and fittings including accessories, supplied, delivered and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.07 Supply, deliver and install primary cables including accessories

The quantity to be paid for shall be the actual area in lot of primary cables including accessories, supplied, delivered and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.08 Supply and deliver to site switchgears assembly including accessories

The quantity to be paid for shall be the actual lot of switchgears assembly including accessories, supplied and delivered to site in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.09 Install switchgears assembly including accessories

The quantity to be paid for shall be the actual lot of switchgears assembly including accessories, installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.10 Supply and deliver to site primary transformers including accessories

The quantity to be paid for shall be the actual lot of primary transformers including accessories, supplied and delivered to site in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.11 Install primary transformers including accessories

The quantity to be paid for shall be the actual lot of primary transformers including accessories, installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.12 Supply and deliver to site generator sets including accessories

The quantity to be paid for shall be the actual lot of generator sets including accessories, supplied and delivered to site in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.13 Install generator sets including accessories

The quantity to be paid for shall be the actual lot of generator sets including accessories, installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.14 Supply and deliver to site distribution panels including accessories

The quantity to be paid for shall be the actual lot of distribution panels including accessories, supplied and delivered to site in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.15 Install distribution panels including accessories

The quantity to be paid for shall be the actual lot of distribution panels including accessories, installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.16 Supply, deliver and install exterior underground distribution, conduits and fittings including accessories

The quantity to be paid for shall be the actual lot of exterior underground distribution, conduits and fittings including accessories, supplied, delivered and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.17 Supply, deliver and install grounding including accessories

The quantity to be paid for shall be the actual lot of grounding including accessories, supplied, delivered and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.18 Supply, deliver and install lightning arrester including accessories

The quantity to be paid for shall be the actual lot of lightning arrester including accessories, supplied, delivered and installed in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Item 3.19 Testing and commissioning

The quantity to be paid for shall be the actual lot testing and commissioning works done in accordance with the plans and specifications and accepted by the Engineer. The contract unit price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

BILL NO. 4

REIMBURSABLE ITEMS

Item 4.01 Provide reimbursable items necessary in the implementation of the project as determined by the Authority.

- a. Office Furniture and Appliances**
- b. Computer and Accessories**

The quantity to be paid for shall be the actual quantity of determined items by the Authority deemed necessary in the implementation of the project, supplied, delivered and accepted by the Authority. Payment for said items shall be made only upon complete delivery/acceptance of such. The contract lump sum price shall be full compensation for providing all determined items. The Contractor's Profit and Overhead, Contingencies and Miscellaneous (OCM) should not be included in the cost of said items. Claims for payment shall be supported by Official Receipt(s) (OR) and at least three (3) canvasses. The amount to be paid for shall be the price indicated in the OR but should not exceed the contract lump sum price. The determined items shall be the property of PPA. Operation and maintenance shall be borne by PPA.

FACILITIES TO BE PROVIDED FOR THE ENGINEER & HIS STAFF

RENTAL OF SITE OFFICE AND RESIDENCE FOR THE ENGINEER & STAFF

The Contractor shall provide a temporary site office and residence (rental) with an area of at least 48 square meters for use of the Engineer and his staff for the whole duration of the project.

OFFICE EQUIPMENT FOR USE OF THE PPA ENGINEER AND STAFF

The Contractor shall provide within thirty (30) days after notice to commence work, the following main items of brand new office equipment for use of the Engineer and his staff. The Contractor shall make available for use of the Engineer other equipment as may be necessary for the proper functioning of the office. The equipment shall be the property of PPA. Operation and maintenance shall be borne by PPA.

a) Office Furnitures and appliances		
2	sets	Office table, 1.5 x 0.70m with chair
1	set	Conference table w/ chair (6-str.)
2	pcs.	Single bunk beds w/ mattress & beddings
2	pcs.	Waste paper basket
1	pc.	Calculator (Scientific, 12 digit capacity)
1	pc.	Communication system, Cell phone
1	pc.	Filing Steel Cabinet, 4-drawers
2	units	Air-conditioned unit (1.0 hp., wdo type)
1	unit	Refrigerator (6 cu.ft.)
1	set	Gas stove (2 burner with tank)
1	unit	Hot and cold water dispenser (5 gal. Cap.)
1	pc.	White board with eraser and marker
1	unit	Stand fan (16" dia.)
b) Computers and Accessories		
2	sets	Desktop Unit & Accessories
2	sets	Printer/scanner and accessories
2	units	Uninterrupted Power Supply (UPS)
2	units	External Hard Drive (USB 3.0, 4TB)
1	unit	Computer Table
1	unit	Computer Chair
c) Licensed Softwares		
2	units	Microsoft Office 2016

COMPUTER AND ACCESSORIES

The Contractor shall provide within thirty (30) days after notice to commence work, **two (2) “Brand New Desktop”**, complete with printer and accessories and licensed software for the use of the PPA Engineer and his Staff at the start of the project. The items shall be the property of PPA. Operation and maintenance shall be borne by PPA.

Description / Specifications:	DESK TOP UNIT
Brand/Model	<i>Asus, Apple, Lenovo, ACER, HP or Equivalent Branded</i>
Processor	<i>Intel® Core™ i7-9700K CPU</i>
System Memory	<i>8GB DDR4 Ram at 2666MHZ up to 32GB, 2DIMM slots</i>
Chipset	<i>Intel B360</i>
CD-ROM	<i>Tray load DVD Drive (Reads and Writes to DVD/CD)</i>
Graphics	<i>NVIDIA GeForce RTX 2060 6GDS</i>
SATA	<i>4 x SATA 6.0 Gbps</i>
HDD/SSD	<i>128GB SSD (M.2 PCIe 128GB) + 1TB HDD (3.5" 7200rpm)</i>
WIFI/ Bluetooth	<i>802.11ac 2x2/ Bluetooth 5.0</i>
LAN	<i>Realtek RTL8111H 10/ 100/ 1000Mbps</i>
Audio	<i>Realtek ALC887, DTS Headphone X</i>
Accessories	<i>Wireless Keyboard and Mouse</i>
Ports	<i>4 x USB 3.2, 2 X USB 2.0, HDMI, Audio Jack, RJ45 and Mic in/ headphone out</i>
Display (Monitor)	<i>27" inch. FHD (1920 x 1080 Display) with speaker, display ports, USB hub, earphone jack and PC audio inputs.</i>
OS Bundled (Certification/License)	<i>Windows 10 PRO for business</i>
Multi-Function Printer (Copy, Scan Printer)	<i>HP, Epson, Brother or equivalent brand with wide format capabilities (A3 size), 128 MB Memory Capacity and Automatic Document Feeder (ADF)</i>
External Hard Drive	<i>Portable (USB 3.0 Interface, at least 4TB Capacity)</i>

SOFTWARE

The Contractor shall provide within thirty (30) days after commence work, the specified **“License softwares” latest version** for the use of the PPA Engineer and staff. The software shall be the property of PPA. Operation and maintenance shall be borne by PPA.

MINIMUM MAJOR EQUIPMENT REQUIREMENTS

1	unit/s	Air Compressor (250 cfm. Minimum), owned	/
1	unit/s	Backhoe (0.40 cu.m., 94.30hp, minimum), owned	/
1	unit/s	Concrete Cutter, owned	/
1	unit/s	Concrete Mixer (1 bagger, minimum), owned	/
1	unit/s	Concrete Bucket, owned	/
1	unit/s	Concrete Screeder, owned	/
2	unit/s	Concrete Vibrator (3.50 hp, minimum), owned	/
1	unit/s	Crawler Crane (30T, minimum), owned/leased	/
1	unit/s	Dump Truck (8 cu.m., minimum), owned/leased	/
2	unit/s	Bar Bender (electric, 25mm dia min.), owned	/
2	unit/s	Bar Cutter (electric, 25mm dia min.), owned	/
1	unit/s	Jackhammer, owned	/
1	unit/s	Oxy/Acetylene Cutting Outfit, owned	/
1	unit/s	Payloader (80 hp, minimum), owned/leased	/
1	unit/s	Plate Compactor (5hp, minimum), owned	/
1	unit/s	Road Grader (125hp, minimum), owned/leased	/
1	unit/s	Road Roller (12.05T, vibratory, minimum), owned/leased	/
2	unit/s	Transit Mixer (5-6 cu.m. cap., minimum), owned/leased	/
1	unit/s	Water Truck (1,000 gal., minimum) with pump, owned	/
2	unit/s	Welding Machine (400 amp., minimum), owned	/
1	unit/s	Cargo Truck (5 Ton, minimum), owned	/
1	unit/s	Backhoe Breaker Attachment, owned	/

CONSTRUCTION SAFETY AND HEALTH REQUIREMENT

The Contractor shall implement the construction safety and health program in accordance with the applicable provisions of the Occupational Safety and Health Standards (OSHS) of the Department of Labor and Employment (DOLE) including stringent covid-19 protocols per PPA Engineering Circular No. 01-2020 and Construction Guidelines for Project Implementation during the period of public health emergency approved by PDCB and CIAP.

The Contractor, subject to the approval of the Engineer shall provide and maintain throughout the duration of the contract a medical room with at least 15 square meters together with all necessary supplies to be sited in the Contractor's main area.

The Contractor shall provide the following minimum requirements:

LABOR

1	no.	Safety Engineer / Officer
1	no.	Nurse / Health Officer

EQUIPMENT / MATERIALS

Personnel Protective Equipment

55	pcs.	Hard Hats
55	pcs.	Gloves (rubberized)
55	pcs.	Safety Glasses/Goggles (clear)
110	pcs.	Long sleeve T-shirt
8	pcs.	Aprons
4	pcs.	Safety Belts
55	pcs.	Safety Shoes
4	pcs.	Life Lines

Safety Devices

1	lot	Barricades
1	lot	Warning signs
2	unit/s	Fire extinguisher
1	lot	Disinfection Booth with Footbath
55	no.	PCR Test for Covid-19 (Initial Testing) ✓
55	no.	PCR Test for Covid-19 (Confirmatory Testing) ✓

Medical and First Aid System	-	Twelve (12) mos.	✓
Temporary shelter for workers	-	220 sq.m.	✓

NOTE:

The Contractor shall provide the above-cited minimum construction safety and health requirements or as required by the Engineer.