SPECIFICATIONS – MOBILIZATION / DEMOBILIZATION

SCOPE OF WORK

This Section includes mobilization, demobilization, assembly and disassembly of equipment/plants including incidentals necessary to complete the work.

MOBILIZATION

1. The Contractor shall mobilize and put into operation all equipment and plants required to undertake the Contract.

2. Mobilization shall include the transferring to the job-sites of all equipment, plants, supplies and materials, personnel, and all items necessary for the execution and completion of the work, and shall also include the setting up of all equipment, instruments and all other plants until rendered operable, subject to the confirmation of the Engineer.

3. Sufficient supply of spares for the equipment and plants shall be carried on-board the towing/carrying vessels. Equipment/plants encountering breakdowns must be repaired on site by the most expeditious method possible at no cost to PPA. In the event that the equipment/plants call for major repair works that cannot be undertaken at the site, the Contractor shall replace such equipment/plants with equal or better performance capacity at no additional mobilization costs to PPA and the Contractor shall not be entitled to any time extension.

DEMOBILIZATION

Demobilization upon request of the Contractor and approved by the Engineer, shall include the following:

1. The dismantling, preparation and loading for removal and shipment of all Contractor's plant, equipment and personnel at each site after completion of the works.

2. Transportation of all the above plant, equipment and materials from each site to the Contractor's home station or somewhere else outside the sites.

3. Removal of all supplementary markers furnished and installed by the Contractor, provided that the Engineer has not taken the option to retain the markers.

4. The clean up of the Site and the removal of materials, debris, waste, etc., and making good damages or temporary alterations.

MEASUREMENT AND PAYMENT

SPECIFICATIONS – MOBILIZATION / DEMOBILIZATION

Payment for this item includes the expenses incurred by the Contractor for moving-in of minimum major equipment and/or plant required for the project and moving out of the same after final acceptance of the work including cleaning-up. Fifty percent (50%) of the total amount shall be payable after mobilization activity while the remaining fifty percent (50%) payable after acceptance of the completed project. A list of equipment showing the detailed cost for its mobilization and demobilization works shall be included in the bid amount for this item.

SPECIFICATIONS – DEMOLITION AND REMOVAL

1. SCOPE

a. The work includes the furnishing of all labor, materials and equipment required to carry out the demolition of all and/or portions of existing wharf including removal of obstructions, extraction/cutting of timber and R.C piles at required depth, the work may include the demolition of miscellaneous buildings, pavements, fences, utilities, navigation aids and wrecks etc., as required for the execution of the Contract.

b. The Contractor shall submit the proposed methodology or procedure of demolition work with detailed drawings and calculations if necessary, to the Engineer for approval, before the execution of the Works.

c. The Contractor shall keep all pavements and landing areas to and from the site of the disposal area clean and free of mud, dirt and debris during and after the execution of disposal. Disposal of debris and materials shall be as directed by the Engineer.

d. For off-shore obstructions to pile driving and dredging, survey shall be executed by the Contractor with the Engineer before any demolition and removal of wrecks is commenced and shall be as directed by the Engineer.

2. OWNERSHIP OF DEMOLISHED MATERIAL

a. Materials coming from the demolition works except general earth shall remain the property of the Authority and shall be stored properly by the Contractor at a place designated by the Engineer.

3. INTERFERENCE WITH PORT OPERATIONS

a. During the execution of the work, the Contractor shall not interfere with the shipping, navigation and other traffic operation in the port.

b. The Contractor shall make arrangements with the port operations people on the schedule of demolition and related works to keep the operation activities undisturbed at all times.

c. Prior to commencement of the demolition works, the Contractor shall inform/announce to all concerned/affected port users the schedule of disconnection of utilities.

4. EXECUTION

a. Prior to the commencement of demolition works, the alignments (lines and grades) of the new construction works to existing pier shall be checked.

b. The width and alignment of portion of existing structure to be demolished shall be marked by paint.

c. With these lines as guides, concrete shall be broken and reinforcing bars cut, such that panels or portions of the structure can be lifted out for disposal elsewhere outside of the operational work area.

d. Extract concrete piles with care in order not to damage existing or adjacent structures, equipment or materials.

e. Piles (timber/concrete) for demolition/extraction) shall be done with care and/or to the required level indicated in the plan as shown in the drawings.

f. Rocks removed from existing slope protection shall be stored for re-use in new construction.

g. Demolish buildings, pavements, curbs, fences, utilities, services, navigation aids and the like as determined in the field for each project and as shown on the drawings or as directed by the Engineer.

5. SAFETY

a. During the course of survey and clearing, only the proper Authority shall remove any obstacles that are recognized and seemed to be explosive or hazardous to workers on the site.

b. At the end of each day's work, the Contractor shall keep the workplace in safe condition, so that no part is in danger of falling or creating hazard to personnel or equipment.

DIVISION 3 PORT FACILITIES

3.1 LAYOUT AND INSTALLATION OF MARKERS

3.1.1 GENERAL

1. Work under this contract shall be in accordance with Division 1, "General Requirements" of these Specifications and shall be applicable to this Section, herein referred to or not.

2. Applicable requirement under Section 2.2 "Surveys/Soundings, Soil Investigations, Installation of Markers, etc." shall apply to this section.

3.1.2 SCOPE OF WORK

This Section covers layout and setting of reference points.

3.1.3 SETTING OF REFERENCE POINTS

1. The Contractor shall establish new permanent benchmarks and monuments based on existing ones designated by the Engineer that can serve as reference points to delineate the technical description of the port zone and plan layout.

2. The Contractor shall submit field notes and computations regarding the above item 3.1.3.1 for reference of the Engineer.

3. Setting of reference points shall include the supply and installation of markers which the Contractor may require for the proper execution and completion of the project. The Contractor shall be solely responsible for the accuracy of setting surveyed points.

3.2 CONCRETE WORKS

3.2.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.2.1.1 SCOPE OF WORK

All works falling under this Section shall include reinforced concrete for all kinds and parts of any reinforced concrete structure.

3.2.1.2 GENERAL PROVISIONS

1. Full cooperation shall be given to the other trades to install embedded items. Suitable templates or instructions will be provided for setting, items shall have been inspected, and tests for concrete or other materials or for mechanical operations shall have been completed and approved.

2. The following publications of the issues listed below, but referred to thereafter by basic designation only, form as an integral part of this Specification to the extent indicated by the reference thereto:

   a. American Concrete Institute (ACI) Standards:

ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 121R	Quality Management System for Concrete Construction
ACI 201.2R	Guide to Durable Concrete
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214R	Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 301	Specifications for Structural Concrete
ACI 304.2R	Placing Concrete by Pumping Methods
ACI 304R	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 308R	Guide to Curing Concrete
ACI 309R	Guide for Consolidation of Concrete
ACI 311.4R	Guide for Concrete Inspection
ACI 318M	Metric Building Code Requirements for Structural Concrete and Commentary

ACI 347	Guide to Formwork for Concrete
ACI SP-15	Field Reference Manual: Standard Specifications for Structural Concrete with Selected ACI and ASTM References
ACI SP-2	ACI Manual of Concrete Inspection

b. American Society for Testing and Materials (ASTM) Publications:

ASTM A 185	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 496	Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A 615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A 966	Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current
ASTM C 1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1064	Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C 1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

ASTM C 1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1116	Standard Specification for Fiber-Reinforced Concrete
ASTM C 1157	Standard Specification for Hydraulic Cement
ASTM C 1202	Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C 1218	Standard Specification for Water-Soluble Chloride in Mortar and Concrete
ASTM C 1240	Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C 1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C 131	Test Method for Resistance to Degradation of Small-size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 127	Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM C 138	Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	Standard Specification for Portland Cement
ASTM C 171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C 192	Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 227	Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 295	Petrographic Examination of Aggregates for Concrete
ASTM C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 441	Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C 469	Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
ASTM C 496	Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens

ASTM C 595	Standard Specification for Blended Hydraulic Cements
ASTM C 597	Pulse Velocity Through Concrete
ASTM C 618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 642	Density, Absorption, and Voids in Hardened Concrete
ASTM C 805	Rebound Number of Hardened Concrete
ASTM C 881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 920	Standard Specification for Elastomeric Joint Sealants
ASTM C 94	Standard Specification for Ready-Mixed Concrete
ASTM C 989	Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C1116	Standard Specification for Fiber-Reinforced Concrete and Shotcrete
ASTM C 1751	Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction. (Non-extruding and Resilient Bituminous Types).
ASTM D 1179	Fluoride Ion in Water
ASTM D 1190	Standard Specification for Concrete Joint Sealer, Hot-Applied Elastic Type
ASTM D 1339	Sulfite Ion in Water
ASTM D 1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

ASTM D 1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Nitrite-Nitrate in Water
ASTM D 3867	Nitrite-Nitrate in Water
ASTM D 512	Chloride Ion in Water
ASTM D 516	Sulfate Ion in Water
ASTM E 329	Standard Specification for Agencies Engaged in the Testing and/ or Inspection of Materials Used in Construction

c. American Welding Society (AWS)

D 12	Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction.

d. All other standards hereinafter indicated.

e. 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.

3.2.1.3 SUBMITTALS

1. Refer to The Technical Specifications Division 1, "General Requirements".

2. Test Reports and Certificates shall be furnished in conformity with Division 1 and approval received before delivery of certified or tested materials to the Project Sites.

   a. Submit Test Reports for the following:

      1) Concrete mixture proportions

         Submit copies of test reports by independent test labs conforming to ASTM C 1077 showing that the mixture has been successfully tested to produce concrete with the properties specified and that mixture will be suitable for the job conditions. Test reports shall be submitted along with the

concrete mixture proportions. Obtain approval before concrete placement. Fully describe the processes and methodology whereby mixture proportions were developed and tested and how proportions will be adjusted during progress of the work to achieve, as closely as possible, the designated levels of relevant properties.

2) Aggregates

Submit test results for aggregate quality in accordance with ASTM C 33. Where there is potential for alkali-silica reaction, provide results of tests conducted in accordance with ASTM C 227 or ASTM C 1260. Submit results of all tests during progress of the work in tabular and graphical form as noted above, describing the cumulative combined aggregate grading and the percent of the combined aggregate retained on each sieve.

3) Admixtures (if required to be used by field conditions subject to approval by the Design Engineer)

Submit test results in accordance with ASTM C 494 and ASTM C 1017 for concrete admixtures, ASTM C 260 for air-entraining agent, and manufacturer's literature and test reports for corrosion inhibitor and anti-washout admixture. Submitted data shall be based upon tests performed within 6 months of submittal.

4) Fiber-Reinforced Concrete (if required to be used by field conditions subject to approval by the Design Engineer)

Test to determine flexural toughness index I5 in accordance with ASTM C 1116.

5) Cement

Submit test results in accordance with ASTM C 150 Portland cement and/or ASTM C 595 and ASTM C 1157 for blended cement. Submit current mil data.

6) Water

Submit test results in accordance with ASTM D 512 and ASTM D 516.

7) Reinforcement and Protective Coating

Provide coating manufacturer's and coating applicator's test data sheets certifying that applied coating meets the requirements of ASTM A 934.

b. Submit Certificates for the following:

1) Curing concrete elements

Submit proposed materials and methods for curing concrete elements.

2) Form removal schedule

Submit proposed materials and methods for curing concrete elements.

3) Concrete placement and compaction

a) Submit technical literature for equipment and methods proposed for use in placing concrete. Include pumping or conveying equipment including type, size and material for pipe, valve characteristics, and the maximum length and height concrete will be pumped. No adjustments shall be made to the mixture design to facilitate pumping.

b) Submit technical literature for equipment and methods proposed for vibrating and compacting concrete. Submittal shall include technical literature describing the equipment including vibrator diameter, length, frequency, amplitude, centrifugal force, and manufacturer's description of the radius of influence under load. Where flat work is to be cast, provide similar information relative to the proposed compacting screed or other method to ensure dense placement.

4) Mixture designs

Provide a detailed report of materials and methods used, test results, and the field test strength (fcr) for marine concrete required to meet durability requirements.

3. The Contractor shall submit shop drawings and erection drawings for formwork and scaffolding at least 14 days prior to commencing the work.

Each shop drawing and erection drawing shall bear the signature of a Contractor's qualified Engineer. Details of all proposed formwork to be prefabricated and formwork to produce special finishes shall be submitted to the Engineer for approval before any materials are ordered. If the Engineer so requires, samples of proposed formworks shall be constructed and concrete placed at the Contractor's expense so that the proposed methods and finished effect can be demonstrated.

The Contractor shall submit shop drawings showing reinforcing bar placing and bar lists for the Engineer's approval. Such shop drawings shall show also supplemental bars for forming, strengthening frames of bars of sufficient rigidity to withstand forces during placing concrete. If necessary, shaped steel may be added to improve rigidity of the frame of bar.

Such shop drawings shall clearly indicate bar sizes, spacing, location and quantities of reinforcement, mesh, chairs, spacers and other details to be as per ACI Manual of Standard Practice for Detailing Reinforced Concrete Structures.

Details shall be prepared for placement of reinforcement where special conditions occur, including most congested areas and connection between precast concrete and concrete in-situ.

All shop drawings shall be reviewed by the Engineer within seven (7) days after receiving them.

At least two (2) days prior to pouring concrete, the Contractor shall submit to the Engineer a pouring permit for his inspection and approval.

4. Field Samples

   a. Slab Finish Sample

      Install minimum of 3m x 3m slab. Finish as required by Specification.

   b. Underwater Concrete Sample

      Place concrete in four 5 gallon buckets below water. Permanently mark as "7 days," "14 days," "28 days," and "Extra." Include date and station. Provide specimen sets at every 46 lineal meter of seawall with a minimum of one set per day of underwater concrete placement. Retrieve specimens at specified intervals. Extract 100 mm diameter by 250 mm core and test in accordance with ASTM C 39.

3.2.2 MATERIAL REQUIREMENTS

3.2.2.1 CEMENT

Unless otherwise specified in the Drawings, only one (1) brand of cement shall be used for any individual structure. In determining the approved mix, only Portland cement shall be used as the cementitious material.

1. Portland Cement: ASTM C 150

   Type I (for general use in construction)

2. High-Early Strength Portland Cement may be used for precast concrete. Cement Type III shall conform to ASTM C 150 with a tricalcium aluminate limited to 8 percent.

3.2.2.2 SYNTHETIC FIBROUS REINFORCEMENT (OPTIONAL)

Unless otherwise indicated on the Drawings or as required by the Design Engineer, synthetic fiber reinforcement shall conform to BS 5139 or ASTM C 1116.

Synthetic fiber reinforcement shall be 100% virgin polypropylene synthetic fiber with micro multi-filament design.

This material shall mainly be used in the following structures:

1. Suspended slabs
2. Plastering on walls of building structures
3. Concrete topping

3.2.2.3 ADMIXTURE (IF NECESSARY)

Unless otherwise required by field conditions, admixture may be used subject to the expressed approval of the Engineer. The cost of which shall already be included in the unit cost bid of the Contractor for the concrete.

1. Air Entraining Admixture shall conform to ASTM C 260.
2. Admixture other than air entraining agent shall conform to ASTM C 494.
3. Admixture containing chloride ions, or other ions producing deleterious effect shall not be used.

3.2.2.4 AGGREGATES

1. Crushed Coarse Aggregate

Conforming to ASTM C 33 and having nominal sizes passing 38.0 mm to 19.0 mm, 19.0 mm to 9.5 mm to No. 4 sieve. The material shall be well graded between the limits indicated and individually stockpiled. It shall be the Contractor's responsibility to blend the materials to meet the gradation requirements for various types of concrete as specified herein.

Nominal sizes for combined gradation shall be as follows:

ASTM Sieves	**Nominal Size of Coarse Aggregates % by Weight Passing**			
	40 mm	25 mm	19 mm	10 mm
50.0 mm (2")	100	-	-	-
38.0 mm (1 ½")	95-100	100	-	-
31.8 mm (1 ¼")	-	90-100	100	-
25.0 mm (1")	-	-	90-100	-
19.0 mm (3/4")	35-70	25-90	-	100
16.0 mm (5/8")	-	-	20-55	85-100
9.5 mm (3/8")	10-30	0-10	0-10	0-20
No. 4	0-5			

2. Fine Aggregate

ASTM C 33 except for gradation which has been revised to meet local conditions unless otherwise required by the Engineer, grading of find aggregate shall be as follows:

ASTM Sieves	**% by Weight Passing**
9.5 mm (3/8")	100
No. 4	90 - 100
No. 8	80 - 100
No. 16	50 - 90
No. 30	25 - 60
No. 50	10 - 30
No. 100	2 - 10

a. Grading of fine aggregates shall be reasonably uniform and fineness modulus thereof shall not vary more than 0.2 from that of the representative sample in which mix proportions of concrete are based.

b. Due care shall be taken to prevent segregation.

3.2.2.5 WATER

The water used in concrete, mortar and grout shall be free from objectionable quantities of silt, organic matter, alkali, salts and other impurities. Sea water shall not be used at any time.

3.2.2.6 ANCHORAGE ITEMS

Dowels for anchoring mechanical items to concrete shall be in conformity to manufacturer's standard and of types required to engage with the anchors to be provided and installed therein under other sections of these Specifications, and shall be subject to the approval of the Engineer.

3.2.2.7 CURING MATERIALS

1. Impervious Sheet Materials: ASTM C 171 type, optional, except that polyethylene film, if used, shall be white opaque.

2. Burlap of commercial quality, non-staining type, consisting of 2 layers minimum.

3. Membrane Forming Curing Compound: ASTM C 309; submit evidence that product conforms to specifications.

3.2.2.8 JOINTING MATERIALS

1. Sealant: Sealant shall be multi-component, polyurethane base compound, gray in color, self-leveling for horizontal joints, 2 part polythremdyne, terpolymer compound, gray in color; non-sag for vertical joints.

   Sealant shall be compatible with materials in contact and to perform satisfactorily under salt water and traffic conditions, and be capable of making joint watertight and allow movement 25% of the width of joint in any direction.

   Sealant shall be guaranteed against leakage, cracking, crumbling, melting, shrinkage, running, loss of adhesion for a period of five years from the date of acceptance of work.

2. Joint backing shall be expanded extruded polyethylene, low density, oval in shape to fit the joints as indicated on the drawings and to be compatible with sealant.

3. Where required, primer shall be compatible with joint materials and installed in accordance with manufacturer's instructions.

4. Joint filler shall conform to ASTM D1751 (AASHTO M213) non-extruding, resilient bituminous type. Filler shall be furnished for each joint in single piece for depth and width required for joint, unless otherwise authorized by the Engineer. When more than one piece is authorized for a joint, abutting ends shall be fastened and hold securely to shape by stapling or other positive fastening.

3.2.2.9 EPOXY BONDING COMPOUND

ASTM C 881. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Class B if placement temperature is between 4 and 16°C; or Class C if placement temperature is above 16°C.

3.2.2.10 NEOPRENE BEARING PAD

Neoprene bearing pad shall be of 60 Durometer Hardness and of size as shown on drawings. It shall conform to AASHTO M 251.

3.2.2.11 REINFORCEMENT

Steel reinforcement, other than Steel for Prestressing, used in Reinforced Concrete, shall conform to ASTM as follows:

- ASTM Designation A615-Deformed Billet Steel Bars for Concrete Reinforcement. Minimum yield strength of 230 MPa (33,400 psi) for diameter of 6 mm to 10 mm and 276 MPa (40,000 psi) for diameter of 12 mm to 36 mm.

- Welded steel wire ASTM Designation A185, Fabric for Reinforcement of Concrete.

All bar reinforcement shall have deformed surfaces except that 6 mm bars may be plain.

3.2.2.12 TIE WIRE

Tie wire shall be plain, cold drawn annealed steel wire 1.6 mm diameter.

3.2.3 SAMPLES AND TESTING

1. Refer to Section 1.6.

2. Cement: Sampled either at the mill or at the site of work and tested by an independent commercial or government testing laboratory duly accredited by the Bureau of Research and Standards (BRS) of the DPWH, Department of Science and Technology (DOST) or the Department of Trade and Industry (DTI) at no additional cost to PPA. Certified copies of laboratory test reports shall be furnished for each lot of cement and shall include all test data, results, and certificates that the sampling and testing procedures are in conformance with the Specifications. No cement shall be used until notice has been given by the Engineer that the test results are satisfactory. Cement that has been stored, other than in bins at the mills, for more than 3 months after delivery to the Site shall be re-tested before use. Cement delivered at the Site and later found after test to be unsuitable shall not be incorporated into the permanent works.

3. Aggregates: Tested as prescribed in ASTM C 33

   At least 28 days prior to commencing the work, the Contractor shall inform the Engineer of the proposed source of aggregates and provide access for sampling.

   Gradation tests will be made on each sample without delay. All other aggregates tests required by these Specifications shall be made on the initial source samples, and shall be repeated whenever there is a change of source. The tests shall include an analysis of each grade of material and an analysis of the combined material representing the aggregate part of the mix.

4. Reinforcement: Certified copies of mill certificates shall accompany deliveries of steel bar reinforcement. If requested by the Engineer additional testing of the materials shall be made at the Contractor's expense.

5. Concrete Tests: For test purposes, provide three (3) sets of test specimens taken under the instruction of the Engineer from each 50 cu.m. or fraction thereof of each class of concrete placed. At least one (1) set of test specimen shall be provided for each class of concrete placed in each 8-hour shift. Each shall consist of two test specimens, and shall be made from a separate batch. Samples shall be secured in conformance with ASTM C 172. Tests specimens shall be made, cured, and packed for shipment in accordance with ASTM C 31. Cylinders will be tested by and at the expense of the Contractor in accordance with ASTM C 39. Test specimens will be evaluated separately by the Engineer, for meeting strength level requirements for

each with concrete quality of ACI 318. The standard age of test shall be 28 days, but 7 day tests may be used, with the permission of the Engineer, provided that the relation between the 7-day and 28-day strengths of the concrete is established by tests for the materials and proportions used. When samples fail to conform to the requirements for strengths, the Engineer shall have the right to order a change in the proportions of the concrete mix for the remaining portions of the work at no additional cost to the Engineer.

6. Test of Hardened Concrete in or Removed from the Structure: When the results of the strength tests of the concrete specimens indicates the concrete as placed does not meet the Specification requirements or where there are other evidences that the quality of concrete is below the specification requirement in the opinion of the Engineer, tests on cores of in-place concrete shall be made in conformance with ASTM C 42.

   Core specimens shall be obtained by the Contractor and shall be tested. Any deficiency shall be corrected or if the Contractor elects, he may submit a proposal for approval before the load test is made. If the proposal is approved, the load test shall be made by the Contractor and the test results evaluated by the Engineer in conformance with Chapter 20 of ACI 318. The cost of the load tests shall be borne by the Contractor. If any concrete shows evidence of failure during the load test, or fails the load test as evaluated, the deficiency be corrected in a manner approved by the Engineer at no additional cost to the Engineer.

7. Synthetic Fibrous Reinforcement: Tested for conformance to the referenced specifications under which it is furnished. The testing shall be conducted with cement and aggregate proposed for the Project.

8. Admixtures/Additives: The admixtures/additives if approved shall be tested for conformance to the referenced specification under which it is furnished. The testing shall be conducted with cement and aggregate proposed for the Project. The admixtures/additives shall be tested and those that have been in storage at the Project Site for longer than six (6) months shall not be used until proven by retest to be satisfactory.

   Five (5) liters of samples of any admixtures/additives proposed by the Contractor shall be submitted for testing at least 56 days in advance of use, , which shall require approval of the Engineer. Testing of admixtures/additives proposed by the Contractor including test mixing and cylinder test shall be at the Contractor's expense.

9. Jointing Materials and Curing Compound Samples: At least 28 days prior to commencing the work, the Contractor shall submit to the

Engineer for his approval samples of the following materials proposed for use together with manufacturer's certificate.

a. 10 kg of joint sealant
b. 1 m length of joint filler
c. 5 li of curing compound
d. 1 m length of joint backing

The Engineer shall deliver to the Contractor his assessment on the materials within seven (7) days after receiving them.

3.2.4 DELIVERY, STORAGE AND HANDLING OF MATERIALS

1. Cement: Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. ACI 301 and ASTM A 934 for job site storage of materials. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed.

   Immediately upon receipt at the Site, the cement shall be stored separately in a dry weathertight, properly ventilated structures with adequate provisions for prevention of absorption of moisture. Storage accommodations for concrete materials shall be subject to approval and shall afford easy access for inspection and identification of each shipment in accordance with test reports.

   Cement shall be delivered to the Site in bulk or in sound and properly sealed bags and while being loaded or unloaded and during transit to the concrete mixers whether conveyed in vehicles or in mechanical means, cement shall be protected from whether by effective coverings. Efficient screens shall be supplied and erected during heavy winds.

   If the cement is delivered in bulk, the Contractor shall provide, at his own cost, approved silos of adequate size and numbers to store sufficient cement to ensure continuity of work and the cement shall be placed in these silos immediately after it has been delivered to the Site. Approved precautions shall be taken into consideration during unloading to ensure that the resulting dust does not constitute a nuisance.

   If the cement is delivered in bags, the Contractor shall provide, at his own cost, perfectly waterproofed and well ventilated sheds having a floor of wood or concrete raised at least 0.5m above the ground. The sheds shall be large enough to store sufficient cement to ensure continuity of the work and each consignment shall be stacked

separately therein to permit easy access for inspection, testing and approval. Upon delivery, the cement shall at once be placed in these sheds and shall be used in the order in which it has been delivered.

Cement bags should not be stacked more than 13 bags high. All cement shall be used within two months of the date of manufacture. If delivery conditions render this impossible, the Engineer may permit cement to be used up to three (3) month after manufacturing, subject to such conditions including addition of extra cement as he shall stipulate.

2. Aggregate: All fine and coarse aggregate for concrete shall be stored on close fitting, steel or concrete stages design with drainage slopes or in bins of substantial construction in such a manner as to prevent segregation of sizes and to avoid the inclusion of dirt and other foreign materials in the concrete. All such bins shall be emptied and cleaned at intervals of every six (6) months or as required by the Engineer. Each size of aggregate shall be stored separately unless otherwise approved by the Engineer.

   Stockpiles of coarse aggregate shall be built in horizontal layers not exceeding 1.2 m in depth to minimize segregation.

3.2.5 FORMWORK

1. Forms: Designed, constructed, and maintained so as to insure that after removal of forms the finished concrete members will have true surfaces free of offset, waviness or bulges and will conform accurately to the indicated shapes, dimensions, lines, elevations and positions. Form surfaces that will be in contact with concrete shall be thoroughly cleaned before each use.

2. Design: Studs and wales shall be spaced to prevent deflection of form material. Forms and joints shall be sufficiently tight to prevent leakage of grout and cement paste during placing of concrete. Juncture of formwork panels shall occur at vertical control joints, and construction joints. Forms placed on successive units for continuous surfaces shall be fitted in accurate alignment to assure smooth completed surfaces free from irregularities and signs of discontinuity. Temporary opening shall be arranged to wall and where otherwise required to facilitate cleaning and inspection. Forms shall be readily removable without impact, shock, or damage to the concrete.

3. Form Ties: Factory fabricated, adjustable to permit tightening of the forms, removable or snap-off metal of design that will not allow form deflection and will not spall concrete upon removal. Bolts and rods that are to be completely withdrawn shall be coated with a non-staining

bond breaker. Ties shall be of the type which provide watertight concrete.

4. Chamfering: External corners that will be exposed shall be chamfered, beveled, or rounded by mouldings placed in the forms.

5. Coatings: Forms for exposed surfaces shall be coated with form oil or form-release agent before reinforcement is placed. The coating shall be a commercial formulation of satisfactory and proven performance that will not bond with, stain, or adversely affect concrete surfaces, and shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for unexposed surfaces may be wet with water in lieu of coating immediately before placing of concrete. Surplus coating on form surfaces and coating on reinforcement steel and construction joints shall be removed before placing concrete.

6. Removal of Forms shall be done in a manner as to prevent injury to the concrete and to insure complete safety of the structure after the following conditions have been met. Where the structure as a whole is supported on shores, forms for beam and girder sides, and similar vertical structural members may be removed before expiration of curing period. Care shall be taken to avoid spalling the concrete surface or damaging concrete edges. Wood forms shall be completely removed.

   Minimum stripping and striking time shall be as follows unless otherwise approved by the Engineer.

   Vertical sides of beams, walls, and columns, lift not 12 hours exceeding 1.2 m

   Vertical sides of beams and walls, lift exceeding 1.2 m 36 hours

   Softlifts of main slabs and beams (props left under) 5 days

   Removal of props from beams and mains slabs and other work 10 days

7. Control Test: If the Contractor proposes to remove forms earlier than the period stated above, he shall be required to submit the results of control tests showing evidence that concrete has attained sufficient strength to permit removal of supporting forms. Cylinders required for control tests shall be provided in addition to those otherwise required by this Specification. Test specimens shall be removed from molds at the end of 24 hours and stored in the structure as near the points as

practicable, the same protection from the elements during curing as is given to those portions of the structure which they represent, and shall not be removed from the structure for transmittal to the laboratory prior to expiration of three fourths of the proposed period before removal of forms. Cylinders will be tested by and at the expense of the Contractor. Supporting forms or shoring shall not be removed until control test specimens have attained strength of at least 160 kg/sq cm. The newly unsupported portions of the structure shall not be subjected to heavy construction or material loading.

3.2.6 REINFORCEMENT

1. Reinforcement: Fabricated to shapes and dimensions shown and shall be placed where indicated. Reinforcement shall be free of loose or flaky rust and mill scale, or coating, and any other substance that would reduce or destroy the bond. Reinforcing steel reduced in section shall not be used. After any substantial delay in the work, previously placed reinforcing steel for future bonding shall be inspected and cleaned. Reinforcing steel shall not be bent or straightened in a manner injurious to the steel or concrete. Bars with kinks or bends not shown in the drawings shall not be placed. The use of heat to bend or straighten reinforcing steel shall not be permitted. Bars shall be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, the resulting arrangement of bars including additional bars necessary to meet structural requirements shall be approved before concrete is placed. In slabs, beams and girders, reinforcing steel shall not be spliced at points of maximum stress unless otherwise indicated. Unless otherwise shown in the drawings, laps or splices shall be 40 times the reinforcing bar diameter.

2. The nominal dimensions and unit weights of bars shall be in accordance with the following table:

Nominal Diameter (mm)	**Nominal Perimeter (mm)**	**Nominal Sectional Area (sq mm)**	**Unit Weight (kg/m)**
6	18.8	28.27	0.222
10	31.4	78.54	0.616
12	37.7	113.10	0.888
16	50.3	201.10	1.579
20	62.8	314.20	2.466
25	78.5	490.90	3.854
28	88.0	615.70	4.833
32	100.5	804.20	6.313
36	113.1	1017.60	7.991
40	125.7	1256.60	9.864
50	157.1	1963.50	15.413

3. Welding of reinforcing bars shall only be permitted where shown; all welding shown shall be performed in accordance with AWS D 12.1.

4. Exposed reinforcement bars, dowels and plates intended for bonding with future extensions shall be protected from corrosion.

5. Supports shall be provided in conformance with ACI 315 and ACI 318, unless otherwise indicated or specified.

6. Concrete Protection for Reinforcement

   a. The minimum concrete cover of reinforcement shall be as shown below unless otherwise indicated in the drawings.

   b. Tolerance for Concrete Cover of Reinforcing Steel other than Tendons.

Minimum Cover	Maximum Variation
7.5 cm or more (marine structures and concrete cast against and permanently exposed to earth) less than 7.5 cm (other structures)	9 mm 6 mm

3.2.7 CLASSES OF CONCRETE AND USAGE

1. Strength Requirement:

   a. Concrete of the various classes unless specified in other Sections or indicated on the Drawings or directed by the Engineer shall be proportioned and mixed to achieve the following strengths:

Class	Specified Compressive Strength - 28 days	
	Fc' = MPa	fc' = psi
A	35	5,000
B1	35	5,000
B2	25	3,500
C	21	3,000
D	17	2,500
E	41.4	6,000

b. In addition to the above, the maximum permissible water-cement ratio by weight shall not be greater than 0.55 unless otherwise permitted by the Engineer.

c. However, for projects located in remote areas where the concrete transit mixer (batching plant) is not available such that the 5,000 psi compressive strength is not attainable for Classes A and B1, the minimum compressive strength of 3,500 psi may be used.

2. Usage: Concrete of the various classes to be used shall be as follows:

a.	Class A concrete	:	Special cases for marine structures
b.	Class B1 concrete	:	Marine Structures (piles/RC for sheet piles and coping for sheet piles/retaining walls/wharf/pier deck), precast or in-situ concrete.
c.	Class B2 concrete	:	Concrete pavement for causeways and roads, stair landings and curbs
d.	Class C concrete	:	Building Works, Utility RC works
e.	Class D concrete	:	Concrete blocks, concrete slabs for buildings with no vehicle access.
f.	Class E concrete	:	Interlocking Concrete Block Pavement

3.2.8 PROPORTIONING OF CONCRETE MIXES

1. Trial design batches and testing to meet requirements of the classes of concrete specified shall be the responsibility of the Contractor. The design mix shall be of consistencies specified hereinafter in Paragraph 3.2.8.6. Tests for slump, unit weight, and air content shall be performed in the field under the presence of the Engineer.

2. Synthetic fibrous reinforcement shall conform to the recommended dosage of the manufacturer.

   Water reducing agents, set retarders or strength accelerators shall not be used in greater dosages than those recommended by the manufacturers.

3. Concrete Proportioning: Samples of approved aggregates shall be obtained in accordance with the requirements of ASTM D 75. Samples of materials other than aggregates shall be representative of those proposed for the Project and shall be accompanied by the manufacturer's test reports indicating compliance with applicable specified requirements. Trial mixes having proportions, consistencies and air content suitable for the work shall be made based on ACI Standard 211.1 using at least three different water-cement ratios which will produce a range of strength encompassing those required for the work. Trial mixes shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 39. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength.

4. Average Strength: For each portion of the structure, proportions shall be selected so that the maximum permitted water-cement ratio is not exceeded and so as to produce an average strength to exceed the specified strength fc' by the amount indicated below. Where production facility has a standard deviation record determined in accordance with ACI 214, based on 30 consecutive strength tests of similar mixture proportions as proposed it shall be used in selecting average strength.

   The average strength used as the basis for selecting proportions shall exceed the specified strength fc' by at least:

   a. 2.94 MPa if standard deviation is less than 1.96 MPa

   b. 3.92 MPa if standard deviation is 1.96 to 2.94 MPa

   c. 4.90 MPa if standard deviation is 2.94 to 3.92 MPa

   d. 5.88 MPa if standard deviation is 3.92 to 4.90 MPa

   e. If a standard deviation record is not available, proportions shall be selected to produce an average strength of at least 6.86 MPa greater than the specified strength.

5. Corrective additions to remedy deficiencies in aggregate gradation shall be used only on written approval of the Engineer.

6. Slump:Tests shall be made in conformance with ASTM C 143, and unless otherwise specified by the Engineer, slump shall be within the following limits:

Structural Element	Slump for Vibrated Concrete	
	Minimum	Maximum
Pavement Concrete	25 mm	50 mm
Precast Concrete	50 mm	70 mm
Lean Concrete	100 mm	200 mm
All other Concrete	50 mm	90 mm

7. Sampling: Provide suitable facilities and labor for obtaining representative samples of concrete for the Contractor's quality control and the Engineer's quality assurance testing. All necessary platforms, tools and equipment for obtaining samples shall be furnished by the Contractor.

3.2.9 MIXING CONCRETE

1. GENERAL

   a. Concrete shall be thoroughly mixed in a mixer of an approved size and type that will insure a uniform distribution of the materials throughout the mass.

   b. All concrete shall be mixed in mechanically operated mixers. Mixing plant and equipment for transporting and placing concrete shall be arranged with an ample auxiliary installation to provide a minimum supply of concrete in case of breakdown of machinery or in case the normal supply of concrete is disrupted. The auxiliary supply of concrete shall be sufficient to complete the casting of a section up to a construction joint that will meet the approval of the Engineer.

   c. Equipment having components made of aluminum or magnesium alloys, which would be in contact with plastic concrete during mixing, transporting or pumping of Portland cement concrete, shall not be used.

   d. Concrete mixers shall be equipped with adequate water storage and a device for accurately measuring and automatically controlling the amount of water used.

   e. Materials shall be measured by weighing. The apparatus provided for weighing the aggregates and cement shall be suitably designed and constructed for this purpose. The accuracy of all weighing devices except that for water shall be such that successive quantities can be measured to within one percent of the desired amounts. The water measuring device shall be accurate to plus or minus 0.5 percent. All measuring devices shall be subject to the approval of the Engineer. Scales and measuring devices shall be

tested at the expense of the Contractor as frequently as the Engineer may deem necessary to insure their accuracy.

f. Weighing equipment shall be insulated against vibration or movement of other operating equipment in the plant. When the entire plant is running, the scale reading at cut-off shall not vary from the weight designated by the Engineer by more than one percent for cement, 1-½ percent for any size of aggregate, or one percent for the total aggregate in any batch.

g. Manual mixing of concrete shall not be permitted unless approved by the Engineer.

2. MIXING CONCRETE AT SITE

a. Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer. The pick-up and throw-over blades of mixers shall be restored or replaced when any part or section is worn 20 mm or more below the original height of the manufacturer's design. Mixers and agitators which have an accumulation of hard concrete or mortar shall not be used.

b. When bulk cement is used and the volume of the batch is 0.5 m^3 or more, the scale and weigh hopper for Portland cement shall be separate and distinct from the aggregate hopper or hoppers.

The discharge mechanism of the bulk cement weigh hopper shall be interlocked against opening before the full amount of cement is in the hopper. The discharging mechanism shall be interlocked against opening when the amount of cement in the hopper is underweight by more than one percent or overweight by more than 3 percent of the amount specified.

c. When the aggregates contain more water than the quantity necessary to produce a saturated surface dry condition, representative samples shall be taken and the moisture content determined for each kind of aggregate.

d. The batch shall be so charged into the mixer that some water enter in advance of cement and aggregates. All water shall be in the drum by the end of the first quarter of the specified mixing time.

e. Cement shall be batched and charged into the mixer by such means that it will not result in loss of cement due to the effect of wind, or in accumulation of cement on surfaces of conveyors or

hoppers, or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

f. Where required, synthetic fibrous reinforcement shall be added directly to the concrete mixer after placing the sufficient amount of mixing water, cement and aggregates.

g. The entire contents of a batch mixer shall be removed from the drum before materials for a succeeding batch are place therein. The materials composing a batch except water shall be deposited simultaneously into the mixer.

h. All concrete shall be mixed for a period of not less that 3 minutes after all materials, including water, are in the mixer. During the period of mixing, the mixer shall operate at the speed for which it has been designed.

i. Mixers shall be operated with an automatic timing device that can be locked by the Engineer. The time device and discharge mechanism shall be so interlocked that during normal operation no part of the batch will be discharged until the specified mixing time has elapsed.

j. The first batch of concrete materials placed in the mixer shall contain a sufficient excess of cement, sand, and water to coat the inside of the drum without reducing the required mortar content of the mix. When mixing is to cease for a period of one hour or more, the mixer shall be thoroughly cleaned.

3. MIXING CONCRETE IN TRUCKS

a. Truck mixers, unless otherwise authorized by the Engineer, shall be of the revolving drum type, watertight, and so constructed that the concrete can be mixed to insure a uniform distribution of materials throughout the mass. All solid materials for the concrete shall be accurately measured and charged into the drum at the proportioning plant. Except as subsequently provided, the truck mixer shall be equipped with a device by which the quantity of water added can be readily verified. The mixing water may be added directly to the batch, in which case a tank is not required. Truck mixers may be required to be provided with a means by which the mixing time can be readily verified by the Engineer.

b. The maximum size of batch in truck mixers shall not exceed the minimum rated capacity of the mixer as stated by the manufacture and stamped in metal on the mixer. Truck mixing shall, unless otherwise directed, be continued for not less than 100 revolutions

after all ingredients, including water, are in the drum. The mixing speed shall not be less than 4 rpm, nor more than 6 rpm.

c. Mixing shall begin within 30 minutes after the cement has been added either to the water or aggregate, but when cement is charged into a mixer drum containing water or surface-wet aggregate and when the temperature is above 32 °C, this limit shall be reduced to 15 minutes. The limitation in time between the introduction of the cement to the aggregate and the beginning of the mixing may be waived when, in the judgment of the Engineer, the aggregate is sufficiently free from moisture, so that there will be no harmful effects on the cement.

d. When a truck mixer is used for transportation, the mixing time in stationary mixer may be reduced to 30 seconds and the mixing completed in a truck mixer. The mixing time in truck mixer shall be as specified for truck mixing.

3.2.10 JOINTS

1. No reinforcement, corner protection angles or other fixed metal items shall be run continuously through joints containing expansion-joint filler, through crack-control joints in slabs on grade and vertical surfaces.

2. Preformed Expansion Joint Filler

   a. Joints with Joint Sealant: At expansion joints in concrete slabs to be exposed, and at other joints indicated to receive joint sealant, preformed expansion-joint filler strips shall be installed at the proper level below the elevation with a slightly tapered, dressed-and-oiled wood strip temporarily secured to the top thereof to form a groove. When surface dry, the groove shall be cleaned of foreign matter, loose particles, and concrete protrusions, then filled flush approximately with joint sealant so as to be slightly concave after drying.

   b. Finish of concrete at joints: Edges of exposed concrete slabs along expansion joints shall be neatly finished with a slightly rounded edging tool.

   c. Construction Joints:

      Unless otherwise specified herein, all construction joints shall be subject to approval of the Engineer. Concrete shall be placed continuously so that the unit will be monolithic in construction. Fresh concrete may be placed against adjoining units, provided the set concrete is sufficiently hard not to be injured thereby. Joints not indicated shall be made and located in a manner not to

impair strength and appearance of the structure. Placement of concrete shall be at such rate that the surface of concrete not carried to joint levels will not have attained initial set before additional concrete is placed thereon. Lifts shall terminate at such levels as are indicated or as to conform with structural requirements as directed. If horizontal construction joints are required, a strip of 25 mm square-edged lumber, beveled to facilitate removal shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 25 mm above the underside of the strip. The strip shall be removed one hour after the concrete has been placed. Any irregularities in the joint line shall be leveled off with a wood float, and all laitance removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in sub-section 3.2.14, "Bonding."

Construction Joint which is not indicated in the Drawings shall be located as to least affect the strength of the structure. Such locations will be pointed out by the Engineer.

3.2.11 PREPARATION FOR PLACING

Hardened concrete, debris and foreign materials shall be removed from the interior of forms and from inner surfaces of mixing and conveying equipment. Reinforcement shall be secured in position, and shall be inspected, and approved before placing concrete. Runways shall be provided for wheeled concrete-handling equipment. Such equipment shall not be wheeled over reinforcement nor shall runways be supported on reinforcement.

Notice of any concreting operations shall be served to the Engineer at least three (3) days ahead of each schedule.

3.2.12 PLACING CONCRETE

1. Handling Concrete: Concrete shall be handled from mixers and transported to place for final deposit in a continuous manner, as rapidly as practicable, and without segregation or loss of ingredients until the approved unit of work is completed. Placing will not be permitted when the sun, heat, wind or limitations of facilities furnished by the Contractor prevent proper finishing and curing of the concrete. Concrete shall be placed in the forms, as close as possible in final position, in uniform approximately horizontal layers not over 40 cm deep. Forms splashed with concrete and reinforcement splashed with concrete or form coating shall be cleaned in advance of placing subsequent lifts. Concrete shall not be allowed to drop freely more than 1.5 m in unexposed work nor more than 1.0 m in exposed work; where greater drops are required, tremie or other approved means

shall be employed. The discharge of the tremie shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than 40 cm thick, and the spacing of the tremies shall be such that segregation does not occur. Concrete to be overlayed shall be screeded to the proper level to avoid excessive shimming or grouting. Conduits and pipes shall not be embedded in concrete unless specifically indicated.

2. Time Interval between Mixing and Placing: Concrete mixed in stationary mixers and transported by non-agitating equipment shall be placed in the forms within 30 minutes from the time ingredients are charged into the mixing drum. Concrete transported in truck mixers or truck agitators shall be delivered to the site of work, discharged in the forms within 45 minutes from the time ingredients are discharged into the mixing drum. Concrete shall be placed in the forms within 15 minutes after discharged from the mixer at the jobsite.

3. Hot Weather Requirements: The temperature of concrete during the period of mixing while in transport and/or during placing shall not be permitted to rise above 36 °C. Any batch of concrete which had reached a temperature greater than 36 °C at any time in the aforesaid period shall not be placed but shall be rejected, and shall not thereafter be used in any part of the permanent works.

    a. Control Procedures: Provide water cooler facilities and procedures to control or reduced the temperature of cement, aggregates and mixing handling equipment to such temperature that, at all times during mixing, transporting, handling and placing, the temperature of the concrete shall not be greater than 36 °C.

    b. Cold Joints and Shrinkage: Where cold joints tend to form or where surfaces set and dry too rapidly or plastic shrinkage cracks tend to appear, concrete shall be kept moist by fog sprays, or other approved means, applied shortly after placement, and before finishing.

    c. Supplementary Precautions: When the aforementioned precautions are not sufficient to satisfy the requirements herein above, they shall be supplemented by restricting work during evening or night. Procedure shall conform to American Concrete Institute Standard ACI 305.

4. Conveying Concrete by Chute, Conveyor or Pump: Concrete may be conveyed by chute, conveyor, or pump if approved in writing. In requesting approval, the Contractor shall submit his entire plan of operation from the time of discharge of concrete from the mixer to final placement in the forms, and the steps to be taken to prevent the formation of cold joints in case the transporting of concrete by chute,

conveyor or pump is disrupted. Conveyors and pumps shall be capable of expeditiously placing concrete at the rate most advantageous to good workmanship. Approval will not be given for chutes or conveyors requiring changes in the concrete materials or design mix for efficient operation.

a. Chutes and Conveyors: Chutes shall be of steel or steel lined wood, rounded in cross section rigid in construction, and protected from overflow. Conveyors shall be designed and operated and chute sections shall be set, to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients, loss of mortar, or change in slump. The discharged portion of each chute or conveyor shall be provided with a device to prevent segregation. The chute and conveyor shall be thoroughly cleaned before and after each run. Waste material and flushing water shall be discharged outside the forms.

b. Pumps shall be operated and maintained so that a continuous stream of concrete is delivered into the forms without air pockets, segregation or changes in slump. When pumping is completed, concrete remaining in the pipeline shall be ejected and wasted without contamination of concrete already placed. After each operation, equipment shall be thoroughly cleaned and the flushing water shall be splashed outside the forms.

5. Wall and Abutments

No load shall be placed upon finished walls, foundations or abutments until authorized by the Engineer. Minimum time before loading shall be 7 days.

6. Concrete Placing on Wharf Deck

When placing concrete on wharf decks, the Contractor shall:

- Ensure that rate of placing is sufficient to complete proposed placing, finishing and curing operations within the scheduled time; that experienced finishing machine operators and concrete finishers are provided to finish the deck; that curing equipment and finishing tools and equipment are at the site of work and in satisfactory condition for use.

- Immediately prior to placing, the Contractor shall place scaffolding and wedges and make necessary adjustments. Care shall be taken to ensure that settlement and deflection due to added weight of concrete will be minimal. The Contractor shall provide suitable means to readily permit measurement of settlement deflection as it occurs.

- Should any event occur which, in opinion of the Engineer, would prevent the concrete conforming to specified requirements, the Contractor shall discontinue placing of concrete until corrective measures are provided satisfactory to the Engineer. If satisfactory measures are not provided prior to initial set of concrete in affected areas, the Contractor shall discontinue placing concrete and install a bulkhead at a location determined by the Engineer. Concrete in place beyond bulkheads shall be removed. The Contractor shall limit the size of casting to that which can be finished before beginning of initial set.

3.2.13 COMPACTION

1. Immediately after placing, each layer of concrete shall be completed by internal concrete vibrators supplemented by hand-spading, rodding, and tamping. Tapping or other external vibration of forms will not be permitted unless specifically approved by the Engineer. Vibrators shall not be used to transport concrete inside the forms. Internal vibrators submerged in concrete shall maintain a speed of not less than 7,000 impulses per minute. The vibrating equipment shall at all times be adequate in number of units and power to properly consolidate all concrete.

2. Spare units shall be on hand as necessary to insure such adequacy. The duration of vibrating equipment shall be limited to the time necessary to produce satisfactory consolidation without causing objectionable segregation. The vibrator shall not be inserted into the lower courses that have begun to set. Vibrator shall be applied vertically at uniformly spaced points not further apart than the visible effectiveness of the machine.

3.2.14 EPOXY BONDING COMPOUND

Before depositing new concrete on or against concrete that has set, the surfaces of the set concrete shall be thoroughly cleaned so as to expose the coarse aggregate and be free of laitance, coatings, foreign matter and loose particles. Forms shall be re-tightened. The cleaned surfaces shall be moistened, but shall be without free water when concrete is placed.

ASTM C 881. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Class B if placement temperature is between 4 to 16 °C; or Class C if placement temperature is above 16°C.

Apply a thin coat of compound to dry and clean surfaces. Scrub compound into the surface with a stiff-bristle brush. Place concrete while compound is tacky. Do not permit compound to harden prior to concrete placement. Follow manufacturer's instructions regarding safety and health precautions when working with epoxy resins.

3.2.15 SETTING OF BASE PLATES

1. Preparation: After being plumbed and properly positioned, base plates shall be provided with full bearing with damp-pack bedding mortar, except where expansive grout is indicated. The space between the top of concrete or masonry bearing surfaces and the bottom of the plate shall be approximately 1/24 of the width of the plate, but not less than 13 mm for plates less than 30 cm wide. Concrete surfaces shall be rough, clean, free of oil, grease and laitance, and shall be damp. Metal surfaces shall be cleaned and free of oil, grease and rust.

2. Mortar: Damp-pack bedding mortar shall consist of one part Portland cement and 2.5 parts of fine aggregates, suitable to the work required, proportioned by weight and not more than 17 liters of water per bag of cement. The space between the top of the plate shall be packed with the bedding mortar by tamping or ramming with a bar or rod until the voids are completely filled.

3. Expansive Grout: Grout shall derive its expansive properties from the liberation of gas into the mixture during and after mixing. This includes typically, the chemical reaction of metallic aluminum with alkali hydroxides in solution which causes the evolution of hydrogen gas. Expansion of such materials may be expected to continue after the gas liberating mechanism has been exhausted or until the mixture has solidified to such an extent that the tendency for the evolving gas to expand is effectively registered by the stiffness of the grout.

    a. When tested as provided for herein, an expansive grout shall meet the following performance requirements:

Expansion, 28 days, %	0.4 (max) 0.03 (min)

    b. It will be the Contractor’s responsibility to supply the necessary manufacturer’s certificates.

3.2.16 FINISHES OF CONCRETE

Within 12 hours after the forms are removed, surface defects shall be remedied as specified herein. The Temperature of the concrete, ambient air and mortar during remedial work including curing shall be above 10 °C. Fine and loose material shall be removed. Honeycomb, aggregate

pockets, voids over 13 mm in diameter, and holes left by the rods or bolts shall be cut out to solid concrete, reamed, thoroughly wetted, brush-coated with neat cement grout, and filled with mortar. Mortar shall be a stiff mix of one part Portland cement to not more than 2 parts fine aggregate passing the No. 16 mesh sieve, with a minimum amount of water. The color of the mortar shall match the adjoining concrete color. Mortar shall be thoroughly compacted in place. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through the outside face. Holes which do not pass entirely through wall shall be packed full. Patchwork shall be finished flush and in the same plane as adjacent surfaces. Exposed patchwork shall be finished to match adjoining surfaces in texture and color. Patchwork shall be damp-cured for 72 hours. Dusting of finish surfaces with dry material or adding water to concrete surfaces will not be permitted.

3.2.17 CONCRETE FINISHING DETAILS

1. Concrete Paving: After concrete is placed and consolidated, slabs shall be screeded or struck off. No further finish is required.

2. Smooth Finish: Required only where specified; screed concrete and float to required level with no coarse aggregate visible. After surface moisture has disappeared and laitance has been removed, the surface shall be finished by float and steel trowel. Smooth finish shall consist of thoroughly wetting and then brush coating the surfaces with cement to not more than 2 parts fine aggregate passing the no. 30 mesh sieve and mixed with water to the consistency of thick paint.

3. Broom Finish: Required for paving, stair landings; the concrete shall be screeded and floated to required finish level with no coarse aggregate visible. After the surface moisture has disappeared and laitance has been removed, surface shall be float-finished to an even, smooth finish. The floated surfaces shall be broomed with a fiber bristle brush in a direction transverse to the direction of the main traffic.

4. Tolerance: Smooth and broom finished surfaces shall be true to plane with no deviation in excess of 3 mm in any direction when tested with a 3 m straightedge.

3.2.18 CURING

1. Concrete shall be protected against moisture loss, rapid temperature changes, mechanical injury from rain or flowing water, for a minimum period of time given below:

Types A, B1 and B2	7 days
Types C and D	5 days

2. Concrete shall be maintained in a moist condition throughout the specified curing period and until remedial work is started under sub-section 3.2.16, "Finishes of Concrete". Curing activities shall be started as soon as free water has disappeared from the surface of the concrete after placing and finishing. Formed under-surfaces shall be moist cured with forms in place for the full curing period or, if forms are removed prior to the end of the curing period, by other approved means. Curing shall be accomplished by any of the following methods or combination thereof, as approved.

3. Moist Curing: Unformed surfaces shall be covered with burlap or mats, wetted before placing and overlapped at least 15 cm. Burlap or mats shall be kept continually wet and in intimate contact with the surface. Where formed surfaces are cured, the forms shall be kept continually wet. If the forms are removed before the end of the curing period, curing shall be continued as on unformed surfaces, using suitable materials.

4. Impervious-sheet Curing: All surfaces shall be thoroughly wetted with a fine spray of water and be completely covered with waterproof paper, polyethylene sheeting or with polyethylene coated burlap having the burlap thoroughly water saturated before placing. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 30 cm and securely weighted down or shall be lapped not less than 10 cm and taped to form a continuous cover with completely close joints. Sheets shall be weighted to prevent displacement or billowing from winds. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

5. Membrane-forming Compound Curing: Before applying curing compound, tops of joints that are to receive sealant shall be tightly closed with temporary material to prevent entry of the compound and to prevent moisture loss during the curing period. The compound shall be applied on damp surfaces as soon as the moisture film has disappeared. The curing compound shall be applied by power spraying using a spray nozzle equipped with a wind guard. The compound shall be applied in a two-coat, continuous operation at a coverage of not more than 10 sq m per liter for each coat.

   When application is made by hand sprayers the second coat shall be applied in a direction approximately at right angles to the direction of the first coat. The compound shall form a uniform, continuous, adherent film that shall not check, crack, or peel and shall be free from pinholes or other imperfections. Surfaces subjected to rainfall within 3 hours after compound has been applied, or surfaces damaged by subsequent construction operations within the curing period, shall be immediately re-sprayed at the rate specified above. Membrane

forming curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Where membrane-forming curing compounds are permitted, permanently exposed surfaces shall be cured by use of non-pigmented membrane-forming curing compound containing a fugitive dye. Where non-pigmented type curing compounds are used, the concrete surface shall be shaded from the direct rays of the sun for the duration of the curing period. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other causes of abrasion and contamination during the curing period.

3.2.19 UNDER WATER CONCRETE

1. Concrete placement under water, when unavoidable, shall be made in accordance with the following requirements and provided always with the Engineer's approval.

    a. Water cement ratio shall be within 50 percent.

    b. Weight of cement per one cubic meter shall be not less than 370 kg.

    c. Use of water reducing admixtures and/or admixtures that reduce concrete contamination by sea water shall be recommended.

    d. Slump shall be within the following limits:

Construction Method	Slump
Using tremie or concrete pump	Between 13 to 18 cm
Using bottom opening type box or buck	Between 10 to 13 cm

    e. Coverage of reinforcement shall be 10 cm or more.

    f. Concrete shall be placed under water in accordance with Sub-section 3.2.12 "Placing Concrete" unless otherwise mentioned below.

        1) Concrete shall be placed under calm weather conditions and current shall be within 3 m/min.

        2) Concrete shall be placed using tremies or concrete pumps or any other approved equipment.

3) Tremies shall be watertight and of size which can deliver concrete freely without any segregation or change in slump. Tremies shall be filled with concrete fully during placing.

4) Pipes of concrete pumps shall be watertight.

5) Tremies shall move carefully up to the designated height under continuous concrete placement operations so that concrete can spread uniformly.

6) Concrete shall not be agitated after placing in the forms in order to prevent laitance formation at the top of the works.

7) Successive concrete placement can be carried out only after all laitance has been removed from existing surfaces.

3.2.20 MEASUREMENT AND PAYMENT

3.2.20.1 MEASUREMENT

1. Concrete shall be measured by the cubic meters of various kind and classes of respective items of work required as shown in the Drawings or as specified and as installed and accepted in completed work.

   Volumes of concrete shall be reduced by the amount occupied by pipes, conduits, chases or other places with net cross section areas more than 100 cm^2 other than the following items:

   a. Reinforcing steel and anchor bolts.

   b. Space required for or occupied by expansion/construction joints, joint fillers, water stops, chamfers and like details of relatively small size.

   Setting out of the work to be paid for shall not be measured separately, the cost shall be deemed as part of and incidentals to the foundation works.

2. Formwork shall not be measured separately for payment. The cost is deemed as part and incidentals to the concrete works.

3. Reinforcing steel bars shall be measured in kilograms incorporated into work, computed from theoretical unit mass for sizes of bars multiplied by length of bars as shown on approved shop drawings except where specified otherwise.

No measurement shall be made for reinforcing steel in catch drains, catch basins, manholes and precast concrete. The cost will be included in the price for each item of work.

Separate measurement will not be made for:

a. Increase of bar sizes or decrease of bar spacing, unless approved in advance by the Engineer.

b. Increase in number of bars resulting from Contractor's constructing method.

c. Bar splicers added for Contractor's convenience or made necessary as a result of using bar lengths less than 10 meters.

d. Weight of quantity of tie wires, chairs, spacers or other accessory items necessary for erection of steel work.

e. Sleeves and work incidental to and necessary for installation of dowels for expansion/construction joints for slabs.

4. Cost of all testing and records to be made shall be deemed included in the unit cost of concrete.

3.2.20.2 PAYMENT

1. The quantities measured as provided above, shall be paid for at the contract unit price according to the class of concrete for the pay item shown in the Bill of Quantities. The unit price shall be considered to include all formwork including scaffolding, forms for construction and expansion joints, vapor barrier and sealant, form oil coating, synthetic fibrous reinforcement/admixtures where required, necessary accesses for pipes, conduits, sewer drains and the like and work required for placing concrete in the final position including material, batching, mixing, transporting, handling, placing, compacting, curing, protection and finishing of concrete surfaces.

2. The quantity of reinforcing steel bars to be paid for shall be measured (as in 3.2.21.1.3) by the weight of reinforcing steel bars supplied and installed completely and certified by the Engineer for payment. The cost shall constitute full compensation for furnishing materials, labor, equipment, tools, and incidentals necessary to complete reinforcing steel works as indicated in the Bill of Quantities.

3.3 PILING WORKS

3.3.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements", and shall apply to the Section, whether herein referred to or not.

3.3.1.1 SCOPE OF WORK

This section covers the technical requirements for the material, workmanship, fabrication, installation and testing of piling works, and shall form part of this Specification to the extent indicated by the reference thereto.

3.3.1.2 GENERAL PROVISIONS

The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

AWS D1.1	Structural Welding Code
ASTM D1143	Load Settlement Relation for Individual Vertical Piles under Static Axial Load

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.

3.3.1.3 COATING PROTECTION

Steel Pipe Pile Coating Protection, when required, shall be as specified in the drawing.

3.3.1.4 METHOD STATEMENT

Before the commencement of any piling works, the Contractor shall submit (allowing sufficient time for consideration) to the Engineer for approval a Safety Policy and a Method Statement which shall include the following information:

1. Program of Works detailing sequence and timing of individual portions of works.
2. Maximum proposed lead at any stage of driving between a pile and its neighbor and the limitations of same if hard driving is encountered.

3. Contingency plan in the event of encountering obstructions or reaching driving refusal to minimize disruption/delay especially when using pitch and drive methods.

3.3.2 MATERIAL REQUIREMENTS

3.3.2.1 PRECAST REINFORCED CONCRETE PILES (RC PILES)

Precast concrete for reinforced concrete piles and its reinforcement shall conform to the requirement of Section 3.2 “Concrete Works”.

1. Fabrication Yard and Equipment

   Reinforced concrete piles shall be products of approved manufacturers regularly engaged in pile production of the same size or larger for a period of three years or more. However, the Contractors may be allowed to manufacture RC piles upon presentation to the Engineer of proof that they have past experienced in manufacturing RC piles from their previous contracts having the same or bigger requirements.

   Before casting of piles is started, approval shall be obtained of the casting method, the casting yard and storage site and equipment. The Contractor shall provide all equipment necessary for the fabrication of piles. Special care shall be made for curing, handling and transport of piles.

2. Casting and Fabrication

   Piles shall be cast separately. The formwork for the piles shall have an even and solid bed and be constructed so that the piles can be easily removed from the form. The formwork and its placing shall be approved before casting of concrete. The formwork shall not be removed from its bed until the concrete has attained a compressive strength of at least 70% of its required 28 day strength.

   The pile shall not be removed from its casting bed until it has reached its full 28 day compressive strength. Piles shall be moist cured for a period of 28 days after casting.

   The Contractor shall determine the points where the piles will be supported during handling, transportation and storage. Care shall be taken to prevent piles from any damage during transportation. If the piles are placed in stacks, the supporting points at each layer shall be vertically over one another and the location of the supporting points shall be approved by the Engineer.

3. Formwork

   Forms shall conform to the applicable provisions in Section 3.2, "Concrete Works." Chamfers shall be provided at each corner of piles as indicated on the Drawings.

4. Marking

   After the concrete has hardened, the piles shall be marked in approved format in durable paint indicating:

   a. Serial Number, marked close to both ends
   b. Date of casting, marked as (a)
   c. Date of arrival, marked as (b)
   d. Length of pile, marked as (c)
   e. Position of lifting points as approved by the Engineer
   f. Meter marks in two faces, throughout the length

3.3.2.2 PRESTRESSED REINFORCED CONCRETE PILES (RC PILES)

Prestressed concrete piles shall be constructed in accordance with the normal practice employed for the particular system specified and as directed by the Engineer subject to the following clauses.

1. Prestressed concrete piles shall be of readymade products of approved fabricator regularly engaged in the production of prestressed concrete piles for a period of three years or more.

2. The design report, specification, handling manual and shop drawings of piles to be applied shall be submitted by the Contractor for the Engineer's approval.

3. If an alternative system of prestressing to that shown in the Drawings is proposed by the Contractor, full details, procedures and explanations shall be submitted in writing to the Engineer for his approval. When approved for the work, the provisions of this Specification and such other provisions as he may require shall be fully satisfied.

4. Concrete strength, wires/strands, bars to be used for prestressed concrete work shall be as specified in the Drawings.

5. The Contractor shall submit the casting method including prestressing, application of stress and casting schedule and shall obtain the approval of the Engineer before commencement of fabrication of the piles.

6. The Contractor shall arrange for the Engineer to have free access to the place of manufacture of the piles.

7. Casting of prestressed concrete piles shall be in a manner that there shall be no leakage of concrete or grout into the space to be occupied by the steel. The ducts shall be of the correct cross-section, the ends being formed out as shown on the Drawings or as required by the prestressing system in use. Adequate means, subject to the Engineer's approval, shall be employed to ensure that their location is maintained exactly throughout the concreting operations. Passage shall be provided in the locations indicated on the Drawings for the injection and escape of grout and the release of air.

   Piles shall be cast on a horizontal platform in approved steel moulds and details of the formwork and methods of concreting shall be as specified. The concreting of each pile shall be completed on one continuous operation and no interruption shall be permitted.

   The ends of the piles must be formed truly square to the axis of the pile.

8. Anchorages shall be made from steel of a suitable quality to withstand permanently the forces imposed upon them, and shall in general be in accordance with the normal practice of the proprietors of the prestressing system in use.

9. Application of stress, grouting of prestressing cables, protection of prestressing cable anchorages and other necessary steps to complete the prestressing process shall conform to the standard practice of the prestressing system in use or as directed by the Engineer.

   When the stress has been transferred to the pile, the pile shall exhibit no curvature in its length on any face greater than 3 millimeters deviation along a chord of 15 meters (1 in 500).

10. Precast prestressed units shall be lifted only by lifting holes near the ends of the units, or when not provided can be lifted by slings placed securely at corresponding points. Units shall be kept in the upright position at all times and shock shall be avoided. Any unit considered by the Engineer to have become sub-standard in any way shall be rejected and replaced by an acceptable unit.

11. Each prestressed member is to be uniquely and permanently marked to show its type, date of casting and reinforcement.

12. Forms shall conform to the applicable provisions in Section 3.2. Chamfer shall be provided at each corner of piles as shown on the Drawings.

13. The Contractor or approved manufacturer shall mark the casted piles in same manner discussed in Sub-section 3.3.2.1.4).

3.3.2.3 REINFORCED CONCRETE SHEET PILES

Same requirements for reinforced concrete piles shall be applied to reinforced concrete sheet piles.

3.3.2.4 STEEL PIPE OR TUBULAR PILES

1. Steel Pipe Piles

   Steel tubular piles required under this heading may either be fluted or plain, tapered or cylindrical, seamless or welded type or as indicated in the drawings conforming to the requirements of ASTM A 252 Grade 2, equal or better. Minimum shell thickness shall be as indicated in the drawings. Piles may be supplied knockdown in the sections then fabricated or welded to the required length in the field prior to driving.

   a. Underwater Petrolatum Tape System with High Density Polyethylene (HDPE) Jacket as Protective Coating of Steel Piles

      Unless otherwise specified on the Drawings, the Underwater Petrolatum Tape System with High Density Polyethylene (HDPE) Jacket (Heavy Duty Application) shall be used as protective coating for steel piles.

      (1) Material Requirements:

         (a) Petrolatum Paste

            - Petrolatum Paste is a soft paste containing water displacing, corrosion inhibiting and flow control additives with broad-spectrum biocides. It does not dry, harden or crack.

            - Applicable to badly corroded and fitted steel above and below water surface prior to the application of the marine piling tape. It fills pits and depressions on the steel pile surface and does not contain volatile organic components.

- Specially designed for underwater applications.

  Properties:

Flash point	=	180˚C (minimum)
Specific Gravity	=	+ 1.08

  Temperature Range:

For Application	=	0°C to 40°C
For Service	=	- 30°C to 55°C

(b) Petrolatum Marine Piling Tape

- Petrolatum Marine Piling Tape is a synthetic filament fabric coated with a neutral compound based on saturated petroleum hydrocarbons and inert mineral fillers with additional inhibitors and water displacing agents.
- It is primarily used for the protection of jetty piles particularly in the splash and inter-tidal zones.
- It is an anti-corrosion tape that can be applied to metal under water that adheres and remains attached to all cleaned, sound, wet or dry metal surfaces.

(c) High Density Polyethylene (HDPE) Jacket

- HDPE Jacket is a flexible plastic outer cover, new, seamless, non-rigid virgin material. The sheet shall be uniform throughout, free from dirt, oil and other foreign matter and free from cracks. This sheet shall conform to the following mechanical and physical properties:

Tensile Strength @ Break	=	187 kg/cm2
Elongation @ Break	=	610%
Thickness	=	2.00 mm
Tear Resistance	=	146 kg/cm^2

(2) Installation Procedure

(a) Surface Preparation

- Prior to the application of Petrolatum Paste, the Pile Surface should be thoroughly cleaned starting from the interface of the bottom of pile cap down to elev. – 3.00m (Splash Zone).

- All Marine growths, loose and flaking paint, adhering rust scale and deep pitting corrosion products should be removed by chipping hammers and/or hand power tools.

- Weld scars and protrusion of any kind (other than the welded seam on the pile) should be cut away and smoothened to removed sharp edges and sudden changes of profile.

(b) Petrolatum Paste

- Apply the petrolatum Paste by hand, brush, glove, rag or roller.

- Apply a thin uniform film over the entire surface to be wrapped with Petrolatum Marine Piling tape.

(c) Petrolatum Marine Piling Tape

- A minimum of two layers of marine piling tape should be wrapped around the surface of the steel piles along the splash zone.

(d) High Density Polyethylene (HDPE) Jacket

- A minimum of 50 mm overlap width is required along joints.

b. Other Protective Coating for Steel Piles

Unless otherwise specified on the drawings, when the steel pipe piles or tubular piles are extended aboveground surface or water surface, they shall be protected by two (2) coats of epoxy coal tar. If concrete jacket is required, a minimum thickness of 0.15m shall be used. These protections extend 1.00m below the water elevation on finished ground to the top of the exposed steel.

c. Exterior Surfaces

All exterior surfaces of pile shall be shop coated with red lead primer or as indicated in the drawings.

2. Concrete and Reinforcement Works

Concrete and reinforcement works (where required) for filler of steel pipe piles, concrete jacket and pile cap shall be in accordance with Section 3.2, “Concrete Works” where concrete compressive strength at 28 days shall be [35.0] MPa [5,000 psi].

Provide reinforced concrete filler for steel pipe piles from the top of piles up to 2.00 m below MLLW (Elevation 0.00). Concrete jacket (100 mm thick) shall be provided up to 1.00 meter below MLLW as indicated on the Drawings.

3. Welding Requirements

The welding material used for the production of steel piles by circumferential welding of steel pile or in the attachment of accessories shall have a tensile strength not less than the following standards.

JIS Z 3211 - Covered Electrodes for Mild Steel

JIS Z 3213 - Covered Electrodes for High Tensile Strength Steel

JIS Z 3312 - MAG Welding Solid Wires for Mild

JIS Z 3313 - Flux Cored Wives for Gas Shielded and self-shielded Metal Arc Welding of Mild Steel, High Strength Steel and Low Temperature Service Steel

JIS Z 3352 - Submerged Arc Welding Fluxes for Carbon Steel and Low Alloy Steel

The welder shall have a qualification specified in JIS Z 3801 Standard Qualification Procedure for Welding Technique or equivalent.

4. Splicing

The Contractor shall splice the pile as shown on the drawings or by other methods approved by the Engineer.

5. Tip Protection

The Contractor shall submit shop drawing and methods of pile tip protection to the Engineer for approval.

6. Marking

The pile shall be marked on durable paint indicating:

1. Serial Number, marked close to both ends
2. Date of Arrival, marked same as (i)
3. Length of pile, marked same as (i)
4. Meter marks in two faces, throughout the length

7. Workmanship

All piles shall be correctly finished free of cracks, surface flaws, laminations and all other defects. The repairs of minor defects by welding or otherwise will be permitted but such repairs shall only be done after obtaining the permission of the Engineer in writing. Detail of the defect and of the proposed method of repair shall be submitted to the Engineer at least 48 hours before it is desired to effect the repair.

8. Documents to be submitted

The following documents shall be submitted to the Engineer prior to the commencement of welding work of tubular steel piles:

1. Steel pipe (pile) manufacturing plan
   (steel pipe production plan, welding method, welding material, production location, production method, transportation, etc.)
2. Design plan
3. Manufacturing process
4. Shipment method and stacking plan
5. Steel pipe inspection certificate
6. Size inspection record
7. Radiographic test record

3.3.2.5 STEEL SHEET PILES

1. Quantities and Dimensions

Steel sheet piles shall be of the type indicated on the Drawings with continuous interlock. The sections and grade of steel shall be as shown on the Drawings or approved equivalent.

All steel sheet piles shall conform to ASTM A 328 or approved equivalent.

2. Quantities and Dimensions (Tie-Rods, Walings and Fittings)

All components of tie-rod assemblies to be supplied, assembled and installed by the Contractor shall be in accordance with the applicable requirements of the ASTM standards. The tie-rods shall have upset treaded ends and the minimum yield point shall be as shown on the drawings.

Structural Steel shapes for walings shall be supplied, fabricated, assembled and installed by the Contractor as shown on the Drawings. The structural steel shall conform to Section 3.15 “Steel and Metal Works”.

Bolts for assembly of structural steel walings and for connections or special sections shall conform to ASTM A 325 and ASTM A 307 or as specified on the Drawings.

3.3.2.6 TIMBER PILES

1. Material

The timber piles shall be straight and treated apitong or equivalent and creosoted with minimum butt diameter of and a minimum tip diameter of 200mm and a length as shown on the Drawings. The piles shall be free from ring shakes, unsound spots or knots and short bends. All knots shall be trimmed close to the body and the piles peeled soon after cutting. The piles shall have a uniform taper such that a line drawn from the center of the top to the center of the tip shall be within the body of the pile. No piles shall be driven without the acceptance of the Engineer.

2. Creosoting

Creosoting of piles shall be by the Pressure Process and in accordance with the Philippine Standard Association, Inc. Standard Specification for preservation of Timber Piles by pressure Process, (PHILSA 168:1978).

a. Conditioning

1)	Air Seasoning	-	Seasoning to a moisture content of 35% and below
2)	Streaming Temperature	-	118 C, maximum
	Duration	-	20 hours, maximum

3) Boultonizing Temperature - 110 C, maximum
Duration - 20 hours, maximum
Vacuum - 550 mm Hg, maximum

4) Heating in Preservative - 104 C, maximum
Duration - no time limit

b. Treatment

1) Pressure - 10.5 kg/cm², minimum
14 kg/cm², maximum
Duration - 3 hours, maximum

2) Expansion Bath Temperature -104 C, maximum
Duration - as required

3) Final Steaming Temperature -118 C, maximum

c. Retention

Creosote retention shall be 320 kg/m^3

d. Sampling Zone

Sampling zone shall be 0 to 75mm from the surface of each timber pile.

e. Determination of Penetration

All boring shall be taken between the butt and tip of each pile. Penetration of creosote preservative shall be 100% of the sapwood or not less than 25mm from the surface of the pile.

All holes made for determining penetration of preservative shall be filled with tight-fitting treated plugs.

3.3.3 GENERAL REQUIREMENTS

Pile Length: Pile lengths shown on the Drawings are for estimating purpose only and are based upon probable lengths remaining in place in the completed structure.

1. Test piles of length shown on the drawings shall be driven at such points as designated by the Engineer that they may be left in place, cut off, and become a part of the permanent structure. From their performance under driving, the Engineer will determine the lengths of piles required.

This pile shall be longer than ordinary piles shown in the pile schedule to provide for contingencies due to variations in soil behavior. Pile penetration observed per blow of the hammer shall be recorded. If refusal is observed while the required penetration is not yet obtained, the Contractor shall continue driving the pile with the aid of water jets. Water jets shall be carried out in all respect with rigorous control and not to detriment the surrounding ground or any part of the Works.

If necessary, test pile/s shall be spliced and redriven until the bearing power and penetration are acceptable to the Engineer.

2. Lengths of regular piles shall be computed by the Hiley Formula or other formulas accepted by the Engineer.

   The above shall not be construed to mean that driving may stop when such penetration as shown on the plans has been secured, but that driving shall continue in every case until the total penetration obtained is satisfactory to the Engineer, regardless of the fact that sufficient bearing capacity as determined by the formula may be obtained at a lesser depth.

3.3.4 TESTING OF MATERIALS

1. Reinforced Concrete Piles and Concrete Sheet Piles

   The requirements regarding testing of concrete and reinforcement used in reinforced concrete piles and sheet piles shall be in accordance with Section 3.2, “Concrete Works”.

   However, the Engineer may conduct the necessary testing at the approved fabricator’s casting yard whenever he considers necessary. Tests shall be carried out at the Contractor’s expense.

2. Steel Pipe Piles and Steel Sheet Piles

   The Contractor shall submit to the Engineer three (3) copies of test reports by the approved steel mill certifying that the steel pipe pile or steel sheet pile meets the requirements specified in these technical specifications.

3. Timber Piles

   The Contractor shall submit to the Engineer three (3) copies of the test reports certifying the timber pile meets the specified requirements in accordance with the Standard Specifications for preservation of Timber Piles by pressure Process.

3.3.5 STORAGE AND HANDLING

1. When raising or transporting piles, the Contractor shall provide slings or other equipment to avoid any appreciable bending of the pile or cracking of the concrete. Pile materials damaged in handling or driving shall be removed from the site and replaced by the Contractor at his expense.

   Concrete piles shall be so handled at all times as to avoid breaking or chipping of the edges.

   Before delivering steel pipe piles to the construction site, they shall be inspected as to external appearances, shapes, and dimensions in accordance with ASTM A 252, Grade 2 or its equivalent.

2. Piles may be stored in open air but on wooden sleepers to be placed in a manner so as not to cause excessive bending.

3. Piles shall be stacked on a stable yard and shall not be stacked more than three (3) tiers high.

3.3.6 PILE DRIVING

1. Uncapped pile heads shall be protected against damage by the use of appropriate pile driving caps and/or cushions to centralize the driving impact.

2. The pile headers shall be of sufficient rigidity and fixity to hold the pile firmly in position and true alignment during driving operations.

3. The procedure and the data for the hammer to be used in driving shall be submitted to the Engineer prior to starting the driving operation. The Engineer's approval of the pile driving equipment will not release the Contractor from the responsibility for the adequacy of selected equipment.

   A steam or diesel pile hammer shall be used for driving reinforced concrete and tubular steel piles. For timber piles a gravity or drop hammer may be allowed.

   When steam hammers are used, the energy delivered in the pile being driven shall not be less than 5,300 ft.-lbs. The total energy developed by the hammer shall not be less than 6,000 ft.-lbs. per blow. Self-powered or diesel hammers of corresponding energy may be used in lieu of steam hammer for the particular pile/s being driven. For gravity hammers, the weight of ram shall be at least 50% of the weight of the pile being driven but should not be less than 907 kg. (2,000 lbs) for piles weighing 1,814 kg. (4,000 lbs) or less.

The fall of hammer shall not exceed 6 m (19.18 ft) and shall be of uniform frequency to avoid injury to the piles.

Piles driven shall be held firmly in position in axial alignment with the hammer by means of leads of adequate length. Approved cushions shall be provided to the pile butts.

4. Piling shall commence from the interior outward as the lateral displacement of soil may influence driving and heaving of already driven piles.

5. Every effort shall be made to drive continuously without interruption.

6. The Contractor shall repair all damages to piles during driving. A minimum cut-off allowance, not less than 600 mm shall be provided for all corrections at in-place splices and at all the pile heads for removal after completion of the driving.

   Any pile damaged by improper driving or driven out of its proper location, or driven out of elevation fixed on the plans, shall be corrected correspondingly at the Contractor's expense by any of the following methods:

   a. Withdrawal of the pile and replacement by a new pile,
   b. Driving a second pile adjacent to the defective one, or
   c. Splicing an additional length

   The method to be adopted in each case shall be at the discretion of the Engineer.

7. The piles which have been uplifted after being driven shall be re-driven to the required penetration after completing other activities in the nearby areas. As heaving is anticipated, survey benchmarks should be established and elevations must be taken of the driven piles adjoining the piles being driven to avoid pile displacement affected by the swell rise of sub-soil structures.

8. Splicing of piles if any, shall be subject to the Engineer's approval. The Contractor may propose splicing procedures.

3.3.7 OBSTRUCTION

Where boulders or other obstructions make it impossible to drive certain piles in the location shown and to the required bearing strata, the Engineer may order additional pile or piles driven at other suitable location after consultation with the Structural Engineer.

3.3.8 PILE DRIVING RECORDS

3.3.8.1 R.C. PILES

Pile driving records shall be prepared for each pile on Form No. 001 attached at the end of this Section and shall be submitted to the Engineer two (2) signed typewritten copies daily. The records shall show the number of blows per 0.75 m. penetration from the pile tip, attain a depth of 5.0 m., the penetration under the last 10 blows, and the calculated safe load according to the Hiley Formula or other formula acceptable to the Engineer.

3.3.8.2 STEEL PIPE PILES

Driven Piles

1. Pile Details (for each pile)

    a. The date, start time and finish time of driving the pile.
    b. Date of casting and concrete quality.
    c. The location number, identification number, pile dimensions and specified rake.
    d. The seabed elevation.
    e. The pile toe elevation.
    f. Elevation of soil inside the pile upon completion of each driving operation, and hence the drawdown of the soil plug.
    g. Elevation of the pile head after driving.
    h. Actual length of the pile, cut-offs and extensions.
    i. Deviation of the pile from the true location, orientation and rake.
    j. Pile penetration (before and after driving).

2. Equipment Used

    a. The make, model, type, size and efficiency of hammer and its stroke and characteristics including rated energy and operating speed.
    b. Weight of hammer and ram.
    c. Type, thickness and condition of capblock and pile cushion.
    d. Weight and dimensions of drive cap and follower.
    e. For gravity and single-acting hammers: the height of drop
    f. For double-acting hammers: the frequency of lows.

3. Driving Details

   a. The number of blows per 250 mm penetration.
   b. The final set of mm/blow for the last ten blows and the actual stroke of the hammer.
   c. The results of the Pile Driving Analyzer and CAPWAP analysis showing total resistance, friction and tip resistance, maximum pile press and effective pile length.
   d. Unusual behavior of hammer or pile during driving.
   e. Details of interruption in driving, including "set up" time.
   f. Details of redriving.

   In case a pile in-situ, then the record shall also show the length of extension, time of welding, results of non-destructive tests on the weld, date and time of restarting pile driving and details of protective coating of the weld and adjacent area.

3.3.9 PERMISSIBLE TOLERANCE

1. Position error in plan : ± 100 mm

2. Cut-off elevation : + 10 mm

3.3.10 NOT PERMITTED

Pulling the head of the pile to attain the design position shall not be permitted.

3.3.11 MEASUREMENT AND PAYMENT

3.3.11.1 R.C. SHEET PILING

1. The quantity of precast R.C. sheet piles wall to be paid for shall be measured by the linear meter or a fraction thereof-cast in accord with the contract and as ordered, specified and accepted by the Engineer.

2. Driving of R.C. sheet piles which consist of regular and corner RC sheet piles including grouting of gap between piles, to be paid for shall be measured by the linear meter or a fraction thereof placed in accord with the Contract and accepted in completed work, excluding pile length cut from driven piles to adjust to the cut-off elevations and as required and shown in the drawing.

3. In case of sheet piles not driven to full length due to unforeseen obstruction, the Contractor shall be compensated for the whole cost of driving the full length of piles without additional cost for the cutting of pile to meet the desired cut-off elevation.

4. Accessories

   a. Supply and installation of structure steel walings shall be measured by weight in kilograms of waling materials supplied and installed. The unit price shall include loading, transportation, unloading, storage, cutting connection, fabrication at the site, and installation of waling. The unit price shall also include bolts, nuts, and other fittings as shown on the drawings.

   b. Supply and installation of tie rods shall be measured per sets of each dimension of tie rods. The unit price shall include loading, transportation, unloading, fabrication, storage at the site, and installation of tie rods. The unit price shall also include fittings and joints as shown on the drawings. Temporary support of suspended tie rod shall be incidental to the work and shall not be measured separately.

5. Measurement and payment for concrete work for concrete coping and concrete anchor block shall be in accordance with Section 3.2, Concrete Works.

3.3.11.2 PRESTRESSED CONCRETE PILES AND PRECAST REINFORCED CONCRETE PILINGS WORKS

1. The quantity of Prestressed Concrete Piles and Precast R.C. piles, to be paid for shall be measured by the linear meter or a fraction thereof as ordered cast in accordance with the Contract and as specified and accepted by the Engineer.

2. Driving of Prestressed concrete piles and Precast R.C. piles to be paid for shall be measured by the linear meter or a fraction thereof placed in accord with the contract and accepted in completed work up to desired cut-off elevation as shown on the drawings.

3. Chip-off/cut-off elevation: The quantity to be paid shall be the actual number per unit of driven piles chipped-off and cut-off to the desired elevation as shown on the drawings and approved by the Engineer. Payment shall include the cost of disposal, labor, tools, equipment and other incidental expenses necessary to complete the work.)

4. If splicing is necessary, cost of splicing shall not be paid separately but included under pay-item for driving of piles.

3.3.11.3 STEEL PIPE PILES AND STEEL SHEET PILES

1. The quantity of steel pipe piles and Steel sheet piles, to be paid for shall be measured by the linear meters or a fraction thereof as ordered in accordance with the Contract and as specified and accepted by the Engineer.

2. Driving of steel pipe piles and Steel sheet piles to be paid for shall be measured by the linear meter or a fraction thereof placed in accord with the Contract and accepted in completed work up to desired cut-off elevation as shown on the drawings.

3. There will not be any particular payment for cutting of steel pipe piles and steel sheet piles to adjust to desired cut-off elevation.

4. The cost is included in the driving price as specified above.

5. If splicing is necessary, cost of splicing shall not be paid separately but included under pay-item for driving of piles.

6. All concrete and reinforcement works shall not be paid separately but shall be included under concrete works of structures where concrete filled steel pipe piles shall be installed. No additional payment shall be made for any incidental works that may arise to comply with the requirements specified under Sub-section 3.3.2.4.2 since such expenses incurred shall be included under above-mentioned pay-item for concrete works.

3.3.11.4 TIMBER PILES

1. Timber piles shall be measured and paid for in lineal meter of materials shall be measured by the linear meters or a fraction thereof as ordered in accordance with the Contract and as specified and accepted by the Engineer.

2. Driving of steel pipe piles and Steel sheet piles to be paid for shall be measured by the linear meter or a fraction thereof placed in accord with the Contract and accepted in completed work up to desired cut-off elevation as shown on the drawings.

3. There will not be any particular payment for cutting of steel pipe piles and steel sheet piles to adjust to desired cut-off elevation.

4. The cost is included in the driving price as specified above and as shown on the Drawings and supplied and delivered on site.

3.3.11.5 TEST PILES

The supply and driving of test piles shall be measured per pile tested at the site and accepted by the engineer. Payment for test piles will be made at the contract unit price by the number of each test pile actually placed and accepted in the final position. The unit price will be full compensation for furnishing all materials, labor, tools, test, and other incidental expenses necessary to complete the work.

PILE RECORD

Sheet No. _____
Date _____

Ref. Elev. _____

Form No. 001 Job No. _____ Plant _____ Water Depth _____

HAMMER DATA PILE DATA

	Pile No.	Butt Dia	Tip Dia	Length	Ground Elev.	Cutoff Elev.	Final Tip Elev.

Make _____
Model _____
Energy _____
Blows/Min _____

DRIVING RECORD

Tip Elevation (m)	Depth of Penetration (m)	Total Blows	Blows per 30 cm	Length of Stroke (m)	Remarks

Note: Indicate by number in remarks column, thus 1, 2, etc. any important information e.g. jetting, delays, breakage, out of plumb, obstruction, etc.

Contractor : _____

3.4 CAUSEWAY

3.4.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements" and shall apply to this section, whether herein referred to or not.

3.4.1.1 SCOPE OF WORK

This Specification covers the construction of the causeways for the Project. The works to be carried out shall be, but not limited to the following:

1. Supply and laying of core rocks
2. Supply and laying of secondary rock - one (1) or two (2) layers
3. Supply and laying of armour rock - one (1) or two (2) layers
4. Supply and laying of quarry run filler to fill the voids of top core rocks.
5. Placement of concrete curb
6. Construction of concrete pavement
7. Toe Protection

3.4.1.2 SETTING OUT WORKS

1. Topographic/Hydrographic Survey:

   Prior to commencement of the work, the Contractor shall conduct a topographic/hydrographic survey in conjunction with the Engineer's instructions. This survey shall form the basis for future quantity measurements.

2. The Contractor shall set out works and be solely responsible for accuracy of such setting out.

   Prior to placement of any material, the Contractor shall establish construction markers to clearly define the horizontal and vertical limits of works.

3. Applicable requirements under Section 2.3 shall apply to this Section.

3.4.2 MATERIAL REQUIREMENTS

1. Concrete work and reinforcement work (where required) for curbs shall be in accordance with Section 3.2, "Concrete Works", where concrete compressive strength (fc') = [25] MPa.

2. Concrete works for payment shall be in accordance with Division 5.0, "Roads and Pavements."

3. All rocks to be used shall be angular, hard, durable and not likely to disintegrate in seawater. Rock layers to be installed should more or less be 'global in shape", "angular in surface" and should avoid "river run rocks". Rocks that are sub-angular may be subject to the approval of the Engineer. Rounded or well rounded pieces will not be accepted.

4. All rocks shall have a minimum unit weight of 2,650 kg per cubic meter (specific gravity 2.65) of solid materials when measured dry.

5. Rocks with specific gravity higher than the above specified is preferable and will readily be accepted. But no adjustment (increase) in the contract price will be made on this account.

6. Rocks of the primary cover layer should be sound, durable and hard. It should b free from laminations, weak cleavages, and undesirable weathering, and should be of such character that it will not disintegrate from the action of the air, seawater, or in handling and placing. All stone should be angular quarry stone.

7. The greatest dimensions individual rock unit should be no greater than three times the least dimensions.

8. All rocks should conform to the following test designations: Apparent specific gravity, ASTM C-127 and abrasion, ASTM C-131.

9. Weight of the individual pieces of rock.

    a. Armour Rock

        Refer to the Drawings for the required sizes of the armour rocks for the 1st and 2nd layers.

    b. Core Rock

        Refer to the Drawings for the required sizes of the core rock.

        Core rock bedding shall be reasonably well graded in weight between the minimum and maximum sizes.

c. Quarry run filler shall consists of pieces of varied sizes of small rocks from quarry (minimum of 10% of the weight of core rocks) to fill the voids of top rocks prior to the placing of subbase course.

3.4.3 EXECUTION

1. Construction method of concrete pavement shall be in accordance with Division 5.0 "Roads and Pavements".

2. The core rock shall be placed at convenient height and width for each delivery of materials.

3. Armour rocks shall cover the sides and berm of the causeway.

4. Armour rock fillers shall not be less than one half (1/2) of the weight of the armour rock.

5. Armour rocks shall be placed with the longitudinal section perpendicular to the slope and longitudinal section of the causeway.

6. No cutting, spalling or coursing of the stones shall be allowed, but it is expected that the work shall be done in a workmanlike and skilled manner, which implies careful selection of stones.

7. The armour rock fillers shall be wedged firmly in between the facing of armour rocks so that the latter shall be in the stable position.

8. Armour rocks shall be placed individually by crane equipped with suitable bucket or by other means acceptable to the Engineer.

9. Secondary rocks of specified sizes and weights could be dumped along the size slopes of the structure after the core rock has been placed up to required elevation as shown on the Drawings. Utilizing a crane, the materials can be placed individually maintaining the alignment along the side slopes.

10. The rock causeway can be constructed by any method acceptable to the Engineer. Prior to the start of work, the Contractor shall submit to the Engineer for approval his method and sequence of construction. The Engineer approval of the method and sequence of construction shall not release the Contractor from the responsibility to achieve the satisfactory implementation of the work.

11. Quarry run fillers shall be wedged firmly in between the facing of top core rocks at minimum depth of 300 mm below the neat line and elevation so that the latter shall be in stable position.

12. Permissible Tolerance

    a. Core Rock

Slope	:	plus or minus 0.30 m
Elevation	:	plus or minus 0.30 m

    b. Armour Rock

Slope	:	plus or minus 0.30 m
Elevation	:	plus or minus 0.20 m

3.4.4 QUARRY SITE AND ROCK QUANTITY

Refer to Section 3.5 of these Specifications.

3.4.5 MEASUREMENT AND PAYMENT

1. Quantities of core rocks, secondary rocks and armour rocks to be paid for shall each be measured in cubic meters. The volume to be paid for shall be measured by taking cross-sections of the sea bed on the site of work at 10-meter intervals or closer, if necessary, immediately before placing the rock. The volume of the different classes of rocks shall then be computed based on the neat lines and elevations shown on the Drawings and on the foregoing data, with probable settlement as shown in the Drawings.

   Quarry run fillers shall not be measured separately as the payment for quarry run fillers shall be included under pay-item for top rocks.

2. Unless otherwise directed by the Engineer, measurement for settlement shall be done by providing a 28mm diameter x 6.0m round bar calibrated rod attached or welded to the center of a one (1) m x one (1) m steel plate at 6mm thick. Measurement device shall be installed at 20.0m interval prior to laying of 1st stage rock.

3. Measurement and payment for concrete and reinforcement works for the construction of R.C. Curb shall be in accordance with Section 3.2, "Concrete Works."

3.5 REVETMENT

3.5.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements" and shall apply to this Section, whether herein referred to or not.

3.5.1.1 SCOPE OF WORK

This Specification covers the construction of all revetments for the Project. The works to be carried out shall be, but not limited to the following:

1. Supply and laying of erosion protection mat (filter fabric) as shown in the drawings. Refer to Section 3.8 “Reclamation” of these Specifications.

2. Supply and laying of core rocks as shown in the drawings.

3. Supply and laying of secondary rocks as shown in the drawings.

4. Supply and laying of armour rock as shown in the drawings.

5. Casting of reinforced concrete curbs as shown in the drawings.

3.5.1.2 SURVEY AND SETTING OUT

1. Topographic/Hydrographic Surveys: Prior to commencement of the Work the Contractor shall conduct a topographic/hydrographic survey in conjunction with the Engineer instructions. This survey shall form the basis for future quantity measurements.

2. The Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal limits of Works.

3.5.2 MATERIAL REQUIREMENTS

1. Type of Revetment (as shown in the drawings).

2. Concrete curb shall be fabricated in accordance with Section 3.2 - Concrete Works. Use fc' = [25] MPa.

3. The weight of individual pieces may exceed the maximum specified in the drawings by up to 25 percent.

4. Rock works shall be in accordance with Section 3.4, “Causeway.”

3.5.3 EXECUTION

1. Revetments may be constructed by any method acceptable to the Engineer. Prior to start of work, the Contractor shall submit his method and sequence of construction for approval to the Engineer. The Engineer's approval of the method and sequence of construction shall not release the Contractor from the responsibility to achieve the satisfactory implementation of the Work.

2. Core rocks shall be placed as uniformly as possible by controlled dumping or by other means acceptable to the Engineer.

3. Armour rocks and secondary rocks where required or as indicated in the Drawings shall be placed individually by a crane equipped with a suitable bucket or by other means acceptable to the Engineer.

4. Permissible Tolerance

   a. Core Rock:

      Alignment : plus or minus 0.30 m
      Elevation : plus 0.20 m

   b. Armour Rock:

      Alignment : plus or minus 0.30 m
      Elevation : plus 0.20 m

   c. Reinforced Concrete Curb

      Alignment : plus or minus 0.05 m
      Elevation : plus 0.05 m

3.5.4 QUARRY SITE AND ROCK QUANTITY

1. It is the Contractor's responsibility to make necessary surveys / investigations on quarry sites applicable to the Works, taking into consideration the nature of the rock works required under the Contract such as required quality, total quantity and daily required quantity, transportation method and route etc.,

2. The Contractor shall submit data on characteristics of proposed quarry sites together with the location of sites, test results of their products and samples for the approval of the Engineer.

3. When the Contractor intends to operate a quarry for the Works, the Contractor shall take all the responsibilities in connection with its operation including, but not limited to, obtaining all necessary permits and approvals, payment of safety measures or like (if any), provisions and maintenance of safety measures and temporary access roads, all of private and public roads and temporary jetties to be used to transport quarried materials and the compliance with all regulations etc. required by the authorities having jurisdiction over any part of the operation.

   Should any explosive be used in the quarry operations, the Contractor shall be responsible to meet laws and regulations, wherever applicable, established by the Local Government and Central Government Department concerned.

4. Despite the Engineer's previous approval of the natural rock and borrow pits, the Engineer reserves the right to suspend any operation in connection with the rock, if, in its opinion, such rock is not suitable for the work. In such case, the Contractor shall comply with the Engineer's instructions.

3.5.5 MEASUREMENT AND PAYMENT

1. Quantities of core rock, rubble, secondary rock, armour rock and rock fragments to be paid for shall each be measured in cubic meters. The volumes to be paid for shall be measured by taking cross-sections of the sea bed on the site of work at 10 meter intervals or closer, if necessary, immediately before placing the rock. The volumes of the different classes of rock shall then be computed based on the neat lines and elevations shown on the drawings and on the foregoing data, with probable settlement as shown in the drawings.

2. Unless otherwise directed by the Engineer, measurement for settlement shall be done by providing a 28mm diameter x 6.0m round bar calibrated rod attached or welded to the center of a one (1) x one (1) m steel plate at 6mm thick. Measuring device shall be installed at 20.0m interval prior to laying of 1st stage rock.

3. Concrete works for reinforced concrete curb shall be measured and paid for by the length in linear meters of each type of curb along its front face at the finished grade elevation. Reinforcing steel bars for R.C. curb shall be measured in accordance with Section 3.2, “Concrete Works”.

3.6 DREDGING

3.6.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements" shall apply to this Section whether herein specified or not.

3.6.1.1 SCOPE OF WORK

Dredging of the sea bed where required (where shown on the drawings).

3.6.1.2 GENERAL REQUIREMENTS

1. If dredged materials are to be used for reclamation, separate payment will not be made for dredging. These costs shall be considered as incidental to and part of the reclamation works.

2. A marine survey of the dredged area inside the port shall be carried out by the Contractor and monitored by the Engineer after dredging stages are completed. In the event the survey reveals that any finished area was under-dredged, the Contractor shall complete that portion of the dredging.

    a. Upon assumed completion of all the dredging operations inside the project area, the Contractor shall sweep the dredged areas within the limits stated in the specification to ensure that no shoals higher than the specified depth exist. The Contractor shall remove all shoals so discovered.

    b. The Contractor shall be responsible during the Work for all horizontal layouts and vertical profiling of the dredging work inside the port.

3.6.2 CHARACTERISTICS OF MATERIALS

Information regarding the characteristics of soils which may be encountered in the performance of this Contract is shown in the Tender Drawings for review.

3.6.3 INTERFERENCE WITH NAVIGATION

1. The Contractor shall familiarize himself with vessel movement and fishery activities in the area affected by dredging operations. The work shall be in a manner that will not impede navigation including movement of vessels at adjacent wharves or interfere with fishing operations.

2. The Contractor shall coordinate dredging works with Harbor Authorities, port users and other Contractors.

3.6.4 NATURE OF MATERIALS TO BE DREDGED

1. Refer to borehole logs as indicated in the drawings for characteristics of material to be dredged at each location. The data is made available for information only and the Engineer does not warrant its accuracy at any location other than the referenced borehole.

2. After examination, determine properties of materials to be dredged, the most suitable method and equipment to be employed including disposal of dredged spoil.

3.6.5 ASSISTANCE TO THE ENGINEER

On request of the Engineer, furnish use of such boats, equipment, labor and materials forming ordinary and usual part of dredging plant as may be reasonably necessary to inspect and supervise work.

3.6.6 EXECUTION

1. Dredging shall consist of all underwater excavation/removal of all materials.

2. The equipment to be used in dredging and filling operations is subject to approval by the Engineer.

3. Dredging shall be carried out only in the locations and in the order as approved by the Engineer, and only within limits shown on the drawings or as shown on drawings prepared by the Contractor and approved by the Engineer.

4. Approved dredged materials is to be deposited in areas allocated for port developments whereas dredged material, unsuitable for fill, shall be deposited in areas approved by the Engineer.

5. The dredging and the disposal of the dredged material including placing and operation of equipment and conveying pipes, and transportation of dredged material to disposal sites shall be done without interference with port operations.

6. Stones which may be encountered in the materials to be dredged, and having a smallest dimension of at least 300 mm may be buried in the seabed. No part of buried stones must extend above a level 500 mm below the dredging levels indicated. Stones smaller than those mentioned above may be left on the seabed of partly embedded provided that the stones are below the dredging levels indicated.

3.6.7 PREPARATION

1. The Contractor shall mark floating equipment with lights in accordance with International Regulations for Prevention of Collision at Sea and maintain a radio watch on board.

2. The Contractor shall place and maintain buoys, markers and lights required to define work and disposal areas.

3. The Contractor shall layout work from baseline established by the Engineer. He shall be responsible for accuracy of work relative to established baseline and shall provide and maintain equipment as normally required for accurate dredging control.

4. The Contractor shall establish and maintain tide gauges in order that proper depth of dredging can be determined. Locate gauges so as to be clearly visible.

5. The Contractor shall establish and maintain on-land targets for location and definition of designated dredge area limits. Targets to be suitable for control of dredging operations and locating soundings. Remove targets on completion of work.

3.6.8 DREDGING OF SLOPES FOR DYKES

1. Details on temporary slopes, dredged for the execution of Dykes, to be provided by the Contractor and shall be included in their construction method.

2. The work shall be measured and approved by the Engineer before any sand or stone material is placed unless directed otherwise by the Engineer.

3.6.9 DREDGING OF BASINS AND APPROACH CHANNEL

1. The lines shown on drawings indicate the boundaries of the dredging. Carry out dredging to a depth equal to or below the specified level, with a maximum permissible over-dredging of 400 mm below the specified level.

2. Cut side slopes between original seabed and dredged levels as shown on the drawings unless otherwise authorized in writing by the Engineer.

3. The Engineer shall verify that the dredging has been carried out as required. In general, the dredged depths shall be checked by Echo-Sounder recording. The survey pattern and method, and the Echo-Sounder type shall be approved by the Engineer. In areas where additional precision is required, the verification shall be carried out by

suspending a 6 to 10m long straight edge from a vessel, so that the underside of the straight edge is horizontal and level with the indicated dredging level. A sounding rod shall be connected to each end of the straight edge and shall extend vertically above the water surfaces in order to determine the vertical movements of the straight edge.

4. The vessel shall be moved slowly across the area in a manner which will ensure that the total area is covered by the straight edge. Areas where the straight edge cannot pass freely shall be marked and dredged and the check shall be repeated.

5. In case of excessive overdredging the Contractor shall backfill the overdredged areas and/or take all necessary measures as directed by the Engineer without cost to the Engineer.

3.6.10 DREDGING IN FRONT OF WATERFRONT STRUCTURE

1. In addition to the requirements of Sub-section 3.6.9, the following shall apply for dredging carried out in front of waterfront structure.

2. The maximum permissible overdredging is 200 mm.

3. Dredging may proceed unrestricted in accordance with Section 3.6.9 and provided that in the opinion of the Engineer, a stable, temporary slope to the edge of the strip is maintained.

4. The Contractor shall be fully responsible for the safety of the permanent structures in the temporary phases of construction. Temporary and permanent bench marks and reference points shall be established as directed by the Engineer for recording immediate and future movements of waterfront structures.

5. In case of excessive overdredging, the Contractor shall on his account backfill the overdredged areas and/or take all necessary measures as directed by the Engineer.

3.6.11 SPOILS FROM DREDGING

1. All dredged material, which in the opinion of the Engineer is unsuitable for fill, shall be dumped at the spoil area indicated on the drawings or into the open sea of depth of at least 20 m MLLW and at least 500m away from the project site.

2. Deposit dredged material suitable for fill in accordance with Sub-Section 3.8, "Reclamation."

3. All dredged material, which in the opinion of the Engineer, is suitable for fill but is in excess of the quantities required for the present project shall be deposited as directed by the Engineer.

3.6.12 ARTICLES OF VALUE

Disposal of all articles of value discovered on the site of the works shall be in accordance with appropriate provision of Conditions of Contract.

3.6.13 WRECKS

Should any wreck or obstruction be found, other than that caused by the Contractor, the Contractor is to comply with such instructions as the Engineer may issue regarding its removal.

3.6.14 MEASUREMENT AND PAYMENT

1. Before dredging in any location and in accordance with the approved schedule, the Contractor shall perform a new sounding survey over the area to be dredged and its adjoining areas in accordance with Division 1, "General Requirements."

2. On completion of dredging in any location, perform a sounding survey in accordance with General Requirements to verify compliance with Contract and as a basis for measurement of dredging quantities.

3. Do not disturb or displace rip-rap or armour protection during dredging. Reset or replace any disturb or displaced materials without additional compensation or time extension.

4. Only materials excavated above dredged line and within side slope specified or indicated in the drawings or authorized in writing by the Engineer will be measured for payment.

5. Dredging will be measured in cubic meters, in place measurement determined from approved soundings - taken before and after dredging.

6. Dredged volumes by section of work shall be considered for inspection and acceptance.

7. Supply all equipment and assistance needed for inspection and measurement by the Engineer. Cost of such assistance is incidental to dredging work and shall not be measured for payment.

8. Disposal is incidental to dredging work and will not be measured for payment.

9. No additional cost shall be charged to the Engineer where excavation of corals, bedrocks or hard materials has been encountered by the Contractor.

3.7 SAND REPLACEMENT

3.7.1 GENERAL

Works under these Contract shall be in accordance with Division I, "General Requirements" and shall apply to this Section, whether herein referred to or not.

3.7.1.1 APPLICATION

This section shall apply to the sand replacement work to be carried out under the Contract.

3.7.1.2 GENERAL PROVISION

1. The area, formation levels and slopes of the volume to be replaced shall be as indicated on the drawings. The Contractor shall replace existing marine soft clay with the specified materials, in other words backfilling of specified material into the empty space left after dredging operation or underwater excavation.

2. The provision of Sub-section 3.5.4, "Quarry Site and Rock Quantity" shall also apply to this Section.

3.7.2 MATERIAL REQUIREMENTS

Sand shall be well graded and with less than 20% of its weight or particles classified finer than sand. The sample and its sieving result shall be submitted to the Engineer for approval prior to commencement of the laying works.

Notwithstanding any or all of the requirements of these Specifications, the Engineer shall reject any sand which he considers to be unsuitable and the Contract shall remove such rejected sand from the Site and replaced it with an approved quality at no cost to the Employer.

3.7.3 BACKFILLING WORKS

1. The work methodology and sequence of replacement works shall be submitted to the Engineer for approval prior to the commencement of work.

2. The dredging depths and slope for the work shall be undertaken as shown on the drawings, prior to the commencement of backfilling.

3. No dredged slope and bottom shall be exposed longer than seven (7) calendar days before backfilling with the replacement material takes place.

4. Interim slope of fill shall not be greater than the slope indicated on the drawings to ensure stability of bottom layer against slope failure.

3.7.4 SURVEY WORKS

Prior to sand replacement, the Contractor shall perform a sounding survey over the area to be filled to provide a basis for measurement of fills. Sounding work shall be done in conjunction with and to the approval of the Engineer, in accordance with Section 2.3 of these specifications.

On completion of underwater fill in any one section, the Contractor shall perform a sounding survey over the filled area to verify that the fills have been placed to the section shown on the drawings.

Sand replacement shall be inspected and measured by the Engineer as the work proceeds. The Contractor shall attend such inspection and measurement operations and make records as he requires.

The Contractor shall supply all equipment and assistance needed for inspection and measurement and shall plot results on drawings for approval, as required by the Engineer.

Work covered before inspection and approval of drawings shall not be eligible for payment until satisfactory re-execution in accordance with this Section.

3.7.5 MEASUREMENT AND PAYMENT

Measurement and payment shall be made in cubic meters of material in-placed to the neat lines and elevations. Material outside the neat lines and elevations will not be measured for payment.

Unit Price shall constitute full payment for all labor, material and equipment and all incidental works necessary to complete the work.

3.8 RECLAMATION AND FILL

3.8.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements" and shall apply to this Section, whether or not referred to herein.

3.8.1.1 SCOPE OF WORK

The area to be reclaimed shall be as indicated on the Drawings.

The work includes furnishing of all labor, materials and equipment required to complete/finish the reclamation and filling the area in accordance with the Drawings and the Specifications.

The following major items of work are included:

1. Supply and fill of suitable materials to places required to form the land reclamation areas as shown in the drawings.

    a. Compaction of fill materials.

    b. Supply and placing of filter fabric.

2. The work may also include the construction of temporary dike or structure to enclose the reclamation material before the completion of a permanent waterfront bulkhead.

3. Soil Consolidation (if Necessary)

    The work shall include the soil consolidation by the use of prefabricated vertical drain to be carried out under this Contract.

The Contractor shall include in his unit prices allowances to cover all risks for any contingencies, except noted otherwise, that may arise during the execution of the works.

3.8.1.2 GENERAL REQUIREMENTS

The Contractor shall not commence filling any area until that area has been surveyed by the Contractor and the survey results are accepted by the Engineer.

The Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of such setting out the Contractor shall establish visible construction markers to clearly define horizontal limits of Works.

The Contractor shall keep all pavements and areas adjacent to and leading to/from the Site, clean and free from mud, dirt and debris.

The Contractor shall not interfere with shipping and navigation or other traffic during execution of the Works.

3.8.2 MATERIAL REQUIREMENTS

1. Filling Materials

   a. General

      All sources of filling materials shall be approved by the Engineer.

      Appropriate quantities of sample of all materials to be used in the Works shall be submitted for acceptance and approval by the Engineer thirty (30) days before the commencement of work.

      General filling shall consist of approved material from approved sources of suitable grading obtained from excavation, quarries or borrow pits, without excess fines, clay or silt, free from vegetation and organic matter.

      Sample of approved materials shall be kept/stored in the field for ready reference/comparison of the delivered materials.

      The Contractor shall insure that adequate quantities of required materials that comply with the specifications and quality approved by the engineer are available at all times.

   b. Fill Materials other than Dredged Materials

      Fill materials for reclamation purposes other than dredged materials shall be pit sand, quarry run, gravel or mine tailings. The fill material shall be of the same quality or better, as approved by the Engineer and called for in dredged material specification.

   c. Dredged Materials

      Hydraulic fill shall be well-graded gravel.

   d. Types of Filling Materials

      1) Selected Fill Materials

         The material shall not have high organic content and shall meet the following requirements:

(i) Not more than 10 percent by weight shall pass the No. 200 sieve (75 microns).
(ii) Maximum particles size shall not exceed 75 mm.
(iii) The fill materials shall be capable of being compacted in the manner and to the density of not less than 95%.
(iv) The material shall have a plasticity index of not more than 6 as determined by AASHTO T 90.

2) Sand and Gravel Fill:

The materials shall be composed of 50% sand and 50% gravel and shall be free from rocks, wood, scrap, vegetables, and refuse. The materials shall not have organic content and the maximum particle size shall not exceed 100mmm. Source of materials shall be river or mountain quarry.

2. Soil Consolidation: Prefabricated Vertical Drain

The Prefabricated Vertical Drain (PVD) shall be of newly manufactured materials and shall consist of a high density polyethylene core with a cuspated profile (to ensure high strength and drainage) enclosed in a non-woven spunbonded polypropylene or polyester fabric filter jacket. The jacket shall allow free passage of pore water to the core without loss of soil material or piping. The core shall provide continuous vertical drainage.

The PVD shall be band-shaped with an aspect ratio (width divided by thickness) exceeding 50.

Refer to the table below for the required properties of the preferred product specifications:

Properties	*Unit*	*Test Method*	*FD5*
Core			
Structure	-	-	Cuspated Profile
Material	-	-	HDPE
Compressive Strength	kPa	ASTM D 1621	> 450
Drain			
Weight	g/m	-	70
Width	mm	-	100
Thickness	mm	-	5
Discharge Capacity, qw			
@ i = 1, 10 kPa	m^3/s	ASTM D 4716	90 x 10 –6
@ i = 1, 350 kPa	m^3/s	ASTM D 4716	60 x 10 –6
Tensile strength	kN/100mm	ASTM D 4595	2.2
Elongation at 1 kN	%	ASTM D 4595	< 10
Filter			
Structure	-	-	Non woven
Material	-	-	Spunbond
Tensile Strength	kN/m	ASTM D 4595	Polyester
Permeability	m/s	ASTM D 4595	5.5
Permittivity	s-1	ASTM D 4491	1.0 x 10 -4
Apparent Opening Size	microns	ASTM D 4751	0.5
			< 75
Packing Details			
Roll Length	m	-	200
Roll Diameter	m	-	1.2 ± 5%
20ft container	m	-	40,800
40ft container	m	-	86,800

3.8.3 EXECUTION

1. Reclamation and Fill

    a. General: The Contractor shall be responsible for all ancillary earthworks that are necessary for the reception of the fill material and including, all spout handling, temporary dike or shoring construction where necessary, temporary protection to dikes in the sea and drainage of excess water.

The arrangements of these ancillary earthworks shall be laid out in consultation with the Engineer and to the Engineer's satisfaction and care shall be taken to minimize the loss of fill.

b. Replacement, backfilling and reclamation may be done by any method acceptable to the Engineer. Prior to start of Work, the Contractor shall submit his method and sequence of performing the works to the Engineer for approval. However, the Engineer's approval of the method and sequence of construction shall not release the Contractor from the responsibility for the adequacy of labor and equipment.

c. The Engineer shall approve the type of material to be used as fill prior to its placement. If the material is rejected, such material shall be deposited into areas designated or as directed by the Engineer.

d. When suction dredges are used, discharge pipework shall be arranged in conjunction with the Engineer's instructions and shall be such that by means of operating valves, material can be deposited to several places without altering the pipework or interrupting dredging. Where necessary vehicle overpasses shall be constructed by the Contractor.

e. Reclamation of fill material shall be placed in horizontal layers not exceeding 200mm (8 inches), loose measurement, and shall be compacted as specified before the next layer is placed. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density. Water shall be added or removed, if necessary, in order to obtain the required density. Removal of water shall be accomplished through aeration by plowing, blading, dicing, or other methods satisfactory to the Engineer.

Even though the thickness of layers is limited as provided above, the placing of individual rocks and boulders greater than 600 mm in diameter will be permitted provided that when placed, they do not exceed 1200mm (48 inches) in height and provided they are carefully distributed, with the interstices filled with finer material to form a dense and compact mass.

Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of earth. Lifts of material containing more than 25 mass percent of rock larger than 150mm in greatest dimension shall not be constructed above an elevation 300mm (12 inches) below the finished subgrade. The balance of the reclamation work shall be

composed of suitable material smoothed and placed in layers not exceeding 200mm (8 inches) in loose thickness and compacted as specified for embankments.

Dumping and rolling areas shall be kept separate, and no lift shall be covered by another until the necessary compaction is compacted.

Hauling and leveling equipment shall be so routed and distributed over each layer of the fill in such a manner as to make use of compaction effort afforded thereby and to minimize rutting and uneven compaction.

f. Field Compaction Test

Field Density tests to determine the percent of compaction of the material shall be conducted at elevation + 1.60 from MLLW. Compaction of each layer thereafter shall continue until a field density of at least 98 percent of the maximum dry density in accordance with AASHTO T/180. Method D has been achieved. In place density determination shall be made in accordance with AASHTO T191.

g. Permissible Tolerance

Elevation: plus 5 cm

2. Soil Consolidation

a. General

Prefabricated Vertical Drains (PVD) are artificially created drainage paths which can be installed by one of several methods and which can have a variety of physical characteristics. A PVD can be defined as any prefabricated material or product having the following characteristics:

1) ability to be installed vertically into compressible subsurface soil strata under field conditions,

2) ability to permit pore water in the soil to seep into the drain, and

3) a means by which the collected pore water can be transmitted up and down the length of the drain.

For a particular project, the performance of the PVD will be influenced by the soil conditions, type of PVD, equipment and construction technique (i.e. contractor). The installation of PVD shall be carried out by the Specialist contractor.

b. Installation of Pre-fabricated Drain

1) Installation Equipment

a) Prefabricated Vertical Drains (PVD) shall be installed with approved modern equipment of a type which will cause minimum disturbances to the subsoil during the installation operation and maintain the mandrel in a vertical position.

b) PVD shall be installed using a mandrel or sleeve which shall be inserted (i.e. pushed or vibrated) into the soil. The mandrel or sleeve shall protect the drain material from tears cuts and abrasion during installation and shall be retracted after each drain is installed.

c) To minimize disturbance of the subsoil, the mandrel or sleeve shall have a maximum cross-sectional area of approximately 65 cm^2 the mandrel or sleeve shall be sufficiently stiff to prevent wobble or deflection during installation.

d) The mandrel or sleeve shall be provided with an anchor plate or similar arrangement at the bottom to prevent the soil from entering the bottom of the mandrel during the installation of the PVD and to anchor the drain tip at the required depth at the time of mandrel withdrawal. The dimensions of the anchor plate shall conform as closely as possible to the dimensions of the mandrel so as to minimize soil disturbance. The Engineer shall determine the acceptability of the anchorage system and procedure.

e) The mandrel or sleeve shall have visible external markings at maximum one (1) meter increments to enable measurement of penetration depth of PVD.

2) Installation Procedures

a) Prior to the commencement of the PVD installation, the Specialist Contractor shall submit full details on the materials equipment, sequence and method proposed for PVD installation to the Engineer for review and approval.

b) Approval by the Engineer of installation sequence and methods shall not relieve the Specialists contractor of its responsibility to install drains in accordance with the plans and specifications.

c) Prior to the installation of PVD, the Specialist Contractor shall demonstrate that its equipment, methods and materials produce a satisfactory installation in accordance with these specifications. The Specialist Contractor may be given instruction by the Engineer to carry out trial installation of PVD at designated locations.

d) PVD shall be clearly located, numbered and staked-out by the Specialist Contractor using a baseline and benchmark provided by the Engineer. The Specialist Contractor shall take all reasonable precautions to preserve the stakes and is responsible for any necessary re-staking. The as-built location of the PVD shall not vary by more than 250mm from the plan location designated on the drawings.

e) PVD shall be installed from the working platform to the depth shown on the drawings, or to such as directed by the Engineer. The Engineer may vary the depths, spacing or the number of drains to be installed and may revise the plan limits for this work as necessary.

f) Equipment for installing PVD shall be plumbed prior to installing such drain.

g) PVD shall be installed during a continuous push using static weight or vibration.

h) The installation shall be performed without any damage to the PVD during advancement or retraction of the mandrel. In no case will alternate raising or lowering of the mandrel during advancement be permitted. Raising of the mandrel will only be permitted after completion of a drain installation.

i) The completed PVD shall be cut off neatly 150mm above the working platform or as otherwise specified on the contract drawings.

j) Shown below is the detailed rig specifications

Base Machine	Crawler Crane (min. 50 metric ton)
Penetration Force	9 ton
Extraction Force	9 ton
Driving System	Mechanical System
Mandrel	120mm x 60mm x 10mm (thk)
Total Weight	43.5 ton
Maximum Depth	35.0 m
Height of PVD Rig	Approximately30m
PVD Productivity	4,000 m/day/rig

3) Splicing

a) Splicing of PVD material shall be done by stapling a workmanlike manner and so as to ensure structural and hydraulic continuity of the drain.

b) b) A maximum of one (1) splice per drain installed will be permitted without specific permission from the Engineer.

c) c) The jacket and core shall be overlapped a minimum of 150mm at any splice.

4) Obstruction

a) Where obstruction is encountered below the working platform which cannot be penetrated by the PVD installation equipment, the Specialist Contractor shall complete the drain from the elevation of the working platform to the obstruction and notify the Engineer. At the direction of the Engineer and under his review, the Specialist Contractor shall attempt to install a new drain within 500mm horizontally from the obstructed drain. A maximum of two attempts shall be made as directed by the Engineer. If the drain still cannot be installed to the design tip elevation, the drain location shall be abandoned and the installation equipment shall be moved to the next location, or other action shall be taken as directed by the Engineer.

b) If directed by the Engineer, the Specialist Contractor may use auguring, spudding, pre-boring or other methods to penetrate through the obstruction. The cost incurred by the Specialist Contractor to penetrate through the obstruction shall be compensated based on the contract unit price per linear meter.

5) Site Records

The Specialist Contractor shall provide competent personnel to continuously supervise and observe the installation of PVD, and furnish the Daily Record sheets to the Engineer each week. The Daily Record Sheets signed by the Specialist Contractor's representative and the Engineer shall contain the following information.

a) Date of installation

b) Type of PVD

c) Location of PVD (installation point)

d) Depth of length of PVD installed at each location

e) Details of obstruction, delays and any unusual ground conditions

6) Specialist Contractor

To insure the quality of services rendered the following conditions must be met by the Specialty Contractor:

a) The Specialty Contractor must be a Filipino owned company with at least 10 years of existence.

b) The Specialty Contractor must have already installed a total of at least 7 million linear meters of PVD in past completed projects.

c) The Specialty Contractor must have proven itself capable of installing at least 3 million meters within the duration of one year.

d) The Specialty Contractor's Project Supervisor must have at least 5 years experience in PVD installation.

e) The Specialty Contractor's Project Foreman must have at least 5 years experience in PVD installation.

3.8.4 GEOTEXTILE FABRIC

3.8.4.1 SCOPE

This work covers all the following requirements regarding the installation of geotextile (filter fabric) in accordance with the lines, grades, and dimensions shown on the Drawings.

3.8.4.2 GENERAL

The geotextile fabric shall meet the following requirements in full. If required, a sample of 1.0 m^2 shall be supplied to the Engineer for approval and retention for purposes of comparative testing against materials randomly sampled from the site.

1. PHYSICAL PROPERTIES

   a. The geotextile material shall be a nonwoven needle punched type comprising of needlepunched polypropylene fibers or its equivalent. The geotextile shall be manufactured from two (2) component geotextile layers with different diameter size fibers needlepunched together to provide a homogenous sheet.

   b. The design of the component layers shall be such that one layer shall exhibit proven constriction characteristics and one layer ensures construction survivability.

   c. The geotextile material shall be UV stabilized to ensure retention of minimum 70% original tensile strength after 90 days exposure to sunlight. The manufacturer shall submit test results to support this.

   d. The geotextile must be highly resistant to long term contact with damp cementitious substances or acid or alkali solutions in the pH range 2-13. The manufacturer shall submit test data to ensure resistance of the polymer.

   e. The minimum required porosity of the geotextile shall be >80%.

   f. The geotextile filter should satisfy the Filter Criteria" of $O_{98} < D_{15,}$ where O_{98} is the effective opening size of the geotextile which corresponds to the average diameter of a sand fraction 98% of which remains on the geotextiles filter during sieving.

2. MECHANICAL AND HYDRAULIC PROPERTIES

   The geotextile supplier is required to certify that the materials delivered to site will be proven to meet or exceed the following properties:

TECHNICAL PROPERTIES	UNIT	Minimum	TEST STANDARD
A. Physical Characteristics:			
Minimum Mass (per unit area)	(g/m^2)	600	ASTM D5261 ISO 9864
Thickness	mm	2kPa 4.5	ASTM D5199 ISO 9863
B. Mechanical Properties:			
Tensile Strength	kN/m	(md/cd) 30/30	ASTM D4595 ISO 10319
Tensile elongation	%	(md/cd) 90/40	ASTM D4595 ISO 10319
CBR Puncture Resistance	N	4,500	ASTM D6241 ISO 12236
Dynamic Drop Cone	(mm)	10	EN 918
C. Hydraulic Properties:			
Effective Opening Size (O_{90} Wet Sieving) (()$_{95}$ Dry apparent Opening)	(mm) (mm)	.08 < 0.075	ISO12956 ASTM D4751
Water Permeability: Permittivity	(s^{-1})	0.85	ASTM D4491

3.8.4.3 STORAGE AND INSTALLATION

1. The geotextile shall be delivered to site with an outer wrapper to protect it from exposure to the elements.
2. Installation of the geotextile shall be in accordance with the manufacturer's instructions.
3. The Engineer reserves the right to sample geotextile delivered to site for individual quality control testing at the contractor's expense. A material not meeting the manufacturer's certified values will be rejected from the site.
4. The geotextile shall be proven to resist dynamic puncture damage when subject to impact stress from stone armor (200-400 kg) dropped from a minimum height of 2.0 m and should be laid on at least 1-foot sand and/or gravel bedding. Geotextile failing to resist puncture shall not be accepted.
5. To facilitate site Quality Assurance, each roll of geotextile delivered to site shall be clearly labeled with brand name, grade, and production batch number and this information is required to be clearly printed at regular intervals along the entire length of each roll.
6. Geotextile overlaps shall be at least 1.0 m when installed underwater and 0.35 m for installation in dry conditions unless otherwise stated on the drawings. Alternatively, geotextile overlaps are to be heat-welded or sewn using appropriate polyester, polypropylene or other synthetic

thread and portable hand sewing equipment. Joint seams shall meet or exceed 80% of the fabric's tensile strength.

3.8.5 MEASUREMENT AND PAYMENT

1. The quantities of fill to be paid for shall be the volume in cubic meters of earthwork material compacted in place, after clearing, grubbing and stripping, and as accepted by the Engineer. The probable settlement indicated in the drawings may be considered for the calculation of the quantities to be paid (subject to Contractor justifications and the Engineer's approval). Compaction test shall be performed by an authorized approved testing laboratory. Cost of test shall be incidental to reclamation and shall not be measured for payment.

2. Filter fabrics to be paid for shall be measured by the actual surface area in square meters of geotextile filter fabric supplied, set in place and finished in accordance with the Specifications and accepted by the Engineer.

   All work performed and measured as provided shall be paid for at the contract unit price per square meter for filter fabric, which price shall include furnishing of labor, equipment, tools, materials, supplies and incidentals necessary to complete work.

3.9 MULTI-PURPOSE PIER/WHARF/TRESTLE

3.9.1 GENERAL

Work under this contract shall be in accordance with Division 1, "General Requirements" and shall apply to this section, whether herein referred to or not.

3.9.1.1 SCOPE OF WORK

This Section includes the furnishing of all labor, materials, equipment and all incidentals for the construction of the multi-purpose pier and all its appurtenances. The works to be carried out shall be, but not limited to the following:

1. Driving of [___] mm and [___] mm diameter steel pipe piles
2. Driving of __ m x __ m pre-cast concrete piles
3. RC and steel pipe pile caps and beams
4. Concrete apron construction
5. Installation of accessories such as mooring bollards, bitts, cleats, fenders and timber pile dolphins.

3.9.1.2 SURVEY AND SETTING OUT

Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal / vertical of works.

3.9.2 MATERIALS REQUIREMENTS

1. Submittal

    a. Certified Laboratory Test Report

        Before delivery of materials, certified copies in triplicate of the reports of all tests required herein under materials shall be submitted for approval by the Engineer.

    b. Materials Samples

        Representative samples of all materials to be used when required by the Engineer shall be submitted before the delivery of the materials. Representative samples shall be accompanied by certified laboratory test reports.

2. Materials

    a. Precast/Reinforced Concrete (RC/PC) Piles
    b. Steel Pipe Piles
    c. Concrete (fc' = [35] MPa)
    d. Accessories

        1) Mooring Bollards, Bitts and Cleats - refer to material requirements in Section 3.14
        2) Rubber Fenders - refer to material requirements in Section 3.14
        3) Timber Pile Dolphins – refer to material requirements in Section 3.14

    e. Guardrail for trestle: Reinforced concrete guardrail shall have the dimensions as specified on the drawings. Concrete and reinforcement works shall conform with the requirements of Section 3.2, "Concrete Works" with concrete compressive strength of [__] MPa [(_____ psi)] for the pre-cast horizontal beams and for the cast in place columns. Apply non-shrink grout between joints as indicated on the Drawings in the proportions recommended by the manufacturer. The Contractor shall ensure that the grout fills all voids.

3.9.3 EXECUTION

1. Piling Works

    a. All piling works shall follow specification prescribed in Section 3.3.

    b. The pile length shall be as decided and directed by the Engineer based on the results of the boring investigations and test pile driving.

    c. Test piles which may form part of the structure as directed by the Engineer shall be driven to the required depth and “refusal."

2. Replacement of Bed Materials

    The method of dumping, placing of well-graded crushed stone (1-100 kg/pc) over the excavated portion of the seabed is subject to the Engineer’s approval.

3. Concrete Works

    All concrete works shall follow specifications prescribed in Section 3.2, "Concrete Works."

4. Shop Drawings

    The Contractor will submit shop drawings and erection drawings for formwork, falsework and the reinforcing bar lists for the Engineer’s review and approval in accordance with the applicable requirements in Section 3.2, “Concrete Works,” and Section 3.3, “Piling Works.”

5. Mooring Bollards, Bitts, Cleats, Rubber Dock Fenders and Timber Pile Dolphins

    a. All materials shall be installed at the location shown on the drawings in accordance with the approved manufacturer’s instructions and shop drawings.

    b. The Contractor shall submit the detailed construction method based on the manufacturer’s recommendations for the Engineer’s approval.

    c. The installation and testing procedure for the mooring bollards, bitts, cleats, rubber dock fenders and timber pile dolphins shall follow specifications prescribed in Section 3.14, “Mooring and Fender System.”

3.9.4 MEASUREMENT AND PAYMENT

1. Refer to specific sections of this specification for the method of measurement and payment of piles, concrete works, mooring and fender systems necessary for the construction of piers/wharves/trestles and their appurtenances. The unit price shall be considered to include all materials, fabrication, installation, painting and all other incidental work.

3.10 RO-RO RAMP

3.10.1 GENERAL

Division 1, "General Requirements" and shall apply to this section, whether herein referred to or not.

3.10.1.1 SCOPE OF WORK

This Section includes furnishing of all labor, material, equipment and all incidentals for the construction of the Ro-Ro ramp and all its appurtenances. The works to be carried out shall be, but not limited to the following:

1. Driving of [__] m x [__] m precast concrete piles
2. Concrete Works (Section 3.2)
3. Installation of accessories

3.10.1.2 SURVEY AND SETTING OUT

Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal/vertical limits of Works.

3.10.2 MATERIAL REQUIREMENTS

1. Precast/reinforced concrete (PC/RC) Piles
2. Concrete (f'c = [__] MPa)
3. Accessories : Fenders

    a. Rubber Fenders shall be V-type or equivalent with dimensions as shown on the drawings. Refer to Section 3.14, "Mooring and Fender System" for the material requirement of rubber fenders.

    Rubber Fenders shall be installed as shown in the drawings.

3.10.3 EXECUTION

1. Piling Works

    a. All piling works shall follow specifications prescribed in Section 3.3, “Piling Works.”

    b. The pile length shall be as decided and directed by the Engineer based on the results of boring investigations and test pile driving.

    c. Test piles which may form part of the structure as directed by the Engineer shall be driven to the required depth and “refusal.”

2. Replacement of Bed Materials

    The method of dumping and placing of well-graded crushed stone (1-100 kg/pc) over the excavated portion of the seabed is subject to the Engineer’s approval.

3. Concrete Works

    All concrete works shall follow specifications prescribed in Section 3.2, "Concrete Works."

4. Rubber Dock Fenders

    a. All materials shall be installed at the location shown on the drawing in accordance with the approved manufacturer’s instructions and shop drawings.

    b. The Contractor shall submit the detailed construction method based on the manufacturer’s recommendations for the Engineer’s approval.

    c. The installation and testing procedure for the Rubber Dock Fenders shall follow specifications prescribed in Section 3.14, “Mooring and Fender System.”

3.10.4 MEASUREMENT & PAYMENT

Refer to specific sections of this specification for the measurement and payment of piles, concrete works and rubber fenders necessary for the construction of Ro-Ro ramp and its appurtenances.

3.11 STAIR LANDINGS

3.11.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements" and shall apply to this section, whether herein referred to or not.

3.11.1.1 SCOPE OF WORK

This Section includes furnishing of all labor, material, equipment and all incidentals for the construction of the stair landings and all appurtenances. The works to be carried out shall be, but not limited the following:

1. In-situ R.C. stair landings (Concrete Works-Section 3.2).

2. Casting and installation of precast concrete block, dimensions as shown on the drawings.

3. Preparation of rock bedding for the installation of precast concrete block.

4. Installation of Mooring Rings.

3.11.1.2 SURVEY AND SETTING OUT

Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal/vertical limits of works.

3.11.2 MATERIAL REQUIREMENTS

1. Applicable requirements under Section 3.2, "Concrete Works" shall apply to this Section.

2. Concrete of the stair landing and precast concrete block shall be Class B2 concrete for marine structure with a compressive strength of fc' =[25] MPa [(3,500 psi)].

3. Mooring rings shall be 16 mm ø stainless steel plain bar.

3.11.3 EXECUTION

3.11.3.1 FABRICATION

1. Fabricated pre-cast concrete blocks shall be free from bends and twists. Where bends shall exist in any section along length of the block, it shall not exceed 5 mm permissible tolerance.

2. Concrete curing shall be done by covering with wet burlap for a period of not less than 21 days.

3. The Contractor will be permitted to obtain precast concrete units from outside suppliers provided that they comply with the specification and that the Contractor obtains the Engineer's approval to each supplier.

3.11.3.2 CONSTRUCTION REQUIREMENT

1. Rock bedding where the precast concrete block will be installed, shall be placed uniformly as possible and graded acceptably to the Engineer.

2. The top of precast concrete block shall be installed at 0.00 elevation referred to M.L.L.W datum with + 0.05 m tolerance.

3. The lowest step shall be at the top of the precast concrete block.

4. The dimension of the steps shall be 30 cm tread with a 20 cm riser.

5. No precast units shall be removed from the casting beds until the concrete samples representing them reach a strength not less than that specified as the minimum concrete strength at seven days for the class of concrete concerned. Similarly no units shall be set in place until the samples representing them reach a strength not less than that specified as the minimum concrete strength at twenty eight (28) days for the class of concrete concerned. All units shall be clearly marked with a serial number and date of casting.

6. The Contractor shall submit to the Engineer's approval full details of his proposed methods of handling pre-cast concrete works.

7. In-situ and precast concrete for the stair landings shall be cast and/or placed to the following tolerances:

   1) Lengths: $\pm$ 20 mm

   2) Cross Section (each direction, width and depth)
      Outward + 10 mm
      Inward - 5 mm

3.11.4 MEASUREMENT & PAYMENT

1. Measurement

   The quantity of stair landings shall be measured in cubic meter of in-situ concrete, in kg of reinforcing bars, in cubic meter of precast concrete blocks inclusive of reinforcing bars and in number of sets of mooring rings.

   Payment for the rock filler to be used in the preparation of rock bedding for precast concrete block shall be included under Pay-item for the Supply and Place of Armour Rock.

2. Payment

   Stair landings measured as provided above shall be paid at contract prices which prices and payment shall constitute full compensation for the furnishing of all labor, equipment and tools and materials and constructing complete as per drawings and specifications and accepted.

3.12 REPAIR AND REHABILITATION OF EXISTING PORT FACILITIES

3.12.1 DESCRIPTION

1. The work consists of furnishing all labor, materials, equipment and incidentals necessary to undertake rehabilitation of existing port facilities, in accordance with the Specification, the Drawings and to the approval of the Engineer.

2. The Contractor shall be deemed to have satisfied himself of the site conditions and to have included in his unit prices all risks that may arise during or in connection with the work.

3. This Section shall be read together with the Section on concrete works, piling, fender systems of these Specifications.

4. The location and position for repair and rehabilitation works shall be in accordance with the Drawings and as directed by the Engineer.

5. The Contractor shall submit his proposal of work methods for the approval of the Engineer prior to the commencement of the works.

3.12.2 MATERIAL REQUIREMENTS

1. All the materials to be used for the works described in this Section shall have the same strength as, or more than, that of the original materials which are to be repaired, unless otherwise specifically stated. The materials shall be approved by the Engineer before use.

2. Fill repair materials shall be non-shrinkage type of either concrete, cement mortar or epoxy mortar. The selection of materials as well as the mix design shall be approved by the Engineer.

3. Adhesive bond shall be of epoxy type especially manufactured for the purpose of the concrete repair. Its application shall be in accordance with the manufacturer's specifications.

4. Mortar for concrete lining and repair of existing damaged grouted riprap, shall consist of cement, sand and water conforming to the requirements given under Section 3.2, “Concrete Works,” mixed in the proportion of one part cement to two parts sand by volume, and sufficient water to obtain the required consistency.

5. Fiber Reinforced Plastic (FRP) are used for applications requiring high strength to weight ratio and resistance to deterioration, such as

   Pile jackets for steel, concrete and timber piling to reduce corrosion or erosion, for reinforcement and to prevent marine borer attack.

   FRP systems are composed of several distinct chemical and components, including various primers, chemicals and components, including various primers, putties and adhesives, as well as the fibres fabrics and epoxy saturants that eventually become the FRP materials.

TYPICAL DRY FIBER PROPERTIES

Tensile Strength	550,000 psi (3.79 GPA)
Tensile Modulus	33.5 x 10^6 psi (231 GPa)
Ultimate Elongation	1.5%
Density	0.065 lbs./in.^{3} (1.81 g/cm3)
Volumetric Fiber Content	68%

COMPOSITE GROSS LAMINATE PROPERTIES

PROPERTY	ASTM METHOD	TYPICAL TEST VALUE	DESIGN VALUE*
Ultimate tensile strength in primary fiber direction, psi	D-3039	326,000 psi (2.25 GPa)	293,400 psi (2.02 GPa)
Elongation at break	D-3039	1.3%	1.3%
Tensile Modulus, psi	D-3039	22.5 x 10^6 psi (155 GPa)	20.2 x 10^6 psi (139 GPa)
Ultimate tensile strength fiber, psi	D-3039	0	0
Layer Thickness		Varies	Varies

TYPICAL FIBER PROPERTIES

Tensile Strength	470,00 psi (3.24 GPa)
Tensile Modulus	10.5 x 10^6 psi (72.4 GPa)
Ultimate Elongation	4.5%
Density	0.092 lbs/in.^{3} (2.55g/cm^3)
Weight per sq. yd.	14.9 oz. (505 g/m^2)
Fiber Thickness	0.0075 in. (0.19 mm)

COMPOSITE GROSS LAMINATE PROPERTIES

PROPERTY	ASTM METHOD	TYPICAL TEST VALUE	DESIGN VALUE*
Ultimate tensile strength in primary fiber direction, psi	D-3039	83,400 psi (575 MPa) (2.17 kip/in.width)	66,720 psi (460 MPa) (1.7 kip/in. width)
Elongation at break	D-3039	2.2%	2.2%
Tensile Modulus,psi	D-3039	3.79 x 10^6 psi (26.1 GPa)	3.03 x 10^6 psi (20.9 GPa)
Ultimate tensile strength 90 degrees to primary fiber, psi	D-3039	3750 psi (25.8 MPa)	3,00 psi (20.7 MPa)
Laminate Thickness		0.026 in. (0.66 mm)	0.026 in. (0.66 mm)

EPOXY MATERIAL PROPERTIES

Curing Schedule 72 hours post cure at 140°F (60°C)		
PROPERTY	**ASTM METHOD**	**TYPICAL TEST VALUE***
Tg 140 ^{0}F (60 ^{0}C)		180^{0}F (82 ^{0}C)
Tensile Strength[1], psi	ASTM D-638 Type 1	10,500 psi (72.4 MPa)
Tensile Modulus ,psi		461, 000 psi (3.18 GPa)
Elongation Percent	ASTM D-638 Type 1	5.0%
Flexural Strength, psi	ASTM D-790	17,900 psi (123.4 MPa)
Flexural Modulus, psi	ASTM D-790	17,900 psi
Flexural Modulus, psi	ASTM D-790	452,000 psi (3.12 GPa)

6. Underwater Petrolatum Tape System with High Density Polyethylene (HDPE) jacket

   (a) Petrolatum Marine Piling Tape

   Petrolatum Marine Piling Tape is a synthetic filament fabric coated with a neutral compound based on saturated petroleum hydrocarbons and inert mineral fillers with additional inhibitors and water displacing agents.

   It is primarily used for the protection of jetty piles particularly in the splash and inter-tidal zones.

   It is an anti-corrosion tape that can be applied to metal under water that adheres and remains attached to all cleaned, sound, wet or dry metal surfaces.

   (b) Petrolatum Paste

   Petrolatum Paste is a soft paste containing water displacing, corrosion inhibiting and flow control additives with broad-spectrum biocides. It does not dry, harden or crack.

   Applicable to badly corroded and fitted steel above and below water surface prior to the application of the marine piling tape. It fills pits and depressions on the steel pile surface and does not contain volatile organic components.

Specially designed for underwater applications.

Properties:

Flash point	=	180^0C (minimum)
Specific Gravity	=	+ 1.08
Temperature Range:		
For Application	=	0°C to 40°C
For Service	=	- 30°C to 55°C

3.12.3 EXECUTION

1. Preparatory Work

   The Contractor shall verify the dimensions and locations of damaged portions of existing structures and confirm the type of repair works prior to the commencement of works.

   Within twenty eight (28) days from the commencement of the work, the Contractor shall submit to the Engineer for approval his detailed methodology and sequence of construction including the mix proportion and materials he proposes to use for the works.

   The Contractor shall carry out all the necessary preparatory works needed such as setting out, marking, temporary staging etc., prior to the commencement of such works.

   The Contractor shall also clean all the surfaces to be repaired by means of brushing, sand blasting or any other appropriate means for rust, dust, weathered materials or any other deteriorated part of structures.

2. Records of Repair Works

   The Contractor shall take photographs including underwater photographs for all the places to be repaired prior to the commencement of such works.

   These photographs shall be in the monthly reports with identification numbers for each location, namely bay number for slab, etc.

Photographs after repairing works shall be also taken at the same locations and from the same directions. The Contractor shall submit two (2) copies of color photos to the Engineer upon the completion of such works.

3. Rehabilitation of Concrete Slabs (For Causeways & Piers)

   a. Repair and rehabilitation works of concrete slabs shall be carried out according to the specified type of repair works as shown on the Drawings.

   b. The location and position of each type of repair and rehabilitation works of damaged slabs at existing piers and causeways, shall be in accordance with the drawings and as directed by the Engineer.

   c. Type of repair works:

Type	Application	Repair Method
SA/SB	Medium to wide crack at location directed by the Engineer.	Patching of mortar to level.
SC/SD	Spalled concrete without exposed rebars at location directed by the Engineer	Patching of mortar to level.
SE/SF	Spalled concrete with exposed rebars not more than 50% of the panel at location directed by the Engineer	Replacing of corroded rebars and injection of mortar.
SG	Spalled concrete with exposed rebars more than 50% of the panel and depth of spalled concrete more than 150 mm	Replacing concrete and rebars for entire slab panel.

   d. Particulars:

      1) The surface of the damaged part of the concrete shall be removed by chipping as indicated on the drawings, without damaging other parts, until fresh concrete appears.

      2) The exposed concrete shall be brushed clean and free from concrete debris. Heavily corroded rebars shall be replaced with the same size and quality as the original rebars.

3) Before casting new concrete, the old concrete shall be saturated by water sprays for at least 24 hours.

4) After applying epoxy bond onto the surface of the fresh concrete and rebars, temporary formwork shall be provided and fixed in position, if necessary, by either hole-in anchors or temporary supports.

5) The temporary form prefabricated on land with injection and exhaust pipes shall be rigid enough to support the cast concrete or mortar.

6) The non-shrink concrete or mortar shall be cast in by pumping through injection pipes.

4. Rehabilitation of Concrete Beam

a. Repair and rehabilitation works of concrete beams shall be performed following to the specified type of repair works as shown on the Drawings.

b. The location and position for each type of repair and rehabilitation works on damage beam at existing piers and wharf shall be in accordance with the Drawings and as directed by the Engineer.

c. Type of repair works.

Type	Application	Repair Method
BA/BB	Medium to wide crack at location directed by the Engineer.	Patching of mortar to level.
BC	Spalled concrete without exposed rebars at location directed by the Engineer.	Patching of mortar to level
BD	Spalled concrete with exposed rebars but at the side of beam at location directed by the Engineer	Replacement of corroded rebars and mortar injection.
BE	Spalled concrete with exposed rebars at the bottom of beam	Replacement of corroded rebars and mortar injection.

d. Particulars

Particular for this works are described in Sub-section 3.12.3.3, Urgent Rehabilitation of Concrete Slab, paragraph “d” 1 to 6.

5. Rehabilitation of Pile Cappings

a. Repair and rehabilitation works of pile cappings shall be applied to the following specified type of repair works as shown on the Drawings.

b. The location and position for each type of repair and rehabilitation works of damaged concrete pile cappings at existing piers and wharf shall be in accordance with the Drawings and as directed by the Engineer.

c. Type of repair works.

Type	Application	Repair Method
PA/PB	Fine to wide crack at location directed by the Engineer.	Patching of mortar to level.
PC	Spalled concrete without exposed rebars at location directed by the Engineer	Patching of mortar to level.
PD/PE	Spalled concrete with exposed rebars.	Pile jacket by injection of mortar.

d. Particulars:

Refer to Sub-section 3.12.3.3, Rehabilitation of Concrete Slab, paragraph “d”

6. Rehabilitation of Damaged Piles

Rehabilitation works shall be applied following to the specified grade of repair works for each pile as described in Sub-section 3.12.3.5.

7. Installation or Demolition of Bollards

    a. The specified existing bollards installed at the existing piers and wharf shall be removed from their existing positions in accordance with the Drawings or as directed by the Engineer.

    b. The removed bollards shall be stored in the Contractor's storage for re-use or dumped in the disposal area, as directed by the Engineer.

    c. The Contractor shall repair the concrete base after the removal of bollards.

    d. Strengthening of existing concrete slab and/or beam for installation of bollards, shall be undertaken if instructed by the Engineer.

8. Installation of Rubber Fenders

    a. Concrete base for installation of rubber fenders shall be provided to the existing marginal wharf in accordance with the Drawings.

    b. The face line of the rubber fenders after installation shall be straight for safe ship operation.

    c. Rubber fender shall be set as shown on the Drawings with anchor bolts as specified in Section 3.13 "Mooring and Fender System".

9. Replacement of Timber Fender Piles

    a. Existing fender piles shall be removed or cut at the design seabed elevation and then stored in the yard for re-used or dumped in the disposal area if instructed by the Engineer.

    b. Setting-out shall be made by the Contractor to maintain straight faceline as indicated on the Drawings.

10. Strengthening of Concrete Structures using FRP

    a. Only trained and certified Specialty Contractors should be used for strengthening of concrete structures using FRP.

    b. Concrete Preparation

        (1) Concrete substrate must be in a clean and sound condition.

            (a) Remove unsound concrete
            (b) Repair corroding reinforcing steel

(c) Patch large voids
(d) Inject large cracks

c. Surface Preparation

(1) The surface must be prepared to receive the FRP system.

(a) Level the concrete surfaces with epoxy putty
(b) Round sharp edges where required

d. Adhesive mixing

Well mixed resin is critically important, and manufacturer recommendations should be followed.

e. FRP Installation

FRPs are bonded to the surface of the concrete

(1) Pre-cured laminate and Strip System

Rigid FRP plates or strips are bonded to the surface of the concrete with an epoxy adhesive.

(2) Fabric System

Flexible fibre fabrics are bonded to the concrete using epoxy adhesives/saturants

For Dry lay-up Systems, Fabric is saturated during lay-up operation.

(3) Protective Coatings

Aesthetics, fireproofing, UV Radiation, or otherwise protective coatings are often applied to install FRP systems.

(4) Curing Conditions

The following must be carefully monitored and controlled during curing of the epoxy saturants/ adhesives.

11. Repair of Damaged Tape or Coating on Steel Piles

    a. Remove damaged tape or non-adhering coating. Remove corrosion materials. Apply thin coat of petrolatum paste. Begin the application of tape a minimum of 50 mm back from the damaged area utilizing the recommended overlap. Complete wrapping of repair area so that the tape overlaps at least 50 mm onto the original coating.

    b. When repairing petrolatum tape, the damaged area frequently can be repaired by applying a patch or full circumferential wrap. The new petrolatum tape can readily be pressed onto the old tape. Patches should only be installed on the top half of a pipe surface.

3.12.4 MEASUREMENT AND PAYMENT

1. Measurement

   All items for the repair and for the rehabilitation of the existing structure shall be measured based on actual quantities and on the item included in the bill of quantities. The Contractor shall measure the work at the presence of the Engineer and submit the unit for approval.

2. Payment

   All payments shall be done in quantity as mentioned above. All unit prices shall include (if under the Bill of Quantities there is no specific price applicable) excavation, clearing, chipping, materials with accessories, reinforcing bars, forms, scaffolding, backfilling and other related works to be carried out in the works specified.

3.13 MOORING AND FENDER SYSTEMS

3.13.1 GENERAL

3.13.1.1 SCOPE OF WORK

1. The work includes furnishing of all labor, materials and equipment to complete the installation of mooring bollards, bitts, cleats and fenders in new piers.

2. The work shall include the supply, transport, handling, storage and installation of fender systems in the newly constructed piers.

3. The work shall include the furnishing, driving, cutting off and binding of timber piles in clusters (dolphins) in the new trestles as shown on the drawings and in accordance with this specification.

4. The Contractor shall furnish and install the necessary fittings for a complete job as shown on the drawings and/or as specified.

   Supplementary parts necessary to complete and install each item of works shall be included whether or not shown or specified. The Contractor shall furnish to relevant trades all anchors, fastenings, inserts, fittings, fixtures or the like to be installed on or required for securing the works.

   The Contractor shall submit shop drawings of all fitting works prior to placing orders and commencement of any fabrication.

3.13.1.2 MOORING SYSTEM

1. Designated load capacity of mooring bollards, bitt and cleats shall be as shown on the drawings, and shall refer to the safe working load. The bollards shall be capable of withstanding a proof test load of 1.5 times the safe working load.

2. The following publications listed below shall form a part of these Specifications to the extent indicated by the reference thereto.

   Publication

   G 5101 SC 46, Carbon Steel
   G 3101 SS 41, Rolled Steel for General Structures
   JIS B0205 Standard M Screw
   JIS B1181 Hexagon Nut

3. Bollards at the new berth shall be installed at the edge of concrete decks of piers.

3.13.1.3 RUBBER FENDER SYSTEMS

1. Material for fender systems such as rubber fenders, anchor bolts and templates shall be supplied by the Contractor.

2. The Contractor shall install the fender system properly according to the drawings and the instructions prepared by the Engineer.

3. Performance Requirements

   The fenders shall be procured in accordance with the performance characteristics, under 45%-50% fender deflection, specified hereunder:

Type of Fender	Min. Energy Absorption (Ton-M)	Max. Reaction Force (Ton)
(1)	1.0	15
(2)	1.8	20
(3)	2.8	32

4. Types of Fenders

   Type (1) = 200 mm in height and 1000 mm in length
   Type (2) = 250 mm in height and 1500 mm in length
   Type (3) = 300 mm in height and 1500 mm in length

5. Manufacturing Rubber Main Body

   Rubber fenders shall be manufactured at the factories of approved makers.

   Basic manufacturing methods shall be as follows:

   - Shape of rubber main body: refer to the Drawings
   - Fabrication of rubber main body shall be completed at the factory
   - No connection of main body shall be permitted out of the factory
   - Steel plate shall be embedded in the deck sides of rubber main body.
   - The Contractor shall submit manufacturer's methods of manufacturing for approval by the Engineer.

3.13.1.4 TIMBER PILE DOLPHINS

1. Materials for timber pile dolphins such as creosoted apitong timber piles, connection wire rope, staples and protector shall be supplied by the Contractor subject to approval of the Engineer.

2. The Contractor shall install the dolphins properly according to the drawings and instructions prepared by the Engineer.

3. Related specification will be provided in Section 3.3, "Piling Works."

3.13.1.5 SUBMITTALS

1. Shop drawings and/or catalogues of mooring bollards, bitts, cleats and rubber fenders indicating size, weight and mounting requirements shall be submitted for approval of the Engineer.

2. No materials or fitting shall be ordered without prior approval of the Engineer.

3.13.2 MATERIAL REQUIREMENTS

3.13.2.1 MOORING SYSTEM

1. Mooring bollards, bitts and cleats shall be of the dimensions, weights, capacities and design in accordance with shop drawings approved by the Engineer and shall be fabricated by approved manufacturers with cast steel conforming to the following requirements or approved equivalent.

Part	Spec. (JIS or its equivalent)	Grade
Body	JIS G5101 3	Grade SC46
Anchor	JIS G3101 2	Grade SS41
Bolts	JIS B0205	M64-6
Nut	JIS B1181 1 Class 3	Grade 1 4T, N64-6
Washer	JIS B1256	Steel Bars
Foundation Plate	JIS G3101 2 or JIS G5101	Grade SS41 Grade 3 SC46

The size of the bolts, nuts and washers shall be in accordance with the specifications of the manufacturer. However, the length of the bolts shall be as indicated on the drawings. The anchor plate shall be connected to the holding down bolt with 12.5 mm weld, as shown on the drawings. All bolts, nuts, washers, etc. that are exposed shall be galvanized to the satisfaction of the Engineer. Provide lead cover for exposed threads of galvanized anchor bolts.

Samples of the bolts, nuts, washers and anchor plates shall be submitted to the Engineer for approval before being used in the Works.

a) The upper parts of bollards, bitts, and cleats not embedded in concrete shall be painted. The surface of bollards and bitts shall be cleaned thoroughly by wire brush or other means prior to painting to remove rust or any other contamination which may interfere with bond of paint to metal.

   The exposed surface shall be coated with rust proof paint and finishing paint, which shall be coal-tar epoxy of 120 micron thickness in accordance with JIS K5623 or the approved standard.

b) Alternative

The Contractor can submit to the Engineer's approval cleats, bitts or bollards different from these specifications but with the capacities indicated in the drawings.

c) Concrete foundations/base of bollards and bitts shall conform to the requirements of Section 3.2, "Concrete Works."

d) Visual Inspection

All bollards, bitts and cleats delivered to site shall be inspected by the Engineer for any signs of flaws or defects inimical to usage.

e) Mill Test Certificates

Two (2) copies of mill test reports shall be submitted certifying that materials meet the specified standards.

f) Tests and Inspection

Inspection of all materials and methods of fabrication shall be carried out by the Contractor. However, the Engineer reserves the right to inspect all facilities at any time during the manufacture to ensure that the materials and workmanship are in accordance with the specifications and the best workmanship.

3.13.2.2 RUBBER FENDER SYSTEM

1. Concrete with reinforcing bars on which the fenders are fixed shall conform to the requirements of Section 3.2, "Concrete Works."

2. Physical Properties

Material for rubber fenders will be one of the international accepted materials.

Test methods shall conform to JIS K6301 or equivalent.

The rubber material used for rubber fenders shall be a compound of natural rubber and synthetic rubber of high quality having sufficient resilience, anti-aging, weather and wear resistant property according to the following table.

	Property	Requirement	Test Method (JIS K6301)
Tension test (before aging)	Hardness (HS)	77 max.	Spring type Hardness type
	Tensile Strength (kg/cm^2)	160 min.	Test piece Dumbell No. 3
	Elongation (%)	350 min.	
Tension test (after aging)	Hardness	+8 max. from original value	Air heating 70 °C x 96 hrs.
	Tensile Strength (kg/cm^2)	not less than 80% of original value	
	Elongation	not less than 80% of original value	
Tear resistance (kg/cm^2)	Inner rubber	70 min.	Test piece
	Outer rubber	60 min.	
Compression Set (%)		30 max.	
Oil Resistance (volume change)	Industrial gasoline (%)	60 max. 20 max.	25 °C x 24 hrs.

3. Anchor

Anchor Bolts and connecting hardware shall be fabricated from type SUS 304 stainless steel to the required shapes and sizes as shown on the approved shop drawings, and conforming to JIS G 4303 or equivalent.

4. Testing

The Contractor shall be required to submit test certificates showing compliance to the above requirements. The test certificates should be certified by an independent inspection organization recommended by the Contractor and approved by the Engineer.

One fender of each type (1, 2 & 3) selected at random shall be tested for performance. The fender shall be compressed repeatedly three times to the minimum deflection at speed from 2 to 8 cm. per minute.

The load and deflection values shall be recorded with a precision of 0.5 mm. The results shall be plotted in the form of load-deflection-energy absorption curves. The average data obtained in the second and third test loadings shall be considered as performance values. The tests and reporting shall be carried by an approved laboratory and shall be supervised and certified by the independent inspection organization.

The performance shall satisfy the requirements indicated in Sub-section 3.13.1.3 paragraph 3.

If any of the tested fenders fail to satisfy the performance requirements, retesting shall be conducted on one piece for every 10 fenders of the same type. If the second sample still fails the test, all the remaining fenders of this type shall be tested.

5. Sampling of Specimen

The specimens of rubber shall be taken at the mixing stage directly from each batch of rubber compound for manufacturing of fenders. The specimens shall be tested for compliance with requirements as specified in paragraph b of this Sub-section.

6. Inspection for Dimension

The fenders shall be inspected by the independent inspection organization.

One fender out of five fenders of each type shall be inspected for compliance with dimensions.

Five percent (5%) of anchor bolts and fittings shall be selected at random and inspected. Materials for bolts and fittings to be covered by certified steel manufacturer's mill sheet shall be verified by the independent inspection organization.

7. Acceptance Tolerance

The acceptance tolerances shall be as stipulated in the following:

a. Fender Dimension

	Length	**Width**	**Height**	**Thickness**
Tolerance	+4% -2%	+4% -2%	+4% -2%	+8% -2%

b. Anchoring Bolt Holes in Fender

	Diameter of the Hole	Pitch of the Hole
Tolerance	+2 mm	+4 mm

c. Performance requirements shall conform to paragraph c of Sub-section 3.13.1.3

As basis for acceptance of all finished fenders supplied, a tolerance of +10% on the performance requirements indicated will be acceptable.

The cost of tests and inspection required herein are all for the Contractor's account.

8. Marking

All fender units shall be clearly numbered and marked. Each fender shall have the following marking:

a. Fender type and manufacturer's name or trademark

b. Production serial number

c. Date of manufacturing

d. Main dimensions (length, height)

e. Bill number in accordance with the project code specified in the Bill of Quantities.

9. Warranty

The Contractor shall guarantee the fenders against any defects that are attributable to faulty design and manufacture and shall also guarantee the performance of the fenders under normal working conditions. The guarantee shall be for a minimum period of 12 months from the date of the issuance of Taking-Over Certificate of the Works.

During the period of guarantee, repairs and replacement of defective fender units and/or material shall be carried by the Contractor at his own cost.

3.13.2.3 TIMBER PILE DOLPHINS

1. Timber piles shall be “Creosoted Apitong” (Dipterocarpus Grandiflorus) of the best grade. It shall be free from loose knots, splits, worn holes, decay, warp, ring separation or any deflects which will impair its strength or render it unfit for its intended use. Creosoted Timber Piles shall have the diameter and length shown on the drawings. No cracks will be permitted in any pile.

   Timber treatment shall consist of the forcing of creosote oil into the outer fiber of the timber by a heat and pressure process. The treatment shall be so regulated that the curing process will not induce excessive checking.

   The minimum penetration of the preservative with the surface of the timber shall be 20mm. The minimum retention of preservative per cubic meter of timber shall be 320 kg. By “Full Cell Process” for treated timber intended for marine use.

   The Engineer shall be notified at least ten (10) days in advance of the date that the treating process will be performed in order that the untreated timber, the treatment process and the finished treated timber may be inspected. The Engineer will inspect the timber prior to treatment to determine conformance with the specifications and suitability of conditions for treatment. He shall be permitted free access to the plant in order that temperatures, pressures and quantities and types of treatment materials used may be observed. Samples of the creosote oil shall be furnished as required for tests.

   After completion of the treatment, the timber shall be checked to determine penetration of treatment, amount of checking, quantity of free preservative remaining on the timber and any other visual evidence that the treatment has been performed in a satisfactory manner. The penetration of treatment shall be determined by boring a sufficient number of well distributed holes to determine the average penetration. All such holes shall be plugged with plugs approximately 2 mm larger in diameter than the bit used in boring the holes.

   If the penetration of preservative is less than the required amount, the entire charge, or such parts thereof as are determined by the Engineer to be unsatisfactory, shall be retreated. If after retreatment, the penetration is still insufficient, the retreated pieces shall be rejected.

   Any excessive checking caused by the treating process shall be cause for rejection of the pieces in which the excessive checking occurs.

The treating plant shall be equipped with adequate thermometers and pressure gages so that the process can be accurately controlled and a continuous record made of stages of the treating process. If requested by the Engineer, records shall be furnished showing the duration, maximum and minimum temperatures and pressures used during all stages of the process.

All timber which is to be stored on the job for any length of time prior to its use in the structure shall be nearly stacked in piles to prevent warping or distortion. Creosote treated timber shall be open-stacked and piled to prevent warping. The ground underneath and in the vicinity of all material piles shall be cleared of all weeds and rubbish. Care shall be exercised in handling treated timber so as not to break or penetrate the treatment with any tool or handling equipment. Any piece of timber that has been damaged by the Contractor shall be replaced by him without extra compensation.

2. Connection wire shall be 6 x 9 galvanized wire rope with fiber core, 25 mm diameter, weight 1.98 kg/m, breaking load 27.6 tonnes (160 kg/mm^2).

3. Preservative shall be creosoted oil and shall conform to ASTM D-1760 “Standard Specification for Pressure Treatment of Timber Products.” Creosoted petroleum oil blend shall not be used for timber piles intended for marine use.

4. All staples, caps, bolts shall be of galvanized steel.

3.13.3 EXECUTION

3.13.3.1 MOORING SYSTEM

All bollards, bitts and cleats shall be installed at the locations shown on the drawings and in accordance with the approved manufacturer's recommendations and shop drawings, and as directed by the Engineer.

3.13.3.2 RUBBER FENDER SYSTEM

All fenders shall be installed at the locations shown on the drawings and in accordance with the approved manufacturer's recommendations and shop drawings.

3.13.3.3 TIMBER PILE DOLPHINS

All timber piles shall be installed at the location shown on the drawings and connected to each to form a cluster piles.

The timber pile should be driven to a penetration below seabed to a depth indicated on the drawings. This penetration may increased or decreased depending upon the nature of the material encountered and as directed by the Engineer.

Bind the piles as shown on the drawing to form a pile clusters with galvanized wire rope which should be secured to every pile in contact with galvanized staples and the ends of wire rope to be looped securely fastened. The top of the pile and wire rope after cutting and placing respectively shall be treated with two (2) thick coats of hot tar before placing of the metal cap. The top of the cap should be painted with one (1) coat of tar.

All works shall be carried out in accordance with the approved shop drawings. Pile driving shall conform to requirements of Section 3.3, "Piling Works."

3.13.4 MEASUREMENT AND PAYMENT

1. Measurement and payment of the quantities of bollards, bitts and cleats shall each be based on the number of sets of bollards, bitts and cleats completely installed (excluding concrete base/foundation) with anchor bolts and certified by the Engineer.

   Reinforced concrete base/foundation of mooring bollards and bitts to be installed on piers shall not be paid separately and such shall be included under pay-item for Concrete Works of pier.

   Separate measurement shall be made for reinforced concrete base/foundation of mooring bollards and bitts to be installed on structures other than pier which shall be paid for per cubic meters of concrete and per kilograms of reinforcing bars.

2. Measurement and payment of the quantities of rubber fender system shall be based on the number of sets of rubber fender systems completely installed with anchor bolts with necessary sleeves and certified by the Engineer.

3. The furnishing of creosoted timber piles for fender cluster/breasting dolphins to be paid for shall be measured by the number of pieces as ordered in accordance with the Contract and as specified and accepted by the Engineer.

   The installation of timber pile dolphins (with specified number of piles per cluster) shall be measured and paid for by the number of sets of timber pile dolphins placed in accordance with the Contract and accepted in completed work.

4. Payment stated above shall be full compensation for all labor, materials and equipment and all preparatory and incidental works necessary to complete the work.

3.14 STEEL AND METAL WORKS

3.14.1 GENERAL

3.14.1.1 SCOPE OF WORK

The work includes the furnishing of all labor, material and equipment required for performing all operations in the fabrication and installation of structural steel and miscellaneous metal work as specified and shown on the drawings.

Materials shall conform to the requirements hereinafter specified. Connections for which details are not indicated shall be designed in accordance with the American Institute of Steel Construction, Manual of Steel Construction, latest edition, and shall be welded or bolted, except as shown otherwise.

Bolted connections for structural steel work shall be made with high strength steel bolts. Holes shall be provided where necessary for securing other work to steel framing. Steel less than 4.75 mm thick shall be in accordance with the American Iron and Steel Institute's light gauge Steel Design Specification.

Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Miscellaneous bolts and anchors, supports, braces and connections necessary for completion of the work shall be provided.

3.14.1.2 STANDARDS INCLUDED IN THE SPECIFICATIONS

The following publications listed below form a part of these Specifications to the extent indicated by the reference thereto.

1. American Institute of Steel Construction (AISC) Publication:

   Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

2. American Society for Testing and Materials (ASTM) Publications:

   A-123 Zinc (Hot-Galvanized) Coating Products Fabricated from Rolled Pressed and Forged Steel Shapes, Plates, Bars and Strips

A-153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A-386 Zinc Coating (Hot-Dip) on Assembled Steel Products

3. American Welding Society (AWS) Publications:

   D1.1 Structural Welding Code

4. Japanese Industrial Standard (JIS) Publication:

   JIS B 1186 Sets of High Strength Hexagon Bolts, Hexagon Nuts, and Plain Washers for Friction Grip Joints

   JIS G 3101 Rolled Steel for General Structures

   JIS G 3444 Carbon Steel Tubes for General Structural Purposes

   JIS G 3445 Carbon Steel Tubes for General Structural Purposes

   JIS G 3452 Carbon Steel Pipes for Ordinary Piping

   JIS G 3454 Carbon Steel Pipes for Pressure Services

   JIS G 4303 Stainless Steel Bars

   JIS G 4313 Cold Rolled Stainless Steel Strip for Spring

   JIS G 4051 Carbon Steel for Machine Structural Use

3.14.1.3 STORAGE

Structural material, either plain or fabricated, shall be stored above the ground upon platforms, skids or other supports. Materials shall be kept free from dirt, grease and other foreign matter and shall be protected from corrosion.

3.14.1.4 SUBMITTALS

1. Shop Drawings

   The Contractor shall submit shop drawings for the whole of the steelwork to the Engineer for approval. All such drawings shall show the dimensions of all parts, method of construction, spacing of rivets, bolts, welding, sectional areas and all other details. Riveted or welded construction may be employed subject to approval and neatness of design. Where welds are used, either at works or on site, they shall wherever possible, be continued and returned around any meeting face to ensure that the joints are completely sealed against corrosion.

The details of connections on shop drawings shall be such as to minimize formation of pockets to hold condensation, water or dirt and a minimum gap between abutting angles and the like shall be provided wherever possible to eliminate any traps and facilitate maintenance painting.

No material shall be ordered nor fabrication commenced until such drawings are approved by the Engineer in writing.

The Contractor shall be responsible for all errors of detailing fabrication and for correct fitting of the structural members.

2. Erection Procedures

The Contractor shall submit work program and statement to illustrate the structural steel erection and temporary staying and bracing and to give clarification on data submitted by him should the Engineer requested the same. He shall also submit the data on welding equipment he proposes to use in the field, such data shall include the type, voltage and amperage of the said equipment and be subject to approval of the Engineer.

3. Proof of Compliance with the Specifications for Materials

The Contractor shall submit the following test results as a proof that the materials he will use complies with the requirement of the specifications.

a. Reports of ladle analysis for steel

1) Mill tests reports for main members
2) Fabrication's affidavit for secondary and detail members.

b. Reports of tensile properties and bed tests for:

1) Steel shapes
2) Steel bars
3) Steel plates

c. Certification of conformance for:

1) Structural steel tubing
2) Steel bar grating
3) Filler metals for welding

d. Reports of mechanical properties of headed stud type shear connectors.

e. Reports of mechanical tests for high strength threaded fasteners.

4. Manufacturer's Literature

The Contractor shall submit manufacturer's literature describing the type of welding studs and arc shields used.

5. Inspection Report

The Contractor shall likewise submit the result of inspection tests specified in this Sub-section 3.14.3.4.

3.14.2 MATERIAL REQUIREMENTS

All materials shall be of new stock, free from surface imperfections and shall conform to the applicable ASTM, JIS, AISC or other equivalent standards.

Structural steel plates, shapes, grating and bars shall conform to JIS G 3101 SS 41.

Structural carbon steel shall conform to ASTM designations A 36 or equivalent. Shapes of structural members shall be as given in AISC, Manual of Steel Construction or equivalent.

High strength structural bolts, nuts and washers shall conform to JIS B 1186 F 11T.

Electrodes for arc welding shall conform to American Welding Society Specification A5.1.

Chains and fittings for fender systems shall conform to JIS F 3303 "Electrical Welded Anchor Chain Cables". All chains and accessories shall be hot-dip galvanized.

3.14.3 EXECUTION

3.14.3.1 QUALIFICATION

1. Steel Fabricator

Steel Fabricators shall have a minimum of 5 years experience in fabrication of structural steel for projects of similar size. The Contractor shall submit a written description of fabrication ability including facilities, personnel and lists of similar completed projects,

including quality control capability and specifically the type and extent of quality control procedure which the fabricator intends to employ on this project.

2. Steel Erector

Steel Erectors shall have a minimum of 5 years experience in the erection of structural steel structures of similar size to the proposed structure. The Contractor shall submit a written description of structural steel erection ability including equipment, personnel and a list of completed projects.

3. Qualified Welders and Welding Procedures

Welders, tackers, welding procedures and operations shall be in accordance with AWS D1.1. The Contractor shall submit for the Engineer's approval the welding procedure, welder's qualifications and the test results of each type of welding to be performed.

Procedures shall be developed for welding all metals included in the work. The Contractor shall not start welding until procedures, welders, welding operator and tackers have been qualified as specified herein. The Contractor shall perform qualification testing by an approved testing laboratory, or by the Contractor if approved by the Engineer. Cost of such testing shall be borne by the Contractor.

The Contractor shall qualify each welder, welding operator and tacker assigned to work on this project by tests using equipment, positions, procedures, base metal and electrodes that will be encountered in their assignment. The Contractor shall furnish to the Engineer for approval certification that each welder, welding operator and tacker is qualified in accordance with the requirements of AWS D1.1 or approved equal.

3.14.3.2 WELDING

1. General

All welders, welding operators and tackers to be employed on the Works shall have been qualified by tests prescribed by the Structural Welding Code of American Welding Society (AWS D1).

Before the work is started the welding procedure of each type of joint shall be approved by the Engineer and the Contractor shall make such trial welds and tests as required for the proposed method.

2. Equipment

Machine welding shall be used wherever possible. All shop welds shall be carried out by qualified operators under proper supervision. The work shall be properly prepared for welding and the correct sequence adhered to.

All site welding shall be carried out by the electric arc process, with coated electrodes.

The welding plant shall be of modern design and with ample capacity to provide the required current to each welding point without appreciable fluctuations.

3. Welding Material

The Contractor shall employ only welding electrodes, welding wire and fluxes capable of producing satisfactory welds when used by qualified welders or welding operators using qualified welding procedures. Filler metals for welding may be any or combination of the following:

a. Shielding metal-arc welding: AWS A5.1 or A 5.5
b. AWS A 5.18 and Article 417 of AWS Building code
c. Flux core arc welding: AWS A5.2 and article 418 of AWS Building Code.

4. Welded Construction

Welded connection shall be permitted only where indicated on the approved shop drawings. Welded construction shall conform to the following:

a. Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign materials except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

b. Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more that 4.75 mm. If the separation is 1.6 mm or greater, the size of the filler welds shall be increased by the amount of the separation. The separation between facing surfaces of lap joints and the butt joints on a backing structure shall not exceed 1.6 mm. The fit of joints at contact surfaces which are not completely sealed by welds shall be close enough to exclude water after painting.

c. Abutting parts to be butt welded shall be carefully aligned. Misalignments greater than 3.2 mm shall be corrected and in making the correction, the part shall not be drawn into a sharper slope than 2 degrees. Prior to welding, all parts shall be held securely in position by tack welds, clamps or other means.

d. The work shall be positioned for flat welding whenever practicable.

e. The technique of welding employed, the appearance and quality of welds made, and the methods used in correcting defective work shall conform to Section 4 - Workmanship, of the Standard Code for Arc and Gas Welding in Building Construction of the American Welding Society.

3.14.3.3 FABRICATION

The Contractor shall fabricate structural steel in the shop to the greatest extent possible for transporting in accordance with AISC Building Code with the modifications and additional requirements specified in this section.

Bolted or welded connections shall be provided whether constructed in the shop or in the field as shown on the drawings or as approved by the Engineer. High strength threaded fasteners for all bolted connections shall be used unless otherwise shown on the drawings or approved by the Engineer.

Connections shall be as shown on the drawings or as approved by the Engineer. Holes shall be cut, drilled, or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Draw allowance shall be made for draw in all tension bracing.

All sharp edges and corners be ground to a minimum radius of 1 mm and all sharp irregularities, burrs, slag and spatters on welds shall be removed.

Bearing plates shall be provided under beams resting on concrete walls.

3.14.3.4 TEST AND INSPECTION

Welds shall be inspected visually. A min. 10% of all butt welds and a min. 5% of all fillet welds to be designated by the Engineer shall be examined by radiographic, liquid penetrant, magnetic particle or ultrasonic method, alone or in combination to determine conformance to the acceptance specified herein. All testing shall be performed by an approved testing agency performed in the presence of the Engineer. All tests shall be certified and submitted to the Engineer.

3.14.3.5 DELIVERY TO SITE

Anchor bolts and other anchorage devices which are to be embedded in cast-in-place concrete construction shall be delivered to site before the start of the said work.

The Contractor shall number in accordance with shop drawings the materials tested and approved by the Engineer before delivery to the site, and prepare a list showing number, size, quality and quantities of materials.

Material shall be transported in accordance with material list and transportation schedule approved by the Engineer.

Materials shall be protected to prevent damage during transportation. The Contractor shall package and label small parts such as bolts and rivets.

3.14.3.6 FIELD ERECTION

Steel erection shall conform to the requirements of these Specifications and to the applicable requirements of AISC, "Specification for the Design, Fabrication, and Erection of Structural Steel for Building" and the AISC "Code of Standard Practice for the Steel Building and Bridges".

The Contractor shall set and wedge or shim loose bearing plates and erect individual pieces not deviating from vertical level and alignment more than 1 in 500.

For the field assembly the Contractor shall:

1. Assemble structural steel frames accurately to the lines and elevations indicated and within the specified erection tolerance.

2. Align and adjust accurately various members forming parts of a complete frame of structure before fastening.

3. Fasten splices of compression members after the abutting surfaces have brought completely into contact.

4. Clean bearing surfaces in permanent contact of all rust and scale and surface coated with the required corrosion protection before members are assembled.

5. Provide splices only where indicated.

6. Provide bolted and welded field connections as specified in this Section.

7. Remove run-off tabs and grid surfaces where requested by the Engineer.

8. Clean weld spatter from contact surface.

Field correction of fabrication by gas cutting shall not be permitted on any major member of the structural framing without prior approval of the Engineer.

Structural steel members of high strength steel shall be marked to permit visual verification of the grade of steel used.

3.14.3.7 BOLTING

Bolts shall be driven accurately into the holes without damaging the thread. Bolt heads shall be protected from damage during driving. Bolt heads and nuts shall rest squarely against the metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, beveled washers shall be provided to give full bearing to the head or nut. Where self-locking nuts are not furnished, bolt threads shall be upset to prevent the nuts from backing off.

Unfinished bolts transmitting shear shall be threaded to such a length that not more than one thread will be within the grip of the metal. The bolts shall be of the length that will extend entirely through but not more than 6.4 mm beyond the nuts. Bolts heads and nuts shall be drawn tight against the work with a suitable wrench not less than 80 mm long. Bolt heads shall be tapped with a hammer while the nut is being tightened. After having been finally tightened, nuts shall be locked.

Alternatively, bolts shall be tightened with a torque wrench to the appropriate torque for the bolt diameter.

3.14.3.8 GALVANIZING

Galvanizing, where called for, shall conform to the requirements of ASTM A 123. The required weight of the zinc coating for each type of material category with corresponding range of thickness is shown below in compliance with ASTM A 123.

Minimum Average Coating Thickness Grade by Material Category

Materials Category	All Specimens Tested (Steel Thickness Range (Measured), in. (mm)				
	<1/16 (<1.6)	1/16 to < 1/8 (1.6 to <3.2)	1/8 to <3/16 (3.2 to 4.8)	>3/16 to <1/14 (>4.8 to <6.4)	≥1/4 (≥6.4)
Structural Shapes & Plate	45	65	75	85	100
Strip & Bar	45	65	75	85	100
Pipe & Tubing	45	45	75	75	75
Wire	35	50	60	65	80

Coating Thickness Grade

Coating Grade	mils	Oz/ft^2	µm	g/m^2
35	1.4	0.8	35	245
45	1.8	1	45	320
50	2	1.2	50	355
55	2.2	1.3	55	390
60	2.4	1.4	60	425
65	2.4	1.5	65	460
75	3	1.7	75	530
80	3.1	1.9	80	565
85	3.3	2	85	600
100	3.9	2.3	100	705

Conversion Factors
Mils = µm x 0.03937
Oz/ft2 = µm x 0.02316
g/m2 = = µm x 7.067

3.14.3.9 PAINTING

Shop paint for all structural steel shall be carried out in accordance with Sub-section 4.5.5, "Painting".

3.14.3.10 INSPECTION

1. Recommendation and procedures governing inspection are in general described in API RP 2A Section 7 - Inspection, and description in this Section.

2. Inspection by the Engineer does not relieve the Contractor of his responsibility to provide the necessary inspection of his own work, and that of his sub-contractors, to ensure compliance with Contract Drawings and Specifications.

3. All sub-contractors, used for steel fabrication work by the Contractor shall be subject to the approval of the Engineer prior to their start of any work for this project.

4. The fabrication and erection facilities, materials and quality workmanship of the Contractor and his sub-contractors shall be available for inspection by the Engineer at all times during the progress of work. The Engineer shall have the right to reject work not satisfying the requirements of their governing references as mentioned herein before.

3.14.4 MEASUREMENT AND PAYMENT

The unit price of structural steel shall be measured and paid for by the kilograms and shall include procurement, transportation, fabrication, painting, erection and all related works. The unit prices shall constitute full payments for all labor, materials, scaffoldings, etc. necessary for the successful completion of the work.

3.15 RUBBLE CONCRETE

3.15.1 GENERAL

Division 1, “General Requirements” contain provision and requirements essential to these specifications, and apply to this section, whether or not referred to herein.

3.15.1.1 SCOPE OFWORK

This section shall consist of the furnishing and placing of rubble concrete for breakwater and other structures called for on the drawings, constructed on the prepared foundation bed, in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the drawings.

Rubble concrete shall be Class C concrete with stones embedded therein.

3.15.1.2 GENERAL REQUIREMENTS

Concrete works shall conform with the requirements of Section 3.2, “Concrete Works.”

3.15.1.3 SURVEY AND SETTING OUT

Contractor shall set out works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal/vertical limits of works.

Applicable requirements under Section 2.3, “Surveys, Soundings, Soil Investigations, Installation of Markers, etc.,” shall apply to his section.

3.15.2 MATERIAL REQUIREMENTS

3.15.2.1 STONES

Stones for rubble concrete shall consist of rocks as nearly rectangular in section as is practical. The stones shall be sound, tough, durable, dense, resistant to the action of air and water and suitable in all respects for the purpose intended.

Unless otherwise indicated on the drawings, stone for rubble concrete shall have a minimum weight of 5kg. to a maximum of 20kg. with at least 50 percent of the stones weighing more than 15 kg.

3.15.2.2 CONCRETE

Concrete shall be Class C, conforming to the requirements given under Section 3.2, “Concrete Works.”

3.15.2.3 FORMWORK

Formwork shall conform to the requirements given under Section 3.2, “Concrete Works.”

3.15.3 EXECUTION

All stones shall be cleaned thoroughly and wetted immediately before being set. Stones shall be laid firmly on prepared foundation bed starting from the base or bottom laying upslope. Concrete, 300 mm thick shall be laid first prior to placement of stones. Stones shall be carefully hand laid and thoroughly incorporated into the mass at least 300mm below the outside surface of the concrete. Horizontal and vertical spacing of stones shall not be less than 30 mm. Class C concrete shall be placed and spread to properly filled all the voids and up to the required sections, grades and elevations shown on the drawings. Finish surface of rubble concrete shall be smooth and no portion where stone is visible after completion of the works. Minimum covering of concrete shall be 300 mm all throughout.

3.15.4 MEASUREMENT AND PAYMENT

The quantities of rubble concrete to be measured for payment shall be the number of cubic meters of rubble concrete in place including preparation of foundation bed, in close conformity with the drawings and accepted by the Engineer.

The computation of the quantities will be based on the volume within the limiting dimensions designated on the drawings or as determined by the Engineer.

The quantities measured as provided above shall be paid for at the contract unit prices as shown in the Bill of Quantities, which price and payment shall be full compensation for the necessary excavation and preparation of the foundation bed, for furnishing and placing materials including all labor, equipment, tools and incidentals necessary to complete this item.

3.16 NAVIGATIONAL AID

3.16.1 SCOPE OF WORK

This Section covers the procurement and installation of light beacons and buoys for navigational aid including sinkers and reinforced concrete foundation. Unless otherwise instructed by PPA, the Contractor shall procure and install beacons at the location as indicated on the drawings.

The Buoy system shall be in accordance with the International Association of Lighthouse Authorities (IALA) Maritime Buoyage System B.

3.16.2 MATERIAL REQUIREMENTS

3.16.2.1 GENERAL DESCRIPTION

For reference and guidance, hereunder are the general descriptions of the light beacons to be procured and installed by the Contractor.

3.16.2.2 DESCRIPTION OF NAVIGATIONAL AIDS

Materials shall conform with the specified material or approved equivalent.

1. Light Buoy (Entrance Buoy) : Solar and Turbine (Wave Activator)

a. Buoy Data

1)	Main material	:	Steel plate
2)	Height overall	:	Approx. 8.9 m
3)	Focal plane height	:	Approx. 4.8 m

4)	Outside diameter of float	:	Approx. 2.6 m diameter
5)	Total weight	:	Approx. 5.5 tons
6)	Total buoyancy	:	Approx. 8.7 tons
7)	Reserved buoyancy	:	Approx.3.2 tons

b. Body

1)	Material	:	9 mm thick rolled steel plate
2)	Cathodic Protection	:	Anode plate
3)	Lifting eye	:	40mm steel plate (2 places)
4)	Mooring eye	:	40mm steel plate (2 places)
5)	Counter weight	:	Cast steel
6)	Bolts and Nuts	:	Stainless steel
7)	Buoy color	:	Starboard hand (RED) Port hand (GREEN)
8)	Rubber fender	:	Marine grade fender

c. Superstructure

1)	Material	:	Steel angle
2)	Bolts and nuts	:	Stainless steel
3)	Top mark	:	Steel

d. Mooring Equipment

1)	Main chain	:	32mm dia. Stud link chain with end link 30M x 1 pc JIS Grade 2
2)	Bridal chain	:	32mm dia. Stud link chain with end link 9M x 1 pc JIS Grade 2
3)	3 eyes piece	:	for 32mm dia. Chain x 1 pc
4)	Swivel piece	:	for 32mm dia. Chain x 1 pc
5)	Joining shackle	:	for 32mm dia. Chain x 6 pcs
6)	Anchor shackle	:	for 32mm dia. Chain x 1 pc
7)	Sinker (not to be supplied)	:	10 ton concrete sinker x 1 pc

e. Lighting Equipment

1)	Lantern	:	4 layer LED model
2)	Lens	:	Polycarbonate 4 layer type Fresnel lens

3)	Light color	:	Starboard hand (RED) Port hand (GREEN)
4)	LED load	:	12V 19.2W (RED colored light/ Green color)
5)	Flasher	:	Solid state system Pre-programmed with 256 flashing characters (248 pre-programmed, 8 as specified by customer). And 256 flashing characters are filled adjustable. At least 248 flashing characters should be pre-programmed.
6)	Sun Switch	:	Photo electric cell system
7)	Luminous intensity (fixed)	:	258 cd for Red light 265 cd for Green light
8)	Effective Range (T=0.74)	:	6.3 N.M. for Red 6.4 N.M. for Green
9)	Light Character	:	Fl 4 sec. (0.5+3.5 =4 sec)
10)	Protection for Stealing	:	Consideration must be taken for securing lantern to avoid loss after installation at sea.

f. Power Source

1)	Solar cell module	:	(12V, 26.2W) x 2 pcs Total output power 17.4V 52.4W
2)	Charging controller	:	Over voltage, over current and reverse current protection type
3)	Wave activated generator	:	maximum output power 12V 100W. Average output, power, more than 55W (in case wave height 40 cm and wave period sec)
4)	Storage battery	:	Sealed lead acid battery (12V, 40Ah) x 3 pcs
5)	Battery life (without charge)	:	More than one month operation

6) Protection form theft : Consideration must be taken for securing power source to avoid loss after installation at sea.

g. GPS Synchronizer

GPS synchronizer can control for synchronize group flashing period.

1)	Model	:	(GPS receiving type)
2)	Receive frequency	:	1575 42 MHz
3)	Receiving channel	:	8 Channel
4)	Signal pulse voltage	:	5V +- 0.1V (p-p)
5)	Signal pulse time	:	2.0ms +- 0.5 ms
6)	Shape signal pulse	:	Rectangular shape
7)	Interval time of signal pulse	:	1 time every 2 hours
8)	Signal pulse accuracy	:	Within 3±3 ppm /sec.
9)	Power voltage	:	DC 12V
10)	Power consumption	:	0.125Ah / day 12V D.C. power supply

h. Lens Reflector

a.	Model	:	(equivalent area 10 square meter)
b.	Weight	:	Approx. 6.5 kg
c.	Main Material	:	F.R.P. resin

i. Paint Schedule

Process	Kind of Paint	Number of Coat	Thickness
Above water line			**Total 338 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	2	200 microns
Final coat	Epoxy Topcoat	2	120 microns
Under water line			**Total 418 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	2	200 microns
Final coat	Epoxy Topcoat	2	200 microns
Interior			**Total 36 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	1	18 microns

2. Light Buoy (Channel Buoy)

a. BUOY DATA

1)	Main material	:	Steel plate
2)	Height overall	:	Approx. 5.7 m
3)	Focal plane height	:	Approx. 3.0 m
4)	Outside diameter of float	:	Approx. 1.5 m diameter
5)	Total weight	:	Approx. 1.7 tons
6)	Total buoyancy	:	Approx. 2.7 tons
7)	Reserved buoyancy	:	Approx. 1.0 tons

b. BODY

1)	Material	:	4.5 mm thick rolled steel plate
2)	Cathodic Protection	:	Anode plate
3)	Lifting eye	:	steel plate (2 places)
4)	Mooring eye	:	steel plate (2 places)
5)	Counter weight	:	steel plate
6)	Bolts and Nuts	:	Stainless steel
7)	Buoy color	:	Starboard hand (RED) Port hand (GREEN) Hazard (YELLOW)
8)	Rubber fender	:	Marine grade fender

c. Superstructure

1)	Material	:	Steel angle
2)	Bolts and nuts	:	Stainless steel
3)	Top mark	:	Steel

d. Mooring Equipment

1)	Main chain	:	24mm dia. Stud link chain with end link 20M x 1 pc JIS Grade 2
2)	Bridal chain	:	24mm dia. Stud link chain with end link 4M x 2 pcs JIS Grade 2
3)	3 eyes piece	:	for 24mm dia. Chain x 1 pc
4)	Swivel piece	:	for 24mm dia. Chain x 1 pc
5)	Joining shackle	:	for 24mm dia. Chain x 6 pcs
6)	Anchor shackle	:	for 24mm dia. Chain x 1 pc
7)	Sinker (not to be supplied)	:	10 ton concrete sinker x 1 pc

e. Lighting Equipment

1)	Lantern	:	1 layer LED model
2)	Lens	:	Polycarbonate 1 layer type Fresnel lens
3)	Light color	:	Starboard hand (RED) Port hand (GREEN) Hazard (YELLOW)
4)	LED load	:	12V 4.8W (RED colored light/ Green color)
5)	Flasher	:	Solid state system Pre-programmed with 256 flashing characters (248 pre-programmed, 8 as specified by customer). And 256 flashing characters are filled adjustable. At least 248 flashing characters should be pre-programmed.

6)	Sun Switch	:	Photo electric cell system
7)	Luminous intensity (fixed)	:	38 cd for Red light 48 cd for Green light 37 cd for Yellow light
8)	Effective Range (T=0.74)	:	4.0 N.M. for Red 4.8 N.M. for Green 4.0 N.M. for Yellow
9)	Light Character	:	Fl 4 sec. (0.5+3.5 =4 sec) for green and red
		:	Fl.5 sec. (0.5+4.5 = sec) for yellow
10)	Protection for Stealing	:	Consideration must be taken for securing lantern to avoid loss after installation at sea.

f. Power Source

1)	Solar cell module	:	(12V, 11.5W) x 1 pc Total output power 17.4V 11.5W
2)	Charging controller	:	reverse current protection type
3)	Wave activated generator	:	maximum output power 12V 100W. Average output, power, more than 55W (in case wave height 40 cm and wave period sec)
4)	Storage battery	:	Sealed lead acid battery (12V, 40Ah) x 1 pc
5)	Battery life (without charge)	:	More than one month operation
6)	Protection form theft	:	Consideration must be taken for securing power source to avoid loss after installation at sea.

g. Paint Schedule

Process	Kind of Paint	Number of Coat	Thickness
Above water line			**Total 338 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	2	200 microns
Final coat	Epoxy Topcoat	2	120 microns
Under water line			**Total 418 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	2	200 microns
Final coat	Epoxy Topcoat	2	200 microns
Interior			**Total 36 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	1	18 microns

3. Light Beacon

a. Beacon Data

1) Main material : Mild Steel
2) Height overall : Approx. 3.3 m
3) Focal plane height : Approx. 3.2 m
4) Outside diameter of body : Approx. φ318.5 mm & φ 508mm
5) Total weight : Approx. 407 kg

b. Body

1) Material : 8.0 mm thick steel pipe
2) Bolts and nuts : Stainless steel
3) Buoy color : White

c. Superstructure

1) Material : Steel pipe
2) Bolts and nuts : Stainless steel

d. Lighting Equipment

1)	Lantern	:	(1 layer LED model)
2)	Lens	:	Polycarbonate Fresnel lens
3)	Light color	:	White
4)	LED load	:	12V 4.8W White color light
5)	Flasher	:	Solid state system Pre-programmed w/ 256 flashing characters. (248 pre-programmed 8 as specified by customer). And 256 flashing characters are field adjustable. At least 248 flashing characters should be pre-programmed.
6)	Sun Switch	:	Photo electric cell system
7)	Luminous intensity (fixed)	:	40 cd for White
8)	Effective luminous intensity	:	28 cd for White
9)	Effective Range (T=0.74)	:	3.7 N Miles for White
10)	Light Character	:	Fl 4 sec. (0.5+3.5 = 4 sec) for white
		:	Fl.6 sec. (0.5+5.5 = 6 sec) for white

e. Power Source

1)	Solar cell module	:	12V, 11W) x 1 pc
2)	Charging controller	:	Over voltage charger
3)	Storage battery	:	Sealed lead acid battery (12V, 40Ah) x 1 pc
4)	Battery life (without charge)	:	Approx. 30 days operation

f. Paint Schedule

Process	Kind of Paint	Number of Coat	Thickness
Interior of battery box body			**Total more than 220 microns**
Under coat	Epoxy zinc rich primer	1	more than 25 microns
	Epoxy resin	2	more than 125 microns
Final coat	Polyurethane resin	1	more than 35 microns
	Polyurethane resin	2	more than 35 microns
Exterior of body			**Total more than 220 microns**
Under coat	Epoxy zinc rich primer	1	more than 25 microns
	Epoxy resin	2	more than 125 microns
Final coat	Polyurethane resin	1	more than 35 microns
	Polyurethane resin	2	more than 35 microns

4. Light Beacon

a. Beacon Data

1) Main material : Mild Steel
2) Height overall : Approx. 3.6 m
3) Focal plane height : Approx. 3.5 m
4) Outside diameter of body : Approx. φ216.3 mm
5) Total weight : Approx. 150 kg

b. Body

1) Material : 5.8 mm thick steel pipe
2) Bolts and nuts : Stainless steel
3) Buoy color : White

c. Superstructure

1) Material : Steel pipe
2) Bolts and nuts : Stainless steel

d. Lighting Equipment

1)	Lantern	:	(1 layer LED model)
2)	Lens	:	Polycarbonate Fresnel lens
3)	Light color	:	White
4)	LED load	:	12V 4.8W White color light
5)	Flasher	:	Solid state system Pre-programmed w/ 256 flashing characters (248 pre-programmed, 8 as specified by customer). And 256 flashing characters are field adjustable. At least 248 flashing characters should be pre-programmed.
6)	Sun Switch	:	Photo electric cell system
7)	Luminous intensity (fixed)	:	40 cd for White
8)	Effective luminous intensity	:	28 cd for White
9)	Effective Range (T=0.74)	:	3.7 N Miles for White
10)	Light Character	:	Fl.4 sec. (0.5+3.5 = 4 sec) for white
		:	Fl.6 sec. (0.5+5.5 = 6 sec) for white

e. Power Source

1)	Solar cell module	:	(12V, 11W) x 1 pc
2)	Charging controller	:	Over voltage charger
3)	Storage battery	:	Sealed lead acid battery (12V, 40Ah) x 1 pc
4)	Battery life (without charge)	:	Approx. 30days operation

f. Paint Schedule

Process	Kind of Paint	Number of Coat	Thickness
Interior of battery box body			**Total more than 220 microns**
Under coat	Epoxy zinc rich primer	1	more than 25 microns
	Epoxy resin	2	more than 125 microns
Final coat	Polyurethane resin	1	more than 35 microns
	Polyurethane resin	2	more than 35 microns
Exterior of body			**Total more than 220 microns**
Under coat	Epoxy zinc rich primer	1	more than 25 microns
	Epoxy resin	2	more than 125 microns
Final coat	Polyurethane resin	1	more than 35 microns
	Polyurethane resin	2	more than 35 microns

3.16.3 EXECUTION

1. Prior to procurement of light beacons and bouys, the Contractor shall submit the manufacturer's catalogue, with detailed information of the product, for approval of the Engineer. The Contractor shall carry out detailed hydrographic survey in the vicinity of the place where light beacons and bouys are intended to be installed for Engineer's approval. The Contractor shall also secure permit/clearance to install the light beacons from the Philippine Coast Guard.

2. After installation, the actual location of light beacons as installed shall again be surveyed and the results thereof shall be submitted to the Engineer for approval.

3.16.4 MEASUREMENT AND PAYMENT

Measurement and payment of quantities of light beacon and bouys shall be based on the number of sets of light beacon completely installed including reinforced concrete base certified by PPA.

The work includes the furnishing of all labor, materials, and equipment required to install all navigational aids, in accordance with these Specifications and where shown on the Drawings and to the approval of the Engineer.

The Contractor shall satisfy himself and shall be deemed to have satisfied himself as to the nature of the sub-soil conditions, topographic and hydrographic conditions.

The Contractor shall be deemed to include in his unit prices allowances to cover all risks, except noted otherwise, for any contingencies that may arise during or in connection with the works.

3.17 PRECAST CONCRETE

3.17.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

Precast concrete to be used shall comply generally with the sections relating to concrete and reinforcement concrete and the following clauses, including those for prestressed concrete where applicable.

Concrete members so specified shall be fabricated as precast units with concrete for the specified class placed into a grout-tight mould. If so required, the mould shall be laid on the vibrating table and vibration applied while the concrete is placed.

Permanently exposed surfaces shall have a finish given by moulds of closely-jointed steel material. The surface shall be improved by carefully removing all fins and other projections. After inspection by the Engineer, any concrete surfaces which have been accepted but contain blemishes filled with a cement and fine aggregate paste matching the color of the concrete.

Surfaces which will subsequently received grout or concrete to complete a structural connection or other composite structural component of which the precast unit forms a part, shall be prepared for surfaces treatment as early as possible after casting. This preparation shall be carried out preferably when the concrete has set but not hardened, by jetting with a fine spray of water or rushing with a stiff brush, just sufficient to remove the outer mortar skin and to expose the larger aggregate without its being disturbed. Where this treatment is impractical, sand blasting or a needle gun should be used to remove the surface skin and laitance. Hacking shall be avoided.

The Contractor will be permitted to obtain precast concrete units from outside suppliers provided that they comply with the Specification and that the Contractor obtains the Engineer’s approval for each supplier.

The Contractor shall give to the Engineer full details of proposed methods of handling and stacking precast concrete units. The Engineer will examine these details and will either approve the methods or cite other modifications design to ensure that no excessive stresses are set up in the units. The finally approved methods shall be adhered to at all times and the

Contractor shall be deemed to have included in his rates for all measures required to handle and stack beams and units safely and without undue stressing.

3.17.2 CASTING BED AND MARKING

All precast units shall be cast on a suitably prepared level, unyielding paved area or on suitable platforms. A suitable serial number indicating the date of casting shall be impressed or painted on each unit or portions cast.

3.17.3 CONSTRUCTION JOINT

Every unit shall be cast in one continuous operation. Construction joints shall be avoided.

3.17.4 TOLERANCES FOR INDIVIDUAL UNITS

Precast concrete units shall be true to the size and dimensions shown on the Drawings within the following limits:

Lengths

up to 3 meters	± 6
More than 3 meters but less than 6 meters	± 9
6 meters or more	± 12

Cross Section (each direction)

up to 0.5 meters	± 6
More than 0.5 meters but less than 0.75 meters	± 9
0.75 meters or more	± 12

Straightness or bow (deviation from intended line)

up to 3 meters	± 6
More than 3 meters but less than 6 meters	± 9
6 meters or more	± 12

3.17.5 SQUARENESS

When measuring the squareness of a corner, the longer of the two adjacent sides shall be taken as the base line. The shorter side shall not vary in its distance from a perpendicular so that the difference in mm. between the greatest and shortest dimensions exceeds :

Lengths of short side

up to 1.2 meters	± 6
More than 1.2 meters but less than 3 meters	± 9
3 meters or more	± 12

3.17.6 TWIST

Any corner shall not be more than the tolerance stated in mm. from the plane containing the other three corners:

up to 0.7 meter wide and up to 6 meters in length	± 6
over to 0.7 meter wide and for any length	± 9

3.17.7 MEASUREMENT AND PAYMENT

1. Prices to be paid shall constitute full payment for all labor, materials, and equipment and all testing and incidental works necessary for the completion of the work.

2. Precast concrete shall be measured either by the number of each precast unit or by volume in cubic meter whichever is called in the Bill of Quantities. Payment shall include the cost of reinforcing steel bar needed for each precast units.

   No deduction shall be made for volume of concrete displaced by reinforcing steel, structural steel or steel piles.

3.18 PRESTRESSED CONCRETE

3.18.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.18.1.1 SCOPE OF WORK

The sections relating to concrete, reinforced concrete and precast concrete shall be read in conjunction with the following clauses.

The work shall consist of furnishing, transportation, storage and placing of prestressed concrete, stressed by pretensioning or post-tensioning method. It shall be in accordance with the Drawings and as specified herein Also the work shall be in accordance with Section 3.2, “Concrete Works” of these Specifications.

Unless otherwise ordered by the Engineer, the Contractor shall certify for the Engineer’s approval that a technician skilled in the required prestressing method will be available during its implementation to give aid and instruction in the use of prestressing equipment and installation of materials as maybe necessary to produce prestressed concrete.

3.18.1.2 DEFINITION

1. Post-tensioning is defined as any method of prestressing concrete in which tensioned reinforcement is stretched after the concrete has hardened.

2. Pretensioning is defined as any method of prestressing concrete in which the tensioned reinforcement is tensioned before the concrete is placed.

3. Prestressing reinforcement is defined as any reinforcement to which prestress is applied by post-tensioning or pre-tensioning method.

3.18.2 MATERIAL REQUIREMENTS

3.18.2.1 TYPES OF CONCRETE

The concrete shall be of the types as specified on the Drawings and at the time of prestressing shall have reached the specified strengths as determined by the test cylinders which have matured under the same conditions as the units to which the cylinders shall be marked conspicuously with the date of casting and other identification marks as directed by the Engineer.

3.18.2.2 PRESTRESSING STRAND

Prestressing strand to be used shall be high-tensile strand conforming to JIS G 353G, SWPR 19 (AASHTO M 203, “Steel Strand, Uncoated Seven-Wire for Prestressed Concrete” or ASTM A 416, “Steel Strand, Uncoated Seven-Wire for Prestressed Concrete”).

3.18.3 EXECUTION

3.18.3.1 GENERAL

Prestressed concrete structural members shall be constructed and placed in accordance with the requirements of Section 3.2, Concrete Works”.

3.18.3.2 PRESTRESSING METHODS

The methods of prestressing to be used shall be optional but shall be subject to all requirements herein after specified.

The Contractor, prior to casting any members to be prestressed shall submit in advance for approval of the Engineer complete details of the methods, materials and equipment proposed to be used in the prestressing operations. Such details shall outline the method and sequence of prestressing, complete specifications and details of the prestressing steel and anchoring devices proposed for use, anchoring stresses, type of sheath, and all data pertaining to the prestressing operations including the proposed arrangement of the prestressing units in the members pressure grouting materials and equipment.

3.18.3.3 PRESTRESSING EQUIPMENT

Hydraulic jacks shall be equipped with accurate pressure gauges. The Contractor may elect to substitute screw jacks or other types for hydraulic jacks. In which case, proving rings or other approved devices shall be used in connection with the jacks. All devices, whether hydraulic jack gauges or otherwise shall be calibrated so as to permit the stress in the prestressing steel to be computed at all times. A certified calibration curve shall accompany each device. Safety measures shall be taken by the Contractor to prevent accidents due to possible breaking of the prestressing steel or the slipping of the grips during the prestressing process.

3.18.3.4 CASTING YARD

The precasting of prestressed concrete structural members may be done at a location selected by the Contractor, subject of the approval of the Engineer

3.18.3.5 PLACING ENCLOSURES

Enclosures for prestressed reinforcement shall be accurately placed at locations shown on the Drawings or approved by the Engineer.

3.18.3.6 PLACING OF STEEL STRANDS

All steel strands units shall be accurately and firmly placed in the position shown on the drawings or as instructed by the Engineer.

Steel strands clearance from the forms shall be maintained by stays, blocks, ties or hangers approved by the Engineer. Blocks for holding units from contact with the forms shall be precast mortar blocks of approved shape and dimensions. Layers of units shall be separated by mortar blocks or other equally suitable devices. Wooden blocks shall not be left in the concrete.

Suitable horizontal and vertical spacers shall be provided if required to hold the wire and strand correctly in place in the sheath.

3.18.3.7 PLACING OF CONCRETE

Concrete shall be deposited in the forms only after the Engineer had inspected and approved the reinforcement, enclosures, anchorages, and prestressing steel. The concrete shall be vibrated internally or externally or both with care as ordered by the Engineer in such a manner as to avoid displacement of reinforcement, enclosures, or prestressing strand.

3.18.3.8 CONTRACTION/CONSTRUCTION JOINT

Concreting for single prestressed concrete units shall be done continuously without any contraction joint.

Construction joints shall not be allowed unless permitted by the Engineer in writing.

3.18.3.9 CURING

Concrete shall be adequately cured to prevent the harmful effects of drying and rapid change in temperature. Curing shall be done by methods approved by the Engineer. Proper care shall also be exercised to insure that fresh concrete will not be damaged by vibration, impact or lifting or loading.

Prestressed concrete slabs shall be adequately cured before the application of tensioning.

3.18.3.10 PRE-TENSIONING

The prestressing elements shall be accurately held in position and stressed by jacks. The Contractor shall record the jacking forced and the elongations produced. Several units may be cast in one continuous line and stressed at one time. Sufficient space shall be left between ends of units to permit access for cutting after the concrete has attained the required strength. No bond stress shall be transferred to concrete, nor end anchorages released until the concrete has attained a compressive strength, as shown by cylinder tests, of at least 28 MPa. The elements shall be cut or released in such an order that lateral eccentricity or prestress will be a minimum.

3.18.3.11 POST-TENSIONING

Tensioning of the prestressing reinforcement shall not be commenced until tests on concrete cylinders, manufactured from the same concrete and cured under the same conditions has attained a compressive strength of at least 28 Mpa.

The steel strands shall be stressed by means of jacks to the required tension and the stressed transferred to the end anchorages. The tensioning process shall be conducted in a manner that the tension being applied and the elongation of the prestressing elements may be measured at all times.

To minimize possible irregularity in quality the tensioning operation shall be closely supervised for each group of strands to insure that tension applied will not go under the specified value.

During the tensioning operation the Contractor shall monitor the amount of tension and the elongation of strand to insure that they are proportional. The tension applied to the strand shall be measured by the load gauge and the elongation by approved method. The tensioning operation shall be re-executed if the relationship between the applied tension and the elongation vary from the allowed proportion. In the event that any abnormality is found after re-execution of tensioning the operation shall be suspended and the cause determined taking into account friction loss, deformation or slippage of anchors and other causes allowed by the Engineer. Where tension is applied to each piece of strand or group of strands, care shall be exercised so that no harmful stress is allowed to concentrate at any stage of operation. The tension to be applied at the end of strands shall be determined taking into account the change in tension applied to each group of strand due to elastic deformation of concrete.

3.18.3.12 GROUTING

Grouting shall be done in such a way that it will fill up the duct while the strands are well protected and concrete and strands are firmly bonded.

The grout shall be tested in accordance with the test methods for consistency, bleeding ratio, expansion ratio and concrete strength recommended by the Japan Society of the Civil Engineers or other equivalent standards of tests.

The test results shall comply with the following requirements:

- Consistency, Flow Time

  15-30 sec (JA funnel) or 6-12 sec (J funnel)
- Expansion ratio, Less than 10%
- 28 - day compressive strength more than 200 kg./cm^2.

The cement ratio of the grout shall less be than 45%.

All prestressing strands to be bonded shall be free of dirt, loose rust, grease, or other deleterious substances. Before grouting, the ducts shall be free of water, dirt or any other foreign substance. Cleaning may be done preferably by bombarding with compressed air until no water comes through the duct. The grout pump shall be capable of pumping grout gradually and without any air bubble. The duct shall be thoroughly cleaned and wet with water before commencing the grouting operation. Pouring of grout shall be done slowly, using the grout pump. The grout shall be filtered through suitable sieve before grouting. Sufficient pressure shall be used in grouting to force the grout completely through the duct, care being taken that rupturing of the ducts does not occur.

The grout mixer shall be of sufficient capacity and capable of mixing grout for a 5 minutes continuous grouting operation. Grout of uniform consistency shall be delivered through the outlets in sufficient amount. The outlets shall then be closed one by one along the direction of grouting. The grout shall be of fluid or thick paint consistency proportioned so that free water will not separate from the mix. Commercial plasticizers used in accordance with the manufacturer's recommendation may be used provided they contain no ingredients that are corrosive to steel.

3.18.3.13 PREMOLDED EXPANSION JOINT FILLER

Premolded expansion joint filler used for the wharf widening section, distance beam and the landside crane rail foundation beam shall be soft fiber strips impregnated with bitumen, conforming to Item 405-2.8,Standard Specifications for Highway and Bridges of the Department of Public Highways, revised 2004.

3.18.4 MEASUREMENT AND PAYMENT

1. The quantity of precast prestressed members to be measured shall be the actual number of members, of types installed in place, level completed and accepted before placement of any in-situ concrete.

2. The work measured as provided above shall be paid for at the unit rates entered into the Bill of Quantities.

3. The unit rates for precast prestressed members shall include for:

   a. Concrete, formwork, non-prestressed and prestressed reinforcement, enclosures for prestressing steel, anchorages, grouting curing plates, nuts and other such incidentals necessary to complete the work.

   b. Delivery and Settings: The payment shall be fully compensated for furnishing and placing of all materials including all labor, tools, equipment, testing and incidentals thereto.

3.19 PAINTING OF PORT FACILITIES

3.19.1 GENERAL

VOLUME I, preceding these Technical Specifications and Section these Technical Specifications and Section I, - GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, Whether or not referred to herein.

3.19.1.1 SCOPE OF WORK

This Section covers the surface preparation, coating materials and application of coatings system required for the Works.

3.19.1.2 GENERAL PROVISIONS

1. All exposed metal surfaces, except metal surfaces embedded in concrete or galvanized shall be painted unless otherwise specified. All tools and equipment shall be suitable for the work and shall be maintained in good order.

2. Applicable Publications: The following publications listed below, but referred to thereafter by basic designation only, forms a part of this specification to the extent indicated by the reference thereto:

Steel Structures Painting Council (SSPC) U.S. Specification.

JIS K 5628 Red-lead Zinc Chromate Anti-Corrosive Paint.

3.19.1.3 STORAGE AND DELIVERY

1. The Contractor shall deliver all materials to the job site in the original labeled seated cans and containers, with labels intact and seal unbroken.

    a. Seals shall remain unbroken until after inspection and acceptance of materials by the Engineer.

    b. The Contractor shall deliver materials in ample quantities in advance of the need to avoid any delays or interruptions in the Work.

2. Storage: Paint and thinner shall be stored in accordance with the manufacturer's printed instructions.

    a. Observe all regulations required for storage of paint and post all necessary safety signs required by governing codes.

    b. Repair any damage caused by failing to exercise proper precautions in paint storage.

    c. All containers of paint shall remain unopened until required for use; containers which have been opened shall be used first, otherwise the oldest paint shall be used first.

    d. No paint material shall be used which has exceeded the manufacturer's recommended shelf life.

3.19.1.4 QUALITY ASSURANCE

1. Surface preparation and painting work shall be carried out in accordance with the requirements specified herein.

2. The paint manufacturer's instructions shall be observed at all times, with particular reference to storage, mixing, thinning, application and the time interval between paint coats.

3. The Contractor shall ensure that his shop and site personnel, have at all times, available for the Engineer copies of al above mentioned standard Specifications and the applicable manufacturer's instructions and data sheets.

3.19.2 MATERIALS

3.19.2.1 GENERAL

Paints for the protective coating system shall be the product of a manufacturer, approved by the Engineer.

3.19.2.2 GENERAL PAINT SCHEDULE

1. Protective shop coating for metal works shall be as follows:

    a. Primer: One (1) coat of red-based zinc chromate anti-corrosive paint 3 mils (76 microns) conforming to JIS K 5628 or approved equal.

    b. Coating: Two (2) coats of anti-corrosive paint 6 mils conforming to JIS K 5621 or approved equal.

2. Protective shop coating for exposed general metal structures.

    a. Primer: One (1) coat of red-lead zinc chromate anti-corrosive paint 3 mils (76 microns) conforming to JIS K 5628 or approved equal.

    b. Coating: Two (2) coats of anti-corrosive paint for general use 6 mils conforming to JIS K 5621 or approved equal.

    c. Color: As shown on the Drawings or as requested by the Engineer.

3. Cement Mortar Wall and Wood as shown on the Drawings or as directed by the Engineer shall be painted with one coat of linseed oil and two coats of oil paint of approved quality.

4. Equipment

    a. Paint Mixers: Mechanical mixers shall be employed for all paint mixing operations, except that the Engineer may allow hand mixing of small quantities at his discretion.

    b. Compressed air supply for blast cleaning and paint spraying shall be adequate in pressure and volume.

3.19.3 EXECUTION

1. Steel surface shall be cleaned in accordance with the approved method as described below:

a. All ground welds, burrs and sharp surface projection shall be ground smooth and all weld splatter shall be removed prior to blast cleaning.

b. The grit size shall be 20-40 mesh Ottawa Fint Silica or equivalent. Grit or shot blasting which obtain the desired profile and degree of cleaning are also acceptable.

c. Blast cleaning operations shall not be conducted on surfaces that will be wet after blasting and before coating, or when the surfaces are less than 10°C above degree points, or when the relative humidity of the air is greater than 95 percent.

d. Any oil grease, soil, dust or other foreign matter deposited on the cleaned surfaces shall be removed prior to painting. In the event that rusting occurs after completion of the surface preparation, the surfaces shall be cleaned again in accordance with the specified method.

e. Particular care shall be taken to prevent contamination of cleaned surfaces with the salt, acids, alkali or other corrosive chemicals before the application of the paint. Such contamination shall be removed from the cleaned surface by flash blasting and the paint applied immediately.

f, Care shall be taken to prevent contamination of cleaned and painted surfaces by cleaning operations in an adjacent area.

g. Surfaces not included to be painted shall be suitably protected from the effects of cleaning and painting operation.

2. All loose mill scaled and all loose or non-adherent rust and all loose paint, shall be removed by one or more of the following methods; but large areas of tight, well adhered paint, even though they may be removable, shall be removed only if specified. The methods for such removal are:

a. Power wire brushing using rotary radial or cup brushes of suitable size, entering all accessible openings, angles, joints, and corners. The steel wire of such brushes shall have sufficient rigidity to clean the surface. Brushes shall be kept free of excess foreign matter, and shall be discarded shall be cleaned but not burnished to a detrimental degree.

b. Power impact tool cleaning using power driven needle guns, chipping or scaling hammers, scalers, or other similar impact cleaning tools. Cutting edges of such tools shall be kept in effective condition.

c. Power grinding using abrasive wheels or power sanding using abrasive materials. Sanding or abrasive materials shall be discarded when they become in effective.

3. Mill scale, rust and paint are classified as “loose mill scale”, “loose and non-adherent rust,” and “loose” or “removable paint” if they can be removed from a steel surface by power wire brushing using a commercial air or electric wire brushing machine operated at a speed under load of 3450 RPM and equipped with a 150 mm diameter cup brush, of double row knotted construction made of No. 20 gauge music wire (Osborn Manufacturing Company), Cleveland, Ohio, Brush No. 4503 or equal. The brush shall be held against be held against the steel surface with a forced of 35.2 kgs And the rate of cleaning shall be 0.186 square meters of surface per minute. This test must be conducted on an area not previously brushed, scrapped, or sanded, but from which all detrimented stratified rust (rust-scale), oil and grease, if present, have been removed. This test establishes a standard for surface preparation and shall not be considered as establishing the production rate of cleaning.

4. Regardless of the method use for cleaning under this specification, the surface shall be cleaned at least as well as the surface resulting from the test as specified in this specification or to match the alternatively specified visual standard.

5. In preparing surfaces for repainting, all loose paint shall be removed. Thick edges of remaining old paint shall be feathered so that the repainted surface can have a smooth appearance. The remaining old paint shall have sufficient adhesion so that it cannot be lifted as a layer by inserting the blade of a dull putty knife under it.

6. All accessible weld flux and spatter shall be removed by blast cleaning or by power tools. Any remaining detrimental weld flux deposits shall be removed by blast cleaning, thorough power tool cleaning, or by washing with water or with phosphate solution as described in the approved standard specifications.

7. The accessible portions of all partially enclosed steel members shall be cleaned. On new work, areas which will be inaccessible after assembly shall be cleaned before assembly.

8. Rivet heads, cracks, crevices, gap joints, filler welds, and re-entrant angles shall be cleaned by the use of power wire brushes, needles, guns, sharp chisels used in chipping, scaling hammers, rotary grinders, or sanders, or by a combination of such tools.

9. All tools shall be operated in such a manner that no burns or sharp ridges are left on the surface and no sharp ridges are left on the surface and no sharp cuts are made into the steel.

10. Areas inaccessible for cleaning by power tools but accessible for hand cleaning shall be cleaned by the approved methods.

11. After the aforesaid operations are competed, dust and other loose matter shall be removed from the surface. If detrimental amounts of grease or oil are still present, these areas shall be spot cleaned with solvent.

12. The pretreatment (if any), or the prime coat of paint shall be applied as soon as possible after cleaning and before further deterioration of the surface occurs.

3.19.3.1 ALTERNATIVE SURFACE PREPARATION OF STEEL

1. The procedures required for the pickling process of steel surfaces prior to the application of Inorganic zinc coating shall consist of the following sequences of operations:

    a. Pretreatment: Remove soil, drawing compounds, salts or other foreign matter (other than grease or oil) by brushing with stiff fiber or wire brushes or by scraping.

        1. Deposits of oil grease shall be completely removed by solvent wiping the surface with rags or brushes soaked in solvent. The final cleaning shall be done using clean solvent and clean rags or brushes to provide an oil-free surface.

        2. An alternate method may be used where heavy deposits are removed by the above method, followed by vapor degreasing using stabilized chlorinated hydrocarbon solvents.

    b. Acid Baths: The steel shall then be dipped into a solution of 5 - 6 percent sulphuric acid that is maintained at a temperature of 71 - 82°C until all rust and scale is removed. The required time for removal of rust and scale can vary from 5 - 32 minutes, depending on thickness of the steel.

    c. Water Rinse: The steel is then rinsed in a fresh water tank maintained at a temperature of 38 - 60°C for a minimum time of two minutes to completely neutralize the steel surface.

d. Caution: Prolonged immersion in the acid bath will caused smut deposit on the surface. Steel surfaces shall be examined prior to coating and, if surface is contaminated with smut, the surface shall be cleaned with rags.

e. Requirements: The maximum allowable concentration of dissolved iron content shall not exceed 5 percent in the sulphuric acid bath. Water rinse tanks shall contain only fresh water. The rinse tank shall be continuously supplied with fresh water and the total sulphate shall not exceed 0.1 percent by weight.

3.19.3.2 SURFACE PREPARATION OF WOOD

1. Wood surfaces shall be sanded to a fresh surface. Surface mould where present, shall be removed by washing, rubbing down and burning off as necessary. Oily timbers shall be swabbed with white spirt. Resinous exudation and large knots shall be removed and replaced with filler or knotting.

2. Parts of timber to be enclosed in walls shall always be primed unless already impregnated. Priming shall be brushed on and a minimum of two coats applied to end grain. When the priming paint is hard, all cracks, holds, open joints, etc. Shall be made good hard stopping and rubbed down with fine abrasive paper. Priming of joinery shall be applied only on site after the Engineer has approved such joinery and before it is fixed. For internal surfaces primer coats shall be carefully flatted.

3.19.3.3 MIXING AND THINNING

1. Mixing and thinning of paint shall be done in accordance with the manufacturer's printed instructions. The pot life of each paint as stated by the manufacturer shall not be exceeded.

3.19.3.4 WEATHER CONDITION

1. The paint shall not be applied when the relative humidity is above 85 percent. The paint shall not be applied in rain, wind, fog, dust or mist.

3.19.3.5 APPLICATION

1. Paint shall be applied in accordance with the manufacturer's printed instructions.

2. The paint work crew shall be property trained in the use of the paint materials specified herein. Paint shall not be applied by personnel who are not familiar with the paint and its application.

3. Each coat of paint shall be applied as a continuous film of uniform thickness free of pores. Any thin spots or missed areas shall be repainted and permitted to dry before the following coat of paint is applied.

4. During the application of the paint care shall be taken to prevent all runs or sags. Should either occur, they shall be brushed out. Paint shall be worked into all crevices and corners.

5. If during the application of the paint, there appears faulty paint, i.e., in color, consistency, dry lime or quality of finish, then the work shall be stopped by the Contractor and the manufacturer consulted. The Contractor shall also notify the Engineer in writing. The responsibility for such action lies solely with the Contractor.

6. Areas where field welds are to be made shall not be painted within the 150 mm of the edges to be field welded.

7. After the application of each coat, the dry film thickness shall be checked by means of a micrometer or magnetic thickness gauge.

8. Paint that curls or lifts after application shall be removed and the area shall be cleaned and repaired in accordance with these Specifications.

3.19.3.6 TOUCH-UP PAINTING

1. Touch-up painting shall be done with the same paint as used for the original coat. The resulting minimum dry film thickness shall be the same as for the original coat.

2. Touch-up painting shall include cleaning and painting of field connections, welds and all damaged or defective paint and rusted areas.

3. During touch-up painting, only loose, cracked brittle of non-adherent paint shall be removed during cleaning. All exposed edges shall be feathered. Touch-up painting shall be performed in a manner which will minimize damage to sound paint. Rust spots shall be thoroughly cleaned and edges of the existing paint shall be scraped back to sound material.

3.19.3.7 DRYING

1. No primer or paint shall be forced dried under conditions which will cause cracking, wrinkling, blistering, formation of pores which would detrimentally affect the condition of the paint.

2. No drier shall be added to the paint unless specified in the manufacturer's printed instructions.

3. Painted surfaces shall be protected from dust, dirt, and the elements of the weather until dry to the fullest extent practicable.

4. After drying, any areas of paint damaged from any cause shall be removed, the surface again prepared and then repainted with the same paint and to the same thickness as the undamaged areas.

3.19.3.8 HANDLING

1. Paint which is damaged in handling shall be scraped off the touched-up with the same paint and in the same thickness as was previously applied to the damaged are at Contractor's expense.

2. Precautions shall be taken to minimize damage to paint films resulting from stacking for drying.

3.19.3.9 INSPECTION

1. All work and materials supplied under this specification shall be subject to inspection by the Engineer.

2. The Contractor shall correct such work or replace such material as is found defective under this Specification at his own expense.

3.19.3.10 MEASUREMENT AND PAYMENT

1. Measurement for painting of Port facilities is included in the individual work items of structural steel, navigation aids and fender system.

2. Painting of port facilities will not be measured for payment and all costs thereof shall be deemed to be included in other items of work.

3. Payment for painting of buildings shall be by the square meter at the contract unit price for the pay items as shown in the Bill of Quantities which includes all other related works as prescribed in this Section.

3.20 CERAMIC-FILLED LIQUID MEMBRANE

3.20.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.20.1.1 SCOPE

This work covers all the following requirements regarding the application of a ceramic-filled liquid membrane on the surface of concrete deck in accordance with the dimensions shown on the Drawings.

3.20.1.2 DELIVERY AND STORAGE

The ceramic-filled liquid membrane shall be delivered in pre-measured containers of 15 litter pails (net material volume). The containers must be appropriately sealed and boxed to protect from spillage and exposure to the elements.

3.20.2 MATERIAL REQUIREMENTS

The ceramic-filled liquid membrane shall meet the following requirements in full. if required, a sample of the material in 3 pieces of 150 mm x 150 mm in shall be supplied to the Engineering for approval and retention for purposes of comparative testing.

3.20.2.1 PHYSICAL PROPERTIES

1. The ceramic-filled liquid membrane shall be a single component with a vehicle type of water based vinyl terpolymer matrix, 56% volume solids.

2. The material furnished under this specification shall be moisture resistant, UV resistant, non toxic and non flammable.

3. The material furnished under this specification when mixed and applied in accordance with the manufacture's instruction, shall produce a high quality, durable, seamless and flexible membrane.

4. The ceramic-filled liquid membrane shall have a flat finish.

5. The DFT of the applied ceramic-filled membrane shall be at least 12 mils applied in two coats at 6 mils per coat.

3.20.2.2 MECHANICAL AND CHEMICAL PROPERTIES

The ceramic-filled liquid membrane supplier is required to certify that materials delivered will have to meet or exceed the following properties:

Drying Time	Typical 1 hour under normal ambient conditions
Elongation	230% (ASTM D 2370)
Fire Retardancy	Does not support combustion (ASTM D 1360)
Standing Water	Atlas Cell Test-No blistering, debonding or water penetration after 1 month submerged and at 100% humidity.

1. Installation of the ceramic-filled liquid membrane shall be in accordance with the manufacturer's instructions and recommendations. Suppliers shall be required to provide detailed descriptions of their proposed installation procedure for each unit of the material. mThese descriptions shall include the following:

    a. Surface preparation techniques to insure effective adhesion of the membrane to various substrates.

    b. Application procedures of the membrane.

    c. Time and temperature conditions to be obtained in order to completely solidify and cure the membrane.

2. To facilitate Quality Assurance, each unit of the material delivered to site shall be clearly labeled on the box with the manufacturer's name, product name, and production batch number.

3. The ceramic-filled liquid membrane shall be manufactured by a reputable manufacturer who shall confirm in writing that their material meets or exceeds the specification required herein. Such written confirmation must be attached to the bid for the bid to receive consideration.

4. To ensure proper handling and installation, each unit of the material shall have a Material Safety Data Sheet and installation Instructions Manual attached inside the carton/box

5. The Engineer reserves the right to sample and inspect the delivered materials for individual quality testing at the contractor's expense. Materials not meeting the manufacturer's certified values will be rejected.

3.20.2.3 WARRANTY

1. Manufacturer must submit a warranty for the ceramic-filled membrane against manufacturing defects for a period of one (1) year from the data of original purchase.

2. Approved bidders must submit a warranty for all applications for no less than a one (1) year period for the installation of the materials.

3.20.3 MEASUREMENT AND PAYMENT

The quantity of waterproofing works shall be measured by the area of waterproofing in square meters including cement or concrete leveling and topping (if required) , installed, completed and accepted by the Engineer.

The quantity determined above shall be the basis of payment of the unit price for the pay items shown in the Bill of Quantities which price and payment shall be the full compensation for furnishing all materials, labor, equipment, tools and other incidentals necessary including tests to complete the waterproofing work, accepted and certified for payment by the Engineer.

3.21 SLIP RESISTANT SYSTEM FOR ROLL-ON/ROLL-OFF CONCRETE RAMP

3.21.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.21.1.1 SCOPE

This work covers all the following requirements regarding the application of a slip/skid resistant system on the concrete RO-RO ramp in accordance with the dimensions shown in the drawings.

3.21.1.2 DELIVERY AND STORAGE

1. The polymer composite structural adhesive shall be delivered in pre-measured containers of 5 kg units (net material weight). The containers must be appropriately sealed and boxed to protect from spillage and exposure to the elements. The Base component and activator component shall be packaged in separate and differently sized metal containers. The containers shall be packaged together in a cardboard carton.

2. The metallic oxide aggregates shall be delivered in pre-weighed 25 kg bags.

3.21.2 MATERIAL REQUIREMENTS

3.21.2.1 GENERAL

The slip/skid resistant system shall meet the following requirements in full. If required, a sample of the material on a concrete block 150 mm x 150 mm shall be supplied to the Engineer for approval and retention for purposes of comparative testing.

3.21.2.2 PHYSICAL PROPERTIES

1. The slip/skid resistant system shall be composed of a polymer composite structural adhesive and metallic oxide aggregates.

2. The polymer composite structural adhesive shall be a two-component, 100% solids material comprised of a Base component and an activator component.

3. The polymer composite structural adhesive material furnished under this specification shall be of high molecular weight polymer base.

4. The polymer composite structural adhesive shall consist of a DGEBA polymer Base and an amidoamine Activator.

5. The polymer composite structural adhesive material furnished under this specification when mixed and applied in accordance with the manufacturer's instructions, shall produce a corrosion resistant, highly durable, waterproof bonding agent between the cured concrete and aggregates.

6. The polymer composite structural adhesive must be free of harmful odors that could damage the environment as well as the personnel handling the application or installation.

7. The metallic oxide aggregates furnished under this specification shall be of grit size between # 16 to # 24.

8. The cured slip/skid resistant system shall be resistant to permanent immersion in sea water and shall be impervious to water. The manufacturer shall certify in writing that exposure of the cured material to such working environments will not affect its adhesive properties and corrosion resistance.

3.21.2.3 MECHANICAL AND CHEMICAL PROPERTIES

The polymer composite structural adhesive supplier is required to certify that materials delivered will have to meet or exceed the following properties:

Shelf life	Indefinite
% Volatile	Not Volatile (zero evaporation rate)
Minimum Pot life @25^{o}C	45 minutes
Mixing Ratio (by volume)5(Base):	1 (Activator)

Direct Tensile Adhesion (ASTM D-4541):

Substrate	Bond Strength (psi)	Failure Mode
Unblasted Carbon Steel	1,500	Stud and panel adhesive failure
Unblasted Stainless Steel	1,400	Stud and panel adhesive failure
Dry Concrete	400	Concrete cohesive failure
Damp Concrete	400	Concrete cohesive failure

3.21.3 EXECUTION

1. Installation of the slip/skid resistant system shall be in accordance with the manufacturer's instructions and recommendations. Supplier shall be required to provide detailed descriptions of their proposed installation procedure. These descriptions shall include the following:

   a. Surface preparation techniques to insure effective adhesion of the system to the concrete

   b. Mixing and installation of the polymer composite structural adhesive and metallic oxide aggregates.

   c. Time and temperature conditions required to completely solidify and cure the system.

2. The polymer composite structural adhesive shall be manufactured by a reputable manufacturer who shall confirm in writing that their materials meets or exceeds the specifications required herein. Such written confirmation must be attached to the bid for the bid to receive consideration.

3. To ensure proper handling and installation, each unit of the material shall have a Material Data Sheet and an installation / instruction manual inside the carton/box.

3.21.4 WARRANTY

1. Approved bidder must submit a warranty for all applications for no less than a one (1) year period for the installation of the anti-skid system.

3.21.5 MEASUREMENT AND PAYMENT

The quantity of the application of a slip/skid resistant system on the concrete Ro-Ro ramp shall be measured by the area in square meters installed, completed and accepted by the Engineer.

The quantity determined above shall be the basis of payment of the unit price for the pay items shown in the Bill of Quantities which price and payment shall be the full compensation for furnishing all materials, labor, equipment, tools and other incidentals necessary including tests to complete the application of slip/skid resistant system on the concrete Ro-Ro ramp, accepted and certified for payment by the Engineer.

3.22 FORGED WELDED GRATINGS

3.22.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.22.1.1 SCOPE

This work covers all the following requirements regarding the manufacture and installation of steel gratings and steel angle frames in accordance with the lines, grades, and dimensions shown in the drawings.

3.22.1.2 DELIVERY AND STORAGE

1. The steel gratings and steel angle frames shall be delivered at site in matching sets with the manufacturer’s brand name, inspections tags, and production number to facilitate site quality assurance.

2. Upon delivery at site from the manufacturer, the hot dip galvanized steel gratings shall not be subjected to the following activities:

a. Re-fabrication
b. Cutting
c. Grinding
d. Welding
e. Drilling
f. Sawing
g. Any hot works or similar activities

3. The steel gratings and steel angle frames shall not be exposed to sea water and other corrosive chemicals or substances prior to installation.

3.22.2 MATERIAL REQUIREMENTS

3.22.2.1 GENERAL

The steel gratings and steel angle frames shall meet the following requirements in full. If required, a 1.0 linear meter x required load bar span dimension sample shall be supplied to the Engineer for approval and retention for purposes of comparative testing against materials randomly sampled from the site.

3.22.2.2 PHYSICAL PROPERTIES

1. The steel gratings shall be manufactured using the forge-welding process wherein the steel load bars and the twisted cross rods become homogenously unified through fusion.

2. Manually welded load bars to twisted cross rods shall be rejected.

3. The steel gratings and steel angle frames shall all be hot dip galvanized in accordance with international standards BS EN1460.

4. Painted steel gratings shall be rejected. Likewise, painted steel angle frames shall be rejected.

5. The end-banding of the steel gratings shall be attached using the Metal Inert Gas (MIG) Welding Process. Likewise, steel angle frames shall be manufactured using the Metal Inert Gas (MIG) Welding Process.

6. The allowable tolerances on dimensions on the steel load bars shall not exceed the following:

   a. Thickness - 0.2 mm
      (i.e. for 5mm required load bar thickness, the allowable thickness is from 4.8 mm to above 5.0 mm only)

b. Height - 0.5 mm
(i.e. for 65mm required load bar height, the allowable height is from 64.5 to above 65 mm only)

7. The allowable tolerances on dimensions on the twisted cross rods shall not exceed the following:

a. Thickness - 0.1 mm
(i.e. for 5.7mm required twisted cross rod, the allowable thickness is from 5.6 mm to above 5.7 mm only)

3.22.2.3 MECHANICAL PROPERTIES

The steel gratings supplier shall be required to submit test certificates for steel materials used in its manufacture; and for hot dip galvanizing which shall meet or exceed the following properties:

ASTM A36 Carbon Steel	
Yield Strength	Min 250 Mpa
Tensile Strength	Min 400 Mpa

BS EN1460 Hot Dip Galvanizing
Minimum Coating Mass of 610 grams/sqm; or
Minimum Coating Thickness of 85 microns using the 5-Point Elcometer Test

3.22.3 EXECUTION

Installation of the steel gratings and steel angle frames shall be in accordance with the manufacturer's instructions.

3.22.4 MEASUREMENT AND PAYMENT

1. Measurement of the total quantities of work completed under this section shall be per linear meter of steel gratings installed complete and accepted by the Engineer in compliance with the requirements as indicated on the Drawings and these Specifications.
2. The quantity determined above shall be the basis of payment of the unit price for the pay items shown in the Bill of Quantities which price and payment shall be the full compensation for furnishing all materials, labor, equipment, tools and other incidentals necessary including tests to complete the installation of forged welded gratings accepted and certified for payment by the Engineer.

3.23 CORROSION PROTECTION CLADDING FOR STEEL POLE

3.23.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.23.1.1 SCOPE

This work covers all the following requirement regarding the application of a corrosion resistant cladding material on the outside surface of floodlight steel pole in accordance with the dimensions shown ion the drawings.

3.23.1.2 DELIVERY AND STORAGE

The cladding material shall be delivered in pre-measured containers of 5kg units (net material weight). The containers must be appropriately sealed and boxed to protect from spillage and exposure to the elements. The Base component and activator component shall be packaged in separate and differently sized metal containers. The containers shall be packaged together in a cardboard carton.

3.23.2 MATERIAL REQUIREMENTS

3.23.2.1 GENERAL

The corrosion resistant cladding material shall meet the following requirement in full. If required, a sample of the material in 3 pieces of steel plate 150 mm x 150 mm shall be supplied to the Engineer for approval and retention for purposes of comparative testing.

1. PHYSICAL PROPERTIES

   a. The corrosion resistant cladding material shall be made of a two-component, 100% solids reinforced polymer composite system comprising of a Base component and an Activator component.

   b. The material furnished under this specification shall be of high molecular weight polymer base reinforced with abrasion resistant non-metallic fillers.

   c. The material furnished under this specification when mixed and applied in accordance with the manufacturer’s instructions, shall produce a high quality metal resurfacing and protection application.

d. The cladding material shall be of Diglycidyl Ether Bisphenol A (DGEBA) Polymer Base.

e. The cladding material shall have a smooth, high gloss finish.

f. The cladding material must be highly resistant to damage against exposure to sea water/breeze. The manufacturer shall certify in writing that exposure of the material to such working environment will not affect its adhesive properties and corrosion resistance.

g. The cladding material must be free of harmful odors that could damage the environment as well as the personnel handling the application or installation.

h. The DFT of the applied cladding material shall be between 300 microns and 400 microns.

2. MECHANICAL AND CHEMICAL PROPERTIES

The corrosion resistant cladding material supplier is required to certify that materials delivered will have to meet or exceed the following properties:

Mixed Density	1.28 grams per cc
Shelf Life	Indefinite
% Volatile	Not Volatile (zero evaporation rate)
Minimum Working Life @30^{o}C	55 minutes
Mixing Ratio (by volume) 5 (Base):	2(Activator)
Tensile Shear Adhesion (ASTM D-1002):	
Steel	259kg/cm^2
Stainless Steel	245 kg/cm^2

3.23.3 EXECUTION

1. Installation of the corrosion resistant cladding material shall be in accordance with the manufacturer's instructions and recommendations. Suppliers shall be required to provide detailed descriptions of their proposed installation procedure for each unit of the cladding material.

These descriptions shall include the following:

a. Surface preparation techniques to insure effective adhesion of the cladding material to various substrates including: steel, aluminum, copper, brass, bronze, cast iron, pvc, fiberglass, plastics, glass, wood, etc.

b. Mixing and Application of the cladding material.

c. Time and temperature conditions to be obtained in order to completely solidity and cure the cladding material.

2. To facilitate Quality Assurance, each unit of the material delivered to site shall be clearly labeled on the box with the manufacturer's name, product name and production batch number.

3. The corrosion resistant cladding material shall be manufactured by a reputable manufacturer who shall confirm in writing that their material meets of exceeds the specifications required herein. Such written confirmation must be attached to the bid for the bid to receive consideration.

4. To ensure proper handling and installation, each unit of the material shall have a Material Safety Data Sheet and installation Instructions Manual attached inside the carton/box.

5. The Engineer reserves the right to sample and inspect the delivered materials for individual quality testing at the contractor's expense. Materials' not meeting the manufacturer's certified values will be rejected.

3.23.4 WARRANTY

1. Manufacturer mush submit a warranty for the corrosion resistant cladding material against manufacturing defects for a period of one (1) year from the date of original purchase.

2. Approved bidder must submit a warranty for all applications for no less than a one (1) year period for the installation of the material.

3.23.5 MEASUREMENT AND PAYMENT

1. Measurement of the total quantities of work completed under this section shall be per square meter of the application of a corrosion resistant cladding material on the outside surface of floodlight steel pole cladding, installed complete and accepted by the Engineer in compliance with the requirements as indicated on the Drawings and these Specifications.

2. The quantity determined above shall be the basis of payment of the unit price for the pay items shown in the Bill of Quantities which price and payment shall be the full compensation for furnishing all materials, labor, equipment, tools and other incidentals necessary to complete the installation of corrosion resistant cladding material on the outside surface of floodlight steel pole accepted and certified for payment by the Engineer.

DIVISION 2 SITE WORKS

2.1 DEMOLITION AND REMOVAL WORKS

2.1.1 DESCRIPTION

The work includes the furnishing of all labor, materials and equipment required to carry out the demolition and removal of obstructions, portions of existing piers including extraction/cutting of timber and R.C piles at required depth and demolition of miscellaneous buildings, pavements, fences, utilities, navigation aids and wrecks etc., as required for the execution of the Contract.

The Contractor shall submit the proposed methodology or procedure of demolition work with detailed drawings and calculations if necessary, to the Engineer for approval, before the execution of the Works.

The Contractor shall keep all pavements and landing areas to and from the site of the disposal area clean and free of mud, dirt and debris during and after the execution of disposal. Disposal of debris and materials shall be as directed by the Engineer

For off-shore obstructions to pile driving and dredging, survey shall be executed by the Contractor with the Engineer before any demolition and removal of wrecks commence and shall be as directed by the Engineer.

2.1.2 GENERAL PROVISIONS

1. The Contractor shall be deemed to have satisfied himself of the site conditions, and to have included in his unit prices provision for all risks that may arise during or in connection with the work.

2. The demolition work shall be carried out by approved methods and equipment such as concrete breakers, gas-cutters, hydraulic jacks, compressed air disintegrators, etc., however, no blasting shall be used unless approved in writing by the Engineer and after obtaining the written permission of the concerned Authorities.

3. The Contractor shall provide suitable equipment, skilled labor and appropriate temporary works such as scaffoldings to ensure safety in his demolition works as well as in the adjacent area.

4. The Contractor shall demolish all the structural members above the level on which the subsequent and permanent works under this Contract will begin. To this end, the temporary construction works such as excavation shall be conducted by the Contractor.

5. Materials coming from the demolition works, except general earth, shall remain the property of the Procuring Entity, the designated part of which shall be stored by the Contractor at places specified by the Engineer’s authorized Representative.

2.1.3 INTERFERENCE WITH PORT OPERATIONS

1. During the execution of the work, the Contractor shall not interfere with the shipping, navigation and other traffic in the port.

2. The Contractor shall make arrangements with the operations people on the schedule of demolition and related works to keep port operation activities undisturbed at all times.

3. Prior to commencement of the demolition works, the Contractor shall inform/announce to port users the schedule of disconnection of utilities.

2.1.4 STORAGE AND DUMPING

Prior to the commencement of the demolition work, the Engineer shall submit to the Contractor a list in which all the materials to be salvaged and overhauled, as property of PPA and the location of their storage shall be described. Materials embedded in concrete units shall not be salvaged.

The Contractor shall separate materials to be salvaged from debris. Salvaged materials shall be loaded, transported and unloaded by the Contractor at the specified locations.

Debris, if it does not contain any pollutant in the opinion of the Contractor may be dumped at the offshore area.

The Contractor may dump debris on land areas but out of the site, which areas shall be procured and prepared at his own expense. In this case, safety measures shall be undertaken in the transporting, unloading, covering and others as requested by the Engineer.

2.1.5 EXECUTION

1. Prior to the commencement of demolition works, the alignments of the new construction works to existing pier shall be checked.

2. The width and alignment of portion of existing structure to be demolished shall be marked by paint.

3. With these lines as guides, concrete shall be broken and reinforcing bars cut, such that panels or portions of the structure can be lifted out for disposal elsewhere outside of the operational work area.

4. Extract concrete piles with care in order not to damage existing or adjacent structures, equipment or materials.

5. Piles (timber/concrete) for demolition/extraction shall be done with care and/or to the required level indicated in the plan as shown in the drawings.

6. Rocks removed from existing slope protection shall be stored for re-use in new construction.

7. Demolish buildings, pavements, curbs, fences, utilities, services, navigation aids and the like as determined in the field for each project and as shown on the drawings or as directed by the Engineer.

8. Materials coming from the demolish works shall be properly disposed by the Contractor.

2.1.6 SAFETY

At the end of each day's work, the site shall be left in safe condition, so that no part is in danger of toppling, or falling or creating hazards to personnel or equipment.

2.1.7 MEASUREMENT AND PAYMENT

Demolition and removal, unless otherwise noted, shall be measured by number or unit quantities or lump sums as appropriate for each class of work for each category. Cost of disposal of debris shall be incidental to the work and shall not be paid for separately.

Demolition and removal of existing pavement shall be measured and paid for under this section unless such pavement falls within or above the new subgrade, in which case, measurement and payment shall be under Division 5, "Roads and Pavements."

The price listed above shall be full compensation for all labor, materials, tools and equipment and all incidental works necessary for the successful completion of work.

2.2 SURVEYS, SOUNDINGS, SOIL INVESTIGATIONS, INSTALLATION OF MARKERS, ETC.

2.2.1 GENERAL

Work under this Contract shall be in accordance with Section 1, "General Requirements" of these Specifications and shall apply to this Section whether herein referred to or not.

2.2.2 SCOPE OF WORK

This Section covers topographic and hydrographic surveys including setting out of works, as well as soil investigations.

2.2.3 PRELIMINARY REMARK

All data relating to surveys, soundings, soil investigations, included in the Bid Documents and all data contained in the Drawings are honestly given in order to provide the Contractor with the best possible information needed for the proper performance of the works.

Relating to these data, the Contractor will have to make his own investigations to verify and to complete the given data.

These additional investigations by the Contractor are deemed to be included in the Contract Prices and will not involve any additional cost to the Engineer.

2.2.4 TOPOGRAPHIC AND HYDROGRAPHIC SURVEYS

1. References: All surveys shall be carried out with reference to benchmarks or monuments and Chart Datum proposed by the Contractor and approved by the Engineer.

2. Surveying: All survey work specified in this Section shall be carried out by licensed surveyors. The Contractor shall submit in advance for the Engineer's approval, true copies of the license and qualifications of the surveyors to be employed for the works.

3. The Contractor shall carry out the topographic and hydrographic surveys of the job-site, as required for the proper performance and quantity measurement of the works, by means of traversing, sounding and leveling, and shall prepare topographic maps and/or hydrographic charts at the appropriate scales.

2.2.5 SOILS INVESTIGATIONS

1. The Contractor shall locate the sites of soils investigations based on the Engineer's maps and drawings. The Contractor shall also establish the ground levels and the various levels of investigations. He shall be solely responsible for the accuracy of such locations and elevations.

2. The boring schedule to verify the foundations of the proposed new structures is described below.

3. All borings shall be made using rotary drilling. Samples for identification of soils shall be taken at every 1.5 m and at any point where material changes in character. Each sample shall be kept in an approved sample bottle which shall be sealed and on which a label with the descriptions of the sample shall be fixed. The Contractor shall submit to the Engineer all samples in sealed bottles placed in a case/container for permanent storage thereof.

4. During the boring operations, standard penetration tests shall be carried out at one-meter intervals in accordance with ASTM D 1586.

2.2.6 SETTING OUT OF WORKS

1. The Contractor shall set out the Works and shall be solely responsible for the accuracy of such setting out. The Contractor shall provide, fix and maintain all stakes, marks or the like which are necessary for the accurate setting out of the Works, and shall take all necessary precautions to prevent their removal or disturbance, all as approved by the Engineer. The Contractor shall provide a suitable range in the water to indicate the face lines of the quays, revetment, breakwater and related facilities.

2. Setting Out of Works shall include the verifications of position of all markers and the supply and installation of any and all other markers which the Contractor may require for the proper execution and completion of the Works, and shall also include the repositioning of the PPA's markers if such repositioning is deemed necessary by the Contractor and approved by the Engineer.

2.2.7 FIELD NOTES, ETC.

Field notes, calculation sheets and all other documents shall be prepared in the English language and in a manner acceptable to the Engineer. The Contractor shall submit such notes and other documents upon completion of the respective works or if so required, the Engineer may have the option to inspect even during the progress of works.

2.2.8 MEASUREMENT AND PAYMENT

2.2.8.1 TOPOGRAPHIC AND HYDROGRAPHIC SURVEYS

1. Cost for the topographic and hydrographic surveys including preparation of topographic maps and hydrographic charts that could be required for the proper execution of the works and/or for the calculation of the quantities to be paid shall be deemed to be included in the unit prices of the corresponding works.

2. Separate payment will not be made for setting out of works as such setting out will be considered as incidental to and part of the various works to be executed.

2.2.8.2 SOIL INVESTIGATIONS

Borings and soil tests made by the Contractor in addition to the given data shall not be normally paid separately. The cost shall be deemed to be included in the Contract unit prices.

2.3 MAJOR FACILITIES FOR CONSTRUCTION

2.3.1 GENERAL

1. Work under this contract shall be subject to the terms and conditions stipulated in the Conditions of Contract.

2. This Section generally defines the major facilities needed for construction as a whole and major terms of work to be done under each facility.

3. This Section relates the general composition of the Technical Specifications in correlation of this Document to the Bill of Quantities.

2.3.2 BRIEF DESCRIPTION/LOCATION OF THE FACILITIES

[Indicate Port Facilities to be included as part of the Project. Listed below are the major part facilities.]

1. WHARVES/PIERS/TRESTLES

   A wharf, pier or trestle is a reinforced concrete apron on reinforced concrete (RC) or steel pipe piles reaching depths not less than those shown on the Drawings. These structures are for multi-purpose uses.

2. CAUSEWAY

   A causeway is a rock mound jetty with a roadway built generally perpendicularly to the shoreline to reach the future port basin area.

3. REVETMENT

   A revetment is a rock structure enclosing, protecting and retaining a causeway or a reclaimed area.

4. RECLAMATION AREA

   A reclaimed area is a yard area obtained by fill on land or on water.

5. RO-RO RAMP

   A Ro-Ro ramp is a berthing facility with a sloping ramp to be used for loading/unloading transport vehicles to/from vessels.

6. STAIR LANDING

   A stair landing is a stepped RC facility located on the slope of revetment with its lower level at about 0.00 meter MLLW.

2.3.3 MAJOR FACILITIES WORK ITEMS

[Listed below is major Port Facilities Work Item. Indicate the required Port Facilities for Particular Project]

1. Wharf/Pier & Ro-Ro Ramp Construction

   a. Casting of RC and Steel Pipe Piles
   b. Driving of RC and Steel Pipe Piles
   c. Casting of Pile Caps
   d. Casting of Beams & Fascia Beams
   e. Casting of Apron Slab
   f. Supply & Installation of Fenders
   g. Supply & Installation of Bollards and Bitts

2. Dolphin and Fender Construction

   a. Supply of timber piles
   b. Driving of timber piles

3. Causeway/Revetment

   a. Quarrying and placing of rocks
   b. Rock grading

4. Dredging and Reclamation

   a. Dredging works
   b. Reclamation works

5. Stair Landing

    a. Casting and installation of concrete block
    b. Asphalt Concrete Pavement/Portland Concrete Pavement Works

6. Roads and Pavement

    a. Base courses
    b. Concrete works

7. Buildings

    a. Excavation and backfilling
    b. Concrete Works
    c. Masonry Works
    d. Steel and Metal Works
    e. Doors and Windows
    f. Finishes
    g. Utilities

DIVISION 4 BUILDING WORKS

4.1 SURVEY AND LAYOUT WORK

4.1.1 GENERAL

1. Work under this Contract shall be subject to Division 1,"General Requirements," which contain provisions and requirements essential to these specifications and apply to this section, whether or not referred to herein.

2. This Section sets forth provisions relating to general surveying and other layout Works required under this Contract.

4.1.1.1 GENERAL REQUIREMENTS FOR SURVEY AND LAYOUT WORK

1. Data and information developed as work herein shall be reviewed with the Engineer when requested.

2. Survey and layout works may be reviewed, verified or checked at any time by and at discretion of the Engineer.

3. Field work or calculations found incorrect, and any work installed improperly due to incorrect field and layout work or calculations, shall be corrected by the Contractor as directed by the Engineer.

4. Checking or verifications of work herein by the Engineer shall not relieve the Contractor from responsibility for providing work in compliance with requirements of contract documents.

5. No work under this Contract shall be permitted to proceed until respective survey and layout work have been provided and verified correct.

4.1.1.2 GENERAL REQUIREMENTS

1. Survey work under this Section shall be under direct control and continuous supervision of a registered Civil/Geodetic Engineer or Licensed Surveyor; qualified and experienced in type of work herein required; retained and paid by Contractor as part of work under this Contract.

2. Survey calculations and drawings shall be developed as necessary for work required.

4.1.2 SURVEY FIELD WORK

1. Survey field work shall be performed using established surveying, measuring and leveling methods; and using orderly and methodical procedures.

2. Surveying instruments and measuring equipment shall be precision made, with standard calibration, accurately adjusted, and of types sufficiently refined for work as required.

3. Field markings, lines, colored markers or other indicators shall be materials not readily faded by sun or washed away by water.

4. Stakes, markers, survey pins, and other devices shall be provided as necessary to enable setting or erecting various structures, items or portions of work without resorting to any further special calculations or particularly difficult measurement or use of other than regular straight edge, rule, snap-line and plumb bob methods.

5. Datum for the work shall be as indicated on drawings or as established in the field under separate Civil Engineering Works Contract.

4.1.3 CONSTRUCTION SURVEY REQUIREMENTS

Following herein are items which the Contractor shall provide prior to commencement of and during construction operations at premises for work under this Contract.

1. Establishment in the field of a building column/grid reference system; and boundary or primary perimeter lines of buildings and various other structures included under this Contract.

2. Utility entrance points at perimeters of buildings or other structures or areas as applicable.

3. Establishment and control of floor and other structures; and finish grades or areas, as applicable.

4.1.4 OTHER LAYOUT WORK

1. Other layout work required of Contractor shall be based upon lines and levels developed and provided under Survey Work.

2. Primary layout work extended in from survey layouts shall be performed by a civil, geodetic engineer or a licensed surveyor.

3. Layout work herein shall be provided to the extent as necessary to assure all work is placed and positioned as required by Contract drawings, approved shop drawings or other related instructions issued by the Engineer.

4. Interior Layout Work

   Layout, locations and dimensions shall be rechecked and verified with the drawings prior to making roughing-ins or setting of other work.

4.1.5 MEASUREMENT AND PAYMENT

The method of measurement and payment under this Section shall be in accordance with Section 2.3 under Division 2, Site Works of these Specifications.

4.2 EXCAVATION AND BACKFILLING FOR BUILDINGS

4.2.1 GENERAL

Division 1, "General Requirements", contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

4.2.1.1 SCOPE OF WORK

1. This Section sets forth general requirements applicable to excavation and backfilling works required for the foundation of buildings.

2. Each Section in which this Section is referenced shall include same as part of that Section; unless otherwise specified.

4.2.1.2 GENERAL PROVISIONS

1. Excavated materials required and approved for backfill shall be stockpiled in areas approved by the Engineer.

2. Remove all unsuitable or excess materials from the site.

3. Each phase of excavation and backfilling work shall be approved by the Engineer as completed prior to removing earthwork equipment from the site or prior to proceeding with subsequent operations which cover or disturb completed phases of works.

4.2.2 EXCAVATION

1. General: The excavation shall conform to the dimensions and elevations indicated for each building and structure, except as specified hereinafter, and shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services and for inspection, except where the concrete for walls and

footings is authorized to be deposited directly against excavated surfaces. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory materials encountered below the grades shown shall be removed as directed and replaced with satisfactory materials; satisfactory materials below the depths indicated without specific direction of the Engineer shall be replaced at no additional cost to PPA to the indicated excavations grade with satisfactory materials, except that concrete footings shall be increased in thickness to the bottom of the overdepth excavations. Satisfactory/backfill shall be placed and compacted as specified in paragraph: "Backfilling." Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done as directed by the Engineer.

2. Drainage: Excavation shall be performed such that the areas of the site including its immediate surroundings and other areas affected by the operation, will be continually and effectively drained. Waters shall not be permitted to accumulate in the excavation. The excavation shall be drained by pumping or other satisfactory methods to prevent softening of the foundation bottom, undercutting of footings, or other actions detrimental to proper construction procedure and stability of the structures.

3. Classification of Excavation: Excavation will be unclassified regardless of the nature of material encountered and excavated.

4. Blasting will not be permitted.

5. Excavated Material: Satisfactory excavated material required for fill or backfill shall be placed in the proper sections of the permanent work as required. Satisfactory excavated material in excess of that required for the work under this section shall be made available for use in other portions of the permanent site work required for the permanent work; and unsatisfactory material shall be Contractor's responsibility. No satisfactory material shall be wasted or used for the convenience of the Contractor unless so authorized. Stockpiles and waste materials shall be placed, graded, and shaped for proper drainage giving due consideration to drainage from adjacent properties.

6. Final grade of surfaces to support concrete: Care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall not be made until the concrete is just ready to be placed.

4.2.3 BACKFILLING

1. Satisfactory materials shall be used in bringing fills to the lines and grades indicated and for replacing unsatisfactory material. Satisfactory material shall be free from roots and other organic matter, trash, debris, and stones larger than 75mm in any dimension.

2. Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved; forms removed and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grades and shall not be placed in wet, muddy or spongy areas. Backfill shall be of satisfactory materials placed and compacted as specified.

   Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted to required thickness with power driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes to avoid damage to coatings or wrappings. Backfill shall not be placed against foundation walls prior to seven (7) days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall.

3. Placing: Satisfactory material shall be placed in horizontal layers not exceeding 20cm in loose depth and then compacted. No material shall be placed on surfaces that are wet, muddy or spongy.

4. Compaction shall be accomplished by sheep-foot rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

5. Tests shall be performed on backfill as required by the Engineer. Compaction shall be up to 95 percent maximum dry density per ASTM.

4.2.4 PROTECTION

Settlement or washing that occurs in graded or backfilled areas prior to acceptance of the work shall be repaired and graded re-established to the required elevations and sloped at no additional cost to PPA.

4.2.5 GRAVEL BEDDING

Gravel bedding shall be in accordance with Sub-section 5.9.2 of these specifications.

4.2.6 MEASUREMENT AND PAYMENT

1. Quantities of structure excavation to be paid for shall be the number of cubic meters of unclassified excavation removed and disposed at locations specified or directed. Prior to excavation, drawings, showing paylines for excavation shall first be submitted to the Engineer for approval. Measurement shall be made by cross sectioning ground surface prior to excavation work, and later estimating the volume of materials excavated by computation. No additional payment shall be made for excavating beyond the approved payline.

2. Backfilling for building foundations shall be measured and paid for in cubic meters based on the volume of excavation less volume of concrete and other filling materials or as directed by the Engineer.

   Backfilling of trench shall be measured and paid for by volume in cubic meters of backfill work completed. Measurement shall be based on the volume of excavation less volume of pipes and other materials placed before backfilling.

   Filling above the original ground level shall be measured and paid for by volume in cubic meters. Watering for compacting is considered incidental to filling and backfilling.

   The unit price shall constitute full payment for all labor, materials, equipment, testing, and all incident work called for to complete the work.

   The quantity of gravel bedding to be paid for shall be measured by the design volume in cubic meters as shown on the drawing, placed and completed in accordance to this specification and accepted by the Engineer.

4.3 TERMITE PROOFING, BUKBOK PROOFING

4.3.1 GENERAL

Division 1, "General Requirements", contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

4.3.1.1 SCOPE OF WORK

The Contractor shall hire the services of an approved or accredited pesticide company to furnish all labor, materials, equipment, tools, plant, and services to complete the termite and “bukbok” proofing work hereinafter described.

4.3.1.2 EXAMINATION OF SITE

Inspect the site of work and examine the premises to fully understand existing conditions with respect to the work involved. Prior to soil stripping, excavation or filling all termite mounds within the area should be demolished, removed and treated.

4.3.2 MATERIAL REQUIREMENTS

4.3.2.1 CHEMICALS AND EQUIPMENT

For termite proofing, use LENTREK TC Termiticide Concentrate or approve equal.

For “bukbok” proofing of kiln dried wood, use Penthachlorophenon while for untreated wood, use chemical name accredited name/or acceptable to the PPA and should have valid license from Fertilizer and Pesticide Authority (FPA).

The pest control Contractor shall submit the specified chemicals in their original manufacturer sealed containers to the Project Inspector of inspection, sampling and safekeeping. Containers with broken seal shall not be accepted.

Dilution ratings (for LENTREK TC):

1 part LENTREK TC to 50 parts water

Penthachlorophenon – 1 : 100 concentration

Dilutions shall be done only at the jobsite in the presence of the Project Inspector. The strength of the mixture or solutions shall be made uniform by thorough stirring. All solutions prepared for termite proofing shall be used within 24 hours.

4.3.3 EXECUTION

4.3.3.1 CONTRACTOR LICENSE AND CERTIFICATION REQUIREMENT

The pesticide company should have a valid license from Fertilizer and Pesticide Authority of the Department of Agriculture.

All pesticide shall be applied by or under the direct supervision of a certified pesticide applicator.

4.3.3.2 ENVIRONMENTAL AND SAFETY CONDITIONS

Formulation, treatment, storage and disposal of pesticide shall be in accordance with label directions. Water for formulation shall be drawn only form site(s) designated by the Project Inspector, and the filling hose shall be fitted with a backflow preventor meeting local plumbing codes/standards. The filling operation shall be under the direct and continuous observation of the Project Inspector to prevent overflow.

4.3.3.3 APPLICATION

1. Termite Control

Application of solution shall be done by means of power sprayers fitted with flow meters for accurate monitoring of actual quantity used. At the time of soil treatment application, the soil shall be preferably in a friable condition with low moisture content to allow uniform distribution of the treatment solution throughout the soil. Do not apply pesticide during or immediately following heavy rains, or when conditions will cause runoff and create an environmental hazard. Cover treated area with waterproof sheeting if concrete is not poured on the same day as the soil treatment. Take precautions to prevent disturbance of the pesticide barrier. Before the placement of structural components, re-treatment where soil or fill is disturbed after treatment. Apply pesticide prior to placement of gravel base, vapor barrier or waterproof membrane.

a. Slab on Grade Construction: Establish a horizontal pesticide barrier over areas intended for covering by floors, porches, attached entryways, garages, carports and terraces. Apply treatment solution with a low pressure coarse spray at the rate of four (4) liters solution per square meter. Apply at the rate of seven (7) liters solution per square meter if the fill is washed gravel or other course material. Establish a continuous chemical barrier in the voids of hollow block foundation or voids of masonry. Apply treatment at the rate of seven (7) liters per 3 linear meter. Make pesticide band at least 15 cm wide the pesticide evenly distributed throughout. Treat buildings constructed with basement slabs in the same manner.

b. Crawl Space Construction: Establish a vertical pesticide barrier inside of foundation walls, both sides of interior partition walls, around piers, plumbing, and rodding and utility conduits. Apply treatment solution by rodding or rodding and trenching the fill at the rate of 15 liters solution per 3 linear meter, and 30 cm deep from grade to bottom of foundation. Treat both sides of foundation and around all piers and pipes. Make treated barrier of fill at least 15 cm wide with the pesticide evenly distributed throughout.

c. Dry Pipes and Conduits: Establish pesticide barrier on various dry pipes and conduits such as electrical service entrance, raceways, pipe chase, vents. Use powder type termiticide by injecting it inside the pipe.

d. Termite Mounds: Demolish and treat all termite mounds within the property found after the construction.

2. "Bukbok" Proofing

Kiln-dried wood, plywood, tanguile, apitong, cabinets, dividers, and paneling shall be brushed generously with Penthachlorophenon before painting or varnishing.

3. Sun-Dried Wood Treatment

Sun-dried lumber to be used for ceiling joint runners, nailer, etc. shall be brushed with Penthachlorophenon before installation of plywood or ceiling panels.

4.3.3.4 ENGINEERS

The Contractor shall submit to the Engineer for approval, a copy of the pest control company's proposal and chemical application, method/procedure including the description of the equipment to be used before start of work.

4.3.3.5 INSPECTION AND TEST

Sampling shall be done only in the presence of the Project Inspector.

Amount of sample to be taken: LENTREK TC (From Original container) 50 cc each.

4.3.3.6 CONTRACTOR'S GUARANTEE

Upon completion of work, and on a condition for final acceptance, the Contractor shall submit to PPA a written guarantee from the pesticide company which shall provide that:

1. The soil poisoning treatment shall prevent subterranean termites from attacking the building on its contents for a period of not less than five (5) years.

2. The Contractor shall thereby warrant all works in pest control that all materials and workmanship applied under the contract are of good quality in every respect and will remain as such for not less that five (5) years.

Should there be termite and “Bukbok” infestation within the one (1) year period the Contractor thereby agrees to do all necessary repairs on the damaged portions of the buildings caused by termite infestation to the satisfaction of PPA, at the Contractor’s expense. Retreatment shall also be done by the Contractor after completion of the repairs and at his expense. Such repairs and corrective works shall be done within five days after a written notice from the Owner has been received by the Contractor.

Should there be infestation after the one (1) year period up until the five (5) year guarantee, the pesticide company agrees to do all the necessary repairs at their expense. The pesticide company shall conduct annual inspection of the building and surrounding to check any infestation during the guarantee period. Notice shall be given by the pesticide company to PPA in case there is presence of termites in the surroundings.

4.3.4 MEASUREMENT AND PAYMENT

1. The work done under this Section shall be measured per square meters of the area of wood surfaces where the liquid termite control chemicals is applied. The quantity to be paid for shall be determined and accepted by the Engineer.

2. The accepted quantities, measured as prescribed above shall be full compensation for furnishing and applying termite control chemicals including the use of equipment and tools, labor and incidentals necessary to complete the work prescribed in this Section.

4.4 CONCRETE WORKS FOR BUILDINGS

4.4.1 GENERAL

Division 1, "General Requirements," contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

4.4.1.1 SCOPE OF WORK

The work shall include reinforced concrete structures such as reinforced concrete footings with or without tie-beams, reinforced concrete columns girders, slabs, other cast-in-place and precast concrete including excavation and backfilling work.

The work shall consist of furnishing of all labor, materials, equipment and other incidentals necessary for the supply of concrete materials and the complete construction of the concrete structures for the building shown on the drawings in accordance with these specifications and as directed by the Engineer.

4.4.1.2 GENERAL REQUIREMENTS

Concrete works shall conform with the requirements of Section 3.2 “Concrete Works” except noted otherwise in this Section.

4.4.1.3 SHOP DRAWINGS

Together with requirements in sub-section 3.2.1.3.3, the Contractor shall show the following in the shop drawings:

1. Surface finish

2. Fitting to be embedded

4.4.2 MATERIAL REQUIREMENTS

1. Concrete shall consist of Portland cement, fine and coarse aggregates and water and shall conform with the requirements of Section 3.2, “Concrete Works”.

2. Deformed bars to be used shall conform with the reinforcement requirements in Section 3.2, “Concrete Works.” The size shall be as shown on the drawings.

4.4.3 FORMWORKS

4.4.3.1 GENERAL REQUIREMENTS

Materials and construction of formwork shall be in accordance with formwork requirements in Section 3.2, “Concrete Works.”

4.4.3.2 REMOVAL OF FORMWORK

The minimum stripping and striking time for formwork shall be as follows unless otherwise approved by the Engineer.

Conditions	Minimum Period
Vertical sides of beams, wall, piles, pile caps and columns, lift not exceeding 1.2m	24 hours
Vertical sides of beams and walls, lift exceeding 1.2m	48 hours
Soffits of main slabs and beams (props left under)	5 days
Removal of props from beams and main slabs and other works	10 days

4.4.4 CONCRETE

4.4.4.1 CLASSES OF CONCRETE AND USAGE

1. Strength Requirement

Classes	Size of Aggregate (mm)	fc' = MPa	Specified Compressive Strength – 28 days fc’ = Psi
C	19	21	3,000
D	25	17	2,500

2. Usage: The class of concrete to be used shall be as follows:

   a. Class C Concrete : For beams and concrete pedestals, slabs on fill

   b. Class D Concrete : Leveling concrete

4.4.4.2 SLUMP TEST

Tests shall be made in conformity with ASTM C 143, and unless otherwise specified by the Engineer, slump shall be within the following limits:

Structural Element	Slump for Vibrated Concrete	
	Minimum (mm)	Maximum (mm)
Precast concrete	80	180
Wall, column and beam 25cm max. thickness	80	180
Concrete slab	80	150
Lean concrete	70	150

4.4.4.3 CONCRETE COVER FOR REINFORCEMENT

Minimum concrete cover for reinforcement shall be as follows:

Net Concrete Cover	Minimum Cover (mm)
- Concrete cast against and permanently exposed to earth	75
- Concrete exposed to earth or weather:	
Primary reinforcement	50
Stirrups, ties, and spirals	40
- Concrete deck slabs:	
Top reinforcement	50
Bottom reinforcement	35
- Concrete not exposed to weather nor in contact with ground:	
Primary reinforcement	40
Stirrups, ties and spirals	25

4.4.5 CONSTRUCTION JOINTS AND WATERSTOPS

Construction joints shall be provided where shown on the drawings or when approved with written permission of the Engineer. Special care shall be used in preparing concrete surfaces at joints where bonding between two sections of concrete is required. Unless otherwise indicated on the drawings, such bonding will be required at all horizontal joints in walls.

Waterstop material shall be an elastomeric plastic compound, the basic resin of which shall be polyvinyl chloride, and containing any additional resins, plasticizers or other materials needed for the material to comply with the requirements specified.

The waterstop shall be fabricated by an extrusion process such that it will be dense, homogeneous, free from holes and other imperfections. The cross section of the waterstop shall be uniform and symmetrical along its entire length.

Surfaces shall be prepared as follows:

The surface of concrete upon or against which the placement of contiguous concrete or masonry is later required shall be struck off true to the elevations indicted on the drawings after the concrete has been placed. Thereafter as soon as the condition of the concrete permits it, and before the concrete has hardened appreciably, i.e. normally within 2 hours after being deposited, all water, scum, laitance and loose aggregate shall be removed from the surface by means of wire or bristle brooms in such a

manner that the course aggregate is left lightly exposed, and the surface cleaned. No raking will be permitted.

The Contractor shall then take all necessary precautions to ensure that all surfaces thus prepared shall be kept free from storage piles, drippings, staining or foreign matter, which could adversely affect the concrete or the bond between the concrete layers.

Waterstops for all joints shall be continuous around the corners and at intersections, either in horizontal or vertical direction, as indicated on the drawings. Field splices and joints shall be made in accordance with the waterstops manufacturer's instructions, using a thermostatically controlled-heating iron.

4.4.6 MEASUREMENT AND PAYMENT

1. Setting out the Work shall not be measured separately. The cost shall be deemed as part of and incidentals to the foundation works.

2. Excavation, backfilling and gravel fill to be paid for shall be measured in Section 4.2 “Excavation and Backfill for Buildings”.

3. The price to be paid shall constitute full payment for all labor, materials and equipment and all testing and incidental works necessary for the completion of the work.

4. Structural concrete, unless noted otherwise, shall be measured in cubic meters calculated from neat dimensions shown on drawings or authorized in writing by the Engineer.

   No deductions shall be made for the volume of concrete displaced by reinforcing steel and structural steel.

   No deductions shall be made for the volume of concrete displaced by drainage openings less than $0.1m^2$ in cross sectional area.

   Cooling of concrete and providing protection against hot weather shall not be measured for payment and are considered incidental to work.

   Supply and installation of concrete fasteners, anchor bolts, washers and nuts shall not be measured and shall be considered incidental to work unless otherwise specified.

   Supply and placement of grout, joint filler, sealants at joints, waterstops, saw-cutting, neoprene pads, and synthetic fibrous reinforcement / admixture where required shall be incidental to relevant work and shall not be measured for payment.

5. Formwork shall be incidental to work and shall not be measured for payment.

   Scaffolding and falsework shall be incidental to work and shall not be measured for payment.

6. Reinforcing steel bars shall be measured in kilograms incorporated into work, computed from the theoretical unit mass for sizes of bars multiplied by length of bars as shown on approved shop drawings except where specified otherwise.

7. Chairs, spacers and hangers shall be incidental to work and shall not be measured for payment.

8. Cost of all testing and records to be made shall be deemed included in the unit cost of concrete.

4.5 MASONRY

4.5.1 GENERAL

Division 1, "General Requirements," contain provisions and requirements essential to these Specifications and apply to this Section, whether or not referred to herein.

4.5.1.1 SCOPE OF WORK

This Section includes the furnishing of all labor and materials to complete the work as shown on the drawings and specified herein. The works shall include but not necessarily be limited to the following:

1. Supply and installation of concrete hollow block (CHB) walls with reinforcement

2. Plastering

3. Installing temporary works like scaffolding, platforms, steps, etc.

4.5.1.2 GENERAL PROVISIONS

The following publications of the issues below but referred to thereafter by basic designation only, form a part of these specifications to the extent indicated by the reference thereto:

American Society for Testing and Materials (ASTM) Publications:

A 615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

A 33 Concrete Aggregates

C 129 Specification for Non-Load Bearing Concrete Masonry Units

C 144 Specification for Aggregate for Masonry Mortar

C 270 Mortar for Unit Masonry

4.5.2 MATERIAL REQUIREMENTS

Materials shall conform to the respective specifications and other requirements specified below:

4.5.2.1 CONCRETE HOLLOW BLOCKS (CHB):

CHB shall be of standard manufacture, machine vibrated with fine and even texture and well-defined edges and conforming with the requirements of ASTM C 129. Unless otherwise specified on the Drawings, It shall have a minimum compressive strength of *[2.45 MPa (350 psi)/4.5MPa (650 psi)].* CHB shall be uniform and essentially smooth as normally achieves by standard molding methods and shall be free from any cracks, flaws or other defects.

4.5.2.2 BEDDING MORTAR:

Mortar shall be composed of 1 part of Portland cement, 3 parts of sand and ½ part of lime. It shall have a compressive strength of *[14 MPa (2,000 psi)]* at 28 days and shall comply with property specifications for type N mortar set forth in ASTM Specification C 270 and as modified herein, proportioned and tested in an approved laboratory at the expense of the Contractor. When tested for water retention, the mortar shall have a flow after suction, of 75 percent or more when mixed to an initial flow of 125 to 140 percent. When tested for compressive strength, mortar shall be mixed to a flow of 100 to 115 percent. Aggregate for mortar shall conform to ASTM C 144.

4.5.2.3 PLASTER:

Plaster shall comply with the same specification as those for bedding mortar and will include the use of synthetic fibrous reinforcement of type and dosage recommended by the manufacturer.

4.5.2.4 REINFORCING STEEL BARS AND RODS:

ASTM Specification A 615 with minimum yield strength of *[230 MPa (33,400 psi]* for 10 mm diameter and *[276 MPa (40,000 psi)]* for 12 mm diameter.

4.5.3 SAMPLES AND TESTING

1. The following shall be submitted for approval and in addition, representative samples shall be taken periodically from on-the-site stockpiles as required for testing or checking during the progress of the work.

Anchors and ties	:	Two of each type proposed for use.
Concrete Hollow Blocks	:	Shapes, sizes and kinds in sufficient numbers to show full range of quality and texture.

2. Sampling and testing, unless otherwise specified, shall be performed by an approved independent commercial testing laboratory at the expense of the Contractor. Certified copies of laboratory test reports, including all test data, shall be submitted at least 10 days before delivery of the units or mortar materials represented by the tests to the project site.

3. Mortar shall be laboratory-proportioned and tested. Certified copies of approved laboratory-established proportions shall be submitted with the required test reports and test data. Approved laboratory-established proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in mortar for the work unless additional evidence is furnished that the mortar meets the specified requirements.

4.5.4 ERECTION

1. GENERAL

No unit having a film of water on its surface shall be laid. Masonry shall be laid plumb, true to line, with level courses accurately spaced. Bond pattern shall be kept plumb throughout. Corners and reveals shall be plumb and true. Vertical joints shall be shoved tight. Each unit shall be adjusted to final position while mortar is still soft and plastic. Any unit that is disturbed after mortar has stiffened shall be removed and relaid with fresh mortar. Courses shall be so spaced that backing masonry will level off, flush with the face work at all joints where ties occur. Chases and rake-out joints shall be kept free from mortar or other debris.

2. Anchorage to concrete. Anchorage to abutting columns shall be provided only where indicated. Details shall be as indicated including anchorage to underside of beams and slabs.

3. Cutting and fitting, including that required to accommodate the work of others shall be done by masonry mechanics. Wherever possible, full units of the proper size shall be used in lieu of cut units. Cut edges shall be clean, true and sharp. Openings shall be carefully cut, formed or otherwise neatly made for recessed items and for electrical, plumbing, or other mechanical installations so that wall plates, cover plates, or escutcheons required by the installation will completely conceal the openings and will have bottoms in alignment with lower edge of masonry joints. Webs of hollow masonry units shall be cut to the minimum required for the installation. Reinforced masonry lintels shall be provided as indicated above openings over 300mm wide, for pipes, ducts and cable trays, unless steel sleeves are used.

4. Embedded Items: Spaces around built-in items shall be filled with mortar. Openings around flush-mounted electrical outlet boxes in wet locations shall be pointed flush with mortar including flush joints above the boxes. Anchors, ties, accessories, flashing, pipe sleeves and other items required to be built-in shall be built-in as the masonry work progresses. Anchors, ties, and joint reinforcement shall be fully embedded in mortar.

5. Unfinished work shall be stepped back for jointing with new work. Toothing may be resorted to only when specifically approved. Before laying new work, loose mortar shall be removed and the exposed joint shall be thoroughly cleaned.

6. Protection: Surfaces of masonry not being worked on shall be properly protected at all times. At the end of each workday period and when rain is imminent, the top of exposed masonry shall be covered with a strong non-staining waterproof membrane well secured in place and in a manner that will prevent moisture. Adequate provisions shall be made during construction to prevent damages by wind.

7. Mortar: Materials shall be accurately measured in laboratory-established proportions and mixed with as much water as may be necessary to produce the wettest workable consistency possible. Mortar shall be placed in final position within one hour after mixing. Mortar not used or that has started to set within this time interval shall be discarded.

8. Jointing: Joints in exposed-to-view except control joints, joints to be pointed or caulked or sealed, and openings around flush-mounted electrical outlet boxes in wet locations shall be tooled slightly concave with the mortar thoroughly compacted and pressed against the edges

of the units. Tooling shall be done when the mortar has been thumbprint hard. The tooled joint shall be finished to uniformly straight and true lines and surfaces, smooth and free of tool marks.

9. Placing Reinforcing Steel

Prior to placing grout, all reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout or other coating which might destroy or reduce its bond with grout. Details of reinforcement shall be as indicated in the drawings. Reinforcing shall not be bent or straightened in a manner injurious to the steel. Bars with kinks or bends not shown on the drawings shall not be used. Placement of reinforcement shall be inspected and approved prior to placing grout. One piece vertical bars extending from floor to floor or roof above shall be provided. Vertical bars shall be spliced only where indicated.

a. Positioning Bars

Vertical bars shall be positioned accurately at the centerline of the wall. A minimum clearance between the bars and masonry units of 12mm and between parallel bars of one diameter of the reinforcement shall be maintained. Vertical reinforcing shall be held in place using metal supports, centering clips, spacers, ties or caging devices located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement.

b. Splices

Splices shall be located only as indicated. Splices shall be staggered in adjacent bars at least 600 mm. Bars shall be lapped a minimum of 40 diameters of the reinforcement.

4.5.5 PAINTING AND CLEANING

Mortar daubs or splashing, before setting or hardening, shall be completely removed from masonry unit surfaces that will be exposed or painted. Before completion of the work, all defects in joints or masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Masonry surfaces shall not be cleaned, other than removing excess surface mortar until mortar in joints has hardened. Masonry hardened surfaces shall be left clean, free of mortar daubs, dirt, stain and discoloration, including scum from cleaning operations and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

4.5.6 MEASUREMENT AND PAYMENT

1. Quantities of unit masonry to be paid for shall be units or number of square meters of various thicknesses, types, kinds and/or sizes of respective items of work required as shown or specified and as installed and accepted in completed work.

2. Measurement of unit masonry shall be the area of one face of each respective type and thickness of walls and partitions required, determined by overall horizontal and vertical dimensions thereof.

3. No separate measurement will be made for grouting, forming of joints to be sealed, base stud lintel, and other auxiliary work required except for reinforcing steel bars which shall be measured for payment in kilograms computed from the theoretical unit mass for sizes of bars multiplied by length of bars as shown on approved shop drawings except where specified otherwise.

4. No separate measurement will be made for individual detail items of this work not listed herein nor for compliance with various detail requirements applicable to this work; as such shall be considered incidental to work as specified above.

4.6 STEEL AND METAL WORKS

4.6.1 GENERAL

Division 1, "General Requirements," contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

4.6.1.1 SCOPE OF WORK

The work includes the furnishing of all labor, materials, equipment and other incidentals necessary for the fabrication and installation of structural steel and miscellaneous metal works as specified in relevant items of these specifications and as indicated on the drawings.

4.6.1.2 SUBMITTAL

1. Before placing orders for materials for the steel and metal works, the Contractor shall submit to the Engineer for approval shop drawings for all steelwork. All project shop drawings shall show the dimension of all parts, method of construction, bolts, welding sectional areas and other details.

2. The detail of connections shown on the shop drawings shall be such as to minimize formation of pockets to hold condensation, water or dirt. A minimum gap between abutting angles and the like shall be provided wherever possible to eliminate any traps and facilitate maintenance painting.

3. No materials shall be ordered nor fabrication commenced until the shop drawings are approved by the Engineer.

4.6.1.3 STORAGE OF MATERIALS

Structural materials, either plain or fabricated, shall be stored above the ground upon platforms, skids, or other supports. Materials shall be kept free from dirt, grease, and other foreign matter and shall be protected from corrosion.

4.6.2 MATERIAL REQUIREMENTS

1. Unless specified herein all steel structures and metals shall conform with the requirements of Section 3.15, “Steel and Metal Works.” Connections where details are not specified or indicated herein, shall be designed in accordance with the American Institute of Steel Construction (AISC), Manual of Steel Construction, latest edition.

2. Structural steel works consisting of channels, gusset plates and other structural steel shape shall be as indicated on the drawings and shall be structural carbon steel conforming to ASTM A 36. Shapes shall be as given in AISC, Manual of Steel Construction.

3. High strength structural bolts, shall conform to ASTM A 325, Types 1 or 2. Nuts shall conform to ASTM A 560, Grade A, heavy hex style, except nuts 38 mm (1- 1/2 inch) may be provided in hex style. Washers shall conform to ANSI B 18.22.1, Type B.

4. Electrodes for arc welding shall be E70 series conforming to American Welding Society Specifications A5.1.

5. Tests are required under the ASTM Standards for steel to be used in the Works and shall be carried out in the presence of the Engineer and at least four (4) days notice must be given to him of the dates proposed for such tests. Four (4) calendar days notice on which fabricated steelwork will be ready for inspection in the Contractor’s yard.

6. Standard bolt shall conform to ASTM A 307 Carbon Steel Externally Threaded Standard Fasteners.

4.6.3 **EXECUTION**

4.6.3.1 QUALIFICATION

Qualification of steel fabricators, erectors and welders shall comply with the requirements of sub-section 3.15.3.1.

4.6.3.2 FABRICATION REQUIREMENTS

1. Workmanship

   Fabrication shall be performed within the permissible tolerance by the approved fabricator. All workmanship shall be of the best quality with respect to internationally recognized standards of practice.

2. Cutting

   Low-carbon structural steel may be cut by machine-guided torch instead of by shears or saw.

   Harmful notches, burrs, irregularities, etc., shall not be developed at the cut surface.

3. Contact Faces

   Contact surfaces between bases or other elements bearing directly upon bearing plates shall be ground or milled as necessary for full effective bearing.

   Edges for welding shall likewise be properly prepared.

4. Bolt Holes

   Bolt holes shall be according to engineering practice and as specified in these specifications.

   Gas burning of holes will not be permitted.

5. High Strength Bolt Assembly Preparation

   Surfaces of high strength bolted parts in contact with bolt heads and nuts shall not have a slope of more than 1:20 with respect to a plane normal to the bolt axis.

   Where the surface of a high strength bolted part has a slope of more than 1:20, a beveled washer shall be used to compensate for lack of parallelism.

High strength bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials.

When assembled, all joint surfaces including those adjacent to washers shall be free of scale except tight mill scale, and shall be free from dirt, loose scale, burrs, and other defects that would prevent solid seating of parts.

Contact surfaces of friction-type joints shall be free from oil, paint, lacquer or galvanizing.

6. Welding

All welding shall be done only by welders certified as to their ability to perform in accordance with accepted testing requirement.

Welding of parts shall be in accordance with structural standards and the Standard Code for Arc and Gas Welding in Building Construction of AWS, and shall only be done where shown, specified, or permitted by the Engineer.

Damage to galvanized areas by welding shall be thoroughly cleaned with wire brushing and all traces of welding flux and loose or cracked zinc coating shall be removed prior to painting. The cleaned area shall be painted with two coats of zinc oxide-zinc dust paint. The paint shall be properly compounded with a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight. As an alternative to the above, the Contractor may submit for approval the use of a galvanizing rod or galvanizing solder to repair damaged areas.

The welding machine shall be a stable welder, and have suitable functions for the dimension of materials to be welded. The auxiliary tools used for welding shall perform sufficiently and adequately.

The welding machine used for field welding shall be of readily adjustable for electric current.

7. Shop Assembly

Structural units furnished shall be assembled in the shop.

An inspection shall be made to determine that the fabrication and the matching of the component parts are correct.

Jigs shall be used for the assembly of units as much as possible to maintain appropriate position of mutual materials.

Approval of the Engineer shall be required when drilling temporary bolt holes or welding temporary support to the assembled structure.

The tolerances shall not exceed those allowed by codes and each unit assembled shall be closely checked to insure that all necessary clearances have been provided and that binding does not occur in any moving part.

In order to maintain accurate finished dimensions and shape, appropriate reverse strain or restraint shall be provided as required.

Assembly and disassembly work shall be performed in the presence of the Engineer, unless waived in writing by the Engineer any errors or defects disclosed shall be immediately remedied by the Contractor.

Before disassembly for shipment, component parts of the structures shall be match marked to facilitate erection in the field.

4.6.3.3 FABRICATION TOLERANCES

1. Dimensional Tolerances for Structural Work

   Dimensions shall be measured by means of an approved calibrated steel tape at the time of inspection. Unevenness of platework shall not exceed the limitation of the standard mill practice as specified in the American Institute of Steel Construction, “Manual of Steel Construction”.

2. Camber

   Reverse camber in any structural steel members in excess of 1/1,000 of the span length shall cause rejection. The minimum dead load camber for any structural steel member shall be as allowed by Code, or otherwise specified.

4.6.3.4 INSPECTION AND TEST OF WELDING

1. Inspection of Welding

   Inspection of welding shall be executed for the following work phases.

   a. Before Welding

      Scum, angle of bevel, root clearance, cleaning of surface to be welded, quality of end tab, drying of welding rod.

b. During Welding

Welding procedure, diameter of coil and wire, type of flux, welding current and voltage, welding speed, welding rod position, length of arc, melting, cleaning of slag of each level under surface chapping, supervision of welding rod.

c. After Execution of Welding

Assurance of bead surface, existence of harmful defects, treatment of crater, quality of slag removal, size of fillet, dimension of extra fill of butt welding, treatment of end tab.

2. Testing of Welding

Twenty percent (20%) of welds contributing in the overall strength of the structure and which will be inaccessible for the inspection in service shall be tested.

Welding shall be tested by ultrasonic test to the extent specified herein or as directed by the Engineer.

Where partial inspection is required, the ultrasonic test shall be located at random on the welds so as to indicate typical welding quality.

If ten percent (10%) of the random ultrasonic tested indicate unacceptable defect, the remaining eighty percent (80%) of the welding shall be tested.

Repair welding required shall be ultrasonic tested after the repairs are made.

4.6.3.5 CORRECTIONS

In lieu of the rejection of an entire piece or member containing welding which is unsatisfactory or which indicates inferior workmanship, corrective measures may be permitted by the Engineer whose specific approval shall be obtained for making each correction. Defective or unsound welds or base steel shall be corrected either by removing and replacing the entire weld, or as follows.

1. Excessive convexity or overlap shall be reduced by grinding.

2. Undercuts, lack of weld shall be repaired with necessary reinforcement of weld after removal of any foreign materials such as slag, dust, oil, etc.

3. Any defects such as slag inclusions, incomplete fusion, or inadequate joint penetration, shall be completely removed, cleaned and re-welded.

4. Cracks in welds or base steel, shall be removed to sound steel throughout their length and 5cm beyond each end of the crack, followed by welding. The extent of the crack, depth and length, shall be ascertained by the use of acid etching, magnetic particle inspection or other equally positive means.

The removal of welded steel shall be done by chipping, grinding, oxygen cutting, oxygen gouging, or air carbon arc gouging and in such a manner that the remaining welded steel or base steel is not nicked or undercut. Defective portions of the welding shall be removed without substantial removal of the base steel.

4.6.3.6 INSTALLATION

1. Installation Program

   a. Prerequisite Condition

      Prior to executing steel fabrication and field installation, the Contractor shall prepare a comprehensive installation program including engineering supervision organization, fabrication procedures, field installation procedures, material application, machinery applications, inspection procedure, scope and standard of quality judgment, and submit to the Engineer for approval.

   b. Special Technical Engineering

      Special technical engineering different from contract specifications can be applied upon receiving approval of the Engineer.

2. Installation Requirement

   a. Setting of Anchor Bolt and Others

      1) Anchor bolts shall be set in accurate position by using templates.

      2) The setting method shall be proposed to the Engineer for his approval before setting starts.

      3) The threads of bolt shall be cured with an appropriate method against rust and/or any damage before tightening.

      4) Non-shrink mortar shall be placed under base plates, well cured to obtain the sufficient strength before bearing loads are applied to base plates.

b. Temporary Bracing

1) Temporary bracing shall be installed as necessary to stay assemblies and assume loads against forces due to transport, erection operations or other work.

2) Temporary bracing shall be maintained in place until permanent work is properly connected and other construction installed as necessary for support, bracing or staying of permanent work.

3) Extent and quality of temporary bracing shall be as necessary against wind and other loads, including seismic loads not less than those for which the permanent structure is designed to resist.

c. Adequacy of Temporary Connections

During erection, temporary connection work shall be securely made by bolting and/or welding for all dead load, wind and erection stresses.

d. Alignment

No permanent bolting or welding shall be done until the alignment of all parts with respect to each other shall be true within the respective tolerances required.

e. Field Welding

1) Any shop paint or surfaces adjacent to joints where field welding is to be executed shall be wire brushed to remove paint/primer.

2) Field welding shall conform to the requirements specified herein, except as approved by the Engineer.

f. High Strength Bolts

1) Final tightening of high strength bolts shall be done by using manufacturer’s power operated equipment without any overstress to the threads.

g. Correction of Errors

1) Corrections of minor misfits by use of drift pins, and reaming, chipping or cutting will be permitted and shall be provided as part of erection work.

2) Any errors to be corrected or adjusted, preventing proper assembly, shall be immediately reported to the Engineer, and such corrections or adjustments shall be made as necessary and approved by the Engineer.

3) Cutting or alterations other than as approved will not be permitted.

h. Erection

1) Erection and installation shall be as per approved shop drawings.

2) Each structural unit shall be accurately aligned by the use of steel shims, or other approved methods so that no binding in any moving parts or distortion of any members occurs before it is finally fastened in place.

3) Operations, procedures of erection and bracing shall not cause any damage to works previously placed nor make overstress to any of the building parts or components. Damage caused by such operations shall be repaired as directed by the Engineer at no extra cost to the Employer.

4.6.4 **GALVANIZING**

4.6.4.1 PREPARATION

All mild steel parts exposed to weather shall be hot-dipped galvanized after fabrication in accordance with the requirements of ASTM A 123 or ASTM A 153. Prior to galvanizing, the surfaces shall be cleaned of dirt, weld splatter, grease, slag, oil, paint or other deleterious matters. The steel surfaces shall be chemically de-scaled and cleaned with the same abrasive blast or other suitable method as approved by the Engineer.

4.6.4.2 COATING

The zinc coating shall consist of uniform layers of commercially pure zinc free from abrasions, cracks blisters, chemical spots or other imperfections, and shall adhere firmly to the surface of the steel. The weight of zinc coating per square meter of actual surface shall not be less than 550 grams. Any surface damaged subsequent to galvanizing shall be given two coats of approved zinc rich paints.

4.6.5 **PAINTING**

This work shall consist of the preparation of the metal surfaces, the application, protection and drying of the painted surfaces, and supplying of all tools, tackle, scaffolding, labor and materials necessary for the entire work. Painting shall be applied in the field or shop as approved by the Engineer.

Unless otherwise specified or approved, all painting work for structural steel shall comply with the requirements of this Section.

4.6.5.1 SHOP PAINTING

All structural steel shall be given a shop primer after fabrication and cleaning before delivery to the site.

All steel work shall be thoroughly dried and cleaned of all loose mill scale, rust and foreign matters by means of sand blasting or other suitable methods approved by the Engineer before shop painting shall be applied. Each individual piece shall be painted prior to assembly. Portions where field welding or field contact with concrete is required, shall not be painted.

Shop Paintings - Except for galvanized surfaces and items to be encased in concrete, clean ferrous metal surfaces shall be given one coat of Amerlock 400 Epoxy Primer at 100 Microns or approved equal. Additional coat shall be applied to surfaces that will be concealed or inaccessible for finish painting by Amerlock 400, Top Coat at 150 Microns with color or equivalent.

4.6.5.2 FIELD PAINTING

After erection, the Contractor shall thoroughly prepare and clean the entire surface of all structural steel from all dirt, grease, rust or other foreign matters. The entire surface of all members shall then be field painted.

4.6.5.3 MATERIALS

1. Structural Steel Work

    a. After surface preparation, steelwork shall be given one coat of approved prefabricating primer.

    b. Before final assembly of steelwork at the fabricator’s shop, two shop coats of special red lead primer shall be applied to the surface of sections to be in permanent contact, meeting faces and all other concealed surfaces. After final assembly, but before delivery to the project site, the steelwork shall likewise be given two shop coats of special red lead primer.

2. Galvanized Steelwork

All galvanized steelwork shall be treated with zinc chromate two-pack etch primer followed by one coat of non-etch zinc chromate primer.

3. Miscellaneous Metal Work

Unless otherwise specified in other Sections of the Specifications or shown on the drawing, miscellaneous metal works such as ladders, structural steel ladder rungs, etc. shall be given two shop coats of epoxy primer and two coats of epoxy enamel.

4.6.5.4 CONSTRUCTION METHODS

1. Cleaning of Surfaces

Surfaces of metal to be painted shall be thoroughly cleaned; removing rust, loose mill scale, dirt, oil or grease, and other foreign substances. Unless cleaning is to be done by sand blasting, all weld areas, before cleaning is started, shall be neutralized with a proper chemical, after which they shall be thoroughly rinsed with water.

Three methods of cleaning are provided herein. The particular method to be used shall be as directed by the Engineer.

2. Hand Cleaning

The removal of rust, scale, and dirt shall be done by the use of metal brushes, scrapers, chisels, hammers or other effective means. Oil and grease shall be removed by the use of gasoline or benzene.

Bristle or wood fiber brushes shall be used for removing loose dirt.

3. Sandblasting

All steel shall be cleaned by sandblasting. The sandblasting shall remove all loose mill scale and other substances. Special attention shall be given to cleaning of corners and re-entrant angles. Before painting, sand adhering to the steel in corners and elsewhere shall be removed. The cleaning shall be approved by the Engineer prior to any painting which shall be done as soon as possible before rust forms.

4. Flame Cleaning

All metal, except surface inside boxed members and other surfaces which shall be inaccessible to the flame cleaning operation after the member is assembled, shall be flame cleaned in accordance with the following operations.

a. Oil, grease, and similar adherent matter shall be removed by washing with a suitable solvent. Excess solvent shall be wiped from the work before processing with subsequent operations.

b. The surface to be painted shall be cleaned and dehydrated (free from occluded moisture) by the passage of oxyacetylene flames which have an oxygen to acetylene ratio of at least 1.0. The oxyacetylene flames shall be applied to the surfaces of the steel in such a manner and at such speed that the surfaces are dehydrated; dirt, rust loose scale in the form of blisters or scabs, and similar foreign matters are freed by the rapid, intense heating by the flames. The number arrangement and manipulation of the flames shall be such that all parts of the surfaces to be painted are adequately cleaned and dehydrated.

c. Promptly after the application of the flames, the surfaces of the steel shall be wire brushed, hand scraped wherever necessary, and then swept and dusted to remove all free materials and foreign particles.

d. Paint shall be applied promptly after the steel has been cleaned and while the temperature of the steel is still above that of the surrounding atmosphere.

5. Weather Conditions

a. Exterior Coatings: Coatings to surface shall not be applied during foggy or rainy weather, or under the following surface temperature conditions: below 4°C, or over 35°C, unless approved by the Engineer.

b. Interior Coatings: Coatings shall be applied when surfaces to be painted are dry and the following surface temperatures can be maintained: between 18 to 35°C during the application.

6. Application

a. Paint shall be factory tinted and mixed. All paint shall be field mixed before applying in order to keep the pigments in uniform suspension.

b. Field Painting

When the erection work is complete, including all bolting and straightening of bent metal, all adhering rust, scale, dirt, grease or other foreign materials shall be removed as specified above.

As soon as the Engineer has examined and approved each steel and metal works structures, all field bolts, all welds, and any surfaces from which the top or first coat of paint has become worn off, or has otherwise come defective shall be cleaned and thoroughly covered with one coat of paint.

Surfaces to be bolted and surfaces which shall be in contact with concrete, shall not be painted. Surfaces which shall be inaccessible after erection shall be painted with such field coats as are required. When the paint applied for retouching the shop coat has thoroughly dried, and the field cleaning has been satisfactorily completed, such field coats as are required shall be applied. In no case shall a succeeding coat be applied until the previous coat is dry throughout the full thickness of the paint film. All small cracks and cavities which were not sealed in a watertight manner by the first field coat shall be filled with a pasty mixture of red lead and linseed oil before the second coat is applied.

The following provision shall apply to the application of both coats. To secure a maximum coating on edges of plates or shapes, bolt heads and other parts subjected to special wear and attack, the edges shall first be striped with a longitudinal motion and the bolt heads with a rotary motion of the brush, followed immediately by the general painting of the whole surface, including the edges and bolt heads.

The application of the second field coat shall be deferred until adjoining concrete work has been placed and finished. If concreting operations have damaged the paint, the surface shall be re-cleaned and repainted.

c. General Manners

Painting shall be done in a neat and workmanlike manner. Paint may be applied with hand brushes or be spraying, except aluminum paint which preferably shall be applied by spraying. By either method the coating of paint applied shall be smoothly and uniformly spread so that no excess paint shall collect at any point. If the work done by spraying is not satisfactory to the Engineer hand brushing shall be required.

d. Brushing

When brushes are used, the paint shall be so manipulated under the brush as to produce a smooth, uniform, even coating in close contact with the metal or with previously applied paint, and shall be worked into all corners and crevices.

e. Spraying

Power spraying equipment shall be used to apply the paint in a fine spray. Without the addition of any paint, the sprayed area shall be immediately followed by brushing, when necessary, to secure uniform coverage and to eliminate wrinkling, blistering and air holes.

f. Removal of Paint

If the painting is unsatisfactory to the Engineer the paint shall be removed and the metal thoroughly cleaned and repainted.

4.6.6 MEASUREMENT AND PAYMENT

For structural steel the method of measurement shall be in accordance with Section 3.15 “Steel and Metal Works”.

Measurement of the total quantities of work completed under this section shall be the total weight in kilograms of structural steel framing complete with gusset plates, bolts and accessories. Payment shall be the unit price for every unit of measurement listed in the Bill of Quantities of which shall include materials, labor, tools, equipment, and all appurtenances necessary to complete the work.

Payment includes all materials, labor, tools, equipment and all appurtenances for the completion of the work.

4.7 CARPENTRY AND JOINERY

4.7.1 GENERAL

Division 1, "General Requirements," contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

4.7.1.1 SCOPE OF WORK

The work shall consist of furnishing all materials, tools, labor, equipment and incidentals necessary to perform and complete the carpentry works as indicated on the drawings and specified herein together with the supervision necessary to the work involved.

The work shall include the doors jambs and other wood works under various items of the specification.

4.7.1.2 DELIVERY AND STORAGE

The Contractor shall protect lumber against dampness and from the weather during and after delivery.

The Contractor shall stack lumber in a manner to insure proper ventilation and drainage, at least 150 mm above ground. Lumber shall be stored under cover, not exposed to extreme temperature and humidity and in a manner to provide air circulation around all surfaces of each piece.

Interior millwork product such as doors, etc. shall not be stored or installed into the buildings until concrete masonry work and plaster are thoroughly dry.

4.7.1.3 SHOP DRAWING

Shop drawings for all carpentry and other woodwork items as required shall be submitted sufficiently in advance of need to allow for review and approval. Shop drawings shall indicate materials and details of construction, methods of fastening, and erection details.

Materials shall not be delivered to the site until after the approved shop drawings have been returned to the Contractor. The Contractor shall be responsible for all errors of detailing and fabrication, and for the correct fitting of fabricated items shown on the shop drawings.

4.7.1.4 WORKMANSHIP

All wood finish works shall be true to details, clean and sharply defined. Panels must be set to allow for free movement in case of swelling or shrinkage. Means of fastening various parts together shall be concealed and as shown on the drawings or as directed by the Engineer.

4.7.2 MATERIAL REQUIREMENTS

4.7.2.1 GENERAL

1. Lumber shall either be kiln dried or as directed by the Engineer and shall be free from imperfections that will impair its strength and finish.

2. Lumber shall be of the best grade available of the respective kinds required for the various parts of the work, well-seasoned, thoroughly dry, sound, straight, free from warps, loose or unsound knots. Lumber with cuts, shakes or other imperfections impairing its strength, durability or appearance shall not be used. All exposed surfaces shall be smooth unless otherwise indicated on the drawings or specified.

3. Any lumber equally good for the purpose intended may be substituted for the kind specified upon prior written approval of the Engineer.

4.7.2.2 MATERIALS

1. Kiln dried tanguile lumber, sound, hard and free from defects shall be used for:

   a. Exterior and interior millwork, siding and finish and trim, as shown on the drawings;

   b. Wood doors, frames and panels,

   c. Cabinet works;

2. Yakal shall be used for all doors and window jambs, transom bars, wood plates and other woodwork in contact with concrete or masonry.

3. Apitong: Sound and thoroughly seasoned, warp free, treated with pressure impregnated preservative, smooth and level on one side or whenever in contact with paneling.

   Unless otherwise indicated on the Drawings, use Apitong, pressure treated for all truss members and rafters; and carpentry; except where in contact with concrete.

4. Plywood

   Plywood shall conform to Commercial Standard PSI and shall be of local manufacture.

   Plywood to be varnished shall be tanguile or kalantas veneers (as indicated), ribbon grained, water resistant, Class B and of the thickness indicated.

   Plywood to be painted shall be tanguile veneer ordinary rotary-cut, water resistant, Class C and of the thickness indicated.

   Plywood exposed to the outside elements or where indicated shall be waterproof or marine plywood and of the thickness indicated.

   The minimum number of plies required for plywood shall be as follows: 3 plies for 4mm to 9mm thick, and 4 plies for 11mm to 19mm thick. Plywood to be pressure-preservative treated shall be fully-waterproof-flue type. Grade for preservative-treated plywood shall not be less than that specified for the specific use. Plywood shall be clean and smoothly sanded on 2 sides. Shelves are considered exposed.

a. 19mm thick plyboard for built-in cabinets

b. 6 mm thick tanguile plywood for ceilings on wood frame and elsewhere as shown in drawings, and for flush type marine hollow core doors for toilets as shown in drawings.

Skeletal wood framing and other woodworks not otherwise specified herein shall be coated/treated with wood preservative.

Grading of Plywood - Each sheet of plywood shall bear the mark identifying the plywood as to wood species, glue type, and grade.

5. Fastenings

Fastenings shall be common nails, glue or specified, flat-head wood screws (F.H.W.S), round-head wood screws (R.H.W.S), bolts or lag screws where specified or called for shall be used. Conceal fastenings as much as possible; where not possible, locate them in inconspicuous places. Where nailing is permitted through woodwork smooth-finished face, conceal nail heads.

Nails - shall be of the smooth shank, zinc coated, common wire nails of local manufacture, and of types and sizes best suited for the purpose.

Wood Screws - shall be brass or cadmium plated, of the best available commercial quality, and of types and sizes suited for the purpose.

4.7.2.3 MOISTURE CONTENT

1. Lumber treated with water-borne preservatives shall be dried to a moisture content not exceeding 19 percent after treatment.

2. Interior finishing lumber shall be kiln-dried, and at the time of delivery to the building site, the moisture content shall not exceed 12 percent for material 25mm or less in thickness, and shall not exceed 15 percent for material over 25mm in thickness.

3. Woodwork that is assembled or built-up of more than one piece at the mill, except doors, shall have a moisture content not in excess of 12 percent at time of delivery to the site.

4.7.2.4 SUBSTITUTION

Any lumber equally good for the purpose intended may be substituted for the kinds specified, subject to the approval of the Engineer. Provided, however, that in the substitution of a cheaper kind of lumber to that which is specified, a reduction in the contract price equal to the difference in the cost of the two kinds of lumber will be made.

4.7.3 **EXECUTION**

4.7.3.1 ERECTION

1. Timber construction assembled with nails and spikes.

    a. For wire nails, the tensile strength shall be not less than 60kg/mm^2 and for wrought and pressed nails not less than 40kg/mm^2.

    b. Unless otherwise specified, square spikes with countersunk square heads shall be used of a length not less than 2 ½ times the minimum dimension of the timbers to be fastened together.

    c. When nailing timbers together, the units to be fastened shall be butted together and be nailed perpendicularly to their surfaces. Heads of nails and spikes shall be driven flush with the surface of the timber.

    d. Points of spikes or nails emerging from the timber shall be turned over transversely to the wood fibers. Care shall be taken that the timbers do not split during nailing.

2. Timber construction assembled with bolts

    a. The bolts used for assembling timber shall be of steel conforming to the requirements of ASTM Designation A307. The tensile strength of bolt steel shall be between 34 and 55kg/mm^2. Members shall be drilled accurately for bolting with suitable washers provided under heads and nuts.

    b. Bolts, washers, nuts, and fish-plates shall be galvanized.

    c. Washer plates for bolt heads and nuts shall have the following dimensions:

        For 13mm bolts use 7.5 x 75mm washers
        For 19mm bolts use 10 x 100mm washers
        For 25mm bolts use 13 x 130mm washers
        For 38mm bolts use 20 x 200mm washers

    d. Bolt holes in timber shall be drilled with a drill having a diameter slightly smaller than that of the bolt so that the bolt has to be forced into the hole. The bolts shall be re-tightened several times as requested by the Engineer in order to ascertain that the bolts have obtained a suitable and stable degree of tension.

3. Timber construction assembled with screws

   a. The screws used for assembling the timer shall comply with relevant ASTM Designations.

   b. Undersized screw holes shall be drilled in advance. Screws shall not be hammered into holes.

4.7.3.2 FINISH

The Contractor shall mill, fabricate and erect interior finish products as indicated on the drawings. Machine-sand cut joints at the mill shall be hand sand smooth.

Joints shall be made tight and in a manner to prevent shrinkage. The Contractor shall secure trim with fine finishing nails, screws, or glue where required and nails shall be set for putty topping.

4.7.3.3 WOOD DOORS, JAMBS AND HEADERS

Door frames shall be set plumb and level and braced until built-in.

Anchor wood frames in masonry with approved metal anchors on each side of jamb. Top and bottom anchors shall be placed 200mm from head and floor unless indicated on the drawings or directed by the Engineer.

4.7.3.4 HARDWARE INSTALLATION

Accurately fit and finish hardware items required.

If surface-applied hardware is fitted and applied before painting, remove all such items except butts and re-install after painting.

4.7.3.5 PRESSURE TREATED LUMBER

Preservative Treatment - All lumber indicated to be pressure treated, shall contain any of the following net retention of solid preservative.

Boliden salts	-	45.5 kg. dry chemical per cubic foot of wood.
Wolman salts	-	.31 kg. dry chemical per cubic foot of wood.
Tenalith salts	-	.34 kg. dry chemical per cubic foot of wood.

The Contractor shall submit an affidavit signed by an official of the preservative treatment company to the Engineer. This affidavit shall indicate the net retention of solid preservatives obtained and shall certify that pressure treated lumbers have a moisture content that does not exceed 17 percent upon shipment from the treatment plant.

Where it is necessary to cut or bore pressure-treated lumber on the job, two coats of prepared concentrated preservatives solution shall be applied to the end-cut or bored surfaces.

4.7.3.6 ROUGH CARPENTRY

All works shall be well fitted, accurately set, and rigidly secured in place.

Cutting and fitting to accommodate other works shall be done as required and in a neat workmanlike manner, and cut or damage works shall be patched and made good.

Framing and structural lumber shall be well-seasoned, straight, square-edged stacked, and free from loose or unsound knots, back edges or other defects that will impair its strength.

Anchors, connectors and fastenings not indicated or specified shall be of the types and size necessary to suit the conditions encountered. Size, type and spacing of nails, screws and/or bolts for installation of manufactured building materials shall be as recommended by the approved manufacturer unless indicated or specified otherwise.

All lumber surfaces in contact with concrete or masonry shall be given a brush coat of bituminous paint.

4.7.3.7 JOINERY WORK

All lumber used for joinery work shall be of the kinds and grades specified and shall have the contours, patterns and profiles indicated.

All joints shall be made in an approved manner, installed tight and securely fastened. Exterior joints shall be mitered and interior angles coped. Panels shall be fitted to allow for shrinkage, avoid swelling and insure that the work remains in place without warping, splitting and opening of joints.

All exposed surfaces shall be machined and hand sanded to an even smooth surface, ready for finish. No hammer marks or other unsightly marks shall be allowed on any wood panel or veneer.

4.7.4 MEASUREMENT AND PAYMENT

No separate payment shall be made for carpentry or joinery work as such work is deemed part of the specified wood work items as indicated in the Bill of Quantities.

4.8 ROOFING AND TINSMITHRY

4.8.1 SCOPE OF WORK

The work shall include but not limited to all labor, materials, tools, equipment and incidentals necessary to furnish and install the roofing sheets including fittings, flashing caps, ridge rolls, gutters and construction of concrete eaves and canopy excluding waterproofing, to provide completely sound water tight roof for the buildings as shown on the Drawings and specified herein.

4.8.2 MATERIAL REQUIREMENTS

4.8.2.1 ROOFING SHEETS

a. Galvanized Iron Roofing

Long span, pre-painted with high grade polyester paint over epoxy primer Galvanized iron roofing [rib/corrugated] type, highly resistant to corrosion and shall comply with the following:

1. Minimum metal base thickness of 0.60mm
2. Minimum paint thickness

   10 microns for bottom coat

   25 microns for top coat
3. Minimum metal base yield stress of 550 MPa

4.8.2.2 FASTENERS AND ACCESSORIES

Roofing sheet fastener shall be 0.025 GI straps and units with washers and cutting screws with neoprene washers or as recommended by the approved manufacturer.

4.8.2.3 TRANSLUCENT FIBERGLASS SKYLIGHTS

Skylights panels shall be fibrous glass translucent panels consisting of a reinforcing mat of 25% glass by weight bonded between surface mats made by borosilicate glass with less than 7% alkali. The binding material shall be of 100% acrylic bonding resins. Panels shall not be less than 3.00mm thick, rib-type to suit the rib of roofing sheets to be used.

Fasteners shall be cadmium plated stove bolts with 1.8mm cadmium washer and rubber washer.

4.8.2.4 HANDLING AND STORAGE

Sheet shall be lifted directly and shall not be dragged over the other sheets or over rough surfaces.

When working on a roof, the workers shall wear flat rubber soled shoes.

Tool shall be handled carefully to prevent them from sliding over the coated surface.

When installation work is completed, all metal off-cuts, used nails and other metallic scrap shall be removed from roof area.

When using drills, hacksaws, or files in the roof area, care shall be taken that metal particles and fillings are swept off the roof immediately.

If not required for immediate use, sheets or bundles shall be staked and clear off the ground. If left in the open, sheets shall be protected by loose tarpaulin or similar covers.

Bundles shall not be left expose to the weather.

4.8.2.5 CONCRETE EAVES AND CANOPY MATERIALS

Concrete materials shall comply with the requirements in Section 3.2, Concrete Works.

Reinforcing Steel bars shall likewise conform with the requirements in Section 3.2, Concrete Works.

4.8.2.6 FIXED METAL LOUVER VENTILATOR

Louver blades shall be gauge # 18 pressed steel.

4.8.2.7 SAMPLES

Samples shall be submitted for Engineer's approval before any order for roofing materials be made by the Contractor.

4.8.3 **INSTALLATIONS**

4.8.3.1 ROOFING SHEETS

1. GI Sheets

   At least 28 days before laying of roofing sheet start, the Contractor shall submit for approval of the Engineer, shop drawings indicating materials and method of installation. No roofing sheets laying work

shall commence without the Engineer's approval of the shop drawings and work method.

Laying shall start from the end opposite the side from where the prevailing monsoon is coming from. The first sheet shall be laid and installed with the turned-down edge towards the outside of the area to be covered. The next sheet shall be overlapped to the previous sheet in such a manner that the exposed edge is turned down and the covered edge is turned up. The overlapped edge in the side shall be with the rib having the anti-capillary groove. End and side laps including flashing shall be as approved by the Engineer.

The straps shall be fixed and fastened with the fastener and washer as shown on the Drawings.

2. Translucent Fiberglass Skylights

Installation of skylights shall be coordinated with and shall follow the sequence of the laying of the roofing sheets. Overlap of skylight panels shall not be less than 300mm at the ends and 2-1/2 corrugations at the sides. No nails shall be used for fastening the skylights panels. All the sheets shall be secured to the purlins with stove bolts and clips complete with one cadmium washer and one rubber washer on top and below the sheet.

All sheets shall be secured to the purlins. Side laps shall be bolted at the center of purlin spaces. Mastics solvents and sealers listed as unsatisfactory to acrylic panels shall not be used.

4.8.3.2 CONCRETE EAVES AND CANOPY

Construction of concrete eaves and canopy shall be in accordance with Section 3.2, "Concrete Works" as shown on the Drawings and as directed by the Engineer.

Waterproofing shall be in accordance with Section 4.9, "Concrete Waterproofing".

4.8.4 MEASUREMENT AND PAYMENT

The quantities to be paid for shall be measured as follows and as indicated on the pay items

1. Roofing sheets and sidings by the area in square meters of roofing sheets or sidings.

2. Ridge rolls by the length in linear meter of ridge rolls

3. Flashing by the length in linear meter of flashing

4. Steel fixed louver vents by the area in square meter of fixed metal louver ventilator

5. The quantity of concrete eaves and canopy to be paid for shall be measured in accordance with Section 3.2, “Concrete Works”.

Payment shall constitute full compensation for furnishing all labor, materials, tools and equipment and other incidentals necessary to complete the work.

4.9 CONCRETE WATERPROOFING

4.9.1 GENERAL

Division 1, "General Requirements," contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

4.9.1.1 SCOPE OF WORK

The work shall cover the waterproofing requirements for buildings as shown on the drawings.

The work shall consist of furnishing all labor, materials, equipment and other incidentals necessary for the membrane waterproofing works where required as shown on the drawings and in accordance with the requirements of these specifications and as directed by the Engineer.

4.9.1.2 SUBMITTAL

1. The Contractor shall submit for approval of the Engineer the name of the manufacturer nominated for the supply of materials and installation. Sub-contracting documents shall be submitted to the Engineer by the Contractor.
2. The Contractor shall submit the procedure of waterproofing installation/construction for approval of the Engineer.
3. Membrane waterproofing materials shall be installed only by an experienced installer and shall be installed in accordance with the approved manufacturer's installation procedures or methods, approved by the Engineer.

4.9.1.3 PRODUCT HANDLING

Materials shall be delivered to site in the original sealed containers and packages bearing the manufacturer's name.

4.9.1.4 ALTERNATIVE

No substitution of materials shall be made unless authorized in writing by the Engineer prior to starting the work of waterproofing.

4.9.1.5 MINIMUM GUARANTEE PERIOD

The Contractor shall guarantee the work for a minimum guarantee period of five (5) years. The Contractor shall make sub-contract agreement with approved manufacturer in which following conditions shall be included:

1. Minimum guarantee period of five (5) years after the issuance of Taking-Over Certificate.

2. The Contractor shall transfer all the rights to the Employer, free of charge after the issuance of Taking-Over Certificate.

4.9.2 MATERIAL REQUIREMENTS

4.9.2.1 MEMBRANE SHEETS

Membrane sheets shall be pre-formed elastic, self-sealing, cold-applied bituminous membrane sheet made of a combination of selected asphalt, high-grade plasticizers and 0.075 mm thick polyethylene sheet with the following thickness:

1. 3-ply, 2 mm thick, elastic self-sealing bituminous membrane reinforced with 0.075 mm (3 mils) thick polyethylene sheet which is sandwiched between layers of 1.00 mm thick each elastic self-sealing membranes.

2. Primer

   Priming substrate shall be emulsified asphalt (cutback type) applied at a minimum rate of 4 liters per 9 sq.m.

3. Sealant

   Sealant to seal membrane joint overlaps and termination edges shall constitute 2-component mixture of selected asphaltic material and special grade of mineral matter, applied at a minimum rate of 1.2 kg per sq.m. or 3 kg per membrane sheet.

4.9.2.2 CONCRETE TOPPING

1. For RC eaves, cement mortar topping shall have a minimum 28 day compressive strength of 17 MPa (2500 psi) and shall be in accordance with ACI Specifications. Topping shall be 50 mm thick concrete with synthetic fibrous reinforcement or reinforced with hyrib mesh wire at the sides.

2. For roof decks and canopies, cement mortar topping shall have a minimum 28-day compressive strength of [21] MPa [(3000] psi) with a thickness of 50 mm topping with synthetic fibrous reinforcement or reinforced with hyrib mesh wire.

3. For Toilets, cement mortar topping/mortar setting beds shall have a minimum 28 day compressive strength of [17.2] MPa ([2,500] psi) and shall be in accordance with ACI specifications. Topping shall be 25 mm think and side topping reinforced with hyrib mesh wire.

4. All concrete and mortar materials shall conform to Section 3.2, "Concrete Works."

4.9.3 **EXECUTION**

4.9.3.1 SURFACE PREPARATION

1. Horizontal and vertical concrete and masonry substrate surfaces shall be steel troweled to smooth finish, fully cured, dry, clean and free of rubbish, loose or foreign materials.

2. Surfaces shall be properly sloped (1.5%) to drain water freely into drain lines, gutters and downspouts.

3. Inside corners shall be provided with cement mortar cants of 50 mm x 50 mm (min.) or rounded off at 50 mm (min.) radius.

4. Outside corners shall be curved at approximately 50 mm radius.

5. Reglets about 40 mm deep x 40 mm wide at 0.25 m above floor finish shall be provided along walls or concrete fascia for the termination of the waterproofing system (flashing).

4.9.3.2 PRIMING

A primer shall be applied to impregnate the surface of the base substrate by brush or roller at a coverage of not less than 9 sq.m per 4 liters from a pre-selected side of the area towards the other end of the surface area. The Contractor shall allow the primer to dry or become tacky for at least one hour.

4.9.3.3 MEMBRANE INSTALLATION

1. Membranes shall be installed by peeling off the plastic covering of the sticky side and unrolling slowly into place. The sheets shall be pressed firmly to the surface and forced out any entrapped air. Membranes shall be applied from the low point to the high point across the fall line so that the laps shed water.

2. Subsequent sheets shall be installed with 50 mm minimum overlaps on all sheet joints. All overlaps shall be bonded using a sealant of a 2-component mixture of selected asphaltic material and special grade of mineral matter or sealant for joint overlaps and termination edges.

3. Construction and expansion joints shall be double-covered with a strip of the same grade of membrane of about 300 mm wide centered on the axis of the corner or joint.

4. Membrane edges shall be extended over the edge of slabs or over the top of concrete fascia. All edges shall be sealed with a troweled bed of sealant.

5. For drains, membranes shall be extended down the drains over about a 30 mm length, and edges bonded and sealed with the sealant.

6. For protrusions, membrane shall be extended about 200 mm high. The vertical sheet shall be bonded and sealed with sealant.

7. For high vertical walls, membrane shall be terminated into reglets as described in item 5 of sub-section 4.9.3.1.

8. After the membranes are installed, the Contractor shall inspect carefully for punctures and damages on the installed membranes. Any punctured or damaged membrane shall be patched up with the same grade of membrane strip.

4.9.3.4 FLOODTESTING

Floodtest for a duration of 48 hours shall be undertaken upon completion of waterproofing installation to determine any leakage or defect on the materials and/or workmanship.

4.9.3.5 PROTECTIVE LAYER

The required topping as shown on the drawings, shall be made after acceptance of the floodtesting.

4.9.4 MEASUREMENT AND PAYMENT

The quantity of waterproofing works shall be measured by the area of waterproofing in square meters including cement or concrete leveling and topping and reglets, installed, completed and accepted by the Engineer.

The quantity determined above shall be the basis of payment of the unit price for the pay items shown in the Bill of Quantities which price and payment shall be the full compensation for furnishing all materials, labor, equipment, tools and other incidentals necessary including tests to complete the waterproofing work, accepted and certified for payment by the Engineer.

4.10 CEILING AND WALL INSULATIONS

4.10.1 GENERAL

Division I, “General Requirements,” contain provisions and requirements essential to these Specifications; and apply to this section, whether or not referred to herein.

4.10.1.1 SCOPE OF WORK

The work covered in this section shall include all labor, materials, tools, equipment and incidentals necessary to furnish and install pre-fabricated insulated panels and door including aluminum cobing angle, joiner mould, capping and ceiling suspension system, door hardware and other accessories to provide a completely sound watertight ice storage as shown on the Drawings and specified herein.

4.10.1.2 GENERAL PROVISIONS

1. Pre-fabricated insulated panels and door shall be a product of a single manufacturer.

2. Trade names of the materials or components indicated in the specifications are intended only to show the standard of the materials or component on which the design of the particular work is based and also to avoid ambiguous descriptions of the materials or components on the drawings.

   The indication of trade names, therefore, shall in no way be considered to limit the acceptability of other products of equal or better functions, performances, reliability and durability.

4.10.1.3 SUBMITTALS

Samples, specifications and construction procedures proposed for use shall be submitted to the Engineer for approval.

4.10.1.4 DELIVERY AND STORAGE

Pre-fabricated insulated panels and door shall be supplied and delivered in their finished form. They shall be stored at a place properly protected from rain and sunlight. Extended, outdoor exposure shall not be allowed. Insulation materials shall not become wet or soil. Contractor shall comply with manufacturer’s recommendation for handling, storage and protection during installation.

4.10.2 MATERIAL REQUIREMENTS

1. 100 mm thick pre-fabricated insulated panels for wall, ceiling and door with a core of polystyrene foam, machine laminated onto pre-painted continuous steel sheets.

Technical Description

Specifications	
Dimension	1200 mm width by any length
Thickness	100 mm
Weight	13.2 kg/m^2
Surface	Plain
Skins	0.60 mm thick steel, 350 g/m^2 (nominal) zinc coating with oven baked epoxy primer and polyester finish. Color – off white
Core	Self-extinguishing polystyrene foam, density 16 kg/m^3
Structural Properties	
Compressive Strength	110 kn/m^2 at 10% compression
Shear Strength	670 kn/m^2
Insulation Properties	
Vapor Permeability	NIL
Temperature Range	+80°C to –150°C
Thermal Conductivity	3.5 x 10^{-2} with m/°C @ 25°C
Fire Properties (Composite Panel)	
Surface Flame Spread	Class O (BS476, Pt7 1971)
Early Fire Hazard Properties	Range 0-20 (ASK 1530 Pt3)
Surface Properties	
Surface Scratch Resistance	2000 g (DEF 1053)
Corrosion Resistance	
Salt Spray test	No blistering, undercutting or loss of paint adhesion after 1200 hours (ASTM B 117-64)
Humidity resistance	Paint unaffected after 3000 hours (ASK 41 Method 452.1)
Water Immersion	Paint unaffected after 3000 hours
Weather Resistance	Surface unaffected after 5 years exposure to industrial, marine and sub-tropical conditions.

2. Accessories

   Manufacturer's standard for the item required or type best suited for the intended use.

4.10.3 EXECUTION

Install pre-fabricated insulated panels and door according to the direction of the manufacturer.

4.10.4 MEASUREMENT AND PAYMENT

Quantities of pre-fabricated insulated wall and ceiling panels including insulated door and accessories to be paid for shall be measured by lump sum for each building installed, completed, tested, approved and certified for payment by the Engineer.

Payment shall constitutes full compensation for furnishing and installation of pre-fabricated insulated panels and door including all labor, equipment, tools, accessories and other incidentals necessary to complete the work prescribed in this item.

4.11 DOORS AND WINDOWS

4.11.1 GENERAL

Division I, "General Requirements," contain provisions and requirements essential to these Specifications; and apply to this section, whether or not referred to herein.

4.11.1.1 SCOPE OF WORK

The work shall cover the fabrication, delivery and complete installation of doors and windows including glazing for the buildings.

The works shall consist of furnishing all labor, materials, tools, equipment and other incidentals necessary for the complete installation of the above mentioned doors and windows, including glazing, as shown on the drawings and in accordance with this specifications or as directed by the Engineer.

4.11.1.2 SUBMITTAL

The Contractor shall submit the shop drawings for the fabrication of the doors and windows to the Engineer for approval, twenty eight days before the start of works.

The shop drawings shall indicate the following:

1. Elevations for each type;

2. Details for each type;

3. Location in the building for each item;

4. Typical and special details of construction; and

5. Location and installation requirements for hardware.

4.11.1.3 HANDLING AND STORAGE

All doors and windows and door frames shall be delivered, stored and handled so as not to be damaged or deformed. All doors and windows and door frames stored at the site before installation shall be stocked vertically on non-absorptive strips or wood platforms and covered with suitable covering to provide weathertight protection and proper air circulation.

4.11.2 MATERIAL REQUIREMENTS

4.11.2.1 WOOD DOORS

1. Wood doors shall be of the following types where indicated on the drawings with complete locksets, hinges and accessories.

   a. Flush-type marine hollow core plywood doors.
   b. Flush type marine plywood with fixed wood louver door
   c. Panel type wood tanguile doors
   d. Louver type wood door

2. Frame wood block insets shall be kiln-dried tanguile, as shown on the drawings.

3. Facings shall be raised wood panels, ordinary plywood, marine plywood where shown on the drawings. Plywood shall be first quality, grain and color suitable for natural finish and of the thickness indicated on the drawings.

4. Door jambs and headers shall be well-seasoned yakal.

5. Nails shall be of the smooth shank, zinc-coated, common wire nails of the types and sizes suited for the purpose and as directed by the Engineer.

6. Wood screws shall be brass or cadmium plated of the best available commercial quality of the types and size suited for the purpose.

4.11.2.2 STEEL DOORS

1. Swing type metal door shall be gauge 20 metal door with mineral core, as indicated in the drawings.

2. Gauge 20 metal door with baked enamel finish and stainless steel trim and fitting shall be used for toilets. It shall be connected to a cubicle type partitions as indicated in the drawings.

4.11.2.3 ROLL-UP DOOR

1. Roll up door shutters shall be made of cold rolled pre-painted, galvanized steel or black Iron and must be of structural section to withstand all conditions of stresses to which it may be subjected during opening and closing operations and wind pressure of 196 kg/m^2.

   Roll-up door shall be ball bearing mounted to suspend the heavy rotating members. Full door weight shall be carried by side guides.

2. Guides shall consist of steel structural shapes or formed steel not less than 50mm deep and 1.2mm to 1.4mm thick (Pre-painted galvanized steel/black iron) Guide shall be securely attached to wall or column by 10mm diameter by 83mm hexagonal bolts with expansion shield spaced at 600mm on center. Pre-painted and galvanized side guides shall be installed with PVC reinforcement as sound reducer.

3. Curts shall be formed by interlocking steel slots, roll formed from 0.80mm to 1.20mm, depending on the requirements, pre-painted, galvanized steel or B Iron sheets.

   Windlocks shall be provided as required by door size and shall withstand wind pressure of 196 kg/m^2.Windlocks shall be galvanized malleable cast iron and fastened to curtains slats with three or more zinc-plated steel rivets per lock..

4. Bottom bar of the curtain will be reinforced with two (2) pieces of angular bars of not less than 44mm x 44mm x 1.60mm thick pre-painted, galvanized steel or black iron. Compressible and replaceable rubber vinyl weather strip shall be attached on the bottom rail.

5. Brackets shall be fabricated of heavy cast iron or steel, designed to close the end of the roller shaft housing and to form a supporting ring or hood. Bracket hubs or shaft plugs shall be equipped with pre-lubricated ball bearings, shielded or sealed.

   Endlocks made of malleable cast iron, galvanized and fastened to alternating slats shall be installed to prevent slats from wearing at the surface coming in contact with the side guides.

   Roller shaft shall be constructed of steel pipe or commercial steel tubing of proper diameter and thickness for the size of the curtain. Deflection shall not exceed 0.030 inch per foot of span. End of roller shall be closed with cast iron plugs machine to fit the pipe.

6. Rubber bumpers shall be installed to protect the base of the roll-up doors even when ample pressure is applied on pushing the door up. The bumpers shall also minimize the load, clashing sound when the doors are lifted.

4.11.2.4 ALUMINUM DOOR

1. All frames for aluminum door shall consist of aluminum shapes and materials extruded from alloy 6063-T5 to ASTM B 221. Frames shall be coated with polyester powder and with shade as shown on the Drawing or as directed by the Engineer. Powder coating shall satisfy the following requirements:

Pre-treatment	:	zinc chromating and acid rinsing
Powder application	:	one operation using electrostatic gun
Oven curing temp	:	200ºC for 20 min,
Coating thickness	:	min. 60 microns
Impact resistance (ASTM D 2794)	:	min. 20 in/lb

2. Door panels shall either be clear or tinted glass with panel thickness as shown on the Drawings.

4.11.2.5 PVC DOORS

Vinyl: Integral color PVC compound containing impact-resistant solid plasticizer.

Comply with ASTM D 4216.

4.11.2.6 MELAMINE FACED PARTICLE BOARD FOR TOILET ENCLOSURE

Toilet enclosures shall be 33 mm thick H.M.R. (High Moisture Resistant) Melamine Faced Practice Board.

Colors shall be as designated by the Engineer. Submit samples for each type of toilet enclosure for approval prior to installation.

4.11.2.7 JALOUSIE GLASS TYPE WINDOW WITH SECURITY GRILLES

Glass slats shall be 5.5 mm thick obscured glass 100 mm wide smooth edged glass.

The vertical operating mechanism shall be of extruded aluminum conforming to ASTM B 211 with paired zigzag cut members one fixed to the concrete jambs.

Lower handles shall also made of aluminum that lock the unit in closed position.

Wrought iron grilles shall be manufactured from 12 mm square bars conforming to the shop drawing submitted and approved by the Engineer.

4.11.2.8 ALUMINUM WINDOWS

All frames for window shall consist of aluminum shapes and materials extruded from alloy 6063-T5 conforming to ASTM B 221. Frames shall be coated with polyester powder conforming to the requirements of Section 4.11.2.5. (exterior use) or epoxy/polyester powder coated (interior) aluminum window frame. It shall be of fixed window, half-fixed and half-open sliding window, half-fixed and half-open sliding window below a fixed window as indicated in the drawings.

Glass for window shall either be clear, obscured or tinted with pane thickness as shown on the Drawings.

4.11.2.9 FIXED GLASS COUNTER WINDOWS

Window frames shall either be wood or aluminum conforming to Section 4.11.2.1. or 4.11.2.5 or as shown on the Drawings.

Glass shall be clear glass not less than 5.5 mm thick.

Nails shall be as provided in Section 4.11.2.1.5.

4.11.2.10 FIXED LOUVER WINDOWS

Fixed louver windows shall be of the thickness and dimensions indicated. The fixed louvers shall be fabricated from gauge 16 G.I. sheet. Unless otherwise indicated, metal louver windows shall be constructed to withstand a minimum of 240 kg/m2 windload.

4.11.2.11 GLASS

Glass for window sashes shall be of the best quality of its respective kind and shall be free from internal or surface defects. It shall not be clouded, cracked or imperfect.

Glass shall be provided in locations as indicated and the corresponding type specified on architectural drawings. Each glass has the manufacturer’s label showing the type, thickness, and quality of glass. Labels shall not be removed until the glazing has been approved.

1. Clear glass shall be 6.35 mm thick for doors and 5.50 mm thick for windows. It shall be heat-strengthened for fixed window panes with a clear rubber sealant nearly and properly installed.

2. Reflective type glass shall be 6.35 mm thk for doors and windows and shall be heat strengthened tempered glass.

3. Wired glass or fire-rated glass shall be 6.30 mm thick.

4. Glazing materials and accessories such as weather-stripping, glazing sealant, gasket, channel, beads, clips, primer, masking tape, edge spacer and others shall comply with all pertinent codes and regulations and shall be as recommended by the glass manufacturer as approved by the Engineer.

5. Hardware - All items of finish hardware shall be furnished, packaged and labeled in sets. All items of finish hardware of like kind and purpose shall be the same manufacturer and shall be made of 630 Stainless steel.

4.11.2.12 WEATHERSTRIPING

Weather strips shall be continuous wool pile, silicon treated weather stripping or any type of weatherstripping recommended by the approved door manufacturer to be fitted of stile rails and bottoms of doors.

Extruded aluminum snap-in glazing beads with vinyl inert glazing gaskets shall be provided on the exterior side of doors and windows.

4.11.2.13 MIRRORS

Mirrors shall be plate glass, not less than 6.35mm thickness, mirror glazing quality or better, free from imperfection with silvering, electro-copper plated back coating and shall be of the best commercial quality. Edges shall be ground smooth and polish. 6mm marine plywood backing shall be provided. Size shall be as shown on the drawings.

4.11.3 **EXECUTION**

4.11.3.1 WOOD DOORS

1. Wood panel doors shall be of the designs, sizes and thickness as shown on the drawings. Frames shall be set plumbed and true and braced to prevent distortion.

   Frames in concrete and masonry walls shall be secured by anchor bolts or as shown on the drawings or as directed by the Engineer.

2. Wood panel doors shall be of the types, sizes and thicknesses as shown on the drawings. Top and bottom edges of all interior and exterior doors shall be given a coat of lead and oil priming paint or a coat of water-resistant spar varnish after cutting, fitting and prior to installation in the work. Doors shall be glazed as indicated. Doors shall be primed before glazing.

3. Flush wood doors shall be fabricated such that the entire core and frame assembly shall be bonded to the face veneers with approved type of water resistant adhesives, and cured under controlled heat and pressure. Facing shall be waterproofed plywood or ordinary plywood as shown on the drawings. Items of finishing hardware specified in other sections of the specifications shall be fitted carefully and attached securely. Care shall be exercised so as not to mar or injure the work.

4. Hinged doors shall be plumbed and fitted accurately allowing 1.5 mm clearance at the jambs and heads and 3.0 mm over thresholds. Clearance at the bottom of the door having no thresholds shall be 9.5 mm. Lock stiles of door 44.5 mm thick and thicker shall be beveled 3 mm. Knob locks and latches shall be installed 1.75 mm from the finished floor to the center of the locks.

4.11.3.2 STEEL DOOR

The installation of steel door and frames shall be performed by the Contractor under the supervision of the manufacturer. Frames shall be prepared to receive standard hardware, provided with anchors for building into masonry, and shall extend 63 mm (2-1/2") below finished floor lines.

All steel doors shall be checked for warps and when installed shall be hung plumb and true and when closed shall contact the joint over its entire length.

4.11.3.3 GLASS JALOUSIE TYPE WINDOWS

Jalousie frames shall be temporarily fixed at bottom and top ends using wood screws or concrete nails.

Glass slats shall be placed into the slat chips starting below until the whole units are entirely glazed.

Units shall be operated and adjustments made when required taking into consideration that all units shall be properly aligned and satisfactorily operational.

The slats chips shall be closed so that the glass slats are securely fixed then the units shall be permanently fixed with wood screws or approved fastening device.

4.11.3.4 ALUMINUM DOORS AND WINDOWS

1. Fabrication

   All frames shall be factory prefabricated in accordance to the designs and dimensions indicated in the Drawings. Minimum metal wall thickness shall be 3mm except glazing beads, moldings, and trim which shall not be less than 1.5mm. Frames that are to receive fixed glass shall have removable glass stops and glazing beads.

   Cut, join and fit rails and stiles to hairline joints securely reinforced and joined by means of concealed fastening wherever possible.

   Protective Coating: Clean all surfaces and apply a protective coating of clear, water-white methacrylate-type lacquer, resistant to alkaline mortar and plaster immediately after fabrication. Covering shall not chip, peel or flake due to temperature or weather, and shall protect against discoloration and surface damage from transportation, storage, and construction activities. Covering shall be readily removable without affecting the finish. Covering shall either be adhesive paper, waterproof tape, or strippable plastic and may not be removed even after completion of installation.

2. Installation

   Set and anchor frames as shown in details and in approved shop drawings.

   Set frames plumb and square and brace where necessary to prevent distortion. Set frames without springing, forcing or distorting the product.

   Secure frames in accordance with the manufacturer's instructions.

   Wedge clear of masonry all frames set in prepared openings 4.76 mm (3/16”) to 6.35 mm (1/4”) to allow for caulking. Aluminum louvers can be installed flush-mounted to fit masonry or as free standing barriers or screens.

   Protection of aluminum from dissimilar materials:

   Aluminum to dissimilar metals: where aluminum surfaces come in contact with metals other than stainless steel, zinc or white bronze of small area, keep aluminum surfaces from direct contact with incompatible metals by the following methods:

   - Painting the dissimilar metal with one coat of heavy-bodied bituminous paint.

- Applying good quality caulking materials between the aluminum and the dissimilar metal.

Drainage from dissimilar metals: Paint dissimilar metals used in location where drainage from them passes over aluminum as specified above, to prevent staining of aluminum.

Aluminum to masonry and concrete: Give aluminum surfaces in contact with mortar, concrete, or other masonry materials one coat of heavy-bodied bituminous paint.

Adjust all frames and attach hardware before glazing. Secure all windows and doors to be watertight and all hardware operating free and easy.

Upon completion and installation, thoroughly clean surfaces of doors and frames in accordance with the recommended procedure of the manufacturer. Do not use abrasive, caustic or acid cleaning agents.

4.11.3.5 SPECIAL INSTALLATION PROCEDURE FOR GLASS JALOUSIE WINDOWS

Jalousie metal frames shall be temporarily fixed at bottom and top end using wood screw.

Place glass slats into the slat clips starting below until the whole units are entirely glazed.

Operate units and make adjustment where required taking into consideration that all units are properly aligned and satisfactorily operational.

Close the slats clips in a manner that the glass slats are securely fixed with wood screws.

4.11.3.6 PVC DOORS

1. Fabrication

Fabricate frames and panels with mitered and fusion welded corners and joints. Trim and finish corners and welds to match adjacent surfaces.

Provide concealed metal reinforcement in sash frame for attaching lock mechanism.

2. Examination

   a. Examine openings in which doors will be installed.

   b. Verify that fasteners in framed walls are fully driven and will not interfere with door installation.

   c. Verify that sill is flat and level.

3. Installation

   Install doors in framed walls in accordance with manufacturer's installation instructions.

4. Adjusting

   Adjust operating panels and hardware for smooth operation and tight fit with weatherstripping.

5. Cleaning

   Clean soiled surfaces using a mild detergent and warm water solution with soft, clean cloths.

4.11.3.7 TOILET DOORS AND PARTITIONS

1. Install toilet partitions on the locations and heights indicated on the drawings and according to manufacturer's recommended instructions.

2. Hardware shall be checked and adjusted for smooth operation after installation.

4.11.3.8 ADJUSTMENTS

1. Adjust all frames and attach hardware before glazing.

2. Secure all windows and doors to be watertight and all hardware operating free and easy.

4.11.3.9 CLEANING

Upon completion and installation, thoroughly clean surfaces of doors and frames in accordance with the recommended procedure of the manufacturer. Do not use abrasive, caustic or acid cleaning agents.

4.11.4 MEASUREMENT AND PAYMENT

The quantity of doors and windows to be paid for shall be measured and paid for by the number of sets of various kinds, types and size of doors and windows, properly installed, complete with all the necessary hardware, jambs, and other incidentals as shown on the drawings ready to function and as indicated in the Bills of Quantities and accepted and certified for payment by the Engineer.

No separate payment for glass and glazing shall be made. The cost shall be deemed as part of and incidental to the supply and installation of each corresponding set of doors or windows.

4.12 FINISH HARDWARE

4.12.1 GENERAL

Division I, "General Requirements," contain provisions and requirements essential to these Specifications; and apply to this section, whether or not referred to herein.

4.12.1.1 SCOPE OF WORK

The work covered shall include all labor, materials, tools, equipment and incidentals necessary to furnish and install all finish hardware as shown on the drawings and as specified herein.

4.12.1.2 SUBMITTAL

A complete hardware schedule and shop drawings, together with manufacturer's catalogs, shall be submitted by the Contractor to the Engineer for approval.

The hardware schedule shall indicate the manufacturer's catalog number, function, material, finish and other information required. Samples shall be submitted upon request of the Engineer.

The hardware's furnished shall conform to the approved hardware schedule, shop drawings or samples.

4.12.2 MATERIAL REQUIREMENTS

1. All items of finish hardware of like kind and purpose shall be of the same approved manufacturer.

   The Contractor shall measure and verify all dimensions and conditions before proceeding with the work in connection with finish hardware. Hardware applied on metal shall be made to standard templates. The

Contractor shall furnish and install all finish hardware to complete the work as indicated on the drawings. Finish hardware shall be suited and adopted to its required use and shall fit its respective location. Finish hardware not specified shall be as directed by the Engineer.

2. Items of hardware shall be delivered to the job site in their original individual containers, complete with the necessary appurtenances including screws, keys and instructions. Each individual container shall be marked with the manufacturer's name and catalog number as they appear in the hardware schedule.

3. Unless otherwise shown on the drawings or specified, butt hinges shall be brass for interior and for exterior doors, with oil-impregnated bearings, non-rising loose steel pins with button tips and mounting screws of the same material. Butt hinges shall have five knuckles and shall be of the type specified under hardware schedule.

4. Locksets shall have cylindrical type case 50 mm (2") to 63 mm (2-1/2") diameter, with separate latch bolt cast, 19 mm (3/4") to 25 mm (1") diameter, with chromium plated dull finish. Cylindrical case locks and latches shall be applied to doors by inserting cylindrical type case into a hole bored through the face of the door stile, and separable latch bolt case into a hole bored in the edge of the stile. Cylindrical cases shall be secured in doors by means of flanges attached to the case; and the latch bolt case shall be secured by attachment to the edge of the door and to cylindrical case of operating mechanism. Brands shall be "YALE" or "SCHLAGE" or approved equal.

   Cylindrical rim type deadlock and latches shall be with cast iron case and strike. Operation shall be by key from outside and turn knob from inside. Special locksets shall be furnished for installation of locks as required.

5. Tubular cylinder type deadlock and latches shall be with cast bronze bolts, cast bronze cylinder and bronze cases. Deadlocks shall be operated by key from either side. Night latches shall be operated by key from outside and turn knob from inside, with mechanisms to hold latch retracted when desired. Special cases welded to stile shall be furnished for installation of locks and latches, as required.

6. Hinge hasps for lockers shall be zinc-coated wrought steel with pin. Unless otherwise shown or specified, width shall be 48 mm (1-7/8") and length shall be 100 mm (4 inches).

   Fasteners of proper type, quality, size, quantity and finish shall be supplied with the hardware. All fasteners exposed to the weather shall be non-ferrous metal and shall match the trim finish as closely as possible.

Spring hinges shall be 75 mm x 75 mm (3" x 3") plated wrought steel with steel pins and fully enclosed coil springs with adjustable tension. Cylinders shall be integral with one leaf.

7. Padlocks shall be of pin tumbler type with solid or laminated brass case, and steel hardened shackles.

8. Butt Hinges

   a. Each panel of hinged doors shall be provided with two (2) butts for doors 1.5 m or less in height; three (3) butts, over 1.5 m high and not over 2.10 m; four (4) butts, above 2.10 m in height.

   b. Doors of a greater height than 2.10 m, unless otherwise specified, shall be provided with an additional one (1) butt for each 0.65 m or fraction thereof.

   c. Size of Butt Hinges required:

Thickness of Door	Width of Door	Size of Butt Hinges
21 mm or 25 mm (7/8" or 1")		63 mm (2-1/2")
28 mm (1-1/8")		75 mm x 75 mm (3" x 3")
35 mm (1-3/8")	0.90 m (3") or less	89 mm x 89 mm (3-1/2" x 3-1/2")
44 mm (1-3/4")		100 mm x 100 mm (4" x 4")
56 mm (2-1/4") and greater		125 mm x 125 m (5" x 5")

   d. Where the size of the butt hinges is not sufficient to allow door to clear door trim in open position, same shall be increased.

4.12.3 EXECUTION

1. All hardware, shall be installed in a neatly, workman-like manner following the manufacturer's instructions and as shown on the drawings. Fasteners supplied with the hardware shall be used to secure the hardware in place. Wood screws shall be used for securing hardware to wood surfaces. Machine screws, set in expansion shields, shall be used for securing hardware to masonry or concrete surfaces.

2. The bolts shall be used where specified or where necessary for satisfactory installation. After installation hardware shall be protected by the Contractor from paint, stains, blemishes and damages until issuance of Taking-Over Certificate of the work. All hardware shall be properly adjusted and checked-out in the presence of the Engineer to see that the hinges, locks, latches and bolts operate properly. After the hardware is checked, keys shall be tagged, identified and delivered. Any error in cutting and fittings, or any damages to adjoining work shall be replaced, as directed by the Engineer.

4.12.4 MEASUREMENT AND PAYMENT

No separate payment shall be made for finish hardware as such shall be deemed part of the particular set of doors, windows and other fixtures.

4.13 FINISHES

4.13.1 GENERAL

Division 1, "General Requirements," contain provisions and requirements essential to these Specifications; and apply to this section, whether or not referred to herein.

4.13.1.1 SCOPE OF WORK

The work covered by this section consist of furnishing all labor, materials, equipment, tools and incidentals necessary to undertake, complete al finishing works and painting for the buildings as indicated on the drawings and as specified herein.

Wall, floor, ceiling and other finishing works shall include but are not limited to the following:

1. Plain cement plaster (steel trowel) finish painted with acrylic latex paint for exterior and interior CHB (Concrete Hollow Blocks) wall;

2. Glazed tile wainscoting for toilet;

3. Vinyl tile finish;

4. Vitrified ceramic tiles for toilet floor;

5. Pebble wash-out finish;

6. Non-skid Ceramic Tiles

7. Plain cement steel trowel floor finish with non-metallic floor hardener;

8. Rubbed concrete finish, painted with acrylic latex paint for exposed R.C. Ceiling (bottom of roof slab and beams)

9. Fiber Cement Board for Ceiling

4.13.1.2 SUBMITTAL

1. Shop drawings for all finishing and painting works for the building shall be submitted in advance to allow twenty eight days for review and approval. Shop drawings shall indicate materials and details of finishing works. The Contractor shall be responsible for all errors of detailing and fabrication, and for the correct finishing work items shown on the shop drawings.

2. The Contractor, before placing order for the finishing materials shall submit to the Engineer for approval representative samples of finishing materials. No placing of orders for material for finishing works shall be made without his approval.

3. Samples of all walls finishes, measuring not less than 1000 mm x 1000 mm shall be submitted to the Engineer for approval as to its finish texture and workmanship.

4.13.2 **MATERIAL REQUIREMENTS**

4.13.2.1 WALL FINISHES AND COUNTERTOPS

1. Plain Cement Plaster Finish

   a. Sand shall be clean and hard material. Sand shall be free from deleterious substances and conforming with the requirements of ASTM C 33.

   b. Cement shall be Portland cement conforming with the requirements of ASTM Designation C 150.

   c. Water shall be clean and potable.

   d. Bonding compound shall conform to ASTM C 631.

   e. Hydrate lime shall conform to ASTM C 206.

   f. Synthetic fibrous reinforcement shall conform to BS 5139 or ASTM C 1116.

2. Wall Ceramic Tiles

   a. Wall tiles shall be 100 mm x 100 mm glazed ceramic wainscoting Color as per Engineer's approval.

   b. Trimmers and moulding shall be lustrous, glazed with size and color corresponding to wall tiles.

   c. Portland cement, sand, bonding compound, lime and water shall conform with Sub-section 4.13.2.1.1 above.

3. Marble

   a. Marble shall be local natural mined and polished for toilet countertops, fascia and splashboard. Dimensions as shown on the Drawings.

   b. Shall be sound material with uniform and favorable working qualities and with very limited natural faults.

   c. Color, veining and quality shall be approved by Engineer.

   d. Veining shall run vertically on all vertical surfaces and direction of veining shall continue in same directions over horizontal surfaces except as directed by the Engineer.

   e. Marble components shall be factory fabricated and finished and delivered ready for installation without further preparation or modification.

   f. Sealer

      1) Shall be a commercial penetrating type free from harmful alkali or acid content and especially prepared for marble work.

      2) Shall have a Ph factor between 7 and 9.

      3) Shall not discolor.

      4) Shall produce a slip resistant surface.

      5) Shall have a flash point not less than 35 degree C.

   g. Cleaning fluid

      1) Shall be commercial neutral liquid type especially prepared for marble work.

      2) Shall have a Ph factor between 7 and 9.

      3) Shall be free from crystallizing salts or water soluble alkaline salts.

      4) Shall be biodegradable and phosphate free.

4.13.2.2 FLOOR FINISHES

1. Vinyl Tile Finish

    a. Vinyl tiles shall be 3 mm thick x 300 mm x 300mm. Samples of the tile for color selection shall be submitted and approved by the Engineer.

    b. Waterproof contact adhesive shall be as recommended by the tile manufacturer and approved by the Engineer.

2. Vitrified Ceramic Unglazed Tiles

    a. Vitrified ceramic unglazed floor tiles shall be 100 mm x 100 mm, white for toilets and as shown on the drawings or to be designated by the Engineer.

    b. Portland cement, sand and water shall conform with the requirements specified in Sub-section 4.13.2.1.1 above.

    c. Vitrified ceramic unglazed floor tiles shall be delivered in the manufacturer's original unbroken packages or containers that are labeled plainly with the manufacturer's name and brand. Containers shall be grade scaled. Materials shall be stored in dry weathertight enclosures, and shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness.

3. Plain Cement Floor Finish

    a. Portland cement, sand, bonding compound and water shall conform with the requirements specified in Sub-section 4.13.2.1.1 above.

    b. Mortar shall be one part of Portland cement to three parts sand.

    c. Hardener shall be non-metallic floor hardener, delivered in cartons, cans or bags to the construction site with the labels installed and seals unbroken.

4. Non-skid ceramic floor tiles

    Non-skid ceramic tiles shall be 100mm x 200mm white ceramic tiles to be used [for kitchen] as shown on the Drawings.

5. Pebble Washout Finish

    a. Pebble shall be no. 10, and in black color, sound pea gravel, clean, hard, wash river gravel, well selected and graded, rounded non-slip type and not flaky.

Portland cement shall be the best commercial standard conforming to ASTM C 150, type I. Black cement of U.S. brand shall be added to Portland cement base for desired effect.

4.13.2.3 CEILING FINISHES

1. Rubbed Concrete Finish

   Portland cement, sand, bonding compound and water shall conform with the requirements specified in Sub-section 4.13.2.1.1 above.

2. Gypsum Ceiling Board

   Gypsum board to be used for ceiling shall be 13 mm thick and 1.2 m wide and shall conform with ASTM C36. Joint treatment materials and fastening system shall be as recommended by the gypsum board manufacturer and as approved by the Engineer.

3. Fiber Cement Board

   Plain fiber cement board on metal frame shall be 6mm thick for interior ceiling and 9 mm thick of exterior ceiling.

4. Fiberglass Ceiling Board

   Fiberglass ceiling board shall be fashionetone, fissured design, and 600mm x 600mm x 19mm in dimension.

4.13.3 **EXECUTION**

4.13.3.1 WALL FINISHES

1. Plain Cement Plaster Steel Trowel Finish

   a. Preparation of Surfaces

      All surfaces shall be cleaned and projections, dust, loose particles and other materials, which would prevent good bond, shall be removed.

      Plaster shall not be applied directly to concrete and masonry surfaces coated with bituminous compounds and surfaces previously painted or plastered.

      All surfaces shall be thoroughly wetted before plastering.

b. Trial Mix

A trial mix of at least three (3) different water-cement ratios for a proposed mix shall be prepared under full scale conditions and adequate workability. The proportions by weight of cement to the weight of sand shall not be less than one part of Portland cement to two parts of sand.

The proportion of cement-sand and water necessary to produce the cement plaster of the required consistency shall be subject to the approval of the Engineer. Such approval may be withdrawn at any time and a change in proportions may be required. Based on the approved mix proportions, the Contractor shall prepare a list showing the number of kilograms of the various materials to be used in the cement plaster finish mix.

No cement plaster finish shall be started without an approved trial mix by the Engineer.

c. Cement Plaster Finish Application

A brown coat with sufficient pressure shall be applied to fill the gaps, and to secure a good bond. Moistened for 48 hours, each coat of cement plaster shall be kept after application and allow to dry.

A finish coat shall be applied after the brown coat has set. The brown coat shall be moistened before application of the finish coat. Finish coat shall be floated to plumb, even planes and surfaces.

Final plaster finishes shall be rubber sponged.

d. Tolerance

The Contractor shall finish plaster work plumb, level, square and true within tolerance of 3 mm in 3 meters, without cracks and other imperfections.

e. Patching and Cleaning

Upon completion of the building, and when directed, all loose, cracked, damaged or defective plastering shall be cut out and replastered in a satisfactory and approved manner.

2. Wall Tiles

a. Mortar Preparation

All mortar setting beds shall be mixed by volume in the proportion of 1 part Portland cement and 3 parts dry sand and not more than 1/10 part hydrated lime.

Mortar materials shall be measured in approved containers, which will insure that the specified proportions of materials will be controlled and accurately maintained during the progress of the work. Measuring materials with shovels, "shovel count", will not be permitted. Unless specified otherwise, mortar shall be mixed in proportions by volume, in an approved mortar box.

The quantity of water shall be controlled accurately and uniformly. The aggregates shall be introduced and mixed in such manner that the materials will be distributed uniformly throughout the mass. A sufficient amount of water shall be added gradually and the mass further mixed until a mortar of the elasticity necessary for purpose intended is obtained. Mortar boxes, pans and wall surfaces shall be kept clean and free from debris or dried mortar. The mortar shall be used before the initial set of the cement has occurred. Re-tempering of mortar in which cement has started to set will not be allowed.

b. Application of Wall Tile

Interior masonry shall be clean, thoroughly dry, sound and sufficiently rough to provide strong mechanical bond. Surfaces shall be evenly damped immediately prior to the application of the scratch coat.

Scratch coat shall be applied to masonry, as backing for wall tile, not less than 24 hours or more than 48 hours before starting the tile setting. The scratch coat shall not be less than 6 mm from the face of the masonry. The scratch coat shall be applied with sufficient pressure to ensure a proper bond with the base for the setting bed. While the mortar is still plastic, the scratch coat shall be cut with a trowel at all internal vertical angles for the depth of the coat with the full height of the tile bed and shall be cross-scratched, in 25 mm centers for the extent of the tile bed.

Immediately before the application of mortar setting bed, the scratch coat shall be moistened thoroughly but not saturated. Temporary screeds shall be applied to the scratch coat with mortar to provide a true and plumb surface, the proper distance back from the finished wall line. The setting bed shall be applied, rodded and

floated flush with the screeds over an area not greater than the area to be covered with the tile while the bed remains plastic. The thickness of the setting bed shall not exceed 15 mm and the mortar shall not be retempered. The setting bed shall be cut with a trowel at all internal corners as specified for the scratch coat.

Mounted tiles shall be soaked in clean water a minimum of one hour before they are set. Absorptive mounted tiles shall be damped by placing sheets on a wetted cloth in a shallow pan before setting. A skim coat of neat Portland cement mortar, mixed with water to the consistency of a pasty, thick cream, shall be applied 0.8 mm to 1.6 mm thick to the mortar setting bed, or to the back of each tile as laid. The tiles shall then be pressed firmly on the setting bed and tamped until flush and in the plane of the other tiles. The tiles shall be applied before the mortar bed has taken its initial set.

Intersections and returns shall be formed accurately. Where cutting of tiles is necessary it shall be done at the internal angles of the walls or wainscots. Cutting and drilling tiles shall be done neatly without marring the surfaces. The cut edges of tiles against trim, built-in fixtures, and similar surfaces shall be ground and jointed carefully. The tiles shall fit closely with plumbing fixtures and around electric outlets, pipes and fittings, so that the plates or escutcheons will properly overlap the tiles. Wainscots shall be within one half of the heights indicated without cutting of the tiles.

Bases, caps, bull-nose corners, and all other trimmers moulded or shaped features, and accessories shall be backed thoroughly with mortar and set firmly into place. All lines shall be kept straight and true, and all finished surfaces brought to true and even planes, straight and plumb, and internal corners squared and external corners rounded.

Horizontal joints shall be maintained level and vertical joints plumb and in alignment. The completed work shall be free of broken, cracked, damaged or otherwise faulty tiles.

Joints shall be parallel and uniform in width, plumb, level and in alignment. End joints in broken-joint work shall be made as far as practicable, on the center line of adjoining tiles. Except in special arrangement and design, as indicated or specified, square tiles shall be set with straight joints, and oblong tiles shall be set with broken joints.

Joint widths shall be uniform and spaced to accommodate the tile in the given spaces with a minimum of cutting. Tiles shall be wetted, if they have become dry, before applying grout. Joints 3

mm or less in width shall be grouted with a neat Portland cement grout of the consistency of thick cream. Other joints shall be pointed with mortar consisting of one part Portland cement and two parts pointing sand. The grout for walls and other vertical surfaces shall contain non-staining white Portland cement. Grout and pointing mortar shall be forced into joints by using trowel, brush or finger application.

Before the grout or mortar sets, the joints of cushion edge tiles shall be struck or tooled to the depth of cushion, filling all skips or gaps, and the joints of square edge tiles shall be filled completely flush with their surface. Dark cement shall not show through grouted white joints. Care shall be taken to avoid scratching glazed finishes. All mortar or grout shall be removed before it has set or hardened.

c. Cleaning and Curing

All completed tile work shall be thoroughly sponged and washed diagonally across joints, and finally polished with clean, dry cloth. Acid cleaning of unglazed tile, when necessary, shall not be done within ten days after setting tile. All metal shall be covered with an approved grease and the tile shall be wetted with clean water, before tile is cleaned with 10% muriatic acid solution. After acid cleaning, the tile shall be flushed with clean water, and the grease coating on metal shall be removed. Acid cleaners shall not be used on glazed tile.

d. Protection

Tiled walls outside corners (external angles) shall be protected with board corner strips in areas used as passage ways by workmen. Extreme care should be taken not to disturb walled tiled until mortar has fully set.

4.13.3.2 FLOOR FINISHES

1. Vinyl Tiles

No vinyl tile work shall start until the Engineer has approved the time when such work shall start.

The Contractor shall furnish and install all vinyl tiles and base where and as shown on the drawings or as specified. The temperature shall be maintained at 22°C for 48 hours before, during and 48 hours after the application of tiles.

Vinyl tile shall be laid in accordance with the approved manufacturers recommended method of laying.

Waterproof contact adhesive shall be applied both on the floor and tile, spread evenly and allowing 10 minutes drying time prior to installation.

Tiles shall be laid with close, straight joints, bedded in contact adhesive in accordance with method approved and rolled with roller of sufficient weight to press tile firmly in place and provide smooth, plush surfaces at the joints. Tiles shall be fitted close to all pipes, base and other intersection surfaces.

All finished floors shall be protected in a manner that will prevent the finish from any damage. The Contractor shall remove and replace any defective materials and/or workmanship or damage of the finished floors.

2. Vitrified Ceramic Tiles

   a. Mortar Preparation

      Mortar mix proportion and preparation shall be in accordance with the requirements in paragraph b of sub-section 4.13.3.1.

   b. Surface Preparation

      Surfaces to receive the tiles shall be clean, free of dust, dirt, oil, grease, and other deleterious substances. Floor tile operations in spaces receiving wall tile shall not be started until wall tile installation has been completed. Before tile is applied with a dry-set mortar bed, the structural floor shall be tested for levelness or uniformity of slope by flooding it with water. Areas where the water ponds shall be filled and leveled with mortar and shall be retested before the setting bed is applied.

   c. Placing of Setting Beds and Floor Tile

      Mortar setting beds shall have a minimum thickness of 20 mm for floors. The structural concrete slab shall be soaked thoroughly with clean fresh water on the day before the setting bed is to be applied. Immediately preceding the application of the setting bed, the structural slab shall again be wetted thoroughly, but no free water shall be permitted to remain on the surface.

      A skim coat of neat Portland cement mortar shall then be applied not more than 4 mm thick. The mortar shall be spread until its surface is true and even and thoroughly compacted, either level or sloped uniformly for drainage, as the case requires. A setting bed,

as large as can be covered with tile before the mortar has reached its initial set, shall be placed on one operation; but in the event that more setting mortar has been placed than can be covered, the unfinished portion shall be removed and cut back to a clean beveled edge.

All mounted tiles shall be soaked in clean water a minimum of one hour before they are set. Absorptive mounted tile shall be dampened by placing sheets on a wetted cloth in a shallow pan before setting. No free water shall remain on the tiles at the time of setting. Before the initial set has taken place in the setting bed, a skim coat of neat Portland cement mortar, 0.7 mm to 1.6 mm thick, shall be trowelled or brushed over the setting bed and/or the back of the tile, or a thin layer of Portland cement, 0.79 mm to 2 mm thick, may be hand-dusted uniformly over the setting bed and worked lightly with a trowel or brush until thoroughly damp.

The tiles shall then be pressed firmly upon the setting bed, and beaten into the mortar until true and even with the plane of the finished floor line. Beating and leveling shall be completed within one hour after placing tiles or sheets. Borders and defined lines shall be laid before the field or body of the floor. Where floor drains are provided, the floors shall be sloped to drain properly to the drains. Intersections and returns shall be formed accurately.

Cutting of tile, where necessary, shall be done along the outer edges of the floor. As far as practicable, no tiles of less than half size shall be used. Cutting and drilling of tiles shall be done neatly without marring the tile surfaces. The cut edges of tile against trim, bases, thresholds, pipes, built-in fixtures, and similar surfaces shall be ground and jointed carefully. Tile shall fit closely and neatly at all plumbing fixtures and around electrical outlets, pipes and fittings so that cover plates or escutcheons will overlap the tiles properly. Tiles shall be secured firmly in place and loose tiles or tiles sounding hollow shall be removed and replaced. All lines shall be kept straight, parallel, and true, and all finished surfaces brought to true and even planes. The inner edges of borders shall be kept straight and, where practicable, shall form right angles at all returns. The paper and glue shall be removed from mounted tile, without using excess water, within one hour after installing the tiles.

Joints shall be parallel and uniform in width, plumb, level and in alignment. End joints in broken-joint work shall be made as far as practicable, on the center lines of adjoining tiles. Except in special arrangement and design, as indicated or specified, square tiles shall be set with straight joints, and oblong tiles shall be set with broken joints.

Joint widths shall be uniform and spaced to accommodate the tile in the given spaces with a minimum of cutting. Tiles shall be wetted, if they have become dry, before applying grout. Joints 3.2 mm or less in width shall be grouted with a neat Portland cement grout of the consistency of thick cream. Other joints shall be pointed with mortar consisting of one part Portland cement and two parts pointing sand.

The grout or mortar for joints on floors shall be white Portland cement or as specified by the Engineer. Grout painting mortar shall be forced into joints by using trowel, brush or finger application. Before the grout or mortar sets, the joints of cushion edge tile shall be struck or tooled to the depth of the cushion, filling all skips or gaps, and the joints of square edged tiles shall be filled completely flush with their surface. Dark cement shall not be seen through grouted white joints.

All surplus mortar or grout shall be removed before it has set or hardened.

d. Cleaning and Curing

Floors shall be covered with waterproofed paper with all joints lapped at least 96 mm and allowed to damp cure for at least 72 hours before foot traffic is permitted thereon.

All completed tile work shall be thoroughly sponged and washed diagonally across joints, and finally polished with clean, dry cloth. Acid cleaning of unglazed tile, when necessary, shall not be done within ten days after setting the tile. All metal shall be covered with approved grease and the tile shall be wetted with clean water, before tile is cleaned with 10% muriatic acid solution. After acid cleaning, the tile shall be flushed with clean water, and the grease coating on metal shall be removed.

Finished tile floors shall be covered with clean building paper before foot traffic is permitted on them. Board walkways shall be placed on floors that are to be continuously used as passage ways by workmen. Thresholds shall be covered with boards. Tiles vertical outside corners (external angles) shall be protected with board corners strips in areas used as passage by workmen.

3. Plain Cement Floor Finish with Non-metallic Floor Hardener

a. Trial Mix

No plain cement floor finish work shall be started without the approval of the Engineer of the trial mix.

b. Application

The concrete sub-floor shall be cleaned and projection, dust, loose particles and other materials which would prevent good bond shall be removed. The sub-floor surface shall be moistened but not soaked, dry cement shall then be sprinkled over it and the mortar shall be spreaded on the setting bed. The surface shall be tamped to assure a good bond over the entire area and screeded to provide a smooth and level bed at proper height.

Mortar mix shall be one part Portland cement to three parts sand. Following the placing of leveling concrete on the floor and after the concrete is free from excess water, a dry mixture of 2 parts of floor hardener and 1 part Portland cement shall be uniformly dusted over the floor. Three kilograms of floor hardener shall be used for every square meter of flooring or in accordance with approved manufacturer's specifications. The dry mixture shall be floated thoroughly into the surface which shall be finished by steel trowelling and cured by water or curing compound for seven (7) days.

4. Pebble washout Finish

a. Trial Mix

No exposed aggregate or pebble wash-out finish shall be started without the approval of the Engineer of the trial mix.

b. Preparation of Surface

All surface shall be cleansed and projections, dust, loose particles and other material which would prevent the good bond shall be removed.

c. Placing

The well graded “pea” gravel shall be trowelled or floated into the cement-mortar finish (1:2 mix), pressed into it to an even surface after the mortar has been placed even but before the initial set.

All exposed gravel, covering about 90-95% of the mortar surface shall not be fully embedded into the cement mortar bedding.

At the proper time, “pea” graven finish of mortar splatter shall be cleaned and exposed with brush and water leaving it clean in its natural color and texture.

5. Protection

   a. Before turn over of the building to the Owner, wash pebble surfaces with 1 part muriatic acid to 6 parts clean water.

   b. Apply an overlapping strokes of watershield using brush or by low pressure spraying. Dries to a tack-free surface in 4-6 hours and cures to form an effective water repellant film in approximately 24 hours.

   c. Protect finished surface with specified hardeners and sealants.

4.13.3.3 CEILING FINISH

1. Rubbed Concrete Finish

   After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water for a minimum period of three hours. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing of holes, honeycomb spots, broken corners or edges and other defects to thoroughly set. Surfaces to be finished shall be rubbed with a minimum coarse carborundum stone using a small amount of mortar on each face. The mortar shall be composed of cement and fine sand mixed in the proportions used in the concrete being finished. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids have been filled, and a uniform surface has been obtained. The face produced by this rubbing shall be left in place at this time.

   After all concrete above the surface being created has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of smooth texture and uniform color.

   After the final rubbing is completed and the surface has dried, it should be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks.

2. Gypsum Ceiling Board

   The board shall be installed in accordance with ASTM C 840 and the requirements specified on the Specifications and Drawings. Neatly fit abutting end and edge joints. Use gypsum board of maximum practical length. Cut out gypsum board as required to make neat close joints around openings. Apply gypsum board in accordance with ASTM C840.

3. Fiber Cement Board

   a. Install fiber cement board in accordance with approved layouts on metal grid supports not more than 50 cm apart. When structural supporting members are set at such spacing that the above requirements cannot be complied with, adequate intermediate supports shall also be provided.

   b. Each board shall be tightly and rigidly secured in place and free from unnecessary movement.

   c. Each board shall be set square, straight, plumb and/or level, accurately positioned at locations and to layouts required, with adjacent like units or members accurately aligned.

   d. Board joints shall be tightly abutting and flush across adjacent units.

   e. The installation shall be free from exposed fastenings, unnecessary cuts or holes, other than as particularly shown, specified or approved.

   f. Exposed surfaces shall be completely clean and free from dust, dirt, smudges, fingerprints, scratches, dents, warping, waviness, buckling, broken parts or units, chips, cracks, misaligned or improperly fitted joints, stains, discoloration or other defects or damage.

4. Fiberglass Ceiling Board

   Edges of ceiling board shall be in close contact with the metal supports and in true alignment. Arrange units so that units less than 1/2 width are minimized.

4.13.4 MEASUREMENT AND PAYMENT

The quantity of finishing work to be paid for shall be measured by the number of square meters of various types of finishes installed, applied, completed and accepted by the Engineer.

Payment of above item of work shall constitute full compensation for completed work and certified for payment by the Engineer.

4.14 PAINTING

4.14.1 GENERAL

Division 1, "General Requirements," contain provisions and requirements essential to these Specifications; and apply to this section, whether or not referred to herein.

4.14.1.1 SCOPE OF WORK

This Section covers the surface preparation, coating materials and application of coatings systems required for the Works.

The work shall consist of furnishing of all labor, materials, equipment and other incidentals necessary for the supply of painting materials and the complete painting of surfaces as shown on the drawings in accordance with this Specification and as directed by the Engineer.

The term paint as hereinafter used includes emulsion paints, varnishes, oils, pigments, thinner and dryers.

All exposed metal surfaces, except metal surfaces embedded in concrete, shall be painted unless otherwise specified.

4.14.1.2 STANDARD

The following publications listed below, but referred to thereafter by basic designation only, forms a part of these Specifications to the extent indicated by the reference thereto:

Steel Structures Painting Council (SSPC) U.S. Specification
JIS K 5628 Red-lead Zinc Chromate Anti-Corrosive Paint.

4.14.1.3 SUBMITTAL

1. The Contractor shall submit work method statements with lists of materials to the Engineer for approval twenty eight days before the starting of works. This statement shall include following items:

    a. Type of paint and manufacturer
    b. Manufacturer's specifications
    c. Storage and delivery of materials
    d. Surface preparation
    e. Finish painting and drying
    f. Touch-up painting, if any
    g. Equipment

2. The Contractor, before placing order for the painting materials, shall submit to the Engineer for approval samples of materials. No placing of orders for material shall be made without his approval.

4.14.1.4 STORAGE AND DELIVERY

1. The Contractor shall deliver all material to the site in the original labeled sealed cans and containers, with labels intact and seal unbroken.

   a. Seals shall remain unbroken until after inspection and acceptance of material by the Engineer.

   b. The Contractor shall deliver materials in ample quantities sufficiently in advance of the need to avoid any delay or interruptions in the works.

2. Paint in thinner shall be stored in accordance with the approved manufacturer's instructions.

   a. All regulations required for storage of paint shall be observed and all necessary safety signs required by governing codes shall be posted.

   b. Any damage caused by failure to exercise proper precautions in paint storage shall be repaired.

4.14.2 **MATERIAL REQUIREMENTS**

4.14.2.1 PAINT

Paints for the protective coating system shall be the product of a manufacturer approved by the Engineer.

4.14.2.2 SCHEDULE OF PAINTING

Paint manufacturers shall be BOYSEN, DAVIES or approved equal.

	M A N U F A C T U R E Boysen : Davies
<u>Architectural Items</u>	<u>Number : Number</u>
a) <u>Exterior Finishes</u>	
1. <u>On Concrete Walls</u>	
Two Coats, Concrete 1350/MEGACRYL Masonry Paint	BT01/B715 B710 or EL-0020/EL-2000

2. Unprimed Ferrous Metal including GI Roofing

First Coat:		
Rush inhibitive ferrous metal primer	B320	940
Second Coat:		
Exterior Enamel	B2501	DV-50-00

3. On Concrete Block Wall

First Coat:		
Concrete block primer sealer	B701	1350/EL-0020
Second Coat:		
Concrete Masonry Paint	B701	MEGACRYL-ACRYLIC LATEX-PAINT/EL-2000
Third Coat:		
Concrete Masonry Paint	B701	MEGACRYL-ACRYLIC LATEX-PAINT/EL-2000

4. On Wood

First Coat:		
Exterior Wood Primer	B800	300
Second Coat:		
Exterior Enamel	B600	400
Third Coat:		
Exterior Enamel	B600	400

b) Interior Finishes

Location of the various finishes are listed in the Finish Schedule on the Drawings or else will be confirmed by PPA.

1) On primer & coated metal two coats of interior semi-gloss enamel or as indicated in the schedule finish — B200 — 600

2) On Plaster

First Coat:		
Pigmented sealer		
Second Coat:		
Enamel undercoater	B701	MEGACRYL-ACRYLIC LATEX-PAINT/EL-2000
Third Coat:		
Interior flat enamel	B701	22

3) <u>On Wood</u>

First Coat:		
Enamel undercoater	B800	1360
Second Coat:		or
Enamel undercoater	B800	300/BIO-FRESH.001
Third Coat:		
Interior flat enamel	B800	300/BIO-FRESH.001

4) <u>Wood Stain Finish</u>

Oil Stain with Filler	B2700	25 (paste filler)
Boiled on top coat		20-91 (top coat)

5) <u>Wood Lacquer Finish</u>

Wood Paste Filler w/ natural	B60/B1258	77/701/702
Oil top coat of lacquer	B60/B1253	77/79/703

c) <u>Non-Architectural items</u>
(Piping, Valves, Equipment, etc.)

1) Piping, valves, equipment etc. in rooms are to be painted

2) Galvanized pipes & ducts

Primer - one coat	B320	940
Finish - one coat	B2501/B600	DV-50-00/400

3) Black Steel Pipes

Primer - one coat	B320	940
Finish - one coat	B2501/B600	DV-50-00/400

4) Mechanical Items

a) Ungalvanized Ferrous Metal

Primer - one coat	B320	940
Finish - one coat	B2501/B600	DV-50-00/400

b) Galvanized Ferrous metal

Primer - one coat	B320	940
Finish - one coat	B2501/B600	DV-50-00/400

c) Submerged Galvanized Ferrous Metal

Primer - one coat	B2200	92-00

d) Burried Miscellaneous Ferrous surface, valves, & flanged joints (excl. pipe)

Primer - one coat	B2199	Coal-tar enamel or match adjacent pipe coating (if any)

4.14.3 **EXECUTION**

4.14.3.1 SURFACE PREPARATION OF STEEL

1. Steel surfaces shall be cleaned as follows:

    a. All round welds, burrs and sharp surface projections shall be ground smooth and all weld splatter shall be removed prior to blast cleaning.

    b. Sand abrasives, if used, shall be clean, and free from salt and extraneous matter. The sand shall pass through a 2.0 mm test sieve, and be substantially retained on a 0.18 mm test sieve, with at least 25 percent retained on a 0.355 mm test sieve.

    c. Metallic abrasive, if used, shall be sharp, hard and free from dust, and shall pass through a 1.8 mm test sieve.

    d. Blast cleaning operations shall not be conducted on surfaces that will be wet after blasting and before coating, or when the surfaces are less than 10°C above degree points, or when the relative humidity of the air is greater than 95 percent.

    e. Any oil, grease, soil, dust or other foreign matter deposited on the cleaned surfaces shall be removed prior to painting. In the event that rusting occurs after completion of the surface preparation, the surfaces shall be cleaned again in accordance with the specified method.

    f. Particular care shall be taken to prevent the contamination of other corrosive chemicals before the application of the paint. Such contamination shall be removed from the cleaned surface by flash blasting and the paint applied immediately.

    g. Care shall be taken to prevent contamination of cleaned and painted surfaces by cleaning operations in an adjacent area.

    h. Surfaces not to be painted shall be suitably protected from the effects of cleaning and painting operations.

4.14.3.2 SURFACE PREPARATION OF WOOD

1. Wood surfaces shall be sanded to a fresh surface. Surface mould where present, shall be removed by washing, rubbing down and burning off as necessary. Resinous exudation and large knots shall be removed and replaced with filler or other materials approved by the Engineer.

2. Parts of timber to be enclosed in walls shall always be primed unless already impregnated. Priming shall be brushed on and a minimum of two coats applied to end grain. When the priming paint is hard, all cracks, holds, open joints, etc. shall be made good with hard stopping and rubbed down with fine abrasive paper. Priming of joinery shall be applied only on site after the Engineer has approved such joinery and before it is fixed. For internal surfaces primer coats shall be carefully flatted.

4.14.3.3 SURFACE PREPARATION OF CONCRETE AND PLASTER

Concrete and cement plaster surfaces to be painted shall be prepared by removing efflorescence, dust, dirt, grease, oil, asphalt, tar, excessive mortar and mortar dropping and by roughening to remove glaze. A zinc sulfate solution shall be applied before prime cost.

4.14.3.4 SURFACE PREPARATION FOR FIBER CEMENT SURFACES

Shall be dry and clean prior to application of the specified first-coat material. Oil, grease, or rust stains shall be carefully removed by the use of suitable solvent. Wire brushing will not be permitted. After the first coat has become dry and prior to application of finish coats, touch-up coats shall be applied to suction spots.

4.14.3.5 ADDITIONAL REQUIREMENTS FOR PREPARATION OF SURFACES WITH EXISTING COATINGS

Before application of coatings, perform the following on surfaces covered by soundly-adhered coatings, defined as those which cannot be removed with a putty knife:

1. Wipe previously painted surfaces to receive solvent-based coatings, except stucco and similarly rough surfaces clean with a clean, dry cloth saturated with mineral spirits, ASTM D 235. Allow surface to dry. Wiping shall immediately precede the application of the first coat of any coating, unless specified otherwise.

2. Sand existing glossy surfaces to be painted to reduce gloss. Brush, and wipe clean with a damp cloth to remove dust.

3. The requirements specified are minima. Comply also with the application instructions of the paint manufacturer.

4. Previously painted surfaces, specified to be repainted or damaged during construction shall be thoroughly cleaned of all grease, dirt, dust or other foreign matter.

5. Blistering, cracking, flaking and peeling or other deteriorated coatings shall be removed.

6. Chalk shall be removed so that when tested in accordance with ASTM D 4214, the chalk resistance rating is no less than 8.

7. Slick surfaces shall be roughened. Damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls shall be repaired with suitable material to match adjacent undamaged areas.

8. Edges of chipped paint shall be feather edged and sanded smooth.

9. Rusty metal surfaces shall be cleaned as per SSPC requirements. Solvent, mechanical, or chemical cleaning methods shall be used to provide surfaces suitable for painting.

10. New proposed coatings shall be compatible with existing coatings.

4.14.3.6 EXISTING COATED SURFACES WITH MINOR DEFECTS

Sand, spackle, and treat minor defects to render them smooth. Minor defects are defined as scratches, nicks, cracks, gouges, spalls, alligatoring, chalking, and irregularities due to partial peeling of previous coatings. Remove chalking by sanding so that when tested in accordance with ASTM D 4214.

4.14.3.7 REMOVAL OF EXISTING COATINGS

Remove existing coatings from the following surfaces:

1. Surfaces containing large areas of minor defects;

2. Surfaces containing more than 20 percent peeling area; and

3. Surfaces designated by the Engineer, such as surfaces where rust shows through existing coatings.

4.14.3.8 SUBSTRATE REPAIR

1. Repair substrate surface damaged during coating removal;

2. Sand edges of adjacent soundly-adhered existing coatings so they are tapered as smooth as practical to areas involved with coating removal; and

3. Clean and prime the substrate as specified.

4.14.3.9 SURFACE PREPARATION FOR CONCRETE AND MASONRY - FOR OLD OR PREVIOUSLY PAINTED SURFACES

1. Scrape off loose, scaling and peeling old paints. Sand the whole surfaces including those where old paint still adheres very well.
2. For areas with extreme chalking problems, steel brush, blow air from a compressor or wipe with a clean rag pre-wetted with water. Let dry, then apply one (1) cost of concrete scaler. Dry for at least 4 hours before applying subsequent coats.
3. For areas affected by molds and mildew, wash the whole surface with water or with hypochlorite washing solution. Scrub using a stiff nylon brush, then rinse with water. Apply fungicidal washing compound. Leave overnight.
4. For areas with mapping problems, properly prepare the surface then apply concrete sealer. Dry for at least 4 hours.
5. Putty hairlines cracks.

4.14.3.10 STEEL/ALUMINUM DOORS AND WINDOWS

All metal surfaces shall undergo pre-treatment process which includes: desmutting, water-rinsing, degreasing/etching, water rinsing, zinc phosphating, water rinsing and acid rinsing.

Powder coating application, shall be factory applied and shall be done in one operation using an electro-static powder gun. The materials to be coated should be well connected to earth. Coating thickness should be kept to a minimum of 60 microns for exposed areas. On details which are to be treated mechanically after coating (drilling, sawing, etc.), the coating film must not exceed 100 microns.

The powder coating shall be oven cured in the range of 20 minutes at 220° Centigrade (metal temperature measured on the area with greatest metal thickness). The temperature variation in the oven should not exceed +/- 10° Centigrade.

Handling: Coated items should be cooled to no less than 40° Centigrade before handling. Precautions should be taken to avoid damages on the finished coating during stacking, storing and transportation.

Storage and Delivery: Inspect materials delivered to the site for damage. Unload and store with minimum handling. Provide storage space in dry location with adequate ventilation, free from dust or water and easily accessible for inspection and handling. Store materials neatly on the floor, properly stacked on non-absorptive strips or wood platforms. Protect finished surfaces during shipping and handling using manufacturer's standard method.

4.14.3.11 WOOD REPAIR

Badly decayed areas shall be removed and repaired. Areas and pieces decayed beyond repair shall be replaced with new pieces that match originals in all respects. Moderately decayed areas, weathered, or gouged wood shall be patched with approved patching compounds, and shall be sanded smooth. The source or cause of wood decay shall be identified and corrected prior to application of patching materials. Wet wood shall be completely dried to a moisture content not exceeding 12 percent, as measured by a moisture meter, to its full depth before patching, unless otherwise authorized. Wood that is to be patched shall be clean of dust, grease, and loose paint.

1. Epoxy Wood Repair

   Epoxy wood repair materials shall be applied in accordance with manufacturer's written instructions. Health and safety instructions shall be followed in accordance with the manufacturer's instructions. Clean mixing equipment shall be used to avoid contamination. Mix and proportions shall be as directed by the manufacturer. Batches shall be only large enough to complete the specific job intended. Patching materials shall be completely cured before painting or reinstallation of patched pieces.

2. Epoxy Consolidant and Epoxy Paste

   Epoxy liquid wood consolidant shall be used: 1) to penetrate and impregnate deteriorated wood sections in order to reinforce wood fibers that have become softened or absorbent. 2) as a primer for areas that are to receive epoxy paste filler. Epoxy paste shall be used to fill areas where portions of wood are missing such as holes, cracks, gaps, gouges, and other voids.

4.14.3.12 MIXING AND THINNING

Mixing and thinning of paint shall be done in accordance with the approved manufacturer's printed instructions. The pot life of each paint as stated by the manufacturer shall not be exceeded.

4.14.3.13 WEATHER CONDITION

The paint shall not be applied when the relative humidity is above 85 percent. The paint shall not be applied in rain, wind, fog, dust or mist.

4.14.3.14 APPLICATION

Workmanship shall be first class in every respect. All work shall be done in a workmanship manner so that the finished surfaces shall be free from

runs, chop, ridges, waves, laps and unnecessary brush marks. All coats shall be applied in such manner as to produce an even film of uniform thickness. Edges, corners, crevices, welds and rivets shall receive special attention to ensure that they receive an adequate thickness of paint.

All painting shall be done by thoroughly experienced workmen.

Safety regulations shall be adhered to at all times, including the wearing of respirators by persons engaged on assisting in spray painting. Adjacent areas and installation shall be protected by the use of cloths or other approved precautionary measures.
Plain enamel and varnish shall be applied carefully with good clean brushes or approved spraying equipment, except that the initial coat on any surface shall be applied with brush. Sufficient time shall be allowed between coats to assure thorough drying and each coat shall be in proper condition before receiving the next coat.

Sanding and dusting as required shall be performed between coats in varnishing work. Finish coat shall be smooth and free from runs, sags, and other defects. Exterior paint shall not be applied during rainy days.

All paint when applied shall provide a satisfactory film and smooth, even surface. Paint shall be thoroughly stirred and kept at a uniform consistency during application. Powdered metallic pigments added at the time of use shall be mixed by adding the powder in small increments to about one-third of the base paint or vehicle, with thorough mixing to obtain a smooth paste. The remainder of the base paint shall then be thoroughly stirred in.

Different brands of emulsion paints shall not be mixed prior to application of the materials.

Where necessary to suit conditions of surface temperature, weather and method of application, the package paint may be thinned immediately prior to application in accordance with the approved manufacturer's directions, but not in excess of 125 cc of suitable thinner per liter (one pint per gallon). Before using, the paint shall be mixed to a uniform consistency and shall be stirred frequently during application.

Paints other than water-thinned paints shall be applied only to surfaces which are completely free of moisture as determined by sight or touch and only such combinations of humidity to be painted as will cause evaporation rather than condensation.

Surfaces which have been cleaned, pretreated and/or otherwise been prepared for painting shall be primed or painted with one coat of finish paint as soon as practicable after such preparation has been completed, but in any event prior to any deterioration of the prepared surfaces.

The first coat of paint on all exterior surfaces shall be applied by brush. Interior prime coats and all other subsequent coats on either exterior or interior surfaces may be applied by brush or spray. Whenever spraying is permitted all areas inaccessible to spray painting shall be coated by brushing or other suitable means. Brushes to be used for application of water-emulsions shall be soaked in water for a period of 2 hours prior to use.

All cloths and cotton waste which might constitute a fire hazard shall be placed in closed metal containers or destroyed at the end of each day.

Upon completion of the work, all staging, scaffolding, and containers shall be removed from the site or destroyed in a manner approved by the Engineer. Paint spots, or stains upon adjacent surfaces shall be removed and the entire job left clean and acceptable to the Engineer.

No smoking shall be permitted in the vicinity where painting is going on.

4.14.3.15 TOUCH-UP PAINTING

Touch-up painting shall be done with the same paint as used for the original coat. The resulting minimum dry film shall be the same as for the original coat.

Touch-up painting shall include cleaning and painting of field connections, welds and all damaged or defective paint and rusted areas.

During touch-up painting, only loose, cracked, brittle or non-adherent paint shall be removed during cleaning. All exposed edges shall be feathered. Touch-up painting shall be performed in a manner which will minimize damage to sound paint. Rust spots shall be thoroughly cleaned and edges of the existing paint shall be scraped back to sound material.

4.14.3.16 DRYING

1. No primer or paint shall be forced to be dried under conditions which will cause cracking, wrinkling, blistering, formation of pores which would detrimentally affect the condition of the paint.
2. No drier shall be added to the paint unless specified in the approved manufacturer's instructions.
3. Painted surfaces shall be protected from dust, dirt, and the elements of the weather until dry to the fullest extent practicable.
4. After drying, any areas of paint damaged from any cause shall be removed, the surface again prepared and then touched-up with the same paint and to the same thickness as the undamaged areas as specified in sub-section 4.14.3.7 above.

4.14.3.17 HANDLING

1. Precautions shall be taken to minimize damage to paint films resulting from stacking for drying.

2. Paint which is damaged in handling shall be scraped off and touched-up with the same paint and in the same thickness as was previously applied to the damaged area at Contractor's expense.

4.14.3.1 INSPECTION

1. All works and materials supplied under this Specification shall be subject to inspection by the Engineer.

2. The Contractor shall correct such works or replace such materials found defective under these Specifications at his own expense.

4.14.4 MEASUREMENT AND PAYMENT

1. The quantity of painting work to be paid for shall be made by the area in square meters of painting works completed and accepted by the Engineer on each type of works, except marine works as indicated in the Bill of Quantities, which payment shall constitute full compensation for the completed work and certified for full payment by the Engineer.

2. Measurement for painting of materials of port facilities, Division 3 are included in the individual work items of structural steel, and fender systems. No separate measurement for painting will be made for port facilities.

4.15 PLUMBING AND SANITARY WORKS

4.15.1 SCOPE OF WORK

The work covered for this section shall consist of furnishing all labor, tools, equipment, materials and incidentals necessary for the complete installation, testing and operation of the plumbing and sanitary system within the buildings and premises in accordance with these Specifications and as shown on the drawings or as directed by the Engineer. The septic tank and their effluent and discharge pipelines shall be part of other section of these specifications.

4.15.2 MATERIAL REQUIREMENTS

4.15.2.1 SUBMITTAL

1. The Contractor shall submit his work method statement with necessary shop drawings to the Engineer for approval twenty eight (28) days before the start of the works.

   Shop drawings shall be dated and shall contain the name of the project and location of the subject item in the shop drawing which is to be installed.

   The Engineer will review and approve or return for correction all shop drawings with reasonable promptness. The Contractor shall make any corrections required and file with the Engineer three (3) corrected copies of the shop drawings.

2. The drawings shall indicate the general arrangement of all pipings, however, where actual conditions necessitate re-arrangement in opinion of the Contractor and/or the Engineer, the Contractor shall prepare and submit to the Engineer for approval, twenty eight (28) days before placing the order for materials, shop drawings of the proposed re-arrangement. Because of the small scale of the drawings, shop drawings to indicate all offsets, fittings and accessories shall be prepared. The Contractor shall carefully examine the drawings and shall carefully investigate actual structural and finish conditions affecting all his work.

3. The Contractor shall be responsible for the proper fitting of materials, equipment and accessories without substantial alteration and at no cost to the Employer.

4. The Contractor shall be responsible for the proper coordination of the work and shall provide all necessary clearance where necessary.

4.15.2.2 STANDARDS

Use of materials shall further be governed by other requirement imposed on other sections of these Specifications. Materials shall be subject to tests necessary to ascertain their fitness if the Engineer so requires. All works shall comply with the pertinent provisions of the Plumbing Code of the concerned city or town, the Code on Sanitation of the Philippines, and/or the National Plumbing Code of the Philippines.

4.15.2.3 MATERIALS

1. Identification of Materials

   Each length of pipe, fittings, traps, fixtures and devices used in the plumbing work shall have cast, stamped or indelibly marked on it, the approved manufacturer's trademark or name, the weight, type and class of product when so required by the standards mentioned above.

2. Alternative Materials

   Use of any material not specified in this Specification may be allowed provided such alternate has been approved by the Engineer and provided further that a test, if required, shall be done by an approved agency in accordance with generally accepted standards.

3. Soil, Waste, Drain, Vent Pipes and Fittings

   Soil, waste and vent pipes shall be unplasticized Polyvinyl Chloride (uPVC) pipes. Diameter shall be as indicated on the Drawings. It shall conform to ASTM D 1784 or ASTM D 2729.

   Drainage pipes shall be reinforced concrete pipes (RCP), diameter shall be as indicated on the Drawings.

4. Jointing Material

   The joint material for uPVC pipes shall be PVC solvent cement as recommended by the approved pipe manufacturer.

5. Water Supply Pipes

   Water supply pipes shall be polypropylene random-80 (PPR-80) pipes PN 20 conforming to DIN Standards DIN 1988/DIN 8078, German made. Jointing shall be fusion welded.

6. Cleanouts, Plugs and Tee

   Cleanouts shall be of the same material as the pipe to be fitted. Cleanouts installed in connection with uPVC hubs and spigot pipes shall consist of a long sweep quarter bend of ¼ as shown on the drawings.

7. Pipe Sleeves

   Pipe sleeves shall be installed and properly secured in place at all points where pipes passes through masonry or concrete. Pipe sleeves shall be uPVC pipe, Schedule 40.

8. Downspout

   All downspout shall be unplasticized polyvinyl chloride (uPVC) pipe class DWV conforming to ASTM D2729 or ASTM D1784 for sanitary pipes, Series 1000.

9. Splash Block

   Provide splash blocks at the outlet of downspout emptying at grade which shall be made of pre-cast concrete, with smooth finished counter sunk dishes sloped to drain away from the building. Dimensions as shown on the Drawings.

10. Roof Strainers

    The Contractor shall provide fittings and install 100 mm 0 G.I. mesh wire strainers where shown or indicated on the drawings and/or where the Engineer directs. Each strainer shall fit the size of the corresponding downspout which is to be installed.

11. Shower, Floor and Urinal Drain

    Shower and floor drains shall be made of stainless steel non-tilting grate, perforated or slotted. Urinal drains shall be cast iron dome type drain.

12. Pipe hangers, Inserts and Support

    a. Pipe hangers shall be wrought iron, malleable iron pipe hangers spaced not over 1.5meters apart for uPVC pipes and 3.0meters apart for iron pipes. Chain straps, perforated bars or wire hangers will not be permitted.

       Hangers shall have short turnbuckles or other approved means of adjustment. Turnbuckles may be omitted on hangers where space does not permit their use. Trapeze hangers may be used in lieu of separate hangers for pipes running parallel to each other and close together.

    b. Inserts shall be of cast iron or cast steel and shall be of a type to receive a machine bolt head or nut after installation.

    c. Wrought iron clamps or collars shall be used to support vertical runs of pipes.

13. Unions

    Union pipe 50 mm in diameter and smaller shall be malleable iron. Union on water piping 63mm in diameter and larger shall be flanged pattern and shall be of galvanized (zinc coated) cast iron. Gaskets for flange unions shall be of best quality fiber plastic or leather.

14. Valves

    Valves shall be cast bronze of brass body. Chrome plated finish for all fixture taps and faucets and natural finish for all others, like hose bibbs, gate valves and which are not tapped directly to a plumbing fixture. Concrete valve boxes shall be installed where required and will be of sufficient size for operating the valve.

15. Fixtures

    a. Water Closets

       All water closets for toilets as shown on the drawings shall be TANK TYPE, white with complete fittings and mounting accessories.

    b. Lavatories

       1) Lavatory (Wall Hung): Shall be vitreous china, wall hung lavatory with rear overflow holes, fitting ledge suitable for single faucet holes on centers complete with faucet, standard fittings, trap and lavatory brackets and other accessories.

       2) Lavatory (Countertop Lavatory): Shall be vitreous china, oval or round shaped countertop lavatory with front overflow hole, complete with faucet, supply valve and fittings with P-trap. Fitting ledge suitable for single hole on center.

    c. Urinals

       1) Urinals for all comfort buildings shall be built-in urinal trough as shown on the drawings.

       2) Urinals: Shall be vitreous china, wall-hung washout urinal, flushing rim, integral trap, 19mm top and shall be provided with water saving flush system .

    d. Service Sinks

       Service sinks where indicated or shown on the Drawings shall be stainless steel, with single bowl and with complete U.S. or Japan imported fittings.

e. Slope Sinks

Slop sink shall be 24”x20” acid resisting enamel on Cast-Iron with concealed hanger and faucet.

Hose bibb shall be of brass finish.

f. Soap Holder

Soap holder and toilet paper holder shall be vitreous china, wall mounted. All toilet/bath rooms will be provided with soap holder, toilet paper holder and chrome plated towel racks.

g. Faucet for lavatory

Faucet for lavatory shall be in chrome-finish.

h. Bath and shower fitting

Bath and shower fitting shall be chrome-finish.

i. Towel Rail

Towel rail shall be tubular stainless steel, 2.7mm diameter, and 0.54m long or as specified in the drawings.

j. Curtain rod

Curtain rod shall be tubular stainless steel, 19mm diameter or as specified in the drawings.

k. Grab Bar

Grab bar shall be tubular stainless steel, 25mm diameter or as specified in the drawings.

16. Concrete, Reinforcing Steel, Pipe and Steel Plate

Materials for wash pits, catch basins and manholes shall conform to the requirements as follows:

a. Concrete materials shall conform with the requirements of Section 3.2, “Concrete Works” and shall be Class C concrete with a 28-day minimum compressive strength of 21 MPa (3000 psi).

b. Reinforcing steel shall be as shown on the drawings and shall conform with the requirements of reinforcing steel bars in Section 3.2, “Concrete Works.”

c. Pipes shall be as shown on the drawings and shall comply with the relevant item of the particular pipe.

d. Steel plates shall be as shown on the Drawings and shall comply with Section 4.6, “Steel and Metal Works”.

17. Non-reinforced Concrete Pipe

Non-reinforced concrete pipe shall be as shown on the Drawings and shall conform with the requirements of non-reinforced concrete pipes AIC latest edition. Concrete shall be with a 28-day minimum compressive strength of 20.7 MPa.

18. Valve for Drinking Fountain

Valve where drinking fountain will be connected shall be polished brass pipe and shall have red enameled handle.

4.15.3 **EXECUTION**

All installation works shall be in conformity with the National Plumbing Code of the Philippines (NPCP).

4.15.3.1 EXCAVATION, TRENCHES AND BACKFILLING

1. Trenches for all underground pipelines shall be excavated to the required depth. The bottom of trenches shall be tamped hard and graded to secure the required fill. Bell holes shall be excavated so that pipes will rest on solid ground for their entire length.

Rocks where encountered, shall be excavated to a depth of 150 mm below the bottom of the pipe and before the pipe is laid, the space between the bottom of the pipe and the rock shall be filled with sand. Sewer and water pipes shall be laid in separate trenches.

2. After pipelines have been tested, inspected and approved by the Engineer and prior to backfilling, all forms shall be removed and the excavation shall be cleaned of all trash and debris.

Materials for backfilling shall consist of acceptable excavated soil, borrow of sand, gravel or other materials approved by the Engineer and shall be free from trash, lumber or other debris. Backfilling shall be placed in horizontal layers not exceeding 150 mm in thickness and properly moistened to approximate optimum requirements. Each layer shall be compacted by hand or machine tamper or by other suitable equipment to a density that will prevent excessive settlement or shrinkage.

Backfilling shall be brought to a suitable elevation above grade to provide for anticipated settlement and shrinkage thereof.

Water pipes shall have a sand cushion 150 mm below and above the pipes.

4.15.3.2 INSTALLATION OF SOIL, WASTE DRAINS OR VENT PIPES

1. Horizontal Drainage Pipe and Vent Piping

   Horizontal waste pipes 75 mm in diameter and smaller shall have a minimum grade of 6.5 mm per 0.30 m and for 100 mm diameter and larger, 3.2 mm per 0.30 m. All main vertical soil and waste stacks shall be extended full size above the roof line as vents, except where otherwise specifically shown.

   Where practicable, two (2) or more vent pipes shall be connected together and extended as one pipe through the roof. Vent pipes in roof spaces shall be run as close as possible to the underside of roof with horizontal piping pitched to stacks using fittings as required without forming traps in pipes.

   Vertical pipe vents may be connected to a vent line carrying other fixtures. The connection shall be at least 1.20 m above the floor on which the fixtures are located to prevent the use of vent lines as waste. Horizontal waste lines receiving the discharge from two (2) or more fixtures shall be provided with vents, unless separate venting of fixtures is noted.

2. Fittings

   All changes in pipe sizes on soil waste lines shall be made with reducing fittings or recessed reducers. All changes in direction shall be made by the appropriate use of forty five (45) degree wyes. Long sweep quarter bends or elbows may be used in soil and waste lines where the change in direction of flow is from the horizontal to the vertical and on the discharge from water closets.

   Where it becomes necessary to use short radius fittings in any location, the approval of the Engineer shall be obtained before they are installed.

3. Joints

   a. PVC Soil Pipe

      All joints in uPVC soils, waste and vent pipe shall be accomplished by the use of PVC solvent cement.

b. All joints for uPVC shall be accomplished by applying the manufacturer's recommended solvent before connection to the pipe.

4. Cleanouts

Cleanouts at the bottom of each soil stack, waste stack and where else indicated shall be the same size at the pipe.

Cleanouts on floors shall be by uPVC plug adapter fit into the hub and fitted with uPVC screw plugged flush with the floor.

Cleanout shall be provided at every change in direction greater than 45 degrees.

5. Flashings

All pipes passing through the roof shall be provided with lead flashings. All flashings shall be built to 40 lbs. bituminous felts and shall extend up to the pipe and down-over to top of pipe at least 150 mm and along the roof not less than 300 mm and shall lap over flashing to make a weatherproof joint.

6. Traps

Each fixture and piece of equipment requiring connections to the drainage system, except fixtures with continuous waste shall be equipped with a trap. Traps shall be specified to be supplied with the fixtures. Each trap shall be placed as near to the fixtures as possible. Traps installed on threaded pipes shall be recessed drainage pattern.

7. Pipe Sleeves, Hangers and Supports

Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through masonry or concrete except unframed floors on earth.

Pipes shall not be permitted to pass through footings or beams unless noted on the drawings.

Pipe sleeves in floors shall extend not less than 25 mm and not more than 50 mm above the finished floor. After installation of the pipe, the space around the pipe shall be packed with plastic material and made watertight. Flashing shields for sleeves passing through waterproofing membrane shall be thoroughly mopped into the membrane. The space between the pipe and sleeves shall be made watertight by inserting approved sealing and caulking materials.

4.15.3.3 INSTALLATION OF WATER PIPES, FITTINGS AND CONNECTIONS

1. Gate Valves and Outlets

Gate valves shall be installed close to the point of connection to the existing service line outside the building. The piping shall be extended to all fixture outlets and equipment from the gate valves. Outlets where indicated shall be capped or plugged and left ready for future connections.

2. Mains, Branches and Runouts

All runs of piping shall be installed as shown on the drawings. The piping shall be cut accurately to measurements, and installed at the building site by the Contractor and shall be worked into place without springing or forcing. Care shall be taken not to weaken the structural portions of the buildings.

All pipes above ground shall be run parallel with the lines of the building unless otherwise shown on the drawings. Branch pipes from service lines may be taken off on top of mains, bottom of mains or side of mains, using such cross over fittings as may be required by structural or installation conditions.

All service pipes, valves and fittings shall be kept at sufficient distance from the other work to permit finished covering not less than 6.5 mm from such other work and not less than 13 mm between finished covering on different services. No water piping shall be buried in floors unless specifically indicated on the drawings or approved. Changes in pipe sizes shall be made with reducing fittings.

The use of long screws and bushings is prohibited.

3. Joints

Joints and connections in the plumbing system shall be gas-tight and watertight for the pressures required by test.

After cutting and before threading all pipes shall be reamed and shall have burrs removed. All screwed joints shall be applied with an approved graphite compound or TEFLON tape to facilitate connections. Threads shall be full cut and not more than three threads on the pipe shall remain exposed.

Caulking of threaded joints or top to prevent leaks shall not be permitted.

Unions shall be provided where required for disconnection. Threaded swing bolts shall be used for branch connections to risers and mains.

4. Unions

Where required unions shall not be concealed in walls, ceilings or partitions.

5. Tests

The following tests shall be conducted by the Contractor at his expense under the supervision of the Engineer.

a. Tests for Drainage and Venting System

The entire drainage and venting system shall have necessary openings plugged to permit the entire system to be filled with water to the level of the highest vent stack above the roof. The system shall hold the water for 30 minutes with a drop not greater than 100 mm.

b. Sterilization

The entire water supply piping system shall be sterilized with a solution containing not less than fifty (50) parts per million of available chlorine, either liquid chlorine or a solution of sodium hypochlorite. The sterilizing solution shall remain in the system for a period of not less than 8 hours during which time all valves and faucets shall be opened and closed several times. After sterilization, the solution shall be flushed from the system with clean water until the residual chloride content is not more than 0.2 parts per million.

c. Pressure Test for Water Lines

1) After the pipe have been installed, the joints completed and with joints exposed for examination, all newly installed pipe or any valve section, thereof, shall be subjected to hydrostatic pressure one and one half (1½) the designed working pressure of the system or as specified by the Engineer.

2) The duration of each pressure test shall be at least 20 minutes unless otherwise specified by the Engineer.

3) Each section of pipeline shall be slowly filled with water and the specified test pressure, measured at the point of lowest elevation, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. During the filling of the pipe and before applying the test pressure, all air shall be expelled from the pipeline. To accomplish this, tap shall be made if necessary, at the highest point of the pipe under test and after completion of the test, the taps shall be tightly plugged unless otherwise specified. During the test, all exposed pipes, fittings, valves, joint and couplings will be carefully examined. If found to be cracked or defective, they shall be removed and replaced by the Contractor with sound materials at his expense. The test shall then be repeated until satisfactory results are obtained.

d. Leakage Test for Water Lines

1) Leakage test shall be conducted after satisfactory completion of the pressure test and shall consist of an examination of all exposed joints for leakage as well as an overall leakage test of the completed pipeline.

2) The pressure to be maintained during the test shall be the designed working pressure of the system.

3) Leakage test shall be made only after a minimum of 24 hours after the pipe to be tested has been filled with water.

4) The duration of each leakage test shall be two hours unless otherwise specified by the Engineer.

5) Each section of pipeline shall be slowly filled with water and the specified test pressure, measured at the point of lowest elevation shall be applied by means of a positive displacement type pump and reservoir connected to the pipe in a manner satisfactory to the Engineer.

6) Before starting the leakage test, all air shall be expelled from the pipe. All exposed pipes, fittings, valves and joints shall be examined for leakage during the test.

7) Allowable leakage rate per 100 joints per inch of Pipe Diameter at Pressure Stipulated.

PRESSURE		LEAKAGE RATE	
psi	**kg/cm^2**	**liters/hr**	**liters/2 hrs**
50	3.5	1.45	2.90
75	5.3	1.75	3.50
100	7.0	2.05	4.10
125	8.8	2.30	4.60
150	10.5	2.50	5.00
200	14.0	2.90	5.80

e. Defective Work

1) If the inspection or test shows any defect, such defective work or material shall be replaced and the test shall be repeated until satisfactory to the Engineer.

2) All repairs to piping shall be made with new materials at the expense of the Contractor.

3) No caulking of screwed joints or holes will be accepted.

4.15.3.4 ASSEMBLY, INSTALLATION AND CONNECTION OF FIXTURES

Fixtures shall be supported and fastened in a satisfactory manner. Where secured to concrete or masonry work walls, fixtures and equipment shall be fastened with brass bolts or machine screws in lead-sleeve type anchorage units or with brass expansion bolts. Expansion bolts shall enter 7.5 cm into solid concrete or masonry works and shall be fitted with loose tubing or sleeves of proper length to bring expansion sleeves into the solid concrete masonry walls.

Where wood screws are used, screws shall go into solid pieces set between studs. Where through-bolts are used, bolts shall be provided with plates or washers at back set, so that they will be concealed by plaster. Bolts and nuts shall be hexagonal and exposed nuts, cap nuts, and screw heads shall be provided with chromium plated brass washers.

4.15.3.5 PROTECTION OF FIXTURES

Pipe openings shall be closed with caps or plugs during installation. Fixtures shall be tightly covered and protected against dirt, water and chemical injury. At the completion of all works, all fixtures shall be thoroughly cleaned and delivered in a condition satisfactory to the Engineer.

4.15.3.6 FIXTURES AND FASTENING

All fixtures shall be supported and fastened in a satisfactory manner as follows:

1. Where secured to concrete or concrete hollow block walls, they shall be fastened with one quarter inch brass bolts with twenty threads to the inch and of sufficient length to extend at least 7.5 cm into solid concrete or hollow block work, fitted with loose tubing or sleeve insert and shall be securely anchored and installed flush with the finished wall and shall be completely concealed when the fixtures are installed.

2. Where through-bolts are used, they shall be provided with plates or washers back set so that heads, nuts and washers will be concealed by plaster. Bolts and nuts shall be hexagonal. Exposed bolts, nuts, capnuts and screw heads shall be provided with chromium plated brass washers.

4.15.3.7 GUARANTEE

Upon completion and before final acceptance of the equipment installation, the Contractor shall furnish the Engineer a written guarantee stating that all equipment installed under this Section free from defects. The guarantee shall be for a period of one (1) year from the date of final acceptance of the work. Any part of the equipment that becomes defective during the term of the guarantee shall be replaced, renewed and/or made good by the Contractor, at his own expense and in a manner satisfactory to the Engineer.

Guarantees made by the approved manufacturers or suppliers beyond one year, shall be transferred to PPA without any expense on his part.

4.15.3.8 AS-BUILT DRAWINGS

Upon completion of and before final acceptance of the work, the Contractor shall prepare, at his own expense, and submit to the Engineer as-built drawings showing conditions of the work actually performed.

Where as-built drawings are required for a submission to enforcing authorities, same shall be submitted first to the Engineer for verification and checking. One (1) set of the drawings duly approved by the proper enforcing authorities shall be submitted to the Engineer together with the reproducible originals.

4.15.3.9 CLEANING UP

Upon completion of the work, all parts of the installation shall be thoroughly cleaned of grease, metal cuttings and sludge which may have accumulated during the testing operation.

4.15.3.10 PLUMBING, FIXTURES AND TOILET ACCESSORIES INSTALLATION

All installation works shall be as shown on the drawings and shall conform to the applicable standards set forth by the Philippine National Plumbing Code. All fixtures shall be fastened and/or supported in accordance with the given requirements.

4.15.4 MEASUREMENT AND PAYMENT

The quantity of plumbing and sanitary works within the buildings and its premises to be paid for shall be measured as indicated in the Bill of Quantities as follows:

1. Water closets, urinals, lavatories and service sink by the number of fixtures installed, completed, tested and approved and certified for payment by the Engineer.

2. Complete plumbing system for water supply inside the building (PPR pipes, fittings and accessories) by the lump sum for each building installed, completed, tested, approved and certified for payment by the Engineer.

3. Complete sanitary sewer works inside the building including all sewer pipes, fittings, septic tank, earthwork, etc. by the lump sum for each building installed, completed, tested, approved and certified for payment by the Engineer.

4. Reinforced concrete pipes for building drainage systems by the number of linear meters installed, tested, approved and certified for payment by the Engineer.

5. No separate payment for concrete and reinforcing bars for urinal trough and catch basin as this is included under pay-item for concrete works.

4.16 SIGNAGES

4.16.1 GENERAL

4.16.1.1 SCOPE OF WORK

Furnish materials and perform labor to include miscellaneous works required for the installation of room identification for the toilets and port office (Multi-purpose Shed).

4.16.1.2 SAMPLE AND SHOP DRAWINGS

The Contractor shall submit samples for approval by the Engineer. For the room I.D. full size lettering layout and installation method shall be submitted to the Engineer for approval before start of work.

4.16.2 MATERIAL REQUIREMENTS

Room Markers: Black acrylic letters, 38 mm (1-1/2") high on white acrylic background, 63 mm (2-1/2") high, with clear acrylic cover. Lengths shall be as required by the full notation therein.

4.16.3 EXECUTION

4.16.3.1 WORKMANSHIP

Workmanship shall be executed in high quality comparable with artworks.

4.16.3.2 MOUNTING

For all mounted assemblies, appropriate mounting hardware and connectors which are concealed shall be sufficiently used.

Assemblies shall be mounted plumb, straight, level, and at prescribed heights.

4.16.3.3 INSTALLATION

Installation shall be done in a secure and permanent manner at prescribed heights and/or layout. The backwall shall not be mutilated. After the dowels are positioned, fill with expanding grout, or other approved fillers, and retouch, flashed to the backwall surface.

4.16.4 MEASUREMENT AND PAYMENT

Signages will not be measured and paid separately, as it is deemed included under pay-item on Doors where the signages shall be installed. Signages will be measured and paid by the number of quantities required

which shall include tools, labor, equipment, materials and all incidental to complete the works.

4.17 FACILITIES AND DEVICE FOR DISABLED PERSONS

4.17.1 GENERAL

4.17.1.1 SCOPE OF WORK

The work shall consists of furnishing materials, tools, labor and incidentals necessary for the construction/installation of facilities and device for disabled persons as shown on the Drawings and in accordance with the Implementing Rules and Regulations of Batas Pambansa Bilang 344 and this Specification.

4.17.2 MATERIAL REQUIREMENTS

4.17.2.1 GRAPHIC SIGNS

Graphic signs like the International Symbol of Access shall be fabricated from plastic materials, white color with either dark blue background. Letters and symbols shall be laminated and raised from the background.

4.17.2.2 HANDRAILS

Handrail for ramp shall be fabricated from galvanized iron pipe schedule 40, with a diameter of 38mm. It shall be provided with a small hole as of a Braille system.

4.17.2.3 GRABRAIL

Grabrail shall be manufactured from gauge 18 tubular stainless steel 25mm ∅ and provided with safety grip finish.

4.17.2.4 CONCRETE MATERIALS FOR RAMPS

1. Portland cement shall conform with the requirement of Section 3.2, “Concrete Works”.

2. Aggregates shall conform with the requirements of Section 3.2, “Concrete Works”.

3. Temperature bars shall have diameter of 10mm conforming with the requirements of Section 3.2, “Concrete Works”.

4.17.3 **EXECUTION**

4.17.3.1 GRAPHIC SIGNS

1. Directional and information signs, indicating the location of the ramp for physically handicapped persons, shall be installed/placed at the front of the main entrance of the Terminal Building. The signed board shall be 300mm x 300mm mounted on a 50mm Ø, schedule 40, signpost and the text and arrow shall be in accordance with the International Symbol of Access “B”.
2. Signs shall be placed at the entrance and exits of the ramps and toilets, installed at conspicuous locations. The signboards shall be 150mm x 150mm and the text shall be in accordance with the International Symbol of Access “A”.

4.17.3.2 RAMP

The ramp shall be constructed as shown on the Drawings and with a non-skid surface.

4.17.3.3 GRABRAILS

Lavatories, urinals and water closets of the Terminal Building where indicated on the Drawings shall be provide with grabrails. The position and distance from the floor shall be as shown on the Drawings.

4.17.4 **MEASUREMENT AND PAYMENT**

Graphic signs, and grabrails to be paid for shall be measured by the piece installed, completed as shown on the Drawings and accepted and certified for payment by the Engineer.

Handrails to be paid shall be measured by the linear meter of piece installed, completed as shown on the Drawings and accepted and certified for payment by the Engineer.

DIVISION 7 ELECTRICAL WORKS

7.1 ELECTRICAL GENERAL REQUIREMENTS

7.1.1 GENERAL

7.1.1.1 APPLICATION

This section applies to all sections of "Electrical Division" of this project except as specified otherwise in each individual section.

7.1.1.2 WORK INCLUDED

The work to be done under this division shall include the furnishing of all tools, labor, supervision, equipment, fixtures and all necessary materials, each complete and in proper working condition unless one or other is specifically excluded or stated otherwise in this specifications but not limited to the following items of works.

[Shown below are the standard scope of electrical works. Indicate the scope of work applicable to the subject Project]

1. All works and material for a complete lighting and power systems including cables and conduits, circuit breakers, panelboard and connection to all lighting fixtures and power outlets, motor appliances, switches, supports and accessories.

2. All excavation works, backfilling, dewatering, removal of surplus earth, preparation of formworks and pouring of concrete envelopes as indicated on the drawings or as required to complete the installation.

3. All steel support for conduits, wires, panelboard, boxes, lighting fixtures, etc. as indicated or as required to complete the installation.

4. A complete grounding system as required by the governing codes.

5. A complete testing of all electrical systems.

6. Where material are furnished and supplied by the Engineer, the Contractor shall receive, unload, handle and transport to the site, assemble and install completely. This Contractor shall be responsible for safekeeping and warehousing of such materials/equipment from the time of his acceptance.

7. All items incidentals to and or required for the proper completion such as painting of boxes, conduits and the likes.

8. Coordination with other trade Contractors.

9. Coordination with other companies/offices including handling of all material related to material testing and application of electrical permits.

10. Preparation of necessary shop drawings required for the proper execution of the works subject to the approval of the Engineer.

11. Preparation of “As-Built” drawings.

7.1.1.3 WORK NOT INCLUDED UNDER ELECTRICAL WORKS

The work excludes the furnishing of the following:

1. Supply and installation of all motors, pumps and their associated control equipment.

    a. All electrical system installation beyond the motor branch circuit breakers.

    b. All motor controllers as indicated to be supplied with equipment.

    c. Structural foundation of the above.

7.1.1.4 SUBMITTALS

Obtain approval before procurement, fabrication or delivery of items to the job site. Partial submittals will not be entertained and will be returned without review. Submittals shall include the manufacturer’s name, trade name, place of manufacturer, catalogue model of number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference and technical society publication references, and other information necessary to establish contract compliance of each item to be furnished.

1. Shop Drawings

    In addition to the requirements of the contract clauses, shop drawings shall meet the following requirements:

    a. Drawings shall be a minimum of 210 mm x 297 mm in size or in A3 size, except as specified otherwise.

    b. Drawings shall include wiring diagrams and installation details indicating the proposed location layout and arrangement, control panels, accessories, and other items that must be shown to assure a coordinated installation.

    c. Wiring diagrams shall identify circuit termination and the internal wiring for each item of equipment and its interconnection.

d. Drawings shall indicate adequate clearances for operation, maintenance and replacement of equipment devices. If the layout is disapproved, revise the layout and resubmit.

2. Manufacturer's Data

Submittal for each manufactured item shall be current descriptive literature of cataloged products.

3. Publication Compliance

Where equipment or materials are specified to conform to industry and technical society publications of organizations such as American National Standard Institute (ANSI), American Society for Testing and Materials (ASTM) and Underwriters Laboratories, Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In each of the publications referred to herein, consider the advisory provisions to be mandatory as though the word "shall" had been substituted for "should" wherever it appears. Interpret reference in these publications to the authority having jurisdiction, or words of similar meaning, to mean the Engineer. In lieu of the label or testing, submit a certificate from an approved independent testing organization, adequately equipped and component to perform such services, organization's test methods and not the item conforms to the specified organizations publications.

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.

7.1.1.5 CERTIFICATES OF COMPLIANCE

Submit manufacturer's certifications as required on products, materials, finish and equipment indicated in the Technical Sections. Certifications shall be documents prepared specially for the contract. Preprinted certifications and copies of previously submitted documents are not acceptable. The manufacturer's certification shall name the appropriate products, equipment or materials and the publication specified as controlling the quality of the item. Certification shall not contain statement to imply that the item does not meet requirements specified such as "Good As", "Achieves the same end use and results as materials formulated in accordance with referenced publications" or "Equal or exceeds the service and performance of the specified materials". Certifications shall simply state that the item conforms to the requirements specified; and shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official, authorized to sign certificates of compliance.

7.1.1.6 OPERATION AND MAINTENANCE MANUALS

Submit as required for systems and equipment indicated in the Technical Sections. Furnish three (3) copies, bound in hardback binders or an approved equivalent. Furnish one complete manual prior to performance of system or equipment tests, and furnish the remaining manual prior to contract completion. Inscribe the following identification on the cover: the word "Operation and Maintenance Manual", the name and location of the system equipment, building, name of Contractor and contract number. Include in the manual the names, addresses and telephone numbers of each sub-Contractor installing the system or equivalent and the local representatives for the system or equipment. Include a table of contents and assemble the manual to conform to the table of contents with the tab sheets placed before instruction covering the subject. The instructions shall be legible and easily read with large sheets of drawings folded in the manual shall include the following:

1. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the system or equipment.
2. A control sequence describing start-up, operation and shut-down.
3. Description of the function of each principal item of equipment.
4. Installation and maintenance manual.
5. Safety precaution
6. Diagrams and illustrations
7. Testing methods
8. Performance data
9. Lubrication schedule including type, grade, temperature range and frequency
10. Part list
11. Appendix

List qualified permanent servicing organization for support of the equipment, including addresses and certified qualifications.

7.1.1.7 POSTED OPERATING INSTRUCTIONS

Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel. The operating instructions shall include diagrams, control diagrams and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in

approved laminated plastic. Attach or post the operating instructions adjacent to each principal system and equipment including start-up, proper adjustment, operating, lubrication, shutdown, safety precautions, procedure in the event of equipment failure, and other items of instruction recommended by the manufacturer of each system for operating instruction exposed to the weather. Operating instructions shall not fade when exposed to the weather and shall be secured to prevent easy removal or peeling.

7.1.1.8 INSTRUCTIONS TO PERSONNEL

Where indicated in the technical sections, furnish the services of competent instructors to give full instructions to personnel in the adjustment, operation and maintenance of systems and equipment, including safety precautionary measures. Each Contractor shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work, instructions shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Engineer for regular operation. The number of man-days (8 hours) of instruction shall be as specified in each individual section.

7.1.1.9 DELIVERY AND STORAGE

Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B, Appendix 1, titled "Equipment Storage and Maintenance during Construction". Replace damaged or defective items with new one.

7.1.1.10 CATALOGUE PRODUCTS/SERVICE AVAILABILITY

Materials and equipment shall be current products by manufacturers regularly engaged in the production of such products. Products shall have been in satisfactory commercial or industrial use for two (2) years prior to bid opening. The two (2) year period shall include applications of equipment and materials under similar circumstances and of similar size. The two (2) year period shall be satisfactory completed by a manufacturer's catalog or brochures. Products having less than two (2) year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6,000 hours, exclusive of the manufacturer’s factory or laboratory tests is furnished. The equipment item shall be supported by service organization, which are reasonably convenient to the equipment on a regular and emergency basis during the warranty period of the contract.

7.1.1.11 MANUFACTURER'S RECOMMENDATIONS

Where installation procedures or any parts thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendation prior to installation. Installation of the items shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or materials.

7.1.1.12 "AS-BUILT" DRAWINGS

The cost of as-built drawings shall be borne by the Contractor. Submittal of such drawings shall be a condition to final payment.

7.1.1.13 MATERIALS/SUBSTITUTION/TESTS

All materials to be installed shall be brand new and shall conform with specifications except as otherwise noted on the drawings. All materials where not specified shall be of the best of their respective kind. Samples of said material including its manufacturer's data shall be submitted for approval. Necessary tests on the installations shall be made by the Contractor in the presence of the Engineer. These tests shall include but not limited to ground test, performance test, phase sequence test, etc. Records of approved tests result shall be relayed to the Engineer in writing. This Contractor shall within ten (10) days after the award of the contract, submit a list of materials he proposes to use. All materials installed without prior approval shall be at the risk of the Contractor.

7.1.1.14 COORDINATION/GUARANTEES/SUSPENSION OR DELAY

The Contractor shall be familiar with the specifications of the other trades and coordinate with them thoroughly so that he can arrange his work and dispose his materials without interfering the work of other Contractors. The Contractor shall guarantee that the electrical systems shall be free from all defects of workmanship and of materials, and that it will remain so for a period of one year from the date of acceptance by the Engineer. Any remedy to correct defects deemed to be caused by such shall be made at the expense of the Contractor.

The Contractor shall not suspend or delay the work without justifiable cause. Subsequent delays shall be deemed as a sufficient cause for penalties or termination of contract in which the Engineer shall have the right to take-over the work and all materials on the site and make arrangements necessary to complete the work. It shall be the sole responsibility of the Contractor to ensure that the Electrical sub-contractor conducts coordination of his activities to other trades.

7.1.1.15 SLEEVES/INSERTS/CUTTING/PATCHING/BACKFILL

The Contractor shall provide all openings, sleeves, also inserts in walls, floors, and beams as required for his work. All unused openings shall be grouted in. the Contractor shall do all patching requirements necessary and these shall be done so as to exactly match the surrounding area without the evidence of alteration or patching. The Contractor shall provide all necessary backfill on all excavation works of his doing.

7.1.1.16 TEMPORARY LIGHT AND POWER

The Contractor shall make all arrangements and pay for the provisions of the necessary electrical power of the type and capacity required for the performance of the work of all trades engaged in the construction of the building.

7.1.1.17 CLEANING UP

The Contractor shall remove all dirt, debris, and rubbish and waste materials caused by him in the process of his work. He shall also remove all tools, temporary power installation, scaffolding and surplus materials after completion and acceptance of work.

7.1.1.18 ELECTRICAL CHARACTERISTICS

The electrical characteristics for this project shall be 230V, 3 wire, single phase and 60Hz or as per system requirements.

7.1.2 MATERIAL REQUIREMENTS

7.1.2.1 NAMEPLATES

Provide laminated plastic nameplates for each panelboard, equipment enclosure, relay, switch, and device. Each nameplate inscription shall identify the function and when applicable, the position. Nameplate shall be melamine plastic, 3.2mm thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the black core. Minimum size of nameplates shall be 25mm x 38mm. Lettering shall be a minimum of 6mm, high normal block style.

7.1.3 EXECUTION

7.1.3.1 NAMEPLATE MOUNTING

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.

7.1.3.2 PAINTING OF EQUIPMENT

1. Factory Applied: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.30.

2. Field Applied: Paint electrical equipment as required to match finish or to meet safety criteria.

7.1.4 MEASUREMENT AND PAYMENT

The work under this section shall be incidental to other items of work and shall not be measured for payment unless otherwise specified in the Bill of Quantities.

7.2 DIESEL ENGINE GENERATOR SET

7.2.1 GENERAL

Work under this Contract shall be in accordance with Section 7.1 "Electrical General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

7.2.1.1 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.

7.2.1.2 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 National Standards Institute, Inc. (ANSI)

B15.1-72	Safety Standard for Mechanical Power Transmission Apparatus.
C50.10-77	General Requirements for Synchronous Machines

2. American Society of Mechanical Engineers (ASME) Publication:

   PTC 26-62 Speed-Governing Systems for Internal Combustion Engine-Generator Units.

3. Diesel Engine Manufacturers Association (DEMA) Publications:

   (Sixth Edition 1972) Standard Practices for Stationary Diesel and Gas Engines

4. Institute of Electrical and Electronics Engineers (IEEE) Publication:

   126-59 Recommended specification for Speed Governing of Internal Combustion Engine-Generator Units

PEC (2000) Philippine Electrical Code

5. Underwriter's Laboratories, Inc. (UL) Publications:

   142-1981 (AM 85) Steel Above ground Tanks for flammable and Combustible Liquids

   1236-1978 (1994; R 1999) Electric Battery Charges

6. Bureau of Product Standard (BPS)

PNS (2000) Philippine National Standard

7.2.1.3 QUALITY ASSURANCE

Engines installed shall meet all of the operating experience requirements listed below:

1. Only electrical generation service is considered as equivalent experience. Engine driving pumps or compressors, or those in marine propulsion or railroad service, are not acceptable.

2. 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 of engines.

3. Only experience at the identical rotative speed as that which is offered is acceptable.

4. Only experience at the identical or higher brake mean effective pressure as that which is offered is acceptable.

5. Only experience with fuel oil is acceptable.

7.2.1.4 SUBMITTAL

The Contractor shall furnish certificate(s) within twenty eight (28) days after commencement of works certifying that no less than two engines of identical number of cylinder size, identical rotative speed, and identical or higher Brake Mean Effective Pressure (BMEP), and of the same basic configuration (in-line or Vee) as the engine to be furnished, shall have driven generators which have produced in satisfactory operation not less than 500 KWH of electricity for each KW of generator nameplate capability within a two (2) year period. Certificate(s) shall include:

1. A list of at least two engine installation meeting the experience requirements set forth in Sub-section 7.2.1.3 entitled “Quality assurance”.

2. Owner and location of each such installation.

3. Date of initial operation of each such installation.

4. Number of KW hours produced per KW of generator rated capability of each installation.

5. Horsepower rating, KW rating, and rotative speed of each unit.

6. Brake Mean Effective Pressure (BMEP) rating of each engine.

7. Design characteristics of each unit, such as bore and stroke, number of cylinders, and configuration (in-line or Vee).

7.2.1.5 SHOP DRAWINGS AND CALCULATIONS

The Contractor shall submit shop drawings and calculation for diesel engine generating unit and auxiliary equipment, including the following:

1. Certified outline, general arrangement (setting plan), and anchor bolt details. Drawings shall show the total weight and center of gravity of the assembled equipment of the mounting skid.

2. General arrangement drawings showing location of all auxiliary equipment in relation to the diesel generating unit.

3. Piping schematic for compressed air starting, fuel oil, lubricating oil, jacket water, and cooling water integral with diesel engine.

4. BMEP calculations.

5. Air Starting and Cranking time calculations.

6. Battery sizes.

7. Critical speed calculations.

8. Electrical elements, schematics and writing diagrams, including details of the safety shutdown systems and main generator circuit breaker trip system.

7.2.1.6 CERTIFIED TEST REPORTS

1. Diesel engine shop tests
2. Generator shop tests
3. Diesel engine driven electric generator set shop test tests
4. Radio-interference suppression.

7.2.1.7 MANUALS

The Contractor shall provide three (3) sets of operation and maintenance manuals for equipment. Identification symbols for all replaceable parts and assemblies shall be included. Information in manuals shall be comprehensive and specific.

7.2.1.8 SAFETY REQUIREMENTS

Safety requirements shall comply with ANSI B15.1 or with the manufactured recommendation.

7.2.2 MATERIALS REQUIREMENTS

7.2.2.1 MATERIALS

1. Standard Commercial Product

   Generator set shall, as a minimum, be in accordance with the requirements of this specification and shall be the manufacturer's standard commercial product with any added features needed to comply with the requirements. Additional or better features which are not specifically prohibited by this specification, but which are apart of the manufacturer's "standard commercial product " is defines as a product which has been or will be sold on the commercial market through advertisement or manufacturer's catalogs, or brochures, and represents the latest production mode(s).

2. Materials and Equipment

The Contractor shall furnish new materials of high quality which will give long life and reliable operation. Equipment shall not have been in prior service except as required by factory tests. Workmanship shall be of highest quality in every detail.

7.2.2.2 DIESEL-ELECTRIC GENERATOR SET AND AUXILIARY EQUIPMENT

Each generator set shall consist of a diesel engine connected to an alternating current generator with brushless excitation system mounted on a steel subbase and provide with all necessary accessories, auxiliaries, and control equipment resulting in a complete self-contained unit people capable of operation.

Set shall be arranged for manual starting. Generator set must be capable of providing full rated power within 10 seconds after starting.

1. Equipment Rating and Capability

Diesel-electric generating set shall have a net continuous rating as indicated at 0.8 power factor for 3-phase unit. Both the engine and generator of the generator set shall be capable of satisfactorily carrying a load 10% in express of the net continuous rated generating capacity at 0.8 power factor for a period of 2 continuous hours out of any 24 consecutive hours.

Gross kW rating of each diesel generating set shall be not more than the figure obtained by multiplying the delivered shaft horse power rating of the engine by 0.746 and by the overall efficiency of the generator at the corresponding load. Overall efficiency of the generator shall allow for power required to operate the exciter, including power consumed in losses and in windage and friction for generator and rotating exciter.

Rated net capacity of each generating set is defined as gross electrical power output of generator minus total electrical power requirements of “engine assemble,” as defined in NEMA publication “Standard Practices for Stationary Diesel and Gas Engine”. All auxiliary equipment furnished shall be designed for continuous duty at 110% of rated net capacity of generating set.

The generating set shall be rated for [__] kW, 0.8 power factor [__] ø, [__], [__] volts.

2. Critical Speeds

Each complete diesel-electric generating set shall be free of electrical speeds of either a major or minor order that will endanger satisfactory operation will be considered endangered if torsional vibration stresses exceed 390 kg/cm^2 with 10% above or below rated engine speed. The Contractor shall submit three (3) copies of a summary of computations of critical speeds to the Engineer.

7.2.2.3 DESIGN AND CONSTRUCTION

Rotating or reciprocating parts, or other parts that may present a hazard to operating personnel shall be isolated or shielded to minimize danger. Design characteristics shall limit operating temperatures at critical points of maximum wear at full-load operating conditions.

7.2.2.4 DIESEL ENGINE AND ACCESSORIES

1. Type and Requirements

The diesel engine to be furnished shall drive the A/C generator and shall be base mounted.

The diesel engine shall be of vertical, single acting, solid injection, 4-stroke cycle, cold starting, water cooled diesel engine.

Main parts shall possess excellent properties against heat, pressure, erosion and wear. All parts shall be manufactured to ensure the highest accuracy and precision by means of limit gages, special jigs, fixtures, etc., so that they are entirely interchangeable with each other.

The diesel engine shall be furnished with a cooling water pump to circulate the cooling water for the diesel engine. The pump shall be driven by the main diesel engine. The requirements of the cooling water pump shall be of the engine manufacturer's standard.

The design conditions for the main diesel engines shall be as follows:

Type and Requirements	Power Plant
1. Continuous rating output: (Approx,) PS	[___] x [___] RPM
2. 1 Hour rating output 110% load for continuous rating: (Approx.) PS	
3. Continuous operating speed: rpm	
4. Bore of Cylinders: mm	
5. Number of Cylinders	[___] - [___]
6. Specific fuel Consumption: g/ps.hr	[___] - [___]
7. Starting System	Compressed air starting
8. Location of Operation:	At Site and operation room
9. Engine cooling system	Forced water cooling by cooling water pump
10. Engine Lubrication System:	Forced lubrication by use of gear pump mounted on engine
11. Fuel Oil Recommended	Diesel light oil ASTM D 975

2. Manufacturing and Materials

a. Cylinder Block Head and Crankcase

The cylinder block, head and crankcase shall be made of cast iron.

Replaceable wet type cylinder liners shall be made of high grade cast iron.

b. Crankshaft

The crankshaft shall be of the forged, one piece-type, made of carbon steel. Bearing surfaces shall be of sufficient size to safely sustain all bearing loads imposed, and shall be heat-treated to provide resistance against shocks and wear.

c. Camshaft

The camshaft shall be made of carbon steel, driven by gears from the crankshaft. The hard-wearing surfaces shall be treated by high frequency induction hardening.

d. Piston and Piston-Pin

Pistons shall be of trunk type and made of special cast iron or high grade heat treated light alloy, and shall have sufficient resistance against heat and pressure. Piston rings shall consist of two or

three compression rings and one or two oil scraping rings. The piston-pins shall be of full floating type and completely carbonized.

e. Connecting Rods

Connecting rods shall be made of forged steel and designed for using replaceable and precision insert type crank pin bearings. A drilled passage for piston-pin lubrication shall be incorporated.

f. Bearings

The bearings for both main and crank pin journals shall be of precision insert bearings and readily replaceable. The piston-pin metals shall be of the special phosphorous bronze.

g. Fuel Injection Nozzle

Each one set of fuel pump with plunger, for adjusting injection volume and timing, shall be provided for each cylinder.

The injection nozzle shall be pin hole type and designed to adjust the needed injection pressure automatically and to meet with any load conditions immediately.

h. Governor

The governor is of mechanical and/or hydraulic type and so sensitive in operation that it is able to adjust the fuel injection volume at any sudden change of loads automatically and immediately. Engine speed variation is calculated not more than 10% (instantaneous) and 5% (steady).

i. Exhaust System

The diesel engine exhaust gas shall be released to atmosphere outside the house through exhaust pipe works and silencers. All exhaust pipe work inside the house shall be lagged by thermal insulation materials with aluminum sheet.

Each silencer shall be positioned as shown on the Drawings. The exhaust system shall be complete with expansion below, support structures and brackets where necessary.

3. Accessories

The accessories of the diesel engine to be furnished shall be as follows:

a. Gauges

Tachometer, lubrication oil pressure, cooling water pressure, suction air pressure, fuel oil pressure, etc.

b. Thermometer

Lubrication oil, cooling water, exhaust gas, etc.

c. Auxiliary Priming Pump

Wing type lubrication oil pump.

d. Strainer and Cooler

Fuel oil strainer, lubrication oil strainer, lubrication oil cooler, suction air cooler, etc.

e. Safety Devices

Lubrication oil pressure relay, cooling water high temperature relay, over and under speed relay, cooling water flowsight glass, etc.

f. Miscellaneous

Exhaust system has turbo-supercharger, pressure indicator cock for each cylinder, flywheel and dual air reservoir tanks, flexible pipe joints, installation bolts, etc.

4. Fuel Oil System

Conform to NFPA 30 and NFPA 37 and the requirements herein. Provide motors and flange connections in accordance with paragraphs entitled "Motors" and "Flange Connections."

a. Tanks

Tanks may be standard design as recommended or used by the engine manufacturer or shall be constructed as specified in paragraph entitled "Tank Construction."

(i) Fuel Oil Day Tanks

Provide tanks with a minimum capacity of 8 hours of engine-generator unit operation at full rated load for the engine-generator unit. Provide tanks with a level gage and makeup control valve. Include connections of the indicated size for inlet, outlet, overflow, drain, vent, and level controller, and a high and low level alarm switches.

(ii) Fuel Oil Drip Tank

Provide tank to receive dirty fuel oil drips from the engine. Working capacity of tank shall be not less than 38 L per engine. Include connections of the indicated size for inlet, outlet, overflow, drain, vent, and level gage, and high level alarm switch. Locate high level alarm switch 150 mm below the top of the tank.

(iii) 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 the station battery voltage. Contact ratings shall be A150 in accordance with NEMA ICS 2.

(iv) Tank Gages

Provide tank gages conforming to CID A-A-50568. Gages for fuel oil day tanks shall be buoyant force type, with dial indicator not less than 100 mm in size and arranged for side mounting. Each reading 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.

b. Fuel Oil Pumps

Each pump unit shall consist of a horizontal, positive-displacement, rotary pump driven by a three-phase electric motor. Direct connect each pump to its driving motor through a flexible coupling. Mount pump and motor on a common steel or cast-iron base plate and provide a coupling guard. Equip each pump with a bypass relief valve. Each pump shall conform to CID A-A-50561. Pumps shall be capable of pumping the following quantities of fuel oil at a temperature of 32°C.

c. Duplex Fuel Oil Strainer

Provide the type having two straining chambers and arranged to divert the flow from one chamber to the other without interruption at any point of the changeover. Design shall allow for cleaning, by permitting removal of the strainer basket not in use while the other strainer basket is in use. Construct strainer baskets of corrosion-resistant metal. Strainer mesh, type, and size shall be as recommended by the engine manufacturer. Construct body of cast iron suitable for 861 kPa (gage) working pressure. Provide a remote differential pressure gage between inlet and outlet of duplex-strainer to indicate the pressure drop of strainer chamber on line.

d. Fuel Oil Meters

Provide positive displacement type. Maximum variation from absolute accuracy measurement over entire range of meter shall be not greater than plus or minus five-tenths of one percent. Provide meters with horizontal setback registers calibrated to read in liters and tenths of liters. Construct meters with cast-iron bodies, with working parts made of material to resist wear, friction, and corrosion and can handle oil containing a small percentage of sulphur.

e. Day Tank Makeup Control Valve

Provide one control switch and solenoid type control valve for each fuel oil day tank as indicated. Valve body shall have a minimum working pressure rating of 1033.5 kPa (gage) at 93°C. The level control switch shall energize to open the solenoid control valve and start the fuel oil transfer pump at low level conditions and close the valve and stop the transfer pump at high level conditions. For multiple day tank installations, the level control switches shall actuate their respective solenoid valves and the selected fuel pump through the necessary relays and control switches. The day tank system control shall be controlled by an "OFF-AUTO" switch on the engine control panel with a contact rating of not less than A150 in accordance with NEMA ICS 2.

f. Fuel Oil Filters

Provide two filters of the throwaway filter element type, consisting of shell, filter elements, drains, and necessary connections and fittings. Equipment and component parts shall be the standard product of the filter manufacturer to ensure prompt and continuing service and delivery of repair or maintenance parts and shall be standard with the engine manufacturer. Component parts of the

unit need not be the product of the same manufacturer. Each filter shall be capable of removing not less than 95 percent of all particles larger than 5 microns. Filter elements shall be factory-assembled type, with compression type end seal gaskets at top and bottom and with suitable pullout device. Filter material shall be cellulose, laminated fiber discs, or acid resistant textile material. Elements shall be designed for an initial pressure drop not in excess of 35 kPa at a flow rate of 0.0972 L/s per element. Construct filters with sides having double walls. Install insulating material between the inner and outer walls. Inner shell shall be pressed steel or welded steel construction enclosing, supporting, and protecting all elements. Filters shall have flanged, removable bolted top cover for access to all components without disconnecting any connections or fittings. Provide compartments for clean and dirty oil. Provide supports for base mounting. There shall be tie-bolts, or equivalent means, for holding down the filter elements and cover, and recesses or other means for receiving and locating the elements. Design and construction shall conform to the ASME BPVC SEC VIII D1. Filter cover shall be steel and secured to the shell by swing-type bolts with hex nuts. Use lifting devices with integral supports for covers weighing over 14 kg. Arrange connections so that filter elements may be removed without breaking outside connections. Mount pressure gages on filter shell to indicate pressure before and after the filter elements. Provide a tapped drain and exterior valved pipe connection. A duplex gage may be provided. Gages shall conform to ANSI/ASME B40.1 and shall be pressure detecting class, 108 mm size, and 0 to 689 kPa range. Provide a needle valve and fittings for mounting each gage and differential pressure switch. Equip each unit with instruction plates and diagrams, suitably located, describing special or important procedures to be followed in operating and servicing the equipment. Plates shall be copper or zinc base alloy, adequately secured to the unit. Provide an adjustable pressure switch with contacts suitable for the starting battery voltage to indicate high differential fuel-oil filter pressure.

g. Fuel Oil Centrifuges

Provide two identical fuel oil centrifuges. Centrifuges shall be capable of removing and discharging water and sludge from incoming fuel oil. Each centrifuge shall be of the unit type, including inlet and outlet oil transfer pumps with integral bypass relief valves, interconnecting piping, sight flow indicators, thermometer, sampling cocks, and three-phase electric motor all mounted on a common steel or cast-iron base plate. Bowls shall be corrosion-resistant construction and arranged for self draining. Provide each centrifuge with an air-tight cover hinged to the frame of the unit, locking it in either the open or closed position. Arrange

check valve to automatically shut off the oil when cover is raised. Provide each unit with a friction clutch to ensure that the machine will be properly and automatically brought up to speed without danger of overloading either motor or gears. Provide safety shutdown interlocks for dangerous vibration, open bowl, low-flow operation, low-water pressure, and bowl completely stopped before cover can be opened.

7.2.2.5 GENERATORS AND EXCITATION SYSTEMS

1. Generators

The generator for the unit shall be as indicated, 60 Hertz, 0.8 power factor, 3-phase, alternating-current type with revolving field. The speed of the generator shall be that of the engine. The generator shall be capable of carrying continuously a 0.80 power factor load equal to the gross kilowatt rating of the diesel generating unit and to carry a 0.80 power factor load 10% in excess of the gross kilowatt rating of the diesel generating unit for 2 continuous hours out of any period of 24 consecutive hours at normal voltage and with a temperature rise of not more than 80ºC as measured by resistance based on 40ºC ambient temperature. Enclosures shall be the general-purpose open type with ventilating openings covered with removable screens having a mesh not larger than 12 mm.

The generator shall conform to ANSI C50.10 and to NEMA MG-1. The generator shall have form-wound coils and Class H sufficient flywheel effect to meet the requirements of regulation and operation as specified. The rotor shall be mounted on an extended shaft which shall be coupled rigidly to the engine. Crankshaft. Impellers shall be mounted on the rotor for cooling the generator. The rotor shall be capable of safe operation at a speed 25% in excess of its rated synchronous speed. The generator armature, field, and ground leads shall clamp or crimp-type lugs or connectors for electrical connections. Terminal markings shall conform to NEMA MG-1.

2. Excitation and Voltage Regulation System

The excitation system shall be integral brushless-type consisting of a rotating AC exciter and rectifier diode assembly together with a static-type voltage regulating system and including surge protection and the required accessories. The system shall serve as an individual excitation and regulation system for the generator specified herein, and there is no requirement for parallel operation with other exciters.

The excitation system shall have a continuous current rating of not less than the generator excitation current required when the generator operates at 105% rated voltage under the condition of continuous

rating requiring maximum field current. The voltage rating of the system shall be as required to match the generator field requirements. The excitation system response ration shall not be less than 0.5 and the ceiling voltage shall not be less than 120% of rated voltage.

3. Exciter

   The exciter shall be a rotating AC generator having a rotating armature on the rotor spider and a stationary field on the stator frame. The exciter insulation shall be Class B and the temperature rise shall not exceed 70ºC when measured by resistance based on a 40 ºC ambient temperature.

4. Rectifiers

   Rectifiers shall be full-wave silicon diode type, with each diode protected by individual fuses. The rectifiers shall be mounted on the rotating part of the exciter to convert AC exciter output to DC for the main generator excitation. Connection shall be provided between, the exciter, rectifier, and generator field without uses of brushes or slip rings.

5. Voltage Regulator

   The voltage regulator shall be completely solid-state type for control of generator voltage by control of the exciter field. The regulator shall be suitable for mounting in the generator control panel. The regulator shall control the generator exciter field as required to maintain a constant and stable generator output voltage within plus or minus ¼ of 1% of nominal for all steady-state loads from no load to full lead including a 5% variation in frequency and the effects of field heating. The regulator shall be designed for single-phase voltage sensing. Electromagnetic interference suppression shall be an integral part of the regulator. Thermal protection for power semi-conductors, inherent overvoltage protection, and fuse protection shall be provided internally in the regulator. No electrolytic capacitors, vacuum tubes, or electro-mechanical relays shall be used in the voltage regulator. The regulator shall have provisions for switching to manual control to allow the generator voltage to be controlled either manually or automatically. The following regulator components shall be mounted on the front of the generator control panel.

   a. Voltage adjusting rheostat

   b. Manual voltage control with adjusting rheostat

6. Engine Generator Instruments and Controls

   NEMA ICS 1,2,3,4, and 6 shall be applied.

7. Engine Instrument

   Engine instruments shall include the following as minimum components:

   a. Lubricating Oil Pressure Gauge

      Lubricating oil pressure gauge shall be indicating dial type utilizing a Bourdon tube for confining the pressure medium. The Bourdon tube shall be seamless and made of phosphor bronze. Gauge shall be accurate to within 2 percent of full scale reading. Gauge subject to rapid pressure surges shall be properly suppressed

   b. Coolant temperature Indicators

      Coolant temperature indicators shall be indicating dial type. Capillary tubing shall be covered with a protective casing throughout its entire length and reinforced with an additional casing at the connection to the bulb or socket. The temperature indicator shall be accurate to within 2 percent of full scale reading.

   c. Generator Controls and Instruments

      NEMA ICS 1,2,3, and 4 shall include the components listed below. Instruments shall comply with ANSI C39.1.

      1) Voltmeter and Ammeter:

         Semi-flush mounted direct indicating type, not less than 110 mm inch nominal round or square, 180º arc, with accuracy of 2% of full scale.

      2) Frequency Controls and Instruments

      3) Control Switches:

         Voltage and ampere ratings suitable for the intended use. Contacts shall be rated in accordance with NEMA Standards ICS 2-125.

      4) Generator Output Circuit Breaker:

         Molded case type, trip-free, and shall be mounted to allow operation from outside the control panel. Frame size shall be

adequate for generator amperage when operating at standby rating, and an adjustable trip shall be provided. Lugs shall be provided for electrical connections.

5) Voltage adjustment rheostat

6) Panel lights and control switch

7) Alarm indicating panel

7.2.2.6 BASE ASSEMBLY AND ENCLOSURE: NEMA ICS 6

1. Engine Generator

Engine Generator shall be mounted on a fabricated steel skid base suitable for supporting, transportation, and skidding engine and generator without damage to equipment or alignment.

2. Vibration Isolators

Vibration isolators shall be provided to isolate the engine-generator set from the building floor, at least four isolators, as recommended by the isolator manufacturer, are required. The isolators shall be manufactured by a firm specializing in this product, and the unit shall be specifically listed for this application and have a maximum deflection of 25 mm.

7.2.2.7 TREATMENT AND PAINTING

All parts, including engine subject to high temperature, shall be treated and painted in accordance with manufacturer's standards. The generator and all associated electrical equipment shall be thoroughly cleaned and treated prior to painting. Color shall be manufacturer's standard.

7.2.3 EXECUTION

7.2.3.1 INSTALLATION

Installation shall conform to the requirements of NFPA 70.

7.2.3.2 DIESEL ENGINE GENERATOR

Diesel generating unit shall be installed on a concrete foundation as indicated. Vibration isolators shall be provided to isolated vibrations from the diesel generating unit to the foundations.

7.2.3.3 TESTING

The following tests shall be performed on the generator set system provided. The Engineer shall be given seven (7) working days notice prior to each test. The Contractor shall provide all test equipment and personnel and submit three (3) copies of all test results.

1. Factory Tests

   The engine-generator shall be subject to the manufacturer's standard run-in and conditioning tests.

   Following the run-in tests, the engine-generator set shall be tested at rated speed and voltage for 8 hours of continuous operations with 2 hours each at 50, 74, 100 and 110 percent of rated load, consecutively, 0.8 power factor. The Contractor shall determine generator frequency, phase current, and voltage and record at 15 minute intervals. The Contractor shall tests run on the voltage regulator to determine the variation in terminal voltage under conditions of constant load, and under conditions of abrupt load changes to determine the maximum voltage change during the surging period and the time required.

2. Speed Governing Test

   Engine speed governing system shall be tested in accordance with ASME PTC26.

3. Field Tests and Inspections

   The Contractor shall perform all field tests and trial operations, and conduct all field inspections (except final field inspection). The Contractor shall provide all labor, equipment, and incidentals requirements, including water, fuel, and lubricants required for tests. The Contractor shall give ample notice of the dates and times scheduled for tests, trial operations, and inspections which require the presence of the Engineer. All deficiencies found shall be rectified and work affected by such deficiencies shall be completely retested at the Contractor's expense. Field tests shall include the following:

   a. Demonstrate proper operation of all system

   b. Conduct three (3) hour run utilizing Contractor-furnished portable load bank or dummy load as follows:

      ½ load - one hour

      Full load - two hours

7.2.4 MEASUREMENT AND PAYMENT

The quantity of standby diesel engine generating set shall be measured and paid for by the number of sets supplied, installed and certified by the Engineer to have passed the quality and operation test and for full payment. The set shall include accessories and other complimentary equipment and parts necessary for satisfactory performance of the above mentioned set.

The quantity of above ground fuel tank shall be measured and paid for by the number of set of fuel tank supplied, installed and accepted by the Engineer. Payment shall include cost of concrete work, fuel tank, plumbing work and all valves and gauge necessary including the supply of fuel transfer pump and all the necessary plumbing and electrical works.

Payment above shall include the cost of furnishing materials, supplies, labor, equipment, tools including accessories and complimentary electrical equipment and other incidentals and subsidiary work necessary to complete the installation, and certified by the Engineer for full payment

7.3 OVERHEAD ELECTRICAL WORKS

7.3.1 GENERAL

7.3.1.1 GENERAL REQUIREMENTS

Section 7.1 “Electrical General Requirements” applies to this section with additions and modifications specified herein.

7.3.1.2 SUBMITTALS

Submit the following information for approval.

1. Catalog Information

    a. Conductor (list each size and type)
    b. Insulator (list each size and type)

7.3.2 MATERIAL REQUIREMENTS

7.3.2.1 MATERIALS

All materials shall be new and shall conform with the standard of Underwriter’s Laboratory (UL), the latest edition of Philippine Electrical Code, the local utility company and other local enforcing authority. Samples of any material shall be submitted to the Engineer for approval prior to installation.

7.3.2.2 POLES

Unless otherwise indicated on the Drawings, creosoted wood poles shall be used. Provide at least two (2) secondary rack insulators on each new poles and one (1) on the existing wherein termination of wires are to be made. Provide messenger wire if necessary. Install the racks at least one (1) meter from the top of the poles or as required to site conditions.

7.3.2.3 CONDUCTORS

Overhead secondary conductors shall be of recent manufacture and no case shall be more than six (6) months old. Any conductor that shows sign of deterioration within one (1) year from final acceptance of work shall be replaced by the Contractor at his own expense.

7.3.3 EXECUTION

7.3.3.1 INSTALLATION

Provide overhead pole line installation conforming to the requirements of Philippine Electrical Code (PEC), and the local enforcing authority.

1. Pole Setting

   Pole holes shall be at least as large at the top as at the bottom and shall be large enough to provide 100 mm clearance between the pole and the side of the hole.

   a. Unless otherwise indicated on the Drawings, pole setting depths all be as follows:

Length of Pole (m)	Setting in Soil (m)	Setting in Solid Rock (m)
10	1.7 (5.5 ft)	1.04 (3.5 ft)

   b. Setting in soil depths shall apply where pole holes are in soil, and or gravel or any combination of these; where the soil layer over solid rock is more than 600 mm deep; where the hole in solid rock is not substantially vertical; or where the diameter of the hole at the surface of the rock exceeds twice the diameter of the pole at the same level. At corners, dead ends and other points of extra strain, poles 10 meters or more shall be set 150 mm deeper.

   c. Setting in solid rock shall apply where poles are to be set in solid rock and where the hole is substantially vertical of an approximately uniform diameter and large enough to permit the use of tamping bars the full depth of the hole.

d. Where there is a layer of soil 600 mm or less in depth over solid rock, the depth of the hole shall be the depth of the soil in addition to the depth specified under “Setting in solid rock” provided, however, that such depth shall not exceed the depth specified under “Setting in soil.”

e. On sloping ground, always measure the depth of the hole from the low side of the hole.

f. Thoroughly tamp pole backfill for the full depth of the hole and mound the excess fill around the pole.

g. Provide plastic pole caps with 6.4 mm sealing rings and four screwing tabs. Fill sealing area with sealing compound to the level of the sealing ring, place on pole top and screw each tab down with a 32 mm long screw.

2. Conductors

Conductors shall be handled with all necessary care to prevent nicking, kinking, ganging, flattening or otherwise deforming or weakening the conductor or impairing its conductivity and insulation resistivity. Remove all damaged sections of conductor and splice the conductor.

a. Conductor splices, as installed shall exceed the ultimate rated strength of the conductor and shall be of the type recommended by the conductor manufacturer. No splice shall be permitted within 3 meters of any support.

b. Ties on insulators shall be tight against the conductor and insulator and end shall be turned down flat against the conductor so that no wire ends project.

c. Existing conductors to be reinstalled or resagged shall be strung to “Final” sag table values for the particular conductor type and size involved.

d. String new conductors to “Initial” sag table values recommended by the manufacturer for the conductor type and size of conductor and ruling span indicated.

e. Dead end fittings, clamp, or compression type shall conform to the written recommendations of the conductor manufacturer and shall develop the full ultimate strength of the conductor.

f. Make copper connections to any other materials using only splices, connectors, lugs, or fittings designed for that specific purposes. Submit the manufacturer's directions for applying these fittings for reference and one additional copy maintained at the job site for the use of the inspector.

g. All conductors shall be cleaned thoroughly by wire busing before splicing.

3. Taps and Jumpers

a. Jumpers and other leads connected to the line conductors shall have sufficient slack to allow free movement of the conductors. Where slack is not shown on the drawings it will be provided by at least two bends in a vertical plane, or one in a horizontal plane, or the equivalent.

7.3.4 MEASUREMENT AND PAYMENT

The work under this Section shall be measured either by lengths, pieces, set and linear meters actually placed and installed as shown on the approved drawings.

Measurement and payment for poles shall be by the number of set of poles including the necessary accessories shown on the drawings for each type of pole supplied, delivered to site, installed, tested, commissioned, and accepted by the Engineer.

All works performed and measured and as provided for in the Bill of Quantities shall be paid or at the Contract Unit Price which payment shall constitute full compensation including labor, material, tools, equipment and incidentals necessary whether shown on the drawings or not but necessary for the successful completion and operation of the system.

7.4 UNDERGROUND ELECTRICAL WORKS

7.4.1 GENERAL

7.4.1.1 GENERAL REQUIREMENTS

Section 7.1, "Electrical General Requirements" applies to this section with additions and modifications specified herein.

7.4.1.2 SUBMITTALS

Submit the following information for approval:

1. Manufacturer's Data and Shop Drawings:

    a. Conduit
    b. Handholes
    c. Electrical Cables

2. Certificates:

    a. Materials and Equipment:

        1. Cables
        2. Conduit

7.4.2 MATERIAL REQUIREMENTS

7.4.2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated.

1. Conduit:

    a. Rigid Plastic Conduit: UL 651, Schedule 40 PVC.
    b. Rigid Steel Conduit (RSC): Hot dip galvanized.
    c. Intermediate Metal Conduit: UL 1242.

2. Fittings and Outlet Boxes:

    a. PVC Fittings: UL 651.
    b. Fittings for Metal Conduit: UL 514B. Ferrous fittings shall be hot dip galvanized in accordance with UL 514.

    Fittings for RSC: shall be threaded type.

    Split couplings are not acceptable.

3. Tape:

    UL 510. Plastic insulating tape shall be capable of performing in a continuous temperature environment of 80°C.

4. Power Wire and Cable:

    a. Wire and Cable Conductor Sizes:

        Wire and cable conductor sizes are designated by square millimeters. Conductors shall be copper. Insulated conductors shall bear the date of manufacture imprinted on the wire insulation with other identification. Wire and cable manufactured more than 6 months before delivery to the job site shall not be used. Provide conductor identification within each enclosure where a tap, a splice or a termination is made.

5. Wire Conformation:

    Provide wires conforming to UL 83. Only wires with “W” in the type designation shall be used in wet or damp locations.

    a. 600 Volt Wires and Cables:

        Conductor sizes are indicated by square millimeters (mm^2) for copper conductors. Insulated wires and cables manufactured more than six months prior to delivery shall not be used.

6. Connector and Terminals:

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

7. Pull Wire:

    Pull wire shall be 2.0 mm hot-dip galvanized steel or plastic having a minimum tensile strength of 90 kg in each empty duct. A minimum of 300 mm of slack shall be left at each extremity of pull wires.

8. Grounding and Bonding Equipment:

    Shall conform to UL 467.

9. Underground Structures:

    Handholes shall have a smooth trowel finish for floors and horizontal surfaces. Top and bottom shall consist of reinforced concrete. Walls shall consist of concrete hollow blocks. Bottom shall be monolithic concrete construction. Duct entrances and windows shall be located near the corners of structures to facilitate cable racking. Covers shall fit the frames without undue play. Steel and iron shall be formed to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair their strength or

appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide all necessary brackets. Set pulling-in irons and other built-in items in place before depositing concrete. A pulling-in iron shall be installed in the wall opposite each duct line entrance. The words “Electric” shall be cast in the top face of all handhole covers.

a) Drainage Pipe and Fittings:

Cast-iron, extra strength. Drains shall be cast-iron, coated or uncoated, plain pattern, bottom outlet with perforated or slotted hinged cover.

7.4.3 EXECUTION

7.4.3.1 INSTALLATION

Underground cable installation shall conform to PEC, NFPA 70 and ANSI C2.

1. Concrete:

Concrete for electrical requirements shall be at least [21 MPa (3000 psi)] concrete with 19 mm maximum aggregate.

2. Earthworks:

Excavation, backfilling, and pavement repairs for electrical requirements shall conform to the requirements of Section 4.2, “Excavation and Backfilling for Buildings.”

3. Concrete Hollow Block Handholes:

Provide concrete hollow block handholes as indicated. Masonry works shall conform to the requirements of Section 4.5, “Masonry.”

a. Ground Rods:

In each electrical handhole, at a convenient point close to the wall, a 20 mm by 3.0 meter copper-clad steel ground rod shall be driven into the earth before the floor is cast so that approximately 100 mm of the ground rod will extend above the handhole floor.

b. Handhole Grounding:

Ground rods installed in electrical distribution system handholes shall be properly connected to the cable shielding, metallic sheaths, and armor at each cable joint or splice by means of 8.0

mm^2 or equivalent braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 50 mm above and 150 mm below concrete penetrations. Ground wires shall be neatly and firmly attached to handhole walls and the amount of exposed bare wire shall be held to a minimum.

4. Underground Ducts with Concrete Encasement:

Construct underground duct lines of individual conduits encased in concrete. Except where rigid galvanized steel conduit is indicated or specified, the conduit shall be of Schedule 40 PVC. Do not mix the kinds of conduit used in any one duct bank. Ducts shall be as indicated on the drawings. The concrete encasement surrounding the bank shall be rectangular in cross section and shall provide at least 76 mm of concrete cover for ducts.

a. The top of the concrete envelope shall not be less than 600 mm below grade.

b. Duct lines shall have a continuous slope downward toward handholes and away from buildings with a pitch of not less than 76 mm in 30 meters. Except at conduit risers, accomplish changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, by long sweep bends having a minimum radius of curvature of 7.6 meters. 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 900 mm for ducts of 80 mm in diameter and larger.

c. Terminate conduits in end-bells where duct lines enter handholes. Separators shall be of precast concrete, high impart 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 a 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 handhole, 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.

5. Cable Pulling:

   Test duct lines with a handhole and thoroughly swab out to remove foreign materials before the pulling of cables.

   Pull cables down grade with feed-in points at the handholes or buildings at the highest elevation. Use flexible cable feeds to convey cables through the handhole openings and into the duct runs. Cable slack shall be accumulated at each handhole where space permits by training the cable around the interior to form one complete loop. Minimum allowable bending radii shall be maintained in forming such loops.

   a. Lubricants for assisting in the pulling of jacketed cables shall be those specifically recommended by the cable manufacturer. Cable lubricants shall be soapstone, graphite, or talc for rubber or plastic jacketed cables. The lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.

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

   c. Secondary cable runs, 600 volts and less, in non-metallic duct conduit shall, although not indicated, include and insulated copper equipment grounding conductor sized as required by the rating of the overcurrent device supplying the phase conductors.

   d. Installation of Cables in Handholes:

      Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. All cables shall form to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators at a maximum of 457 mm. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath.

6. Grounding:

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

Grounds in handholes	10 ohms
Grounded secondary distribution system neutral and non-current carrying metal parts associated with distribution systems and grounds not otherwise covered.	25 ohms

a. 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 stated for the particular equipment being grounded.

b. 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. Make thermit welds strictly in accordance with the weld manufacturer's written recommendations. Welds which have "puffed up" of which show convex surfaces indicating improper cleaning are not acceptable. No mechanical connector is required at thermit weldments.

c. In lieu of an exothermic type process, a compression ground grid connector of 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.

d. Grounding conductors shall be bare soft-drawn copper wire minimum unless otherwise indicated or specified.

e. Connect copper-clad steel ground rods only to insulated TW copper ground conductor and weld the connection. Insulate the entire area of the rod in the vicinity of the weld and the connecting wire and seal against moisture penetration.

7.4.3.2 FIELD TESTS

As an exception to requirements that may be stated elsewhere in the contract, the Engineer shall be given a five (5) working day notice prior to each tests.

1. Distribution Conductors 600 Volt Class:

   Test all 600 volt class conductors to verify that no short circuits or accidental grounds exist. Make tests using an instrument which applies a voltage of approximately 500 volts to provide a direct reading in resistance.

2. Test Report

   Grounding electrodes and systems (identify electrodes and systems, each test)

7.4.4 MEASUREMENT AND PAYMENT

7.4.4.1 GENERAL

Payment for all items stated and described in this Section shall be full compensation for all labor, materials, tools and equipment, test and all incidentals necessary whether shown on the Drawings or not but necessary for the proper operation of the system.

7.4.4.2 HANDHOLES

The quantity of handholes with cover shall be measured and paid for by the number of units constructed/installed complete and certified by the Engineer for full payment. Excavation and backfilling shall be deemed included in the cost of each unit of handhole.

7.4.4.3 DUCT BANK

The quantity of duct bank to be measured and paid for shall be in linear meters of each type of duct bank installed and completed including earthworks, conduits, concrete and reinforcing steel bars, if reinforced.

7.4.4.4 SERVICE ENTRANCE

Lump sum price will be allocated for providing service entrance as shown on the Drawings. Payment shall be full compensation for all earthworks, concrete, rebars, conduits and other incidental and necessary fixtures needed for the complete installation of the service entrance except conductor wire which will be measured and paid for separately.

7.4.4.5 CONDUCTOR WIRE

The quantity of conductor wire installed to be measured and paid for shall be in linear meters installed complete including splicing and other appurtenant items and incidentals and certified by the Engineer for full payment.

7.4.4.6 CONDUITS

The quantity of conduits shall be measured and paid for in linear meter of each size and type of conduit materials installed complete including joints, bends, fittings, locknut bushing, supports, adaptor, coupling and all other incidentals and appurtenances. It shall be certified by the Engineer for full payment.

7.4.4.7 CONCRETE ENCASEMENT

The quantity of concrete encasement for conduits shall be measured and paid for in cubic meter of concrete placed and accepted by the Engineer. Payment shall be full compensation for all labor, material, and equipment and other incidental necessary to complete the work. Earthwork shall be included in the unit cost of concrete encasement.

7.4.4.8 GROUNDING SYSTEM

The quantity of ground electrode shall be measured and paid for in number of electrodes supplied, installed, tested and accepted by the Engineer for payment.

The quantity of counter poise wire shall be measured and paid for in meter of counter poise wire supplied, installed and accepted by the Engineer for payment.

7.5 INTERIOR WIRING SYSTEMS

7.5.1 GENERAL

Section 7.1, “Electrical General Requirements,” applies to this section with additions and modifications specified herein.

7.5.1.1 SUBMITTALS

1. Shop Drawings: Submit for the following:

   a. Panelboards

2. Manufacturer’s data:

   Submit for the following:

   a. Circuit breakers
   b. Switches
   c. Conduit and fittings (each type)
   d. Ground rods
   e. Device plates
   f. Insulated conductors
   g. Outlet and junction boxes

3. Test Reports: Submit test results for approval in report form.

   a. 600Volt - wiring test
   b. grounding system test

4. Quality Assurance

   In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word “shall” has been substituted for “should” wherever it appears. Interpret reference in these standards to “authority having jurisdiction,” or words of similar meaning, to mean Engineer.

7.5.2 MATERIALS AND EQUIPMENT REQUIREMENTS

Materials, equipment, and devices shall, as minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70. All items shall be new.

7.5.2.1 CONDUIT AND FITTINGS

1. Rigid Steel Conduit (RSC): Hot dip galvanized: ANSI C80.1.

2. Flexible Metal Conduit: UL 1.

   a. Liquid Tight Flexible Metal Conduit (Steel): UL 360.

3. Rigid Plastic Conduit: PVC schedule 40 in accordance with UL 651.

4. Fittings for Metal Conduit, and Flexible Metal Conduit: UL 514B. Ferrous fittings shall be hot dip galvanized in accordance with UL 514.

   a. Fittings for RSC: Shall be threaded-type. Split couplings are not acceptable.

   b. Fittings for Rigid Nonmetallic Conduit: NEMA TC3.

7.5.2.2 OUTLET BOXES AND COVERS

UL 514, hot dip galvanized for ferrous metal.

7.5.2.3 CABINETS, JUNCTION BOXES, AND PULL BOXES (WITH VOLUME GREATER THAN 100 CUBIC INCHES)

UL 50, hot dip.

7.5.2.4 WIRES AND CABLES

Wires and cables shall meet applicable requirements of PEC, NFPA 70 and UL for types of insulation, jackets, and conductors specified or indicated. Wires and cables manufactured more than 6 months prior to date of delivery to site shall not be used.

1. Conductors: Conductor 3.5mm^2 and smaller shall be solid, 5.5 mm^2 and larger shall be stranded. All conductors indicated shall be copper.

   a. Equipment Manufacturer Requirements:

      If manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to satisfy manufacturer's requirements.

   b. Minimum Conductor Sizes:

      Minimum size for branch circuits shall be 3.5 mm^2.

2. Color Coding

   For 240V, 60Hz, 1ø, 2 wire

   Phase A - Black
   Phase B - Red
   Grounding - Green

   For 480/277 volt, 3 phase

   Phase A - brown
   Phase B - orange
   Phase C - yellow
   Grounding - Green

3. Insulation:

   Unless specified for indicated otherwise or required by PEC and NFPA 70, power and lighting wires shall be 600volt, Type THHN or THW.

4. Bonding Conductors:

   ASTM B1, solid bare copper wire for sizes 8.0 mm2 and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes 14 mm2 and larger diameter.

7.5.2.5 SPLICES AND TERMINATION COMPONENTS

UL 486A as applicable, for wire connectors and UL 510 for insulating tapes. Connectors for 5.5 mm^2 and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A or UL 486C (twist-on splicing connector).

a) Provide solderless terminal lugs on stranded conductors.

7.5.2.6 DEVICE PLATES

Provide UL listed, one-piece device plates for outlets and fittings to suit the devices installed. For metal outlets and fittings, plates on unfinished walls and on fittings shall be of zinc-coated sheet steel or cast metal having round or bevelled edges. Plates on finished walls shall be urea or phenolic, minimum 2.5mm wall thickness. Plates shall be same color as receptacle or toggle switch with which they are mounted. Screws shall be machine-type with countersunk heads in color to match finish of plate. Use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and UL listed for “wet locations.”

7.5.2.7 SWITCHES

1. Toggle Switches:

   Totally enclosed with bodies of thermosetting plastic and mounting strap. Wiring terminal shall be screw-type, side-wired. Switches shall be rated quiet-type AC only, 250 volts, with current rating and number of poles indicated.

2. Receptacles

   UL 498 and NEMA WD 1, heavy duty, grounding type. Ratings and configurations shall be as indicated. Wiring terminals shall be screw-type, side-wired. Connect grounding pole to mounting strap.

7.5.2.8 SPECIAL PURPOSE RECEPTACLES:

Receptacles serving as indicated are special purpose. Provide ratings as indicated. Furnish one matching plug with each receptacle.

7.5.2.9 PANELBOARDS

UL 67 and UL 50. Panelboards for use as service disconnecting means shall additionally conform to UL 869. Panelboards shall be circuit breaker-equipped. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as

required by UL. Where “space only” is indicated, make provisions for future installation of breaker sized as indicated. Panelboard locks shall be keyed same. Directories shall be typed to indicate load served by each circuit and mounted in holder behind transparent protective covering.

1. Panelboard Buses:

   All buses shall be copper support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or lapping. Provide separate ground bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2. Circuit Breakers:

   Ambient-compensated thermal magnetic-type solid state-type with interrupting capacity of 10,000 amperes symmetrical minimum. Breaker terminal shall be UL listed as suitable for type of conductor provided. Plug-in circuit breakers are unacceptable.

   a. Multi-pole Breakers

      Provide common trip-type multi-pole breakers with single operating handle. Breaker design shall be such that an overload in one pole automatically causes all poles to open.

7.5.2.10 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual moulded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit interrupting rating as indicated. Enclosure type as indicated.

7.5.2.11 REEFER VAN OUTLET

1. The refrigerated van power center shall be to service various container van of different origin or countries including Japan, USA, Australia and other European countries.

2. Socket outlet for 250 volts shall be capable of handling current up to 60 amperes, 3 phase. Socket outlet shall be R-24604B-60 or R6-W0602B-60 series I or approved equal.

3. Connectors shall be capable of servicing van socket and plug with ease and simple operation. If, required, socket adaptor shall be type P-24604 P-4 and C-W4332B-3h and C-W4501B-A or approved equal.

4. Plug shall be capable of insertion with the socket outlet in smooth operation. Mechanical interlock, switch and circuit breaker shall be provided for safety operation of reefer van outlets. Plug shall be type P-W4604 P-A or approved equal.

5. The socket outlet for 250 volts, 3 phase shall be Series 1 and shall meet the requirements of ISO for the container industry for both 250V and 460 volts, 3 phase.

6. For 460 volts, socket outlet shall be Series II, 32 amperes, 3 phase (C.E.E., ISO). This device shall be in accordance with C.E.E. standards, IEC as well as ISO. Voltage configuration shall be capable for 380 to 440 VAC.

7. The socket outlet shall have circuit breaker or switch and C.E.E. 3h contact position. This device shall be non-interchangeable type and keyway shall have 3 o'clock position. The socket outlet type shall be R-W4332B-3h and R7-W0302B-3h and P-W4333p-3h or approved equal.

8. Connector shall be of smooth operation with type no. C-24332B-3h, C-W4315B-A and P-208295 or approved equal.

9. Plug shall be of type, P-W4333p-3h, P-W4392P-A and P-207627-P.

10. All the above devices shall be mechanical interlocked that could not be closed unless the plug is fully inserted.

7.5.2.12 GROUNDING AND BONDING EQUIPMENT

UL 467. Ground rods shall be copper-clad steel, with minimum diameter of 20mm and minimum length of 3 meters.

7.5.2.13 NAMEPLATES

Provide as specified in Section 7.1 "Electrical General Requirements."

7.5.3 EXECUTION

7.5.3.1 INSTALLATION

Electrical installation shall conform to requirements of PEC, NFPA 70 and to requirements specified herein.

1. Underground Service:

   Underground service conductors and associated conduit shall be continuous from service entrance equipment to outdoor power system connection.

2. Wiring Methods:

   Provide insulated conductors installed in conduits, except where specifically indicated or specified otherwise or required by PEC and NFPA 70 to be installed otherwise. Provide insulated, green equipment grounding conductor in feeder and branch circuits, including lighting circuits. Provide insulated, green colored conductor for grounding conductors installed in conduits or raceways.

   a. Service Entrance Conduit: Rigid Steel Conduit (RSC), conduit underground: PVC schedule 40. The underground portion shall be encased as indicated.

   b. Underground Conduit (other than service entrance) PVC where non-metallic conduit is used, shall be converted to plastic – coated rigid steel conduit before rising through floor slab; plastic coating shall extended at least 152mm above floor.

   c. Conduit in Floor Slabs: RSC

3. Conduit Installation:

   Unless indicated otherwise, conceal conduit within finished walls, ceilings, and floors. Keep conduit a minimum of 150mm away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project. Run conduits in crawl space under slab as if exposed.

   a. Where conduits rise through floor slabs, curved portion of bends shall not be visible above finish slab.

   b. Conduit Support:

      Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded studs, or spring tension clamps on steelwork. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners shall not exceed one-fourth proof test load. Fasteners attached to concrete ceilings shall be vibration resistant and shock resistant. Holes cut to depth of more than 40mm in reinforced concrete beams or to depth of more than 20mm in concrete joints shall not cut main reinforcing bars. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run

conduit above ceiling. Do not support conduit by ceiling support system. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations.

c. Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

d. Install pull wires in empty conduits in which wire is to be installed by others. Pull wire shall be plastic having minimum 91 kgs. tensile strength. Leave minimum 300mm of slack at each end of pull wire.

e. Conduit Installed in Concrete Floor Slabs:

Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab. Do not stack conduits. Space conduits horizontally at a minimum of three diameters, except at cabinet locations. Curved portions of bends shall not be visible above the finish slab. Increase slab thickness as necessary to provide minimum 25 mm cover over conduits. Where embedded conduits cross expansion joints, provide suitable watertight expansion fittings and bonding jumpers. Conduit larger than 25mm trade size shall be parallel with or at right angles to main reinforcement; when at right angles to the reinforcements, the conduit shall be closed to one of the supports of the slab.

f. Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by PEC and NFPA 70, where insulated bushings are used, and where bushing cannot be brought into firm contact with the box; otherwise, use minimum single locknut and bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by PEC and NFPA 70.

g. Flexible Connection:

Provide flexible connection of short length, 1.8 meters maximum for recessed and semi-recessed lighting fixtures.

4. Boxes, Outlets, and Supports:

Provide boxes in wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type

when located in wet locations, when surface mounted on outside of exterior surfaces, when installed exposed up to 2.1meters above interior floors and walkways, or when installed in hazardous areas. Boxes in other locations shall be sheet steel, except that aluminum boxes may be used with aluminum conduit. Each box shall have the volume required by PEC and NFPA 70 for the number of conductors enclosed in the box. Boxes for mounting lighting fixtures shall not be less than 100 mm^2 or octagonal, except that smaller boxes may be installed as required for fixture configurations as approved. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature. Fixtures shall be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports, or make adequate provisions for distributing load over ceiling support members. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. In open overhead spaces, cast boxes threaded to raceways need not separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved type fastener maximum 600mm from the box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

a. Boxes for use with raceway systems shall be minimum 40mm deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets shall be minimum 100mm^2, except that 100 by 50mm boxes may be used where only one raceway enters outlet.

b. Pull Boxes:

   Construct of at least minimum size required by PEC and NFPA 70 of code-gauge aluminum sheet steel except where cast-metal boxes are required in locations specified herein. Furnish boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

5. Mounting Heights:

Mount panelboards, and circuit breakers, so height of operating handle at its highest position is maximum 1.8 meters above floor. Mount

lighting switches 1.4 meters above finished floor, receptacles 300mm above finished floor and other devices. Measure mounting heights of wiring devices and outlets to center of device or outlet.

6. Conductor Identification;

   Provide conductor identification within each enclosure where tap, splice, or termination is made.

7. Splices:

   Make splices in accessible locations. Make splices in conductors 5.5 mm2 and smaller diameter with insulated, pressure-type connector. Make splices in conductors 8.0 mm^2 and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

8. Covers and Device Plates:

   Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Plates shall be installed with alignment tolerance of 3mm. Use of sectional-type device plates are not permitted. Plates installed in wet locations shall be gasketed.

9. Electrical Penetrations:

   Openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings shall be sealed to maintain fire resistive integrity as tested per ASTM E 814.

10. Reefer Van Outlets

    Installation of the reefer van outlets and other related accessories shall be in accordance with the approved Drawings accepted by the Engineer.

11. Grounding and Bonding:

    In accordance with PEC and NFPA 70. Ground all exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and non-metallic raceways, and conductor of wiring systems. Make ground connection to driven ground rods on exterior of building. Where ground fault protection is employed, ensure that connection of ground does not interfere with correct operation of fault protection.

a. Grounding Conductor:

Provide insulated, green equipment grounding conductor in feeder and branch circuits, including lighting circuits. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated, green conductor for grounding conductors installed in conduit or raceways.

b. Resistance:

Maximum resistance-to-ground of grounding system shall not exceed 25 ohms, contact the Engineer for further instructions.

7.5.3.2 FIELD QUALITY CONTROL:

Furnish test equipment and personnel and submit written copies of test results. Give the Engineer five (5) working days notice prior to each test.

1. Devices Subject to Manual Operation:

Each device subject to manual operation shall be operated at least five times, demonstrating satisfactory operation each time.

2. Test on 600Volt Wiring:

Test 600Volt wiring to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance shall be 25,000 ohms.

3. Grounding System Test:

The Grounding system shall be tested to ensure continuity and resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to the Engineer and indicate location of rods as well as resistance and soil conditions at the time measurements were made.

7.5.4 MEASUREMENT AND PAYMENT

1. The work under this Section shall be measured either by lengths, pieces, pairs, set and linear meters actually placed and installed as shown on the approved Drawings.

2. All works performed and measured and as provided for in the Bill of Quantities shall be paid or at the Contract Unit Price which payment shall constitute full compensation including labor, material, tools, equipment and incidentals necessary to complete this Section.

7.6 INTERIOR LIGHTING

7.6.1 GENERAL

7.6.1.1 GENERAL REQUIREMENTS

Section 7.1, “Electrical General Requirements,” applies to this section, with the additions and modifications specified herein.

7.6.1.2 DESCRIPTION OF WORK

The work includes providing lighting fixtures for interior use, including accessories mounted on the exterior surfaces of buildings. Materials not normally furnished by manufacturers of these devices are specified in Section 7.5, “Interior Wiring Systems.”

7.6.1.3 SUBMITTALS

Data, shop drawings showing mounting heights, and reports shall employ the terminology, classifications, and methods prescribed by the IES Lighting Handbook, as applicable, for the lighting system specified.

1. Manufacturer’s Data:

    a. Lighting fixtures, including lamps and ballasts

7.6.2 MATERIAL REQUIREMENTS

7.6.2.1 FLUORESCENT LIGHTING FIXTURES

UL 1570 except lighting fixtures for damp and wet locations shall conform to UL 57.

1. Fluorescent Lamps:

    Provide the number, type and wattage indicated.

2. Fluorescent Ballasts:

    UL 935, ANSI C82.1, and shall be labeled Certified Ballast Manufacturers (CBM) certified by Electrical Testing Laboratories (ETL). Ballasts shall be high power factor type and shall be designed to

operate on the voltage system to which they are connected. Ballasts shall be Class P and shall have sound rating “A”. Fixtures and ballasts shall be designed and constructed to limit the ballast case temperature to 90 degrees Celsius (C) when installed in an ambient temperature of 40 degrees C.

7.6.2.2 COMPACT FLUORESCENT FIXTURES

Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballasts integral to the fixture. Providing assemblies designed to retrofit incandescent fixtures is prohibited except when specifically indicated for renovation of existing fixtures. Fixtures shall use lamps as indicated.

7.6.2.3 RECESS AND FLUSH-MOUNTED FIXTURES

Provide types that can be relamped from the bottom. Trim for the exposed surface of flush-mounted fixtures shall be as indicated.

7.6.2.4 SUSPENDED FIXTURES

Provide hangers capable of supporting twice the combined weight of the adjoining fixtures. Provide with swivel hangers to ensure a plumb installation. Hangers shall be cadmium-plated steel with swivel-ball tapped for the conduit size indicated. Hangers shall allow fixtures to swing within an angle of 20 degrees. Brace pendants 1.2 meters or longer to limit swinging. Single-unit suspended fluorescent fixtures shall have twin-stem hangers. Multiple-unit or continuous row fluorescent fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Rods shall be a minimum 5mm diameter.

7.6.2.5 POWER HOOK FIXTURE HANGERS

Provide UL listed assembly including through-wired power hook housing, interlocking plug and receptacle, power cord, and fixture support loop. Power hook housing shall be cast aluminum having two 20mm threaded hubs. Fixture support loop shall be cast aluminum with provisions for accepting 20mm threaded fixture stems. Power cord shall include 400mm of 3-conductor No. 16 Type SO cord.

7.6.3 EXECUTION

7.6.3.1 INSTALLATION

Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturer’s directions and approved shop drawings. The installation

shall meet with the requirements of PEC and NFPA 70. Mounting heights specified or indicated shall be to bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before installation commence and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Recessed and semi-recessed fixtures may be supported from suspended ceiling support system ceiling tees if the ceiling system support rods or wires are provided at a minimum of four rods or wires per fixture and located not more than 150 mm from each corner of each fixture. Do not support fixtures by ceiling acoustical panels. Where fixtures of size less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently or with at least two 20mm metal channels spanning, and secured to, the ceiling tees. Provide rods or wires for lighting fixture supports under this section of the specifications. Additionally, for recessed fixtures, provide support clips securely fastened to ceiling grid members, a minimum of one at or near each corner of each fixture.

7.6.3.2 GROUNDING

Ground non-current-carrying parts of equipment as specified in Section 7.5, “Interior Wiring Systems.” Where the copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

7.6.3.3 FIELD TESTS

The Contractor will provide electric power required for field tests.

1. Operating Test:

   Upon completion of the installation, conduct an operating test to show that the equipment operate in accordance with the requirements of this section.

2. Insulation Resistance Test:

   Perform as specified in Section 7.5, “Interior Wiring Systems”, both before and after connection of fixtures and equipment.

3. Ground Resistance Tests:

   Perform as specified in Section 7.5, “Interior Wiring System.”

7.6.4 MEASUREMENT AND PAYMENT

1. The quantity of interior lighting system to be measured and paid for shall be the number of sets of each lighting fixtures installed including supports and accessories complete as a system and certified by the Engineer for full payment.

2. Payment shall constitute full compensation for all labor, materials, tools and equipment and all necessary test and incidental work needed for the successful operation of all lighting fixtures.

7.7 EXTERIOR LIGHTING

7.7.1 GENERAL

Section 7.1, "Electrical General Requirements," applies to this section, with the additions and modifications specified herein.

7.7.1.1 REFERENCES

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.

1. American Association of State Highway and Transportation Officials (AASHTO)

AASHTO LTS-3	(2006) Structural Supports for Highway Signs, Luminaires and Traffic Signals

2. American National Standards Institute (ANSI)

ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
ANSI C136.14	(2004) Roadway Lighting Equipment - Enclosed Side-Mounted Luminaires for Horizontal-Burning High-Intensity-Discharge Lamps

3. American Society for Testing and Materials (ASTM)

ASTM A123/A123M	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A153/A153M	(2005) Zinc Coating (Hot-Dip) on Iron and Steel Hardware - AASHTO No.: M232

4. Illuminating Engineering Society of North America (IES)

IES LHBK	(1993) Lighting Handbook, Reference and Application

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

IEEE C2	(2007; Errata 2007) National Electrical Safety Code (ANSI/IEEE)
IEEE C136.3	(2005) Roadway Lighting Equipment - Luminaire Attachments
IEEE C136.10	(1996) Roadway Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing

6. National Electrical Manufacturers Association (NEMA)

NEMA C78.41	(2001) Guidelines for Low-Pressure Sodium Lamps
NEMA C78.42	(2007) Electric Lamps - Guidelines for High-Pressure Sodium Lamps
NEMA ICS 2	(2000; Errata 2002; R2005; Errata 2006) Industrial Control and Systems Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993; R2006) Industrial Control and Systems Enclosures

7. National Fire Protection Association (NFPA)

NFPA 70	(2007) National Electrical Code
8.1.1.8	Underwriters Laboratories Inc. (UL)
UL 773	(1995; R 2002) Plug-In, Locking Type Photocontrols for Use with Area Lighting

UL 773A	(1995; R 2003) Non-industrial Photoelectric Switches for Lighting Control
UL 1029	(1994; R 2001) High-Intensity-Discharge Lamp Ballasts

8. Institute of Integrated Electrical Engineer (IIEE)

PEC	(2002) Philippine Electrical Code

9. Philippine National Standard (PNS)

BS	(2002) Bureau of Standard

7.7.1.2 DEFINITIONS

7.7.1.2.1 AVERAGE LIFE

Time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

7.7.1.2.2 GROUNDLINE SECTION

That portion between 300 mm above and 600 mm below the groundline.

7.7.1.3 SUBMITTALS

Submit the following.

1. Shop Drawings

   a. Luminaire drawings

   b. Poles

2. Product Data

   a. Luminaires
   b. Lamps
   c. Ballasts
   d. Lighting contactor
   e. Photocell switch
   f. Steel poles
   g. Brackets

3. Samples

    a. Luminaires

        Submit one sample of each luminaire type, complete with lamp and ballast.

4. Test Reports

    a. Test Data for luminaires

7.7.1.4 QUALITY ASSURANCE

7.7.1.4.1 DRAWING REQUIREMENTS

1. Luminaire Drawings

    Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and computerized candlepower distribution data shall accompany shop drawings.

2. Poles

    Include dimensions, wind load determined in accordance with AASHTO LTS-3, pole deflection, pole class, and other applicable information.

7.7.1.4.2 TEST DATA FOR LUMINAIRES

1. Distribution data according to IES classification type as defined in IES LHBK.

2. Computerized horizontal illumination levels in lux at ground level, taken every 3000 mm. Include average maintained lux level and maximum and minimum ratio.

7.7.1.5 DELIVERY, STORAGE, AND HANDLING

7.7.1.5.1 STEEL POLES

Do not store poles on ground. Support poles so they are at least 305 mm above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

7.7.2 MATERIAL REQUIREMENTS

7.7.2.1 PRODUCT COORDINATION

Products and materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 7.4, "Underground Electrical Works".

7.7.2.2 LUMINAIRES

ANSI C136.14 or UL 1572. Provide luminaires as indicated. Provide luminaires complete with lamps of number, type, and wattage indicated. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs, light distribution and brightness characteristics, and of equal finish and quality will be acceptable as approved.

7.7.2.2.1 LAMPS: PROVIDE THE TYPE AND WATTAGE AS INDICATED.

1. Ballasts for High Intensity Discharge (HID) Luminaires

   UL 1029 and ANSI C82.4, and shall be constant wattage autotransformer (CWA) or regulator, high power-factor type. Provide single-lamp ballasts which shall have a minimum starting temperature of minus 30°C. Ballasts shall be:

   a. Designed to operate on voltage system to which they are connected.

   b. Constructed so that open circuit operation will not reduce the average life.

   HPS ballasts shall have a solid-state igniter/starter with an average life in the pulsing mode of 3500 hours at the intended ambient temperature. Igniter case temperature shall not exceed 90°C.

2. Floodlight Fixtures

   Floodlight fixture is in heavy duty weather resistant, a die cast aluminum housing with hinged, removable and gasketed front housing and captive screws for relampimg access, integral ballast, optical assembly with provisions for vertically or horizontally mounted lamp, an adjustable aiming stops and built -in rifle sight for daytime aiming, ballast shall be mounted on the back housing and shall be prewired to the lamp socket, terminal board and ignitor or equivalent.

HPI-T 1000W lamp are single ended metal halide lamps consisting of a quartz discharge tube , containing high pressure mercury and a mixture of metal halides, which is housed in a hard glass outer envelope , fitted with a standard screw base. They offer a unique combination of a natural white colour appearance, and high luminous efficacy both initially and through their long lives, giving many years of reliable operation, and making them an ideal lamp choice for many applications. The high luminous efficacy reduces the number of luminaries needed, minimizing installation and energy cost, while excellent lumen maintenance and lamp life ensures high maintained illuminance levels and minimal maintenance costs. The colour points is on the black body locus giving a natural white light colour appearance. This combined with good colour rendering makes it easy to distinguish colours and ensures a pleasant ambience and user comfort.

7.7.2.3 LIGHTING CONTACTOR

NEMA ICS 2, electrically held contactor. Contacts shall be rated 240 volts, 20 amperes, and 2 poles. Coils shall be rated 240 volts. Provide in NEMA 3R enclosure conforming to NEMA ICS 6. Contactor shall have silver alloy double-break contacts and shall require no arcing contacts. Provide contactor with hand-off-automatic selector switch. Contactor shall be hermetically sealed.

7.7.2.4 PHOTOCELL SWITCH

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated 240 volts ac, 60 Hz with single pole double-throw (spdt) contacts for mechanically held contactors rated 1000 watts. Switch shall turn on at or below 30 lux and off at 30 to 100 lux. A time delay shall prevent accidental switching from transient light sources. Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition.

7.7.2.5 POLES

Provide poles designed for wind loading of [175] km/hr determined in accordance with AASHTO LTS-3 while supporting luminaires having effective projected areas indicated. Poles shall be anchor-base type designed for use with underground supply conductors. Poles, shall have oval-shaped handhole having a minimum clear opening of 65 by 130 mm. Handhole cover shall be secured by stainless steel captive screws.

7.7.2.5.1 STEEL POLES

AASHTO LTS-3. Provide steel poles having minimum 11-gage steel with minimum yield/strength of 331 MPa and hot-dipped galvanized in accordance with ASTM A123/A123M factory finish. Provide a pole

grounding connection designed to prevent electrolysis when used with copper ground wire. Base covers for steel poles shall be structural quality hot-rolled carbon steel plate having a minimum yield of 248 MPa.

7.7.2.6 POLE FOUNDATIONS

Anchor bolts shall be steel rod having a minimum yield strength of 344.5 MPa; the top 305 mm of the rod shall be galvanized in accordance with ASTM A153/A153M.

7.7.2.7 HIGH MAST TOWER

The high mast tower shall be transported by the contractor to the erection sites at his expenses and responsibility and shall be handled with care to avoid bending or damaged to the galvanizing. Materials on which galvanizing have been damage shall be re-dipped unless in the opinion of the Engineer the damage is local and can be repaired by painting with at least two (2) coats of zinc paint. The repair shall be made by and at the expense of the contractor. The number of floodlight fixtures pre-required as shown in the plan.

Detail connection of high mast tower as shown in the plan. Anchor bolts to be stainless steel or galvanized steel and designed and provided by the high mast tower manufacturer to ensure that the high mast tower and anchor bolts assembly capacity meets all the stresses composed of wind, luminaires weight and live load of maintenance personnel.

Protective coating for the high mast tower as be as follows:

1. Galvanizing Preparation

   All mild steel parts exposed to weather shall be hot-dipped galvanized after fabrication as shown in the approved plan or directed by the Engineer in accordance with the requirements if JIS H88641. Prior to galvanizing, the surface shall be cleaned of dirt, weld splatter, grease, slag, oil, paint or other deleterious matters. The steel surfaces shall be chemically descaled and cleaned with abrasive blast or other suitable method as approved by the Engineer.

2. Coating

   The zinc coating shall consist of uniform layer of commercially pure zinc free from abrasions, cracks, blisters, chemical spots or other imperfections, and shall adhere firmly to the surface of the steel. *The weight of the zinc coating per square meter of actual surface shall not be less than 550 grams.* Any surface damaged subsequent to galvanizing shall be given two coats of approved zinc paint.

3. Painting of Galvanize Steel Work

Hot-dipped galvanized high mast tower are to be treated at the works with an appropriate zinc chromate two packs etch primer followed by one coat of non-etch zinc chromate primer and one coat of micaceous iron oxide paint before shipment. On site damage to the coating is to be repaired and a final coat of micaceous iron oxide is to be applied after erection, generally in accordance with the specifications for shot blasted steel.

Manufacturer must submit a warranty for the corrosion resistant cladding material against manufacturing defects for a period of one (1) year from the date of original purchase.

7.7.3 EXECUTION

7.7.3.1 INSTALLATION OF POLES

IEEE C2, NFPA 70, PEC and to the requirements specified herein.

7.7.3.1.1 STEEL

Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 1.57 rad at the bottom end. Provide galvanized nuts, washers, and ornamental covers for anchor bolts. Concrete for anchor bases, polyvinyl chloride (PVC) conduit ells, and ground rods shall be as specified in Section 7.4, "Underground Electrical Works." Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.

7.7.3.1.2 POLE SETTING

Depth shall be as indicated.

7.7.3.1.3 PHOTOCELL SWITCH AIMING

Aim switch according to manufacturer's recommendations.

7.7.3.2 INSTALLATION OF HIGH MAST TOWER (METHOD OF ERECTION)

The Contractor shall use standard and accepted practice and methods of erecting the high mast tower depending upon their location. The high mast tower shall be erected by the Contractor in accordance with the structure list and the erection diagrams prepared by the high mast tower manufacturer.

The high mast tower may be erected by assembling in sections on the ground and hoisting successive sections in place, or they may be build-up in place individual members at the option of the Contractor. If erected by assembling in sections, not less than fifty percent (50%) of all bolting in place shall be done on each section before starting another section. All bolts shall be drawn up tight but not to such a degree as to endanger the strength of the bolt. All nuts shall be locked in place. All bolts ends below three (3) meters above ground should be flattened to prevent the nut from being taken out from the bolt. Only wrenches approved by the Engineer shall be used on the work, and the use of any wrench that may deform the nut or cut or flake the galvanizing shall not be permitted.

A reasonable amount of drifting shall be allowed in assembling but reaming for correction of mismatched holes due to shop errors shall be permitted. If any shop error in the steel is discovered, the Contractor shall notify the Engineer, who will decide whether the errors may be corrected in the field or the members returned to the manufacturer for correction or replacement. Galvanized damaged during the corrections of shop errors shall be repaired in accordance with the plans/ specifications.

Final inspection of the high mast tower shall be made by the Engineer who shall make and report all loose bolts and other errors in erection, and shall make sure all bolts are in place and are tightened properly and that all nuts are locked properly.

The high mast tower shall be erected so that any portion of the high mast tower shall be in correct position relative to the high mast tower vertical center line, which shall not deviate from any plumb by more than 0.2% of height in either the transverse or longitudinal direction.

Construction of reinforced concrete high mast tower foundation and handhole shall be in accordance with all the details in the plan.

Excavations / backfilling required before /after installation of high mast tower and concrete pedestal post shall conform to the provisions of Earthwork and Concrete Construction.

Concrete Pedestal Post shall be reinforced concrete with appropriate weatherproof fittings as constructed as shown in the approved plan. Reinforced concrete materials shall conform to the requirements of concrete. Concrete shall be of 210kg/cm^2 compressive strength.

Metering: the local utility company shall be responsible for the supply and installation of metering equipment, and its accessories, but it is part of the contractor responsibility and expense to coordinate with them on this regard.

7.7.3.3 GROUNDING

Ground noncurrent-carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 7.4, "Underground Electrical Works." Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

7.7.3.4 FIELD QUALITY CONTROL

Upon completion of installation, conduct an operating test to show that the equipment operates in accordance with the requirements

7.7.4 MEASUREMENT AND PAYMENT

7.7.4.1 CONDUCTOR WIRE

The quantity of conductor wire installed to be measured and paid for shall be in linear meters installed complete including splicing and other appurtenant items and incidentals and certified by the Engineer for full payment.

7.7.4.2 CONDUITS

The quantity of conduits shall be measured and paid in linear meter of each size and type of conduit materials installed complete including jointing, bends, fittings, locknut bushing, supports, adaptor, coupling and all other incidentals and appurtenances. It shall be certified by the Engineer for full payment.

7.7.4.3 CONCRETE ENCASEMENT

The quantity of concrete encasement for conduits shall be measured and paid in cubic meter of concrete placed and accepted by the Engineer. Payment shall be full compensation for all labor, material and equipment and other incidental necessary to complete the work. Earthwork shall be included in the unit cost of concrete encasement.

7.7.4.4 POLES

The quantity to be measured and paid for poles in the perimeter, parking area and roadway floodlight shall be by the number of sets of poles which include the steel mast, reinforced concrete foundation and accessories installed complete and certified by the Engineer for full payment.

7.7.4.5 LIGHTING FIXTURES FOR AREA, ROADWAY AND FLOOD LIGHTING

The quantity of lighting fixtures to be measured and paid for shall be in the number of sets of each type of lighting fixtures, panels and accessories supplied and installed complete, operational and certified for full payment by the Engineer.

7.7.4.6 PERIMETER AND PARKING AREA LIGHTING

The perimeter lighting shall be measured and paid for by the number of sets of lighting fixtures supplied and installed which include the pipe extension, and accessories installed complete, operational and certified by the Engineer for full payment.

7.8 GROUNDING SYSTEM AND LIGHTNING PROTECTION

7.8.1 PART 1 – GENERAL

7.8.1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. American National Standards Institute (ANSI)

ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

2. Institute Of Electrical And Electronics Engineers (IEEE)

IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Potentials of a Ground System

3. National Fire Protection Association (NFPA)

NFPA 70	(2007) National Electrical Code
NFPA 780	(2007) Lightning Protection Code

4. Underwriters Laboratories (UL)

UL Elec Const Dir	(2007) Electrical Construction Materials Directory

UL 96	(2005) Lightning Protection Components
UL 96A	(2007) Installation Requirements for Lightning Protection Systems
UL 467	(2007) Grounding and Bonding Equipment

5. Institute of Integrated Electrical Engineer (IIEE)

PEC	(2002) Philippine Electrical Code

6. Philippine National Standard (PNS)

BS	(2002) Bureau of Standard

7.8.1.2 RELATED REQUIREMENTS

Section 7.1, "Electrical General Requirements," applies to this section with additions and modifications specified herein.

1. System Requirements

   Materials shall consist of standard products of a manufacturer regularly engaged in production of lightning protection systems and shall be manufacturer's latest UL approved design. Lightning protection system shall conform to PEC, NFPA 70, NFPA 780, UL 96 and UL 96A.

7.8.1.3 SUBMITTALS

1. Shop Drawings

   Overall lightning protection system

   Each ***major*** component

2. Test Reports

   Grounding system test

   Lightning protection system inspection

3. Certificates

   UL listing or label

7.8.1.4 QUALITY ASSURANCE

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears.

1. Installation Drawings

   a. Submit installation shop drawing for the overall lightning protection system. Drawings shall include physical layout of the equipment, mounting details, relationship to other parts of the work, and wiring diagram.

   b. Submit detail drawings for each major component to include manufacturer's descriptive and technical literature, catalog cuts, and installation instructions.

2. UL Listing or Label

   Submit proof of compliance. Label of or listing in UL Elec Const Dir is acceptable evidence. In lieu of label or listing, submit written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that items have been tested and conform to requirements and testing methods of Underwriters Laboratories.

7.8.1.5 SITE CONDITIONS

Contractor will become familiar with details of the work, verify dimensions in the field, and advise the Engineer of discrepancies before performing work. Deviations from contract drawings will not be made without prior approval of the Engineer.

7.8.2 MATERIAL REQUIREMENTS

7.8.2.1 MATERIALS

Do not use a combination of materials that forms an electrolytic couple of such nature that corrosion is accelerated in presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, provide conductors with protective coatings or oversize conductors. Where mechanical hazard is involved, increase conductor size to compensate for hazard or protect conductors by covering them with or tubing made of nonmagnetic material.

1. Main and Bonding Conductors

   NFPA 780 and UL 96

2. Copper

   Provide copper conductors on nonmetallic stacks that do not weigh less than 144.83 kg per 300 meters, and provide cable such that the size of any strand in the cable is not less than 2 mm2.

7.8.2.2 COMPONENTS

1. Air Terminals

   Provide terminals in accordance with UL 96. Support air terminals by suitable brace, with guides, not less than one-half the height of the terminal.

2. Ground Rods

   Provide ground rods made of copper-clad steel conforming UL 467. Provide ground rods that are not less than 20 mm in diameter and 3000 mm in length. Do not mix ground rods of copper-clad steel, stainless steel, galvanized ferrous, or solid copper on the job.

3. Connections and Terminations

   Provide connectors for splicing conductors that conform to UL 96, class as applicable. Conductor connections can be made by clamps or welds (including exothermic). Provide style and size connectors required for the installation.

4. Connector Fittings

   Provide connector fittings for "end-to-end", "Tee", or "Y" splices that conform to NFPA 780.

5. Lightning Protection Components

   Provide bonding plates, air terminal supports, clips, and fasteners that conform to UL 96 classes as applicable.

7.8.3 EXECUTION

7.8.3.1 INTEGRAL SYSTEM

Lightning protection system consists of air terminals, down conductors, ground connections, grounding electrodes and ground loop conductor. Electrically interconnect lightning protection system to form the shortest distance to ground. Do not use non-conducting parts of the structure as part of the building's lightning protection system. Conductors are required to be in protective sleeves.

1. Air Terminals

Air terminal design and support conforming to NFPA 780. Rigidly connect terminals to, and make electrically continuous with, down conductors by means of pressure connectors or crimped joints of T-shaped malleable metal. Provide pressure connector or crimped joint with a dowel or threaded fitting to connect ground rod conductor with air terminal. Set air terminals at ends of structures not more than 610 mm from ends of ridges. Where nonmetallic spires, is present, mount air terminals to the side. In addition, where spires project more than 3050 mm above the building, continue conductor from air terminal to nearest down conductor securely connect thereto.

2. Down Conductors

Make down conductors electrically continuous from air terminals to grounding electrodes. Equally and symmetrically spaced down conductors about the perimeter of the structure. Protect conductors where necessary, to prevent physical damage or displacement to the conductor.

a. Ground Connections

Securely connect conductor forming continuations of down conductors from structure to grounding electrode in a manner to ensure electrical continuity between the two. Provide clamp type connections or welds (including exothermic) for continuation. Attach down conductor to ground rods by welding including exothermic, brazing, or clamping. Provide clamps suitable for direct burial. Protect ground connection from mechanical injury. In making ground connections, take advantage of all permanently moist places where practicable, although avoid such places when area is wet with waste water that contains chemical substances, especially those corrosive to metal.

b. Grounding Electrodes

Provide grounding electrode for down conductor. Extend driven ground rods into the existing undisturbed earth for a distance of not less 3050 mm. Set ground rods less than 610 mm nor more than 3050 mm, from the structure. After the completed installation, measure the total resistance to ground using the fall-of-potential method described in IEEE Std 81. Maximum resistance of a driven ground rod shall be 10 ohms, under normally dry conditions. Make connections between ground conductors and grounds or electrically continuous.

7.8.3.2 FIELD QUALITY CONTROL

1. Grounding System Test

Test the grounding system to ensure continuity and that resistance to ground is not in excess of 10 ohms. Test the ground rod for resistance to ground before making connections to the rod. Tie the grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Include in the written report: locations of ground rods, resistance, and soil conditions at the time that measurements were made. Submit results of each test to the Engineer.

2. Lightning Protection System Inspection

Make visual inspections to verify that there are no loose connections which may result in high resistance joints, and that conductors and system components are securely fastened to their mounting surfaces and are protected against accidental mechanical displacement.

7.8.4 MEASUREMENT AND PAYMENT

Quantity for grounding rod to be measured and paid shall be in number of ground rod supplied, installed, tested and certified for full payment by the Engineer.

Quantity for grounding wire to be measured and paid for shall be in linear meter of wire supplied, installed, tested and certified for dull payment by the Engineer.

Payment stated above shall be full compensation for all labor, materials, equipment, tests and reports and all incidental works and accessories necessary to make the system operation.