

SECTION 21300 PORTLAND CEMENT CONCRETE PAVEMENT

- 21301 Scope of Work**
- a) The work under this Section to be carried out by the Contractor, consists of the execution and completion of Portland Cement Concrete Pavement to all required areas.
 - b) Portland Cement Concrete Pavement shall be provided by the Contractor to all areas of the Engineers Design as indicated on the Drawings.
 - c) Portland Cement Concrete Pavement shall be provided by the Contractor to main road and container yard areas.
 - d) Portland Cement Concrete Pavement shall include the construction of Portland cement concrete pavement on prepared base course, including the provision of all materials and equipment, mixing, hauling, placing, compacting and finishing to meet the requirements of strength, location, thickness, line, and grade designated in the Drawings and as specified herein.
 - e) The Portland cement concrete mix is to be designed by the Contractor to achieve the designated strength using materials that comply with the characteristics as specified herein.
 - f) Prior to commencement of the Portland cement concrete pavement the Contractor shall secure the Engineer's approval for the materials to be used, the design of the concrete mix and the equipment to be used and the methods of work execution.
- 21302 Materials**
- a) All coarse and fine aggregates, cement, water and admixtures shall be in accordance with Section 21200 Asphalt Concrete Pavement.
 - b) All reinforcement and dowel bars shall be in accordance with Section 20200: Materials.
 - c) Crusher Run for Subbase Course shall be placed in accordance with the requirements for layer thickness designated on the Drawings or as directed by the Engineer.
 - d) **Joint Filler**
Joint Filler shall be well adaptable to expansion and contraction of concrete slabs, and shall be durable without permanently collapsed or deformed.
The joint filler shall meet the requirements of the size as designated in the Drawings, and shall satisfy the following requirements:

	Foam Rubber Material	Wood or Bituminous Material
Stress to compress the filler by 50% in thickness (kgf/cm ²);	2-5	20-100
Recovery from 50% compression in 10 minutes;	95% or more	65% or more
Protrusion when compressed by 50% (mm);	4 or less	4 or less

e) Joint Sealer

Joint filler, packing and sealants shall be well adaptable to expansion and contraction of concrete slabs, resistant to water, oil and fuel and to the approval of the Engineer. It shall also be durable to withstand hot weather and impact caused by operation of the work and have high adhesive qualities. Joint seals shall be complete with approved type of backing cord.

f) Steel Material

Tie bars and steel mesh shall be deformed bars. Dowel bars shall be perfectly straight. Size of the steel bars shall be in accordance with the requirements designated in the Drawings.

g) Separation Layer

The separation layer shall be durable and easy to handle.

The separation layer shall be polyethylene film or kraft building paper to be approved by the Engineer.

h) Cover Material for Curing

The curing materials shall conform to one of the following requirements:

Liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C 309 TYPE 2.

White polyethylene film for curing concrete shall conform to the requirements of ASTM C171.

White burlap polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C 171.

Waterproof paper for curing concrete shall conform to the requirements of ASTM C 171.

**21303
Construction
Requirements**

21303.1 Foundations

The foundation bed shall be prepared and compacted in accordance with the requirements of the drawings and applicable requirements of the specifications. Any unsuitable material encountered shall be removed and replaced with selected filling provided to the approval of the Engineer, at the Contractors expense.

Routs, depressions or other damage cause to the underlying granular base course shall be repaired to the satisfaction of the Engineer before and concrete works commence.

The foundation shall be approved by the Engineer before placing the aggregate or concrete layers.

21303.2 Form Works

Sufficient straight side forms shall be securely set in advance of concrete placement to ensure continuous paving operations. Forms shall be made of steel and have sufficient rigidity to withstand impact and vibration loads from the concrete finishing and vibration operations without distortion and movement. Forms shall be cleaned and oiled prior to concrete placement.

21303.3 Concrete Works

Concrete shall be placed to the sections and dimensions indicated on the drawings. Concrete shall be placed on the prepared base course with the minimum of handling and shall be continuous, with no intermediate forms installed at joint locations. Any necessary manual spreading shall be done with shovels and not rakes.

21303.4 Strike-off, Consolidation and Finishing

- a) The sequence of operations shall be strike off and consolidation, floating and removal of laitance, straight edging and final surface finish. The addition of water to the surface concrete to assist finishing operations shall not be permitted.
- b) Once concrete has been manually spread and vibrated it shall then be struck off and screeded by an approved finishing machine without displacing side forms or joint assemblies. The finishing machine shall:
 - be equipped with immersed tube or multiple spud vibrators over its full width, and a tachometer or other device for measuring the frequency of vibrators,
 - have sufficient eccentric weights fitted to achieve an acceptable concrete density and quality,
 - have one or more oscillating-type transverse screeds.
- (c) When the finisher is travelling on the forms it shall not lift or deviate off line to such an extent as to adversely affect the surface finish.
- (d) The screed on the finisher shall move with a combined longitudinal and transverse shearing motion and produce a surface that is uniform in texture, free of porous areas and to the elevations and grades shown on the Drawings. Excessive operation in one area should be avoided.
- (e) After the concrete has been struck off and consolidated by the finishing machine the surface shall be further regulated by using either a manual or mechanical float. After floating, any excess water and laitance shall be removed from the pavement surface using a straight edge not less than 3m long.
- (f) The surface finish of the pavement shall be formed by brooming, when the water sheen has practically disappeared from the surface. The brooming operation shall be carried out in a transverse direction and form corrugations that are uniform in appearance and approximately 2mm deep. The equipment

used shall not unduly roughen or tear the surface, and any damage caused shall be repaired immediately by the Contractor.

21303.5 Joints

All joints shall be constructed true to line and locations indicated on the drawings. The faces of expansion and construction joints shall be vertical. Each day's concreting operations should be planned to terminate at a designated joint location.

a) Contraction joints

Timber crack inducer forms shall be securely and accurately positioned for the full width of the slab before concrete operations start. Care must be taken to ensure that these are not broken or displaced while concrete is being placed and finished.

The surface groove shall be formed by accurately sawing a straight transverse line directly above the timber crack inducer to the dimensions shown on the Drawings.

Sawing shall commence as soon as concrete has hardened sufficiently to permit cutting without chipping, spalling or tearing along the formed groove.

(b) Expansion Joints

Dowel bars shall be securely and accurately fixed using a dowel assembly which will remain in the pavement and ensure that dowels are not displaced during construction.

Pre-moulded joint filler shall be securely fixed, to the dimensions and locations shown on the Drawings, so that displacement is not possible during concreting operations.

The groove for the joint sealer shall be formed by a timber fillet, fixed securely in place on top of the filler before concrete works commence.

c) Construction Joints

Construction joints shall be installed when concrete placement is interrupted for more than 30 minutes. Construction joints shall be formed in the same way as contraction joints.

21303.6 Curing

a) Curing of the concrete shall be in accordance with Section 20300.

b) Side forms shall not be removed for at least 24 hours, and these shall be carefully removed to avoid damage to the concrete. Curing of vertical concrete faces shall begin immediately side forms are removed.

21303.7 Backfilling

a) On completion of the structure, backfilling shall be undertaken in compacted layers with materials approved by the Engineer, to the grade and elevation as designated in the Drawings. Each layer shall not exceed 25 cm unless otherwise specified up to the level required for subsequent permanent works, with equipment approved by the Engineer.

- b) The backfilling shall not be carried out until 7 days after the concrete has been placed, or the concrete has attained sufficient strength to withstand shocks or strain exerted by the backfilling or compaction equipment.

**21304 Control of
Traffic on
Completed
Work**

- a) The Contractor shall be responsible for controlling and directing vehicles on the completed concrete pavement to avoid damage.
- b) Any damage occurring to the concrete pavement prior to final acceptance shall be repaired, or the concrete replaced, at the Contractor's expense and to the engineers satisfaction.

**21305 Quality
and
Workmanship
Standards**

21305.1 Quality Standards

The quality shall satisfy the standard values shown in Table 21300 -1.

21305.2 Workmanship Standards

The allowable workmanship and construction tolerances shall be as shown in Table 21300 - 2.

Table 21300-1
Quality Control and Testing Requirements

Location	Test Item	Test Method	Frequency	Standard values		
Raw Materials	Cement	ASTM C-150 & BS 196	Once every delivery to Site or change of supplier	To comply with BS 12 Portland cement		
	Aggregates	ASTM C-33	Once every 1,500m ³ delivered to Site	As Tables 20200.1		
	• Gradation					
	• Abrasion			less than 35%		
	• Soundness	ASTM C-33	Once every 1,500m ³ delivered to Site	less than 12%		
	• Deleterious material	ASTM C-33	Once every 1,500m ³ delivered to Site	Characteristic	Max. Value %	
					Fine	Coarse
	Clay Lump				1.0	0.25
	Loss in Test				3.0	3.0
			Lightweight Material	0.5	0.5	
	Proportioning in place	As approved by the Engineer	At every material change			
Mixing Plant	Accuracy of scales	As approved by the Engineer	Once a week or as directed by the Engineer	± 0.5% throughout range		
	Moisture content of aggregates	ASTM C-33	for fine aggregate – morning and afternoon for coarse aggregate – once a day			
	Gradation of aggregates	ASTM C-33	Once a day from each bin	As Tables 20200.1		
	Deleterious material	ASTM C-33	As instructed by the Engineer	As above		
Construction	Slump	ASTM C-1077	As instructed by the Engineer	5cm ± 1cm		
	Compressive strength	ASTM C-1077	9 samples a day from one delivery	3 samples for 7-day strength 3 samples for 28-day strength 3 samples for possible re-test		
	Air content	BS 1881 Part: 106	Once every morning and afternoon	Range 4% to 6%		

Table 21300-2

Portland Cement Pavement Construction Tolerances

Work Item	Characteristic to be Checked	Method	Frequency	Allowable Construction Tolerance	Note
Road Pavement	Width	Survey or measurement	As directed by the Engineer	+ 30mm - 20mm	
	Thickness of layer	Core	Once every 1,000m ²	+ not specified - 5mm	
	Level of surface	Survey	As directed by the Engineer	± 10mm	
	Surface irregularity	Measurement	As directed by the Engineer	10mm	Measured using a 3m straight edge

SECTION 21400 INTERLOCKING CONCRETE BLOCK PAVEMENT

21401

Scope of Work

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of Interlocking Concrete Block Pavement to all required areas.
- b) Interlocking Concrete Block Pavement shall be provided by the Contractor to all areas of the Engineers Design as indicated on the Drawings.
- c) Interlocking Concrete Block Pavement shall be provided by the Contractor to all sidewalks.
- d) Construction details, materials and workmanship for the Contractor design portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- e) Interlocking Concrete Block Pavement shall include the provision and laying of interlocking concrete blocks, on prepared base course, including the provision of all materials and equipment, placing, jointing, compacting and finishing to meet the requirements of strength, location, thickness, line, and grade designated in the Drawings and as specified herein.
- f) Prior to commencement of the concrete pavement the Contractor shall secure the Engineer's approval for the materials to be used, the design of the concrete mix and the equipment to be used and the methods of work execution.

21402

Interlocking Concrete Blocks (ICB)

- a) **Shape and Dimensions**
Interlocking concrete shall be rectangular in shape and dimensions as indicated on the Drawings.
- b) **Concrete Blocks**
Concrete blocks shall meet the following requirements in accordance with Section 20300.

Compressive Strength : Not less than 25 N/mm² at 28 days.
- c) **Manufacturing Tolerances**
 - Thickness ± 3 mm from the indicated figures
 - Other dimensions ± 2 mm from the indicated dimension
- d) **Sampling and Testing**
The following number of test specimens of concrete blocks shall be taken for testing as selected at random from every 5,000 units.
 - Compressive Strength Test 10 specimens
 - Flexural Strength Test 5 specimens

•Abrasion Index Test 5 specimens

**21403
 Construction**

- a) Precast concrete edge strip or cast-in-situ-concrete edge strip shall be used, but the cast-in-situ concrete edge strip shall be cured for at least 14 days before adjacent block work is commenced. Concrete edge strip shall be depressed curb, vertical curb or curb and gutter.
- b) A laying course of sharp sand shall be laid over the base course to such thickness that after compaction the sand thickness shall be 20 mm. The sand shall not contain more than 3% of silt and clay by weight, with not more than 15% retained on a 2.0 mm sieve. The sand shall be uniform in both type and moisture content, and shall be spread to a smooth level without uneven pre-compaction.
- c) A layer of sand shall be evenly spread and leveled over the Base Course as shown on the Drawing, before Interlocking Blocks are placed. The interlocking Blocks shall be carefully placed so that the sidewalk looks well harmonized as a whole. After placing the Interlocking Blocks, sand shall be evenly spread for packing materials between them and shall be compacted by means of approved compaction equipment.
- d) Blocks shall be laid to their final level with a plate vibrator. The vibrator shall have a plate area between 0.2 and 0.3 square meters, and a centrifugal force of about 10 kilo-newtons. The vibrator shall be guided over the whole area avoiding unrestrained edges by not less than two meters. The blocks shall be vibrated until no further settlement occurs.
- e) After initial vibration, sand shall be brushed evenly over the surface of the blocks at the rate of 1 m² per 500 m² and vibrated into the joints with a further three passes of the plate vibrator. After all joint are filled, surplus sand shall be swept away and disposed of.
- f) Tolerance

The finished surface of the blockwork on completion of the construction shall comply with the following tolerances:

- Level : Within ± 25 mm
- Maximum deviation from 3 meter straight edge : 5 mm
- The algebraic difference of the deviations from the specified level at any two points les than 50 meters apart shall not exceed : 20 mm
- Blockwork that fails to comply with these requirements shall be taken up and relaid.
- Gaps of less than 40 mm at an edge shall be filled with a 3 to 1 sand/cement mortar.

**21404
 Spare Blocks**

- (1) The following number of interlocking concrete blocks (ICB) shall be provided by the Contractor upon completion of the Works and stored as spare blocks at the location designated by the Employer and the quality shall be to the satisfaction of the engineer

ICB... ..500 Nos.

- (2) Delivery of such spare blocks shall be made not later than 30 days after issuance of Taking-Over Certificate for that section of the Works includes the paving works, and appropriate measures for the protection of stocked spare blocks shall be made as directed by the Engineer.

SECTION 21450 MACADAM PAVEMENT

21451 Scope of Work

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of Macadam Pavement to all required areas.
- b) Macadam Pavement shall be provided by the Contractor to all areas of the Engineers Design as indicated on the Drawings.
- c) Macadam Pavement shall be provided by the Contractor to open storage for multi-purpose berth, truck parking and empty container yard in container yard and open storage for vehicles, etc.
- d) Construction details, materials and workmanship for the Contractor design portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- e) Macadam Pavement shall include the provision and spreading of asphalt bituminous, on prepared base course, including the provision of all materials and equipment, placing, jointing, compacting and finishing to meet the requirements of strength, location, thickness, line, and grade designated in the Drawings and as specified herein.
- f) Prior to commencement of the asphalt pavement the Contractor shall secure the Engineer's approval for the materials to be used, the design of the concrete mix and the equipment to be used and the methods of work execution.

21452 Material

- a) Coarse Aggregate and Fine Aggregate

All coarse and fine aggregate shall be in accordance with Section 21200 Asphalt Concrete Pavement.

Material used in the insulation course shall be either coarse sand or coarse screening. Screening shall consist of tough, durable particles of crushed stone. Installation material shall be free from dirt and other objectionable material.

- b) Screening Material

Screening material shall be crushed stone, free from dirt and other objectionable material and shall have the following gradation;

Passing 20 mm sieve	100 %
Passing 10 mm sieve, not more than	75 %

- c) Asphalts

Hot asphalt mix shall be in accordance with Section 21200 Asphalt Concrete Pavement.

21453 Weighing

All materials shall be weighted on an accurate and reliable platform scale, approved by Engineer.

21454 Inspection

All materials and work shall be subject to inspection at all time by the Engineer, or his duly authorized representative, and no materials shall be delivered or accepted nor work performed without proper authorization of the Engineer.

**21455
Equipment**

All equipment, tools, machinery and other appliances used in handling materials and performing any part of the work shall be subject to the approval of the Engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the Engineer.

Rollers and compactors shall include self-powered three (3) wheeled and tandem steel rollers and self-propelled pneumatic-tired rollers, weighing not less than seven (7) nor more than ten (10) tons, and multiple vibratory compactors of approved design.

Steel-wheeled rollers shall be equipped with scrapers to keep the surface of the wheels clean. All rollers and compactors shall be equipped with devices to wet the wheels, or contract surface, to prevent the material being compacted from sticking to them.

**21456
Construction**

a) Preparing and Compacting Subgrade

Preparing and compacting subgrade shall be in accordance with Section 21200 Asphalt Concrete Pavement.

b) Spreading and Compacting Coarse Stone

Spreading and compacting coarse stone shall be in accordance with Section 21200 Asphalt Concrete Pavement.

c) Application of Asphalt

Hot asphalt, as specified hereinbefore, shall be applied on each course of rolled base at the uniform rate of six (6) liters per square meter at application temperature with an allowable tolerance of 0.30 liter per square meter plus or minus. Every precaution shall be used to avoid lapping either along the edges or at the ends of successive application runs.

d) Spreading and Compacting Succeeding Courses of Base Aggregate

Succeeding course of base aggregate shall be spread, compacted and finished in the same manner and to the same tolerances as hereinbefore specified for the first course.

e) Screening

Immediately after the asphaltic cement has been applied to the final course of the base aggregate and while it is yet warm, screening of crushed rock, as specified hereinbefore, shall be spread over the surface in just sufficient quantity to fill the surface interstices. This stone shall be spread by means of an approved mechanical spreader at the rate of not more than Thirteen (13) kg per square meter. Any cover material remaining unbounded on the pavement shall be swept up and removed. The top surface of the asphalt coated coarse stone of the final base course shall be exposed upon completion of the cleaning operation to provide a secure bond for the asphaltic concrete surface course to follow.

SECTION 21500 STORM DRAINAGE WORKS

21501 General

This Section covers drainage works, including pipe culverts, trenches, diversion drainage, manholes and gratings for the Project.

These works shall be constructed to the lines, grades and dimensions indicated on the Drawings or as directed by the Engineer.

Unless otherwise specified in this Section all earth works required for these works shall comply with applicable Section 20600.

21502 Pipe Culvert

21502.1 Scope of Work

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of Culverts.
- b) Prior to commencement of these works, the Contractor shall obtain the approval of the Engineer on the material to be used, the design of the concrete mixes, the equipment to be used and the methods of work execution. No materials shall be used or installed until the Contractor has been notified by the Engineer of his approval.
- c) Culverts are to be provided to the areas of the Engineer's Design i.e. underneath the Road, Container Yard, Multi-Purpose Yard and so on, as indicated on the Drawings.
- d) Construction details, materials and workmanship for the Contractor design portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- e) All work shall be in accordance with the strength, location, dimension, line elevation and finish designated in the Drawings and as specified herein.

21501.2 Materials

- a) Crushed Stone

Crushed stone shall be placed in accordance with the requirements for layer thickness designated on the Drawings or as directed by the Engineer. The crushed stone, shall meet the requirements specified in Section 20200: Granular Base and be compacted to not less than 90 % of the maximum dry density

- b) Backfilling

Backfill shall meet the requirements of Section 20600.

21502.3 Construction Requirements

- a) General

All Excavation work shall be in accordance with the provisions of Section 20600 Structural Excavation.

Foundation beds shall be prepared and compacted in accordance with requirements of the drawings and applicable requirements of the Specification. Any unsuitable material encountered shall be removed and replaced with selected filling, to the approval of the Engineer at the expense

of the Contractor.

Foundation bed shall be compacted to meet the following requirements:

- For non-cohesive soils, not less than 90% of the maximum dry density.

The formation of excavations shall be approved by the Engineer before placing the gravel or concrete layers.

b) Laying and Installing Pipes

The Contractor shall provide concrete shaped supports to sustain the barrel of the pipe during laying or excavate pockets to accommodate pipe sockets and to ensure fully and evenly maintain installation of pipes to the line and grade designated in the Drawings.

Equipment for placing the pipe into trench or for backfilling, shall not damage or disturb the pipe or the trench.

The Engineer will inspect all pipes before they are laid, and may reject any pipe that has been damaged by handling or which is defective in any way that will adversely affect the durability or service of the pipe.

The upper end of pipelines not terminating in a structure shall be plugged or capped after each day's work.

Pipes not laid to a true level, gradient or alignment, or which show settlement on inspection, shall be removed and replaced at the Contractor's expense.

The Contractor shall allow, for all temporary diversion of stream, waterways or the like to ensure that installation is always carried out under dry conditions.

c) Backfilling

On completion of the pipe installation or culvert structure, backfilling shall be undertaken in compacted layers with materials approved by the Engineer, to the grade and elevation as designated in the Drawings. Each layer shall not exceed 25 cm unless otherwise specified, up to the level required for subsequent permanent works.

The backfilling shall not be carried out until 7 days after insitu concrete has been placed, or the concrete has attained sufficient strength to withstand shocks or strain exerted by the backfilling or compaction equipment and until specified testing on the structure has been successfully carried out.

Backfilling to pipelines shall be in accordance with Section 20600.

d) Clearing and Restoration of Site

After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish in the disposal area designated in the Drawings or as directed by the Engineer. The Contractor shall restore all disturbed areas to their original condition.

21503

Trench

21503.1 Scope of Work

- a) The work under this Division to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of the trench.
- b) Trenches shall be provided by the Contractor to all areas of the Engineers Design as indicated on the Drawings.
- c) Trenches shall be provided by the Contractor to all roads, all paved areas and other required areas. Construction details, materials and workmanship for the Contractor design portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- d) Prior to commencement of these works, the Contractor shall obtain the approval of the Engineer on the material to be used, the design of the concrete mixes, the equipment to be used and the methods of work execution. No materials shall be used or installed until the Contractor has been notified by the Engineer of his approval.
- e) All work shall be in accordance with the strength, location, dimension, line, elevation and finish designated in the Drawings and as specified herein.
- f) The work in this Section includes construction of the trenches adjacent to roads with cover slabs and catch basins and inlets, all as shown on the Drawings or as directed by the Engineer and as specified herein.

21503.2 Materials

- a) Concrete

Concrete shall be of the class as indicated in Section 20300 and / or as required by the Engineer.

All concrete work, reinforcement and formwork and associated work shall be in accordance with Section 20300 CONCRETE.

- b) Trench Covers

- Reinforced concrete;
- Steel Grating Cover

- c) Lifting Rings

- Mild steel hinged lifting rings shall be provided to all catch basin covers.
- Rings and hinges to be hot dip zinc galvanized after fabrication to ASTM A-385.

- d) Crushed Stone

Crushed Stone shall be placed in accordance with the requirements for layer thickness designated on the Drawings or as directed by the Engineer. The crushed Stone shall meet the requirements specified in Section 20200: Granular Base and be compacted to not less than 90% of the maximum dry density.

e) Backfilling

Backfilling shall meet the requirements of Section 20600.

21503.3 Construction Requirements

a) Excavation and Foundations

All Excavation work shall be in accordance with the provisions of Section 20600 Earthwork. Excavation for and construction of Trenches, shall be commenced only after the required settlement of the reclamation has been achieved in accordance with Section 20500.

Foundation beds shall be prepared and compacted in accordance with requirements of the drawings and applicable requirements of the Specification. Any unsuitable material encountered shall be removed and replaced with selected filling, to the approval of the Engineer, at the expense of the Contractor.

Foundation bed shall be compacted to meet the following requirements:

-For non-cohesive soils, not less than 90% of the maximum dry.

The formation of excavations shall be approved by the Engineer, before placing the sand or concrete layers.

b) Concrete

Concrete shall be placed to the sections and dimensions indicated on the drawings.

The pre-cast cover slabs shall have attained a minimum 7 day concrete strength before striking formwork unless otherwise agreed by the Engineer.

c) Backfilling

The backfilling shall be controlled in accordance with Section 21501.

d) Placement and Treatment of Castings, Frames and Fittings

All castings, bearing frames, covers and fittings shall be placed in the positions indicated on the Drawings or as directed by the Engineer, and shall be set true to line and to correct elevation.

After concrete or mortar has been allowed to harden for 7 days, then the gratings or covers shall be placed and fastened down.

e) Clearing and Restoration of Site

After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish in the disposal area designated in the Drawings or as directed by the Engineer.

21504

21504.1 Scope of Work

Diversion

- a) This work shall consist of stone lined open drainage channels (diversion) to be constructed in accordance with the location, dimension, shape, line, grade

and elevation designated in the Drawings; and as specified herein

- b) The Contractor shall, before the work of open diversion is started, obtain the Engineer's approval on the materials to be used and on the methods of the work execution.

21504.2 Materials

- a) Concrete

Concrete shall have a compressive strength of 18N/mm² at 28 days in accordance with Section 20300.

- b) Stone and Rock Lining

Stone and rock for masonry lining shall be tough and durable, and shall neither be flat nor slender. Specific gravity shall be more than 2.0.

Weight of one piece shall be more than 20 kg.

- c) Mortar

Mortar shall consist of Portland cement, sand and water (cement-sand volume ratio of 1 to 2).

21504.3 Construction Requirements

- a) Excavating and Preparing Foundation Bed

The drainage layer bed upon which the item is to be built shall be compacted properly with compaction equipment approved by the Engineer.

All moistened and unsuitable soil shall be removed from the foundation bed and replaced with suitable materials as designated by the Engineer.

The foundation bed shall be checked and accepted by the Engineer before placing concrete or spreading crushed aggregate.

- b) Pouring Concrete

Concrete shall be poured in accordance with the requirements specified in Section 20300.

- c) Placing of Stone Lining

Stones shall be selected for evenness of size and compatibility of shape.

Stones shall be bedded and joints completed filled with mortar. Joints shall be flush pointed.

Finished surfaces shall be even and flush.

- d) Clearing and Restoration of Site

After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish in the disposal area designated in the Drawings or as directed by the Engineer. The Contractor shall restore all disturbed areas to

their original conditions.

21505

Manhole

21505.1 Scope Of Work

- a) This work shall consist of manholes, inlets and outlets to be constructed in accordance with the requirements of location, dimension, shape, and elevation designated in the Drawings; and as specified herein.
- b) The Contractor shall, before the work of manholes, inlets and outlets is started, secure the Engineer's approval on the material to be used and on the methods of the work execution.

21505.2 Materials

- a) Concrete

Concrete to be used shall be a compressive strength of 18 N/mm² at 28 days as specified in Section 20300.

- b) Reinforcement Bars (Frame)

Reinforcement bars shall meet and the tensile strength at yielding point shall be not less than 2,400 kg/cm². Size of the reinforcement bars shall be as shown on the Drawings.

- c) Crushed Stone

Crushed Stone shall be meet the requirements specified in Section 21401.

- d) Lean Concrete

Lean concrete shall be meet the requirements specified en Section 20300.

- e) Frames, Covers and Gratings

Bearing frames, covers and gratings shall conform to the following requirements:

Gray iron castings shall meet the requirements of ASTM A 48.

Malleable iron castings shall meet the requirements of ASTM A 47.

Steel castings shall meet the requirements of ASTM 27

Structural steel for gratings and bearing frames shall conform to the requirements of ASTM A-6/6 M

21505.3 Construction Requirements

- a) Excavation

Excavation for structures or for foundation of structures shall be performed in conformity with the location, grade and elevation designated on the Drawings and as specified in Section 20600 of this Specification. The Engineer shall be authorized to change the construction methods in the foundations including the elevation of bottom in consideration of the stability of the ground.

The Contractor shall provide all safety and drainage materials and equipment for excavations so as to meet the requirements of excavation as specified on the Drawings.

The foundation bed for structures shall be compacted properly with compaction equipment approved by the Engineer. After the excavation is completed, the Contractor shall inform the Engineer of its completion. Concrete or reinforcement bars shall be brought into the site after the Engineer has approved the depth of the excavation and condition of the foundation.

b) Concrete Structures

Concrete structures shall be built on prepared foundation, conforming to the dimensions and shape designated on the Drawings. The construction shall conform to the requirements specified in Section 20300. Any reinforcement bars required shall be placed as designated on the Drawings and shall be approved by the Engineer before the concrete is poured.

All bottoms of channels shall be constructed and shaped accurately to allow smooth, and undisturbed flow of water.

Unless otherwise specified, the Contractor shall remove timbers, covers, and supports upon completion of the structures. The removal operation shall be performed in a manner that the completed structures will not be damaged.

c) Inlet and Outlet Pipes

Unless otherwise specified, the inlet and outlet pipes shall extend through outer walls of the structures in a sufficient length to allow for connections but shall be cut off flush with the wall on the inside surface. Mortar shall be grouted around these pipes to form tight, neat connection with the structures.

d) Backfilling

After the structures are completed, the spaces around the structures shall be backfilled in layers with approved material, to the finish grade, each layer not exceeding 25 cm thick, and compacted properly with compaction equipment approved by the Engineer. Each layer shall be compacted all around the structures and lifted up to the elevations designated on the Drawings.

Backfilling shall not be carried out until 7 days after the concrete has been placed or the concrete has attained sufficient strength to withstand shocks or strain exerted by the backfilling, or by vibrations of the compaction equipments.

e) Cleaning and Restoration of Site

After the backfilling has been completed, the Contractor shall dispose of all remaining materials, dirt and rubbish in the disposal area designated on the Drawings or as directed by the Engineer. The Contractor shall restore all disturbed areas to their original conditions.

SECTION 21600 QUAY WALL FURNITURE AND FITTINGS

21601 General

Fenders, ladders, mooring rings, bitts or bollards, kerbs, etc and all associated quay fixings and supports shall be furnished and installed as shown on the Drawings.

All marine fittings excluding bollards and fender fixings but including mooring rings, fender chains and shackles, ladders, handgrips, anchor bolts, nuts and washers shall be galvanized. All galvanizing shall comply with the requirements of JIS H 8641 or ASTM A-385.

The Contractor shall submit fabrication drawings and fixing details to the Engineer for his approval. No materials shall be ordered nor fabrication commenced until such drawings are approved by the Engineer.

21602 Bollards and Bitts

The type, shape, manufacturer of the bollards and bitts and method of anchoring to the quay structure shall be to the approval of the Engineer. They shall be capable of withstanding, with a factor of safety of 2, the specified bollard pull over a horizontal range of +/- 90 degrees to the berth face and through an angle of 0 to 45 degrees to the horizontal.

The material for manufacture of the bollards and bitts shall be Carbon Steel Casting SC 46 as specified in JIS G 5101 or equivalent approved. Anchor bolts, nut, washers and other accessories shall be to G 3101 (Rolled Steel for General Structure, SS 400), JIS B 0205 (Standard M Screw) and JIS B 1181 (Hexagon Nut) or equivalent approved.

The size of the bolts, nuts anchor plates and washers shall be in accordance with the specification of the manufacturer and to the approval of the Engineer. All bolts, nuts, washers, etc that are exposed shall be galvanized in accordance with JIS H 8641 or ASTM A-385.

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

The surfaces shall be thoroughly cleaned and painted with two coats of an approved thixotropic bitumen enamel. All recesses are to be filled with an approved sealant.

21603 Fenders

21603.1 Type and Manufacture of Fenders

The type and manufacture of the fenders shall be to the approval of the Engineer.

The fenders shall be of hollow section or open legs or columns formed of solid rubber integrally bonded to a steel backing plate and fitted with approved front protector panels where shown on the Drawings. Energy absorption shall be by buckling of the section.

21603.2 Fixing of Fenders to the Quay

The fenders shall be fixed to the quay in the positions and levels shown on the Drawings, by means of stainless steel bolts passing through the backing plate and either fixed to the quay face by synthetic resin anchor plugs or stainless steel anchor boxes cast in the quay face. The design of the fixings shall be to the approval of the Engineer.

21603.3 Fender Performance

The performance characteristic and location of the fenders is as shown in Table 21600.1

TABLE 21600.1 FENDER PERFORMANCE

Unit Performance Characteristics	Unit	Fender		
		150	800	1000
Height (H)	mm	150	800	1000
Energy Absorption (minimum)	KN-m	17	224	438
Reaction Force (Maximum)	KN	330	502	784
Deflection (Maximum)	Percent (%)	45	70	70
Berthing Ang/ (Maximum)	Degree	10	10	10

21603.4 Fender Rubber Properties

The rubber material used for rubber dock fenders shall be a compound of natural rubber and synthetic rubber of high quality having sufficient resilience, anti-aging, weather and wear resistant properties.

The physical properties of the rubber fender shall comply with the requirements shown in Table 21600.2 ascertained by internationally recognized test methods and approved by the Engineer.

TABLE 21600.2 FENDER RUBBER PROPERTIES

Physical Property		Requirement	
(a)	Tension test (before aging)	Hardness (Hs) Tensile Strength (kg/sq cm.) Elongation (%)	75 degrees max 160 min. 350 min.
(b)	Tension test (after aging)	Hardness (Hs) Tensile Strength (kg/sq cm.) Elongation	+ 8 degrees max. +/- 20% max. +/- 20% max.
(c)	Tear resistance (kg/sq cm.)	Inner rubber Outer rubber	70 min. 60 min. 30 max.
(d)	Compression Set (%) Inner Rubber		
(e)	Oil Resistance (Volume change) Outer Rubber	Industrial gasoline (%) Heavy oil (%)	60 min. 20 max.

21603.5 Protector Panels

Protector panels shall be made of structural steel Grade 43A to ASTM A-616M or Class 2, SS400 to JIS G 3101 or equivalent approved.

The surface shall be painted with one coat of inorganic zinc rich and painted with

two coats of coaltar epoxy or 120 – 140 micron thickness.

21603.6 Fender Face Units

The fender face units shall be made of high molecular weight polyethylene having a maximum friction coefficient of 0.2.

The fender face units shall comply with the following requirements ascertained by internationally recognised test methods, and approved by the Engineer.

TABLE 21600.3 PHYSICAL PROPERTIES OF FENDER FACE

Physical Properties	Units	Requirement
Density	gms/ cu cm.	0.92 – 1.05
Tensile Strength	kg/ sq cm.	200 min.
Elongation	%	500 min.
Compression Strength	kg/ sq cm.	300 min.

21603.7 Supporting Chains Anchors and Shackles

Supporting chains anchors and shackles for the fenders shall comply with JIS G 3101, JIS F 3303, JIS B 2801, ASTM A-616M as appropriate or approved equivalent.

All chains, anchors and shackles shall be hot dip galvanized.

**21604
Protection
Treatment of
Quay Furniture
and Fittings**

All galvanized items except those embedded in concrete shall be painted. No painting shall be carried out until galvanising has been completed for six months. Those parts to be painted shall be thoroughly degreased and painted with a primer coat and three coats of a heavy duty coaltar epoxy paint approved by the Engineer. The total film thickness shall nowhere be less than 375 microns. The paint shall be applied in accordance with manufacturer's instructions and to the Engineer's satisfaction.

**21605
Curb**

Reinforced concrete curbs shall be installed as shown on the Drawings. All fixing bolts and anchors shall be hot-dip galvanized in accordance with Section 20300. The concrete for the curbs shall be Class S1.

**21606
Power, Water,
Telephone
Outlet Pits and
Cable Junction
Pits for Quay
Side Gantry
Cranes and
Covers**

The Contractor shall supply and install the pits, recesses and covers for power, water, loading and unloading outlets and cable junction pits for quay side gantry cranes as shown on the Drawings. The type and manufacture of the covers shall be to the approval of the Engineer. All steelwork shall be grit blasted and primed with our approved zinc rich primer point out painted with two coats of an approved coaltar epoxy paint, 300 microns total thickness.

**21607
Container
Crane Rail**

The Contractor shall supply and fix container crane rails for the quayside gantry cranes and all ancillary equipment. The type of rail to be supplied shall be of CR 73 (73.3 kg/m).

The rail material shall meet JIS E1101 and the Contractor shall submit two copies of mill sheet (manufacturer's mill test report) to the Engineer for his approval.

For installation of rails, double elastic fastening devices indicated on the Drawings shall be used.

The method of burying fastening devices into concrete shall be in accordance with

manufacturer's instruction. However, the Contractor shall work out a programme showing details of work method and the sequence of work and shall submit it to the Engineer for his approval four weeks before the commencement of the work.

The permissible tolerance of the installation of container rails shall be in accordance with the installation standard shown in the following table and the method of measurements shall be as directed by the Engineer.

TABLE 21600.4 PERMISSIBLE TOLERANCE FOR TRAVELING RAIL

Check Item	Tolerance at Installation
Horizontal straightness (Bending left or right)	± 5.0 mm for total rail length
Span of rails	± 5.0 mm
Height difference between rails	150 mm ± 20 mm
Height difference for total rail length	max. 30 mm
Joint difference	max. 0.5 mm
Joint gap	max. 5mm

The Contractor shall fix the following container crane fittings to be supplied at the Site to the specified positions as directed by the Engineer. This work shall include formworks, electric welding and concrete work in accordance with the provisions of Section.

- a) Steel bumper 2 sets
- b) Anchoring device 2 sets

SECTION 21700 NAVIGATION AIDS

21701 General

21701.1 General description of the works

The Works to be undertaken by the Contractor are the design, fabrication, delivery and installation of all navigational aids required for La Union Port Development Project.

The navigation aids included in the Contract comprise followings;

- | | | |
|----|-----------------------------------|--------|
| 1) | Lighthouse | 1 set |
| 2) | Outer Channel Marker Buoy | 9 sets |
| 3) | Inner Channel Marker Buoy | 4 sets |
| 4) | Turning Basin Marker Buoy | 3 sets |
| 5) | Light Beacon | 3 sets |
| 6) | Required spare parts for above | 1 sum |
| 7) | Vessel Traffic Service System | 1 set |
| 8) | Tools for Navigation Control Room | 1 sum |

21701.2 General Requirements

All equipment supplied shall be new and unused. The equipment shall be of high quality, current commercial design, which has proven its reliability and been previously installed and made of components that shall be supported by source vendors for at least five (5) years. All equipment and materials shall be suitable for installation and use under the environmental conditions in El Salvador.

To provide security for lanterns, batteries and solar panels, the connecting fasteners which are exposed and readily apparent shall be equipped with tamper proof nuts which require special hand tools or key to remove them.

In order to avoid excessive heat, batteries are to be placed inside the buoy hull.

For lighthouse and marker buoys, watertight battery boxes shall be provided with a stainless steel padlock specially manufactured with a single master key capable of opening all locks used in the system.

The Contractor shall ensure the compatibility of lighting and recharging equipment on lighthouse, lighted buoys and beacons. The Contractor shall also ensure that all shackles, bridles, swivels, chain and sinkers are proof tested and compatible with the buoys to which they are attached.

The system shall be designed to ensure that minimal maintenance is required and a battery standby capacity providing a minimum of twenty one (21) days period of Autonomy.

All buoys are to come with two (2) solar modules, mounted under the lantern at 180° apart to allow for buoy rotational movement, under an angle of 70 degrees with the horizon.

All buoys to have logo/ identifying mark of CEPA and number affixed to the superstructure.

Solar modules and battery capacity values used in sizing calculations are to include an additional 20% to 30% safety factor, to allow for degradation of array output and battery capacity throughout the life of the solar generator system.

Clear, Red, Green or Yellow lenses/lights as required shall be supplied and all lenses shall meet IALA chromatically standards for marine lights.

Calculation data shall be provided by the Contractor for the approval by the Engineer, clearly showing the effective flashing intensity (e.f.i.) after making allowances for all propagating losses by applying a reduction factor for Red, Green and Yellow lenses.

The Atmospheric Transmissivity factor used is to be calculated using the Schmidt-Clausen method of calculation to determine the effective flashing intensity (e.f.i.) in candela is to be applied, as recommended by IALA.

The manufacture/assembly of the goods shall be undertaken in an approved and reputed manufacture/assembly plant which company shall be an active industrial

member of International Association of Light House Authorities (IALA). If a final assembly of goods will be undertaken after delivery in El Salvador, this shall be supervised by a duly authorized expert of the IALA approved manufacturer/plant. Manufacture of Steel structures and equipments shall be permissible at an approved and reputed manufacturing plant with adequate experience and expertise for manufacture of similar products. Necessary documents pertaining to the qualification shall be submitted. The fitting and assembly of appropriate Aids to Navigation with manufactured structures and equipment in such manufacturing plant shall be carried out and supervised by duly authorized experts of the IALA approved manufacturer/plant. The Contractor is required to submit Clause by Clause compliance and deviation comments to all the technical specifications specified within this Contract in order to clearly understand the equipment and service proposed by the Contractor and whether the system offered is in full compliance with the technical specifications.

21701.3 Environmental Requirements

All materials and equipment shall be operable under normal load conditions with no performance degradation below the acceptable performance limits as specified for the equipment under the following conditions.

	Limits
Operating Temperature	0° to 50° Celsius
Storage Temperature	0° to 50° Celsius
Temperature Cycling between extremes	Unlimited number of cycles
Humidity (operating and storage)	100% Condensing
Wind speed	150 km/h
Insolation	0-1.0 kw/sq m
Current	2.5 m/sec
Waves	8 m

21701.4 Painting

Inside and outside body of lighthouse, marker buoys, beacons shall be painted as specified below.

(1) For Steel Part

Surface of steel part shall be cleaned properly to remove all weld, spatters, rust and grease. Then, all steel surface shall be prepared by sand blasting to a linear white surface. The subsequent paint coating shall be applied without delay after sand blasting. Intervals between coats shall be strictly in accordance with the paint manufacture's instructions. Each coat of paint shall be of appropriate dry film thickness as mentioned in paint scheme.

Paint Scheme for Steel Part.

	Name of Paint	Number of coat	Film Thickness
Under coat	Epoxy primer	1	80 μ
Finish coat			
1) External above HWL	Acrylic paint + antifouling	2 + 1	50 x 2 + 30 μ
2) External below HWL	Synthetic coat + antifouling	2 + 1	50 x 2 + 30 μ
3) Internal	Acrylic paint	2	30 x 2 μ

(2) For Aluminum Part

Surface of aluminum part shall be cleaned properly to remove all oil, grease, and other contaminants by solvents. Then all surface shall be prepared by power tools to provide etched surface. The subsequent paint coating shall be applied without delay. Intervals between coats shall be strictly in accordance with the paint manufacturer's instructions. Each coat of paint shall be of appropriate dry film thickness as mentioned in paint scheme.

Paint Scheme for Aluminum part

	Name of Paint	Number of coat	Film Thickness
Under coat	Epoxy primer	1	80 μ
Finish coat			
1) External above HWL	Polyurethane paint + antifouling	2 + 1	60 x 2 + 30 μ
2) External below HWL	Chrorinated rubber anti corrosive + antifouling	2 + 1	30 x 2 + 100 μ
3) Internal	Polyurethane paint	2	35 x 2 μ

21701.5 Operation Manual

The Contractor shall prepare operation and maintenance manual of all navigation aids which include Lighthouse, marker buoys, beacon and VTS system in both English and Spanish. The manual shall be submitted to the Engineer for his approval at least two (2) months before the installation of navigation aids facilities at site.

21701.6 Tests and Acceptance

The Contractor shall arrange transportation of the equipment and storage at La Union Port and make the equipment available for acceptance and inspection.

Tests will be taken of a minimum 50% of the lanterns, lights, structures and batteries selected at random. The Contractor shall, at his cost, assemble and install buoys, lights and structures and demonstrate its operation.

On successful completion of the tests, the Contractor will receive Acceptance Certificate.

**21702
Lighthouse**

21702.1 General

The major part of lighthouse tower shall be aluminum alloy to be placed on the foundation as shown in the Drawings. The lighthouse shall be equipped with following, but not limited to lighting equipment, solar power system, AIS transponder, VHF/UHF radio relay system, and lightning rod.

21702.2 Lighthouse Tower

The lighthouse tower shall meet the following specifications.

- 1) Total height without lantern 11.5m
- 2) Diameter 2m
- 3) Total Weight not more than 3,000 kg
- 4) Material of tower Aluminum Alloy
- 5) Final paint color White
- 6) Plat form 3.5 m wide with stainless handrail

21702.3 Lighting Unit

The lighting unit shall meet the following specifications.

- 1) Lantern Rotating beacon with halogen ramp
- 2) Light color clear
- 3) Flash character Fl. 3 sec.
- 4) Range of light 15 N.M. or more

21702.4 Power Supply

The solar module shall be designed to meet the following specifications.

- a) The solar module shall consist of not less than thirty (30) monocrystalline silicon cells for a 6V module to be connected in series for a 12V module with the silicon cells encapsulated in UV stabilized water-clear polymer, which is proven for its stability in high temperatures in the presence of water, UV radiation, and oxygen. Cells shall be sandwiched between two (2) pieces of glass to prevent or retard ingress of moisture during the service life of the module. Adequate expansion joints shall be provided to prevent stress fractures of module or cells.

Alternatively, proprietary solar modules will be acceptable which utilize a series of electrically matched single-crystal silicon solar cells to provide maximum power output for minimum array size encapsulated between a toughened glass cover and using Ethylene Vinyl Acetate (EVA) for moisture resistance, the solar cells are to be laminated between the glass front and a durable polymer back sheet.

- b) The solar module shall have a minimum service life of ten (10) years limited warranty under environmental conditions of high humidity, continuous spray, temperature variations from 0° to 50° Celsius and a strong ultraviolet radiation.
- c) The solar module shall be self regulated and be fitted with a blocking diode and bypass diode to prevent the battery from discharging through the solar plant, or to be fitted with a controller/regulator having following or equivalent specification:

Housing	Watertight (IP 65)
Battery charge set point adjustable +/- 10%	14.1V; accuracy +/-1%
Low voltage disconnection at from discharging	10.5 Volt to prevent battery
Operation temperature range	0° to 50° C
Relative humidity	90 %
Temp. compensation of battery set point	4.5mV/° C/Cell

- d) Each solar module shall bear the manufacturer's name and serial number.
- e) The solar panel shall be protected by an edge-gasket which seals the interlocking sides with a strong, lightweight stainless steel (or equivalent material) supporting frame which shall come with tough, multi-layered polymer back sheet for resistance to abrasion, tears, hail impact, humidity and other factors:
- f) The module shall come with an environmentally-sealed marine grade terminal cover (PVC Junction Box) providing watertight protection for the external positive and negative terminals. Each junction box to come with approved marine watertight cable glands;
- g) Insolation data shall be submitted and calculated with a minimum 50% array degradation factor applied to each PV system output designed for a nominal 1 2V system.

A solar module of following shall be provided as a power supply source of lighthouse.

12v 75w x 10 pieces or more for lighting unit

12v 75w x 2 pieces or more for AIS transponder

12v 75w x 2 pieces or more for VHF transmitter

The charging controller shall be provided to control and protect from overcharge, over current and reverse circulation.

The Contractor shall supply 12V rechargeable sealed gel electrolyte lead acid batteries which shall be of the type suitably designed to be recharged. The batteries shall be fully charged upon delivery and installation, and have an operation life expectancy of not less than four (4) years and be capable of operating in temperatures ranging from 0° to 55° Celsius. The battery shall possess self discharge capability not larger than 3% per month at 25 ° C after the battery is stabilized. The batteries shall meet the following general requirements:

- a) Batteries or individual cells, as provided shall be conservatively rated for long life under the operating conditions of the system, but with minimum 4 years service life at 30° C
- b) Maintenance free rechargeable sealed gel electrolyte lead acid batteries with very low self-discharge (less than 3% per month at 25° C)
- c) Batteries shall function satisfactorily in an ambient temperature range from 0° to 55° C and can also operate efficiently when tilted at angles varying from 0° to 90° without any leaks or spills. Battery shall be sealed and be spill-proof and leak-proof;
- d) Batteries shall be sized according to the daily load requirement in ampere hours but with a of minimum twenty one (21) days period of autonomy (standby) or a 12V minimum 200 AH (+ 10%) rechargeable sealed gel electrolyte lead acid battery, whichever is larger.
- e) Battery cover and casing shall be manufactured from non- conductive, chemically neutral polypropylene, which prevents corrosion and shall not cause short circuit or support organic growth.
- f) Minimum 1 core x 35 mm² rubber coated neoprene jacketed cable shall be used for battery to battery interconnection and a minimum of 2 core x 10 mm² rubber coated neoprene jacketed cable (10 AWG) shall be used with each lantern to battery and solar to battery interconnection to ensure correct functioning of the electric light system. Heavy duty stud/flag post terminal connectors are to be supplied with each battery;
- g) Each battery supplied shall be clearly marked with manufacturers name and date of manufacturing.

Battery calculation data shall be submitted for the daily power consumption of each light unit. clearly indicating the minimum battery capacity required and calculated with a minimum 20-30% aging factor applied to each battery.

Battery shall be lead-calcium grid fully sealed type and have following capacity.

24v 900Ah or more for lighting unit

12v 100Ah or more for AIS transponder

12v 100Ah or more for VHF radio relay

21702.5 AIS Transponder

AIS transponder shall have function of receiving AIS information, transmitting AIS information and receiving GPS information of Outer Channel Marker Buoys. AIS transponder shall be designed to receive and transmit all AIS format of ITU recommendation ITU-R M.1371-1.

Antenna shall have a height at least 15m.

21702.6 VHF/UHF radio relay system

VHF/UHF radio information relay system shall be provided.

- 1) VHF radio
Channel program – 8 channel (155.00 –161.475 MHz)
Output power – 25 watts or more
- 2) UHF radio
Channel program – 1 channel (403 – 470 MHz)
Output – 25 watts or more
Antenna for VHF and UHF shall be installed separately.

21703 Outer Channel Marker Buoys

21703.1 General

Outer channel marker buoy shall be equipped with lighting unit, power supply unit, mooring chain and sinker, radar reflector, and GPS synchronized flashing system.

- Each buoy shall be furnished with wide angle buoy lanterns. Color shall be non fading and shall conform to the IALA buoyage system.
- All buoys shall be designed to give good stability in a wide range of sea conditions.

21703.2 Buoy Body

Each body shall be robustly constructed using qualified steel and classified welding workmanship. The design shall minimize maintenance requirements, and simplify deployment and maintenance. The buoy body shall satisfy following specifications.

Float diameter	2.5 m
Overall height	8.5 m
Focal plane height	5.5 m (without moorings)
Total mass	approximate 3,550 kg
Buoyancy	approximate 9,900 kg
Design wave height	8m (significant wave height)
Color/Top Mark	Red/Corn (starboard side for inbound ship) Green/Can (starboard side for inbound ship)

Each buoy body shall be properly fabricated of steel plate and seam welded construction. The main body, top and the bottom dish-end shall be fabricated separately but each of them of one single M.S. plate. It shall be fitted with steel reinforced ballast, two (2) steel mooring eyes, four (4) steel lifting eyes and fittings for superstructure and rubber fender.

The buoy body shall be of simple finish but of best quality steel construction and workmanship so as to ensure smooth surfaces and watertight of hull. All steel plates for the buoy hull shall be at least the shipbuilding quality Lloyds Grade A or equivalent. Electric arc welding shall be applied to all connections of structural parts. Welding of any structural part shall only be made after preparing the edges properly as per shipbuilding practice.

The watertight hatches shall be firmly secured but still easy to open. The elastic/rubber ceiling of the hatch shall be strong and placed to the cover in such a way that it will not be damaged easily.

The Supplier shall prepare all test reports. Copies of the test reports shall be submitted to the Purchaser.

Hull type sacrificial anodes, sufficient in number as per calculation, shall be made of zinc or aluminum alloy with a minimum gross weight of 10 kg each, spread evenly around that ballast chamber.

21703.3 Lighting Unit

The lighting unit shall meet the following specifications.

- 1) Lantern Hi Brilliant Light Emitting Diode
- 2) Light color Red/Green
- 3) Flash character Fl. 2 sec.

- 4) Range of light 4 N.M. or more

21703.4 Power Supply

The solar power supply system shall meet the following or equivalent general requirements:

- a) The design shall consider the electrical characteristics and efficiency of the storage battery;
- b) The design shall consider the annual solar radiation variations as well as buoy rotation;
- c) The design shall provide that the solar power system shall not require maintenance more than once per year. Such maintenance routine shall be limited to cleaning the solar array and checking battery voltage/charge;
- d) The design shall provide that the solar generator components shall not degrade when exposed to humidity, salt spray, heat, and sunlight, and shall operate reliably. All components, except for the battery, shall have minimum design life of ten (10) years;
- e) Each buoy shall come with two (2) solar modules installed under an angle of 70° with horizon and 180° apart to take into consideration the buoy rotation with a 50% rated output factor to be applied to each solar module to account for (35% for buoy rotation and 15% for array degradation, total 50% applied to rated output). Module output is subjected to 360° buoy rotation.

A solar module of 17.4v 53W or more shall be provided as a supply source of light buoy.

The charging controller shall be provided to control and protect from overcharge, over current and reverse circulation.

The Contractor shall supply 12V rechargeable sealed gel electrolyte lead acid batteries which shall be of the type suitably designed to be recharged. The batteries shall be fully charged upon delivery and installation, and have an operation life expectancy of not less than four (4) years and be capable of operating in temperatures ranging from 0° to 55° Celsius. The battery shall possess self discharge capability not larger than 3% per month at 25 ° C after the battery is stabilized. The batteries shall meet the following general requirements:

- a) Batteries or individual cells, as provided shall be conservatively rated for long life under the operating conditions of the system, but with minimum 4 years service life at 30° C
- b) Maintenance free rechargeable sealed gel electrolyte lead acid batteries with very low self-discharge (less than 3% per month at 25° C)
- c) Batteries shall function satisfactorily in an ambient temperature range from 0° to 55° C and can also operate efficiently when tilted at angles varying from 0° to 90° without any leaks or spills. Battery shall be sealed and be spill-proof and leak-proof;
- d) Batteries shall be sized according to the daily load requirement in ampere hours but with a minimum twenty one (21) days period of autonomy (standby) or a 12V minimum 200 AH (+ 10%) rechargeable sealed gel electrolyte lead acid battery, whichever is larger.
- e) Battery cover and casing shall be manufactured from non-conductive, chemically neutral polypropylene, which prevents corrosion and shall not cause short circuit or support organic growth.
- f) Minimum 1 core x 35 mm² rubber coated neoprene jacketed cable shall be used for battery to battery interconnection and a minimum of 2 core x 10 mm² rubber coated neoprene jacketed cable (10 AWG) shall be used with each lantern to battery and solar to battery interconnection to ensure correct functioning of the electric light system. Heavy duty stud/flag post terminal connectors are to be supplied with each battery;
- g) Each battery supplied shall be clearly marked with manufacturers name and

date of manufacturing.

Battery calculation data shall be submitted for the daily power consumption of each light unit, clearly indicating the minimum battery capacity required and calculated with a minimum 20-30% aging factor applied to each battery.

Battery shall be lead-calcium grid fully sealed type 12v 65Ah or more.

The solar system of the buoy shall be watertight.

21703.5 Mooring Chain and Sinker

The sinkers shall be made of R.C.C. as per common practice. Buoy sinkers shall be R.C.C. hemispherical shape and made of cement, sand, 3/4" down graded stone chips and reinforcement with a steel lifting hook. The lifting hook shall be of a sufficient size and strength to withstand not less than double the pull of the weight of the sinker without breakage. The lifting hook shall provide a minimum inside radius of not less than 30 mm.

Chain:

- a) 42 mm grade stud link type chain with 'D' type shackles with forelock keys and tapered pin 6 (six), large square shackles with forelock key and tapered pin 2 (two) complete with 42mm thick triangular plate (monkey plate).
- b) Swivel for 42 mm stud link chain.
- c) 30 m 42 mm stud link pendent chain complete with 'D' type forelock end shackles at both ends.

Sinker:

40 ton R.C. sinker

Chain and bridles shall be made of Carbon steel of uniform quality. The chemical composition and the strength of the steel shall conform to the values of Lloyds Grade U2 or equivalent. Acceptance tests shall be done according to the guidelines of classification agency. Chain shall be marked in such a way that it maintains traceability of steel throughout the production, testing and inspection processes.

Each finished R.C. sinker is to undergo percussion test. Such test certificates are to be submitted at the time of supply.

All mooring equipment shall be painted with Coal Tar Epoxy paint.

Detail drawings of the buoys shall be submitted for the approval of the Engineer.

21703.6 Radar Reflector

A radar reflector shall be fitted to all buoys.

This Radar reflector shall be of a proven type and shall meet the following or equivalent requirements:

- a) Six (6)-corner reflector of the "Speckter design;
- b) Suited to demanding marine environment.

21703.7 GPS Synchronizer

The outer channel marker buoy shall be equipped with GPS synchronizer flashing system.

Synchronizing signal period 0.1 to 16 sec. (setting at 0.1 sec)

Synchronizing signal accuracy +/- 15 ppm

Programmable delay timing 0 to 3 sec (setting at 0.5 sec)

The synchronizer shall have additional functions of input voltage alarm, malfunction memory and manual test. The synchronizer shall be contained in an aluminum die casting case and the antenna shall be waterproofing type.

21704 Inner Channel Marker Buoys

21704.1 General

Inner channel marker buoy shall be equipped with lighting unit, power supply unit, mooring chain and sinker and radar reflector.

- Each buoy shall be furnished with wide angle buoy lanterns. Colors shall be non fading and shall conform to the IALA buoyage system.
- All buoys shall be designed to give good stability in a wide range of sea conditions.

21704.2 Buoy Body

Each body shall be robustly constructed using qualified steel and classified welding workmanship. The design shall minimize maintenance requirements, and simplify deployment and maintenance. The buoy body shall satisfy following specifications.

Float diameter	2.1 m
Overall height	5.0 m
Focal plane height	3.6 m (without moorings)
Total mass	approximate 3,400 kg
Buoyancy	approximate 6,700 kg
Design wave height	3 m (significant wave height)
Color/Top Mark	Red/Corn (starboard side for inbound ship)
Green/Can	(starboard side for inbound ship)

Each buoy body shall be properly fabricated of steel plate and seam welded construction. The main body, top and the bottom dish-end shall be fabricated separately but each of them of one single M.S. plate. It shall be fitted with steel reinforced ballast, two (2) steel mooring eyes, four (4) steel lifting eyes and fittings for superstructure and rubber fender.

The buoy body shall be of simple finish but of best quality steel construction and workmanship so as to ensure smooth surfaces and watertight of hull. All steel plates for the buoy hull shall be at least the shipbuilding quality Lloyds Grade A or equivalent. Electric arc welding shall be applied to all connections of structural parts. Welding of any structural part shall only be made after preparing the edges properly as per shipbuilding practice.

The watertight hatches shall be firmly secured but still easy to open. The elastic/rubber ceiling of the hatch shall be strong and placed to the cover in such a way that it will not be damaged easily.

The Supplier shall prepare all test reports. Copies of the test reports shall be submitted to the Purchaser.

Hull type sacrificial anodes, sufficient in number as per calculation, shall be made of zinc or aluminum alloy with a minimum gross weight of 10 kg each, spread evenly around that ballast chamber.

21704.3 Lighting Unit

The lighting unit shall meet the following specifications.

1) Lantern	Hi Brilliant Light	Emitting Diode
2) Light color	Red/Green	
3) Flash character	Fl. 4 sec.	
4) Range of light	3 N.M. or more	

21704.4 Power Supply

The solar power supply system shall meet the following or equivalent general requirements:

- a) The design shall consider the electrical characteristics and efficiency of the storage battery;
- b) The design shall consider the annual solar radiation variations as well as buoy rotation;
- c) The design shall provide that the solar power system shall not require maintenance more than once per year. Such maintenance routine shall be limited to cleaning the solar array and checking battery voltage/charge;
- d) The design shall provide that the solar generator components shall not degrade when exposed to humidity, salt spray, heat, and sunlight, and shall operate reliably. All components, except for the battery, shall have minimum design life of ten (10) years;
- e) Each buoy shall come with two (2) solar modules installed under an angle of 70° with horizon and 180° apart to take into consideration the buoy rotation

with a 50% rated output factor to be applied to each solar module to account for (35% for buoy rotation and 15% for array degradation, total 50% applied to rated output). Module output is subjected to 360° buoy rotation.

A solar module of 17.4v 53W or more shall be provided as a supply source of light buoy.

The charging controller shall be provided to control and protect from overcharge, over current and reverse circulation.

The Contractor shall supply 12V rechargeable sealed gel electrolyte lead acid batteries which shall be of the type suitably designed to be recharged. The batteries shall be fully charged upon delivery and installation, and have an operation life expectancy of not less than four (4) years and be capable of operating in temperatures ranging from 0° to 55° Celsius. The battery shall possess self discharge capability not larger than 3% per month at 25 ° C after the battery is stabilized. The batteries shall meet the following general requirements:

- a) Batteries or individual cells, as provided shall be conservatively rated for long life under the operating conditions of the system, but with minimum 4 years service life at 30° C
- b) Maintenance free rechargeable sealed gel electrolyte lead acid batteries with very low self-discharge (less than 3% per month at 25° C)
- c) Batteries shall function satisfactorily in an ambient temperature range from 0° to 55° C and can also operate efficiently when tilted at angles varying from 0° to 90° without any leaks or spills. Battery shall be sealed and be spill-proof and leak-proof;
- d) Batteries shall be sized according to the daily load requirement in ampere hours but with a of minimum twenty one (21) days period of autonomy (standby) or a 12V minimum 200 AH (+ 10%) rechargeable sealed gel electrolyte lead acid battery, whichever is larger.
- e) Battery cover and casing shall be manufactured from non- conductive, chemically neutral polypropylene, which prevents corrosion and shall not cause short circuit or support organic growth.
- f) Minimum 1 core x 35 mm² rubber coated neoprene jacketed cable shall be used for battery to battery interconnection and a minimum of 2 core x 10 mm² rubber coated neoprene jacketed cable (10 AWG) shall be used with each lantern to battery and solar to battery interconnection to ensure correct functioning of the electric light system. Heavy duty stud/flag post terminal connectors are to be supplied with each battery;
- g) Each battery supplied shall be clearly marked with manufacturers name and date of manufacturing.

Battery calculation data shall be submitted for the daily power consumption of each light unit. clearly indicating the minimum battery capacity required and calculated with a minimum 20-30% aging factor applied to each battery.

Battery shall be lead-calcium grid fully sealed type 12v 65Ah or more.

The solar system of the buoy shall be watertight.

21704.5 Mooring Chain and Sinkers

The sinkers shall be made of R.C.C. as per common practice. Buoy sinkers shall be R.C.C. hemispherical shape and made of cement, sand, 3/4" down graded stone chips and reinforcement with a steel lifting hook. The lifting hook shall be of a sufficient size and strength to withstand not less than double the pull of the weight of the sinker without breakage. The lifting hook shall provide a minimum inside radius of not less than 25 mm.

Chain:

- a) 32 mm grade stud link type chain with 'D' type shackles with forelock keys and tapered pin 6 (six), large square shackles with forelock key and tapered pin 2 (two) complete with 42mm thick triangular plate (monkey plate).

- b) Swivel for 32 mm stud link chain.
- c) 30 m 32mm stud link pendent chain complete with 'D' type forelock end shackles at both ends.

Sinker:

7.3 ton R.C. sinker

Chain and bridles shall be made of Carbon steel of uniform quality. The chemical composition and the strength of the steel shall conform to the values of Lloyds Grade U2 or equivalent. Acceptance tests shall be done according to the guidelines of classification agency. Chain shall be marked in such a way that it maintains traceability of steel throughout the production, testing and inspection processes.

Each finished R.C. sinker is to undergo percussion test. Such test certificates are to be submitted at the time of supply.

All mooring equipment shall be painted with Coal Tar Epoxy paint.

Detail drawings of the buoys shall be submitted for the approval of the Engineer.

21704.6 Radar Reflector

A radar reflector shall be fitted to all buoys.

This Radar reflector shall be of a proven type and shall meet the following or equivalent requirements:

- a) Six (6)-corner reflector of the "Speckter design;
- b) Suited to demanding marine environment.

21705

Turning Basin
Marker Buoys

21705.1 General

Turning basin marker buoy shall be equipped with lighting unit, power supply unit, mooring chain and sinker and radar reflector.

- Each buoy shall be furnished with wide angle buoy lanterns. Colors shall be non fading and shall conform to the IALA buoyage system.

- All buoys shall be designed to give good stability in a wide range of sea conditions.

21705.2 Buoy Body

Each body shall be robustly constructed using qualified steel and classified welding workmanship. The design shall minimize maintenance requirements, and simplify deployment and maintenance. The buoy body shall satisfy following specifications.

Float diameter	1.85 m
Overall height	4.8 m
Focal plane height	3.1 m (without moorings)
Total mass	approximate 2,300 kg
Buoyancy	approximate 4,600 kg
Design wave height	3 m (significant wave height)
Color/Top Mark	Red/Corn (starboard side for inbound ship)
Green/Can	(starboard side for inbound ship)

Each buoy body shall be properly fabricated of steel plate and seam welded construction. The main body, top and the bottom dish-end shall be fabricated separately but each of them of one single M.S. plate. It shall be fitted with steel reinforced ballast, two (2) steel mooring eyes, four (4) steel lifting eyes and fittings for superstructure and rubber fender.

The buoy body shall be of simple finish but of best quality steel construction and workmanship so as to ensure smooth surfaces and watertight of hull. All steel plates for the buoy hull shall be at least the shipbuilding quality Lloyds Grade A or equivalent. Electric arc welding shall be applied to all connections of structural parts. Welding of any structural part shall only be made after preparing the edges properly as per shipbuilding practice.

The watertight hatches shall be firmly secured but still easy to open. The elastic/rubber ceiling of the hatch shall be strong and placed to the cover in such a way that it will not be damaged easily.

The Supplier shall prepare all test reports. Copies of the test reports shall be submitted to the Purchaser.

Hull type sacrificial anodes, sufficient in number as per calculation, shall be made of zinc or aluminum alloy with a minimum gross weight of 10 kg each, spread evenly around that ballast chamber.

21705.3 Lighting Unit

The lighting unit shall meet the following specifications.

- | | | | |
|----|-----------------|--------------------|----------------|
| 1) | Lantern | Hi Brilliant Light | Emitting Diode |
| 2) | Light color | Yellow | |
| 3) | Flash character | Fl. 2 sec. | |
| 4) | Range of light | 3 N.M. or more | |

21705.4 Power Supply

The solar power supply system shall meet the following or equivalent general requirements:

- a) The design shall consider the electrical characteristics and efficiency of the storage battery;
- b) The design shall consider the annual solar radiation variations as well as buoy rotation;
- c) The design shall provide that the solar power system shall not require maintenance more than once per year. Such maintenance routine shall be limited to cleaning the solar array and checking battery voltage/charge;
- d) The design shall provide that the solar generator components shall not degrade when exposed to humidity, salt spray, heat, and sunlight, and shall operate reliably. All components, except for the battery, shall have minimum design life of ten (10) years;
- e) Each buoy shall come with two (2) solar modules installed under an angle of 70° with horizon and 180° apart to take into consideration the buoy rotation with a 50% rated output factor to be applied to each solar module to account for (35% for buoy rotation and 15% for array degradation, total 50% applied to rated output). Module output is subjected to 360° buoy rotation.

A solar module of 17.4v 53W or more shall be provided as a supply source of light buoy.

The charging controller shall be provided to control and protect from overcharge, over current and reverse circulation.

The Contractor shall supply 12V rechargeable sealed gel electrolyte lead acid batteries which shall be of the type suitably designed to be recharged. The batteries shall be fully charged upon delivery and installation, and have an operation life expectancy of not less than four (4) years and be capable of operating in temperatures ranging from 0° to 55° Celsius. The battery shall possess self discharge capability not larger than 3% per month at 25 ° C after the battery is stabilized. The batteries shall meet the following general requirements:

- a) Batteries or individual cells, as provided shall be conservatively rated for long life under the operating conditions of the system, but with minimum 4 years service life at 30° C
- b) Maintenance free rechargeable sealed gel electrolyte lead acid batteries with very low self-discharge (less than 3% per month at 25° C)
- c) Batteries shall function satisfactorily in an ambient temperature range from 0° to 55° C and can also operate efficiently when tilted at angles varying from 0° to 90° without any leaks or spills. Battery shall be sealed and be spill-proof and leak-proof;
- d) Batteries shall be sized according to the daily load requirement in ampere hours but with a minimum twenty one (21) days period of autonomy (standby) or a 12V minimum 200 AH (+ 10%) rechargeable sealed gel electrolyte lead acid battery, whichever is larger.
- e) Battery cover and casing shall be manufactured from non- conductive, chemically neutral polypropylene, which prevents corrosion and shall not

- cause short circuit or support organic growth.
- f) Minimum 1 core x 35 mm² rubber coated neoprene jacketed cable shall be used for battery to battery interconnection and a minimum of 2 core x 10 mm² rubber coated neoprene jacketed cable (10 AWG) shall be used with each lantern to battery and solar to battery interconnection to ensure correct functioning of the electric light system. Heavy duty stud/flag post terminal connectors are to be supplied with each battery;
 - g) Each battery supplied shall be clearly marked with manufacturers name and date of manufacturing.

Battery calculation data shall be submitted for the daily power consumption of each light unit, clearly indicating the minimum battery capacity required and calculated with a minimum 20-30% aging factor applied to each battery.

Battery shall be lead-calcium grid fully sealed type 12v 65Ah or more.

The solar system of the buoy shall be watertight.

21705.5 Mooring Chain and Sinker

The sinkers shall be made of R.C.C. as per common practice. Buoy sinkers shall be R.C.C. hemispherical shape and made of cement, sand, 3/4" down graded stone chips and reinforcement with a steel lifting hook. The lifting hook shall be of a sufficient size and strength to withstand not less than double the pull of the weight of the sinker without breakage. The lifting hook shall provide a minimum inside radius of not less than 25 mm.

Chain:

- a) 28 mm grade stud link type chain with 'D' type shackles with forelock keys and tapered pin 6 (six), large square shackles with forelock key and tapered pin 2 (two) complete with 42mm thick triangular plate (monkey plate).
- b) Swivel for 28 mm stud link chain.
- c) 25 m 28 mm stud link pendent chain complete with 'D' type forelock end shackles at both ends.

Sinker:

6.3 ton R.C. sinker

Chain and bridles shall be made of Carbon steel of uniform quality. The chemical composition and the strength of the steel shall conform to the values of Lloyds Grade U2 or equivalent. Acceptance tests shall be done according to the guidelines of classification agency. Chain shall be marked in such a way that it maintains traceability of steel throughout the production, testing and inspection processes.

Each finished R.C. sinker is to undergo percussion test. Such test certificates are to be submitted at the time of supply.

All mooring equipment shall be painted with Coal Tar Epoxy paint.

Detail drawings of the buoys shall be submitted for the approval of the Engineer.

21705.6 Radar Reflector

A radar reflector shall be fitted to all buoys.

This Radar reflector shall be of a proven type and shall meet the following or equivalent requirements:

- a) Six (6)-corner reflector of the "Speckter design;
- b) Suited to demanding marine environment.

21706 Light Beacons

21706.1 General

Light beacons shall be installed at the location indicated in the Drawings. The light beacons shall be equipped with lighting unit.

21706.2 Beacon Body

Each beacon body shall be robustly constructed using qualified steel and classified welding workmanship. The design shall minimize maintenance requirements, and simplify deployment and maintenance. The beacon body shall be constructed as shown in the Drawings and it shall satisfy following specifications.

Total height 3.0 m (without lantern)

Main material Hot dip galvanized steel
Color paint Yellow
The beacon body shall be properly fabricated of steel plate and seam welded construction.

21706.3 Lighting Unit

The lighting unit shall meet the following specifications.

- | | | |
|--------------------|--------------------|----------------|
| 1) Lantern | Hi Brilliant Light | Emitting Diode |
| 2) Light color | Yellow | |
| 3) Flash character | Fl. 4 sec. | |
| 4) Range of light | 3 N.M. or more | |

21706.4 Power Supply

The Contractor shall connect electrical line of light beacons with shore power supply system at the nearest junction available.

**21707
Vessel Traffic
Service**

21707.1 General

Vessel Traffic Service System shall be provided at the control room to be located at the Administration Building. The system includes

- | | |
|--------------------------|--------|
| 1) AIS unit with antenna | 1 unit |
| 2) VTS monitor | 1 set |
| 3) UHF radio | 1 set |
| 4) Control room tools | 1 set |

21707.2 Requirements

All equipment supplied shall be new and unused. The equipment shall be of high quality, current commercial design, which has proven its reliability and been previously installed and made of components that shall be supported by source vendors for at least five (5) years. All equipment and materials shall be suitable for installation and use under the environmental conditions in El Salvador.

AIS system shall meet the requirement of IMO standard. AIS unit and VTS display shall be compatible and information to be displayed shall be designed by the Contractor for the approval of the Engineer.

21707.3 AIS Unit

AIS system include AIS receiver and AIS controller with following specifications.

- | | |
|---------------------|--------------------------------|
| (1) AIS receiver | |
| 1) Power supply | DC 24V transformed from AC120V |
| 2) Frequency | 156.025 – 162.025 MHz |
| 3) DSC frequency | CH70 (156.525MHz) fixed |
| 4) Antenna | vertical type |
| (2) AIS controller | |
| 1) Power supply | DC 24V transformed from AC120V |
| 2) Display function | Detailed target data |

21707.4 VTS Monitor

A program shall be developed to display various information in VTS monitor which include, but not limited to;

- 1) Map information within the radius of 1000 N.M from La Union Port.
- 2) Ship position from AIS data
- 3) Ship data (name of ship, LOA, full draft, estimated arrival time, cargo type/volume, stay time, next destination, etc.)

VTS main unit of desktop type PC shall have following specification.

- | | |
|-----------------------|-------------------------------|
| a) CPU | 600MHz or more |
| b) Hard disc capacity | 30GB or more |
| c) Memory | 128MB or more |
| d) Display size | 19" or more |
| e) Interface | USB, 100B-T network connector |
| f) Attachment | CD-R/RW |

21707.5 UHF Radio

The Contractor shall install 1 set of UHF radio at the control room to be located in the Administration Building. UHF radio shall meet following specifications.

- | | | |
|----|-----------------|--------------------------|
| 1) | Channel program | 1 channel (403 – 470MHz) |
| 2) | Output power | 25 Watts |
| 3) | Power supply | AC 120V |
| 4) | Antenna | Vertical type |

21707.6 Control Room Tools

The Contractor shall provide following tools to be utilized in the control room.

- | | | |
|----|--------------------------------|---------|
| 1) | Anemometer with recording unit | 1 set |
| 2) | Barometer with recording unit | 1 set |
| 3) | Binocular | 2 units |

The anemometer shall have a measuring and recording range of all direction with a velocity of 2 to 90m/sec and indicators of instantaneous wind direction and velocity, mean wind direction and mean velocity with 2-3 range shifting type. The recording type shall be luster scan type.

Barometer shall be aneroid type and self recording type. The range of measurement shall cover 940-1045Pa. The recording duration shall be 1 month or more.

Binocular shall be 7 x 50mm.

The Contractor shall supply spare parts of navigation aids listed below.

**21708
Spare Parts**

(1) Spare parts for Lighthouse

- | | |
|--|-----------|
| Lamp | 12 pieces |
| Lens | 1 piece |
| Lamp changer with flasher | 1 set |
| Solar module | 2 piece |
| Charging controller | 1 piece |
| Rubber gasket, packing, fuse
and other consumable | 1 set |
| Relay antenna for VHF/UHF | 1 sets |
| Relay antenna for AIS | 1 set |

(2) Spare parts for Outer Channel Marker Buoy

- | | |
|--|---------|
| Mooring assembly | 20 sets |
| Anode plate | 20 sets |
| Lantern | 10 sets |
| Solar module | 4 sets |
| Charging controller | 4 piece |
| Rubber gasket, packing, fuse
and other consumable | 10 set |

(3) Spare parts for Inner Channel Marker Buoy

- | | |
|--|---------|
| Mooring assembly | 10 sets |
| Anode plate | 10 sets |
| Lantern | 6 sets |
| Solar module | 2 sets |
| Charging controller | 2 piece |
| Rubber gasket, packing, fuse
and other consumable | 6 set |

(4) Spare parts for Turning Basin Marker Buoy

- | | |
|--|---------|
| Mooring assembly | 6 sets |
| Anode plate | 6 sets |
| Lantern | 2 sets |
| Solar module | 2 sets |
| Charging controller | 2 piece |
| Rubber gasket, packing, fuse
and other consumable | 3 set |

(5) Spare parts for Light Beacon	
Lamp	6 pieces
Lens	2 piece
Lamp changer with flasher	1 set
Rubber gasket, packing, fuse and other consumable	3 set

SECTION 21800 MISCELANEOUS WORKS

21801

This section covers construction of pavement marking, curbs, fence and gate and traffic signs.

General

21802

**Pavement
Markings**

21802.1 Scope of Work

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of Pavement Markings to all required areas.
- b) Pavement Markings shall be provided by the Contractor to all areas of the Engineers Design as indicated on the Drawings.
- c) Pavement Markings shall be provided by the Contractor to all roads, medians, Container Yard walls and other required areas.
- d) Construction details, materials and workmanship for the Contractor design portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- e) Pavement Markings shall include markings to:
 - Roads and parking areas,
 - Container Yard
- f) Pavement markings shall include the provision and application of paint in accordance with the locations, colours, shapes, patterns and dimensions shown on the Drawings, approved by the Engineer and as specified herein.
- g) Prior to commencement of the Pavement Marking work the Contractor shall obtain the Engineer's approval for the materials and equipment to be used and the methods of work execution.

21802.2 Materials

- a) Paint shall be an alkyd resin-type road paint conforming to AASHTO M 248.
- b) Glass beads conforming to AASHTO M 247 shall be provide to all paint. The beads shall either be pre-mixed with the paint or applied immediately after paint application to produce an approved reflective finish.

21802.3 Application Methods

- a) Surface preparation, mixing, application, provision of primers and undercoats, the number of coats and film thicknesses, shall be in accordance with the written instructions of the manufacturer, all as approved by the Engineer.
- b) Paint shall not be applied within three months of completion of pavement surfaces or during wet weather, on damp surfaces or in windy and dusty conditions.
- c) Paint shall not be applied to hot surfaces likely to cause lack of bonding and accelerate proper drying.
- d) All paint shall be thoroughly mixed in the field to keep pigments and

components in uniform suspension.

- e) The use of thinners or other additives shall not be permitted unless approved by the Engineer.
- f) The exact locations and shapes of all pavement markings shall be marked out before paint is applied.
- g) Application of paint to pavement surfaces, shall be with an approved self-propelled machine designed to spray paint in a uniform thickness and finish with neat, clean and straight edges. Adjacent pavements, medians, curbs and other surfaces shall be protected from splatters, splashes and other damage from painting operations.
- h) When applied to the surface the paint shall be free from runs, blisters, sagging or discolouring.
- i) If the glass beads are not pre-mixed in the paint then they shall be evenly applied to the paint surfaces immediately after application at a rate of 450gm/m².
- j) Pavement Markings shall be protected from all traffic until markings have dried sufficiently. Any damage shall be repaired at the Contractor's expense.

21802.4 Construction Tolerances

- a) Line lengths shall be as the dimensions shown on the Drawings ± 50 mm.
- b) Line widths shall be as the dimensions shown on the Drawings ± 5 mm.

21803

Curbs

21803.1 Scope of Work

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of Concrete Curbs to all required areas.
- b) Curbs shall be provided by the Contractor to all areas of the Engineers Design as indicated on the Drawings.
- c) Curbs shall be provided by the Contractor to all roads, container yard, Multi-purpose yard, passenger berth, open storage and so on.
- d) Construction details, materials and workmanship for the Contractor design portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- e) Curbs shall include the provision of all foundations with necessary excavation, formwork, concrete, reinforcement, bedding and jointing all to meet the requirements of strength, location, dimension, line and grade designated in the Drawings and as specified herein.
- f) Concrete curbs shall generally be precast concrete unless otherwise approved by the Engineer.
- g) Prior to commencement of the concrete pavement the Contractor shall secure the Engineer's approval for the materials to be used, the design of the concrete

mix, the equipment to be used and the methods of work execution.

21803.2 Materials

a) Concrete Curbs

- Precast concrete natural colour, to the section sizes, profiles and lengths as indicated on the drawings.
- Special curbs shall be provided at crossovers, angles, intersections and curves.
- Curbs shall be manufactured off-site in an approved facility.
- Curbs shall be compressed in steel moulds to produce high quality dense units with a fair, smooth finish.
- Specially manufactured shaped curbs shall be provided at all crossovers, intersections, ramps, radiused bends and curves. Cutting and jointing at these locations will not be permitted.

b) Concrete Foundations / Backings

Concrete foundations and backings shall be a minimum strength of 18 N/mm², placed insitu in accordance with Section 20300.

c) Mortar

Mortar for bedding and jointing shall be cement and sand, mix 1:3 as indicated on the drawings.

d) Preformed Expansion Joint Filler

Unless otherwise approved by the Engineer, preformed joint filler shall be in accordance with AASHTO M33.

21803.3 Construction Methods

a) Excavation and surface preparation

- Excavation shall be made to the required depth and gradient, and compacted to a firm, even surface.
- All soft and unsuitable material shall be removed and replaced with approved material.
- Bedding course material shall be placed and compacted to the required thickness.

b) Insitu Concrete Foundations

- Concrete foundations shall be in accordance with the Drawings.
- When completed, the insitu concrete shall be covered with suitable materials and kept moist for a period of 3 days. The concrete shall be suitably protected from the weather and traffic until thoroughly hardened.
- After the concrete has set sufficiently, the spaces in front and back of the curb and gutter shall be refilled to the required elevation with the proper material, which shall be compacted in layers of not more than 15 centimeters, until properly compacted.

c) Joints

When a curb is placed next to a concrete pavement, expansion joints in the curb shall be located opposite expansion joints in the pavement. Expansion joints shall also be formed at the approved intervals using preformed expansion Joint filler, minimum 10mm thick.

d) Laying and Jointing

Curbs shall be bedded and jointed in cement mortar as indicated. Joints shall not exceed 5 mm wide.

Concrete backing shall be provided behind all curbs to provide adequate lateral strength/restraint.

e) Tolerances

The finished work shall be true to line grade and level to within 3 millimeters and shall present a smooth appearance free from kinks and distortions visible to the eye.

21804

Fence and Gate

21804.1 Scope of Work

- a) The work under this Section to be carried out by the Contractor, consists of the execution and completion of Fence and Gate.
- b) Fencing and Gate shall be provided by the Contractor to all areas of the Engineers Design as indicated on the Drawings.
- c) Fencing and Gates shall be provided by the Contractor to around the boundary of overall Site area. Construction details, materials and workmanship for the Contractor design portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- d) Prior to commencement of the Fencing and Gates, the Contractor shall obtain the approval of the Engineer of the equipment and materials to be used and the methods of work execution. No materials shall be used or installed until the Contractor has been notified by the Engineer of his approval.
- e) Fencing and Gates shall include the provision of foundations, post, wheel, infill galvanized wire mesh and wires, with all necessary fixing, fittings and accessories all as shown on the Drawings or as directed by the Engineer and as specified herein.
- f) All work shall be in accordance with the strength, location, dimension, line, elevation and finish designated in the Drawings and as specified herein.

21804.2 General Design Requirement

Fencing and Gate shall generally with the relevant provisions of BS1722.

21804.3 Materials

a) Chin Link Fence

Chain link fence shall be zinc galvanized steel wire PVC covered,

- interlocking, heavy duty type, of a type and from a manufacturer to be approved.
- Size of chain link mesh shall be 5 cm x 5 cm, and steel wire shall be 4 mm in diameter.
- b) **Barber Wire**
- Barber wire shall be hot dip zinc galvanized barber wire, 2-ply twisted steel wire, each ply being 2.5 mm diameter, meeting the requirements of BS4102 or JIS G 3533. Barbs shall be spaced approximately 10 cm apart.
 - 3 strands of barbed wire shall be provided to top of chain Link Fences
 - 7 strands of barbed wire shall be provided as infill to the post and Wire Fences.
 - Barbed wire shall include approved type screw or clamp fixings to securely fix fencing to framing, without damaging the galvanizing of the frame. If frames are drilled to allow barbed wire to pass through, then frames shall be galvanized after drilling.
- c) **Posts and framing to Chain Link Fencing and Gate**
- Posts and framing shall be constructed of structural steel sections or pipes as indicated on the Drawings.
 - Structural steel sections shall be to JIS G3101
 - Structural steel pipe shall be to JJIS G43444.
 - All open ends of pipe sections shall be capped with welded plate.
 - All surfaces of steel sections and pipes and all fittings shall be hot dip zinc galvanized; 550 g/m²; after fabrication and finished with paint.
 - Paint finish shall be:
 - First coat : Epoxy primer 50 .
 - Second coat : Synthetic rubber paint 35 .
 - Finish coat : Synthetic rubber pain 30 .
 - Galvanizing and painting shall be performed at factory. Steel surfaces shall be cleaned of rust or other foreign substances by sand blast, shot blast or similar mechanical means before galvanizing.
- d) **Posts to Post and Wire Fencing**
- All concrete, reinforcement and finish shall comply with Section 20300.
 - Concrete shall be 18 N/mm²
- e) **Fabrication, Welding and Assembly**
- a) All Chain Link Fencing and Gate, shall be designed by the Contractor to be prefabricated off the Site. Assembly and erection shall be with bolted connections.
 - b) Welding of steel after galvanizing shall not be permitted.
 - c) Welded shall be continuous and on all sides and faces. No gaps or voids

shall be left in the fabricated panel.

f) Concrete for Foundations

Grade 20 concrete to be used in accordance with the Reference Specifications.

g) Gates

- Gates shall be constructed as indicated on the Drawings.
- Gates shall be provided with all hinges, wheels, locks and other hardware as indicated on the Drawings or approved by the Engineer

21804.4 Construction

a) Clearing Fence and Gate Line

The Fence line shall be cleared to a minimum of 60 cm on each side of the centerline of the fence.

Clearing shall include removal of all stumps, brush, rocks, trees, or other obstructions which will interfere with proper construction of the fence. Stumps within cleared area of the fence line shall be grubbed up and removed, all holes remaining shall be back-filled with suitable soil, or other materials acceptable to the Engineer and shall be compacted properly with tampers.

b) Installing Post

The posts shall be firmly set in adequate sized concrete foundations.

Top of concrete foundations shall be slightly above the ground surface, trowel finished, and sloped to drain away from the posts.

21805

Traffic Signs

21805.1 Scope of Work

- a) Prior to commencement of the Road Signs, the Contractor shall obtain the approval of the Engineer on the equipment and materials to be used and the methods of work execution. No materials shall be used or installed until the Contractor has been notified by the Engineer of his approval.
- b) Road Signs shall include the provision of foundations and support poles, with all necessary fixings, fitting and accessories all as shown on the Drawings or as directed by the Engineer and as specified herein.
- c) All work shall be in accordance with the strength, location, dimension, line elevation and finish designated on the Drawings and as specified herein.
- d) Road signs shall comply in all respects with the applicable Salvadorean signage standards and detail shown on the Drawings.

21805.2 Materials

a) Sign Panels

Sign panels for warning, regulatory, and informatory signs shall be flat sheet aluminum, hard alloy 5052-H34 complying with ASTM B 209 and having a minimum Thickness of 3 mm.

Sheets are to be degreased, etched, neutralized and processed prior to application of reflective sheeting sign panels.

b) Reflective Sheeting

The reflective sheeting used on the road signs shall consist of spherical lens elements embedded within a transparent plastic having a smooth, flat surface with a protected precoat adhesive which shall be pressure sensitive for manual application, or tack free heat activated for mechanical vacuum-heat application.

The minimum reflective brightness values of the reflective sheeting as compared to magnesium oxide (MgO) shall be as given in the Table below. The brightness of the reflective sheeting totally wet by rain, shall be not less than 90% of the values in Table 21800-1.

TABLE 21800-1 REFLECTIVE BRIGHTNESS OF TRAFFIC SIGNS SURFACE

Colour	Angle of Incidence	Angle of Divergence	Minimum Reflective Brightness Value Compared With MgO
Red	- 4°	0.5°	15
	20°	0.5°	10
	50°	0.5°	3
White	- 4°	0.5°	75
	20°	0.5°	70
	50°	0.5°	70
Yellow	- 4°	0.5°	35
	20°	0.5°	35
	50°	0.5°	10
Blue	- 4°	0.5°	6
	20°	0.5°	4.5
	50°	0.5°	0.5

The reflective sheeting shall be sufficiently flexible to permit application and adhesion to moderately embossed surface. It shall show no damage when bent 90° over a 50 mm diameter mandrel.

The sheeting shall be solvent-resistant so as to be capable of withstanding cleaning with petrol, diesel fuel, mineral spirits, turpentine or methanol.

The sheeting shall show no cracking or reduction in reflectivity after being subjected to the dropping of a 25 mm diameter steel ball from a height of 2m into its surface.

The adhesive shall permit the reflective sheeting to adhere accurately 48 hours after application at temperatures of up to 90° C.

The reflective material shall be weather-resistant and following cleaning in accordance with manufacturer's recommendations, shall show no discoloration, cracking, blistering, peeling or dimensional change.

Samples of reflective sheeting shall be submitted to the Engineer for approval.

c) Posts

The setting and clearance height of posts should follow the salvadorean signage standards.

Road sign posts shall be constructed of steel pipe, hot dip galvanized, complying with ASTM A 120 and having a minimum internal diameter of 75 mm. This includes pipe fittings and post caps. All open ends shall be capped to prevent water entry.

d) Nut, Bolts and Fixings

Nuts, bolts, washers and other metal fixing parts shall be hot-dip galvanized after fabrications in accordance with the requirements of AASHTO M 111.

e) Concrete Foundations

Concrete for foundations for sign posts shall be of class as shown on the Drawings and shall be in accordance requirements of Section 20300.

All other requirements for materials and foundations shall conform to the applicable requirements of Section 20300.

Signs shall not be erected on the poles until a minimum of 72 hrs after placing the concrete

21805.3 Construction requirements

a) Excavation and Backfilling

Holes shall be excavated to the required depth to accommodate the concrete foundation as shown on the Drawings or as directed by the Engineer.

Backfilling with suitable material approved by the Engineer and compacted in layers no exceeding 150 mm in depth. Surplus excavated material shall be disposed of by the Contractor, as directed by the Engineer.

b) Erection Posts

The posts shall be erected vertically in position in the foundation, prior to the placing of the concrete and adequately supported by bracing to prevent movement of the post during the placing and setting of concrete.

c) Sign Panel Installation

Sign panels shall be installed in accordance with the details shown on the Drawings. Any chipping or bending of the sign panels shall be considered as sufficient cause to require replacement of the panel at the Contractor's expense.

The exposed portion of the fastening hardware on the face of the sign shall be painted with enamels matching the background colour.

**21806
Sodding**

21806.1 Scope of Work

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution, completion and maintenance of Sodding.
- b) Sodding shall be provided by the Contractor to all areas of the Engineers Design as indicated on the Drawings or specified herein.
- c) Sodding shall be provided by the Contractor to all topsoiled areas of open areas, median of the road, slop of cutting, and other required areas.
- d) Prior to commencement of this work, the Contractor shall obtain the approval of the Engineer on the materials to be used, the equipment to be used and the methods of work execution. No materials shall be used or installed until the

Contractor has been notified by the Engineer of his approval.

- c) Sodding works shall also include continued maintenance and responsibility by the Contractor, for all grassed areas throughout the Defects Liability Period, including regular watering, mowing and repair.

21806.2 Materials

- a) Sod

Sod mat furnished by the Contractor shall have a good cover of living or growing grass. All sod shall be obtained from areas where the soil is reasonably fertile and contains a high percentage of loamy topsoil. Sod shall be cut or stripped from living, thickly matted grass and 70% of the plants in the cut sod shall be composed of one (1) species, height of 7 cm or less before sod is lifted. Sod, including the soil containing the roots and the plant growth, shall be cut to a uniform thickness. The sod shall be free of large stones, roots and other materials, which might be detrimental to grass growth.

- b) Agricultural Lime

Lime shall be ground limestone containing not less than 85% of total carbonates, and shall be ground to such fineness that 90% will pass through a No.20 mesh sieve and 50% will pass through No. 100 mesh sieve. Dolomitic lime or a high magnesium lime shall contain at least 10% of magnesium oxide. This shall be applied at the rate of 120 g/m².

- c) Fertilizer

The fertilizer shall be of standard commercial fertilizer supplied separately or in mixtures containing nitrogen, phosphoric acid, and water-soluble potash.

Fertiliser shall be applied at the rate of 120 g/m² and to depth of 5 cm to 10 cm.

It shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizer may be supplied in one of the following forms:

- A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
- A granular or pellet form suitable for application by blower equipment.

- d) Water

Water shall be sufficiently free from oil, acid, alkali, salt, or other harmful materials that would inhibit the growth of grass.

21806.3 Construction Method

- a) Preparation and Cleanup

The work shall be undertaken as soon as practicable after topsoiling works have been completed.

If any damage by erosion, landslip or other causes has occurred after the completion of grading or topsoiling and before beginning application of fertilizer and lime, the Contractor shall repair such damage. This may include filling gullies, smoothing irregularities, and repairing other incidental damage.

b) Applying Fertilizer and Lime for Sodding

Upon completion of the preparation and spreading of topsoil described above, fertilizer and lime shall be uniformly spread at a rate, which will produce specified quantity of each. These materials shall be incorporated into the soil to a depth of 5cm to 10cm by dicing, raking or other methods acceptable to the Engineer.

c) Obtaining and Delivering Sod

After inspection and approval of the source of sod by the Engineer, the sod shall be cut with approved sod cutters to such a thickness that after it has been transported and placed on the prepared bed, it shall have a uniform thickness of at least 5cm (before being compacted). Sod sections shall be cut in squares of not less than 25cm, but of such size as may be readily lifted without breaking, or tearing, or loss of soil. The Contractor may be required to mow high grass before proceeding to cut sod matt.

The sod shall be transplanted within 24 hours from the time it is stripped, unless circumstances beyond the Contractor's control make storing necessary. In such cases, sod shall be kept moist, and protected from exposure to the sun.

Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected. Where the soil is too dry, permission to cut may be granted only after it has been watered sufficiently to moisten the soil to the depth of sod to be cut.

d) Laying Sod

Sodding work shall be undertaken during an appropriate period.

Sodding may be allowed during periods of drought with approval of the Engineer, provided that the sod bed is moistened to a depth of at least 10 cm immediately prior to removing and laying the sod.

Sods shall be moist and shall be laid on a moist earth bed. Pitch forks shall not be used to handle sod, and dumping from vehicles shall not be permitted.

Sodding shall be carefully placed by hand, in rows at right angle to the slopes, commencing at the base of the area to be sodded and working upward.

Sods shall immediately be pressed firmly into contact with the sod bed by tamping or rolling with approved equipment to a true and even surface, and to ensure knitting without displacement of the sod or deformation of the surface of sodded area and the workmen when replacing it shall work from ladder or on a detached work stage to prevent further displacement.

Where the grades are such that run-off of storm water will be from paved surfaces across sodded areas, the surface of the soil in the sod after compaction shall be set approximately 3 cm below the pavement edge. Where the flow will be from the sodded areas towards the pavement surfaces such as around manholes and inlets, the surface of the soil in the sod after compaction shall be made flush with pavement edges.

On slopes steeper than a vertical to horizontal ratio of 1 to 2.5, sods shall be staked pegged with wooden or bamboo pegs spaced in an interval of not smaller than 30 cm. The stakes shall be driven flush with the surface of the sod.

c) Watering Sods

Adequate water and watering equipment must be on hand before sodding begins, and sod shall be kept moist until it has become established and its continued growth is assured. In all cases, watering shall be done in a manner, which will not cause damage to the finished surface.

21806.4 Maintenance and Care of Sod

a) Protection

All grassed areas shall be protected against traffic or other trespassing by warning signs or barricades approved by the Engineer.

b) Mowing

The Contractor shall mow the grassed areas with approved mowing equipment, depending upon climatic and growth conditions and the need for mowing.

c) Repairing Grassed Areas

Surfaces gullied or otherwise damaged following seeding shall be repaired by re-grading and re-seeding as directed by the Engineer.

d) The Contractor shall water as directed, mow and maintain the sodded areas in a satisfactory condition throughout the Defects Liability Period.

21807

Planting

21807.1 Scope of Work

a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution, completion and maintenance of Planting.

b) Planting shall be provided by the Contractor to all areas of the Engineers Design as indicated on the Drawings or specified herein.

c) Planting shall be provided by the Contractor to all required landscaped areas within the median of road, around the building and other required area, which are not seeded or sodded. Construction details, materials and workmanship for the Contractor design portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.

d) Prior to commencement of this work, the Contractor shall obtain the approval

of the Engineer on the materials to be used, the equipment to be used and the methods of work execution. No materials shall be used or installed until the Contractor has been notified by the Engineer of his approval.

- e) The work in this Section includes the provision of trees, shrubs and plants to all required areas of the Site. Planting shall include cultivation and preparation of the surfaces, including treating with fertiliser, provision of trees, shrubs and plants, re-planting as necessary, weeding, watering and pruning, all as necessary to provide well established and healthy Planting, all as shown on the Drawings or as directed by the Engineer and as specified herein.
- f) Planting works shall also include continued maintenance and responsibility by the Contractor, for all areas throughout the Defects Liability Period, including regular watering, weeding, pruning and replacement of any dead, dying or diseased trees, shrubs or plants.
- g) The general design/selection criteria shall be as follows:-
- Trees and shrubs: Selected variable types to provide a mixed, high dense screen and to prevent visual intrusion into the Plant areas.
Initial tree height shall be minimum 4 meters.
Medium and small sized trees and shrubs shall be provided to provide a variable appearance.
Provide in selected and approved areas around office buildings and car parking areas.
 - Plants: Provide dense ground cover planting, to cover landscaped areas and reduce weed growth and maintenance.
- h) Planting work shall be executed by a specialist firm(s) or specialist qualified personnel in the employ of the Contractor. The specialist firm (or Contractor as appropriate) shall assign experienced qualified personnel to design and to supervise the planting works.

21807.3 Planting

a) Planting Program

Planting shall be carried out during the appropriate season.

b) Delivery, storage and handling

Plants should be selected Tigüilote, Almendro de playa, Cenicero, Caoba, Cortes blanco, Flor amarilla or as designated by the Engineer.

All plants shall be basket or pot-grown, well formed and healthy. Plant materials shall be kept moist.

Trees must be pruned before they are planted.

c) Planting

Tree pits shall be excavated with vertical sides. Holes will be of 50 x 50 x 50 cm cube for small trees, and 80 x 80 x 80 cm for regular trees.

Holes shall be covered up until planted.

Top soil (15-20 cm) shall be clearly separated from the subsoil (\pm 40 cm) when digging for stockpiling and the holes shall be backfilled to satisfactory appearance.

Place plant materials for review and final orientation by the Engineer prior to installation.

Strong bamboo or wooden supports shall be driven into the ground.

A density of planting should not be more than 25 m² per tree.

Plants in the baskets shall put at the side of the holes. Then the baskets cut on four sides and removed, and the plants put into the holes.

Soil shall be backfilled and compacted.

Neck of the roots shall lie 5 - 7 cm above the surfaces of the soil.

The tree shall be then tied to the support with pliable ties after being wrapped first with black sugar palm fibre or coconut fibre. Any part of the trunk, which touches the stake, shall be wound with sugar palm or coconut fibre.

Thoroughly water soil when the hole is half full, and again when full. Water plant materials as indicated.

After planting, the plants shall be thoroughly watered by spraying.

d) Fertilizing

Apply fertilizer in accordance with manufacturer's instructions.

Apply after smooth raking of topsoil. Mix thoroughly into upper 20 cm of topsoil.

Lightly water to aid the dissipation of fertilizer.

21807.4 Maintenance

a) Watering

Watering shall be carried out twice a day for the young plants. When plants are established, watering is allowed to be reduced to once a day.

b) Trimming and Thinning

The Contractor shall remove superfluous leave growth, weak or crossing branches, suckers, shoots and generally thinning to open up the head to admit

more light and improve future growth.

Use good clean tools, and all cuts exceeding 1 cm, must be covered with tar.

c) Re-Shaping

The Contractor shall treat previously lopped trees by removal of all growth except for those selected shoots or branches, necessary to restore the tree to a more natural shape and branch system.

d) Spacing

Plants shall be allowed to display fully their individual character and to develop naturally in un-crammed conditions, or at least their own spread away from their neighbors.

e) Loosening of Soil and Weeding

Soil around tree trunk shall be cleared for a distance of 20 - 50 cm, and well loosened.

Soil around bushes or clusters shall be kept clear and loose to a radius of 20 cm.

Grass, groundcovers must be kept free from weeds.

f) Pest and Plant Disease Control

Treat plants to keep them healthy and fertile, free from any plant disease or garden pests.

Treatment shall be carried out by spraying insecticide every 10 - 14 days in the morning, when the weather is good.