installation will completely conceal the openings and will have bottoms in alignment with lower edge of masonry joints. Webs of hollow masonry units shall be cut to the minimum required for the installation. Reinforced masonry lintels shall be provided as indicated above openings over 300mm wide, for pipes, ducts and cable trays, unless steel sleeves are used.

4. Embedded Items

Spaces around built-in items shall be filled with mortar. Openings around flush-mounted electrical outlet boxes in wet locations shall be pointed flush with mortar including flush joints above the boxes. Anchors, ties, accessories, flashing, pipe sleeves and other items required to be built-in shall be built-in as the masonry work progresses. Anchors, ties, and joint reinforcement shall be fully embedded in mortar.

5. Unfinished work shall be stepped back for jointing with new work. Toothing may be resorted to only when specifically approved. Before laying new work, loose mortar shall be removed and the exposed joint shall be thoroughly cleaned.

6. Protection

Surfaces of masonry not being worked on shall be properly protected at all times. At the end of each workday period and when rain is imminent, the top of exposed masonry shall be covered with a strong non-staining waterproof membrane well secured in place and in a manner that will prevent moisture. Adequate provisions shall be made during construction to prevent damages by wind.

7. Mortar

Materials shall be accurately measured in laboratory-established proportions and mixed with as much water as may be necessary to produce the wettest workable consistency possible. Mortar shall be placed in final position within one hour after mixing. Mortar not used or that has started to set within this time interval shall be discarded.

8. Jointing

Joints in exposed-to-view except control joints, joints to be pointed or caulked or sealed, and openings around flush-mounted electrical outlet boxes in wet locations shall be tooled slightly concave with the mortar thoroughly compacted and pressed against the edges of the units. Tooling shall be done when the mortar has been thumbprint hard. The tooled joint shall be finished to uniformly straight and true lines and surfaces, smooth and free of tool marks.

9. Placing Reinforcing Steel

Prior to placing grout, all reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout or other coating which might destroy or reduce its bond with grout. Details of reinforcement shall be as indicated in the drawings. Reinforcing shall not be bent or straightened in a manner injurious to the steel. Bars with kinks or bends not shown on the drawings shall not be used. Placement of reinforcement shall be inspected and approved prior to placing grout. One piece vertical bars extending from floor to floor or roof above shall be provided. Vertical bars shall be spliced only where indicated.

a. Positioning Bars

Vertical bars shall be positioned accurately at the centerline of the wall. A minimum

clearance between the bars and masonry units of 12mm and between parallel bars of one diameter of the reinforcement shall be maintained. Vertical reinforcing shall be held in place using metal supports, centering clips, spacers, ties or caging devices located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement.

b. Splices

Splices shall be located only as indicated. Splices shall be staggered in adjacent bars at least 600mm. Bars shall be lapped a minimum of 40 diameters of the reinforcement.

PAINTING AND CLEANING

Mortar daubs or splashing, before setting or hardening, shall be completely removed from masonry unit surfaces that will be exposed or painted. Before completion of the work, all defects in joints or masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Masonry surfaces shall not be cleaned, other than removing excess surface mortar until mortar in joints has hardened. Masonry hardened surfaces shall be left clean, free of mortar daubs, dirt, stain and discoloration, including scum from cleaning operations and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

ITEM 14 : SECURITY FENCE

DESCRIPTION

This item shall consist of furnishing, construction and installation of security fence components in any combinations in accordance with this specification, lines, grades and cross-sections shown on the Plans, or as directed by the Engineer.

MATERIALS REQUIREMENT

Materials shall conform to the respective specifications and other requirements specified below

CONCRETE HOLLOW BLOCKS (CHB)

CHB shall be of standard manufacture, machine vibrated with fine and even texture and well-defined edges and conforming to the requirements of ASTM C 129. Unless otherwise specified on the Drawings, It shall have a minimum compressive strength of 4.14 MPa (600 psi). CHB shall be non-load bearing uniform and essentially smooth as normally achieves by standard molding methods and shall be free from any cracks, flaws or other defects.

BEDDING MORTAR

Mortar shall be composed of 1 part of Portland cement, 3 parts of sand and ½ part of lime. It shall have a compressive strength of [14 MPa (2,000 psi)] at 28 days and shall comply with property specifications for type N mortar set forth in ASTM Specification C 270 and as modified herein, proportioned and tested in an approved laboratory at the expense of the Contractor. When tested for water retention, the mortar shall have a flow after suction, of 75 percent or more when mixed to an initial flow of 125 to 140 percent. When tested for compressive strength, mortar shall be mixed to a flow of 100 to 115 percent. Aggregate for mortar shall conform to ASTM C 144.

PLASTER

Plaster shall comply with the same specification as those for bedding mortar and will include the use of synthetic fibrous reinforcement of type and dosage recommended by the manufacturer.

REINFORCING STEEL BARS AND RODS

Minimum yield strength of reinforcement shall conform to the specifications in Section of Reinforced Concrete.

CONCRETE

Minimum compressive strength of concrete shall conform to the specifications in Section of Reinforced Concrete.

BARBED WIRE AND STEEL/GI PIPE POST

The materials to be used shall conform to the specifications indicated on the drawings and shall be approved by the Engineer prior to installation.

CYCLONE WIRE MESH

Cyclone Wire Mesh shall conform to the requirements of ASTM A 121, Class I.

CONSTRUCTION REQUIREMENT

The Contractor shall perform such clearing and grubbing as may be necessary to construct the fence to required grade and alignment. Fence shall generally follow the contour of the ground. Grading shall be performed where necessary to provide a neat appearance.

The post shall be erected vertically in position inside the formwork of the foundation block prior to the placing of concrete shall be adequately supported by bracing to prevent movement of the post during the placing and setting of the concrete. The post shall be erected to the height and location shown on the Plans, or as ordered by the Engineer.

Masonry shall be laid plumb, true to line, with level courses accurately spaced. Bond pattern shall be kept plumb throughout. Corners and reveals shall be plumb and true. Vertical joints shall be shoved tight. Each unit shall be adjusted to final position while mortar is still soft and plastic. Any unit that is disturbed after mortar has stiffened shall be removed and relaid with fresh mortar. Courses shall be so spaced that backing masonry will level off, flush with the face work at all joints where ties occur. Chases and rake-out joints shall be kept free from mortar or other debris.

Anchorage to concrete. Anchorage to abutting columns shall be provided only where indicated. Details shall be as indicated including anchorage to underside of beams and slabs

Cutting and fitting, including that required to accommodate the work of others shall be done by masonry mechanics. Wherever possible, full units of the proper size shall be used in lieu of cut units. Cut edges shall be clean, true and sharp. Openings shall be carefully cut, formed or otherwise neatly made for recessed items and for electrical, plumbing, or other mechanical installations so that wall plates, cover plates, or escutcheons required by the installation will completely conceal the openings and will have bottoms in alignment with lower edge of masonry joints. Webs of hollow masonry units shall be cut to the minimum required for the installation. Reinforced masonry lintels shall be provided as indicated above openings over 300mm wide, for pipes, ducts and cable trays, unless steel sleeves are used.

Spaces around built-in items shall be filled with mortar. Openings around flush-mounted electrical outlet boxes in wet locations shall be pointed flush with mortar including flush joints above the boxes. Anchors, ties, accessories, flashing, pipe sleeves and other items required to be built-in shall be built-in as the masonry work progresses. Anchors, ties, and joint reinforcement shall be fully embedded in mortar.

Unfinished work shall be stepped back for jointing with new work. Toothing may be resorted to only when specifically approved. Before laying new work, loose mortar shall be removed and the exposed joint shall be thoroughly cleaned.

Mortar shall be accurately measured in laboratory-established proportions and mixed with as much water as may be necessary to produce the wettest workable consistency possible. Mortar shall be placed in final position within one hour after mixing. Mortar not used or that has started to set within this time interval shall be discarded.

Joints in exposed-to-view except control joints, joints to be pointed or caulked or sealed, and openings around flush-mounted electrical outlet boxes in wet locations shall be tooled slightly concave with the mortar thoroughly compacted and pressed against the edges of the units. Tooling shall be done when the mortar has been thumbprint hard. The tooled joint shall be finished to uniformly straight and true lines and surfaces, smooth and free of tool marks.

Details of reinforcement shall be as indicated in the drawings. Reinforcing shall not be bent or straightened in a manner injurious to the steel. Bars with kinks or bends not shown on the drawings shall not be used. Placement of reinforcement shall be inspected and approved prior to placing

grout. One piece vertical bars extending from floor to floor or roof above shall be provided. Vertical bars shall be spliced only where indicated.

a. Positioning Bars

Vertical bars shall be positioned accurately at the centerline of the wall. A minimum clearance between the bars and masonry units of 12mm and between parallel bars of one diameter of the reinforcement shall be maintained. Vertical reinforcing shall be held in place using metal supports, centering clips, spacers, ties or caging devices located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement.

b. Splices

Splices shall be located only as indicated. Splices shall be staggered in adjacent bars at least 600mm. Bars shall be lapped a minimum of 40 diameters of the reinforcement.

Welding shall be done in accordance with Standard Code and under supervision of Engineer.

PAINTING AND CLEANING

If required in the contract, paint shall be in accordance to the specification indicated in the plans and coordinated with the end user.

Mortar daubs or splashing, before setting or hardening, shall be completely removed from masonry unit surfaces that will be exposed or painted. Before completion of the work, all defects in joints or masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Masonry surfaces shall not be cleaned, other than removing excess surface mortar until mortar in joints has hardened. Masonry hardened surfaces shall be left clean, free of mortar daubs, dirt, stain and discoloration, including scum from cleaning operations and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

ITEM 15A : FINISHES

GENERAL

General Requirements contain provisions and requirements essential to these Specifications; and apply to this section, whether or not referred to herein.

SCOPE OF WORK

The work covered by this section consists of furnishing all labor, materials, equipment, tools, and incidentals necessary to undertake and complete all finishing works as indicated on the drawings and as specified herein.

Wall, floor, ceiling, and other finishing works shall include but are not limited to the following:

WALLS

Exterior

a. Plain cement finished painted with elastomeric paint.

Location as shown in the plans and elevations.

Interior

a. Plain cement finished painted with elastomeric paint.
b. 300mm x 600mm Vitrified Glazed Tiles

Plain Cement Finish

a. Surface Preparation

All surfaces shall be cleaned and projections, dust, loose particles and other materials, which would prevent good bond, shall be removed.

Plaster shall not be applied directly to concrete and masonry surfaces coated with bituminous compounds and surfaces previously painted or plastered.

All surfaces shall be thoroughly wetted before plastering.

b. Trial Mix

A trial mix of at least three (3) different water-cement ratios for a proposed mix shall be prepared under full scale conditions and adequate workability. The proportions by weight of cement to the weight of sand shall not be less than one part of Portland cement to two parts of sand.

The proportion of cement-sand and water necessary to produce the cement plaster of the required consistency shall be subject to the approval of the Engineer. Such approval may be withdrawn at any time and a change in proportions may be required. Based on the approved mix proportions, the Contractor shall prepare a list showing the number of kilograms of the various materials to be used in the cement plaster finish mix.

No cement plaster finish shall be started without an approved trial mix by the

Engineer.

c. Cement Finish Application

A brown coat with sufficient pressure shall be applied to fill the gaps, and to secure a good bond. Moistened for 48 hours, each coat of cement plaster shall be kept after application and allow to dry.

A finish coat shall be applied after the brown coat has set. The brown coat shall be moistened before application of the finish coat. Finish coat shall be floated to plumb, even planes and surfaces.

Final plaster finishes shall be rubber sponged.

d. Tolerance

The Contractor shall finish plaster work plumb, level, square and true within tolerance of 3mm in 3 meters, without cracks and other imperfections.

e. Patching and Cleaning

Upon completion of the building, and when directed, all loose, cracked, damaged or defective plastering shall be cut out and re-plastered in a satisfactory and approved manner.

Painting Works

a. Surface Preparation

Allow new masonry to dry for 14 days (for exterior surfaces) to 28 days (for interior surfaces) under normal conditions before painting. Surface to be painted should be clean and dry, free from oil, grease, dirt, dust, contaminants, and all loose grit and mortar.

Without mesh:

1st Coat: Elastomeric Wall Covering Sealer

2nd and 3rd Coat: Elastomeric Wall Covering Basecoat

4th Coat: Elastomeric Wall Covering Topcoat

With mesh:

1st Coat: Elastomeric Wall Covering Sealer

2nd Coat: Elastomeric Wall Covering Basecoat
Reinforcing Membrane: Fiberglass Matting

3rd and 4th Coat: Elastomeric Wall Covering Basecoat

5th Coat: Elastomeric Wall Covering Topcoat

Wall Ceramic Tiles

a. Wall tiles shall be glazed ceramic tiles color as per Architect's approval.

a. Trimmers and moulding shall be lustrous, glazed with size and color corresponding to wall tiles.

b. Portland cement, sand, bonding compound, lime and water shall conform with the requirements.

FLOORS

1. Substation (Power House)

F1 Plain Cement Finish

a. Switch Gear Area
b. Gen Set Area

F2 600mm x 600mm Unglazed Ceramic Tile Finish

a. Office

F3 600mm x 600mm Non-Slip Tile Finish

a. Office Toilet

F4 Non Skid or Rough Cement Finish

a. Ramps

a. Floor tiles shall be color varies and as shown on the drawings or to be designated by the Architect.

b. Portland Cement, sand, water and adhesive shall conform with the requirements.

c. Floor tiles shall be delivered in the manufacturer's original unbroken packages or containers that are labeled plainly with the manufacturer's name and brand. Containers shall be grade scaled. Materials shall be stored in dry weathertight enclosures, and shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness.

EXECUTION

Floor Tiles

a. Mortar Preparation

Mortar mix proportion and preparation shall be in accordance with the requirements.

b. Surface Preparation

Surfaces to receive the tiles shall be clean, and free of dust, dirt, oil, grease, and other deleterious substances. Floor tile operations in spaces receiving wall tile shall not be started until wall tile installation has been completed. Before tile is applied with a dry set mortar bed, the structural floor shall be tested for levelness or uniformity of slope by flooding it with water. Areas where the water ponds shall be filled and leveled with mortar and shall be retested before the setting bed is applied.

c. Placing of Setting Beds and Floor Tile

Mortar setting beds shall have a minimum thickness of 20mm for floors. The structural concrete slab shall be soaked thoroughly with clean fresh water on the day before the setting bed is to be applied. Immediately preceding the application of the setting bed, the structural slab shall again be wetted thoroughly, but no free water shall be permitted to remain on the surface.

A skim coat of neat Portland cement mortar shall then be applied not more than 4mm thick. The mortar shall be spread until its surface is true and even and thoroughly compacted, either level or sloped uniformly for drainage, as the case requires. A setting bed, as large as can be covered with tile before the mortar has reached its initial set, shall be placed on one operation; but in the event that more setting mortar has been placed than can be covered, the unfinished portion shall be removed and cut back to a clean beveled edge.

All mounted tiles shall be soaked in clean water a minimum of one hour before they are set. Absorptive mounted tile shall be dampened by placing sheets on a wetted cloth in a shallow pan before setting. No free water shall remain on the tiles at the time of setting. Before the initial set has taken place in the setting bed, a skim coat of neat Portland cement mortar, 0.7mm to 1.6mm thick, shall be trowelled or brushed over the setting bed and/or the back of the tile, or a thin layer of Portland cement, 0.79mm to 2mm thick, may be hand-dusted uniformly over the setting bed and worked lightly with a trowel or brush until thoroughly damp.

The tiles shall then be pressed firmly upon the setting bed, and beaten into the mortar until true and even with the plane of the finished floor line. Beating and leveling shall be completed within one hour after placing tiles or sheets. Borders and defined lines shall be laid before the field or body of the floor. Where floor drains are provided, the floors shall be sloped to drain properly to the drains. Intersections and returns shall be formed accurately.

Cutting of tile, where necessary, shall be done along the outer edges of the floor. As far as practicable, no tiles of less than half size shall be used. Cutting and drilling of tiles shall be done neatly without marring the tile surfaces. The cut edges of tile against trim, bases, thresholds, pipes, built-in fixtures, and similar surfaces shall be ground and jointed carefully. Tile shall fit closely and neatly at all plumbing fixtures and around electrical outlets, pipes and fittings so that cover plates or escutcheons will overlap the tiles properly. Tiles shall be secured firmly in place and loose tiles or tiles sounding hollow shall be removed and replaced. All lines shall be kept straight, parallel, and true, and all finished surfaces brought to true and even planes. The inner edges of borders shall be kept straight and, where practicable, shall form right angles at all returns. The paper and glue shall be removed from mounted tile, without using excess water, within one hour after installing the tiles.

Joints shall be parallel and uniform in width, plumb, level and in alignment. End joints in broken-joint work shall be made as far as practicable, on the center lines of adjoining tiles. Except in special arrangement and design, as indicated or specified, square tiles shall be set with straight joints, and oblong tiles shall be set with broken joints.

Joint widths shall be uniform and spaced to accommodate the tile in the given spaces with a minimum of cutting. Tiles shall be wetted, if they have become dry, before applying grout. Joints 3.2 mm or less in width shall be grouted with a neat Portland cement grout of the consistency of thick cream. Other joints shall be

pointed with mortar consisting of one part Portland cement and two parts pointing sand. The grout or mortar for joints on floors shall be white Portland cement or as specified by the Engineer. Grout painting mortar shall be forced into joints by using trowel, brush or finger application. Before the grout or mortar sets, the joints of cushion edge tile shall be struck or tooled to the depth of the cushion, filling all skips or gaps, and the joints of square-edged tiles shall be filled completely flush with their surface. Dark cement shall not be seen through grouted white joints.

All surplus mortar or grout shall be removed before it has been set or hardened.

d. Cleaning and Curing

Floors shall be covered with waterproofed paper with all joints lapped at least 96 mm and allowed to damp cure for at least 72 hours before foot traffic is permitted thereon.

All completed tile work shall be thoroughly sponged and washed diagonally across joints, and finally polished with clean, dry cloth. Acid cleaning of unglazed tile, when necessary, shall not be done within ten days after setting the tile. All metal shall be covered with approved grease and the tile shall be wetted with clean water, before tile is cleaned with 10% muriatic acid solution. After acid cleaning, the tile shall be flushed with clean water, and the grease coating on metal shall be removed.

Finished tile floors shall be covered with clean building paper before foot traffic is permitted on them. Board walkways shall be placed on floors that are to be continuously used as passage ways by workmen. Thresholds shall be covered with boards. Tiles vertical outside corners (external angles) shall be protected with board corners strips in areas used as passage by workmen.

Ceiling

1. Passenger Terminal Building

C1 - Spandrel Ceiling

a. Eaves

Locations are shown in the plan.

C2 - 12mm Thick Gypsum Board Painted On 0.40mm Thick Galvanized Steel Ceiling Suspension System @ 0.40m O.C. (Furring), 600mm O.C. (Carrying Channel) and 0.60m O.C. Both Ways (Suspension Rod)

a. Office
b. Toilet

SUBMITTAL

1. Shop drawings for all finishing and painting works for the building shall be submitted in advance to allow twenty-eight days for review and approval. Shop drawings shall indicate materials and details of finishing works. The Contractor shall be responsible for all errors of

detailing and fabrication, and for the correct finishing work items shown on the shop drawings.

2. The Contractor, before placing order for the finishing materials shall submit to the Engineer for approval representative samples of finishing materials. No placing of orders for material for finishing works shall be made without his approval.

3. Samples of all walls finishes, measuring not less than 1000mm x 1000mm shall be submitted to the Engineer for approval as to its finish texture and workmanship.

QUARTZ TILES

a. Selected quartz slabs for toilet countertops, fascia and splashboard. Dimensions as shown on the drawings.

b. Shall be sound material with uniform and favorable working qualities and with very limited natural faults.

c. Color, veining and quality shall be approved by Engineer.

d. Veining shall run vertically on all vertical surfaces and direction of veining shall continue in same directions over horizontal surfaces except as directed by the Engineer.

e. Sealer

e. 1. Shall be a commercial penetrating type free from harmful alkali or acid content specially prepared for marble work
e. 2. Shall have a Ph factor between 7 and 9
e. 3. Shall not discolor
e. 4. Shall produce a slip resistant surface
e. 5. Shall have a flash point not less than 35 °C

f. Cleaning fluid

f. 1. Shall be commercial neutral liquid type especially prepared for marble work
f. 2. Shall have a Ph factor between 7 and 9
f. 3. Shall be free from crystallizing salts or water soluble alkaline salts
f. 4. Shall be biodegradable and phosphate free

INSTALLATION OF DOORS

1. Surface Preparation

Ensure surfaces to receive panels are structurally sound, even, smooth, clean, dry, and free from defects detrimental to work.

DOORS

Substation (Power House)

D-1 - Roll-Up Door, GA 18 Galvalume Finish, 1-Ton Chain Block with Locking Mechanism for Pulll Chain (4000mm x 3000mm)

D-2 - 44mm Thick 2 Leaf Metal Door with Fixed Metal Louver in Quick Drying Enamel Paint Finish, GA 16 Steel Door Jamb, Full Mortise Heavy Duty Ball Bearing Hinges, Orbit Type Lockset, Top and Bottom Flush Bolts for Inactive Door (1800mm x 2100mm)

D-3 - 44mm Thick 1 Leaf Metal Door with Fixed Metal Louver in Quick Drying Enamel Paint Finish, GA 16 Steel Door Jamb, Full Mortise Heavy Duty Ball Bearing Hinges, Orbit Type Lockset, Top and Bottom Flush Bolts for Inactive Door (900mm x 2100mm)

D-4 - 44mm Solid Wood Painted Finish Panel Door Including Door Jamb, Full Mortise Heavy Duty Ball Bearing Hinges, Orbit Type Lockset, Surface Mounted Door Closer and Floor Mounted Stopper (800mm x 2100mm)

D-5 - 44mm Hollow Core Flush Door with Marine Ply Painted Finish and Wood Louver at the Bottom, Including Door Jamb, Full Mortise Heavy Duty Ball Bearing Hinges, Orbit Type Lockset, Surface Mounted Door Closer, and Floor Mounted Stopper (800mm x 2100mm)

D-6 - 44mm Hollow Core Flush Door with Marine Ply Painted Finish and Wood Louver at the Bottom, Including Door Jamb, Full Mortise Heavy Duty Ball Bearing Hinges, Orbit Type Lockset (700mm x 2100mm)

INSTALLATION OF WINDOWS

1. Surface Preparation

Ensure surfaces to receive panels are structurally sound, even, smooth, clean, dry, and free from defects detrimental to work.

W-1 - Fixed Metal Louver Window GA 18 in Quick Drying Enamel Paint Finish Including GA 16 Channel Window Jamb (2500mm x 2300mm)

W-2 - 1.5mm thk. Aluminum-Framed Powder Coated Finish Fixed Type and Awning Window with 10mm Thick Reflective Tempered Glass (2500mm x 1500mm)

W-3 - 1.5mm thk. Aluminum-Framed Powder Coated Finish Fixed Type Window with 10mm Thick Reflective Tempered Glass (2000mm x 1250mm)

W-4 - 1.5mm thk. Aluminum-Framed Powder Coated Finish Awning Type Window with 10mm Thick Reflective Tempered Glass (1200mm x 500mm)

W-5 - Industrial Supply/ Exhaust Type Fan, Wall Mounted – 1070mm Diameter, 19,715 CFM Rating, 2 HP Motor, (515 RPM. Corrosion Resistant) (1250mm x 1250mm)

W-6 - Toilet Exhaust Fan – Wall Mounted (200MMa) 70 CFM Rating, Corrosion Resistant (500mm x 500mm)

ITEM 15 B: CARPENTRY AND JOINERY WORKS

SCOPE OF WORK

The work shall consist of furnishing all tools, labor, equipment and materials, unless otherwise specified to complete all carpentry and joinery works shown on the Drawings and specified herein.

GENERAL REQUIREMENTS

a. Lumber Grades

Lumber shall be of the best grade available, of the respective kinds required for the various parts of work; well seasoned, thoroughly dry and free from loose or unsound knots, sap, shakes or other imperfections impairing its strengths, durability and appearance. All exposed woodwork shall be smooth by dressed and sandpapered unless otherwise indicated or specified. Framing lumber shall be of the rough dimensions unless otherwise shown on the drawings.

b. Substitution of Lumber

Any lumber equally good for the purpose intended maybe substituted for the kind specified, subject to prior written approval of the Engineer. Provided, however, that in the substitution of the cheaper kind of lumber than that specified, a reduction in the contract price equal to the difference in the costs of the two kinds of lumber shall be made.

c. Delivery and Storage

The Contractor shall deliver lumber to the site in undamaged condition. Lumber shall be stacked in such a manner as to insure proper ventilation and drainage, and shall be supported at least 150 mm above-ground. Lumber shall be protected against dampness before and after delivery, and enough protection under cover in well ventilated enclosure, not exposed to extreme changes of temperature and humidity; and in a manner as to provide air-circulation around all surfaces of each pile to insure thorough air-seasoning. Lumber or millwork in buildings shall not be finished until concrete, masonry work and plaster are dry. Lumber shall be delivered at least thirty (30) days before use.

d. Grading of Plywood

Each sheet of plywood shall bear the mark identifying the plywood as to wood species, glue type and grade.

MATERIALS

a. Lumber

Lumber for various uses shall be one of the species listed for the purpose indicated unless otherwise specified in the drawing. For any use not specified, the lumber shall be the best commercial grade normally used for the purpose, subject to the approval of the Engineer.

All framings shall be done as far as possible with carefully fitted mortise and tenon joints.

All doors, windows, transoms, or other opening where so indicated on plans, shall have frames and sills of the dimensions shown or as hereafter detailed, and all frames coming in contact with concrete shall be anchored by means of 20-d nails, spaced not more than 0.20m, apart, all around the contract surfaces. All frames shall be rabbeted, molded and cut with saw and cut under for water drips.

SPECIE	U S E
Yakal	All door jambs, headers and transom bars, wood plates and all other woodwork in contact with concrete or masonry and where indicated.
Apitong (pressure treated)	All truss members and rafters and where indicated; all wood framings and carpentry, except when in contact with concrete.
Tanguile (Kiln dried)	All exterior and interior mill work, siding, finish and trim, frame work and all other wood works not specifically mentioned; except when in contact with concrete.

b. Plywood

Plywood shall conform to Commercial Standard PSI and shall be of local manufacture.

Plywood to be varnished shall be tanguile or kalantas veneers (as indicated), ribbon grained, water resistant, Class B and of the thickness indicated.

Plywood to be painted shall be tanguile veneer ordinary rotary-cut, water resistant, Class C and of thickness indicated.

Plywood exposed to the outside elements or where indicated shall be waterproof or marine plywood and of the thickness indicated.

c. Fastenings

Fastenings shall be common nails, glue or specified, flat-head wood screws (F.H.W.S.), rough-head wood screws (R.H.W.S.), bolts or lag screws where specified or called for shall be used. Conceal fastenings as much as possible; where not possible, locate them in inconspicuous places, where nailing is permitted through woodwork smooth-finished face, conceal nail heads.

1. Nails

Shall be of the smooth shank, zinc coated, common wire nails of local manufacture, and of types and sizes best suited for the purpose.

2. Wood Screws

Shall be brass or cadmium plated of the best available commercial quality, and of types and sizes suited for the purpose.

PRESSURE TREATED LUMBER

a. Preservative Treatment

All lumber indicated to be pressure treated, shall contain any of the following net retention of solid preservative.

a. Boliden Salts - 45.5 kg. dry chemical per cubic foot of wood
b. Wolman Salts - 0.31 kg. dry chemical per cubic foot of wood
c. Tenalith Salts - 0.34 kg. dry chemical per cubic foot of wood

The Contractor shall submit an affidavit signed by an official of the preservative treatment company to the Engineer. This affidavit shall indicate the net retention of solid preservatives obtained and shall certify that pressure treated lumbers have a moisture content that does not exceed 17 percent upon shipment from the treatment plant.

Where it is necessary to cut or bore pressure-treated lumber on the job, two coats of prepared concentrated preservatives solution shall be applied to the end-cut or bored surfaces.

ROUGH CARPENTRY

All work shall be well-fitted, accurately set, and rigidly secured in place. Anchors and bolts (with nuts and washers) straps and tie rods shall be provided as required.

a. Cutting and Fitting

Cutting and fitting to accommodate other work shall be done in the required manner, and cut or damaged work shall be patched and made good.

b. Framing and Structural

Framing and structural lumber shall be well-seasoned, straight, square-edge stacks, and free from loose or unsound knots, bark edges, or other defects that will impair its strength.

c. Plates for Walls and Partitions

Plates for walls and partitions shall be of the same width as the studs and shall form continuous horizontal ties.

Structural members shall not be cut, bored or notched for the passage of pipes or conduits without prior approval of the Engineer. All members damaged by such cutting or boring shall be reinforced by means of specially formed and approved sheet metal or steel shapes or remove or replaced with new member as directed.

Anchors, connectors and fastenings not indicated or specified otherwise shall be of the size and types necessary to suit the conditions encountered. Size, type and spacing of nails, screws or bolts for installation of manufactured building materials shall be as recommended by the product manufacturer unless indicated or specified otherwise.

Rough hardware, exposed to weather or in contact with exterior walls or masonry or slabs shall be zinc-coated except as specified otherwise.

All lumber surfaces in contact with concrete or masonry shall be given a brush coat of bituminous paint before installation.

JOINERY WORK

All lumber used for the joinery work shall be of the kinds and grades specified and shall be of the contours, patterns and profiles indicated.

All joints shall be made, installed tight and securely fastened in a manner approved by the Engineer. Exterior joints shall be mitered and interior angles coped. Panels shall be fitted to allow for shrinkage, avoid swelling, and insure that the work remain in place without warping, splitting and opening of joints.

Interior trims shall be approved standard stock moldings, except where special patterns or profiles are indicated.

Joints for cabinet work shall be glued in addition to nails or other fastening device required. Nailing shall be concealed where practicable. Where face nailing is used, nails shall be set for putty stopping.

All exposed surfaces shall be machined or hand-sanded finished to an even smooth surface. No hammer marks or other unsightly marks shall be allowed on any wood panel or veneer.

WOOD LAMINATES AND WOOD PLASTIC COMPOSITE PANELS

INTRODUCTION

a. Wood Laminate

A wood laminate is a thin sheet of material used to cover the core of a wood project in order to change the appearance of the material. Laminates may be any material, but typically they are made of veneers, which are thin sheets of wood.

High-pressure decorative laminates are characterized by their qualities, durability, and functional performance. High-pressure laminate sheets are available in a wide variety of colors, patterns, and surface finishes. They are resistant to wear, scratching, impact, moisture, heat, and staining; and possess good hygienic and anti-static properties, being easy to clean and maintain.

b. Wood-plastic composite

Wood-plastic composite architectural products are a sustainable timber alternative with added benefits such as durability and strength.

SCOPE OF WORK

This item shall consist of furnishing all wood laminates and wood composite panel materials, labor, tools and equipment required in undertaking the proper installation as shown on the Plans and in accordance with these specifications.

SPECIFICATIONS

a. Wood Laminates: 0.8mm thick Wood Grain Laminates for Interior Cladding or any approved equivalent by the designing Architect.

b. Wood Composite Panels:

Supply and Installation of Wood-Plastic Composite Fluted panels in sizes: 224mm X 26mm X 2900mm or any approved equivalent by the designing Architect.

Supply and Installation of Wood-Plastic Composite Ceiling Baffles in sizes: 50mm X 90mm including angle bracket support or any approved equivalent by the designing Architect.

SUBMITTALS

a. Product Data

Manufacturer's printed product literature, specifications, and data sheets

b. Shop Drawings

Indicate project layout; dimensions and thickness of panels; connections; details and locations of joints and sealant; methods of anchorage; number of anchors; supports; reinforcement; flashings; accessories; materials; and finishes.

c. Samples

1. Sample materials for selection and verification of finishes, colors, and textures.

2. Sample of panel assembly.

QUALITY ASSURANCE

a. Fabricator/installer to be accepted by the manufacturer.

b. Fabricator/installer to have work similar in scope and size to this project.

c. Take field measurements prior to completion of shop manufacture or fabrication. Coordinate fabrication schedule with construction progress to avoid delay of work. Field fabrication should be allowed to ensure proper fit and keep it to a minimum with the majority of fabrication being done under controlled shop conditions.

PREPARATION

Ensure surfaces to receive wood laminates and wood-plastic composite panels are structurally leveled, even, smooth, clean, dry, and free from defects detrimental to work. Notify consultant thru writing of conditions unfavorable to proper and timely completion of work. Do not proceed with erection until unsatisfactory conditions have been corrected.

ACCESSORIES

Screws, nuts, washers, bolts, rivets, angle bars and other miscellaneous fastening devices shall be made of non-corrosive materials such as aluminum and stainless steel.

ITEM 15 C: ROOFING AND TINSMITHRY

SCOPE OF WORK

The work shall include but not limited to all labor, materials, tools, equipment and incidentals necessary to furnish and install the roofing sheets including fittings, flashing caps, ridge rolls, gutters and construction of concrete eaves and canopy excluding waterproofing, to provide completely sound water tight roof for the buildings as shown on the Drawings and specified herein.

MATERIAL REQUIREMENTS

ROOFING SHEETS

Ultra Panel
Roof, Long span, pre-painted, pre-insulated roof panel system, composed of an exterior metal skin cladding using "snap on side overlap" fastening system and an interior liner cladding of eitheretal skin or aluminum kraft vapor barrier sandwiched between is, PIR "Polyisocyanurate" foam to provide a high level thermal insulation.

Base Metal thickness	:	0.37mm, 0.47mm, 0.57mm
Total Coated thickness	:	0.40mm, 0.50mm, 0.60mm
Anti-rust Coating	:	Alloy coating of aluminum and zinc. Alloy is comprised of 55% aluminum, 43.4% zinc and 1.6% silicon
Coating Standards	:	AZ 150 (150 gm/m^2) ASTMA A - 792 ASTM A - 792
Back Coat	:	5 – 8 microns bottom coat
Length	:	up to transportable length (long span), minimum chance of leaks
Color	:	White
Material Finish	:	Pre-painted galvalume of 0.50mm thk. of metal with 25mm thk. Polyisocyanurate foam "PIR" insulated with aluminum kraft paper backing
Insulation Thickness	:	50mm thk. PIR / 75mm thk. polyisocyanurate foam PIR)
Insulation Materials	:	composed of MDI (polymetric methyl diphenyl isocyanurate) with certain types of polyol

EXECUTION

ROOFING SHEETS

1. Roof, Long span

   Spacing of purlins safe at 1.0m to 1.2m.

   At least 28 days before laying of roofing sheet start, the Contractor shall submit for

approval of the Engineer, shop drawings indicating materials and method of installation. No roofing sheets laying work shall commence without the Engineer's approval of the shop drawings and work method.

Laying shall start from the end opposite the side from where the prevailing monsoon is coming from. The first sheet shall be laid and installed with the turned-down edge towards the outside of the area to be covered. The next sheet shall be overlapped to the previous sheet in such a manner that the exposed edge is turned down and the covered edge is turned up. The overlapped edge in the side shall be with the rib having the anti-capillary groove. End and side laps including flashing shall be as approved by the Engineer.

The straps shall be fixed and fastened with the fastener and washer as shown on the Drawings.

STEEL CANOPY

Construction of the steel canopy shall be in accordance with the Technical Drawings and as directed by the Engineer.

Roofing shall be a 6mm thick Solid Sheet Polycarbonate.

HANDLING AND STORAGE

The sheet shall be lifted directly and shall not be dragged over the other sheets or rough surfaces.

When working on a roof, the workers shall wear flat rubber-soled shoes.

The tool shall be handled carefully to prevent them from sliding over the coated surface.

When installation work is completed, all metal off-cuts, used nails and other metallic scrap shall be removed from the roof area.

When using drills, hacksaws, or files in the roof area, care shall be taken that metal particles and fillings are swept off the roof immediately.

If not required for immediate use, sheets or bundles shall be staked and clear off the ground. If left in the open, sheets shall be protected by loose tarpaulin or similar covers.

Bundles shall not be left expose to the weather.

C CHANNEL

Aluminum C-channel is often referred to as architectural angle and channel. Aluminum C-channel has uses in many industries and is often an ideal choice due to its non-corrosive properties and structural strength. Aluminum C-channel is considerably less expensive than wood, is lighter in weight, insect resistant, and resists warping and cracking from water damage.

C-sections
Height: 100, 120, 150, 200, 250, 300 mm
Thickness: 1.0–3.0 mm
Minimum length 1600 mm
Maximum length 18000 mm

ITEM 15 D : MODULARS, TABLES AND CHAIRS OF VARIOUS TYPE INCLUDING ACCESSORIES

GENERAL

General Requirements contain provisions and requirements essential to these Specifications; and apply to this section, whether or not referred to herein.

SCOPE OF WORK

The work covered by this section consists of furnishing all labor, materials, equipment, tools and incidentals necessary to undertake, a complete supply of gang chairs for the buildings as indicated on the drawings and as specified herein.

MODULARS

Modular System	*Unit*	*Quantity*
Office Table (1500mm x 750mm)	no.	4.00
Side Table	no.	2.00

CHAIRS

Chairs	*Unit*	*Quantity*
Sofa Set	no.	1.00
Mid-back Office Chair	no.	3.00

SUBMITTAL

1. Shop drawings for all gang chair for the building shall be submitted in advance to allow twenty eight days for review and approval. Shop drawings shall indicate materials and details of finishing works. The Contractor shall be responsible for all errors of detailing and fabrication, and for the correct finishing work items shown on the shop drawings.

2. The Contractor, before placing order for the supply shall submit to the Engineer for approval representative samples of finishing materials. No placing of orders for material for finishing works shall be made without his approval.

EXECUTION

All materials will be delivered and installed (if needed to be installed) on site.

ITEM 15 E : CONCRETE WATERPROOFING

GENERAL

General Requirements contain provisions and requirements essential to these specifications and apply to this Section, whether or not referred to herein.

SCOPE OF WORK

The work shall cover the waterproofing requirements for the building as shown on the drawings.

The work shall consist of furnishing all labor, materials, equipment, and other incidentals necessary for the integral waterproofing works where required as shown on the drawings and in accordance with the requirements of these specifications as directed by the Project-In-Charged.

SUBMITTAL

1. Material description and physical properties, application details, and recommendations regarding shelf life, application procedures, and precautions on flammability and toxicity.

2. Samples for each waterproofing type.

DELIVERY AND STORAGE

Deliver manufactured waterproofing materials in manufacturer's original, unopened containers, with labels intact and legible. Containers of materials covered by referenced specification number shall bear the specification number, type, and class of the contents. Store and protect materials in accordance with the manufacturer's instructions, and use within their indicated shelf life. Promptly remove from the site materials or incomplete work adversely affected by exposure to moisture. Use pallets and canvas tarpaulins to cover stored materials top to bottom.

PRODUCTS

I. DEEP PENETRATING SEALER

Deep Penetrating Sealer (DPS) is an environmentally friendly, non-toxic, odorless, clear, water-soluble liquid compound, which is safe and easy to use.

Deep Penetrating Sealer (DPS) penetrates below the surface and chemically reacts with the alkali and lime found in concrete. This reaction creates a silica gel membrane within the pores and capillaries of the concrete, permanently sealing it against the ingress of moisture yet allowing the concrete to breathe. Over a period of time, the silica gel membrane hydrates and solidifies into a crystalline structure, increasing the hardness and strength of both new and old concrete while reducing moisture vapor emissions and permanently stopping the penetration and flow of water and water-borne contaminants such as chlorides and acids, both on the positive or negative side forging a waterproofed and preserved concrete structure.

EXECUTION

- All existing dirt and other surface contaminants adhering on the surface must be thoroughly removed. Apply Concrete Neutralizer using sufficient coats to completely neutralize the surface. Do not wash off. When sufficiently dry, dust lightly to remove crystalline deposits.

- Mix thoroughly the product mixture as per manufacturer's instruction. Any change from the recommended proportion will affect its quality. Scrape the bottoms, sides and corners of the container to ensure complete and full blending. Prepare only enough quantities that can be used within the pot-life period. Do not delay application. Apply DPS by brush or roller or by using an airless spray.

- Allow to cure overnight prior to application of topcoat.

ii. **FLEXIBLE MODIFIED CEMENTITIOUS**

Flexible Modified Cementitious (FMC) is a two-component latex modified cementitious coating. It can be simply achieved by mixing the pre-packed dry-mixing powder with the formulated flexible latex admixture, and subsequent brushing the slurry on various substrates. It protects a wide range of buildings and structural concrete components with excellent resistance to water, aggressive chemicals, long-term weathering, and scratching. It is applicable for those structures subjected to long-term water immersion.

1. Free surfaces from dirt or foreign materials. For the waterproofing to work best, manufacturers recommend the surfaces be sand blasted, bush-hammered or acid-etched.

2. Apply 2 coats of the cementitious waterproofing. The first coat could include the manufacturer's materials only. The second coating will include a cement-sand mixture and also have chemical and metallic elements too. If supplementary waterproofing is required, then a third coat may be required. This typically includes sand and cement for that extra protection.

Methods of Application

Trowel

Application of the coating is done using the handheld trowel, by simply applying and spreading the coating using the trowel.

Spray

This method uses spraying equipment like the ones used in painting vehicles.
It is preferred due to its precise finish and efficiency. It is also faster to use the spray than the trowel method.

Brush

Use a typical brush similar to roll brushes that are used in painting houses. It also has a uniform finish and is faster to use compared to the trowel.

It is good to note that different surfaces will dictate the method of application.

ITEM 15 F : PAINTING

GENERAL

General Requirements contain provisions and requirements essential to these Specifications; and apply to this section, whether or not referred to herein.

SCOPE OF WORK

This Section covers the surface preparation, coating materials and application of coatings systems required for the Works.

The work shall consist of furnishing of all labor, materials, equipment and other incidentals necessary for the supply of painting materials and the complete painting of surfaces as shown on the drawings in accordance with this Specification and as directed by the Engineer.

The term paint as hereinafter used includes emulsion paints, varnishes, oils, pigments, thinner and dryers.

All exposed metal surfaces, except metal surfaces embedded in concrete, shall be painted unless otherwise specified.

STANDARD

The following publications listed below, but referred to thereafter by basic designation only, forms a part of these Specifications to the extent indicated by the reference thereto:

Steel Structures Painting Council (SSPC) U.S. Specification JIS K 5628 Red-lead Zinc Chromate Anti-Corrosive Paint.

SUBMITTAL

1. The Contractor shall submit work method statements with lists of materials to the Engineer for approval twenty eight days before the starting of works. This statement shall include following items:

    a. Type of paint and manufacturer
    b. Manufacturer's specifications
    c. Storage and delivery of materials
    d. Surface preparation
    e. Finish painting and drying
    f. Touch-up painting, if any
    g. Equipment

2. The Contractor, before placing order for the painting materials, shall submit to the Engineer for approval samples of materials. No placing of orders for material shall be made without his approval.

STORAGE AND DELIVERY

1. The Contractor shall deliver all material to the site in the original labeled sealed cans and containers, with labels intact and seal unbroken.

    a. Seals shall remain unbroken until after inspection and acceptance of material by the Engineer.

b. The Contractor shall deliver materials in ample quantities sufficiently in advance of the need to avoid any delay or interruptions in the works.

2. Paint in thinner shall be stored in accordance with the approved manufacturer's instructions.

a. All regulations required for storage of paint shall be observed and all necessary safety signs required by governing codes shall be posted.

b. Any damage caused by failure to exercise proper precautions in paint storage shall be repaired.

MATERIAL REQUIREMENTS

PAINT

Paints for the protective coating system shall be the product of a manufacturer approved by the Engineer.

Paints for exterior finish must be with tile like durability and elegance, fast drying, solvent based acrylic, highly suitable for coastal or polluted areas with excellent anti-fungus properties and alkali resistance.

100% Acrylic, water based, quick-drying, easy to clean-up and environmentally friendly, resist dirt, stains, alkali, water, humidity, algae, mold and mildew growth and highly durable paint for interior finish.

An all-purpose synthetic quick dry paint for all types of wood and metal surfaces. It has high gloss, good color retention and outstanding durability.

For pipes, valves and equipment, galvanized and ungalvanized ferrous metal, use a 100% acrylic gloss paint, has excellent resistance to ultraviolet rays and resists chalking, cracking and color fading, dries fast and environmentally friendly.

SCHEDULE OF PAINTING

Architectural Items	
a. Exterior Finishes	
1. On Concrete Walls	
Three Coats, Concrete Masonry Paint	Elastomeric Paint or approved equal
2. Unprimed Ferrous Metal	
First Coat	Red Oxide Primer, #310 or approved equal
Second & Third Coat	Quick Dry Enamel or approved equal
3. On Concrete Block Wall	
Masonry Neutralizer	Masonry Neutralizer #44 or approved equal
Three Coats	Elastomeric Paint

Concrete Masonry Paint	or approved equal
4. On Wood	
First Coat Exterior Wood Primer	Flatwall Enamel or approved equal
Second & Third Coat Exterior enamel	Quick Drying Enamel or approved equal
b. Interior Finishes Location of the various finishes are listed in the Finish Schedule on the drawings or else will be confirmed by PPA	
1. On primer and coated metal two coats of interior semi-gloss enamel or as indicated in the Schedule finish	Red Oxide Primer #310, Quick Dry Enamel or approved equal
2. On Plaster	
First Coat	Masonry Neutralizer #44 or approved equal
Three Coats	Elastomeric Paint or approved equal
3. On Wood	
First Coat Enamel undercoater	Flatwall Enamel or approved equal
Second & Third Coat Exterior enamel	Quick Drying Enamel or approved equal
4. Wood Stain Finish	
First Coat Second & Third Coats Fourth & Fifth Coats	Oil Wood Stain , Lacquer Sanding Seale r#1254 Clear Gloss Lacquer #1250 or approved equal
c. Non – Architectural Items (Piping, valves, equipment, etc.)	
1. Piping, valves, equipment etc. in rooms are to be painted	
2. Galvanized pipes and ducts	
Primer – one coat Finish – one coat	Red Oxide Primer, #310 or approved equal Quick Dry Enamel or approved equal
3. Black steel pipes	
Primer – one coat Finish – one coat	Red Oxide Primer, #310 or approved equal Quick Dry Enamel or approved equal
4. Mechanical Items	
a. Ungalvanized ferrous metal Primer – one coat Finish – one coat	 Red Oxide Primer, #310 or approved equal Quick Dry Enamel or approved equal or approved

	equal
b. Galvanized ferrous metal Primer – one coat Finish – one coat	 Red Oxide Primer, #310 or approved equal Quick Dry Enamel or approved equal or approved equal
c. Submerged galvanized ferrous metal Primer – one coat	Red Oxide Primer, #310 or approved equal
d. Buried miscellaneous ferrous surface valves, & flanged joints (excl. pipe) Primer – one coat	Red Oxide Primer, #310 or approved equal

EXECUTION

SURFACE PREPARATION OF STEEL

1. Steel surfaces shall be cleaned as follows:

   a. All round welds, burrs and sharp surface projections shall be ground smooth and all weld splatter shall be removed prior to blast cleaning.

   b. Sand abrasives, if used, shall be clean, and free from salt and extraneous matter. The sand shall pass through a 2.0mm test sieve, and be substantially retained on a 0.18mm test sieve, with at least 25 percent retained on a 0.355mm test sieve.

   c. Metallic abrasive, if used, shall be sharp, hard and free from dust, and shall pass through a 1.8 mm test sieve.

   d. Blast cleaning operations shall not be conducted on surfaces that will be wet after blasting and before coating, or when the surfaces are less than 10°C above degree points, or when the relative humidity of the air is greater than 95 percent.

   e. Any oil, grease, soil, dust or other foreign matter deposited on the cleaned surfaces shall be removed prior to painting. In the event that rusting occurs after completion of the surface preparation, the surfaces shall be cleaned again in accordance with the specified method.

   f. Particular care shall be taken to prevent the contamination of other corrosive chemicals before the application of the paint. Such contamination shall be removed from the cleaned surface by flash blasting and the paint applied immediately.

   g. Care shall be taken to prevent contamination of cleaned and painted surfaces by cleaning operations in an adjacent area.

   h. Surfaces not to be painted shall be suitably protected from the effects of cleaning and painting operations.

SURFACE PREPARATION OF WOOD

1. Wood surfaces shall be sanded to a fresh surface. Surface mould where present, shall be removed by washing, rubbing down and burning off as necessary. Resinous exudation

and large knots shall be removed and replaced with filler or other materials approved by the Engineer.

2. Parts of timber to be enclosed in walls shall always be primed unless already impregnated. Priming shall be brushed on and a minimum of two coats applied to end grain. When the priming paint is hard, all cracks, holds, open joints, etc. shall be made good with hard stopping and rubbed down with fine abrasive paper. Priming of joinery shall be applied only on site after the Engineer has approved such joinery and before it is fixed. For internal surfaces primer coats shall be carefully flatted.

SURFACE PREPARATION OF CONCRETE AND PLASTER

Concrete and cement plaster surfaces to be painted shall be prepared by removing efflorescence, dust, dirt, grease, oil, asphalt, tar, excessive mortar and mortar dropping and by roughening to remove glaze. A zinc sulfate solution shall be applied before prime cost.

SURFACE PREPARATION FOR FIBER CEMENT SURFACES

Shall be dry and clean prior to application of the specified first-coat material. Oil, grease, or rust stains shall be carefully removed by the use of suitable solvent. Wire brushing will not be permitted. After the first coat has become dry and prior to application of finish coats, touch-up coats shall be applied to suction spots.

ALUMINUM FRAMES FOR DOORS AND WINDOWS

All metal surfaces shall undergo pre-treatment process which includes: desmutting, water-rinsing, degreasing/etching, water rinsing, zinc phosphating, water rinsing and acid rinsing.

Powder coating application, shall be factory applied and shall be done in one operation using an electro-static powder gun. The materials to be coated should be well connected to earth. Coating thickness should be kept to a minimum of 60 microns for exposed areas. On details which are to be treated mechanically after coating (drilling, sawing, etc.), the coating film must not exceed 100 microns.

The powder coating shall be oven cured in the range of 20 minutes at 220° C (metal temperature measured on the area with greatest metal thickness). The temperature variation in the oven should not exceed +/- 10° C.

Handling

Coated items should be cooled to no less than 40° Centigrade before handling. Precautions should be taken to avoid damages on the finished coating during stacking, storing and transportation.

Storage and Delivery

Inspect materials delivered to the site for damage. Unload and store with minimum handling. Provide storage space in dry location with adequate ventilation, free from dust or water and easily accessible for inspection and handling. Store materials neatly on the floor, properly stacked on non-absorptive strips or wood platforms. Protect finished surfaces during shipping and handling using manufacturer's standard method.

WOOD REPAIR

Badly decayed areas shall be removed and repaired. Areas and pieces decayed beyond repair shall be replaced with new pieces that match originals in all respects. Moderately decayed areas, weathered, or gouged wood shall be patched with approved patching compounds, and shall be

sanded smooth. The source or cause of wood decay shall be identified and corrected prior to application of patching materials. Wet wood shall be completely dried to a moisture content not exceeding 12 percent, as measured by a moisture meter, to its full depth before patching, unless otherwise authorized. Wood that is to be patched shall be clean of dust, grease, and loose paint.

1. Epoxy Wood Repair

   Epoxy wood repair materials shall be applied in accordance with manufacturer's written instructions. Health and safety instructions shall be followed in accordance with the manufacturer's instructions. Clean mixing equipment shall be used to avoid contamination. Mix and proportions shall be as directed by the manufacturer. Batches shall be only large enough to complete the specific job intended. Patching materials shall be completely cured before painting or reinstallation of patched pieces.

2. Epoxy Consolidant and Epoxy Paste

   Epoxy liquid wood consolidant shall be used:

   1. To penetrate and impregnate deteriorated wood sections in order to reinforce wood fibers that have become softened or absorbent.

   2. As a primer for areas that are to receive epoxy paste filler. Epoxy paste shall be used to fill areas where portions of wood are missing such as holes, cracks, gaps, gouges, and other voids.

MIXING AND THINNING

Mixing and thinning of paint shall be done in accordance with the approved manufacturer's printed instructions. The pot life of each paint as stated by the manufacturer shall not be exceeded.

WEATHER CONDITION

The paint shall not be applied when the relative humidity is above 85 percent. The paint shall not be applied in rain, wind, fog, dust or mist.

APPLICATION

Workmanship shall be first class in every respect. All work shall be done in a workmanship manner so that the finished surfaces shall be free from runs, chop, ridges, waves, laps and unnecessary brush marks. All coats shall be applied in such manner as to produce an even film of uniform thickness. Edges, corners, crevices, welds and rivets shall receive special attention to ensure that they receive an adequate thickness of paint.

All painting shall be done by thoroughly experienced workmen.

Safety regulations shall be adhered to at all times, including the wearing of respirators by persons engaged on assisting in spray painting. Adjacent areas and installation shall be protected by the use of cloths or other approved precautionary measures.

Plain enamel and varnish shall be applied carefully with good clean brushes or approved spraying equipment, except that the initial coat on any surface shall be applied with brush. Sufficient time shall be allowed between coats to assure thorough drying and each coat shall be in proper condition before receiving the next coat.

Sanding and dusting as required shall be performed between coats in varnishing work. Finish

coat shall be smooth and free from runs, sags, and other defects. Exterior paint shall not be applied during rainy days.

All paint when applied shall provide a satisfactory film and smooth, even surface. Paint shall be thoroughly stirred and kept at a uniform consistency during application. Powdered metallic pigments added at the time of use shall be mixed by adding the powder in small increments to about one-third of the base paint or vehicle, with thorough mixing to obtain a smooth paste. The remainder of the base paint shall then be thoroughly stirred in.

Different brands of emulsion paints shall not be mixed prior to application of the materials.

Where necessary to suit conditions of surface temperature, weather and method of application, the package paint may be thinned immediately prior to application in accordance with the approved manufacturer's directions, but not in excess of 125 cc of suitable thinner per liter (one pint per gallon). Before using, the paint shall be mixed to a uniform consistency and shall be stirred frequently during application.

Paints other than water-thinned paints shall be applied only to surfaces which are completely free of moisture as determined by sight or touch and only such combinations of humidity to be painted as will cause evaporation rather than condensation.

Surfaces which have been cleaned, pretreated and/or otherwise been prepared for painting shall be primed or painted with one coat of finish paint as soon as practicable after such preparation has been completed, but in any event prior to any deterioration of the prepared surfaces.

The first coat of paint on all exterior surfaces shall be applied by brush. Interior prime coats and all other subsequent coats on either exterior or interior surfaces may be applied by brush or spray. Whenever spraying is permitted all areas inaccessible to spray painting shall be coated by brushing or other suitable means. Brushes to be used for application of water-emulsions shall be soaked in water for a period of 2 hours prior to use.

All cloths and cotton waste which might constitute a fire hazard shall be placed in closed metal containers or destroyed at the end of each day.

Upon completion of the work, all staging, scaffolding, and containers shall be removed from the site or destroyed in a manner approved by the Engineer. Paint spots, or stains upon adjacent surfaces shall be removed and the entire job left clean and acceptable to the Engineer.

No smoking shall be permitted in the vicinity where painting is going on.

TOUCH-UP PAINTING

Touch-up painting shall be done with the same paint as used for the original coat. The resulting minimum dry film shall be the same as for the original coat.

Touch-up painting shall include cleaning and painting of field connections, welds and all damaged or defective paint and rusted areas.

During touch-up painting, only loose, cracked, brittle or non-adherent paint shall be removed during cleaning. All exposed edges shall be feathered. Touch-up painting shall be performed in a manner which will minimize damage to sound paint. Rust spots shall be thoroughly cleaned and edges of the existing paint shall be scraped back to sound material.

DRYING

1. No primer or paint shall be forced to be dried under conditions which will cause cracking, wrinkling, blistering, formation of pores which would detrimentally affect the condition of the paint.

2. No drier shall be added to the paint unless specified in the approved manufacturer's instructions.

3. Painted surfaces shall be protected from dust, dirt, and the elements of the weather until dry to the fullest extent practicable.

4. After drying, any areas of paint damaged from any cause shall be removed, the surface again prepared and then touched-up with the same paint and to the same thickness as the undamaged areas as specified in sub-section 4.14.3.7 above.

HANDLING

1. Precautions shall be taken to minimize damage to paint films resulting from stacking for drying.

2. Paint which is damaged in handling shall be scraped off and touched-up with the same paint and in the same thickness as was previously applied to the damaged area at Contractor's expense.

INSPECTION

1. All works and materials supplied under this Specification shall be subject to inspection by the Project-In-Charge.

2. The Contractor shall correct such works or replace such materials found defective under these Specifications at his own expense.

ITEM 15 G : TERMITE PROOFING, BUKBOK PROOFING

GENERAL

General Requirements contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

SCOPE OF WORK

The Contractor shall hire the services of an approved or accredited pesticide company to furnish all labor, materials, equipment, tools, plant, and services to complete the termite and "bukbok" proofing work hereinafter described.

EXAMINATION OF SITE

Inspect the site of work and examine the premises to fully understand existing conditions with respect to the work involved. Prior to soil stripping, excavation or filling all termite mounds within the area should be demolished, removed and treated.

MATERIAL REQUIREMENTS

CHEMICALS AND EQUIPMENT

For termite proofing, use Termiticide Concentrate acceptable to the PPA and should have license from Fertilizer and Pesticide Authority.

For "bukbok" proofing of kiln dried wood and for untreated wood, use chemical name accredited name/or acceptable to the PPA and should have valid license from Fertilizer and Pesticide Authority (FPA).

The pest control Contractor shall submit the specified chemicals in their original manufacturer sealed containers to the Project Inspector of inspection, sampling and safekeeping. Containers with broken seal shall not be accepted.

Dilution ratings (for Termicide Concentrate):

1 part Termicide Concentrate TC to 50 parts water

Pesticides - 1 : 100 concentration

Dilutions shall be done only at the jobsite in the presence of the Project Inspector. The strength of the mixture or solutions shall be made uniform by thorough stirring. All solutions prepared for termite proofing shall be used within 24 hours.

EXECUTION

CONTRACTOR LICENSE AND CERTIFICATION REQUIREMENT

The pesticide company should have a valid license from Fertilizer and Pesticide Authority of the Department of Agriculture.

All pesticide shall be applied by or under the direct supervision of a certified pesticide applicator.

ENVIRONMENTAL AND SAFETY CONDITIONS

Formulation, treatment, storage and disposal of pesticide shall be in accordance with label directions. Water for formulation shall be drawn only form site(s) designated by the Project Inspector, and the filling hose shall be fitted with a backflow preventor meeting local plumbing codes/standards. The filling operation shall be under the direct and continuous observation of the Project Inspector to prevent overflow.

APPLICATION

1. Termite Control

Application of solution shall be done by means of power sprayers fitted with flow meters for accurate monitoring of actual quantity used. At the time of soil treatment application, the soil shall be preferably in a friable condition with low moisture content to allow uniform distribution of the treatment solution throughout the soil. Do not apply pesticide during or immediately following heavy rains, or when conditions will cause runoff and create an environmental hazard. Cover treated area with waterproof sheeting if concrete is not poured on the same day as the soil treatment. Take precautions to prevent disturbance of the pesticide barrier. Before the placement of structural components, re-treatment where soil or fill is disturbed after treatment. Apply pesticide prior to placement of gravel base, vapor barrier or waterproof membrane.

a. Slab on Grade Construction

Establish a horizontal pesticide barrier over areas intended for covering by floors, porches, attached entryways, garages, carports and terraces. Apply treatment solution with a low pressure coarse spray at the rate of four (4) liters solution per square meter. Apply at the rate of seven (7) liters solution per square meter if the fill is washed gravel or other course material. Establish a continuous chemical barrier in the voids of hollow block foundation or voids of masonry. Apply treatment at the rate of seven (7) liters per 3 linear meter. Make pesticide band at least 15 cm wide the pesticide evenly distributed throughout. Treat buildings constructed with basement slabs in the same manner.

b. Crawl Space Construction

Establish a vertical pesticide barrier inside of foundation walls, both sides of interior partition walls, around piers, plumbing, and rodding and utility conduits. Apply treatment solution by rodding or rodding and trenching the fill at the rate of 15 liters solution per 3 linear meter, and 30 cm deep from grade to bottom of foundation. Treat both sides of foundation and around all piers and pipes. Make treated barrier of fill at least 15 cm wide with the pesticide evenly distributed throughout.

c. Dry Pipes and Conduits

Establish pesticide barrier on various dry pipes and conduits such as electrical service entrance, raceways, pipe chase, vents. Use powder type termiticide by injecting it inside the pipe.

d. Termite Mounds

Demolish and treat all termite mounds within the property found after the construction.

2. "Bukbok" Proofing

Kiln-dried wood, plywood, tanguile, apitong, cabinets, dividers, and paneling shall be brushed generously with Pesticides before painting or varnishing.

3. Sun-Dried Wood Treatment

Sun-dried lumber to be used for ceiling joint runners, nailer, etc. shall be brushed with Pesticides before installation of plywood or ceiling panels.

ENGINEERS

The Contractor shall submit to the Engineer for approval, a copy of the pest control company's proposal and chemical application, method/procedure including the description of the equipment to be used before start of work.

INSPECTION AND TEST

Sampling shall be done only in the presence of the Project Inspector.

Amount of sample to be taken: 50 cc each.

CONTRACTOR'S GUARANTEE

Upon completion of work, and on a condition for final acceptance, the Contractor shall submit to PPA a written guarantee from the pesticide company which shall provide that:

1. The soil poisoning treatment shall prevent subterranean termites from attacking the building on its contents for a period of not less than five (5) years.

2. The Contractor shall thereby warrant all works in pest control that all materials and workmanship applied under the contract are of good quality in every respect and will remain as such for not less that five (5) years.

   Should there be termite and "Bukbok" infestation within the one (1) year period the Contractor thereby agrees to do all necessary repairs on the damaged portions of the buildings caused by termite infestation to the satisfaction of PPA, at the Contractor's expense. Retreatment shall also be done by the Contractor after completion of the repairs and at his expense. Such repairs and corrective works shall be done within five days after a written notice from the Owner has been received by the Contractor.

   Should there be infestation after the one (1) year period up until the five (5) year guarantee, the pesticide company agrees to do all the necessary repairs at their expense. The pesticide company shall conduct annual inspection of the building and surrounding to check any infestation during the guarantee period. Notice shall be given by the pesticide company to PPA in case there is presence of termites in the surroundings.

ITEM 16 : PLUMBING AND SANITARY WORKS

SCOPE OF WORK

The work covered for this section shall consist of furnishing all labor, tools, equipment, materials, and incidentals necessary for the complete installation, testing, and operation of the plumbing and sanitary system within the buildings and premises in accordance with these Specifications and as shown on the drawings or as directed by the Engineer. The septic tank and its effluent and discharge pipelines shall be part of other sections of these specifications.

MATERIAL REQUIREMENTS

SUBMITTAL

1. The Contractor shall submit his work method statement with necessary shop drawings to the Engineer for approval twenty-eight (28) days before the start of the works.

   Shop drawings shall be dated and shall contain the name of the project and location of the subject item in the shop drawing which is to be installed.

   The Engineer will review and approve or return for correction all shop drawings with reasonable promptness. The Contractor shall make any corrections required and file with the Engineer three (3) corrected copies of the shop drawings.

2. The drawings shall indicate the general arrangement of all piping, however, where actual conditions necessitate re-arrangement in the opinion of the Contractor and/or the Engineer, the Contractor shall prepare and submit to the Engineer for approval, within twenty-eight (28) days before placing the order for materials, shop drawings of the proposed re-arrangement. Because of the small scale of the drawings, shop drawings to indicate all offsets, fittings and accessories shall be prepared. The Contractor shall carefully examine the drawings and shall carefully investigate actual structural and finish conditions affecting all his work.

3. The Contractor shall be responsible for the proper fitting of materials, equipment and accessories without substantial alteration and at no cost to the Employer.

4. The Contractor shall be responsible for the proper coordination of the work and shall provide all necessary clearance where necessary.

STANDARDS

Use of materials shall further be governed by other requirement imposed on other sections of these Specifications. Materials shall be subject to tests necessary to ascertain their fitness if the Engineer so requires. All works shall comply with the pertinent provisions of the Plumbing Code of the concerned city or town, the Code on Sanitation of the Philippines, and/or the National Plumbing Code of the Philippines.

MATERIALS

1. Identification of Materials

   Each length of pipe, fittings, traps, fixtures and devices used in the plumbing work shall have cast, stamped or indelibly marked on it, the approved manufacturer's trademark or name, the weight, type and class of product when so required by the standards mentioned above.

2. Alternative Materials

Use of any material not specified in this Specification may be allowed provided such alternate has been approved by the Engineer and provided further that a test, if required, shall be done by an approved agency in accordance with generally accepted standards.

3. Soil, Waste, Drain, Vent Pipes and Fittings

Soil, waste and vent pipes shall be unplasticized Polyvinyl Chloride (uPVC) pipes. Diameter shall be as indicated on the Drawings. It shall conform to ASTM D 1784 or ASTM D 2729.

Drainage pipes shall be reinforced concrete pipes (RCP), diameter shall be as indicated on the Drawings.

4. Jointing Material

The joint material for uPVC pipes shall be PVC solvent cement as recommended by the approved pipe manufacturer.

5. Water Supply Pipes

Water supply pipes shall be polypropylene random-80 (PPR-80) pipes PN 20 conforming to DIN Standards DIN 1988/DIN 8078. Jointing shall be fusion welded.

6. Cleanouts, Plugs and Tee

Cleanouts shall be of the same material as the pipe to be fitted. Cleanouts installed in connection with uPVC hubs and spigot pipes shall consist of a long sweep quarter bend of ¼ as shown on the drawings.

7. Pipe Sleeves

Pipe sleeves shall be installed and properly secured in place at all points where pipes passes through masonry or concrete. Pipe sleeves shall be uPVC pipe, Schedule 40.

8. Downspout

All downspouts shall be unplasticized polyvinyl chloride (uPVC) pipe class DWV conforming to ASTM D2729 or ASTM D1784 for sanitary pipes, Series 1000.

9. Splash Block

Provide splash blocks at the outlet of downspout emptying at grade which shall be made of pre-cast concrete, with smooth finished counter sunk dishes sloped to drain away from the building. Dimensions as shown on the Drawings.

10. Roof Strainers

The Contractor shall provide fittings and install 100mm G.I. mesh wire strainers where shown or indicated on the drawings and/or where the Engineer directs. Each strainer shall fit the size of the corresponding downspout which is to be installed.

11. Shower, Floor and Urinal Drain

Shower and floor drains shall be made of stainless steel non-tilting grate, perforated or slotted. Urinal drains shall be cast iron dome type drain.

12. Pipe hangers, Inserts and Support

a. Pipe hangers shall be wrought iron, malleable iron pipe hangers spaced not over 1.5 meters apart for uPVC pipes and 3.0 meters apart for iron pipes. Chain straps, perforated bars or wire hangers will not be permitted.

Hangers shall have short turnbuckles or other approved means of adjustment. Turnbuckles may be omitted on hangers where space does not permit their use. Trapeze hangers may be used in lieu of separate hangers for pipes running parallel to each other and close together.

b. Inserts shall be of cast iron or cast steel and shall be of a type to receive a machine bolt head or nut after installation.

c. Wrought iron clamps or collars shall be used to support vertical runs of pipes.

13. Unions

Union pipe 50mmØ and smaller shall be malleable iron. Union on water piping 63mmØ and larger shall be a flanged pattern and shall be of galvanized (zinc-coated) cast iron. Gaskets for flange unions shall be of the best quality fiber plastic or leather.

14. Valves

Valves shall be cast bronze of brass body. Chrome plated finish for all fixture taps and faucets and natural finish for all others, like hose bibbs, gate valves, and which are not tapped directly to a plumbing fixture. Concrete valve boxes shall be installed where required and will be of sufficient size for operating the valve.

15. Fixtures

a. Water Closets

All water closets for toilets as shown on the drawings shall be FLUSHOMETER VALVE TYPE, white with complete fittings and mounting accessories.

b. Lavatories

b. 1. Lavatory (Wall Hung)

Shall be vitreous china, wall-hung lavatory with rear overflow holes, fitting ledge suitable for single faucet holes on centers complete with faucet, standard fittings, trap and lavatory brackets, and other accessories.

b. 2. Lavatory (Countertop Lavatory)

Shall be vitreous china, oval or round shaped countertop lavatory with front overflow hole, complete with faucet, supply valve, and fittings with P-trap. Fitting ledge suitable for single hole on center.

c. Urinals

c. 1. Urinals for all comfort buildings shall be built-in urinal trough as shown on the drawings.

c. 2. Urinals shall be vitreous china, wall-hung washout urinal, flushing rim, integral trap, 19mm top and shall be provided with water saving flush system.

d. Service Sinks

Service sinks where indicated or shown on the Drawings shall be stainless steel, with a single bowl and with complete U.S. or Japan-imported fittings.

e. Slope Sinks

Slop sink shall be 24"x20" acid-resisting enamel on cast iron with a concealed hanger and faucet.

Hose bibb shall be of brass finish.

f. Soap Holder

Soap holder and toilet paper holder shall be vitreous china, wall mounted. All toilet/bath rooms will be provided with soap holder, toilet paper holder and chrome plated towel racks.

g. Faucet for lavatory

Faucet for lavatory shall be in chrome-finish.

h. Grab Bar

Grab bar shall be tubular stainless steel, 38mmØ or as specified in the drawings.

i. Bidet Spray Combination

Installed in every cubicle near on the water closet, colored white or its equivalent

16. Concrete, Reinforcing Steel, Pipe and Steel Plate

Materials for wash pits, catch basins, and manholes shall conform to the requirements as follows:

a. Concrete materials shall conform with the requirements in "Concrete Works" and shall be Class C concrete with a 28-day minimum compressive strength of 21 MPa (3,000 psi).

b. Reinforcing steel shall be as shown on the drawings and shall conform with the requirements of reinforcing steel bars in "Concrete Works."

c. Pipes shall be as shown on the drawings and shall comply with the relevant item of the particular pipe.

d. Steel plates shall be as shown on the Drawings and shall comply with Section "Steel and Metal Works".

18. Valve for Drinking Fountain

Valve where drinking fountain will be connected shall be polished brass pipe and shall have red enameled handle.

EXECUTION

All installation works shall be in conformity with the National Plumbing Code of the Philippines (NPCP).

EXCAVATION, TRENCHES AND BACKFILLING

1. Trenches for all underground pipelines shall be excavated to the required depth. The bottom of trenches shall be tamped hard and graded to secure the required fill. Bell holes shall be excavated so that pipes will rest on solid ground for their entire length.

   Rocks where encountered, shall be excavated to a depth of 150mm below the bottom of the pipe and before the pipe is laid, the space between the bottom of the pipe and the rock shall be filled with sand. Sewer and water pipes shall be laid in separate trenches.

2. After pipelines have been tested, inspected and approved by the Engineer and prior to backfilling, all forms shall be removed and the excavation shall be cleaned of all trash and debris.

   Materials for backfilling shall consist of acceptable excavated soil, borrow of sand, gravel or other materials approved by the Engineer and shall be free from trash, lumber or other debris. Backfilling shall be placed in horizontal layers not exceeding 150 mm in thickness and properly moistened to approximate optimum requirements. Each layer shall be compacted by hand or machine tamper or by other suitable equipment to a density that will prevent excessive settlement or shrinkage.

   Backfilling shall be brought to a suitable elevation above grade to provide for anticipated settlement and shrinkage thereof.

   Water pipes shall have a sand cushion 150mm below and above the pipes.

INSTALLATION OF SOIL, WASTE DRAINS OR VENT PIPES

1. Horizontal Drainage Pipe and Vent Piping

   Horizontal waste pipes 75mmØ and smaller shall have a minimum grade of 6.5mm per 0.30m and for 100mmØ and larger, 3.2mm per 0.30m. All main vertical soil and waste stacks shall be extended full size above the roof line as vents, except where otherwise specifically shown.

   Where practicable, two (2) or more vent pipes shall be connected together and extended as one pipe through the roof. Vent pipes in roof spaces shall be run as close as possible to the underside of roof with horizontal piping pitched to stacks using fittings as required without forming traps in pipes.

   Vertical pipe vents may be connected to a vent line carrying other fixtures. The connection shall be at least 1.20m above the floor on which the fixtures are located to prevent the use of vent lines as waste. Horizontal waste lines receiving the discharge from two (2) or more fixtures shall be provided with vents, unless separate venting of fixtures is noted.

2. Fittings

All changes in pipe sizes on soil waste lines shall be made with reducing fittings or recessed reducers. All changes in direction shall be made by the appropriate use of forty five (45) degree wyes. Long sweep quarter bends or elbows may be used in soil and waste lines where the change in direction of flow is from the horizontal to the vertical and on the discharge from water closets.

Where it becomes necessary to use short radius fittings in any location, the approval of the Engineer shall be obtained before they are installed.

3. Joints

a. PVC Soil Pipe

All joints in uPVC soils, waste, and vent pipe shall be accomplished by the use of PVC solvent cement.

b. All joints for uPVC shall be accomplished by applying the manufacturer's recommended solvent before connection to the pipe.

4. Cleanouts

Cleanouts at the bottom of each soil stack, waste stack, and where else indicated shall be the same size at the pipe.

Cleanouts on floors shall be by uPVC plug adapter fit into the hub and fitted with uPVC screw plugged flush with the floor.

Cleanout shall be provided at every change in direction greater than 45 degrees.

5. Flashings

All pipes passing through the roof shall be provided with lead flashings. All flashings shall be built to 40 lbs. bituminous felts and shall extend up to the pipe and down-over to top of pipe at least 150mm and along the roof not less than 300mm and shall lap over flashing to make a weatherproof joint.

6. Traps

Each fixture and piece of equipment requiring connections to the drainage system, except fixtures with continuous waste, shall be equipped with a trap. Traps shall be specified to be supplied with the fixtures. Each trap shall be placed as near to the fixtures as possible.
Traps installed on threaded pipes shall be recessed drainage pattern.

7. Pipe Sleeves, Hangers, and Supports

Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through masonry or concrete except unframed floors on earth.

Pipes shall not be permitted to pass through footings or beams unless noted on the drawings.

Pipe sleeves in floors shall extend not less than 25mm and not more than 50mm above the finished floor. After installation of the pipe, the space around the pipe shall be packed with plastic material and made watertight. Flashing shields for sleeves passing through the

waterproofing membrane shall be thoroughly mopped into the membrane. The space between the pipe and sleeves shall be made watertight by inserting approved sealing and caulking materials.

INSTALLATION OF WATER PIPES, FITTINGS, AND CONNECTIONS

1. Gate Valves and Outlets

Gate valves shall be installed close to the point of connection to the existing service line outside the building. The piping shall be extended to all fixture outlets and equipment from the gate valves. Outlets where indicated shall be capped or plugged and left ready for future connections.

2. Mains, Branches, and Runouts

All runs of piping shall be installed as shown on the drawings. The piping shall be cut accurately to measurements, and installed at the building site by the Contractor and shall be worked into place without springing or forcing. Care shall be taken not to weaken the structural portions of the buildings.

All pipes above ground shall be run parallel with the lines of the building unless otherwise shown on the drawings. Branch pipes from service lines may be taken off on top of mains, bottom of mains, or side of mains, using such cross-over fittings as may be required by structural or installation conditions.

All service pipes, valves, and fittings shall be kept at a sufficient distance from the other work to permit finished covering not less than 6.5mm from such other work and not less than 13mm between finished covering on different services. No water piping shall be buried in floors unless specifically indicated on the drawings or approved. Changes in pipe sizes shall be made with reducing fittings.

The use of long screws and bushings is prohibited.

3. Joints

Joints and connections in the plumbing system shall be gas-tight and watertight for the pressures required by the test.

After cutting and before threading all pipes shall be reamed and shall have burrs removed. All screwed joints shall be applied with an approved graphite compound or TEFLON tape to facilitate connections. Threads shall be full cut and not more than three threads on the pipe shall remain exposed.

Caulking of threaded joints or top to prevent leaks shall not be permitted.

Unions shall be provided where required for disconnection. Threaded swing bolts shall be used for branch connections to risers and mains.

4. Unions

Where required unions shall not be concealed in walls, ceilings or partitions.

5. Tests

The following tests shall be conducted by the Contractor at his expense under the supervision of the Engineer.

a. Tests for Drainage and Venting System

The entire drainage and venting system shall have necessary openings plugged to permit the entire system to be filled with water to the level of the highest vent stack above the roof. The system shall hold the water for 30 minutes with a drop not greater than 100mm.

b. Sterilization

The entire water supply piping system shall be sterilized with a solution containing not less than fifty (50) parts per million of available chlorine, either liquid chlorine or a solution of sodium hypochlorite. The sterilizing solution shall remain in the system for a period of not less than 8 hours during which time all valves and faucets shall be opened and closed several times. After sterilization, the solution shall be flushed from the system with clean water until the residual chloride content is not more than 0.2 parts per million.

c. Pressure Test for Water Lines

1. After the pipe has been installed, the joints are completed and with joints exposed for examination, all newly installed pipe or any valve section, thereof, shall be subjected to hydrostatic pressure one and one half (1½) the designed working pressure of the system or as specified by the Engineer.

2. The duration of each pressure test shall be at least 20 minutes unless otherwise specified by the Engineer.

3. Each section of the pipeline shall be slowly filled with water and the specified test pressure, measured at the point of lowest elevation, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. During the filling of the pipe and before applying the test pressure, all air shall be expelled from the pipeline. To accomplish this, tap shall be made if necessary, at the highest point of the pipe under test and after completion of the test, the taps shall be tightly plugged unless otherwise specified. During the test, all exposed pipes, fittings, valves, joint and couplings will be carefully examined. If found to be cracked or defective, they shall be removed and replaced by the Contractor with sound materials at his expense. The test shall then be repeated until satisfactory results are obtained.

d. Leakage Test for Water Lines

1. Leakage test shall be conducted after satisfactory completion of the pressure test and shall consist of an examination of all exposed joints for leakage as well as an overall leakage test of the completed pipeline.

2. The pressure to be maintained during the test shall be the designed working pressure of the system.

3. Leakage test shall be made only after a minimum of 24 hours after the pipe to be tested has been filled with water.

4. The duration of each leakage test shall be two hours unless otherwise specified by the Engineer.

5. Each section of pipeline shall be slowly filled with water and the specified test pressure, measured at the point of lowest elevation shall be applied by means of a positive displacement type pump and reservoir connected to the pipe in a manner satisfactory to the Engineer.

6. Before starting the leakage test, all air shall be expelled from the pipe. All exposed pipes, fittings, valves and joints shall be examined for leakage during the test.

7. Allowable leakage rate per 100 joints per inch of Pipe Diameter at Pressure Stipulated.

PRESSURE		LEAKAGE RATE	
psi	kg/cm^2	liters/hr.	liters/2 hrs.
50	3.50	1.45	2.90
75	5.30	1.75	3.50
100	7.00	2.05	4.10
125	8.80	2.30	4.60
150	10.50	2.50	5.00
200	14.00	2.90	5.80

e. Defective Work

1. If the inspection or test shows any defect, such defective work or material shall be replaced and the test shall be repeated until satisfactory to the Engineer.

2. All repairs to piping shall be made with new materials at the expense of the Contractor.

3. No caulking of screwed joints or holes will be accepted.

ASSEMBLY, INSTALLATION AND CONNECTION OF FIXTURES

Fixtures shall be supported and fastened in a satisfactory manner. Where secured to concrete or masonry work walls, fixtures and equipment shall be fastened with brass bolts or machine screws in lead-sleeve type anchorage units or with brass expansion bolts. Expansion bolts shall enter 7.5 cm into solid concrete or masonry works and shall be fitted with loose tubing or sleeves of proper length to bring expansion sleeves into the solid concrete masonry walls.

Where wood screws are used, screws shall go into solid pieces set between studs. Where through-bolts are used, bolts shall be provided with plates or washers at back set, so that they will be concealed by plaster. Bolts and nuts shall be hexagonal and exposed nuts, cap nuts, and screw heads shall be provided with chromium plated brass washers.

PROTECTION OF FIXTURES

Pipe openings shall be closed with caps or plugs during installation. Fixtures shall be tightly covered and protected against dirt, water and chemical injury. At the completion of all works, all fixtures shall be thoroughly cleaned and delivered in a condition satisfactory to the Engineer.

FIXTURES AND FASTENING

All fixtures shall be supported and fastened in a satisfactory manner as follows:

1. Where secured to concrete or concrete hollow block walls, they shall be fastened with one quarter inch brass bolts with twenty threads to the inch and of sufficient length to extend at least 7.5 cm into solid concrete or hollow block work, fitted with loose tubing or sleeve insert and shall be securely anchored and installed flush with the finished wall and shall be completely concealed when the fixtures are installed.

2. Where through-bolts are used, they shall be provided with plates or washers back set so that heads, nuts and washers will be concealed by plaster. Bolts and nuts shall be hexagonal. Exposed bolts, nuts, capnuts and screw heads shall be provided with chromium plated brass washers.

GUARANTEE

Upon completion and before final acceptance of the equipment installation, the Contractor shall furnish the Engineer a written guarantee stating that all equipment installed under this Section free from defects. The guarantee shall be for a period of one (1) year from the date of final acceptance of the work. Any part of the equipment that becomes defective during the term of the guarantee shall be replaced, renewed and/or made good by the Contractor, at his own expense and in a manner satisfactory to the Engineer.

Guarantees made by the approved manufacturers or suppliers beyond one year, shall be transferred to PPA without any expense on his part.

CLEANING UP

Upon completion of the work, all parts of the installation shall be thoroughly cleaned of grease, metal cuttings and sludge which may have accumulated during the testing operation.

PLUMBING, FIXTURES AND TOILET ACCESSORIES INSTALLATION

All installation works shall be as shown on the drawings and shall conform to the applicable standards set forth by the Philippine National Plumbing Code. All fixtures shall be fastened and/or supported in accordance with the given requirements.

Item No. 17

TECHNICAL SPECIFICATION FOR ONE (1) QUAYSIDE CONTAINER CRANES (QC)

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1. GENERAL

1.1. Project Description

To carry out the design, construction, delivery, installation, testing and completion of rail mounted containerhandling quayside cranes. The cranes shall be delivered to Purchasers Site as defined in the General Conditions in a fully assembled condition with pre-shipment testing completed at the manufacturer's site.

1.2. Terminal Site

The Cranes shall be delivered, commissioned, and completed on the container-handling Berth at Visayas Container Terminal, Iloilo.

1.3. Overriding Requirement of the Purchaser

The Purchaser's overriding requirement is for the Works to be suitable in all respects for safe, efficient and continuous use under actual operational conditions in a modern, large capacity, international container handling facility for a period of not less than twenty (20) years subject to fair wear and tear (excluding categorically any fatigue failure), and routine maintenance.

For the purposes of this Contract acceptable routine maintenance shall be within the following general parameters.

(1) For steel structures and related component parts, fittings and fixings, acceptable routine maintenance shall be limited to the maintaining of the paint system as stated below. Reinforcing, cutting out and/or replacement of any corroded, fatigued or defective steel or its fixings, etc. shall be Defects remedial works and not maintenance.

(2) For the paint system and galvanized components, acceptable routine maintenance shall be:

- Preparing and over coating the existing system at year 20 after the issuance of the Taking-over Certificate.
- Removing defective parts of the protection system back to clean steel and recoating in isolated areas but not exceeding in aggregate more than 1% and 2% of the total surface area at years 5 and 10 respectively.
- The removal of the protective system back to steel and replacement of the coating in areas aggregating more than the above percentages of the total surface area of the coated part of the Crane shall be Defects remedial works and not maintenance.

(3) For items of electrical and mechanical equipment, controls, systems, components, fittings and fixings, acceptable maintenance shall be the periodic and routine maintenance normally carried outon the various parts generally undertaken as established practices of the Purchaser.

(4) The foregoing shall apply notwithstanding any inconsistent requirement or information in any maintenance instructions provided by the Contractor or otherwise put forward by the Contractor and any such inconsistent requirement or information shall not, and shall not be relied on by the Contractor, to relieve, limit or diminish any obligation or liability of the Contractor under the Agreement or otherwise including in relation to Defects.

1.4. Quay Crane Specification Outline

1.4.1. Crane Details and Accessories

SPEC. REF.	ITEM	SELECTION	COMMENT
General Crane Details & Accessories			
	Number of cranes to buy	One (1)	
	Biggest vessel size to be served	Post Panamax 17 Rows	48m Outreach
	Crane design: • Dual-box boom/girder • Mono-box	TBD	Boom and girder design to be decided based on manufacturer's preference for overall crane weight and wheel loads
	Trolley type: • Rope towed. • Direct-Drive	TBD	Trolley design to be decided based onmanufacturer's preference for overall crane weight and wheel loads
4.9	Spreader	Twin-lift	
	Lashing / Hatch cover platform	None	A hatch cover platform for storing 4 x 40thatch covers. Located LS of LS sill beam
	Checker's cabin:	Underneath LS Sill beam	Access to the checker's cabin frominboard and outboard of the crane.
	Delivery method: • fully erected • semi-erected • erection on site	Fully erected	
Accessories			
4.9.3	Number of spare spreaders	One (1)	One Twin-lift Spreader as per StipulatedComponents list
4.10	Number of spreader trailers	One (1)	
4.11	Number of hook beams	One (1)	
4.12	Container Top Safety Frame(= Lashing cage)	One (1) stored on crane	ICTSI standard: stored on crane. A 20ft Container Top Safety Frame is typically stored on top of the landside sill-beam. If the CTSF shall be stored on a trailer (not included), BU to indicate the number of CTSF required per project.
4.13	Test Weight	Required	A test weight in the format of a 45ftcontainer
6.8.2	Spreader Test Panel	Required	A test panel for operating and testingspreaders in the

			workshop.
6.8.3	Drive Simulator	Not Required	A drive simulator as training aid toelectrical technicians.
Electrical Details			
	Electrical system and installation standard	IEC	Local standard is NEC, but IEC isacceptable for this project.
	Electrical system integration	Crane Manufacturer	

SPEC. REF.	ITEM	SELECTION	COMMENT
	Trolley Power Supply: • Cable chain • Festoon system	Cable chain	IGUS P4 type required
	Remote Crane Condition Monitoring System	Required	Remote Crane Condition Monitoring via fiber optic link to maintenance workshop.
	Independent Main Hoist and Gantry TravelInverters	Required	None = shared Main Hoist and GantryTravel Inverters
	Independent Boom Hoist and Trolley TravelInverters	None	None = shared Boom Hoist and TrolleyTravel Inverters
	Emergency recovery drives	Independent drive for each motion	For emergency recovery operation ofmain hoist, boom hoist and trolley.
	Emergency Power Supply Socket	Not Required	Interlocked plug and socket arrangementbetween cranes for the supply of emergency power in the event of crane power failure.
	Load Weighing	Overload Only	ICTSI Standard: Overload protection onlyA spreader-twist-lock built-in load weighing system to report container weight(s) to the TOS is an option
	RFID Access Control	Not Required	No access to elevator control and e- rooms shall be granted without requiredcoded tag. All requests for access to be logged with date and time stamp and ID tag number.
5.8	Trailer Positioning System	Two Direction, 6 Lanes	Laser scanner system with traffic light indication for stop positions for TerminalTractors.

	Trailer Anti-Lift Protection System	Not Required	
	Malmedie Snag Load System (SOS)	Not Required	
Automation Features			
5.9	Optical Character Recognition System(OCR)	Not Required	Complete OCR System Required (ABB)
5.11	Twist-lock Coupler Detection System	Not Required	
5.12	Container Position Determination System(PDS)	Not Required	Container Position Determination Systemto transmit position of container to the Terminal Operating System when container is dropped or picked – available
5.13	Vessel profiling & Container Soft-Landing	Required	Container height sensor mounted on thetrolley to detect potential container collisions while trolley travelling and soft-landing of spreader and containers.
5.14	Anti-sway System	Not Required	
5.15	Semi-Automation	Not Required	

SPEC. REF.	ITEM	SELECTION	COMMENT
5.16	Automated Back-reach Operation	Not Required	
5.17	Remote Operation Stations	Not Required	RCS Desks
4.14	Automated Lashing Platform	Not Required	

1.4.2. QC Principal Dimensions

ITEM	VALUE		COMMENT
Gantry rail span (centre to centre)	16.0	m	
Centre of waterside rail to fender face	4.5	m	
Beam of Design Vessel	–	m	**This dimension is required to establishthe maximum required outreach (CL waterside rail to the service limit.)*
Outreach from CL waterside rail to the servicelimit	48,000	mm	48,000mm to service limit, 48,500 mmto emergency end stop limit.

Back-reach from CL landside rail to the servicelimit	14,000	mm	14,000 mm to service limit, 14,500 mmto emergency end stop limit.
Minimum clearance required under back reach	N/A	m	Minimum to avoid collision with high mast lights. A trolley back-reach travellimit, with bypass, is required in each position where the trolley travel wouldinterfere with high mast lights. Gantry travel shall also be inhibited when trolley position would interfere with
Lift above top of waterside rail to lowest point ofspreader twist-locks	36,000	mm	36,000mm minimum to the lowestpoint of twist lock.
Lift below top of waterside rail to lowest point ofspreader twist-locks	18,000	mm	Minimum
Total lift	54,000	mm	
Clearance height under portal beam above waterside rail	12.5	m	
Usable inside clearance between legs	18.3	m	
Maximum allowed overall crane length with crane bumpers uncompressed. Maximum allowed overall crane length with crane bumpers compressed.	27.6 27	m m	27,600 mm maximum in bumper freecondition. The bumpers shall be the widest positions on the crane. 27,000 mm compressed
Maximum width of boom or trolley, whicheverthe greater	<8,600	mm	With proposed dimension, it shall bepossible to discharge or load a container adjacent to the bridge without interference between boom
Trolley rail gauge	6,000	mm	Minimum
Trolley rail gauge (mono-box)	3,700	mm	Minimum
Gantry travel distance along quay fromcrossover feeding point	450	m	

1.4.3. QC Lifting System

ITEM		VALUE		COMMENT
Spreader				
	Twin-Lift	Yes		
	Centre Spread	Yes		
	Compatibility with existing spreaders	Yes		
Loads				
	Container type			ISO 20', 40', 45' ISO and up to 53' containers with ISO corner fittings at20', 40' or 45' position.
	Maximum container load underspreader in twin-lift mode	55	MT	2 x 27.5MT
	Maximum container load underspreader in single lift mode	51	MT	At reduced 60% speed
	Maximum load under hook beam	65	MT	At full outreach
	Maximum load under hook beam atreduced outreach	75	MT	
	Test Load for overload test underspreader	68.75	MT	125% load
	Test Load for overload test under hookbeam	93.75	MT	125% load

1.4.4. QC Operational Speeds

	ITEM	VALUE		COMMENT
Note:	Speeds: These speeds must be achieved for Crane operation with or against sustained wind speed of 20 meter/sec.(45MPH) Crane shall be able to be moved to nearest stow pin position with or against sustained wind speed of 25meter/sec. (55MPH)			
Hoist speeds:				
	With max. container load under	90	m/min	
	• Acceleration time hoisting	2	s	
	• Acceleration time lowering	1.5	s	
	• Deceleration time hoisting	1.5	s	
	• Deceleration time lowering	2	s	
	With empty spreader	180	m/min	
	• Acceleration time hoisting	4	s	
	• Acceleration time lowering	3	s	
	• Deceleration time hoisting	2.5	s	
	• Deceleration time lowering	4	s	
	Cargo beam in any load condition	40	m/min	
	• Acceleration time	3	s	
	• Deceleration time	3	s	
Note:	Speeds for intermediate loads are in relationship to a constant power curve (except for cargo beam). Values for acceleration and deceleration may vary depending on motor and drive characteristics.			
Trolley traverse speeds:				
	With or without maximum containerload under spreader	220	m/min	
	• Acceleration / Deceleration Time	4.5	s	
	• Acceleration / Deceleration Time	4.5	s	
Boom hoist speeds:				
	Time from Stowed Mode to OperatingMode and vice versa	2.5	min	
	Time from Stowed Mode to Maintenance Mode and vice versa	2.0	min	
Gantry travel speeds:				

	With or without maximum ContainerLoad under Spreader	50	m/min	

ITEM		VALUE		COMMENT
	• Acceleration / deceleration timeup to 50% operating wind load (WLO)	5	s	Gantry: Gantry travel with or against amaximum 50% operating windload, WLO, with or without rated load, operating, stowed,Or maintenance boom mode. 50m/min. Acceleration/Deceleration time 6 sec
	• Acceleration / deceleration time at maximum sustained operatingwind	10	s	Gantry travel with or against the operating wind load, WLO, with or without the rated load, operating, stowed, or Maintenance boom mode. 50m/min Acceleration/Deceleration time 10 sec
Trim / List / Skew:				
	Trim adjustment with maximumcontainer load	+/- 3	deg	
	Trim speed with maximum container load from centre position to maximum	5 – 10	s	
	List adjustment with maximumcontainer load	+/- 5	deg	
	Max spreader horizontal drift in trolleydirection from zero to max list position.	+/- 150	mm	
	List speed with maximum container load from centre position to maximum	5 – 10	s	
	Skew adjustment with maximumcontainer load	+/- 3	deg	
	Skew speed with maximum container load from centre position to maximumtrim	5 – 10	s	
Note: Trim and skew adjustment systems shall be capable of changing attitude of a maximum weight container load with 1.6 m eccentricity in load centre.				

1.4.5. QC Design Criteria

	ITEM	VALUE	COMMENT
Note: Below classifications are as per F.E.M. 1.001, 3rd Edition Revised 1998.10.01			
Structures:			
	Class of Utilization	U8	
	State of Loading	Q3	
	Group Classification	A8	
	Maximum Operating Cycles	4 million	
Main hoist mechanism:			
	Class of Utilization	T8	
	State of Loading	L3	
	Group Classification	M8	
Trolley travel mechanism:			
	Class of Utilization	T8	
	State of Loading	L3	
	Group Classification	M8	
Gantry travel mechanism:			
	Class of Utilization	T5	
	State of Loading	L3	
	Group Classification	M6	
Boom hoist mechanism:			
	Class of Utilization	T5	
	State of Loading	L3	
	Group Classification	M6	

1.4.6. Site Environmental Data

	ITEM	VALUE		COMMENT
	Maximum recorded ambient	40	°C	
	Minimum recorded ambient	18	°C	
	Sample period	40	years	
	Maximum relative humidity	100	%	
	Maximum sustained operating wind	20	m/s	
	Maximum gust operating wind speed (without warning)	25	m/s	
	Maximum stowed wind speed	70	m/s	
	Tide – Datum reference type	MWLS		Local datum type (Mean Water Low Springs or other) CHART DATUM (Mean Low Water =0m)
	Extreme High Tide	--	m	Above datum (required for vessel berthing and crane discharge)
	Extreme Low Tide	–	m	Below datum (required for vessel berthing and crane discharge)
	Seismic zone reference	--		
	Seismic acceleration (max.)	0.2	g	The value to be taken into account by the crane designer for estimation of loads. Peak Ground Acceleration shall not be less than 0.1g

1.4.7. Vessel / Cranes Delivery Parameters

	ITEM	VALUE		COMMENT
	Minimum draft alongside berth	TBD	m	Required for vessel berthing and crane discharge
	Minimum controlling draft from	TBD	m	
	Maximum height restriction (air draft)	TBD	m	Required for vessel voyage, berthing and crane discharge
	Bollard separation interval along quay	TBD	m	Required for vessel berthing and crane discharge

	Bollard load capacity	TBD	MT	Required for vessel berthing andcrane discharge

1.4.8. Quay Interface - Mechanical

ITEM		VALUE		COMMENT
Gantry Rail				
	Gantry rail type	TBD	Type	DIN 536:1991 Grade 900 (Crane andInfrastructure Interface: Required for STS crane gantry design, to ensure gantry wheel tread size is equal to therail head width.)
	Gantry rail weight	–	kg/m	
	Gantry rail head width	–	mm	Crane and Infrastructure Interface: Required for STS crane gantry design,to ensure gantry wheel tread size is equal to the rail head width.
	Height difference of LS rail above WSrail	0	mm	The landside rail is lower than the waterside rail by 0 mm. A vertical rail tolerance of ± 50 mm measuredat the rail head surface from mean position throughout the gantry rail length shall be permitted.
	Curved gantry rail • Minimum radius WS rail • Minimum radius LS rail	None None None	 m m	STS crane shall have the facility to traverse around a curved gantry rail. *CLARIFICATION: Gantry speed whilst traversing curved rail sectionshall be proposed by the Contractor and approved by the Purchaser.
Permitted Rail Loads				
	Vertical load limit WS rail – operational	76.8	MT/m	
	Vertical load limit LS rail – operational	67.9	MT/m	
	Overload limit WS rail – short duration	119.1	MT/m	Short duration impact or wind gust
	Overload limit LS rail – short duration	120.3	MT/m	Short duration impact or wind gust
	Stowed Condition WS	145.	MT/m	

		4		
	Stowed Condition LS	144.4	MT/m	
	Horizontal load limit LS – operational	34.3	MT/m	
	Horizontal overload limit LS – shortduration	314.9	MT/m	Short duration impact or wind gust
	Horizontal load limit WS – operational	34.3	MT/m	
	Horizontal overload limit WS – shortduration	314.9	MT/m	
Permitted Wheel Loads *(Based on 12 wheels per corner)*				
	Load limit WS wheels – operational	77.1	MT/wheel	
	Load limit LS wheels – operational	68.2	MT/wheel	
	Overload limit WS wheels – short	119.4	MT/wheel	Short duration impact or wind gust
	Overload limit LS wheels – short	120.6	MT/wheel	Short duration impact or wind gust

ITEM		VALUE		COMMENT
	Stowed Condition WS	145.7	MT/wheel	Short duration impact or wind gust
	Stowed Condition LS	144.7	MT/wheel	Short duration impact or wind gust
End of Travel Buffers				
	Centre height above rail	TBD	mm	Crane and Infrastructure Interface: The height of the end stops mountedon the quay, must match the height of the crane buffers, this is typically 1,100mm to the centre of the buffer/end stop. These can be as per crane manufacture preference with civil work following, or we can follow civil
	Load capacity of existing fixed buffers	TBD	kN	Impact force of crane collision with end stop shall be provided by crane manufacturer.
Stow Pins & Typhoon Tie-downs				
	Stow pin slots - Waterside	TBD		Crane and Infrastructure Interface: These can be as per crane manufacture preference with civil work following, or crane design canfollow civil design with details issued
	• Distance from C/L to C/L of rail	TBD	m	
	• Length (parallel with the quay)	TBD	m	
	• Width (perpendicular to rail)	TBD	m	
	• Depth	TBD	m	
		TBD	m	
		TBD	m	
	Stow pin slots - Landside	TBD		Crane and Infrastructure Interface: These can be as per crane manufacture preference with civil work following, or crane design canfollow civil design with details issued
	• Distance from C/L to C/L of rail	TBD	mm	
	Quantity and spacing long quay	TBD	m	
	Stow pin slot horizontal design load	TBD	MT	

	Typhoon Tie-downs	Yes	Crane and Infrastructure Interface: Crane Manufacturer to propose, tie down design to be incorporated into Civil contractor's design.
	Checker's cabin	Yes	
	Checkers cabin position	Land side With Dual Gated Access/ Egress from Inboard and Outboard	

1.4.9. Quay Interface – Electrical

	ITEM	VALUE		COMMENT
MV Power Supply				
	Crane power supply voltage	4.16	kV	
	Supply voltage tolerance	+/- 10	%	
	Main power supply frequency	60	Hz	
	Supply frequency tolerance	+/- 2	%	
	Supply network short circuit capacity	TBD	kA	*Terminal Supply*
	Fuse type in MV substation	TBD		*Terminal Substation*
	MV Service cable length	TBD	m	*From substation to cable connection pit*
	MV Service cable specification	TBD		
	Number and specification of fibre opticsat cross-over cable pit	TBD	Micron	*Single mode or multi-mode and numberof cores*
	Number and positions of cross-over cable pits assigned for all QC under this	TBD		MV power cable connection pits/feedpoints.
	Number of MV cable strain relief drumsassigned for all QC under this project	TBD		*Drums located in* MV power cableconnection pits/feed points.
	Diameter of MV cable strain relief drum	TBD	mm	
	MV cable connection method at cross-over cable pit	Spliced Cable Joint		*Raychem or 3M*
	Preferred MV cable type	Prysmian PROTOLON(SMK)-LWL (N)TSKCGE WOEU 3X25+2X25/ 2+1X(6G62, 5LWL)		*Cable type to be reviewed duringdesign review.*
	MV cable trench - Position • Distance from C/L to C/L of rail	TBD TBD	mm	Crane and Infrastructure Interface: These can be as per crane manufacture preference with civil work following, or crane design can follow civil design with details issued to crane manufacturer

	• Width • Depth	 TBD TBD	mm mm mm mm	
	MV cable trench protection	TBD		
	MV cable pick-up position	RHS Portal WS		*As viewed looking out to water*
Local Electrical Parameters				
	Local Three Phase Voltage	460	V	
	Local Single-Phase Voltage	220	V	
	Frequency	60	Hz	

	ITEM	VALUE	COMMENT
	Three phase plug type for shore supply and/or welding machines	CEE	*IEC 60309:* *32A 3P+T 415V Red 6H IP67* *220V 32A(3P+N+T) Blue 9H IP67*
	Single phase plug type for hand tools	Type B	
Note: Refer to http://www.iec.ch/worldplugs for identification of plug types			
Local Specifics			
	Local Language	English	*Signage, labelling, training and Maintenance and Operation documentation/manuals shall be in English and local language.*

2. OVERALL DESIGN CRITERIA

2.1. Type of Crane

The Crane shall be a traveling gantry with a hinged straight boom at waterside, self-driven or rope towed trolleytype. The crane drive and control shall be supplied with a full AC inverter drive, fully digital control with PLC.The proposed drive and control system shall be a proven system successfully operating on a similar capacitycrane in actual container handling operations. The Crane shall be twin-lift; capable of handling 2 x 20 ft. containers in tandem with a twin lift spreader.

2.2. Type of Cargo

The type of Cargo to be handled by the Crane shall be:

(1) ISO 20ft, 40ft and 45ft containers including highcube, halfheight, flat rack containers.

(2) Other types of container with ISO corner fittings at 20', 40', or 45' position, 48ft and 53ft containers.

(3) 40ft and 45ft containers of weight up to 55 Metric Tonnes (MT).

(4) 2 x 20ft containers of weight each up to 27.5 MT.

(5) Containers with over-height cargoes through an over-height cargo container lifting frame belonging to thePurchaser.

(6) Hatch covers and containers of weight up to 55 MT.

(7) Damaged containers with slings and shackles attached to lifting lugs of the spreader.

(8) Heavy lift cargo
At least 65 MT beneath a Hook Beam attached to the head-block. The heavy lift shall be operable throughthe full hoisting range and across the full distance of trolley travel with 75 MT beneath hook beam at reduced outreach to be determined by the Contractor. The Contractor shall maximize the load capacity under hook beam according to his design.

2.3. Operating Environment and Design Aim

The Crane shall be operated and maintained on a 24-hour per day basis in all weather conditions. All electrical,electronic, and mechanical equipment shall be non-hygroscopic, non-corroding and tropicalized for use. Specialconsiderations shall be given in all aspects of the design for achieving accurate load spotting ability while ensuring full operational capability and safety for around the clock operations, including operations under heavy rain conditions at night.

The Crane shall be exposed to non-technical personnel, specifically at the ground level and passages from ground level to the operator's cab and from the operator's cab to the boom operating station. In these areas ofthe Crane, the Contractor shall ensure that a high degree of personnel safety protection is provided around theequipment and fittings. Ease of maintenance and safety of the maintenance staff shall be considered throughout the entire design to minimize total down time of the Crane.

2.4. Mode of Operation

The Crane shall be manually controlled. All functions on the Crane shall be controlled fully by the operator.

2.5. Statutory Requirements and Applicable Standards

(1) The Crane and its mechanisms shall be designed and manufactured to comply in

all respects with the requirements of applicable state and local country laws, ordinances, rules, orders, or otherlegal or regulatory instruments such as, but not limited to, the following:

(2) Where items are not covered by statutory requirements the Crane and other Works shall be designed and manufactured to at least the standards as defined in this Specification, and for items which are not so specified to at least the current applicable recommendations of the following organizations: -

AISC American Institute of Steel Construction – ASD

AISE Association of Iron and Steel Construction

ANSI American National Standards Institute

ASNT American Society for Non-destructive Testing

ASTM American Society for Testing and Materials

AWS American Welding Society – Bridges and Dynamically Loaded Structures

BSI British Standards Institute

DIN Deutsche Industrie Normen

FAA Federal Aviation Administration

FEM Federation Europeane de la Manutention

IEC International Electro-technical Commission

IEEE Institute of Electrical and Electronic Engineers

ISO International Standards Organization

JIC Joint Industrial Council

JIS Japanese Industrial Standards

NEC National Electric Code

NEMA National Electric Manufacturers Association

SAE Society of Automotive Engineers

UL Underwriters Laboratory

***CLARIFICATION: Where the crane or any of its mechanisms/components do not comply with any of the abovestandards the Contractor must submit each non-compliant item for review and approval from the Purchaser.**

(3) The Contractor shall be required to submit to the Purchaser a full list of applicable standards used in the design of the Crane.

(4) The specifications refer to various U.S. and international standards, materials, and procedures. If the Contractor believes that complying with the references is impracticable, the manufacturer may propose alternative standards. The alternatives will be accepted provided they are, in the Purchaser's opinion, at least equal to the referenced standards. The Contractor shall submit the alternatives to the bid including documentation demonstrating equivalence with the references. The Purchaser will review the proposed alternatives and decide if they are acceptable. If the Contractor submits the proposed alternatives four weeks before the bid date, the Purchaser will respond at least one week before the bid date. If the alternatives are submitted later than fourweeks before the date, the Purchaser may accept them, or may not accept them without reviewof the merits, and the bid shall be based on complying with the references.

(5) Where reference is made to a standard specification, e.g., AWS D1.1, the latest edition published before the date on the title page of this specification shall apply. If, however, the edition is stated,e.g., ISO 4628-/3-1982(E), the stated edition shall apply

2.6. Professional Third-Party Design Review and Quality Inspection Services.

Mandatory professional third-party design review, manufacturing/quality inspection services, progress monitoring services, and such other services necessary to procure all certification/authorities approvals to bringthe Equipment into full operational use to be provided by the 3rd Party Surveyor, which services shall include,inter alia, the duties set out in the scope of works. The services include any additional services and/or extended services and duties that may be instructed from time to time by the Purchaser/Engineer.

The Contractor shall be obligated to provide the Professional 3rd Party design review and inspection services,including all associated costs.

2.6.1. Scope of Services

The Surveyor's duties in carrying out the Services shall include the following:

To set up a meeting with the Contractor within 14 days of date of signing this Agreement and establish a detailed Inspection / Test Schedule (the "Inspection / Test Schedule") for the entire manufacturing and assembly period broken down into weeks showing all items listed in the Inspection / Test Control Sheets at Appendix 3 which forms part of the Specification in each appropriate week. The Inspection / Test Schedule shall also indicate the number and type of its personnel the Surveyor shall require for each week along with facilities such as tools, test weights and others which are required to undertake the tests. A copy of the Inspection / Test Schedule together with a detailed manning schedule of the Surveyors staff shall be submitted to the Engineer for approval within 21 days of date of signing this

To obtain directly from the Contractor *all drawings, calculations, documents, and data necessary to perform the Services.

*All Drawings and calculations shall be requested from the Contractor, however due to the Contractor's strict document control, some documents in electronic format may not be released to the Surveyor.

In this instance, the Surveyor shall report to the Engineer, any necessary documents that are required to perform the Services, that have not been provided.

(i) Design Review:

- Receive and review the Contractors design proposals for the cranes for their compliance with the Technical Specification and applicable standards and procedures.
- Conduct one design review meeting with the Contractor, which shall be attended by the Purchaser, to discuss, comment on and confirm the Contractor's design.
- Follow up on design comments and other changes after the design review meeting. The Purchaser shall be copied on all comments to the design. It is recognized that the Manufacturer is not always responsive to review comments in a timely manner, and hence thefinal design is completely the responsibility of the Manufacturer.
- Provide advisory to the Purchaser on technical queries as they may arise during the durationof the Agreement, on items within the stated scope of services.

To receive data directly from the contractor relating to shipping of the cranes to the Purchaser's siteand undertake the following formal and detailed reviews:

(i) Load-out Operations:

- Receive and review the Contractors design proposals for loading the cranes onto vessel(s) at the manufacturing site(s).
- Review compliance of the equipment design to be utilized during the transfer of crane(s) onto vessel(s)
- Review methods proposed by the contractor for load-out of cranes
- Prepare a summary of risks undertaken by the Contractor during loading, using elements of risk analysis to identify risk and recommend ways in which risk may be mitigated.

(ii) Shipping Operations:

- Receive and review the Contractors sea-fastening and lashing design
- Review sea-fastening calculations submitted by the Contractor and their suitability taking into account forecasted sea/weather conditions, vessel characteristics and forces which are predicted to apply during the sea voyage to the Purchasers Site.
- Review specifications for materials such as wire ropes, steel, shackles, turn-buckles and clips which are proposed by the Contractor for all sea voyage lashings.
- Review and comment as needed on drawings prepared by the Contractor for sea fastening

(iii) Discharge Operations

- Receive and review the Contractors design proposals for discharging the cranes from vessel(s)at the Purchasers Site.
- Review compliance, strength and safety factors of the equipment design to be utilised during the transfer of crane(s) from vessel(s).
- Review methods proposed by the contractor for discharge of cranes.
- Review quality of drawings, data and information provided by the Contractor for discharge operations.
- Prepare a summary of risks undertaken by the Contractor during unloading using elements of risk analysis to identify risk and recommend ways in which risk may be mitigated.

Prior to the vessel departure from the manufacturing site, the site inspectors shall review and inspectduring and upon completion of the sea fastening and lashing installation, the following:

(I) Sea Fastenings and lashings

- Review Crane Sea fastening and lashing to confirm that installation meets approved design, asper approved drawings and installation method.
    - Connection points as per approved design.
    - Sea fastening tubular members, box members and wire rope lashings as per approved design.
    - Connection methods as per approved design (bolted, pinned or welded connections)
    - Pin size and type as per approved design.
    - Bolt size, type and bolt torque as per approved design.
    - Weld quality including any NDT requirements as per approved design
- Make inspections to confirm that temporary ladders and platforms for sea fastening andlashing removal are installed, are safe to use and fit for purpose.
- Review/inspect materials/devices such as wire ropes, steel, shackles, turn-buckles and clips to see that they match the drawing/design criteria.

(ii) Sea voyage water ingress and corrosion protection

- Inspect and confirm that all items which are susceptible to corrosion or water ingress during the sea voyage are sufficiently protected using waterproof wrapping and or greasing toprevent corrosion or water ingress, paying specific attention to the following:
    - Spreader protective cover is fitted correctly and is without damage, in addition ensureall exposed parts or parts susceptible to corrosion such as twist-lock mechanisms, expand retract mechanism, metallic

hydraulic components and electrical boxes and components are sufficiently protected as per approved method or Manufacturer's recommendations.

- Gantry electrical equipment including all motors and integral brakes, air con units, power sockets, light switches, lighting, estops, encoders, cameras beacons andsirens, intercom units, field devices such as anti-collision and proximity switches and gantry I/O/control panels.
- Gantry reducers and wheel brakes
- Hydraulic packs.

(iii) Discharge equipment.

- Inspect and confirm that all equipment to be utilized as per the approved crane dischargemethod is loaded on to the vessel, including but not limited to the following:
  - Crane discharge rails including quantity and type as per approved discharge method.
  - Temporary bogie quantity and type and bogie installation as per approved dischargemethod.
  - Hydraulic jack capacity quantity and type as per approved discharge method.
  - Load spreading sheets or rails as per approved discharge method.
- Ensure all materials and quantities such as wire ropes, steel, shackles, turn-buckles and clipsmeet approved discharge method criteria.

To make available from its staff the appropriate number of suitably qualified and experienced surveyors/ inspectors necessary to provide the Services at the Site and to execute all inspections and tests as set out in the Inspection / Test Control Sheets and the rest of the Specification, in the following

(i) Submit by email to the Engineer, before noon on the last day of each month, a "Monthly Inspection Plan" listing all items to be inspected during the following Month, together with a description of the proposed inspection method for each item. Notwithstanding the approval status of the Inspection / Test Schedule in Clause 3(a) above the Surveyor shall submit the first Monthly Inspection Plan on the third Friday after the signing of this Agreement.

(ii) Execute inspection and / or tests in accordance with the Monthly Inspection Plan (and as modified as appropriate) and submit by email to the Engineer before noon every Monday a "Weekly Inspection Report" covering all items inspected and/or tested during the previous week. In the Weekly Inspection Report each item shall be marked with "Passed" or "Failed", and with a description of the required remedial action for each "Failed" item. (Refer to Inspection Control Sheet items marked "C1", "W1" and "W3").

(iii) The decision of the Surveyor for each "Pass" or "Fail" for each inspection or test and the criteria for each such decision shall be based on the requirements set out in the Specification, the Contractor's drawings approved by the Engineer and / or the Purchaser's design details clarified by the Contractor and agreed by the Engineer in writing.

(iv) Execute verification, inspection, and certification and submit to the Engineer each week, mill certificates, inspection / test records of items verified, inspected or certified by the Surveyor inaccordance with the Inspection / Test Control Sheets and the Monthly Inspection Plan for the previous Month. (Refer to the Inspection Control Sheet items marked "M", "R" and "T"). A listof the certificates / inspection or test records shall be sent by email to the Engineer before noon every Monday with the actual certificates and reports to be sent to the Engineer by courier and received by the Engineer no later than the Friday of the same week.

(v) Notify the Engineer immediately by telephone and email of any discrepancy in the interpretation between the Contractor and the Surveyor of Pass / Fail criteria.

(vi) Review through the monthly meeting with the Contractor to be held within the first week of each month Works progress and submit a report, the "Monthly Works Progress ReviewReport", latest by the end of the second week of each month showing by overlaying the actualProgress of each Work item on the Master Works Schedule of the Contractor pursuant to the Contracts. All delays must be highlighted with Surveyor's comments and the Contractor's confirmed action plan to recover the original schedule.

(vii) To provide specific inspection of components and manufacturing progress linked to progress payments by the Purchaser to the Contractor. These shall include but not be limited to the following:

- Receipt of "Major Stipulated Components" items at the Contractor's site. (refer to the TechnicalSpecifications)
- Stand-up of each crane steel structure.

(viii) Where applicable/possible to inspect and report on spare parts and components which originate from the Contractor's manufacturing plant(s) in China. Particular attention shall be paid to crane main drive gearboxes manufactured at 3rd party gearbox factory. The inspectionscope of gearboxes shall include the following:

- Material Certification and compliance and checks.
- Calibration of measuring equipment.
- Heat treatment traces, certification and sample laboratory checks.
- Material hardness checks
- Dimensional and tolerance compliance with drawing on critical items such as gear profile, axlediameters, bearing housing diameters, bore diameters/relationships and backlash.
- Running tests
- Heat tests

- Cleanliness checks

(ix) Lubricant type, grade, quality and fill levels

(x) To produce a detailed function check document which may be used as a guide to perform and record "Tests on Completion" for each type of crane. The document shall have indexed pages setting out each function test and/or measurement in a logical sequence which shall include atleast the following sections:

- Recording of technical data from major component nameplates
- Principal Dimensions
- Corporate Colors, Identification and Safety Signs
- Lubrication, Sump and Hydraulic Fluid Inspection
- Safety Features Operation and Inspection
- Motor insulation values
- Control Station Features and Function
- Interlock Bypass Functions
- Spreader Data and Function
- Trim List and Skew Device Function and Tests
- Main Drives, Dead Load Tests
- Main Drives, Rated Load Tests
- Other Tests and Inspections
- Static and Proof Load Tests
- Illumination and Lighting Tests
- Noise & Vibration Tests
- Maintenance Crane Tests
- Endurance Tests
- Coupling and machinery Alignment Checks

All the above shall specify design tolerances where appropriate and record actual measured values for comparison and sign off.

Typical templates shall be provided to the Surveyor by the Purchaser which may be amended to reflect the actual parameters and functions contained within the relevant Technical Specification. Draft "Tests on Completion" schedules shall be presented to the Engineer for approval at least two months before the tests are scheduled to start.

To carry out any particular inspection or test on the Equipment as requested in writing by the Engineer.

(i) To notify the Engineer immediately by email in the event that the Surveyor is of

the opinion from its observations and / or progress review that completion of construction or fabrication of any item of Equipment will be delayed due to reasons other than default of the Surveyor beyond the date for delivery of that item of the Equipment by the Contractor to the Purchaser'sPremises as such dates are specified in the Contracts (all of which dates shall be notified to the Surveyor following signing of this Agreement).

(ii) Upon receipt of such notice the Engineer and the Purchaser will review the situation and if theyconsider it necessary, as a result of such delays, the Purchaser shall be entitled by notice to theSurveyor to require that all or any of the Surveyor's personnel cease providing the Services for a temporary period. Upon receipt of the notice from the Purchaser, the relevant personnel of the Surveyor shall cease providing the Services for the requested period and shall resume only at the Purchaser's request. In such a situation, the Surveyor shall provide at no extra charge the necessary personnel to perform the Services beyond the planned completion date for the number of man-hours that is equivalent to such man hours during which the Services were notperformed by its relevant personnel at the Purchaser's request.

(iii) If however, notwithstanding such delays, it is not considered necessary by the Purchaser or theEngineer for any or all of the Surveyor's personnel to cease providing the Services on a temporary basis and as a result of such delays the Purchaser considers that it requires the Surveyor to provide additional personnel to provide the Services, or for the service period for the original personnel to be extended beyond the planned completion date then the Purchaser may, by written notice to the Surveyor, require it to provide such additional personnel or the original personnel for an extended period and the Surveyor shall be entitled to receivepayment for the Services provided by such additional personnel or during such extendedperiod at the rate set out in Schedule 1, payment to be made on a monthly basis within 30days of receipt and confirmation of the relevant invoice from the Surveyor.

To provide two sets of hard copy record of all inspection reports and data collected throughout the project. The hard copy records shall be bound in organized fashion with an index for each crane and besent to the Purchaser.

All communication, correspondence and reports shall be in English language.

2.7. Definitions of Load Names and Load, Stability and Wheel Load Combinations

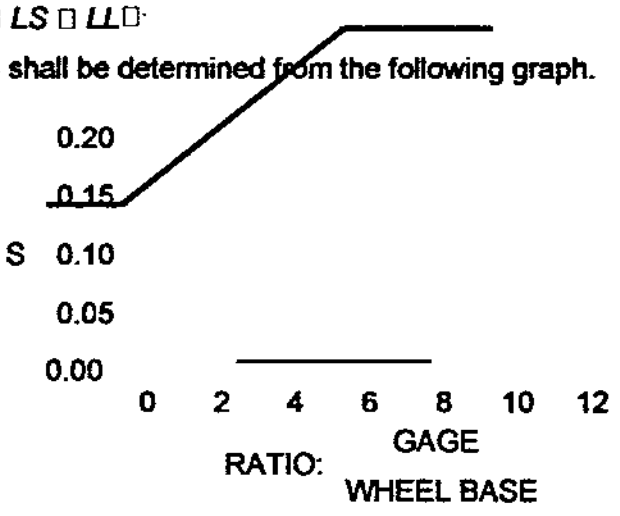
Name	Load	Description
BHRF	Boom Hoist Rope Failure	The loads, including dynamic effects, due to one of the independent boom hoist ropes failing. The trolley and lift system shall be in the parked position.
CBLS	Cargo Beam Lifting System	The weight of the cargo beam, head-block, portions of the lifting ropes, sheaves and all other equipment which hangs from the main hoist ropes when the cargo beam is connected
CBRL	Cargo Beam Rated Load	The greatest concentric load that can be lifted by the cargo beam without requiring any physical changes in the crane components. CBRL shall be a minimum of 61 metric tons.
COLL	Collision Load	The loads determined by dynamic analysis, assuming that the crane, while traveling at full speed with the power off, hits the crane stops or hits another stopped crane or (not concurrently) that the trolley traveling at full speed with the power off, hits its stops. Bumpers shall be provided so these loads govern only localcomponents.
DL	Dead Load	The weight of the crane's structure including all permanentlyattached machinery and equipment.
EQO	Operating Earthquake Load	The load imposed on the crane structure by an earthquake occurring during operation. EQO shall be a minimum of: A. 0.2(DL + TL) or B. The load required to tip the crane such that one corner lifts off of the rail Loading shall be applied in the gantry and trolley travel directions,non-concurrently. The trolley shall be assumed to be at the most adverse position.
EQS	Stowed Earthquake Load	The load imposed on the crane structure by an earthquakeoccurring during stowed condition. EQS shall be a minimum of: 0.2(DL + TL) or B. The load required to tip the crane such that onecorner lifts off of the rail Loading shall be applied in the gantry and trolley travel directions,non-concurrently.
F	Fatigue Condition	See Section 3.7, Fatigue Design Criteria.
IMP	Impact	The loads due to vertical acceleration of the lifted load as sensed by the main hoist ropes. Impact loads shall be determined as described in Section 3 (Crane Structural Specifications)

LATF	Trolley Lateral Load	The lateral trolley inertia force applied parallel to the travel direction shall be at least 0.10□(TL+LS+LLF) for fatigue combinations. The simultaneous inertia force applied perpendicular to the travel direction shall be one-fourth of the force applied parallel to the travel direction. Stresses due to LATFshall be combined with the stresses due to vertical loads. There shall be two starts and two stops for each cycle.

Name	Load	Description
LATT	Trolley Lateral Load	The loads imposed on the crane due acceleration or deceleration of the trolley. The lateral inertia force applied parallel to the travel direction shallbe at least 0.10□(TL+LS+LL) for operating combinations. The simultaneous inertia force applied perpendicular to the traveldirection shall be one-fourth of the force applied parallel to the travel direction.
LATG	Gantry Lateral Load	The loads imposed on the crane due to positive or negativeacceleration of the gantry. The lateral force applied parallel to the travel direction shall be 1.5times the maximum inertia force that can be developed due to acceleration or deceleration of the gantry drive system, except theminimum gantry inertia force shall be at least 0.05 times allweights present on the operating crane. The simultaneous inertiaforce applied perpendicular to the travel direction shall be of one- fourth of the force applied parallel to the travel direction.
LEGL	Leg Lift	The load imposed on the crane due to a 30 mm vertical displacement of one leg relative to the other three legs. This is a parameter load for information only and is not to be used for stress calculations.
LIST	List	The effect of □5 list of the spreader and rated load.
LL	Lifted Load	The weight of containers plus contents which shall be taken as 65MT and shall be applied concentric to the geometric center of the container.
LLE	Eccentric LiftedLoad	The weight of 55 MT containers applied eccentric to the geometriccenter of the container 1220 mm toward either end longitudinally and 230 mm toward either side transversely.

LLF	Fatigue Lifted Load	Fatigue design shall be based on an effective container, which, forsimplicity, is assumed to be equivalent to the actual spectrum of various weight containers including impact effects. The weight of the container plus its contents shall be taken as 30 MT and shall be applied eccentric to the geometric center of the container 760 mm longitudinally. The eccentricity should be considered at one side of the center of the container for half of the design cyclesand the other side of the center for the remaining half of the design cycles. The vertical load does not need to be increased because of vertical acceleration. Forces due to horizontal accelerations shall be based on a container weighing 30 MT.
LS	Lifting System	The weight of the spreader, head-block, portions of the lifting ropes, sheaves and all other equipment, which hangs from, the main hoist ropes and is supported by the container when the spreader is placed upon it.
OL1 OL2 OL3 OL4	Overload Conditions 1, 2, 3 & 4 in the Operating Mode	Refer to Table 2.1 Load Combinations – Operating Modes in thissection.
OL1M OL2M	Overload Conditions 1and 2 in the Maintenance Mode	Refer to Table 2.2 Load Combinations – Stowed and MaintenanceMode in this section.

Name	Load	Description
OL1S OL2S	Overload Conditions 1 and 2 in theStowed Mode	Refer to Table 2.2 Load Combinations – Stowed and MaintenanceMode in this section.
OP1 OP2 OP3	Operating Conditions 1, 2, & 3 in the Operating Mode	Refer to Table 2.1 Load Combinations – Operating Mode in thissection.
OP1M OP2M	Operating Conditions 1 and 2 in theMaintenance Mode	Refer to Table 2.2 Load Combinations – Stowed and MaintenanceMode in this section.
OP1S OP2S	Operating Conditions 1 and 2 in theStowed Mode	Refer to Table 2.2 Load Combinations – Stowed and MaintenanceMode in this section.
RL	Rated Load Container	2 x 20' long containers, 9'-6" high and 8'6" wide weighing, with their contents, 50 MT total. The eccentricity shall be considered (see LLE).
S1S	Stowed Condition 1 in the Stowed Mode	Refer to Table 2.2 Load Combinations - Stowed and MaintenanceMode in this section.
S1M	Storm Condition 1 int h e Maintenance Mode	Refer to Table 2.2 Load Combinations - Stowed and MaintenanceMode in this section.
ST1O ST2O ST3O ST4O ST5O ST6O	Stability Conditions 1 thru 6 in theOperating Mode	Refer to Table 2.3 Stability Combinations in this section.
ST1S ST2S ST3S ST4S	Stability Conditions 1thru 4 in theStowed Mode	Refer to Table 2.3 Stability Combinations in this section.
ST1M ST2M ST3M ST4M	Stability Conditions 1thru 4 in the Maintenance Mode	Refer to Table 2.3 Stability Combinations in this section.

Name	Load	Description
SKT SKG	Trolley SkewLoad Gantry SkewLoad	The loads developed due to wheels rolling along a rail. The force shall be taken as acting normal to the rail and tending to skew thestructure. The horizontal force, perpendicular to the gantry rail, at each corner shall be one fourth of the total vertical load due to: $S \times (DL + TL + LS + LL)$. S shall be determined from the following graph.  Where gage is the distance between the rails and wheel base is the distance center to center of the outermost wheels for SKT andthe main equalizer pins for SKG. If the Contractor demonstrates that the trolley and/or gantryskew load is less than the value shown because of either electricalor mechanical drive controls, then the reduced load may be used accordingly.
SN	Snag Load	The load imposed on the crane due to the head-block and empty spreader traveling at maximum hoist speed becoming jammed in the ship's cell guides or being accidentally two-blocked againstthe underside of the trolley resulting in the kinetic energy of the rotating equipment being dissipated by elastic deflection of the machinery and the structure and special energy absorbing devices. See Section 4.1.4. (Snag Control)
SPRD	Leg Spread	The load imposed on the crane due to a 25 mm horizontaldisplacement perpendicular to the rail of the waterside legs relative to the landside legs. This is a parameter load for information only and is not to be used for stress calculations.
STL	Stall TorqueLoad	The load developed by stalling any motor in the crane. The load shall be due to the stall and/or breakdown torque of AC drives.For the main hoist, stall torque load shall be the load induced by stalling the hoist motors with one end of a container or hatch cover dogged down or with all four corners dogged down concentrically. For the Boom Hoist, stall torque shall be determined based on thereduced stall torque when the boom is fully raised.

TL	Trolley Load	The weight of the trolley including all machinery and equipmentpermanently attached, but excluding the weights included in LS.
TRIM	Trim	The effect of □ 3□ trim of the spreader carrying rated load.
WLO	Operating Wind Load	The load due to an operating wind speed of 20 m/s assumed uniform over the full height of the crane applied in any direction. The lifted container shall be the rated load container.

Name	Load	Description
WLS	Stowed WindLoad	The load due to a storm wind speed of 70 m/s assumed uniform over the full height of the crane applied in any direction. The trolley shall be in the stowed position.
W O L 1 W O L 2 WOL3	Wheel Loads for Overload Conditions 1, 2, and 3 in theO p e r a t i n g Mode.	Refer to Table 2.4 Wheel Load Combinations in this section.
WOL1S WOL1M	Wheel Loads for Overload Condition 1 in the Sto and Maintenance Modes.	Refer to Table 2.4 Wheel Load Combinations in this section.
W O P 1 W O P 2 WOP3	Wheel Loads for Operating Conditions 1, 2, and 3 in theO p e r a t i n g Mode.	Refer to Table 2.4 Wheel Load Combinations in this section.
WOP1S WOP1M	Wheel Loads for Operating Condition 1in in the Sto and Maintenance Modes.	Refer to Table 2.4 Wheel Load Combinations in this section.
W S 1 S W S 1 M W S 2 S WS2M	Wheel Loads for the Stowed Conditions 1and 2 in the in the Sto and Maintenance Modes.	Refer to Table 2.4 Wheel Load Combinations in this section.

Wind loads shall be calculated using force coefficients from engineering references or from wind tunnel tests. Base reactions resulting from applied wind loads shall be equal to or greater than the reactions obtained from wind tunnel tests on suitable models for operating and stowed

configurations. Wind tunnel test results shall include angled wind effects for wind from any direction.

Operating Mode Combinations For Stress Calculation—Boom Down								
Condition		Operating			Overload			
Combination name		OP1	OP2	OP3	OL1	OL2	OL3	OL4
Dead Load	DL	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Trolley Load	TL	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lifting System	LS	1.0	1.0			1.0		1.0
Cargo Beam Lifting System	CBLS			1.0				
Cargo Beam Rated Load	CBRL			1.0				
Lifted Load	LL					1.0		0.5
Eccentric Lifted Load	LLE	1.0	1.0					
Impact	IMP		1.0	1.0				
List	LIST	1.0	1.0		1.0	1.0	1.0	
Trim	TRIM	1.0	1.0		1.0	1.0	1.0	
Trolley Lateral Load	LATT		1.0					
Gantry Lateral Load	LATG	1.0						
Trolley Skew Load	SKT		1.0					
Gantry Skew Load	SKG	1.0						
Operating Wind Load	WLO		1.0	1.0	1.0	1.0		
Stall Torque Load	STL				1.0			
Collision Load	COLL					1.0		
Snag Load	SN						1.0	
Earthquake Load	EQO							1.0

For the special load case when one of the boom hoist ropes fails, combine DL+TL+BHRF with the dynamiceffects of the failure.

Table 2.1: Load Combinations – Operating Mode

Stowed & Maintenance Mode Combinations for Stress Calculations					
Condition	Operating		Overload		Storm
Mode	Combination Name				
Maintenance Mode	OP1M	OP2M	OL1M	OL2M	S1M
Stowed Mode	OP1S	OP2S	OL1S	OL2S	S1S

Dead Load	DL	1.0	1.0	1.0	1.0	1.0
Trolley Load	TL	1.0	1.0	1.0	1.0	1.0
Lifting System	LS	1.0	1.0	1.0	1.0	1.0

Gantry Lateral Load	LATG	1.0				
Gantry Skew Load	SKG	1.0				
Operating Wind Load	WLO		1.0	1.0		
Collision Load	COLL			1.0		
Stowed Earthquake Load	EQS				1.0	
Stowed Wind Load	WLS					1.0
Tie-downs in Place?		No	No	No	No	No

Table 2.2: Load Combinations - Stowed & Maintenance Mode

STABILITY COMBINATIONS														
MODE		Operating						STOWED				MAINTENANCE			
Stability Load Name		ST 1O	ST 2O	ST 3O	ST 4O	ST5 O	ST 6O	ST 1S	ST 2S	ST3 S	ST 4S	ST 1M	ST 2M	ST 3M	ST 4M
Dead Load	DL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Trolley Load	TL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cargo Beam Lift System	CBLS					1.0									
Cargo Beam Rated Load	CBRL					1.15									
Lifting System	LS	1.0	1.0		1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lifted Load	LL	1.0	1.0		1.0		1.5								
Impact	IMP														
Trolley Load Lateral	LATT	1.0					1.0								
Gantry Load Lateral	LATG	1.5						1.5				1.5			
Operating Wind Load	WLO		1.5	1.0	1.0	1.0	1.0		1.5				1.5		
Stall Torque Load	STL			1.15											
Collision Load	COLL				1.15					1.15				1.15	
Stowed Wind Load	WLS										1.2				1.2
Number of Legs Allowed to lift off		0	0	1	1	0	0	0	0	1	0	0	0	1	0

Table 2.3: Stability Combinations

NOTE: The snag load, SN, is not included in the stability combinations since the kinetic energy of the rotatingequipment that is not dissipated cannot topple the crane.

EXAMPLE: ST1O is 1.0 DL + 1.0 TL + 1.0 LS + 1.0 LL + 1.0 LATT + 1.5 LATG with zero-legs allowed to lift off.

One leg allowed to lift off means one leg may lift off while the other three legs remain in contact with the gantry rail.Zero legs allowed to lift off means no legs may lift. All wheels shall remain in contact with the gantry rail.

The Contractor shall submit calculated corner uplift loads for all stability combinations as described

above.Tie-downs may not be used for the stowed wind load condition.

Wheel Load Combinations—Service (Unfactored)									
Boom Position	Mode	Operating			Overload			Stowed	
Boom Down		WOP1	WOP2	WOP3	WOL1	WOL2	WOL3		
Boom 45°		WOP1S			WOL1S			WS1S	WS2S
Boom Up		WOP1M			WOL1M			WS1M	WS2M
Dead Load	DL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Trolley Load	TL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lifting System	LS	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lifted Load*	LL	1.0	1.0	1.0	0.5		1.0		
Impact	IMP			0.5					
Gantry Lateral	LAT	1.0							
Load Operating	G		1.0			1.0			
Wind Load	WLO				1.0				
Earthquake	EQO					1.0			
Load Stall	/S							1.0	
Torque Load	STL								1.0
Collision Load	COL								
Stowed Wind	L								
Load	WLS								
Stowed Earthquake Load	EQS								
Allowable Wheel Linear Loads, MT/meter of rail	Land Side	TBD			TBD			TBD	
	Water Side	TBD			TBD			TBD	

Example: WOP1 is 1.0 DL + 1.0 TL + 1.0 LS + 1.0 LL + 1.0 LATG

The allowable wheel loads shall be calculated by multiplying allowable wheel linear load and average wheelspacing at each corner.

If the wheel loads exceed the allowable values, provide calculated wheel loads with breakdown and proposal to reduce wheel loads.

The Contractor shall submit calculated waterside and landside service wheel loads for the above combinations.

*For the boom 45° and boom up positions, do not include the lifted load.

Allowable Horizontal Loads Perpendicular to rail

Operating condition	Seaside Rail (MT/m)	Landside Rail (MT/m)
Maximum load under operating condition	TBD	TBD
Maximum load under storm condition	TBD	TBD

Table 2.4: Wheel Load Combinations

2.8. Operating, Stowed and Maintenance Modes

2.8.1. Operating Mode

In the Operating Mode, the Boom will be in the fully lowered position

The primary operational function of the crane will be to load and unload container ships. The crane will handle containers, hatch covers and lashing gear. A secondary function will be the handling of non- containerized cargo.

2.8.2. Stowed Mode

In the stowed mode the boom will be raised to approximately 45° for clearance of vessels. The trolley shall be at the park position and no other load other than the empty lifting system will be on the hoist.

The Main Hoist drive shall be operational with the trolley at the park position and with an empty lifting system.

The Trolley drive shall be able to operate within the range from boom up normal stop and the extreme back-reach position

The Gantry drive shall be fully operational, and the forestays shall be constrained from lateral movement during gantry operation.

2.8.3. Maintenance Mode

In the Maintenance Mode the Boom shall be fully raised and in contact with the bumpers. The Trolley shall be at the park position and no load other than the empty lifting system will be on the hoist.

The Main Hoist drive shall be operational with the trolley at the park position and with an empty lifting system.

The Trolley drive shall be able to operate within the range from the boom up normal stop and the extreme back-reach position.

The Gantry drive shall be fully operational, and the forestays shall be constrained from lateral movement during gantry operation.

2.9. Design Rules

2.9.1. General

Unless otherwise stated, F.E.M. 1.001, 3rd Edition Revised 1998.10.01, and relevant other design standards noted in these Specifications, shall be used in the design of the crane and its mechanisms.

2.9.2. Structures:

According to F.E.M. 1.001, 3rd Edition Revised 1998.10.01

Class of Utilization	U8
State of Loading	Q3
Group Classification	A8

Fatigue: Fatigue shall be based on cumulative damage analysis according to F.E.M. 1.001, 3rd Edition Revised 1998.10.01. The load spectrum shall consider a minimum of 4.0×10^6 design cycles with a 30.0 MT effective container weight with 760 mm eccentricity along the container longitudinal axis.

Structural Inspection Program: The structural inspection program shall be based on cumulative damage analysis.

2.9.1. **Mechanisms:**

According to F.E.M. 1.001, 3rd Edition Revised 1998.10.01

Mechanism	Class of Utilization	Service Life (Hrs.)	State of Loading	Group Classification
Hoist	T8	50,000	L3	M8
Trolley Travel	T8	50,000	L3	M8
Gantry Travel	T5	6,300	L3	M6
Boom Hoist	T5	6,300	L3	M6

2.10. General Design Criteria

2.10.1. Quay/Yard Interface

(1) Power Supply

(i) The power supply to the crane shall be --kV ±10% 3 phase, 60Hz±2%.

(ii) The medium voltage trailing cable connection at the power-feeding pit on the quay shall beproprietary MV cable joint. The Contractor shall undertake termination of the cableconductors and fibre waveguide at the feeding pit. The medium voltage cable shall be supplied by the contractor along with a suitable cable reeling device and cable connection joint. A sufficient length of cable to cover 450 meters' gantry travel range either side of thecentral feeding point shall be provided by the Contractor. Contractor shall bring the Cranetrailing cable end to the feeder pit and shall complete the cable connecting work with an approved submersible cable joint kit such as Prysmian, Raychem or 3M. The cable joints made at Site and medium voltage wiring shall pass the inspection requirements of the localpower Supply Company and Very Low Frequency test results shall be provided.

(iii) The medium voltage trailing cable shall be Prysmian Protolon (SMK) round type MV flexiblepower cable with integrated fibre optic data cables.

(2) Curved Gantry Rail and Wheel Loading (Not Required)

(i) Gantry travel around a curved section of quay rail shall be possible, minimum radius of railcurvature for landside and waterside rails shall be provided by Purchaser. The Contractor shallsubmit proposed method for achieving traverse of curved rail and proposed method including gantry speeds shall be approved by the Purchaser.

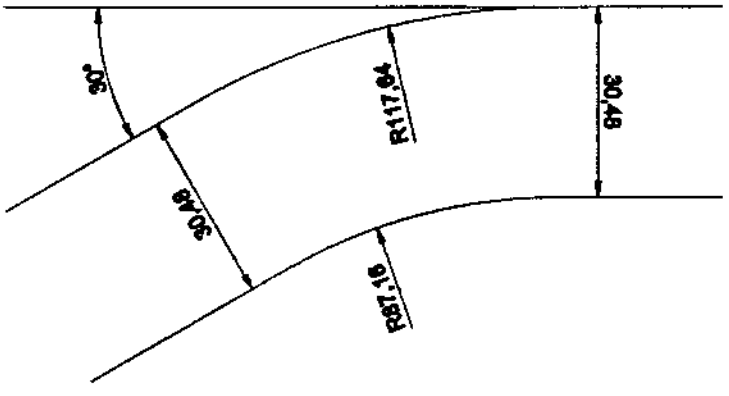


Figure 2.1 Curved rail details

(ii) Uplift load shall not be applied to the gantry rails.

(iii) The Contractor shall submit in its Tender for the Purchaser's review, the Declared Wheel Loads as defined in the Form of Tender to clarify vertical and horizontal loads under operational and stowed conditions.

(iv) The maximum wheel loads shall be calculated with the Trolley in the most severe position and with the wind acting in the most severe horizontal direction.

(v) Wheel Loads shall under no circumstances exceed the Maximum Allowed Crane Loads figures as tabulated in the Form of Tender, **DECLARED WHEEL LOADS AND OTHER LOADS OF THECRANE.** Should any or all of such loads exceed such Maximum Allowed Crane Loads figures,this shall constitute a Defect and the Contractor shall not be entitled to dispute this on anygrounds or in any circumstances.

(3) Stowage Pins
The Contractor shall submit for the Purchaser's review a design of adequate stowage pins to resist horizontal component of the forces applied to the Crane under its stowed condition. The stowage sockets in the quay deck shall be installed by others in accordance with dimension and load characteristics provided by the Contractor.

(4) Tie-downs
Storm tie-downs facilities shall be provided as permanent fixtures on the crane which may be quicklydeployed without requirement for additional equipment. The contractor shall provide a detail drawingof the tie down interface with toleranced dimensions, load magnitudes and directions.

The design of the tie downs shall be such that one person without tools or additional equipment canattach all tie downs on a crane to the mating wharf embedded attachments within 30 minutes. Similarly, the tie downs can be unattached, and the crane made ready for gantry travel by one person without tools or additional equipment within 30 minutes provided there are maximum 4 tie downs per crane. The attachment and disconnection of the tie downs shall be demonstrated by Contractor and timed.

2.10.2. Communication Facility Interface (Radio, Fibre Optic)
The Crane shall be provided with fibre-optic cables and the necessary hardware for data transmission.

2.10.3. Auxiliary Electrical Power Interface
The Purchaser will advise an approved locally available plug and socket arrangement for the shore supply duringthe design phase.

2.10.4. Climatic Condition
The Crane shall be designed and constructed to be fully capable of operating safely and performing as requiredby the Agreement (for condition (1) - (5) below) and withstanding the following climatic conditions.

(1) Ambient temperature +18 deg. C to +40 deg. C

(2) Relative humidity Max. 100%

(3) Dew point Max. 30 deg. C

(4) Sustained wind 20m/s

(5) Wind gust up to 25m/s without warning for normal working condition. This must be taken into account with regards to operating stability and gantry powercalculations.

More stringent and specific requirements shall apply for individual Crane sub-systems and components, whichare separately specified in each relevant clause of this Specification.

2.10.5. Wind Loading Condition

The entire Crane structure with all of its machineries, components, fittings/accessories, and all equipment shallbe designed and constructed to withstand the following wind loading conditions.

In the design calculations, the wind pressure for each condition shown below shall be assumed to act as uniformly constant over the total height of the structure in the parallel, perpendicular and angular wind directions.

(1) For operation of the Crane:
Allow for wind loading of sustained wind speed of 20m/second for safe load handling operation of the Crane.

(2) For the stowed condition of the Crane:
A wind loading of wind speed up to 70m/second shall be allowed for the condition that theCrane is out of service, boom in stowed or maintenance mode, gantry wheel brakes engaged,gantry stowage pins located in sockets in the quay with tie downs deployed.

2.10.6. Load Lifting and Stability Condition

(1) One side landing
A normal operating condition shall include the case of a short side landing of a 45 ft. concentric 55 MT weight container, in which case a set of main hoist wire ropes on the landedside is assumed slack and not carrying the load. Calculation for structural design and mechanical design shall take this case into consideration.

(2) Eccentric container handling
All structural, mechanical and electrical systems and system components shall be designed totake account of the eccentric forces involved in handling containers in the single lift and twin- lift operation in the following combinations.

Single lift condition

(i) 1-unit x 45ft container weighing up to 55 MT with eccentricity of 1.2m in longitudinal (gantry) direction and 0.25m in transverse (trolley) direction.

Twin lift condition

(ii) 2 units x 20ft containers each weighing up to 32.5 MT with eccentricity on each container of 0.6m in the longitudinal (gantry) direction and 0.25m in the transverse(trolley) direction.

(iii) 1-unit x 20ft container weighing up to 32.5 MT with eccentricity of 0.6m in the longitudinal (gantry) direction and 0.25m in the transverse (trolley) direction and 1 unit x 20ft container at 2 MT

(empty) concentric.

Under conditions (ii) & (iii) the center distance between containers shall be amaximum of 7700mm.

(3) Fatigue condition

The structural fatigue calculations must include the cases that the Crane will be continuouslyhanding containers configured respectively as outlined in 2.9.8(2), i), ii) and iii) above andthe Cranes must be suitable for and able to perform as required for this.

(4) Dynamic snag load
A device shall be incorporated into the hoisting system to provide protection against snagging. The Crane shall not sustain any damage due to dynamic snag load. The Contractor shall submit structural calculations to prove that structures are safe under dynamicsnag load.

(5) Stability

The Crane shall be stable with a reasonable factor of safety and shall not sustain any damagewhen a dynamic snag load is applied to the boom at the maximum outreach position.

(6) Other Loading Conditions

All loading conditions forming design criteria other than specified in this Specification shall besubmitted to the Purchaser for review.

(7) Earthquake
The Crane shall also be designed to take account of earthquake loading to 0.2g which maybe subjected to the structure both in service and out of service operation. See EQO and EQSloading, section 2.6.

2.11. Noise Control

(1) Special consideration shall be given to acoustic treatment to reduce noise breakout from themachinery house via the walls, floors, roof, winch wire rope openings, ventilation air intake /discharges.

(2) The maximum noise level measured 1 meter outside and under the machinery house shallnot exceed 85 dB

(3) The noise level inside the operator's cab, checkers cabin and electrical computer monitoringroom shall be below 75 dB during operation, with air-conditioner on, and doors and windowsclosed.

2.12. Operationally Critical Components

The Contractor shall submit the inspection and replacement schedule for the operationally critical components to the Purchaser. The objective is to assist the Purchaser to establish a standard for maintenance and inspection of operationally critical components (i.e., those components and structural areas,joints, tension bars where failure could have catastrophic consequences). The following items shall be included in the list of Operationally Critical Components:

(1) Drum Couplings for the Main Hoist and Boom Hoist

(2) Service and Emergency Brakes for the Main Hoist and Boom Hoist

(3) Wire ropes

(4) Twist-locks for Head-block and Spreader

(5) Elevator

(6) Structural components as defined by the Contractor.

2.13. Duty Cycle

(1) The Crane(s) shall be capable of continuous duty cycle operation at speeds up to full speedwith loads up to 50MT; the Crane(s) need not be capable of continuous duty cycle operation with container loads exceeding 50MT. Performance (speed and accelerations/decelerations) maybe reduced at loads exceeding 50MT, but the Crane(s) shall have no other limitations preventing safe and efficient intermittent operation with container loads between 41MT and 50MT and shall be capable of "continuous" duty cycle operation with container loads of 50 MT for not less than one (1) hour. The Crane(s) shall be easily maintained and suitable for operation in the atmospheric conditions described in Section 2.95

(2) The theoretical duty cycle for use in calculating times and equipment ratings of the main hoist and trolley drive systems shall consist of removing and replacing the containers of a typical hatch on vessel 23 containers wide with seven (7) high stowage above deck and nine (9) high below deck. The equipment ratings shall also consider the various worst-case container handling cycle paths encountered in container handling operations.

(3) The calculations shall be based on the following:

(i) 50MT load each way.

(ii) All loads are lifted 1 meter clear of the highest obstruction in their travel path

(iii) All loads will be lowered to within 1 meter of surface they are to be set upon, stoppedand then lowered onto the surface. Similarly, containers to be put in cells will be stopped 1 meter above the cell guides and then lowered into the guides.

(iv) A dwell time of 2 seconds will be allowed for engaging or disengaging twist-locks, andfor entering cell guides. These are the only dwell times to be considered.

(v) Each motion accelerates travels and decelerates at the maximum rates for which the system is designed.

(vi) Hoist and trolley travel occur simultaneously whenever the container is clear of a cell.Ambient temperature is between +18°C and +40°C plus allowance for solar radiationwhich may increase surface temperatures to 50°C.

(vii) The cycle is repeated indefinitely.

(viii) The wind load is 50% of WLO, applied in the least favourable direction.

(ix) The Contractor shall submit for review, the theoretical duty cycle block diagram for themain hoist and trolley drive

(4) The theoretical duty cycle for the trim/list/skew system components shall consider the above main hoist and trolley duty cycle with the trim/list/skew

system completing two full-range operations per container cycle.

(5) The theoretical duty cycle for the purposes of calculating times and equipment designs of boomdrive shall be based on the following: -

(i) Raise boom from operating to stowed position at rated speed.

(ii) Lower boom from stowed to operating position at rated speed.

(iii) The cycle is to be performed four times with no dwell time.

(iv) The wind load is 50% of WLO, applied in the least favourable direction

(6) For the gantry drive, the theoretical duty cycle for purposes of calculating times and equipment designs shall consist of continuous gantry travel for 60 minutes with empty spreader at any speed to full rated speed against the most severe wind load (including diagonal wind) equivalent to 50% WLO, unless other specified operating modes govern the design.

3. CRANE STRUCTURAL SPECIFICATIONS

3.1. General Requirement

3.1.1. Design

(1) The term "AISC Specification" refers to the Specification for Structural Steel for Buildings, Allowable Stress Design and Plastic Design, June 1, 1989, with Commentary. The terms "AWS Specification," "AWS D1.1," and "AWS D1.1/D1.1M-2006" refer to the AWS D1.1/D1.1M-2006, Structural Welding Code - Steel, an American National Standard. Provisions for bridges and dynamically loaded structures shall take precedence. The terms "AWS D1.5," and "AWS D1.5M/D1.5:2002" refer to theAWS D1.5M/D1.5:2002, Bridge Welding Code, an American National Standard. The structural design shall generally conform to the requirements of the AISC Specification except allowable stresses shall be as specified in this section.

(2) The gantry frame structure shall consist of sections, box or tubular members. The boom and trolley girder shall be either one or two girders. A trussed boom is not preferred but may be permitted with the Purchaser's approval. Cover plates and back-to-back angles or channels shallnot be used. Exterior surfaces of structural components shall be accessible for maintenance. Wirerope or strand shall not be used for structural members. Flattening or crimping of tubing will not be allowed unless approved in writing by the Engineer.

(3) Welded joints are preferable. Bolted joints will only be allowed when specifically approved by the Engineer. If the Contractor proposes to use bolted joints, he shall so indicate in his tender. Bolted joints shall be made using ASTM A325 or A490 bolts or bolts complying with equivalent ISO or British Standards. For Operating conditions, the joints shall be designed to meet the requirements for slip critical joints For Overload and Storm conditions the joints may be allowed to slip provided the slipping is not detrimental to the performance of the joint or the structure. Welds and boltsshall not share the load in any joints. The faying surfaces of all main structural friction-type bolted connections shall be machined. Coatings shall be used on faying surfaces of slip critical connectionsonly if they have been qualified to provide the slip coefficient required by the connection design. The Contractor shall provide supporting documentation if faying surfaces of slip critical connections are coated.

(4) The sill beams, legs and portal beams shall form a continuous rigid frame. The

connections between these members shall be welded and be capable of resisting all six components of force. Bolted joints may be allowed as provided above.

(5) The interiors of all members, large enough to crawl through, shall be accessible for periodic structural inspection. Members that cannot be internally inspected because of size or other practical reasons shall be sealed by welding. Sealed members shall be pressure tested at 10 kPa gauge pressure using soap film to demonstrate air tightness. Sections shall be designed to resist the test pressure without yielding. Stresses developed by a 20· C temperature change of the entrapped air shall not exceed 0.10 times the basic allowable stresses.

(6) Fracture critical members or member components, FCMs, are tension members or tension components of members whose failure would be expected to result in collapse of the crane, collapse or dropping of the trolley or operator's cab, or dropping the load. Tension members or tension components include those portions of a flexural member that are subject to tension stress. Examples of FCMs are stays and the tension flanges of the trolley girder, boom, and trolley girder support beams. Stiffeners used to increase plate buckling strength, and which are not used in the calculations as part of the structural section, may be classified non-fracture critical.

(i) The responsible structural engineer shall determine which member or member component isin the FCM category.

a. As a minimum, the responsible Structural Engineer shall consider the load case (DL + TL + LS + LL + IMP ± LATT) when determining if a member or member component is in tension for FCM classification. The trolley shall be considered in any position. The effect of one trolley corner lifting vertically out of the plane formed by the other three corners should also be included in the above combinationwhen analyzing under-hung trolleys.

(ii) All FCMs shall be identified on the drawings.

(iii) FCMs shall be accessible for periodic structural inspections. Non-fracture critical membersshall be accessible where practical for periodic structural inspections.

(iv) For FCMs, in-plane longitudinal stresses in cruciform joints shall be carried through a welded joint by a full penetration butt weld, i.e. complete joint penetration weld. The butt weld should be completed by fillet weld reinforcement on both faces of leg length at least equal to one fourth the thickness of the connected plate but not less than the minimum fillet weld size specified in AWS D1.1. The plate running through shall be checked before welding for laminar rolling flaws and after welding for lamellar tears. For FCMs, cruciform joints shall have redundant load paths. The design shall provide an alternate load path that does not rely on the strength of the plate subjected to through thickness stress.

(7) Connections shall be detailed to provide a ductile structure capable of withstanding yieldingwithout brittle failure. Transitions shall be gradual. Changes in thickness or width shall be achieved using tapered or curved surfaces. The Engineer may require redesign of connections that, in his opinion, cause unnecessarily high stress intensity.

(8) Fillet welds deposited on opposite sides of a common plane of contact between two parts, "wrap around welds," shall be interrupted at a corner common to both

welds according to AWS D1.1, section 2.8.3.5. The ends of the interrupted welds shall be stopped at least 10 mm from the edge of the connected parts. Connection shall be detailed so wraparound welds do not occur. The fayingsurface at the weld interruption may be sealed by caulking.

(9) All pinned joints in the forestays and similar members shall include aluminium bronze bushings or other equivalent manufactured bearings at all rotating bearing surfaces. Backstays are not included in this requirement. All joints shall be designed assuming at least one bearing surface rotates. All bearing surfaces shall be lubricated. Pins shall not be used to resist forces that reverse during normal operating conditions.

(10) The structural analysis of the crane shall be performed or reviewed by the Contractor's responsible structural engineer and the structural detail design shall comply with *Appendix 5* – "LiftechStandard Structural Details".

(11) A design life of four million moves shall be assumed. The assumption of a design life does not necessarily mean that the structure will no longer be fit for its purpose at the end of that period or that it will continue to be serviceable for that length of time without adequate and regular inspection and maintenance.

(12) The Contractor's responsible structural engineer shall be familiar with the following reference documents:

- F.E.M. 1.001, 3rd Edition Revised 1998.10.01
- Maddox, S. J., Fatigue of Welded Structures, Edison Welding Institute, ColumbusOhio and Abington Publishing, 2nd ed., 1991.
- Rolfe, Stanley T. and Barsom, John M., Fracture and Fatigue Control inStructures, Prentice-Hall, 2nd ed., 1987.
- Structural Stability Research Council, Guide to Stability Design Criteria for MetalStructures, Theodore V. Galambos, editor, John Wiley & Sons, 4th ed., 1988.

(13) A large sign shall be placed on the crane's leg near the access ladder In English and Locallanguage stating:

> "The structural integrity of this crane requires that no attachments or fixtures of any kind be welded to any part ofthe crane without prior written approval of the responsibleMaintenance Manager."

(14) Shop and field erection lugs that will not interfere with the operation of the crane may be left onwhen approved by the Engineer and Purchaser.

(1) The girder and boom design shall allow the operator to escape from the operator's cab to the walkwayof the girder and the boom at any point of trolley travel range including under the machinery house inan emergency.

(2) The girder and boom design shall allow trolley wheel replacement works at any position on girder/ boom of the trolley. In addition, the Machinery House structure shall be designed to permit the trolleywheels to be raised or lowered by the Machinery House maintenance hoist.

(3) The boom structure shall have sufficient torsional rigidity to avoid torsional deformation or overstressof the boom due to winds as specified and one side landing of container as specified.

3.1.2. Machinery on main structure.
The following machinery shall be fitted to the main structure of the Cranes.

(1) Gantry drive machinery.

(2) Gantry buffers.

(3) Poweroperated storm brakes with limit switches.

(4) Cable reel with cable guide and limit switches. (Proximity type)

(5) Main hoist sheaves.

(6) Boom hoist sheaves.

(7) Boom latches with limit switches. (Proximity type)

(8) Trolley drive sheaves.

(9) Stowage pins with limit switches. (Proximity type)

(10) Boom hoist, boom latch and gantry travel control station.

(11) Gantry travel operating station at ground level.

(12) Personnel Elevator.

(13) Trim/List/Skew adjustment devices.

3.1.3. Fittings on Main Structure
The following fittings shall be fitted to the main structure:

(1) Walkways, stairs, ladders and platforms.

(2) Lighting for operation and for walkway, stairs ladders and platforms.

(3) Aviation warning lights.

(4) Wind vane for anemometer at a high level where least affected by turbulence caused by own cranestructure during operation.

(5) Intercom system.

(6) Travel warning device.

(7) Two speakers fitted at quay level on waterside and landside facing inside of the Crane.

(8) Welding outlet.

(9) Service outlets.

(10) Emergency stop buttons.

(11) Drive Lock-Out Switches

(12) Fire extinguishers.

(13) Cab window cleaning platform.

(14) Checker's cab.