

## SECTION 30000 MECHANICAL EQUIPMENT

### 30001 General

All mechanical equipment shall be designed to have sufficient strength for each loading conditions and fatigue. The machinery shall be fully capable of operating the crane, in conjunction with the motors at the specified speeds and required loads, with ease, safe and minimum noise and vibration. All components shall be so designed that they can be easily assembled, adjusted and repaired, and are readily accessible for inspection, lubrication and cleaning.

### 30002 Mechanical Parts

#### 30002.1 Rope Drums

The drums shall be of rolled steel welded construction with a solid through shaft or stub shaft with double end diaphragms or with drum coupling with single end diaphragm. The drum shall have accurately machined grooves and have a pitch diameter not less than 35.5 rope diameters for the main hoist and trolley drives and 28 rope diameters for the boom hoist. The drum shell material shall have sufficient hardness to prevent the groove from being wore due to rope pressure. All drums shall have flanges at each end with diameter larger than the pitch diameter of the drum by at least four (4) times of the rope diameter. Rope shall be spooled in one layer, with three full dead wraps remaining on the drums when the rope is fully paid out for normal operation and with one empty groove remaining on the drums when all ropes are fully wrapped. The groove depth and groove pitch shall be in minimum of 35% and 110% of the rope diameter respectively, and the groove radius shall be at least 0.4 mm greater than the rope radius. The net thickness under the groove shall not be less than the rope diameter. Ends of ropes shall be clamped on two successive grooves with independent clamps. Each clamp only clamps one wrap. The drum shall be stress relieved before machining and statically balanced.

#### 30002.2 Rope Sheaves

All sheaves shall be of rolled steel welded or graphite casting construction, or forged or cast steel construction with machined groove. The groove surface shall have the hardness of not lower than HB 321. Flame and induction hardened grooves may be applied as far as all grooves will be subjected to hardness inspection after fabrication. Groove shall be finished smooth and be free from surface defects which may damage the rope. The edges shall be rounded. Running sheaves shall have a minimum pitch diameters of 30 rope diameters for the main hoist and trolley drives and 24 rope diameters for the boom hoist. The pitch diameter of equalizer sheaves shall not be less than 18 rope diameters. The sheaves excepting the equalizer sheave shall be equipped with anti-friction bearings.

#### 30002.3 Wire Ropes

All ropes shall be Filler 6 x Fi (29) IWRC or equivalent. The ropes will be of high quality and have ample size for their respective purposes. The safety factor of wire ropes based on its minimum breaking strength shall be not less than five (5) for the main hoist, boom hoist and trolley tow ropes.

All wire ropes shall be treated with approved lubricant at the manufacturing stage and at the field prior to installation.

#### 30002.4 Shafts and Pins

All highly stressed shafts shall be made of forged steel or rolled steel. Keyed and pinned shafts will be provided with stoppers to prevent complete disengagement. Heat treatment shall be applied for the shafts and pins in such a way that the designed strength and hardness will sufficiently residual on the part specified even after their machining.

Steel to steel equalizer pin bearings as in gantry truck and equalizer beams shall have 50 points HB difference between the pin and housing with the pin being harder. The pin diameter shall be reduced in internal the nonbearing area to facilitate removal. The four bearing areas shall be machined and lubricated with MoS<sub>2</sub> grease prior to assembly. Pins shall have annular grooves at the midpoint of each of the four bearing areas and each groove shall be independently lubricated by means of a high pressure grease fitting.

#### **30002.5 Bearings and Seals**

The minimum life time of anti-friction bearings based on L-10 life shall be 20,000 hours for the main hoist and trolley drive and 6,300 hours for the boom hoist device. Sleeve bearings may be applied for the equalizer sheave pins and the boom hinge pin. No sleeve bearings shall be applied for the tension bar pins, the gantry equalizer and truck pins, and the connection pins for non rotating connection.

Pillow blocks shall be split on the bearing centerline. Pillow block or bearing cartridges made of cast iron shall not be used. Bearings and housings shall be sealed by cap or spring loaded lip-garter type seals and, except for reducer bearings, provided with pressure grease lubrication. Bearing housings shall have removable end caps to allow periodic inspection of the shafts by non-destructive method. All secondary systems, such as deflector rollers, festoon wheels, etc, shall use sealed-for-life bearings to keep the number of lube fittings requiring maintenance to a practical minimum.

#### **30002.6 Gears**

Gears used throughout the crane shall be of forged carbon steel and cast steel. All gears shall have a standard involute tooth form with 20° pressure angle and shall be machine-cut. All main reduction gear units of the driving gears except for the low reduction gears for gantry drive shall be totally enclosed, running in oil with the gear casing of a split type, arranged to be easily removed for maintenance, the shafts being carried in anti-friction. Suitable oil level indicators and drainage fittings will be provided for the gear reducers. The gear boxes will be free from oil leakage.

#### **30002.7 Wheels**

Wheels shall be of double flange solid type of rolled steel with straight treads. Wheels shall be rim toughened to not less than HB 321. The tread width between flanges shall be so selected as to accommodate a 25 mm deviation in the horizontal alignment of the rail. Axles shall be of forged steel, heat-treated, finished and pressed into wheels. Driving wheels shall be keyed or pressed to axles. Journal boxes will be fitted with roller bearings. Gears which are not enclosed in the gear case shall be provided with a safety cover as far as practicable.

#### **30002.8 Brake Drums**

Brake drums shall be designed so as to have sufficient resistance against wear and impact and to work without a high rise in temperature. They shall be well balanced and free from deformation and cracks. Their material shall be spheroidal graphite castings.

#### **30002.9 Couplings**

Flanged forged steel gears or flexible couplings with exposed bolts shall be provided for main driving shafts. The gear couplings except for drum coupling shall be of flexible gear type with spherically crowned teeth and grease lubricated. They shall transmit only torque. For auxiliary or small drives, roller or rubber type flexible coupling may be used.

Couplings in areas of normal personnel access shall be covered with suitable removable cover guards with access openings for lubrication.

#### **30002.10 Bolts, Nuts, Threads, etc**

Bolts and nuts shall have hexagonal heads. Nuts which are subject to vibration and frequent change of load shall be secured by effective methods. Bolts, nuts, screw threads, etc., will accord with recognized standards.

Joint bolts for main structures shall be high friction bolts authorized by internationally recognized organizations and be tightened in accordance with its specification.

#### **30002.11 Bumpers**

The crane shall be provided with bumpers of Hydraulic-Spring type, capable of stopping the trolley or crane. The gantry-bumper shall be capable of stopping the crane when traveling in either direction at 20 percent of the rated speed, at an average deceleration rate of less than 0.9 m per square second. In addition, bumpers shall have sufficient energy absorbing capacity to stop the crane without any serious damage on it, when it hit the end stopper or the next crane at rest with 70% of rated speed under power off condition.

Trolley-bumpers shall be capable of stopping the trolley with a rated load, when traveling in either direction at 33 percent of the rated speed, at an average deceleration rate of less than 1.0 m per square second. In addition, the bumpers shall have sufficient energy absorbing capacity to stop the trolley without any serious damage on it, when it hit the end stopper with full rated speed under power off condition.

#### **30002.12 Lubrication**

The lubrication of gear surfaces and bearings in an oil-tight gear box shall be made by splash oiling or by oil bathing. Gear lubrication not in the gear box will be made by spreading grease on the gear surface.

Lubrication of other mechanical operating parts shall be by means of a high pressure grease gun. Buttonhead type grease fittings made of brass, monel or stainless steel and with Metric screw shall be used throughout.

The lubrication points shall be centralized as far as possible. All lubrication points shall be safely accessible, or shall have lubrication points extended to battery plates at a proper platform or to deck level.

### **30003 Main Hoisting Device**

The main hoisting device shall consists of one or two machine grooved rope drum(s), one AC motor (main motor), one or two magnetic disk brakes (main brakes), and one base mounted helical gear reduction unit (main gear reducer) which is directly connected to the hoist drum(s) through drum coupling(s) fixed on the diaphragm of the drum(s). The main motor shall be connected to one side of the high speed input shaft of the main reducer with flexible coupling. Brake disks shall be mounted directly on the high speed shaft extension of the main hoist reducer, and not on the main motor shaft.

The main hoist device shall be mounted on a single rigid base and located in the machinery house. It is also acceptable to use the floor construction of the machinery house as the machinery base, if it has enough strength and rigidity.

Limit switch(s) shall be provided to slow down and stop the hoisting when reaching the highest lifting or the lowest lifting position. In addition, an emergency limit switch shall be provided on the trolley to will stop hoisting up by directly activating the mechanical brakes, in case of trouble of the above mentioned limit switch for the

highest lifting.

The thruster disk brake shall work automatically when the hoisting and lowering speed exceeds 115% of the rated speed. Hoisting ropes shall be used to hoist 4 points of the spreader with four (4) falls of wire ropes. Overload protection shall be provided.

**30004  
Trolley and  
Trolley  
Traversing  
Device**

The trolley shall be of the fleet-through type with the hoist sheaves supported on a welded steel structural frame carried on independent four (4) wheels, and be driven back and forward by towing ropes. The trolley frame shall be fabricated of steel plate and shaped beam and have enough rigidity and strength for handling containers. The operator's cab shall be suspended from the trolley frame. The deck of it shall be covered with grating floor plates secured by welding. Trolley wheel bearings shall be of anti-friction type and, for ease of maintenance, shall be held in the split bearing housings securely bolted to each other. Drop lugs shall be provided to support the trolley if an axle fails.

Jacking lugs shall be provided to allow axle replacement at any point of trolley travel. Trolley wheels shall be of double flange type, and a positive means shall be provided on the trolley frame to prevent wheels from lifting off the rails. Four (4) side-rollers, one (1) for each corner, shall be provided on the trolley to prevent skew motion of the trolley and wear of the wheel flange. Wheel and sheave assemblies shall be accessible by the machinery house service crane or other means shall be provided for removal and lowering them to the ground. Hydraulic or spring bumpers shall be equipped either at both ends of the trolley or on trolley travel ends of the boom and trolley girder to absorb impact load when the trolley would accidentally hit the travel end.

The trolley shall be propelled by two sets of tow ropes. A trolley tow rope driving device shall consist of one (1) AC motor, one thruster disk brake, one (1) machine grooved rope drum and one (1) enclosed base mounted helical gear reducer. Both extension shafts of the rope drum shall be supported by anti-friction roller bearings, and one side of the extension shaft shall be connected to the out-put shaft of the gear reducer by a gear coupling.

Electric interlock shall be provided so that the electric circuit can be automatically cut off to stop trolley running, when the trolley reaches the predetermined stop positions at the front end of the waterside boom and the rear end of the landside girder.

Limit switch(es) shall be provided to prevent trolley traversing and hoisting when the boom is not in the horizontal position.

**30005  
Boom Hoisting  
Device**

The boom hoist reeving shall include two independent equalized sets of falls, either of which shall catch the boom without damage in the event of failure of the other one set. The remaining set shall be capable of safely rising or lowering the boom to a secure position. Means shall be provided to equalize the load between two independent falls, and to reduce shock load on the remaining fall in case of failure of the other fall.

Rope guides shall be provided at the boom hinge to guide and control the main hoist and trolley drive ropes during boom hoisting and under all stowed load condition.

Retracting safety stop on the trolley runway at the landside of the boom hinge shall contact the trolley bumpers and prevent passage of the trolley to the waterside when the boom is not in the operating position. The boom hoisting machinery shall be mounted on a single rigid base or alternatively rigid floor structure in the machinery house.

The boom hoisting device shall consist of one (1) machine grooved rope drum, one

(1) AC motor, one (1) magnetic disk brake, one (1) rope drum band or disk brake and one (1) base mounted helical gear reducer which directly connected to the rope drum through drum coupling fixed on the diaphragm of the drum. The other end of the rope drum shall be supported by a self-aligning anti-friction bearing.

The disk brake shall be mounted directly on the high speed shaft extension of the boom hoist reducer, not on the motor shaft.

A mechanical latch device shall be provided at the top of the upper post and sustain the boom in its vertical position (stowed position). Synthetic bumpers shall be provided to cushion the load of the boom entering the latch. The latching hook shall be positioned automatically as the boom approaches the stowed position.

Also, releasing of latching hook shall be done by a thruster which is operated by push-button.

Limit switches shall be provided for both of vertical and horizontal end positions of the boom. In the case that the boom is not in the horizontal position, hoisting and trolley traversing cannot be done.

**30006**  
**Wire Rope**  
**Rereeving-**  
**Device**

One set of motor-driven wire ropes rereeving device shall be provided in the machinery house, and arranged for conveniently rereeving the wire ropes during routine ropes replacement. Alternatively, an independent portable type wire rope rereeving device which works on the ground will also be acceptable. The rope rereeving device shall accommodate a regular commercial wooden rope drum.

**30007**  
**Gantry**  
**Traveling**  
**Device**

Each of the four (4) legs of a crane shall be supported by the load carrying assembly of the equalizer beams, the wheel trucks and wheels. The equalizer beams and the wheel trucks shall be of welded steel plate construction, and each wheel truck shall be fitted with a safety drop block which will limit its drop to 1 cm and support it in the event of axle failure. The wheel truck shall be equipped with two double flanged and rolled steel wheels with rim toughened to HB 321 minimum. The crane legs, the upper equalizers, the lower equalizers, and the wheel trucks shall be mutually connected by lubricated pins to ensure that the load on the corner is equally distributed to all wheels. The gantry wheel arrangement shall comply with the allowable wharf loading condition and crane width limitation.

Two sets of gantry traveling device shall be provided on each corner, which consists of one horizontally mounted AC motor with one DC disk brake, one totally enclosed, oil-lubricated gear reducer and the final stage of gearing. The final two reductions and interconnecting wheel gearing may be open, grease-lubricated, spherical bevel and spur gearing. Alternatively, four sets of driving unit consisting of an AC motor with a DC disk brake and a totally enclosed gear box may be provided on each corner. Each driving unit shall be securely mounted on the extension of the respective wheel shaft and directly drive the wheel through it. The wheel shall be mounted on a shaft by press or shrink fitting and the shaft shall be supported by self-aligning anti-friction bearings. More than half of the gantry wheels shall be driven.

Space shall be provided under each corner of the gantry frame for convenient insertion of lifting jacks to permit the removal of the track wheels.

The crane shall be equipped with one (1) set of bumpers per each corner to keep the crane from being damaged in case of collision at full speed under power off, with the next stopping cranes or the end stoppers on the crane runway. In front of each end wheel, rail sweepers shall be provided to remove any obstruction from the rails.

**30008**  
**Spreader Tilting**  
**Device**

The spreader tilting device shall contain end fixtures on the hoisting rope and rope moving device, which shall be furnished at the seaside end of the boom or the landside end of the girder.

The device shall be able to tilt the spreader with rated load by plus or minus three (3) degrees back and forth (list), and by plus or minus three (3) degrees right and left (trim), when the spreader is at ten (10) meters high from the ground. In addition, the device shall adjust the skew of the spreader about a vertical axis up to plus or minus three (3) degrees.

These three (3) motions shall be either independently or simultaneously controlled from the operator's cab. A means shall be provided to allow the operator to automatically return each motion to the neutral position. A means shall be provided to manually move the spreader to a square or level position and to resume crane operation, in the event of failure of the tilting device. An indicator which shows the present postures of the spreader shall be furnished in the operator's cab.

**30009  
Rail Clamps**

An automatic rail clamp shall be installed under the center of each sill beam. The rail clamp truck shall rest on a steel wheel which runs on the gantry rail and one end of it shall be pin connected to the welded steel column which is rigidly connected to the underside of the sill beam. The rail clamps shall be so designed to hold the crane against the specified wind load in conjunction with the gantry brakes. The clamps shall be of automatic and fail safe type with spring set and hydraulic or electric release mechanism. The rail clamps shall be interlocked with the gantry drive so that the rail clamps can actuate whenever the gantry drive is powered off to a complete stop and also the gantry drive is powered only after complete release of the rail clamps. Push-button switches shall be provided in the operator's cab to enable the rail clamps to be released in case of necessity.

**30010  
Crane Stowage  
Pins**

The crane shall be equipped with stowage pins at each rail side to hold the crane against stowed wind. Stowage pins shall be mounted on the center line of the sill beams or of the main equalizer beam through a welded steel column rigidly connected to them. Stowage pins shall be dropped into and mate with sockets on the ground to keep the crane from running. They shall be so designed that engaging and disengaging operations will easily be done by one workman. A mechanical lock shall be provided to hold each pin in the disengaged position during the crane operation. Limit switches shall be equipped to disable the gantry from driving unless all pins are in the disengaged position.

**30011  
Crane  
Anchoring  
Device**

The cranes shall be equipped with crane anchoring devices at each corner to prevent the crane from overturning under stowed wind condition. Crane anchoring devices shall be mounted on the centerline of the main equalizer beam. The anchoring device shall be a wire rope with a shackle at one end and a turn-buckle at the other end. Two anchoring devices shall be provided at each corner where the shackles are connected to eye plates on the main equalizer beam, and under the stowed wind condition, turn-buckles are secured to the eye plates embedded in the ground to keep the corner from being lifted up.

**30012  
Head Block**

The headblock shall consist of a structural frame with host sheave blocks that are permanently reeved into the main hoist wire ropes coming down from and going up to the trolley. The headblock shall be equipped with four (4) sheaves, a cable coiling tub for the umbilical cable from the trolley, and four (4) twist lock pins for quick manual connection to whichever spreader or cargo beam to be used. The cable and tub system shall be so designed that the cable shall not fall out of the tub under the maximum wind, and maximum hoist and trolley speed and acceleration. A heavy duty personal platform with adequate floor space, handrails and screen in front of running ropes shall be provided. The headblock weight shall be sufficient to allow stable hoisting, lowering and trolley running anywhere between the crane legs without spreader. The headblock shall be equipped with a quick connecting multi-core type electric coupling to connect power and control lines between the headblock and the spreader. Electrical interlocking shall be provided to prevent hoisting of

headblock unless all the twist lock pins are fully engaged or fully disengaged.

**30013  
Spreader**

The telescopic spreader shall be of rigid steel construction and be able to handle ISO 20, 40 and 45 feet containers and a hatch cover of container ships. The spreader shall be extended and retracted by hydraulic cylinders between 20 ft and 45 ft. Automatic positioning shall be provided to accurately position the telescoping members at each operating position. The spreader shall be connected to the headblock by means of four (4) manually operated twist lock pins furnished on the headblock.

A corner flipper and one (1) set of cell-guide corner roller or cell-guide wear plates shall be provided at each corner for easy positioning on a container and smooth running in a ship's cell guide. The corner flippers shall be driven by an hydraulic actuator and operated from the operator's cab. Two flippers on the seaside and two flippers on the landside shall be operated independently.

Four (4) sets of twist lock pin conforming to ISO standard shall be installed in each corner for locking and unlocking containers. These twist lock pins shall be driven by four (4) sets of hydraulic cylinders and operated from the operator's cab. Four (4) landing detecting pins shall be installed at the location just close to the twist lock pins.

One set of hydraulic pump unit and magnetic valve unit shall be installed on the spreader to supply power to the telescoping, flipper and twist lock devices. The hydraulic and electrical equipment shall have enough strength against inertia forces and shall be anti-shock mounted.

For ease of replacement of the electric cable from the trolley, one quick-joint box set will be installed in the spreader.

Four (4) pad eyes shall be provided at each corner of the spreader and another four (4) pad eyes at approximately 2.5 m on either side of the center to allow slinging of a general cargo or deformed container.

The following limit switches shall be installed in the spreader:

- a) container top face detector
- b) twist lock pin motion detector
- c) corner flipper end position
- d) spreader position to 20, 40 and 45 feet length

**30014  
Heavy Lift Hook  
Beam**

The heavy lift beams shall be of welded steel construction. The heavy lift beam shall be equipped with a hook of 45 t capacity. The hook beam shall be connected to the headblock by the manually operated twist lock type quick connective device of the headblock.

**30015  
Personnel  
Elevator**

The cranes shall be equipped with a personnel elevator, providing landings at lower ends of elevator travel, at the Machinery House level, and at other levels as may be required by the crane configuration.

General Specifications :

- |                    |  |
|--------------------|--|
| a) Type:           | Rack pinion drive type with enclosed cage. |
| b) Load capacity : | Not less than 3 persons or 240 kg          |
| c) Cage speed:     | Not less than 17 m/min.                    |

- d) Cage dimension : Not less than 740x800 x 2,000 mm
- e) Stops: Two stops as follow
  - At top of Sill beam
  - At the machinery house level
- f) Location: Landside leg
- g) Safety devices :
  - Emergency stop.
  - Self locking device.
  - Emergency ladder and hatch.
  - Manual lowering function.
  - Manual door with interlock limit switch  
up-down end limit switch.
- h) Accessories: Call push button

**30016  
Trolley Rope  
Tensioning  
Device**

Hydraulically operated tow rope tensioning shall be provided on the tow rope reeving system to maintain proper rope tension during normal operation and compensate for unequal rope stretch. The tensioning device shall be designed for continuous operation.

**30017  
Snag Load  
Protection  
Device**

The crane shall be provided with a snag load control device to limit mechanical and structural loads to their design limit in the event of a snag load incident.

The snag load control device shall be integrated into the main hoistreeving systems and be able to response independently or simultaneously to the snag load on any one of main hoist falls.

The snag control device shall have the following features:

- a) Be hydraulic and absorb energy by fluid flow over relief valves or by a functionally similar hydraulic circuit.
- b) Power reset after a snag incident by a keyed switch, without parts replacement, manual adjustment and manual charging of an accumulator.
- c) Automatically compensate for hydraulic leakage. External leakage is not acceptable.

Snag analysis shall investigate all possible snag load combinations to ensure sufficient energy absorbing capabilities.

The minimum snag and two blocking cases to be investigated are:

- Two blocking empty spreader and headblock at full speed. Spreader at maximum trim. Jamming in ship's cell, 16 m above gantry rail elevation, of a full speed empty spreader and headblock for both of the following occurrences:

- a) One side only jams, two hoist ropes snag.
- b) Both sides jam, four hoist ropes snag.



Snag analysis shall prudently consider the activating time of relief valves, and motor and brake response times.

The snag device shall be set not to trip for any rope load less than 125% of any operating rope load including design impact and eccentricity.

A convenient means shall be provided for maintenance personnel to periodically field-verify the pressure setting of relief valves.

## SECTION 40000 ELECTRICAL EQUIPMENT

### 40001 General

Due consideration shall be given to the design and installation of all electrical equipment, devices, parts and accessories to ensure durability, minimum vibration, anti-corrosion and easy maintenance and replacement.

All electrical equipment, devices, parts and accessories shall have sufficient capacity and performance for the rapid, precise handling of containers in continuous loading and unloading operations.

Each electrical equipment and/or device and part shall have a name plate stating the function of the item and the name of maker.

The electrical system of the main hoist, trolley and gantry travel and boom hoist operations shall be a stepless, regulated, reversing, AC current, adjustable frequency control system by means of inverter units.

The control of the main hoisting, trolley and gantry motion shall be through master switches (lever type) located in the operator's cabin attached under the trolley. The operation of boom hoisting shall be made by a control switch in the boom control station, which shall accomplish only one predetermined speed.

The operator shall be able to increase or decrease the speeds of main hoist, trolley and gantry travel by moving the master switches. The speed of those motions shall steplessly vary from zero to full speed in proportion to turning angle of the master switch lever. In order to provide smooth, precise speed control around zero speed, all master switches shall be equipped with a trigger-operated "float" switch which shall keep the motor loop circuit energized and the brakes released when the master switch is moved the off position. Provisions shall be made to automatically limit the rate of acceleration and deceleration to predetermined values even when the operator will move the master switches too rapidly. Under normal operation, deceleration shall firstly be accomplished electrically, and the mechanical brakes shall be applied when the speed is reduced to about 10% of the rated speed.

Sufficient speed response at low armature voltage and low speed in hoist and trolley shall essentially be provided. All of the operating devices, i.e. main and boom hoist, trolley and gantry travel, and others shall be powered from AC electrical power sources.

### 40002 Operation and Control

#### 40002.1 Main Hoist

Control of the motion shall be conducted by master switches (on the control console) in the operator's cab during normal operation, and by pushbutton switches from the ground level control station for maintenance purpose only.

The main hoist shall be driven by squirrel cage motor(s) whose speed and torque shall automatically be controlled by the inverter conversion assemblies. The operator shall be able to increase or decrease the speed of the drive and alter its direction by moving the master switch levers in the proper direction and angle. Automatic motor field weakening shall be provided for the main hoist to provide faster hoisting and lowering speeds for the loads less than rated load by maintaining constant horsepower at the motors.

Under normal operating conditions, speed deceleration from higher speed to about 10% of rated speed shall be accomplished by only electrical regenerative braking, and then the mechanical disk brakes shall be additionally applied.

The disk brakes, however, shall be instantaneously applied, regardless the running speed, when an emergency stop command is issued (when an emergency stop switch, or overspeed switch or an emergency limit switch is actuated, and/or in the event of

power supply failure).

An interlock shall be provided to disable hoist operations when motor and inverter cooling blowers are not running, boom is not horizontal, load is heavier than rated load (overload), and all of the spreader twist lock pins are not fully locked or unlocked. The crane shall be equipped with a slack rope limiting device which senses rope tension and prevents the main hoist from paying out rope when the ropes go slack. In the raising direction, the device shall limit the hoisting speed to about 20% (adjustable) of rated base speed until the weight of the spreader is fully supported by the hoist rope. An overspeed switch shall be provided on the main hoist motor or drum to shut down the drive and set the brake(s) at 115% of normal no-load speed. Since the hoist inverter is also used for gantry travel by a change-over, it shall not be possible to actuate simultaneously both of the hoist and gantry travel drives.

A change-over switch shall not be particularly provided for selecting hoist or gantry travel operations, and the change-over shall be automatically accomplished when the respective controller is operated. If both controllers are operated together by mistake, the operation which was actuated earlier shall govern (first-come-first-served basis).

#### **40002.2 Trolley Traverse**

Control of the motion shall be conducted by master switches (on the control console) in the operator's cab under the trolley.

The trolley travel device shall be driven by squirrel cage motor(s) whose speed and torque shall automatically be controlled by the inverter conversion assemblies. The operator shall be able to increase or decrease the speed of the drive and alter its direction by moving the master switches in the proper direction.

Under normal operating conditions, speed deceleration from higher speed to about 10% of rated speed shall be accomplished only by electrical regenerative braking, and then the mechanical brakes shall be applied.

The mechanical brakes, however, shall be instantaneously applied, regardless of the running speed, when an emergency stop command is issued (when an emergency stop switch, or overspeed switch or an emergency limit switch is actuated, and/or in the event of power supply failure).

An interlock shall be provided to disable trolley travel operations when motor and inverter cooling blowers are not running, and/or the boom is not at horizontal position.

Since the trolley traverse inverter is also used for boom hoist operations by a change-over, it shall not be possible to actuate both of the trolley traverse and boom hoist operations at the same time.

A change-over switch shall not be particularly provided for selecting trolley traverse or boom hoist operations, and the change-over shall be automatically accomplished when the respective controller is operated. If controllers are operated together by mistake, the operation which was actuated earlier shall govern (first-come-first-served basis).

#### **40002.3 Boom Hoist**

Control of motion shall be conducted by the control switch at the boom hoist operating station. The switch shall be of one notch in each direction.

The operation of the boom latch, i.e. latching and unlatching operation shall be automatically accomplished by logic control combined with boom hoist operation.

The latching and unlatching operation shall also be possible by pushbutton switches at the boom hoist operating station when manual latching and unlatching are

required.

The boom hoist device shall be driven by squirrel cage motor(s) whose speed and torque shall automatically be controlled by the inverter conversion assemblies.

Under normal operating conditions, speed deceleration from higher speed to about 10% of rated speed shall be accomplished only by electrical regenerative braking, and then the mechanical brakes shall be applied.

The mechanical brakes, however, shall be instantaneously operated, regardless of the running speed, when an emergency stop command is issued (when an emergency stop switch, or over speed switch or a emergency limit switch is actuated, and/or in the event of power supply failure). Further, the rope drum shall be provided with a band or disk brake which activates at any speed in case of emergency.

An interlock shall be provided to disable boom hoist operation when motor and inverter cooling blowers are not running, or (for lowering) boom latches are engaged, or the trolley is on the boom. The boom hoist shall be equipped with a slack rope limiting device which stops the drive when the ropes go slack. An overspeed switch shall be provided on the boom hoist drum to shut down the drive and set the brakes at 115% rated speed.

Since the trolley traverse inverter is also used for boom hoist operation by a change-over, it shall not be possible to actuate simultaneously both of the boom hoist and trolley traverse operations.

A change-over switch shall not be particularly provided for selecting boom hoist or trolley traverse operations, and the change-over shall be automatically accomplished when the respective controller is operated.

If both controllers are operated together by mistake, the operation which was actuated earlier shall govern (first-come-first- served basis).

#### **40002.4 Gantry Travel**

Operation shall be made by master switches (on the control console) in the operator's cab under the trolley and, just for maintenance purpose, by a pushbutton switch at the ground level control station. The change-over switches shall be provided for both sides and the effective side shall be decided when both change-over switches select the same place. Eight (8) or sixteen (16) gantry travel motors shall be connected to an inverter drive unit in parallel branches.

The gantry travel device shall be driven by squirrel cage motors whose speed, acceleration/deceleration and torque shall automatically be controlled by the inverter conversion assemblies.

An alarm bell on the landside leg shall sound during gantry travel operation for warning.

Under normal operating conditions, speed deceleration from higher speed to about 10% of rated speed shall be accomplished only by electrical regenerative braking, and then the mechanical brakes shall be additionally applied.

The mechanical brakes, however, shall be instantaneously operated, regardless of the running speed, when an emergency stop command is issued (when an emergency stop switch, or overspeed switch or an emergency limit switch is actuated, and/or in the event of power supply failure).

The disk brakes, however, shall be instantaneously operated when an emergency stop command is issued (when an emergency stop switch, an overspeed switch or an emergency limit switch is actuated and/or in the event of power supply failure).

An interlock shall be provided to disable gantry travel operation when motor and inverter cooling blowers are not running, or the rail cramps and the crane stowage pins are not perfectly released, or the boom is under operation.

Since the hoist inverter is also used for main hoist by a change-over, it shall not be possible to actuate both of the hoist and gantry travel operations at the same time.

A change-over switch shall not be particularly provided for the change-over between hoist and gantry travel operations, and the change-over shall be automatically accomplished when the respective controller is operated. If both controllers are operated by mistake, the operation which was actuated earlier shall govern (first-come-first-served basis).

#### **40002.5 Spreader Trim, List and Skew**

Operation shall be made by the control switch (on the control console) in the operator's cab.

Tilting shall be accomplished by hydraulic or electro-mechanical cylinders, and the squirrel-cage motor incorporated in the hydraulic unit shall be of Direct-On-Line starting by means of magnetic contactor.

#### **40002.6 Spreader**

The motor of the hydraulic pump for operating spreader shall be of squirrel-cage type, and be of Direct-On-Line starting by a magnetic contactor.

The control console and signal lamp box for operation of the spreader shall be installed in the operator's cab.

An interlock shall be provided to enable hoisting or lowering operations only when all of the four spreader twist lock pins are fully locked or unlocked, and to disable locking and unlocking the twist lock pins unless four corners of the spreader are perfectly seated on the container. Accordingly, unlocking of the twist lock pins shall by no means be possible while the container is suspended under the spreader in the air.

#### **40002.7 Maintenance Hoist Crane**

The squirrel-cage motors of the hoist crane shall be of Direct-On-Line starting by magnetic contactors, and operation shall be made by the push-button switch box suspended from the hoist crane.

#### **40002.8 Power Source for Control Circuit**

The power source for DC and AC control circuits shall be turned on and/or off by the push-button switch in the trolley operator's cab and boom hoist operating station.

Control shall also be provided at the auxiliary control panel.

The Power ON indicator lamp shall be provided close to the power push-button.

#### **40002.9 Rail Clamps**

The rail clamps shall be hydraulically operated with solenoid valves.

The motors for the hydraulic pump of the rail clamps shall be of squirrel-cage type and of Direct-On-Line starting by a magnetic contactor. The rail clamps shall automatically be released and engage whenever the gantry travel master switch is energized and restored to neutral.

For the maintenance purpose, the push-button switches with indicating light shall be provided in the operator's cab to enable independent operation of the rail clamps.

These operation modes shall be selected by an override switch provided on the control console in the operator's cab.

An interlock shall be provided to disable engaging rail clamps until the gantry travel motion is completely stopped.

#### **40002.10 Rope Rereeving Device**

Operations shall be made at the independent push-button switch box in the machinery house. The device shall be driven by a squirrel-cage motor, having Direct-On-Line reversible starting system by magnetic contactors.

#### **40002.11 Elevator**

The squirrel-cage motor of the elevator shall be of Direct-On-Line starting by a magnetic contactor, and operations shall be made by the push-button switch.

#### **40002.12 Other Auxiliary Equipment**

Operations of the Machinery House fans shall be started and/or stopped by the push-button switch on the auxiliary control panel.

Blowers for hoist and trolley motors shall automatically start or stop together when the control power is on or off.

The motors shall be of squirrel-cage type, and be of Direct-On-Line starting by magnetic contactors.

#### **40002.13 Emergency Stop Switches**

Emergency stop switches shall be provided in the operator' cab (control console), on the boom hoist operating station (control box) and at the ground level locations on both sides legs of the crane.

Major operations (hoist, trolley traverse, boom hoist and gantry travel, etc.), shall be instantly stopped by operating any one of the emergency stop switches.

### **40003 Crane Power and Circuit/ Equipment Voltage**

The crane main power shall be 4.16 kV, 3 phase, 60 Hz with line voltage rated  $\pm$  5% and be supplied, through the main power supply system, to a primary 4.16 kV, 3 phase switchgear assembly provided in the Machinery House. The primary switchgear shall be provided with a door mounted manually operated disconnect switch assembly, a fused load breaker assembly and emergency stop button. The high voltage incoming power shall produce the following electric voltage and current through transformers and thyrster transducers which will be applied to the relevant electrical drives and systems.

- a) AC Motor Voltage: AC 208 V and AC 480 V, 60Hz, 3-phase, 3-wire
- b) Lighting and others: AC 240 V, 60Hz, single phase, 2 wire DC 24V

In addition, a AC 480V, 60 Hz, 3-phase shore power may be supplied to the crane when the crane is stowed.

### **40004 Power Supply Systems**

#### **40004.1 Main Power Supply System**

One powered cable reel shall be provided at the seaside of one seaside leg. The cable reel shall be of one-line and multi-layers winding type, and shall have a sufficient reel flange diameter to contain the full length of the main power supply cable. The width between both flanges shall be so designed as to prevent the cable from rubbing hard the flanges as well as from thrusting into the underlayer.

The cable reel shall properly be torqued by an electric torque motor to one direction in order to wind up and pay out without loosening and excessive tensioning of cable even during high speed gantry running to either direction. One set of electrical

sliprings shall be provided inside the drum to conduct electrical power to the crane. The cable shall be of four-core 3-phase, flexible flat power type with a long cable to allow the specified travel length from the junction box embedded on the ground. A cable guiding device shall be provided on the crane under the cable reel to precisely lay the cable in the cable tray on the ground.

#### **40004.2 Trolley Power and Control Supply**

Power and control shall be supplied to the trolley by a festoon system. Power and control wiring shall be run in flexible cables from junction boxes on the land side end of the trolley girder(s), via a festoon system, to junction boxes on the trolley. The festoon cable shall have sufficient flexibility and durability for heavy-duty loosening and extending operation.

The festoon trolley shall be equipped with flangeless trolley rollers, side guide rollers and uplift rollers, all of which shall be supported with anti-friction bearings. Festoon trolley wheels shall be readily changeable in place. The cable saddles shall be arranged for easy side loading of a replacement cable. Cable shall be blocked in place on the saddle of the festoon trolley so as not to overlap or slip on the saddle. The festoon system trolleys shall be towed by stainless steel or galvanized steel cable without producing harmful stress on the festoon cables. Festoon trolleys shall be provided with rubber bumpers on both sides so as to prevent the festoon system from being damaged by virtually frequent collision between adjacent trolleys.

#### **40004.3 Spreader Power and Control Supply**

Power and control shall be supplied to the headblock from the trolley junction box by means of a pendent umbilical cable. The cable shall be heavy-duty, pendent service rated, multi-conductor cable. The umbilical cable shall be naturally coiled and housed in the cable tub on the headblock by inherent self coiling features of the cable.

Provision shall be made for design of the cable tub to prevent the umbilical cable from being dislodged even against the maximum wind under the maximum speed and acceleration of hoisting and trolley traveling.

#### **40004.4 Shore Power Supply**

The crane shall be furnished with electrical circuits and equipment for providing electrical power to the specific equipment on the crane when it is stowed and main power supply is disconnected. AC 480V, 60 Hz, three-phase, 30 meters of cable with plugs at both ends shall be stored as accessories on the crane. The shore power shall be supplied to the crane by connecting the power source receptacle on the ground and the power receiving receptacle at the underside of the waterside sill beam with the above mentioned cable. The transfer of power supply from the crane normal power source to the shore power source shall be automatically switched when the shore power supply is connected and the main power supply is de-energized.

The following minimum items should be connected to the shore power supply system.

- a) Access, interior and food lighting
- b) Obstruction lights.
- c) Space heaters for major electrical equipment and control panels.
- d) Electrical house air conditioning.

**40005  
Limits Switches,  
Interlocks and  
Electrical  
Protective  
Devices**

**40005.1 Limit Switches, Sensors and Interlocks**

Where possible, encoders, resolvers, overspeed switches, roller lever arm limit switches, proximity switches, and pressure transducers should be of identical and interchangeable components. They shall be installed at easily adjustable positions and, when installed outdoor, shall be of waterproof construction.

**4005.2 Main hoisting**

The following limit switches, sensors and interlocks shall be installed:

- a) Position sensor  
Slowdown and stop at upper and lower travel limits, over the both sill beams and at the sheave shuttle position. Slowdown over the apron.
- b) Block actuated limit switches  
Stop at emergency upper stop position switches
- c) Speed switch  
Stop at the overspeed of more than 115% of no load rated speed.
- d) Load sensor  
Stop by rope slack, overload and snag load.
- e) Interlock  
With non-horizontal boom, lock and unlock of twist lock pins of the headblock and the spreader.

**40005.3 Trolley Travelling**

The following limit switches and inter-locks shall be installed:

- a) Position sensor  
Slowdown and stop at the extremes of trolley travel ends. Sensing of boom cleared signal, over apron signal, and landside and seaside sill beam zone signals.
- b) Limit switch  
Stop at the emergency travel limits on both ends.
- c) Interlock  
With non-horizontal boom.

**40005.4 Gantry Travelling**

The following interlocks shall be installed:

- a) Limit switch  
Stop at both runway ends.
- b) Anti-collision sensor  
Prevention of crane collision.



c) Interlock with rail clamps and anchors.

Fuses shall be nonrenewable NEC or other internationally recognized, standard cartridge except for special application such as current limiting fuses.

Instantaneous and sustained over-current protection shall be furnished for all major motors.

**40006  
Motors and  
Inverter  
Conversion  
Assembly**

The rating of the motors and inverter conversion assemblies shall be checked on the basis of mechanical information to confirm that the rating are adequate to meet the speed, acceleration/deceleration and theoretical duty cycles.

**40006.1 Inverter Conversion Assembly**

Inverter conversion assemblies shall consist of two (2) inverter converters.

The No.1 inverter converter shall supply power to the main hoist or the gantry travel motors, and the No. 2 inverter converter shall supply power to the trolley travel or the boom hoist motors. The inverter system shall be designed exclusively for continuous container handling operation.

Each inverter conversion assembly shall be selected according to the following criteria:

The nominal current rating of the inverter assembly shall exceed the RMS (Root Mean Square) current of the motor as determined by the theoretical duty cycle.

The continuous current rating of the thyristor assembly shall exceed the RMS current of the motor as determined by the theoretical duty cycle. The continuous current rating of the inverter assembly shall exceed the RMS motor current required for the most severe loading condition.

The 60 seconds current rating of the inverter assembly shall be 150% of the nominal current rating of the inverter.

All the above ratings shall be based on the maximum design ambient temperature, 40° C. Rating shall not be based on forced air cooling.

**40006.2 Motors**

Motors shall be sized based on not only a theoretical duty cycle with the proposed motors but also on the non duty cycle maximum power requirements which may be imposed at any time. Major motors shall have ball bearing and be grease lubricated. Major motors shall be suitable for operation in the ambient temperature and shall have a minimum of Class F insulation. AC motors shall be of squirrel cage type, with continuous ratings, except the boom hoist and gantry motors which may be 30 minutes rating, with adequate thermal characteristics to meet the maximum specified load condition. Motors shall be protected from environmental contaminants in the area of the terminal. Motors located in the Machinery House shall have drip-proof enclosures and protection class IP22, whilst those mounted on the exterior shall be weather-proof totally-enclosed, non-ventilated, or fan-cooled enclosure and their protection class shall be IP55.

Major motors shall be equipped with internal thermal sensing devices to protect them from operating in an overheated condition, and also with a space heater.

The minimum motor capacity of each major drive shall be as follows. The motors with capacity less than below shall not be accepted.

**Table-1 Motors**

| Name              | No. of sets | Total Capacity                           | Remarks  |
|-------------------|-------------|--|--|
| Main hoisting     | 1           | AC minimum 470 kW,<br>Continuous rating  | With AC thruster<br>disk brake (s)                             |
| Trolley traveling | 1           | AC minimum 120 kW,<br>Continuous rating  | With AC thruster<br>disk brake (s)                             |
| Gantry traveling  | 4 or (8)    | AC minimum 37.5 kW,<br>30 minutes rating | With AC magnetic<br>disk brakes                                |
| Boom hoisting     | 1           | AC minimum 750 kW,<br>30 minutes rating  | With AC thruster<br>disk brake (s) and<br>hydraulic disk brake |

Motors (in addition to the above motors) shall be installed for the rail clamps, mechanical ventilators in and electric hoist in the Machinery House, cable reel, hydraulic unit on the spreader, rope tensioner, boom clamps, wire-rope rereeving device and others.

**40007  
Brakes**

All brakes shall be the products of well experienced and reliable brake manufacturer. Each brake shall be capable of stopping its respective drive under emergency stop conditions from maximum speed (overspeed trip speed) to zero without assistance from motor regeneration. All brakes shall remain operable even following such event. When designing the brake torque, brake response time from loss of power shall be considered. The electrical brakes shall be so designed as to be automatically engaged in the event of power failure (fail safe design).

**40007.1 Main Hoist Brake(s)**

The brake shall be AC thruster operated caliper disk brake. The brake shall have a dynamic rating torque equal to at least 150% of the torque required to hold the maximum load at the shaft where the brake is mounted. If two (2) brakes are used, each braking torque shall be more than 100% of the brake torque required to hold the maximum load.

**40007.2 Trolley Brake**

AC thruster operated caliper disk brake. The brake torque shall be more than 100% of the rated motor torque at the shaft where the brake is mounted.

**40007.3 Gantry Brakes**

A motor mounted disk brake, or an independent DC magnetic brake or AC electro-hydraulic thruster brake shall be provided on each motor.

The brake torque shall be more than the maximum motor torque. The gantry motor brakes shall have the thermal capacity to stop the gantry (boom up or down) from the rated speed with the operational wind load under emergency stop conditions. Each brake shall be applied with a watertight enclosure. Brake shall set after an adjustable time delay.

**40007.4 Boom Hoist Motor Brake**

The brake shall be AC thruster disk brake. The brake torque shall be more than 150% of the brake torque required to hold the maximum load at the shaft where the brake is mounted. The boom hoist motor brake shall have the thermal capacity to stop and hold the boom at maximum boom hoist load and overspeed trip speed under emergency stop conditions without help of the drum brake.

If two (2) brakes are used, each braking torque shall be more than 100% of the brake torque required to hold the maximum load.

#### **40007.5 Boom Hoist Drum Brake**

A spring set, hydraulically released caliper disc or band brake shall be mounted on the rope drum. The brake shall be capable of stopping the lowering of the boom at any point in its travel under overspeed conditions without assistance of any other means. Both motor and drum brakes shall set immediately upon loss of electric power or activation of emergency stops.

On normal operation, the control shall cause the drum brake to set after an adjustable time after the motor brake sets on or to release before the motor brake is release by the control command from the control switch.

#### **40007.6 Others Brakes**

If necessary DC magnetic brake or AC electro-hydraulic brake shall be installed on other motors (except above motors).

#### **40007.7 Brake Control Circuits**

The control circuits shall be designed so that all brakes are delayed in setting during normal operation until the associated motor has been slowed to an appropriate low speed by means of electrical braking. However, if the control power has been removed for any reason, all brakes shall set immediately.

### **40008 Transformers**

The following four (4) sets of transformers shall be provided in the protective enclosure in the Machinery House.

- a) for main circuit
- b) for field thyristor power supply and fan motors
- c) for DC control circuit
- d) for lighting and other small appurtenances

The transformers shall be of self cooled, dry type construction with primary and secondary electrical grade copper windings encapsulated with polyester (epoxy) resin. The transformers shall have a primary delta, secondary wye configuration.

The insulating rating of the transformers shall be Class-B for HV (High Voltage) with temperature rating of 80°C rise above maximum ambient temperature and Class F for LV (Low Voltage) with temperature rating of 100°C rise above the maximum ambient temperature. The transformers shall have protective functions for thermal overtemperature trip and warning. Sound levels shall meet the requirements of international standards.

### **40009 Control Panels, and Resistors**

#### **40009.1 Control Panels**

A free-standing, enclosed control panel constructed of sheet steel or open type panel with safety protection shall be provided in the electric room for housing or mounting the control components for the AC electric drive, starters, contactors and switching for both alternating current auxiliary equipment and the direct current drive, together with necessary instruments and wiring. The vertical section of the control panel shall be securely fastened together and the complete panel shall be rigidly fastened to the Machinery House floor. The control panels shall be completely wired with wiring requiring external connections being brought to terminal blocks.

The AC control section for motors shall include voltage regulators for acceleration and deceleration with feedback for fast empty speed.

Classification of color code of cables

a) Sheath  
 Black for all circuits

b) Conductor  
 Manufacturer's standard

- Size of Cables and Wires

Power circuit

- For low voltage : 3.5 mm<sup>2</sup>
- For high voltage : 8.0 mm<sup>2</sup>
- Control circuit : 2.0 mm<sup>2</sup>
- Lighting, warning circuit : 2.0 mm<sup>2</sup>
- Sensor and telephone circuit : 1.25 mm<sup>2</sup> or manufacturer's standard
- Panel internal except for low energy power : same as above

**40010  
 Wiring,  
 Conduit, Cable  
 Tray and Piping**

**40010.1 Wiring**

Electric cables and wires shall be suitable for wet and dry locations. Electric cables or wires shall be of stranded soft drawn copper conductor. All cables or wires shall be continuous from origin to termination without splices in conduit tubes or wire ways. If splices between origin and termination are necessary, splices of cables or wires shall be made in pull boxes or junction boxes. Sufficient slack shall be left at the termination to make proper connection.

Each motor shall be wired independently without common returns. Voltage drop of crane internal from the power feed point to the terminal of a motor shall be no more than five (5) percent of the rated voltage at normal conditions.

a) Classification of electric cables and wires

For high voltage circuit : 5 kV Cross-linked polyethylene insulated PVC sheathed cable (CV)

For low voltage circuit : 600 V moisture and heat-resistant polyvinyl chloride insulated wire (Type HIV)

For control circuit : ditto

For lights, receptacles, warning, etc : ditto

For feeding to moving parts (trolley and spreader) : Round type 600 V grade ethylene propylene rubber insulated and polychloroprene sheathed cable class 2 (2PNCT)

For lines exposed to heat ( such as register) : 600 V Cross-linked polyethylene insulated PVC sheathed cables

For inside panel: Electric manufacturer's standard

For tailing cable : Round type 5 kV grade ethylene propylene rubber insulated and polychloroprene sheathed power cable class 3 (3PNCT)

- b) Classification of color code of cables
  - Sheath  
Black for all the circuits
  - Conductor  
Manufacturer's standard
- c) Size of cables and wires
  - Selection of size. Depending on its duty cycle (for intermittent duty)
  - Minimum size
  - Power circuit
    - For low voltage : 3.5 mm<sup>2</sup>
    - For high voltage : 8.0 mm<sup>2</sup>
    - Control circuit : 2.0 mm<sup>2</sup>
    - Lighting, warning circuit : 2.0 mm<sup>2</sup>
    - Sensor and telephone circuit : 1.25mm<sup>2</sup> or  
manufacturer's  
standard
  - Panel internal except for low energy power : same as above

#### 40010.2 Piping

Electric cables or wires shall be installed in rigid metal conduit tubes, cable steel plate ducts or cable troughs to protect against mechanical damage. Cables shall be laid under the floor of the Machinery House, electrical room, or cab and holes with removable cover shall be provided on the floor to facilitate installation of cables.

Short lengths of flexible metal conduit tubes with protective vinyl jacket shall be used to make connections to control devices, motors or equipment subject to vibration.

All conduit tubes, cable ducts or cable troughs shall be rigidly attached to the structures using suitable attachments to withstand vibration. They shall not be directly welded to structural members.

The piping system shall be installed so that any moisture can be drained away from the pull box or junction box. The sum of all bend angles of a continuous conduit tube from origin to termination, pull box or junction box shall not be more than 270 degrees.

The sum of cross sectional areas of cables or wires installed in conduit tubes or cable ducts shall not exceed the following percent of the interior cross-sectional area of the conduit or duct:

- For conduit : 40%
- For duct : 20%

Electric cables or wires for low voltage circuit, control circuit, lighting circuit or telephone circuit shall be installed in each different conduit and/or duct with separator(s). However conductors for low voltage and lighting circuits may be contained in the same conduit or duct.

**40010.3 Others**

- a) Terminal  
Solderless press-on type and/or clamp type
- b) Marker for cable: Vinyl tube

**40011  
Lighting and  
Accessories**

**40011.1 Lighting**

The lighting system shall provide sufficient illumination to all access ladders, platforms, walkways, operator's cab and machinery house for night operation.

Due consideration must be given in the design and installation of the lighting system to minimize vibration, corrosion and maintenance. The following lighting fixtures shall be installed:

- a) High pressure sodium lamp

| Type   | No. of lamps | Position             | Remarks               |
|--------|--------------|----------------------|-----------------------|
| 1000 W | 7*           | under boom           | for ship              |
| 1000 W | 12*          | under girder         | for apron             |
| 1000 W | 2            | under operator's cab | for apron             |
| 1000 W | 4            | each leg             | for travelling gantry |

Flood lighting excluding the flood lights under the operator cab shall provide a maintained minimum illumination of 50 lux at any point on the wharf level under the girder and boom. The quantities with a \* mark show the minimum requirement and should be increased if necessary to meet the above illumination requirement.

- b) Incandescent lamp

| Type  | No. of lamps | Position                                | Remarks                    |
|-------|--------------|---|----------------------------|
| 100 W | 1            | Boom station                            | for boom hoist operation   |
| 100 W | 20*          | Ladders, Stairs, Walkways and Platforms | for access and maintenance |
| 300 W | 2            | Top cross tie                           | for boom latch             |

Lighting on the ladders, stairs, walkways and platforms shall provide an average illumination of 20 lux for the main root and maintenance area, and 10 lux for the local area. The quantity with a \* mark show the minimum requirement and should be increased if necessary to meet the above illumination requirement.

- c) Fluorescent lamp

|                      |                               |
|----------------------|-------------------------------|
| 20 W x 2 or 40 W x 1 | operator's cab                |
| 40 W x 12*           | machinery and electric houses |
| 20 W x 2             | check man's cab               |

The fluorescent fixture in the operator's cab shall be provided with dimmer control which supplies an average illumination on operating surfaces of 0 lux to 100 lux.

Lighting in the machinery and electric houses shall provide a minimum illumination of 100 lux at any points on the floor level in the houses. The quantity with a \* mark shows the minimum requirement and should be increased if necessary to meet the above illumination requirement.

d) Aircraft obstruction light

The crane shall be equipped with aircraft obstruction lights with red lenses, in the number, wattage, type, and configuration required by local regulation. As a minimum, they shall be located at the cross ties and the boom tips.

e) Control power indicator

The crane shall be equipped with a 100-watt industrial fixture with red lens. The fixture shall be mounted behind the festoon system service platform and be positioned so as to be visible from the entire wharf area. The fixture shall light while AC control power for drive controls is alive.

**40011.2 Receptacles**

120-Volt single-phase outdoor receptacles with built-in ground fault protection shall be provided in minimum as follows:

|  |     |
|--|-----|
| - In the operator's cab                            | x 1 |
| - On the boom                                      | x 3 |
| - At the hinge                                     | x 1 |
| - At the boom hoist sheave nest                    | x 1 |
| - At the boom tip                                  | x 1 |
| - At the gantry frame top cross tie                | x 1 |
| - In the machinery house                           | x 6 |
| - In the electric room                             | x 2 |
| - At wharf elevation (two waterside, two landside) | x 4 |
| - At the festoon system service platform           | x 1 |
| - At the boom hoist control station                | x 1 |
| - On top of trolley                                | x 1 |
| - On the headblock                                 | x 1 |
| - At the snag service platform                     | x 1 |
| - In the elevator                                  | x 1 |
| - In the check man's cab                           | x 1 |

A 100 W portable lamp with a 20 m cable shall be furnished in the Machinery House.

240 V, three-phase, 130 amperes capacity, AC welding receptacles shall be provided to power a portable welding machine as follows:

|  |     |
|--|-----|
| - In the machinery house                           | x 1 |
| - On the landside gantry leg near wharf elevation  | x 1 |
| - On the waterside gantry leg near wharf elevation | x 1 |

- At the boom tip x 1
- At the backreach x 1
- On the trolley x 1

#### **40011.3 Air Conditioner**

An air conditioner of sufficient capacity shall be installed in the operator's cab.

#### **40011.4 Alarms**

The following alarms shall be provided:

a) **Motor siren**

A motor siren shall be installed under the operator's cab. The siren shall be energized by pressing a foot switch installed in the operator's cab. Further the siren shall be energized automatically when the wind blows stronger than 16 m/s at 16 m above the ground.

b) **Electronic "Gong"**

An electrically operated automatic warning gong shall be mounted at each gantry leg and shall sound automatically whenever gantry motors are energized.

c) **Warning light**

A red dome 360° rotation weather proof flashing strobe light shall be mounted at each gantry leg and shall flash automatically whenever gantry motors are energized.

#### **40011.5 Anemometer**

An anemometer shall be provided at the apex of the gantry frame to indicate wind speed and to provide warnings to the operator and ground personnel.

At the preset wind speed, an amber light shall illuminate in the operator's cab, and warning signal shall sound through the intercommunication system audible in the operator's cab and at ground. The anemometer shall not be sensitive to wind gusts of three seconds or less and be able to measure and withstand the maximum storm wind.

#### **40011.6 Space Heater**

Space heaters shall be provided for control panels, enclosed brakes, high voltage disconnectors and motors larger than 3.7 kW with provision to energize those heaters when the crane is not in service, thereby reducing the possibility of moisture condensation within those units. Heaters shall be powered by the shore power circuit independent of the crane control power.

Heaters shall automatically shut off during crane operation unless heaters are thermostatically controlled to maintain operating temperatures when the crane is operating.

#### **40011.7 Lightning Protection**

All electric installations shall be adequately earthed to prevent electrical equipment from damage during lightning storm. Lightning arrestors shall be provided at the tip of the boom and on the top crossbeam of the gantry frame. They shall be connected directly to the ground and insulated from the structure's frame. The structure of the crane shall be electrically bonded to the gantry rail.



**40012**  
**Intercommuni-**  
**cation System**

A 4-way intercommunication system shall be installed. The intercommunication system shall allow communication between the operator's cab/machinery house/electric room/landside gantry truck area/seaside gantry truck area (at ground level)/boom control station/boom tip. If necessary, additional stations may be installed.

Two (2) loudspeakers of weather-proof construction shall be provided on the trolley frame and a microphone in the operator's cab so that the crane operator can to speak to persons on the apron under the crane portal and to persons aboard ships in the immediate vicinity of the loading or unloading operation.

**40013**  
**Crane**  
**Monitoring**  
**Systems**

The crane shall be provided with a Monitoring System which includes diagnostics, crane production monitoring, data logging, preventive maintenance data logging and alarms. The crane monitoring systems shall be housed in one floor-standing unit and installed in the air conditioned electric room within the Machinery House on the crane.

The crane monitoring systems shall have the capability to monitor, record and present crane productivity data such as containers moved per shift, containers per hour per shift, average weight of container moved, maximum weights of container moved, average wait time between moves, maximum wait time between moves, etc.

The system shall have the capability of monitoring drive functions storing data, and plotting five curves simultaneously. It shall be capable of storing two crane cycles of five parameters such as armature current, field voltage, speed reference, speed command, load cell versus time in sufficient detail to be capable of analyzing and trouble shooting the drives. This shall eliminate the need to introduce strip chart recorders to troubleshoot the drives.

The system shall be capable of storing, displaying, and printing the fault log for at least 200 fault events and shall be capable of graphically displaying the status and position of all crane drives and motions for which there is state or position sensing.

It shall display which station and drive is in control, and shall display the status of that drive. Should a fault develop, in addition to the listing of the fault that caused the shutdown, it shall lead the viewer through the fault tree directing them to the source of the fault.

The system shall record and update files listing the running time of the crane and each of its drives. It shall prepare and store files listing total elapsed hours at the end of each day.

A cab mounted operator terminal shall be provided to provide output to the operator. It shall display a series of messages which illustrate the status of the various drive and accessory systems on the crane. It shall list the weight of the load suspended, the wind speed, and any active faults. The operator will not have any influence on the crane system from this terminal.

The monitoring system shall display and store fault diagnostic data to assist the maintenance personnel in rapidly resolving faults. Fault listings shall clearly indicate the first fault of the crane, and the time and date of each event. Printed reports shall contain crane designation headers on each page.

As a minimum, faults to be displayed and specifically identified shall include:

- Motor over temperature
- Motor timed over current
- Motor field loss
- Motor overspeed (main hoist and boom hoist)

- Motor ventilation loss (blower ventilated motors)
- Drive instantaneous over current
- Drive circuit breaker trip
- Drive blown fuse trip (armature)
- Drive open SCR
- Drive Shorted SCR
- Drive over temperature
- Ground fault (transformer secondary)
- Under voltage
- Phase sequence
- Brake failure
- Drive board failure
- Reference/Speed mismatch
- Overload
- Snag load
- Emergency stop push-button operation (identify push-button location)
- End over travel limit switch operation
- AC phase loss
- CPU low battery
- Loss of DC power supply, if applicable
- Remote I/O failure
- High wind warning
- High wind alarm
- Gantry stowage pins

The monitoring system shall maintain 16 variable data messages available, including the messages listed below, updated at every 1.5 seconds:

- CPU time
- Control power hours
- Hoist elapsed time hours
- Trolley elapsed time hours
- Gantry elapsed time hours
- Net run time hours
- Hoist position
- Trolley position
- Boom position

The control system shall record the lifted load and position.

**40014**  
**Electric Sway**  
**Control System**

The electric sway control system shall be provided to limit the sway of the spreader and container for quick and precise positioning. The electric sway control system shall consist of a vertical four-falls reeving system, an accurate detection system of spreader sway and an electric sway control logic to provide the trolley drive with trolley speed reference controlling the sway. The sway control shall be a feed back and closed loop system which verifies the no-sway condition and provides sway correction where required. The system shall be so designed as to reduce the sway to not more than plus or minus five (5) cm around a vertical line, within five (5) seconds after complete stop of trolley motion from full speed with specified deceleration time. Sway includes any induced rotary (skew) motion of the load. The sway shall be measured at the twist locks of an empty spreader and the bottom of the 40 feet, fully loaded container when the elevation of the container is nearly six (6) meters from the dock level. The electronic sway control system shall be capable of operating in automatic or manually assisted modes or of being turned off.

In the automatic mode, the operator shall be able to select predetermined trolley positions by means of a push-button. The trolley shall travel at maximum speed with small sway, and stop at preselected position with sway less than plus-minus five (5) cm. Average acceleration and deceleration rates shall be in accordance with those specified. At any time while in automatic mode, the crane operator can assume control of the trolley motion by moving the trolley master switch. The operator's controls in the automatic mode shall be as follows:

- a) **Ship Push-button**  
When pressed, the trolley will automatically position itself without sway at the last position worked over the ship.
- b) **Truck Push-button**  
When pressed, the trolley will automatically position itself without sway over the selected truck lane under the crane.
- c) **Truck Lane Switch**  
Eight-position selector switch to select the target lane under the crane. The lane positions shall be adjustable to be at any location between the legs or in the backreach.

In the manually assisted mode, the electronic sway control shall be transparent to the operator. The operator shall be able to command speed with the trolley master switch, and the load shall be brought to that speed with no sway. The operator may change the speed command before the load reaches the command speed, and the load will respond to the revised speed command with no load sway. When the electronic sway control system is switched off, the crane shall operate completely under the control of the operator. The trolley and load shall respond to the operator's trolley and hoist commands with minimum delay and deviation to the operator's commands.

## SECTION 50000 STRUCTURE

- 50001 General** The work under this section shall include furnishing all labor, tools, materials, construction plant, and other items necessary for fabrication of the structural steel works indicated in the drawings and as specified herein.
- The work shall be executed by the manufacturers and vendors who are approved at the time of the Contract conclusion.
- 50002 Delivery and Storage of Materials** Materials shall be delivered, stored, handled and installed in a manner to protect them from all damage during the entire construction period.
- Steel shall be stored under cover and protected from rust, oil, grease or distortion. Only the steel needed for immediate use shall be retrieved from the storage.
- 50003 Materials** Structural steel shall comply with JIS G 3101, JIS G 3106 or approved equivalent standards. High strength friction grip bolt shall be reliable product conforming to JIS B 1186 or approved equivalent standards contrived for easy recognition of full tightening by appearance.
- Ordinary bolt (semi finished bolt), nut and washers shall comply with JIS B 1180 or approved equivalent standards.
- Hexagon nut shall comply with JIS B1181 Grade 2 class 1 or class 2 semi finished nut or approved equivalent standards.
- Electrodes shall comply with JIS Z 3201-1990, Z 3211-2000, Z 3212-1999 or approved equivalent standards.
- Anchor bolts shall be JIS G 3101 SS41 or approved equivalent standards.
- Except for materials accompanied by mill certificates clearly stating their quality, all materials shall be subject to tensile strength test and bending test. Test shall be conducted once for every 20 tons or fractions thereof for each cross section.
- The properties of high tension bolts shall be tested according to JIS B 1186 strength grip or approved equivalent standards, except when the statement giving the method of manufacturing control and the result of quality control test is submitted to and approved by the Engineer.
- 50004 Shop Drawings** The Supplier shall prepare shop drawings according to the Contract drawings list and submit them to the Engineer for approval. Shop drawings shall indicate the position, size and dimensions of all members, details of joints, size and dimensions of anchor bolts. Details of bolt joints shall indicate the diameter, gauge, spaces and clearance of bolts. Details of welded joints shall indicate root opening, groove angle and groove depth of butt weld and size of fillet weld.
- 50005 Collation and Calibration of Measuring Tapes** Each measuring tape shall be calibrated periodically. Measuring tape to be used for fabrication shall be collated with that for site construction and adjustment shall be made if necessary.
- 50006 Shop Fabrication in General** Unless otherwise specified, materials shall be cut at right angles to the axis of the material with an automatic gas cutting machine. Where an automatic gas cutting machine is not available, materials shall be cut manually to the shape and dimensions and shall be finished with a grinder or the like. Plates of less than 12 mm in thickness may be sheared but free ends of principal members and sections to be welded shall not be sheared. Any uneven spots, burrs or notches at the cutting edge shall be corrected or removed.

Distortion of a member or an assembled work shall be immediately corrected.

Machining shall be conducted by following methods:

- a) Bolt holes: Drilled by drilling machines
- b) Reamed bolt holes: Drilled and reamed by drilling machines
- (c) Limits and fits: In accordance with recognized standards
- (d) Top surface of motor bases, gear box bases : Finished by planers and bearing bases

The Supplier may propose alternative grades and sizes of structural steel for use in the Works. Such alternative sizes shall satisfy the requirements of JIS G 3101 for the specified grade, and shall have section properties. Alternative sections shall only be used with the approval of the Engineer.

**50007  
Brackets,  
Braces, Straps,  
Anchors, etc**

The Supplier shall provide all necessary metal brackets, braces, straps, and anchors, whether they are indicated on the Drawings or not, for the places where satisfactory support shall be obviously required for safe fabrication work.

They shall be fitted as far as possible by bolts, screws, etc.

**50008  
Welding Joint**

**50008.1 General**

The Supplier shall submit a detailed list of the quality control system for welding, the standard workmanship and the test method adopted for the manufacture to the Engineer for approval.

**50008.2 Welders and Supervisors**

Welders shall be skilled with more than 3 years of experience in the type of welding to be used for the work. A list of qualifications of welder shall be submitted to the Engineer for approval.

All welding operation shall be supervised and controlled by a well experienced supervisor with sufficient technical knowledge in welding operations.

Welders suspected of poor skill shall be tested according to JIS Z 3801/3841 or equal standards and those failed in the test shall be replaced.

**50008.3 Preparation for Welding**

Grooves shall be cut as shown on the approved shop drawings by automatic gas cutting or sawing machine. Irregularities and grooves not coincident with the design shall be corrected.

Electrodes shall be clamped to the correct root opening or full contact as required by the use of suitable jigs. Tack welding shall not be short bead but shall be 40 mm to 70 mm depending on the thickness of plates and be executed by manual, or semi-automatic or automatic method.

Defect tack weld shall be removed. Tack welding shall be avoided for ends, corner or starting and finishing points of permanent weld joints.

Water, oil, slag, paint and other objectionable matters shall be removed from the joints prior to welding.

**50009  
Welding**

**50009.1 General**

Welding machines and accessories shall be of such construction and performance as to be suitable for the welding condition and shall be ensure safe and satisfactory

welding. Weld shall be free from harmful defects and have uniform surfaces.

Welding shall be executed in a flat position as far as possible and in such a sequence as to minimize deformation and restraint due to welding.

End tabs with sufficient length, and same material, thickness and groove as the parent metal shall be welded at both edges of butt joints.

End tabs shall also be used for fillet weld except for the joints of minor importance and of which defect of welding can be avoided by welding a box.

End tabs shall be cut off and the cut end shall be finished to the edge of the parent metal.

Slag shall be removed carefully after each pass and after completion of welding

Remarkable spatters on the surface to be painted shall be removed.

#### **50009.2 Butt Welding**

When backing strip is not used, the joint shall be first welded from the front and after chipping from the backup to the depth of the front weld, back welding shall be applied. If sufficient penetration of weld is ensured with automatic welding, back chipping may be omitted subject to approval of the Engineer.

When backing strip is employed, the first pass of welding shall be enough to attain sufficient penetration of the root portion of the parent metal.

Welds shall be reinforced by weld in gentle and smooth slope of no more than 4 mm in rise. Reinforcement shall be in smooth transition between jointed plates when their thickness is different.

For T joint and corner joint, a fillet weld with a size of not less than a quarter thickness of the butted plate and no more than 10 mm shall be provided.

When the difference of surface is more than 4 mm the thicker plate shall be planed off to the thickness of thinner plate with a slope of no more than 1 to 4.

#### **50009.3 Fillet Welding**

The reinforcement of weld shall be as in the normal practice, having sufficient root length.

#### **50010 Inspection and Test in Shop**

The Supplier shall, after completion of welding, inspect and test the weld as follows, and submit report on their results to the Engineer for approval.

- a) Inspect and record the condition of surface of weld for defects such as irregularity of bead, pit, overlap, undercut and crater.
- b) Measure and record dimensions of the representative welds.
- c) Conduct fluorescent penetrate test (or magnetic powder test) for the portion where crack of weld is suspected, or required by the Engineer in accordance with JIS Z 2343.
- d) Conduct radiographic and/or ultrasonic test for 10% of butt welds according to JIS Z 3104 and/or JIS Z 3060, or approved equivalent standards, by a testing organization not belonging to the manufacturers engaged in the works.

#### **50011 Correction of Defective Weld**

The Supplier shall correct defects of weld as follows:

Harmful defects such as poor fusion, poor penetration, slag inclusion, pits and blow holes shall be removed and rewelded. Welds with cracks shall be removed in the full

length and re-welded. Undercut, insufficient filling of craters, insufficient size and length of weld shall be corrected. Overlap and excess reinforcement shall be removed. Part of welds detected to be defective in radiographic test or ultrasonic test or penetration test or magnetic powder test shall be removed, rewelded and retested. Parent metal with crack caused by welding shall be replaced.

The diameter of the electrode to be used for correction of defective weld shall be no more than 4 mm.

Defects of weld found after the materials are delivered at the site shall also be corrected as directed by the Engineer, but the materials with serious defects shall be rejected.

**50012  
Safety**

The Supplier shall take preventive measures against accidents arising from short circuits, electric shocks and arc light and against fire from molten metal and electric area.

**50013  
Galvanizing and  
Electroplating**

Galvanizing and electroplating shall be carried out in an approved manner and in accordance with JIS H 8641 and JIS H 8610 or approved equivalent standards respectively.

All articles to be galvanized shall be free from paint marks and, if of welded construction, all welds shall be free from slag.

All steel and iron work required to be galvanized shall be pickled in dilute muriatic acid, then stoved and dipped in a bath of pure virgin spelter. All articles shall be passed rapidly through the bath, which is to be of sufficient size to take the sheets without bending, and they shall then be washed and brushed. The galvanizing shall be carried out after all articles are covered evenly on all sides. All galvanized surfaces shall present a bright surface clean and free from "drops" of spelter or treacly edges.

Where galvanizing or electroplating is damaged by welding of joints in structures, the damaged zone and an area extending 75 mm completely around the zone shall be made good by blast cleaning and zinc spraying to JIS H 8300 or approved equivalent standards.

Where a rough galvanized surface is not to be painted and persons can readily come into surface, it shall be buffed smooth.

**50014  
Anchor Bolts**

Anchor bolts shall be embedded in concrete true to link and level by use of templates. The top of the bolts shall be at such a level as to leave more than three threads projected above the nut when the column is set and tightened. Washers of suitable thickness shall be used under the nuts.

Anchor bolts shall be held in position accurately with steel bars welded to reinforcement or fixed to formwork or other structures.

Anchor bolts shall be wrapped with cloth or vinyl covering after embedding and protected against bending, damage to threads, rust and spoiling.

Leveling mortar shall be cement sand mortar with 1:1 mix. Mortar shall be screeded at the central surface of base concrete to the correct level. After the column is erected, the clearance under the base plate shall be packed with mortar.

For columns with a base plate of no more than 300 square millimeters, mortar may be screeded on the whole base surface to the correct level.

**50015  
Transport and  
Erection**

The Supplier shall submit a detailed transport and erection program to the Engineer for approval. Steel materials shall be marked with symbols, letters or numbers to facilitate erection.

Steel materials shall be protected against warping, twisting or any other damage in

transport by use of bracing or reinforcing members if necessary.

Deformation of materials shall be corrected before erection.

All damage to the shop paint occurred during handling, transport and erection shall be made good by the Supplier with two coats of the same paint as applied at the shop.

Erection shall be carried out in the sequence and with the method shown in the approved program. The lifting and transporting gears for erection or unloading of the crane shall have enough capacity and properly installed, maintained and operated. The Supplier shall take every precautionary measures to ensure safety and good order in the working area and not to restrict other works in the neighborhood.

Slender members shall be reinforced and framing shall be fastened temporarily with a sufficient number of bolts and shall be braced securely against lateral forces.

The Supplier shall measure the fall and distortion of frames, and principal dimensions of the crane and correct error, if any, before permanent fastening.

**50016  
High Strength  
Friction Grip  
Bolt Joint**

High strength friction grip bolts shall be stored in their original package on elevated floor at the site and protected from moisture, damage and staining.

Holes for high strength friction grip bolt shall be shop drilled. Holes on plates of less than 12 mm thick may be punched. Mill scale in an area covered by twice the washer diameter on the contact surface of plates shall be removed by blasting or grinding to allow the contact surface to be uniform. There shall be no irregularity on the contact surface such as burr, wrap or caving.

Filler plates shall also be worked as above. Welding of filler plates shall be done after rust develops.

Irregularities of the contact surface under bolt heads and washers shall also be corrected. Loose rust, oil paint or dust on the surface shall be removed prior to fabrication. Filler plate shall be used for difference of thickness exceeding 1 mm. Bolt holes not matched after fabrication shall be corrected with reamer and the dust left by reaming shall be completely removed. Members to be jointed shall be tightened with temporary bolt not less than two in number and not less than one third of number of bolts of that joint and with the same diameter as permanent friction grip bolts to be used. Bolts shall be tightened with a tool recommended by the bolt manufacturer starting from central zone and then outward by first applying approx. 70 % pressure to all bolts and then 100 % of the design pressure, and strictly in accordance with the procedure recommended by the bolt manufacturer. High strength friction grip bolt consisting of bolt, nut and washers shall be those as manufactured by NIHON FASTNER (of Japan or according to approved equivalent standards).



## SECTION 60000 PAINTING, ASSEMBLY AND ERECTION

### 60001 Cleaning and Painting

#### - General

- a) The crane and equipment shall be protected by coating as specified herein, except for standard products supplied by subcontractors.
- b) Items that are procured at the market, such as mechanical and electrical equipment, components, fittings, furniture, etc., shall be coated in accordance with standard practices of respective manufacturers.

#### - Surface Preparation

##### a) Primary Surface Preparation

- Surface of steel materials, to be used for the main structure, shall be shot or sand blasted prior to fabrication.
- Preparation by power tool or pickling shall be permitted for surfaces of the steel to be used for sub-structural parts.
- The grade of primary surface preparation shall be as follows:  
SA 21/2 (SIS 055900), SSPC-SP-10 (SSPC-Vis 1) (Shot or Sand blasting)
- As far as possible, the primary surface preparation and priming shall be applied at the mill shop.
- The primary treated surface shall be immediately coated with one of the approved primer paint.

##### b) Secondary Surface Preparation

After fabrication, the surface to be painted shall be prepared prior to coating as described below:

- Oil and grease is to be removed with air blowing, cleaner broom and the like.
- Chalk mark, soot by welding or gas cutting is to be removed with waste cloth.
- Moisture is to be wiped out with cloth.
- Rusting and damaged parts of primed surfaces, due to welding, burning, cutting and other mechanical treatments are, to be cleaned by disc-sanders and/or powered wire brushes.
- The grade of the secondary prepared surfaces shall be at least SSPC-SP-3.

#### - Painting

The type of painting system shall be as follows:

The Polyurethane Paints System shall be adopted. The details of the coating system shall be in accordance with the recommendation of the original manufacturer of the paints upon approval of the Engineer, and the painting work shall be in accordance with the practice described below:

##### a) Weather Conditions

- Painting shall not be applied on wet or sweaty surfaces.
- Painting in rain, sleet, fog and strong wind condition shall be avoided.

- Care shall be taking to prevent the presence of condensation on surface.
- Generally, painting shall be carried out at a temperature above 5° C, and relative humidity below 85%.

b) **Painting**

- The first coat shall generally be applied on the cleaned shop primed surface, without touching up the shop primer.
- The painting shall be performed by airless spray except for the special cases where hand brush, roller, etc., is permitted in accordance with the paint manufacturer's recommendation.
- No painting shall be applied to the following surfaces:
  - Tread for wheel and rail
  - Groove of rope drum and sheave
  - Inside of air-tight box and tubular section
  - Splice joint
  - Machined surface
  - Non ferrous metal
  - Sliding or rubbing contacting surface.

Surfaces that do not require coating shall be masked or otherwise protected during coating of adjacent surfaces.

Machined surfaces which do not require painting shall be coated with a suitable rust preventive compound.

Galvanized surfaces shall basically not be coated unless the coloring on the surface is required according to the coloring scheme on the crane. When coating on the galvanized surface is necessary due to coloring requirement, it shall be subject to priming and top coating as specified below:

- Unless otherwise specified, all coats including finish coat shall be applied at the fabrication site prior to shipment.
- After completion of the cranes at erection site, areas where paint has been damaged during transportation, storage or field erection shall be touched up according to the shop painting procedure.

**- Typical Painting Specifications**

The following typical painting system or approved equal system shall be applied for the cranes.

- Exterior surfaces of the cranes exposed to the atmosphere shall receive following coating system over the surface prepared as noted for secondary surface preparation.

**Table-1 Painting Specifications**

| Coat         |                                   | Dry Film Thickness |               |
|--------------|-----------------------------------|--------------------|---------------|
| Primer       | Epoxy Resin Primer                | 150                | micron        |
| Finish       | Polyurethane Resin Finish 200Coat | 50                 | micron        |
| <b>TOTAL</b> |                                   | <b>200</b>         | <b>micron</b> |

The crane's interior surface exposed to the atmosphere shall receive the following coating:

Epoxy Resin Primer

75 micron

**60002  
Packing and  
Delivery**

- a) To prevent damage and loss of articles during surface transportation all parts and units shall be packed or tied up carefully according to their characteristics and volume.
- b) Disassembled structural parts shall be matchmarked for ease of assembly at the erection site.  
Instructions and reference diagrams of the matchmark shall be submitted.
- c) When articles are dispatched, a checked invoice of the equipment shall be sent to the Engineer at the same time.

**60003  
Erection**

**60003.1 Erection at Workshop**

The crane structures and components shall be erected and tested at workshop.

The extent of erection and test at workshop shall be determined by the Supplier at his own and full responsibility considering the transportation to and installation at site after erection and test works, disassembled as necessary, for shipment.

**60003.2 Installation at Site**

Installation shall be executed at the Suppliers' own responsibility.

The procedure and schedule shall be established based on the conditions at site, and also upon the Engineer's approval.

Installation shall include unloading, erection and adjusting of components as necessary, acceptance testing, securing (guard and fire watch), handing over of the cranes to the Purchaser, and so forth.

All utilities and facilities required during installation shall be prepared and paid by the Supplier three (3) months prior to the start of installation. The basic installation plans shall be furnished to the Engineer for his review.

The installation and storage, erection sequences and expected time schedule, loading condition on the dock and storage area imposed during installation, expected utility consumption in kinds and capacity of heavy equipment to be employed, employed man power, temporary facilities shall to be prepared by the Supplier.

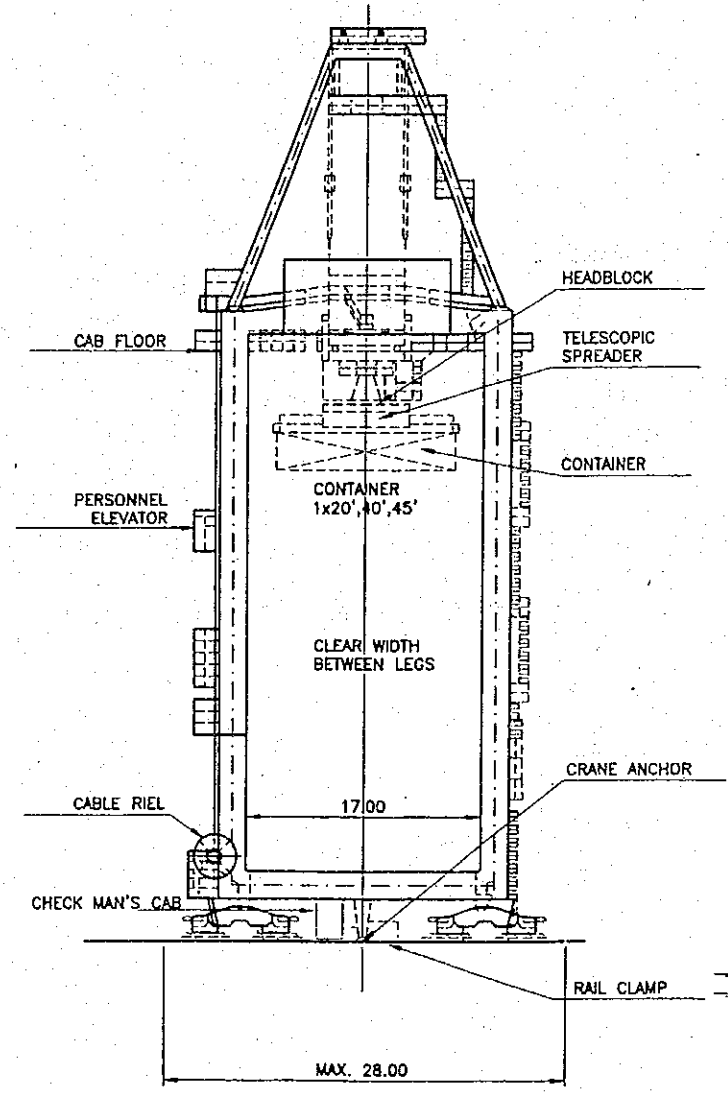
**60004  
Guarantee**

The Supplier shall guarantee the capacity and performance specified in these Specifications, correctness and sufficiency of design, materials and workmanship during two (2) years after taking-over of the cranes.

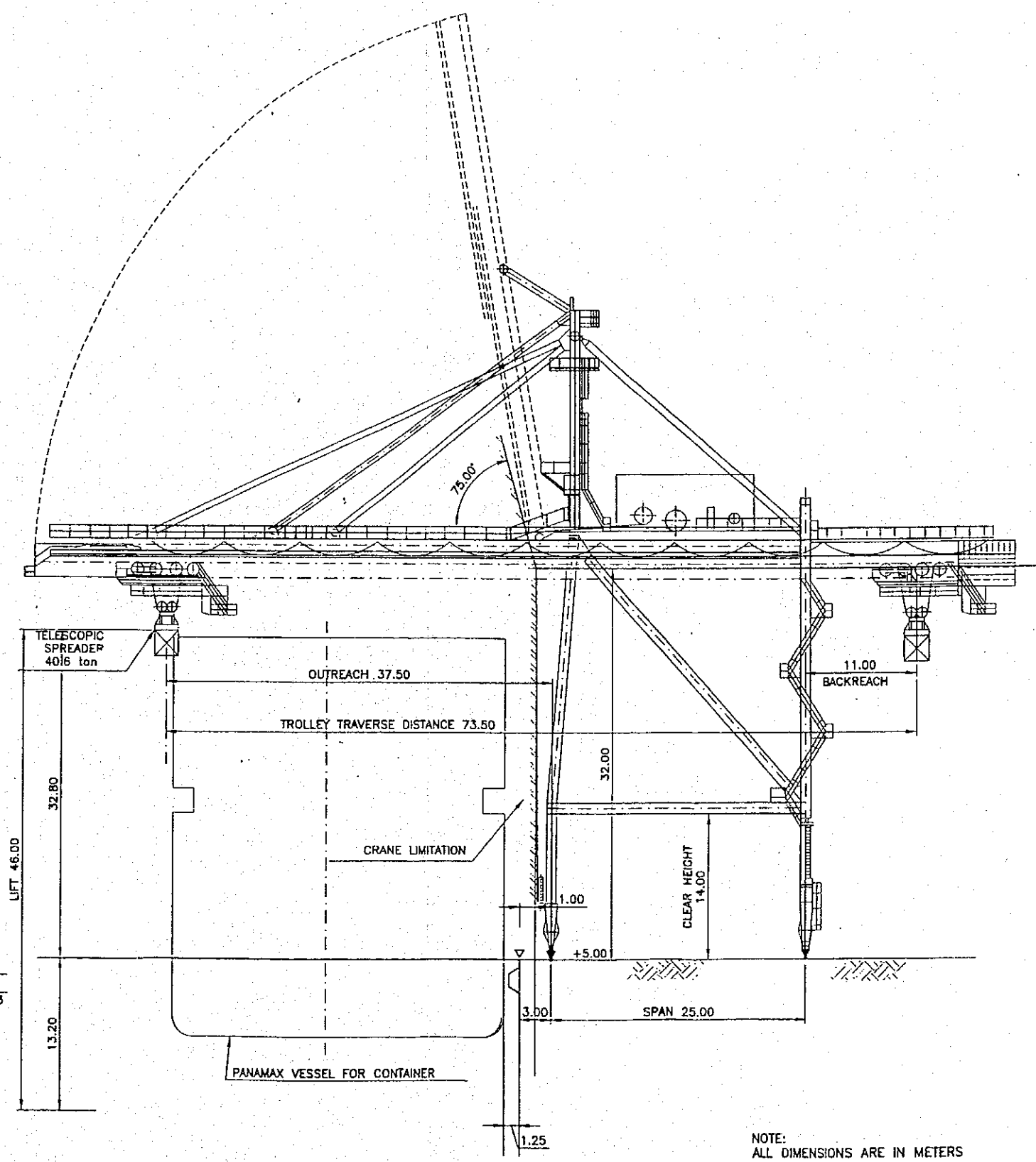
Defects of equipment on the performance shall be replaced by the Supplier as his full responsibility and expense during the guarantee period.

Any defects and events resulting from the following items may not be guaranteed by the Supplier.

- a) Any modification or removal of parts or equipment by the Purchaser without prior written consent of the Supplier.
- b) By cause beyond the Supplier's control, such as climatic effect, war, fire, etc.
- c) Normal wear and corrosion, caused under normal usage.



▽ H W L +3.37  
 ▲ L W L -0.13



NOTE: ALL DIMENSIONS ARE IN METERS

|               |            |    |               |   |   |              |  |                     |
|---------------|------------|----|---------------|---|---|--------------|--|---------------------|
| REV. NO. DATE | COORDINATE | BY | APPROVED DATE | JICA<br>JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) | DETAILED DESIGN ON PORT REACTIVATION PROJECT IN LA UNION PROVINCE OF THE REPUBLIC OF EL SALVADOR<br>NIPPON KOEI CO., LTD. | DESIGNED BY: | SECTION:                               | DATE: JULY/2002     |
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|               |            |    |               | COMISION EJECUTIVA PORTUARIA AUTONOMA (CEPA)          |   | APPROVED BY: | TITLE: PACKAGE B QUAYSIDE GANTRY CRANE | DRAWING NO: DWB-01  |

