RUBBER TYRED GANTRY CONTAINER CRANES

(Fourteenunits for ShahidBeheshtiPort(Chabahar)**)**

TECHNICAL SPECIFICATION

November 2016

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PART 1 - GENERAL

1.1 Introduction

This Specification is for the design, manufacture, delivery, installation, commissioning and testing of fourteen units of Rubber TyredGantry Container Handling Cranes (RTGs) for ShahidBeheshti Port (Chabahar), Islamic Republic of Iran.

1.2 Sub-Contractors and Suppliers

Any Sub-Contractor proposed for the crane structure fabrication work shall be subject to Buyer's approval.

The names of the manufacturers of major component items shall be stated in the technical schedules.

Approved Sub-Contractors and Suppliers shall not be changed following award of the Contract without the Buyer's approval.

1.3 Materials

ShahidBeheshti Port (Chabahar) is located in a highly corrosive marine environment.Due consideration shall be given to the design and selection of materials used for the crane and its component parts. Where stainless steel is used in an exposed location, it shall be grade 316S16 or equivalent. Grades with less resistance to corrosion shall not be used

1.4 Environmental Conditions

The port equipment will be exposed to an extremely corrosive marine atmosphere with particularly high salinity, high temperatures and humidity. In addition, this region of the Persian Gulf and Oman sea are subjected to frequent dust and haze storms and periodic seismic activity.

The Manufacture shall design and construct the cranes to ensure reliable operation under the following site conditions: -

1.4.1 Temperatures (measured in shade)

Ambient Air Temperatures:	Maximum	50°C
	Minimum	0°C

1.4.2 Relative Humidity

Maximum relative humidity (RH)	99%

1.4.3 Rainfall

Mean annual (17 years)	171mm
Max annual (1976)	494mm
Min annual (1962)	1mm
Intensity	20mm/20 mins

1.4.4 Winds

Wind strength and direction variable through the seasons:

Maximum operating wind speed	20m/s
Maximum storm winds	44m/sec (gust)

1.4.5 Seismic

Seismic Design Data:

Horizontal acceleration (50 year) 0.34g
Vertical (50% x horizontal) 0.17g

1.5 Description of the Crane

The crane shall be a diesel-electric powered, rubber tyred gantry crane capable of handling 20ft, 30ft, 40ft, and 45ft containers (9ft 6ins high) up to 40 tonne.

The crane shall stack containers between the legs at a height of 1 over 5 containers (9ft 6ins height containers) and width of 6 container rows + 1 traffic lane.

The crane shall be capable of full speed trolley travelling and gantry traveling simultaneously only when the headblock is at its upper hoisted position. Otherwise, it shall only be possible to operate gantry, trolley and hoist motions, one at a time.

The crane shall be fitted with anti-sway, trim, and horizontal fine positioning systems and be able to skew containers around their vertical axis, and be operated from an insulated and sound proofed operator's cab.

The crane structure and mechanisms shall be based upon designs that have been proven in service. The crane electrical drive systems and equipment shall be of proven design for use with high speed container handling cranes, and obtained from a Sub-Contractor who has an extensive track record in the crane industry.

1.6 Principal Dimensions and Loads

Gantry type	Rubber tyred
Operational power	Diesel-electric
Total number of wheels	16
Inside clear span	Minimum 22 metres for six containers across and one traffic lane.
Wheel span (centre line of tyres)	Maximum 23.50 metres
Overall width of lower part of crane	Maximum 26.50 metres
Lifting height	One over five high containers of 9ft. 6in. height each.
Lifting capacity under spreader	40 tonnes
Length	maximum 13.50 metres
Hoisting speeds: with load of 40 tonnes without load	minimum 26 metres/min +/- 2.5%
Hoisting speeds: without load	minimum 52 metres/min +/- 2.5%
Trolley travel speed	minimum 70 metres/min +/- 2.5%
Gantry speed (without load)	minimum 135 metres/min +/- 2.5%

1.7 Standards

The major design standards to be used for the detail design of the crane shall be:
-

British Standards: -

BS 2573: Rules for the design of cranes: Part 1: Specification for classification, stress calculations and design criteria for structures

BS 2573: Part 2: Permissible stresses in cranes and design rules: Mechanisms

OR

Federation Europeenne De La Manutention (FEM) - Rules for the design of hoisting appliances

The materials, workmanship and component standards to be used shall be British Standards or DIN standards or other equivalent standards specified or approved at the time of placement of the order for the cranes.

1.8 Classification

The crane shall be designed to work continuously, up to a maximum of 24 hours a day at peak, and to work in a service design wind speed of 20m/sec as defined in BS 2573.

Structures shall be classified to BS 2573: Part 1 as follows:

i)	Class of Utilisation	-	U7 (2 million loading cycles)
ii)	State of loading	-	Q2
iii)	Group Classification	-	A7
iv)	Impact factor	-	1.3
v)	Duty factor	-	0.95

The details of the load and load cycle to be used in the fatigue check shall be stated at the time of tendering.

Mechanisms shall be classified to BS 2573: Part 2 as follows:

Mechanisms	Class of Utilisation	State of Loading	Group Classification
Hoist	T7	L2	M7
Traverse (Trolley)	T7	L2	M7
Travel (Gantry)	T7	L2	M7

1.9 Interfaces with Civil Works

The design loading for the stacking area is 60 kN/m_2. The theoretical weight and maximum wheel loads for the crane shall be stated in the tender schedules.

The crane shall be capable of operating fully laden on the following slopes: -

Longitudinal Inclination	up to 1 vertical in 50 horizontal
Lateral slope of yard	up to 1 vertical in 50 horizontal

The crane shall be supplied complete with storm anchor points and crane tie downs.

1.10 Drawings and Documents for Approval

The Manufacturer shall submit the following documents and drawings to the Buyer for approval. Unless otherwise agreed by the Buyer, documents and drawings shall be supplied in four (4) full size paper copies (sizes A0, A1, A2, A3 or A4 as appropriate) plus electronic format (Microsoft office or AutoCAD as necessary). The Buyer shall reply with review / approval comments within a period of four (4) weeks from receipt of paper copies unless otherwise stated in the Contract. Where information submitted to the Buyer is found to be incomplete, the 4 weeks approval period shall commence upon receipt by the Buyer of the additional drawings and documents requested. Where no submission

dates are stated below, these shall be in accordance with dates agreedby the Buyer andindicatedtheManufacturer'sWorkSchedule.

- Within 5 days from Contract award the Manufacturer shall submit for theBuyer'sapprovalcomprehensiveWork Schedule(programme)in the form of a Gantt chart listing all major milestones and detailing all design, manufacturing, testing, delivery, erection and commissioning activities.

- Within two weeks from Contract award the Manufacturer shall submit fortheBuyer'sapprovalpreliminaryContractQualityPlanoutlining QA procedures covering all project management, design, manufacturing and testing processes, including those undertaken by the Sub-Contractors and major suppliers. The Manufacturer shall confirm contact names of the project manager and others who will communicate with the Buyer or the Buyer's representativeon matters relating to technical or commercial aspects of the Contract.

- The Manufacturer shall submit proposed arrangement and detail drawings. These shall include the crane GA with overall dimensions, main structure, spreaders, headblock, access-ways, mechanisms, anti-sway system,machineryhouse,electricroom,operator'scabin,control consoles, layoutof controls, checker'scabin, passengerlift, lighting, electrical schematic and single line diagrams.

- The Manufacturer shall submit calculations in sufficient detail to allow a complete review of the design to be carried out. As a minimum, this shall include calculations for structure, stability, wheel loading, mechanisms, gear reducers, buffers, storm anchors, motor power, and power demand.Procurement specifications defining all technical aspects of major proprietary items as agreed within the Contract Quality Plan.

- Painting specifications for structure and machinery.

- Detailed manufacturing inspections plans for all major assemblies and items agreed within the Contract Quality Plan. These shall list all relevant inspection activities including welding acceptanceand NDT standards applicable.

- Preliminary packing specification, delivery and erection schedules are to be submitted a minimum of four weeks prior to manufacture commencing.to be submitted a minimum of four weeks prior to manufacture commencing.

- Steel mill certificates showing source, grade, composition and strength.

- Works test and inspection reports for welding and painting etc.
- Overload test certificates for lifting components such as spreaders,wireropes, twistlock pins etc.

- Operating and Maintenance Manuals includingbrochures/cataloguesfor the mechanical and electrical components.

- Test certificates for motors, hydraulic components etc.

- Training plan.

- Site erection and testing procedure.

Documents and drawings shall be produced specifically for this project and shall be suitably titled as agreed by the Buyer prior to Contract award.

1.11 Inspection and Testing During Manufacture

TheManufacturershallsubmitfortheBuyer'sapproval,fourweekspriorto commencing manufacture, full details of their proposed inspection and test programme. (QC Plan including Tests, witness and hold points) This shall include all tests to be carried out prior to delivery by the Manufacturer and Sub-Contractors as specified in the Contract and any further tests proposed by the Manufacturer. The scope of inspections to be carried outby the Buyer's representativeshall include, but not necessarily be limited to the following: -

- Conduct visual checks on the quality of incoming materials, which shall include structural steel, motors, reducers, hydraulic components, and other items deemed necessary by the Buyer.
  - ITP (Inspection & Test Plan) and QC Plan shall be approved by the buyer.
- Verification and identification of steel material, including witness of fracture test against mill sheets for major structural items. Review system for material tracing with random witness of identification t.
- Check welders test certificates and welding procedures to ensure that only qualified welders are being used and that correct welding procedures are followed.
- Check material preparation, cutting, fit-up and welding to ensure that they are in compliance with drawings.
- Review qualifications of non-destructive examination operators and procedures. Witness non-destructive examinations of ultra-sonic, magnetic particle and liquid penetrant testing as required. Review radiographs.
- Conduct visual inspections pertaining to the quality of structural welding.
- Compare assembly and mounting of mechanisms with recognized engineering practices.
- Check material surface preparation and coating of paint. Check proper application of paint to meet specifications. Check ambient conditions and/or records during blasting and painting.
- Check electrical wiring for proper installation and termination. Witness high voltage withstand tests and insulation resistance tests.
- Witness shop test of motors, reducers, hydraulic systems and sub-assemblies.
- Witness tests on the crane and spreaders prior to shipment. Witness tests on control panel and drive systems.

- Conduct final checks on the quality of welds, painting, installation of substructures, sea-fastenings, etc. before the crane is shipped out to the site.

1.12 Training

Training shall be provided to the crane operators and maintenance staff by competent instructors in the Farsi language, unless otherwise agreed and approved by the Buyer. The program for training at the Manufacturers works and at site shall be drawn up by the Manufacturer and approved by the Buyer.

1.12.1 Crane Operator Training

Crane operator training number of people shall be undertaken at site, and shall cover, but not necessarily be limited to the following: -

- Familiarisation with controls, operating systems, instrumentation, equipment and fittings.
- Daily routine maintenance.
- Understandingthecrane'scapability,safetyfeaturesandoperational techniques.
- Practical instruction on an operating crane.

1.12.2 Maintenance Staff Training

The TrainingPlanshallincludetrainingattheManufactureorSubContractor's works of a specified number of people appointed by the training at site in accordance with the programme approved by the Buyer.

Maintenance staff shall be trained to use fault diagnostic aids, special tools, jigs, instruments and wear gauges to calibrate crane components and to carry out major repairs and maintenance jobs.

The training shall cover, but not necessarily be limited to the following: -

a. Familiarisation with main components and systems comprising: -
- mechanical system
- drive system
- electrical system
- spreaders
- diagnostics systems

b. Routine maintenance program:-
- Periodic checks and servicing
- Lubrication program

c. Trouble shooting,
d. special adjustments and repairs
e. Familiarisation with manuals and parts book

1.13 Maintenance Tools and Equipment

The Manufacturer shall provide all necessary maintenance tools and Equipment under the Contract with delivery of the first crane. The following shall be included:

- Special instruments and tools required for calibration or fault diagnosis.

- Wear gauges, that can indicate the limits of wear on rope sheaves, rope drums, trolley wheels, etc., shall be supplied with each crane.

- One control panel to test spreader operation in the workshop during maintenance. The panel shall incorporate push buttons, selector switches, indicator lamps, programmable logic controllers, input/output devices, spreader multi-pin plug with cable, and all parts necessary to operate and confirm proper operation of all spreader functions. Power supply cable of at least 20 metres shall be provided with the panel.

- Four infra-red non-contact thermometers for checking the operating temperatures of equipment. The infra-red thermometers shall be equipped with laser sighting to accurately pinpoint the target where temperature measurements are to be taken.

- Mechanical tools etc. multi-size spanners, hammer, adjustable spanner, screw drivers and pliers complete with tool box.

1.14 Drawings and Documents for Maintenance

Copies of the following shall be submitted to the Buyer for approval in advance of training the operators and maintenance staff: -

- Crane operators' manual.
- Maintenance and repair manual. The documentation shall includerelevant software for preventative maintenance.
- Complete set of as-constructed drawings covering all aspects of thestructural, mechanical, electrical, and hydraulic parts of the crane.
- Complete set of electrical and electronic circuit diagrams. Computer
- hardware layout schematics and detailedcircuit diagramstobe illustrated in sufficient detail to enable them to be used for repair and maintenance.
- Computer software documentation.
- Spare parts manual and drawings. Spares used on the crane shall be indicated in the spare parts manual with drawings. These shall include the Manufacturer's and the original Manufacturer'scomponent partSub numbers and descriptions

1.15 Packing for Transportation

TheManufacturershallsubmitfortheBuyer's approval atleastfourweeks prior to commencing manufacture, the proposed packing specification, together with preliminary delivery / shipping and erection schedules. Delivery and erection schedules shall include details of programmed dates for allactivities as derived from the Manufacturer's approved Work Schedule

At least four weeks before shipment of each consignment, the Manufacturer shall inform the Buyer of final packing lists including all details specified in the Contract.

Plant likely to deteriorate due to the weather shall be suitably protected during the programme of the works and particularly during transit and site erection.

Before delivery, plant shall be packed and prepared for export. Plant shall be thoroughly dried and cleaned internally. External unpainted ferrous parts and machined surfaces shall be protected by an approved proprietary preservative, openings shall be covered and screwed connections shall be protected unless otherwise agreed.

Where moisture absorbent materials have been used for protection against corrosion during storage or transit, adequate information of their location and warning as to their removal shall be clearly indicated.

Adequate precautions shall be taken in the packing of plant that has ball or roller bearings so as to eliminate the risk of damage to such bearings during transit.

1.16 Labelling

All labels and name plates shall be permanently engraved or embossed, in English, on phenolic plastic or non-ferrous, rust proof plates and mounted securely by corrosion resistance fasteners at easily visible locations. Name plates and labels shall not be easily removable.

Warning signs and safety notices shall be in both Farsi and English and shall conform to the associated EU regulations. The translated text in Farsi shall be subject to the Buyer's prior approval.

Layout and content of Crane name plates shall be subject to Buyer'
For major components e.g. motors and reducers, name plates from the original equipment manufacturer shall be attached to the components. Name plates

shall bear the model and serial numbers, year and place of manufacture, ratings, ratios, bearing identification number, safety warnings, maintenance limits and any other information critical to the components.

Name plates indicating the function or service of contactors, circuit breakers, hydraulic valves, limit switches, etc. shall be provided. Plates showing hydraulic

circuit diagrams shall be provided on all hydraulic units. Electrical panels and junction boxes shall be provided with electrical connection diagrams with functional descriptions corresponding to the wire/cable numbering for easy troubleshooting.

A plate showing principal dimensions, speeds and capacity of the crane shall be fitted in the operator's cab.

1.17 Dangerous Materials

The crane shall be free from any parts and components made of or containing asbestos.

The crane shall not contain any flammable parts and components except for lubricants.

The crane shall be free from any substances that are to be phased out as stipulated by the Montreal Protocol of 1987, e.g. CFC (Chlorofluorocarbon).

1.18 Inspection and Testing at Site

Inspection and testing shall be in accordance with procedures approved by the Buyer. The Manufacturer shall submit details of proposed site inspections for approval at least four weeks before erection commences. Inspection shall be undertaken before testing. The inspection shall include visual inspection of the completed installations and protective painting systems.

1.18.1 Acceptance Testing

The Manufacturer shall submit a detailed test procedure for approval at least four weeks before testing is due to commence. The Manufacturer shall provide the testing facilities including power supply, instruments, tools and test container. If any of the tests fail, the Manufacturer shall, in accordance with the Contract, remedy the defects and repeat the test to the satisfaction of the Buyer.

The tests shall include no load and full load tests on the mechanisms to check that the performance characteristics are in conformance with the Contract specifications. Measurement of noise levels, lighting levels, structural deflections, anti-sway system performance, shall also be carried out.

Vibration tests of the structure, operator cabin and trolley shall be carried out and results recorded at the complete range of operating speeds and loads. Consideration shall be given to the requirements of BS 6841: 1987 – 'Guide to the measurement and evaluation of human exposure to whole-body
Mechanicalvibrationandrepeatedshockforwhicha certificate confirming, compliance shall be provided.

The crane shall be tested with no load, the safe working load and dynamic 110% overload in that order before the following durability test. In addition, a static overload test of 125% shall be applied at mid span with the structural deflections recorded.

1.18.2 Durability Test

Upon completion of the inspections and acceptance tests, the crane shall be subjected to a durability test in accordance with procedures approved by the Buyer. The test shall include putting the crane into intensive use in actual container operation for a period of 48 hours, or subjecting the crane to continuous simulated container operation with the rated load at 30 lifting cycles per hour up to a minimum of 600 cycles. The test shall be performed by the Manufacturer with his own crane operator.

During the first 10 hours of durability test, failures are allowed provided the time for one single failure does not exceed 15 minutes. If the permitted single failure time is exceeded, the test shall be restarted. Where the sum of failure times reaches one hour, the testing time shall be extended by an hour.

Between the 11th and 24th hour of testing, short interruptions of up to 5 minutes each are allowed but where the sum of interruptions reaches 30 minutes, the testing time shall be extended by one hour. During that hour, no further interruptions are allowed.

The final 24 hours of testing shall be performed without interruption. In the event an interruption due to crane malfunction occurs, the test shall be continued until 24 hours of interruption free operation is achieved.

When final 24 hours of the durability test has been successfully performed, the Manufacturer'scommissioningengineershallensurethatfaultshavebeen eliminated and any necessary repairs carried out to the satisfaction of the Buyer.

There shall be separate durability tests for gantry travel.

1.19 Compliance with Technical Specification

This specification does not cover all details of the crane and nothing written or implied in this specification shall release the Manufacturer from providing a complete working crane that is fully operational, safe and suitable for the purposes of container handling in the particularly arduous Persian Gulf and Oman environmentsea.

1.20 Spares

Spare parts shall be excluded from the Contract Price; however a comprehensive list of spares parts complete with prices shall be submitted with the tender.

A priced list of spare parts recommended by the Manufacturer to cover 12000 running hour shall also be submitted with the tender. The parts shall includeconsumable parts that require frequent replacement and electrical components such as fuses, lamps, relays, contacts, coils etc shall also be identified.

Spares shall be indicated in the spare parts manual with drawings asnecessary. These shall include the Manufacturer's and the originalSub-Contractor's partnumbers and descriptions.

PART 2 - STRUCTURAL

2.1 General

Structural steel shall be to BS EN10113 Grades S275N or S355N or equivalent. Steel shall be supplied with mill certificates for mechanicalproperties and chemical analysis and unless otherwise approved by the Buyer. The Manufacture shall provide additional verification of quality requirements, including supplementary NDT and destructive tests as approved by the Buyer.

The structure shall be designed to minimise swaying and vibration of the cabin.

The crane structure shall be designed to withstand earthquake loads in accordance with specified seismic design data.

The Manufacturer shall submit calculations during the design stage, showing the design deflection values for the proposed crane. The Manufacturer shall provide all instruments, equipment and operators to measure the above deflections during the acceptance testing and commissioning of each crane.

The crane structure shall be designed to avoid water being trapped in corners, recesses or pockets. Splice joints shall be avoided and counterweights will not be approved.

Pin joints may be employed for connections of the wheel bogies to the lower sill beams. Design of bogie pins, sheave pins etc., shall be such that the pins will last the whole life of the crane. Pin joints shall not promote undesirable rocking of the structure. The allowable bearing stress of pins shall not exceed 0.3 times the yield stress of the material. Pin joint bearing surfaces shall be enlarged to minimise wear on the pins and bearing surfaces.

2.2 Stairs, Ladders, Walkways and Platforms.

Stairsshallbe providedforsafeaccesstotheoperator'scabin,machinery house and trolley platform.

Stairs, ladders, walkways and platforms shall be designed and constructed in accordance with, BS 5395 Part 3.

Vertical ladders shall be avoided where possible. Approval must be obtained from the Buyer's Representative fortheuse of vertical ladders on the crane.

Hot dip galvanised gratings shall be used for the walkways and platforms used for inspection purposes, together with all exposed access stairs, ladders and handrailing. Provision shall be made for the gratings to be easily removable for re-galvanising and maintenance. Chequered plate shall not be used for stair treads.

Chequered plates of at least 4.5 mm thick shall be used for platforms where maintenance works are undertaken. Design load for walkways and platforms shall be 5.0 kN/m_2 uniformly distributed load (UDL).

Access ways and permanent platforms shall be provided at areas on the structural frame that require regular or periodic inspection. Platforms shall also be provided on the trolley to facilitate inspection of the girder structure.

2.3 Welding

Welding shall be undertaken in accordance with BS EN 1011-2:2001 Recommendation for welding of metallic materials. Alternative internationally recognised standards such as AWS D1.1 shallbe employed, subject to prior approval by the Buyer.

Welding shall be undertaken by welders who are certified according to BS EN 287-1:1992 requirements. Welding procedure qualification tests shall be carried out for all welding positions employed in the fabrication process, according to BS EN 288-3:1992. Valid welder's qualification certificates a welding procedures shall be reviewed and approved. Reports of such test andwelder'scertificatesshallbe submitted for review prior to fabrication.

As far as possible, welding shall be carried out by automatic or semi-automatic process. Electrodes used for the main structures shall have tensile strength greater than that of the steel material. Quality levels of welds shall be suitable for the specific construction details and shall be subject to approval by theBuyer or Buyer's representative.

Precise details and extent of proposed non-destructive tests and the standards of acceptance shall be submitted for the Buyer'sapproval. Weld testing shall be in accordance with the following standards or approved equivalent:

BS EN 970: Visual Inspection
BS 6072: Magnetic Particle flaw Testing
BS EN 1714: Ultrasonic Testing
BS EN 1435: Radiographic Testing

2.4 Painting and Protective Treatments

The recommendations of BS 5493 Code of Practice for "Protective C IronandSteelStructureagainstCorrosionandBS" EN ISO12944shallbefollowed.

Protective systems shall be compatible with C5-M corrosivity category, suitable for coastal and offshore areas with high salinity. Unless otherwise stated all protective coating systems shall have a life to first major maintenance of 15 years. Details of the proposed paint system shall be submitted for approval.

Minimum blast cleaning standard shall be SA2.5. The paint system shall be applied in a minimum of three coats by the air-less spray method and be overcoatable. Internal surfaces of non-sealed, accessible box sections shall be suitably protected from corrosion.

Blast cleaning and painting shall be undertaken in a dedicated under roof facility where the environment can be controlled. Paint shall not be applied when the temperature is below 5_0 Celsius or the relative humidity over 75%.

Work not undertaken under suitable conditions of temperature and relative humidity will be rejected. Grit blast material shall be regularly checked and replaced with new to ensure correct profile height for subsequent paint key.

Steelwork for stairs, access ladders, handrailing, platforms etc., shall be hot dip galvanised. Due to the extremely corrosive nature of the atmosphere, a thicker coating than normal is required. This shall be achieved by batch hot dip galvanising by a member of Galvanisers Association to BS EN ISO 1461: 1999 after grit blasting to SA2.5 with G24 chilled angular iron grit to achieve a nominal thickness of 120 microns for steel thickness greater than 6mm.

Except where otherwise approved, all steel shall be galvanised after sawing, shearing, drilling, punching and machining work has been completed. The zinc coating shall be smooth, clean, of uniform thickness and free from defects.

FinishedcoloursanddetailsofthePortorTerminalOperator'sLogowillbe advised after the Award of Contract

Capacity signs showing the safe working load of the crane shall be fitted to both sides of the gantry structure and shall be clearly legible from ground level.

After erection, the Manufacturer shall make good to the original standards all paint works damaged during the course of shipment and erection.

PART 3 – MECHANICAL

3.1 Main Hoist

The main hoist machinery shall consist of a single layer deep grooved drum(s) and shall be driven by an AC electric motor through a totally enclosed gear reducer. The hoist drum and associated drive equipment shall be mounted on top of the travelling trolley. A minimum of 2 fail safe brakes that are each rated at 150% of the load shall be provided. A lever mechanism for manually opening the brakes shall be provided.

A switch for preventing excessive speed during lowering shall be provided Limit switches shall be as follows: - slow down and stop limits for hoist emergency over-hoist limit + slow down and stop limits for lower.

Interlocking devices shall be provided to prevent hoisting until all the twist locks are turned the full 90 degrees to lock or unlock position.

The wire rope reeving configuration and sheaves shall be designed such that the wire ropes do not dislodge from the sheaves under any operating conditions. Slack rope limit/s shall be provided. Visual warnings shall beprovided in the operator's cabin to indicate. slack rope condition .

Lowering shall automatically stop when the spreader lands on a container or other object.

An auxiliary control switch for operating the main hoist rope drum at low speed shall be provided near the rope drum. This switch shall be used when replacement of wire ropes is carried out. An interlock switch to disconnect the auxiliary control switch shall be provided in the main hoist control panel inside the electrical control house cubicle.

3.2 Trolley Travel

The trolley shall be self-propelled with the drive mechanism mounted on the trolley. Four double flanged wheels shall support the trolley. Each wheel shall be driven. The mechanism shall include electric motor(s), fail safe disc brake(s), flexible geared coupling(s), gearbox/speed reducer(s) and drive shafts. It shall be possible to remove the motors without disturbing the brakes.

The trolley shall be designed such that it will not fall from the girder structure in the event of a wheel/axle failure. Jacking pads shall be provided on the trolley to facilitate replacement of the wheels, axles and bearings at any position of the trolley along the girder.

The trolley shall be fitted with emergency buffers at each end. The buffers shall be capable of absorbing and dissipating the impact of collision of the trolley travelling at full speed, with the rated load. Compatible buffers or striking pads shall be provided at the extreme ends of the trolley runway.

Slow down and stop limit switches shall be provided at each end of the trolley runway to prevent buffer impact under normal operating conditions.

Stow pins shall be provided on the trolley for parking under storm wind conditions. The pins shall be manually inserted and interlocked with the drive.

3.3 Gantry Travel

The drive mechanism shall incorporate direct driven geared motor units and be designed to enable frequent inching motions with a fully loaded trolley at all working positions. The rating of the drive system shall be continuous.

Safety guards shall be fitted on both sides of the wheels. The guards shall be designed to push obstructions from the path of the wheels. The safety guards shall be durable and easily removable and reinstalled.

On the inner sides of the sill beams, proximity switches shall be installed to prevent the crane structure from colliding with stacked containers during gantry travel.

Substantial steel sections shall be used to protect the gantry travel machinery against damage caused by collision with swinging containers or secondary container handling vehicles.

The crane shall be equipped with manually inserted, interlocked storm anchors capable of holding the crane in out-of-service storm conditions as specified under BS 2573. Anchor sockets shall be provided with the crane.

Lightweight wheel chocks designed for at least 10 years service shall be provided for the wheels. Pockets for storage of the wheel chocks shall be provided on the wheel yokes. The wheel chocks shall be chained to the pockets.

The crane shall be provided with eyes or lugs at the ends of the sill beams on both sides for the purpose of tying down the crane in storm conditions, and for towing the cranes in case of gantry mechanism failure.

The gantry rocker beams shall be electrically bonded to the main structure.

3.4 Straight Line Auto-Steering System

The crane shall be provided with an auto-steering system for automatic straight-line crane gantry travel. The system shall also facilitate gantry travel at defined angles. The proposed system shall be such that no digging up of the container yard surface will be required.

The automatic steering system shall be designed such that the traveling accuracy of the crane is within the range of + 50 mm. An alarm signal shall beprovided in the driver’s cabin and shall be activated in case the cannot keep the crane within the range of + 50 mm. Upon reaching a deviationof more than 100 mm, the crane movement shall be automatically stopped.

The automatic steering system shall identify the exact position of the crane along the runway.

The steering system shall facilitate pivoting of the wheels through 90 degrees permitting the crane to operate in cross travel mode. The time taken to pivot 90 degrees shall not exceed 45 seconds.

3.5 Head Block and Telescopic Spreader

The design of the head block and telescopic spreader shall be for intensive and continuous use (24 hours a day) under all weather conditions, with a fatigue life of two (2) million lifts.

The crane shall incorporate skew, trim (rotation of spreader around transverse axis) and horizontal fine positioning. It shall also be equipped with an effective anti-sway system to improve operability and reduce handling times. Containers eccentrically loaded by 60/40 proportions shall be capable of being handled.

The spreader shall be of an all electric, high performance and low maintenance design, of proven performance and reliability, supplied by a manufacturer approved by the Buyer.

The spreader shall be designed to handle 20ft, 40ft and 45ft containers up to 40t.

The spreader shall be fitted with a monitoring and diagnostics package that feeds information theoperator'scabin and electrical room for operation, maintenance and fault finding purposes.

The head block shall be coupled to the spreader by four (4) twistlock pins. Coupling and uncoupling of the head block and spreader shall be done manually. Safety electrical interlock devices shall be provided to prevent hoisting if any twistlock is not fully locked into, or fully unlocked from the spreader connection. The fully engaged and fully disengaged conditions shall be detected by separate proximity switches. Guides shall be provided on the head block and spreader to facilitate the coupling process. Horizontal float between the spreader and head block shall not be more than 5 mm. Bearing surfaces on the spreaders shall be such that wear of the connection pin hole surfaces will not occur during the life of the spreader.

The spreader cable shall have 20% spare conductors and all spare conductors shall be labelled and terminated at terminal blocks in junction boxes. The connection and isolation of the electrical supply to the spreader shall be done manually. All electrical lines supplying power on the spreader shall beprotected by vibration proof circuit breaker shallat the operator's can be one circuit breaker for every device. The circuit breakers shall preventdamage to in/out devices in case of short circuit occurring.

The load bearing surfaces on the spreader, where connected by twistlocks to the head block, shall be heat treated with minimum hardness of 320 BHN to ensure there is minimal wear on the bearing surfaces.

Head block, spreaders and twistlocks shall be proof-load tested prior to shipment to the site.

Limit switches to detect the various container lengths shall be installed on the main frame adjacent to the telescopic beams. Provision shall be made in the system for flexibility that allows small changes in spreader length when handling distorted containers. Sliding pads that can withstand the impact transmitted to the telescopic beams during container handling operations shall guide the telescopic beams. Means to adjust the clearance between the sliding pads and the telescopic beams shall be provided. The telescopic frames shall be mechanically locked to prevent sliding motion when the telescopic motion is not activated. Stoppers to limit the telescopic action at the various container length positions shall also be provided.

Lifting lugs and slings shall be provided for handling damaged containers that cannot be lifted by the twistlocks, one at each corner of the telescopic spreader. The hole diameter of these lugs shall be 50mm. Each lug shall be rated for a 13 tonnes safe working load.

The twistlocks and telescopic (extend/retract) motions shall be electrically operated. The telescoping and twistlocking mechanisms shall also be capable of manual operation and access to twistlocks shall be provided.

Compartments and junction boxes shall be generously sized and easily accessible from the side of the spreader when coupled to the headblock to enable maintenance and trouble-shooting of cable connections. Hinged doors shall be provided on the compartments and junction boxes. These doors shall be hinged at the top to prevent rain entry if the door is left open. Electrical schematic drawings shall be permanently mounted on the inside of compartments and junction boxes. The compartments and junction boxes shall be water-tight and mounted using shock dampers to withstand the vibration and impact during container handling operations.

There shall be a minimum clearance of 100 mm between a raised flipper and the head block rope sheave, including when the spreader is trimmed or listed to maximum angle. Flippers shall be constructed in such a way that any part can be easily mounted and removed from the spreader.

ISO floating type twistlocks shall be provided. The float shall be + 8 mm. Twistlock pins shall be proof-load tested to 20 tonnes. Electrical as well as mechanical interlocks shall be provided to prevent operation of the twistlock while the container is suspended under the spreader and to immobilise the hoisting system if any of the twistlocks are not securely engaged in the container/hatch cover corner casting. Positive and absolute detection of the twistlock status by limit switches shall be provided.

Top of container (spreader landed onto container) detectors at all four corners of the spreader shall be provided to detect the following:

- full landing of spreader squarely onto container,
- no container under spreader, and
- container suspended under spreader

The above detectors shall be positioned such that they will function on the corner castings of ISO containers and non-ISO type containers.

Spreader limit switches shall be easily accessible for maintenance and shall be protected from impact damage. Limit switches shall be proximity type, except for twistlock and top of container detectors.

Capacity signs showing the safe working load of the spreader shall be fitted on both sides of the spreader.

A specified number of spreader stands shall be provided for ease of maintenance on spreaders. In addition, a specified number of equipment/frames shall be provided for occasional lifting of open top containers that are over height.

3.6 Spreader Skew and Trim

The crane shall be equipped with skew and trim adjustment of +/- 5 degrees with rated load. Sufficient clearance shall be maintained between any part of the spreader (with flipper at raised position) with crane structures (e.g. walkway leading to operator cabin) especially when trolley travelling and spreader is skewed to maximum.

Push button switch(s) on the operator's console shall operate skew adjustment. Push button switches shall also be provided in the operator's cabin to enable the operator to automatically correct the spreader to a 'zero skew' and 'zero trim' position.

3.7 Anti-Sway System

The anti-sway system shall be capable of damping the sway of the spreader, with rated load at a height above ground and beneath the spreader of 4.5 metres, bringing it to rest within + 50 mm displacement in less than five seconds after the trolley is brought to a halt from full speed.

3.8 Horizontal Fine Positioning

The horizontal fine positioning system shall be capable of movement of the spreader relative to the trolley of ±250 mm in both trolley and gantry travel directions.

3.9 Operator's Cabin

The operator's cabin shall be secured to the trolley in a failsafe and easy escape from the cabin at any trolley position shall be made possibleor emergency purposes without having to move the trolley back to the parking position.

There shall be a safety clearance between the cabin and spreader at all working positions.

Rear view mirrors shall be provided to enhance visibility during trolley backward motion. A convex mirror, not smaller than 500 mm x 60 mm, shall be provided and fitted in such a manner that the operator is able to view the off sideof the spreader with container, at any position of the spreader. In additiona CCTV system comprising four (4) cameras and dedicated monitors shall be supplied enabling the driver to view operations when seated in the cab. The LCD type monitors shall be colour and mounted forward of the drive. The cameras shall be mounted on the crane legs, 2 on each, one facing forward and one back.

The cabin shall be insulated against heat, noise and vibration and shall be provided with split type air-conditioner. The design of the supports and mounting shall facilitate easy removal of the air-conditioner using the machinery maintenance hoist/equipment. The air-conditioner shall be of a make that is locally available.

Scratch resistant safety glass that meets the requirements of BS6206, Class A safety glass shallbe used on the windscreenwindowsand ofoperator'scabin. The glass shall have sufficient strength to withstand the impact of an 80 kg operator being thrown against it when the trolley is suddenly stopped. Shields shall be fitted above the windscreen to prevent wire-rope lubricants from splashing onto the glass. The upper portion (above eye level) shall be tinted to reduce glare. The bottom window shall be at least 900mm width and shall offer optimum visibility to the crane operator. For this purpose, safety floor glass shall be used on which the operator can safely walk. Grills and bars shall be provided at the windows only where necessary for safety reasons. All windscreens and windows shall be fitted such that they can be manually cleaned as well as have glass replaced from within the cabin.

There shall be sufficientspacetothefrontoftheoperator'sconsolefor mounting a monitor and keyboard for the crane monitoring system.

The operator'schairshallbe designedforhorizontal,verticaland tilt adjustments. The chair shall incorporate lumbar support, headrest, seat belt, and a U-cut seat for good visibility when viewing between legs. The chair shallbe fitted with a high back that can be reclined 180 degrees to enable the operator to lie back whilst taking a rest.

The seat of the chair shall be upholstered in hard wearing vinyl material and shall be easily detachable for replacement.

The operator control consoles and layout of controls shall be ergonomically designed and details submitted for approval.

A foldable wall mounted seat complete with self-retractable safety seat belts shall be provided in the cabin for an instructor.

Electronic type spreader height and load indicators with digital read outs shall be provided in the cabin. The indicators shall be installed within view of the operator sitting in the normal operating position. An audible alarm for overloaded containers shall be provided.

An anemometer with an audible alarm shall be provided in the cabin to indicate the wind speed. The audible alarm shall be activated when the wind speed exceeds the condition for safe operation of the crane.

The following indicator lights shall be provided inside the cabin at an approved position to enable the driver to detect the following status:

- Spreader squarely landed on top-of-container (yellow).
- Twist lock in locked position (green).
- Twist lock in unlocked position (red).

The operator's cabin shall be equipped with a fire alarm and extinguishers as described elsewhere.

An emergency escape device with test certificate shall be provided in the operator's cabin.

3.10 Fire Extinguishers and Detection Equipment

Fire extinguishers that are approved by the N.F.P.A. shall be provided, located on the crane as follows: -

i)	Diesel Engine Set	-	1 unit 5.0 kg carbon dioxide
ii)	Operator's cabin	-	1 unit 5.0 kg carbon dioxide
iii)	Electrical control enclosure	-	1 unit 5.0 kg carbon dioxide
iv)	Trolley platform	-	1 unit 5.0 kg carbon dioxide

In addition, fire detection systems with suitable audible and visual alarms shallbe provided within the operator's cab, machinery house, electrical control a diesel generator enclosures.

3.11 Rope Drums

Rope drums shall be made of high strength steel and shall have accurately machined grooves to suit the wire ropes. Each drum unless otherwise approved shall have sufficient capacity to carry the required length of the ropes in a single layer. Drums shall be statically balanced and stress relieved. Drum grooves shall have sufficient depth to ensure minimum wear on wire ropes.

The pitch diameter of the rope drums shall not be less than 30 times the wire rope diameter.

There shall be at least four dead turns of wire ropes remaining on the main hoist and boom hoist drums when the spreader or boom is lowered to the lowest position. Guide rollers for wire ropes on the rope drums shall be provided to prevent wire ropes from jumping groves during operations. Guide rollers shall be easily removable for replacement of wire ropes.

The maximum fleet angle of wire rope leading to the drum shall not exceed 3 degrees.

The main hoist drum arrangement shall have at least one metre clearance from main hoist motor.

Drip trays shall be provided beneath every drum to collect spillage and dripping of wire rope lubricant. The trays shall be large enough to cover the entire length and width of the drum.

3.12 Wire Ropes

Wire rope construction shall have a steel core. Steel wire ropes shall be of 6 x 36 construction, independent wire rope core (IWRC). The proposed wire rope diameter and safety factors shall be entered in the tender schedules.

Lubrication of all wire ropes shall be done automatically and be controlled by the computerised Crane Management System (CMS) specified in this specification at the interval of pre-set number of containers handled by the crane or at the pre-set time interval, whichever occur first. The auto wire rope lubricators shall be drip or brush type. The point of application of lubricants to the ropes shall be enclosed to prevent splashing of lubricants from staining the crane structures and platforms. The auto wire rope lubricating system shall ensure that all the moving parts of the ropes are lubricated. Lubricant reservoirs shall be provided and linked to groups of lubricators at various locations on the crane. These reservoirs shall have capacities for supply of lubricant to the lubricators for a minimum period of 2 months or 300 hoist operating hours before the next topping up. Level sensor shall be provided to give warning through CMS when the levels of lubricant fall to the topping up level.

All necessary rope reel stands and equipment shall be provided under the Contract for changing the wire ropes.

3.13 Sheaves

The pitch diameter of wire rope sheaves shall be designed to enhance wire rope life, and shall not be less than 30 times the wire rope diameter unless otherwise approved. Grooves of sheaves shall be appropriately hardened.

All sheaves shall be mounted independently on individual shaft such that if one sheave is removed, other will not be affected. If more than one sheave ismounted on a shaft, independent drilling on the shaft for grease lubrication shall be provided for each sheave.

Mounting of all rope sheaves shall be on split type brackets that enable easy and rapid removal and replacement of the rope sheaves, bearings and shafts. For areas where split type mounting brackets are not possible, every shaft shall be provided with a threaded hole of 20 mm metric thread by 40 mm deep. This hole shall be used for extracting the shaft from its mounting brackets. Sufficient working space shall be provided for safe and easy repairand replacement of sheaves. Rope sheaves shall be mounted above the trolley platform such that the sheaves, covers, shafts and bearing can be accessed from the top direction. All sheaves shall be statically balanced.

3.14 Hydraulic System

Hydraulic piping shall be flared at the ends and connected by flared fittings. Hydraulic piping shall be used on rigid structures. All hydraulic piping and hoses shall be securely clamped at appropriate intervals.

Criss-crossing of hoses and piping shall be avoided as far as possible.

Solenoids of hydraulic valves shall be high-power type that can withstand high in-rush current of 200 VA. Every solenoid shall be earthed. Solenoids shall have means of manual operation.
The relevant hydraulic line distribution schematic drawing shall be prominently displayed on the inside surface of compartment’s door. The drawing engraved and permanently mounted.

Hydraulic units shall be fitted with moisture absorbent breathers. Hydraulic cylinders shall be of high corrosion resistance materials and protected where possible with bellows covers.

3.15 Gear Reducers

All gears in the reducers shall be standard products rather than special and shall be standard products available in the markets. All gears shall be totally enclosed in leakage free casing. Open gears will not be considered. Large gearbox casings shall be split horizontally and arranged such that the top half can be easily removed for maintenance without affecting the position and alignment of the gears and bearings. Oil-tight inspection covers shall be provided on the top half of the casing to facilitate inspection of the gears without having to remove the top casing.

A compressed air operated diaphragm pump complete with valves and hoses for quick refilling of new oils and lubricants shall be provided on every crane. Capacity of the pump shall not be less than 20 litres per minute.

Oil level indicator and dial type temperature gauge shall be provided on every gear reducer. These indicators shall be located for convenience and ease of inspection. Reducer vibration, oil level and oil temperature shall be monitored by the crane management system.

3.16 Bearings

All bearings, except for pin connections, shall be anti-friction type with lubricant retaining seals, and shall have a life compatible with the service life of the mechanism. Pre-lubricated plain bearings shall not be used for major components (e.g. motors, wheels, sheaves, reducers etc.)

3.17 Castings

Cast iron and cast steel shall be of good quality, close grained type, appropriate to the relevant duty and standard.

All surfaces of castings, which are not machined, shall be smooth and shall be carefully fettled to remove all foundry irregularities.

Castings shall be free from non-metallic inclusions and other defects. Castings with defects or repaired castings other than cosmetic dressing will not be accepted.

3.18 Bolts and Nuts

Bolts (including hexagonal cap screws) and nuts used shall be of ISO metric screw threads and dimensions. Bolts and nuts, which are subjected to vibration or frequent changes in state of loading, shall be secured by effective methods. Tack welding on bolts and nuts is not allowed.

Bolts shall have at least two threads protruding from the nuts after the nuts are securely fastened.

Manufacturer shall pay particular attention to the corrosion resistance of all exposed fasteners, and shall ensure the same level of protection as the main structure components is achieved. All fasteners larger than M12 shall be hot dipped galvanised in accordance with BS 7531: Part 6: 1998.

All fasteners M12 and under shall be stainless steel. Bolts for securing covers, which require frequent removal, shall be of stainless steel. Bolts and nuts for installation of all lights, telephones, electrical socket outlets, limit switches and junction boxes shall also be of stainless steel. High tensile steel galvanized bolts and nuts shall be used for installation of stairs, ladders, platforms and covers for rope sheaves.

3.19 Grease Lubrication Systems

Sets of Localized lubrication systems shall be provided, with one set each installed on the trolley platform to lubricate the bearings, on the trolley platform to lubricate the wire ropes and on the bogies. The Manufacturer shall specify other set (if any).

Each Localized lubrication System shall be provided a with reservoir of sufficient capacity or at least for 2 months operation, weather proof electrical motor driven pump(s) (except for bogie), strainers, safety valves, divider valves, metering valves, flow direction valves, etc. and connected to all (except on rotating parts, electric motors, reducers and brakes) lubricating points.

Grease level in the reservoir shall be monitored continuously by the computerised Crane Management System (CMS) as specified elsewhere in this Specification. Design of the Localized lubrication System shall accommodate quick replenishment of grease into the reservoir.

The electrical motor driven pump(s) shall have the capacity for delivering at least 35 cubic centimetres of grease per minute and shall be activated automatically by the computerised CMS at intervals of pre-set numbers of containers handled by the crane or at the pre-set time intervals, whichever occur first. There shall be means to override the computerised lubricating system.

All lubrication points on the gantry wheels rocker beams shall be grouped and linked by piping, divider valves and metering valves to four centralized lubrication points located at the four corners of the crane. Each centralized lubrication system for the gantry wheels shall be provided with a manual operated pump. Provision shall be made on the gantry wheels lubrication System to install automatic operated pump.

Grease distribution lines schematic diagrams shall be prominently displayed for each lubrication systems. The diagrams shall be engraved and mounted near each lubrication system.

All grease fittings shall be brass type standard button head grease nipples. Each lubrication point shall be painted red for easy identification.

All other lubrication points that are in difficult to reach positions shall be routed by tubing and grouped together at convenient, accessible locations for easy application of grease.

Details of the above proposed systems shall be submitted during the design stage. The final design and installation of the systems shall be subjected to approval.

3.20 Wheels and Tyres

The Manufacturer shall submit details of the proposed type, size, inflation pressure and rating of tyres to be used to the Buyer for approval. Tyre, tyre rim, hub shaft and bearing block shall be easily available and represented by local agents in Iran.

3.21 Diesel Set

The diesel set shall be mounted on a structural sub-base within an IP65 enclosure. There shall be adequate ventilation within the enclosure. Temperature inside the enclosure shall not be more than 10 degrees Celsius above the ambient. The diesel set shall be installed in such a manner so as to allow easy maintenance and repair. The structural sub-base and enclosure of the set shall be designed for easy mounting and dismounting using forklift or mobile crane. The enclosure shall be fitted with roller shutter doors of industrial duty construction.

The diesel set and electrical control enclosure shall be installed on different sill beams of the crane. Fluorescent lamps and battery-operated lamps shall be provided inside the enclosures for maintenance purposes.

The design and layout of the set shall be such that all belts, engine oil sump, radiator and fans can be simply replaced. The engine shall have the following basic accessories: -

i) Engine starting equipment - the starter motor shall operate on 24 volts DC. The ignition switch shall be located at the first landing of the access ladder.
ii) Battery charging unit.

iii) Heavy-duty batteries - two 12 volts heavy-duty batteries of not less than 200 AH each shall be provided. The 24 volts DC supply shall be negative earth.

iv) Radiator and cooling unit - due to the mode of operation (high engineidling time) the radiator shall be generously sized to prevent overheating of the engine. An auxiliary tank (expansion tank) separated from the radiator of not less than 10 litres capacity and fitted with easily visible level indicator shall be provided for easy topping up of the radiator water. The external surfaces of the radiator shall be protected with anti corrosive treatment. The radiator shall be mounted such that it can be removed for repair without removing the enclosure.

v) Exhaust silencer complete with acoustic treatment shall terminate at bridge girder level. The noise level shall comply with any local requirements.

vi) Governor for +/- 3 % speed regulation

vii) Fail safe automatic shutdown at high water temperature, low oil pressure and engine over speed. Indicator lights shall be provided in

the cabin to show causes of any shutdown.

A tray shall be provided under the engine to contain all engine oil and cooling water spillage. The tray shall be drained to an 80-litre tank provided at ground level. Outlet with gate valve for draining the waste oil and water from the tank shall be provided. The engine breather shall have a trap to contain the oil and vapour. Suitable protective installations and warning devices shall be provided to prevent spillage of diesel when refuelling.

The oil and water topping up points and the engine oil dipstick shall be located on the same side as the access ladder to enable the operator to carry out daily routine checks.

To ease drainage of the engine oil from the sump, valves, piping and hoses shall be provided and routed to location near to the ground level. The drainage pipes/hoses shall be installed with a lever type globe valve near the oil sump and a gate valve at the drainage outlet near the ground level. The valves shall be protected from accidental damage and unintentional opening.

A stainless steel fuel tank with a capacity permitting continuous operation of the crane for at least 24 hours without refuelling shall be provided. Its design shall permit optimum use (Over 95% of all fuel in the tank) and shall ensure that the diesel fuel does not overflow due to foaming while being refuelled. The refuelling point shall be located at the same side of the ladder but not too near so as to avoid accidental spillage of diesel onto the ladder. Fuel level indicator shall be provided at the same side as the refuelling point and it shall be visible from the refuelling point as well as from a distance from the crane at the ground level. The tank shall be separate from the diesel set enclosure.

The out going cable from the diesel set shall be terminated at the electrical main switchboard via a circuit breaker complete with over current and earth fault protection. The main switchboard shall be equipped with protection relays set to discriminate with the supply of the generator. The relays shall include under-voltage, over-current and earth fault protection.

A fire detection system with suitable audible and visual alarms shall be provided within the enclosure, together with appropriate quantities and sizes of fire extinguishers.

PART 4 – ELECTRICAL

4.1 General Requirements

All electrical installations shall be designed, assembled and tested in accordance with British Standards, European Standards, IEE (Institution of Electrical Engineers, UK) Regulations or other approved standards and

regulations. It shall be the responsibility of the Manufacturer to ascertain that all such local laws, rules and regulations are strictly adhered to.

4.2 Electrical Installation Standard

All electrical installations shall comply with IEE Wiring Regulations for Electrical Installation (BS7671). All installations shall be made with due regards to safety of persons in the proximity of live conductors. All live conductors shall be shielded.

All electrical and electronic equipment shall be protected from multiple transient voltage damage caused by transients in power supply, lightning, etc. The protection system shall include high quality transient voltage surge suppression (TVSS) devices that are capable of withstanding, without degradation, continuous application of IEEE 587, ANSI C 62.41, 43 and 45.

4.3 Wiring

The numbering of cables shall be documented and shall be consistent and easy to interpret.

Cables shall be installed in one length from terminal point to terminal point. Cable terminations shall be by connectors and not loose wired. Cable bends shall be strictly in accordance with the manufacturer recommendations.

Conductors shall be copper and multi-strand. Cabling for 380/415V shall be 600/1000V grade XLPE/SWA/PVC cable. Single core cabling shall be PVC insulated of not less than 1.5 sq. mm2 and shall be run in conduit outside panels. Metal conduits shall be earthed.

A minimum of 10% or two pair, whichever is the greatest, of spare cores shall be provided in each control or signal cable, spare cores shall be marked and terminated at spare connectors or terminal blocks.

The outer sheath of cables located in exposed positions shall be manufactured from materials that have a high level of resistance to damage from contamination by oil or grease.

All cables and cable cores shall be identified at both ends by means of sleeve bands that are indelibly marked with the cable/core reference numbers as shown on the Drawings. The outer protective covering of multi-core cables shall extend into the switch or panel. Cable support/glands shall be provided at the cable entry point to all switches, panels and equipment.

4.4 Cabling to Trolley

Cabling running between the main body of the crane and the trolley shall be supported in a single chain type mechanism. The chain system shall be a proprietary item specifically designed for the purpose.

The materials used shall be suitable for the climatic conditions at the site and the construction shall be suitable for continuous operation in an atmosphere laden with a high level of abrasive dust. To ensure that differential expansion is minimised chain components shall be constructed from the same type of material. The chain shall be designed to minimise the energy required to move the chain and reduce the friction between the chain and the trough and between the layers of chain itself.

The chain shall be sized to carry all cables with sufficient spare capacity to run an additional 10% of cables. Multi core cables shall have a minimum of 10% spare cores.

The chain shall run in a stainless steel trough, the trough shall be designed such that it minimises the retention of dust and solid particles and of sufficient depth to ensure stability of the chain at all times.

Cabling shall be specifically designed for use in chain support systems with a bending radius to match operation of the chain. The outer sheath shall be UV and oil resistant. The material of the sheath shall be low friction and highly abrasive resistant. Cables shall have an earthed metallic sheath under the outer sheath to provide electrical safety and EMC protection. Cabling shall be retained within the chain using stainless steel clamps. The cables running within the chain shall be sized and spaced to allow continuous operation of the drives at full load in the maximum ambient temperatures. The design, spacing and grouping of cables shall be such as to minimise interference between circuits.

4.5 Limit Switches

All limit switches shall be heavy-duty type conforming to requirements of NEMA (NationalElectricManufacturer'sAssociation or theequivalent international standard. Proximity sensors and magnetic switches that have no moving parts and that require no maintenance shall be used for all non-critical applications. Proximity sensors and magnetic switches shall conform to IP 67 protection requirements and shall be capable of withstanding shocks.

Limit switches for sensing of end travel for the trolley shall be heavy-duty type, which have long mechanical life of not less than 10 million cycles. All geared limit switches and over speed control switches (if used) shall be coupled by flexible coupling and not through chain drive. Geared limit switch unit for main hoist shall have two spare limit switches

Electronic absolute digital encoders shall be used for position feedback for the drives. Encoders shall be of IP 65 or above protection. Cables for limit switches shall be connected at terminal blocks in water tight junction boxes, for easy maintenance and troubleshooting.

4.6 Motors

Motor construction shall meet the requirements of BS 4999 and IEC 72. Drives shall use suitably rated AC motors.

Motors shall be tropicalised, suitable for intensive use and continuous operation in the local environment with minimum maintenance requirements. Motors installed indoors shall be drip proof type, motors mounted outdoors shall be totally enclosed.

Main drive motors shall be compatible with AC variable frequency drives, maintenance free, and shall be suitably rated for the duty (min. class S3, duty type 80%).

Variable speed drives shall be force ventilated using ventilation fans driven independently at constant speed. The ventilation fans of the boom hoist motor shall be controlled by a thermostat mounted on the stator and shall continue to cool the motor after boom hoisting or lowering operation is completed. Motors shall use Class F winding insulation with temperature rises to class B limits. i.e. 800C above a 400C ambient

Terminal boxes shall be provided on the motors for connecting the power cables. Motors mounted indoors shall be IP54, whilst motors exposed to outdoor conditions shall be totally enclosed to IP65 protection complete with drainplugsandbreathers,aspermanufacturer's recommendation on the main hoist, boom hoist and trolley travel motors, thermocouples shall be provided to measure the temperatures of the windings. The thermocouple readings shall be input to the crane management system and shall warn the driver of high motor temperatures. In addition, motors shall be fitted with high temperature cut-outs.

Anti-condensation heating elements shall be provided inside motors to prevent condensation when the motor is not in operation. Notices shall be fitted to motor anti-condensation terminal boxes warning of the heater supply and the need to isolate the supply.

Adequate space shall be provided above motor inspection plates to allow internal inspection.

4.7 Speed Drives and Control Systems

A. General

Electronic dynamic braking shall be provided for all the main drives.

The drives shall be provided with accurate setting of the operating parameters, with absence of drift from set values. There shall be protection against accidental disturbance of the set parameters. The drives shall be able to perform fast and accurate communication with the control logic and between drives. When multiple drives are used, there shall be complete synchronization of the signal timings such that no discrepancies occur between incoming, outgoing or feedback signals from two or more drives.

All adjustments of settings for the drives shall be digital and shall be effected through digital keypads with liquid crystal displays (Man Machine Interfaces – MMI's) located in the operators cabin and the electrical equipment parameter settings must be retained in memory during a power failure. Theparameters settings shall be effected through three methods,i.e. the use of

local digital keypads; serially communicated hand held programming panels which can also interrogate the drives and removable programmable ROMcards which allow the settings and programmes to be made in remote locations and downloaded on site.

A full colour printer located within a suitable enclosure mounted on anti-vibration mountings shall be provided within the electrical house. The printer shall be connected and configured to allow the print out of event and fault logs from the crane management system on demand by the maintenance staff. A cabinet shall also be provided for the storage of printer paper and ink cartridges. The system shall be supplied with three spare ink cartridges.

All drive system control circuits shall be protected against overloads. Back-up protection for the drive system shall be provided by circuit breakers external to the drives. Drives shall signal the PLC if any parameters have gone off-limit or if there is failure of any function. The drives shall have the capability to perform self diagnostic tests and to retain diagnostic information for future interrogation.

Data and information about the behaviour of eight different signals during each fault condition for up to five previous faults shall be retained by the drives under power supply loss. Diagnostics shall include indications for; over current, under voltage, over voltage, over temperature, semiconductor failure, communication failure and rotor stalled. Electronic or mechanical counters shall be provided for each drive.

AC inverter drive components shall be protected against all fault conditions including; short-circuit faults and over voltage. The inverter drives shall be protected against the occurrence of earth faults in the output supply to the motor and in the motor itself. The protection mechanism shall switch off the inverter output in the event of a high level of earth current being detected. The inverter drives shall be equipped with radio interference suppressing and noise suppressing equipment.

All ribbon cables employed for connection between cards shall be screened. Twisted differential pair, or coaxial cables, with firm connection that are able to sustain vibration up to 10G shall be used for communication between subsystems.

The power supply to each drive shall run direct from a switchboard or distribution board. Power wiring must be separated from control wiring, and on long cable runs, separated by earth shields within the trunking. Control or signal-carrying wires shall always be individually screened cables. The screens of the cables shall be terminated at one end only, and this point shall be the common termination point for all screens. This point shall become the central earth point (CEP) for the system, and is the connection to which the incoming earth must be bonded. Feed back or input signal to the drive shall be filtered against electrically induced noise.

All electronic components, devices, circuit boards and control systems are to be shielded against the influence of radio frequency interference (RFI) and electromagnetic interference (EMI). The suppression levels are to be in complete compliance with that stated in the directive EEC 82/499. Proper filters are to be incorporated to the input and output of all the drives to suppress the amount of RFI.

The speeds of main hoist, gantry travel and trolley travel drives, shall be step less and variable from low to full speed. Acceleration and deceleration shall belinear and shall have provisions for limitations of acceleration or deceleration to pre-set value even if an excessive fast controller action is being applied.

B. Speed Control

The drive controls shall be fully digital types. The drive control elements shall be modularised for easy inspection and maintenance. Monitoring and diagnostic facilities shall be incorporated into the controllers.

C. Speed Controllers

Master controllers, located in the crane operator's cabin,shall Main Hoist, Trolley and Gantry operation. The controllers shall be digital type, standardised and interchangeable among all the cranes supplied under this Contract. They shall be spring returned to off, lockable at zero notch and released by push button switch (dead man handle) incorporated into the controller joy-stick. Off position interlocks shall be provided for the master switches so that they have to be returned to the off position for re-starting of crane drives after unintentional stopping.

4.8 Crane and Box Management Systems

The overall port main computer system will be defined within the IT framework for the terminal and will be provided by others.

The Manufacturer shall provide wall space (0.75 metre square minimum) within the operators' cabin for the future installation (by others) of data transmissionequipment. Signals for transmission shall be marshalled on terminals within acabinet located adjacent to the reserved space. A 5A 220V supply shall alsobe made available within the cabinet to supply the data transmission
equipment.

4.9 Sequence Control

All sequencing and inter-locking functions for drives, except emergency protection functions shall be performed by Programmable Logic Controllers (PLC). The PLC's shall be able to communicate with each other. T shall have remote communication capabilities. PLC's shall readily be able interrogate other PLC's connected to the same network.

All components of the PLC shall be suitable for use in site environmental conditions. Power failure protection shall be provided to ensure safe operation.

The PLC's shall have sufficient memory capacity for more than on plus at least 30% redundant memory capacity. There shall be facilities andspace provided for adding memory for future developments. It is envisaged that flexible data logging functions will be utilised in the future.

Storage devices for programs and data storage shall be provided. There shall be provision for logging of fault data. The storage devices shall be sized to

provide 30% spare capacity above the requirements of the delivered system. The terminal shall be capable of providing independent off-line development of programs and documentation.

The supply to the PLC's shall be regulated and free from noise and voltage spike. Expansion of the programmable logic controllers shall be by plug-in modules to the common rack. The PLC's shall have self-diagnostic capability both upon power on and continuously during operation. Faults detected shallbe clearly and promptly enunciated. The PLC's shall be capable of detectingthe following categories of faults: -

a. out-of-sequence faults
b. under-time faults
c. over-time faults

All faults shall be displayed sequentially on the fault display panel inside the electrical control enclosure.

The programming language shall be of an International Operating system language and suitable for sequence control purposes. It shall also allow referencing devices by English names consisting of alphanumeric characters of adequate length. There shall be provisions for incorporating comments in the documentation of programs. Security features that permit only authorized users to amend the programmes shall be incorporated.

The PLC shall be provided with I/O ports capable of handling standard input and output signals. The I/O ports shall provide isolation from dangerous voltages and currents. There shall be provisions for adding I/O ports.

The crane shall be equipped with portable programming terminals for easy programming and maintenance work for the cranes. The programmer terminal shall be incorporated with relevant PC hardware, interfacing cards and ports, and the latest version of English International operating system. They will be used on the crane only when there is a failure of the Crane Management System (CMS) computer.

The system shall be capable of providing independent off-line development of programs and documentation.

4.10 Instrumentation

In addition to the features for capturing the utilisation of the engine and motors via the CMS, electro-mechanical running hour meters with at least 5 digits (excluding decimals) display to log the operating hours of the following shall also be provided: -

a) Main hoist motor
b) Trolley travel motor
c) Gantry travel motor
d) Engine

A 6 digit (excluding decimals) electronic counter shall be provided to log the numbers of containers handled. The container counter and hour meter shall be installed in a panel with a transparent cover. The panel shall be positioned at a convenient location about 1.5 m above the ground level to enable easy reading by personnel on the ground.

Engine oil pressure and temperature gauges, water temperature gauge, battery charging ammeter, engine tachometer, frequency meter, ammeters, Maximum Demand (MD) indicator and voltmeters shall be provided in theengine starting panel. Ammeters and voltmeters for the hoist, trolley and gantry drives shall be provided in the electrical control cubicles.

4.11 Telecommunication

A push button select intercom system shall be provided at the following locations on the crane: -

i) Operator's cabin (hands free)
ii) Below each sill beam
iii) Inside the electrical control enclosure
iv) On the trolley platform
v) At the engine starting panel

Communications units located below the sill beams, trolley platform and starting panel shall be installed in IP65 enclosures.

Electric bells shall be installed in the operator's cabin, electric engine alternator enclosure to draw attention of the persons at these areas.

Push buttons for these bells shall be provided at the legs of the crane, inside electrical enclosure, inside engine-alternator enclosure, on trolley platform and intheoperator'scabin. Thebellsystemshallbe poweredfromthecrane's batteries.

A public address system consisting of an amplifier with a hands free microphone shall be installed in the operator's cabin.

Loudspeaker of IP65 construction shall be installed at the following locations: -

a) Below the operator cabin
b) At one of the legs of the diesel generator set enclosure side
c) At one of the legs of the electrical control enclosure side
d) At the top of the trolley platform.

The crane intercom system shall be linked to the public address system such that paging can be made from any intercom unit. Screened cables shall be used on both systems.

4.12 Electrical Supply Outlets

Switched socket outlets, 220V, 16A, conforming to BS EN 60309 with IP67 degree of protection shall be installed at the following locations: -

i) Trolley platform - 1 unit
ii) In the diesel generator set enclosure - 1 unit
iii) In the electrical control enclosure - 1 unit
iv) Spreader - 1 unit
v) On the legs - 1 unit/corner drive
vi) Inside main hoist motor enclosure - 1 unit

The supply to the outlets shall be either from the crane diesel set or mains plug-in supply. Socket outlets shall be protected by earth leakage circuit breakers

4.13 Shore power Supplies

Facilities shall be provided such that a three phase and neutral supply derived from the ports LV system can be connected to the crane. The supply shall be arranged to allow lighting, socket outlets, anti-condensation heaters, air

conditioners, communications and PLC systems to operate. The connection shall be made via a suitably rated plug and socket arrangement and a changeover switch. It shall not be possible to parallel the normal on board generator supply with the shore supply.

4.14 Safety Devices

Interlocks and safety devices shall be provided to ensure the safe operation of the crane at all times.

Six warning strobe lights (amber in colour) shall be fitted, one at each leg and one at each end of the girder structure on the walkway side. The strobe lights shall be automatically activated when gantry motion is selected.

Siren units, independent of the Public Address system, shall be provided and fitted at all the four legs of the crane. The siren shall be automatically activated when gantry motion is selected.

Emergency stop push buttons shall be installed at the following positions on the crane: -

i) 1 unit inside the operator's cabin consolepositioned on the control
ii) 1 unit on the trolley platform
iii) 1 unit below each sill beam and shall be readily reached by ground operating personnel.
iv) 1 unit at the electrical control enclosure
v) 1 unit at the diesel set enclosure

Suitable anti-collision devices shall be installed on the RTG Cranes to detect the proximity of objects that are likely to cause collision. The device shall be activated in the direction of movement of the RTG Crane and shall have two settings i.e. one to give audio warning signal to the operator and the other to bring the RTG Crane to an emergency stop.

RF sensing devices to detect proximity of containers in the stacks shall also be provided. These devices shall provide warning to the operator, during gantry travel mode, when the crane is at near collision path with containers.

4.15 Lighting

The power supply for all lighting shall be single phase. The lighting system shall provide illumination to all work areas of the crane, including ladders, platforms, walkways, control cubicles, main hoist machinery, electrical control enclosure and diesel generator set enclosure and operator's cab Shallbe providedintheoperator'scabintoadjustthelightintensity in the cabin. Lighting at the girders shall be positioned to provide illumination at the chassis lane and on every row in the container stack within the operation range of the crane. The illumination on the ground measured at 6 metres away from the centre line between the two girders shall be as follows: -

i) Under the girder : at least 100 lux at the chassis lane and at every container row
ii) Under the trolley : at least 200 lux

The lighting in the electrical control cubicles shall be activated by the opening and closing of the cubicle doors. All fluorescent lamps shall be of rapid start type, and equipped with steel guards. Safe and easy access for replacement of bulbs or lamps shall be provided for all lighting fixtures. Switches for floodlights and spotlights shall be provided at the engine-starting panel and at the cabin to allow switching from either location.

For emergency use 50%lightingoftheprovinsided the operator'scabin, electrical control enclosure, hoist motor enclosure, diesel generator set enclosure, and on the trolley platform, shall be of the maintained, self-contained, battery backed emergency type.

4.16 Crane Management System

A computerised Crane Management System (CMS) complete with the necessary sensors and transducers shall be installed on each crane and workin conjunction with the ProgrammableLogicCircuit's(PLC)to provide continuousmonitoring,diagnostics,anddatacollectionthecrane's operating systems and essential components which shall at least consist of the engine(s), alternator(s), motor controls, operator control, motors, gear reducers, etc.

The system shall be based on dedicated on board ruggedised industrial PC,totally independent of the crane's PLC system and shall not cause shut down in the event of a CMS fault occurring. The system shall be capablein the future of transmitting data via a remote communication system to the main terminal management system. A dedicated U.P.S shall be provided ensuring that in the event of power loss, power to the computer is maintained before shutting it down in a controlled manner.

The system shall be capable of but not limited to the functions described in the following paragraphs.

A) Condition Monitoring: -

The status and operating data for the electrical systems and sub-systems and all the essential components which are critical to the proper function of the crane, as well as the condition of the Localized lubrication systems and wire rope lubrication system shall be monitored real-time. Any abnormality in the crane's systems and components shall be prompted and immediately displayed on the screen indicated.

Temperatures of the main hoist and trolley gear reducers and motors, engine and alternator shall be monitored continuously and displayed on the screen

whenever desired. The operating voltages, currents and speeds of all motors shall be monitored. Threshold values for warning and shutdown of respective systems and components shall be incorporated. Easy means of adjustment to the threshold values by the engineers shall be made available.

b) Control of oil and grease lubrication systems: -

The Crane Management System shall control the Localized grease lubrication systems and the wire rope lubrication systems. The lubrication systems shall

be activated at the intervals of pre-set number of containers handled by the crane or pre-set time intervals, whichever occur first.

The pre-set intervals and the amounts of oil/grease to be dosed shall be adjustable. The Manufacturer shall advise the engineers on the optimum intervals and correct amounts of oil/grease for the respective lubrication systems/components.

c) Software and Hardware: -

Software and hardware shall be of the latest technology type and fully suitable for crane applications.

4.17 Covers, Junction boxes and Enclosures

Covers, pull-boxes, junction boxes and enclosures for motors, hydraulic compartments, etc. shall be made of stainless steel plate with a minimum thickness of 2 mm.

Covers to junction boxes, inspection covers, machinery hoods etc. shall be hinged and secured with corrosion resistant, durable handles with built-in common master key locks or stainless steel wing bolts. Large junction boxes shall have double hinged covers with built-in common master key lock handles.

Junction boxes shall be protected from corrosion and mechanical damage and exposed junction boxes shall be constructed to provide a minimum enclosure standard of IP66 when installed and cables connected. Each junction box shall carry a unique identifier.

4.18 Container Positioning System

Each crane shall be designed to accommodate the sensors, guiding devices and data interchange channels required for a fully automatic container positioning system which may be part of the future Container Terminal Control System.

Appendix A

List Of Manufacturers

(LOM)

List Of Manufacturers

ShahidBeheshti Port (Chabahar) complex Development Equipment suppliers

Product	Manufacturer /Supplier	Country
Painting and protective treatments	Hempel / Arostal / Ameron	Denmark/Germany
Diesel Engine	Volvo, CAT, cummins	Sweden/USA/UK
Generator	Stamford Newage, Leroy-somer	UK/France
Brakes	Bubenzer, Siegerland	Germany
Couplings	Flender/Siegerland	Germany
Gear reducers	Flender, Brevini/PIV	Germany/Italy
Bearings	SKF, FAG/TNT	Sweden/Germany/Japan
Wire Ropes	Certex, Casar	Germany
Spreaders (complete electric design)	Bromma, RAM, Stinis	Malaysia/UK/Netherland
Rail Clip/pad system (where offered)	Gantrail, Gantrex, manufacturer	UK/Belgium/Manufacturer country
Hydraulic equipment	Mannesmann Rexroth, Vickers	UK/Germany
Lubrication system	Dropsa, Lincoln	European
Cable reels / drums	Cavotec / Specimas, StemmannTechnik	Germany/France
Cable / Energy chain system	Igus, Cavotec	Germany/Sweden
Variable speed drives	ABB, Siemens	Sweden/Germany
Motors	ABB, Siemens	Sweden/Germany
PLC	ABB, Siemens	Sweden/Germany
Electrical cables	Siemens, ABB	Sweden/Germany
Load Measurement	Philips, PAT, Ramsey	Netherland/Germany
Floodlight	Philips / Lumec-Schreder	Netherland/Germany
Air conditioners	Carrier, OGeneral/LG	USA/Japan/Korea
Electrical Components	Siemens, ABB	Sweden/Germany

Note1: For all other items that have not been mentioned, the manufacturing companies shall be wellknown with considerable amount of relevant sales in the past five years.

The other brands maybe indicated by the tenderers. However, the acceptance of the same will be confirmed by the tender holder prior to the end of technical evaluation.

Appendix B

Technical Schedules

Schedule 1.0 Weights

Weights	Tons
Crane Headblock Spreader A Frame complete Main Girder Trolley complete	

Schedule 2.0 Wire Rope Details and Factors of Safety

Main Hoist	

Schedule 3.0 Structure & Painting

Steel grade used for the structure Main Girder Trolley A Frame Bogies Bracing Country of origin of steel	
Paint System Maker Country of origin of paint Coating Systems Details (Include DFT)	

Schedule 4.0 Diesel Set + Generator

Maker Size/Power Full Load Fuel Consumption	

Schedule 5.0 Mains Power Supply

Low power plug-in supply load required as specified (KVA)	

Schedule 6.0 Tyres

Tyre details Pressure	

Schedule 7.0 Preferred Method of Delivery to site and Area Required for erection

Details of preferred method of delivery (Fully erected ,Large Block or Small Piece
Site area required for erection

Schedule 8.0 List of Spare Parts

In executing the design of the equipment and preparing the recommended consumable spare parts list, the Manufacturer shall wherever possible make use of and recommend parts that can be provided by multiple sources.

The parts shall comprise:

- Consumable spare parts for two years of operation of the crane.
- Recommended strategic spare parts such as motors, gearboxes, brake assemblies, wheels, wire ropes, electrical cables etc.
- Small strategic parts such as fuses, lamps, relays, contacts, coils, limits, brake pads, bearings, seals etc.

Ref.	Items	Number