

**MOKOLO AND CROCODILE
WATER AUGMENTATION PROJECT
PHASE 2 (MCWAP-2)**

TENDER NO 054/2024/PMID/MCWAP2/RFB

**PART C3.1
SPECIFICATION**

SECTION 31

CRANES, HOISTS AND WINCHES

PART C3.1 SPECIFICATION

SECTION 31 CRANES, HOISTS AND WINCHES

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SECTION 31**CRANES, HOISTS AND WINCHES****31.1 SCOPE AND DEFINITIONS****31.1.1 Applicable Parts of the Works**

This Section covers the Employer's requirements for all permanent cranes, hoists and winches that is included in the Works.

Section 31 is applicable to the following Parts:

- Part B2.2 (Diversion Works and Low-Lift Pumping Station); and
- Part E.2 (High-Lift Pumping Station).

This Section must be read in conjunction with Section 28 - Mechanical General, Section 38 - Electrical General, Section 37 - Painting and Corrosion Protection as well as Section 48 - Tests on Completion.

31.1.2 Scope as per Drawings

The following Drawings outline the Employer's preliminary assembly and layout requirements of the double girder electrically operated overhead travelling (DGEOT) cranes as well as the portal crane:

31.1.2.1 Low Lift Pump Station DGEOT crane

- a) 2B-C7-302 – Low-Lift Pumping Station – Section 8-8; and
- b) 2B-C7-304 – Low-Lift Pumping Station – Section 10-10.

31.1.2.2 High Lift Pump Station DGEOT crane

- a) 2E-C7-111 – High-Lift Pumping Station – Cross Sections Sheet 1; and
- b) 2E-C7-113 – High-Lift Pumping Station – Cross Sections Sheet 3.

31.1.2.3 Vlieëpoort Weir Portal crane

- a) 2B-C7-201 – Diversion Works – Boulder Trap;
- b) 2B-C7-202 – Diversion Works – Gravel Trap 1;
- c) 2B-C7-205 – Diversion Works – Sand Trap Upstream Cross Section;
- d) 2B-C7-206 – Diversion Works – Sand Trap Long Section; and
- e) 2B-C7-211 – Diversion Works – Sediment Traps Cross Section.

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These Drawings outline the general requirements of the crane installation. The Contractor is to develop the detailed design in each case, within the overall space and layout constraints indicated on the Drawings and in accordance with the overall general and particular requirements of Section 28 – Mechanical General.

31.1.3 Scope of Work

The scope of work shall include the design, supply of all materials, manufacture, shop assembly and testing, corrosion protection, delivery to Site, off-loading and installation at Site, Site painting, putting to work, testing, pre-commissioning and maintenance (other than normal operating maintenance) of the Plant, which is described in detail in Clause 31.11.

All cranes, lifting beams and hoists shall be supplied strictly in accordance with this Specification (and Drawings) and shall include the following, unless otherwise specified:

- a) Lifting hooks that shall raise and lower vertically on centre;
- b) Non-spin wire rope and fitted sheave block with swivel hook;
- c) Slack rope switch on electrically operated cranes;
- d) Load cell controlled overhead cut out;
- e) Motorised cross and longitudinal drives;
- f) Proximity limit switches on all crane motions protected in accordance with IP 65 of SANS 60529 on all electrically operated cranes;
- g) Festoon cable, tracks and mountings for cross travel on all electrically operated cranes;
- h) Push button pendant control all weatherproof and protected to IP 65 of SANS60529;
- i) Remote radio push button control;
- j) Electrical distribution box with isolator fully weatherproofed and protected in accordance with IP 65 of SANS 60529. The cabinet door(s) shall be fitted with suitable seals to prevent the ingress of water;
- k) Crane long travel rails and appropriate temporary and permanent fixings with stop bumpers at both ends;
- l) Cross travel rails with stop bumpers at both ends;
- m) Positive locking devices to store the portal crane at any point on the rails;
- n) Power supply between the isolator box and the crane distribution box. This shall include the conductor bridge rail system as well as all switch gear;
- o) Suitable weatherproof floodlights for lighting the whole area beneath the crane;
- p) Crawls, block and tackles;
- q) The complete conductors system and fixtures;
- r) Design, manufacture, delivery to Site, erection and Pre-commissioning on Site;
- s) The supervision by the Contractor or his representative for off-loading of the crane and auxiliary Plant at Works; and
- t) Operation and Maintenance Manuals which shall include drawings and copies of all shop and field test certificates.

31.1.4 Definitions

The following terms shall have the meanings given:

- a) **“Main hoist”** means the hoist mechanism provided for lifting the maximum rated load.
- b) **“Auxiliary hoist”** is a supplemental hoisting unit on the crane of lighter capacity and unusual higher speed than provided by the main hoist.
- c) **“Trolley”** is the unit which travels on the bridge rails and carries the hoisting mechanisms.
- d) **“Runway”** means an assembly of rails, beams, girders, brackets, and framework on which the crane or trolley travels.
- e) **“Walkway”** means the stationary walkway that runs the full-length of the pump station and forms an integral part of the superstructure of the building.
- f) **“Footwalk”** means the walkway with handrail, attached to the bridge or trolley for access purposes.
- g) **“Bridge”** means the main travelling structure of the crane which spans the width of the pump station consisting of girders, end trucks, footwalks, and drive mechanism which carries the trolley.
- h) **“End trucks”** are located on either side of the span housing the wheels on which the entire crane travels. These wheels ride on the runway beam allowing access to the entire length of the pump station.
- i) **“Holding brake”** is a brake that automatically prevents motion when power is off.
- j) **“Bumper”** [buffer] is an energy absorbing device for reducing impact when a moving crane or trolley reaches the end of its permitted travel.
- k) **“Clearance”** means the distance from any part of the crane to a point of the nearest obstruction.
- l) **“Rope”** refers to wire rope, unless otherwise specified.
- m) **“Span”** means the horizontal distance centre to centre.
- n) **“Emergency stop switch”** is a manually or automatically operated electric switch to cut off electric power independently of the regular operating controls.
- o) **“Limit switch”** is a switch which is operated by some part or motion of a power-driven machine or Plant to alter the electric circuit associated with the machine or Plant.
- p) **“Main switch”** is a switch controlling the entire power supply to the crane.
- q) **“Long travel”** means the crane movement in a direction parallel to the crane runway also known as “bridge travel”.
- r) **“Cross travel”** means the trolley movement perpendicular to the crane runway also known as “trolley travel”.

31.2 GENERAL DESIGN REQUIREMENTS

31.2.1 General Requirements

If the Tenderer offers his standard Plant which exceeds the specified capacity, then the crane shall be designed for this higher load.

The load capacity of the crane shall be clearly displayed on both sides of the bridge as well as on the sheave block e.g. SWL 12 500 kg.

The Plant shall be supplied with all the accessories necessary to give complete working installations including all built-in parts and anchors, rail tracks, hoists, covers and frames, operating gear, controls and safety devices and electrical control panels from and including the main isolating switch on the incoming supply.

The Contractor shall ascertain that the capacity of the main hoist is suitable for safely lifting any part of the mechanical Plant in the area serviced by the crane. Should the specified capacity of the main hoist be inadequate, the Contractor shall communicate this to the Engineer in writing prior to the commencement of the detail design of the crane.

All civil construction work in forming and preparing box outs, chases etc., to receive the built-in parts and in placing concrete around them or grouting in base plates and holding down bolts and the like shall be done by the Contractor. The Contractor shall define his requirements for such box outs; chases etc. and communicate such to the Engineer.

The Contractor shall be responsible for the coordination and proper relation of all work to the building structure and to the work of all trades. The Contractor shall verify all dimensions shown on drawings and physical dimensions of the building proper that relate to runway alignment, crane fabrication and all other requirements under this Section. During the course of construction of the building and superstructure, as-built dimensions may deviate from the intended dimensions shown on the Drawings. It shall be the Contractor's responsibility to be aware of the possible dimensional tolerances permitted for construction and to bring these to the attention of the crane supplier.

31.2.2 Operating Conditions and Climate

For climate conditions reference should be made to Part C4, Section 4.3 for Hydrological Data.

31.2.3 Double Girder Electrically Operated Overhead Travelling Cranes (DGEOT) to the Low-Lift and High-Lift Pumping Stations

The type of crane servicing the proposed Low-Lift and High-Lift Pumping Stations shall be top running (T/R) double girder bridge cranes. This means that the cranes shall consist of two bridge girders supported on two end trucks and a trolley that shall run on rails on the top of the bridge girders.

a) Low-Lift Pumping Station 12.5/2 tonne DGEOT Crane

The Low-Lift Pumping Station DGEOT crane (LLPS Crane) shall have a minimum Lifting capacity of 12 500 kg. The Contractor shall during the detail design stage confirm the required Lifting Capacities of the above DGEOT cranes and inform the Engineer of any amendments.

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Maximum hook height for the main LLPS Crane main hoist shall be 6 meters above the loading bay level at RL 909.15 and a hook travel path down to the pump well at RL 895.0 (see Drawing No's. 2B-C7-302 and 2B-C7-304).

Maximum hook height for the 2 metric tonne auxiliary hoist shall be 6 meters above the loading bay level at RL 909.15 and a hook travel path down to lowest sump pit at RL 894.660 (see Drawing No's. 2B-C7-302 and 2B-C7-304). The 2 tonne auxiliary hoist will be used for general operations and maintenance and lifting and lowering of sump pumps.

b) High-Lift Pumping Station – 12.5/2 tonne DGEOT Crane

The High Lift Pumping Station DGEOT crane (HLPS Crane) shall have a minimum Lifting capacity of 12 500 kg. The Contractor shall during the detail design stage confirm the required Lifting Capacities of the above DGEOT cranes and inform the Engineer of any amendments.

Maximum hook height for the HLPS Crane main hoist shall be 6 meters above the loading bay level at RL 917.4 and a hook travel path down to the pump well at RL 909.1 (see Drawing No's. 2B-C7-113).

Maximum hook height for the 2 tonne auxiliary hoist shall be 6 meters above the loading bay level at RL 917.4 and a hook travel path down to lowest sump pit at RL 908.42 (see Drawing No's. 2B-C7-113). The 2 tonne auxiliary hoist will be used for general operations and maintenance and lifting and lowering of sump pumps.

The DGEOT cranes are required primarily for maintenance operations in the Low-Lift and High-Lift Pumping Stations and lifting of Plant off and onto vehicular transport parked on RL 909.15 and RL 917.4 respectively in the pumping station loading bays as well as into its permanent positions.

The DGEOT cranes may also be used during the installation phase of the proposed Low- and High-Lift Pumping Stations.

The capacity of the cranes shall be sufficient to handle the specified safe working load (SWL) plus an additional 10%.

31.2.4 10 tonne Electrically Operated Portal Crane at the Vlieëpoort Diversion Works and Low-Lift Pumping Station

The type of crane servicing the proposed Diversion Works shall be a 10 metric tonne electrically operated rail-mounted type portal crane with a maximum hook height above deck level as described below and a hook travel path (down to boulder trap canal level) of RL 893.51 m from RL 909.15 downwards (see Drawing No. 2B-C7-211).

The capacity of the crane shall be sufficient to handle the heaviest of the Plant described below plus an additional 10% but shall have a Safe Working Load of not less than 10 tonnes. The maximum hook height above deck level (RL 909.15) shall be the maximum total suspended height of the Boulder or Gravel Trap Radial Gates or Trash Racks plus an additional 600 mm minimum.

Two cantilevered ends of the beam shall be dimensioned to provide an overhang of at least 2 800 mm (i.e. overhang of the hook position beyond the vertical planes of the rails). Total cross travel distance shall be at least 18 000 mm.

The portal crane is required primarily for deploying stop logs and for the handling of the radial and sluice gates as well as the trash racks and fine screens and the Plant to be hoisted from their position to above top deck level RL 909.15 and on to appropriate road transport, and vice versa. It will furthermore be required for any other maintenance operations carried out.

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The crane shall be sized and configured so that the hook can be raised high enough to pass over the primary screens' hoist gantries as they are normally deployed.

The southern cantilever shall be designed so that the crane hook can reach the midpoint of the radial gate for the boulder trap and the midpoint of the two stop logs.

If counterweights are required in order to stabilise the crane under the test load at the limits of travel, then these shall be of solid material; i.e. water ballast is not acceptable. If the counterweight is bolted on, then this shall be of metal or reinforced concrete slabs.

A cow catcher shall be provided at each of the four wheels. The cow catcher shall be designed to push a person's foot and, thereby, prevent injury during movement of the crane in the long travel direction. The cow catcher shall, in addition, be provided with a flat, horizontal top surface onto which a person can climb if required.

The long travel, i.e. the Portal Crane legs' wheel movement; shall be stopped approximately one metre before the end of the rail beam so that a person can safely stand beyond that position.

An appropriately sized auxiliary hoist shall be used for cleaning operations of the trash racks and fine screens.

The portal crane may also be used during the construction for the installation of gates, racks and screens as well as any hydro mechanical Plant.

31.2.5 Monorails and Crawl Beams

The current preliminary Drawings issued do not include any crawl monorails or beams.

Inside the Low- and High Lift Pumping Stations, the Contractor shall ensure that the need for crawl beams are avoided and that all Plant are accessible through the DGEOT with auxiliary hoists.

At the Diversion Works, the Boulder and Gravel Scour Gates, stop logs (boulder and gravel trap Canals) as well as Trash Racks are accessible through the portal crane.

Monorails for operation and maintenance of fine screens, stop logs in the sand trap canals and Sluice Gate (downstream end of Flushing Canal) shall be provided in liaison with the designer of the Gates.

31.3 MECHANICAL DETAILS AND REQUIREMENTS

31.3.1 General

The cranes and hoists shall be, as far as possible, of a manufacturer's standard type with long and cross travel and shall comply with the Occupational Health and Safety Act (Act 85 of 1993) and its regulations.

The minimum hook to deck level clearance shall be as indicated on the Drawings accompanying the Tender documentation.

The limits at which the crane can safely handle loads of full load capacity shall not be less than those shown on the Drawings.

31.3.2 Electrical Cranes and Hoists

The electrically powered crane shall be designed in accordance with *Fédération Européene de la Manutention (FEM), Rules for the Design of Hoisting Appliances, Section 1, Second Edition, 1970* with the following duty factors:

Structures	Cranes, Hoists, etc.	
Class of utilisation	A	
State of loading	2	
Group	3	
Mechanisms (all motions)		
Class of operation	V _{0.5}	V ₂
State of loading	3	2
Operating Group Classification	1A _m	2 _m

31.3.3 Factors of Safety

All parts of the cranes, hoists and lifting devices shall be designed to a factor of safety of at least 4 when working under full load conditions. Lifting ropes and attachments shall have a factor of safety of at least 6 when working under full load conditions. The term "full load" shall be the maximum working load rating specified for each hoist.

31.3.4 Mechanical Chain Blocks

Hand operated hoists and runway beams shall be in accordance with BS EN 1993-6:2007 and BS EN 13157:2004 where applicable. Chains shall be in accordance with BS 1663:1950 and hot-dip galvanised in compliance with Section 37 - Painting and Corrosion Protection.

31.3.5 Hooks and Shackles

The hook assembly shall be carried on antifriction bearings to permit free swivel under rated capacity load. The hook shall be fitted with a spring-loaded safety latch to prevent the disengagement from the hook of the lifting wire, chain or rope to which the load is attached.

The crane hook shall fit freely onto the lifting point of all grappling- and lifting beams / cradles used to lift the fine screens, gates, pumps, etc., in the specific Portion of the Works serviced by that particular crane.

The following standards shall apply to hooks and shackles:

- a) Ramshorn hooks DIN 15402 Part 2;
- b) Standard hooks DIN 15401 Part 2; and
- c) Shackles BS EN 13889:2003.

31.3.6 Runway Beams

Runway beams and long travel rails shall be installed in accordance with the Drawings. The long travel rails for the portal crane shall be set flush with the deck and all rails shall be installed on the centre lines as indicated on Drawing No's 2B-C7-211. The end of the rail at the north eastern side shall be provided with a protective cage formed from DN 150 steel tubing which will form a primary barrier preventing damage by vehicle transgress.

The cranes shall clear all walls and other constraints (as shown on the Drawings) by a minimum of 100 mm.

31.3.7 Rails and Resilient Pad

All long and cross travel rails shall be in accordance with DIN536-1 (or equivalent); i.e. flat-bottomed rails and assembled as per German Standard VDI 3576 (or equivalent). Rails shall be installed complete with end stops, clamps, anchor bolts, fish plates etc. and shall be designed to permit expansion and contraction.

The runway rails shall be secured to the runway beams using specially designed clips and HSFG bolts suitable for the size of crane rails to be used. The rail clips should be installed in a staggered arrangement with 600 mm minimum and 750 mm maximum distance from centre-to centre. Rail clips should be capable of allowing lateral adjustment to the rail to facilitate initial alignment and subsequent realignment. However, the adjustment should be limited to the size of the girder in order to avoid excessively eccentric application of the vertical wheel load to the girder, which could produce transverse bending stresses in the web and the flange-to-web weld.

All rail section lengths shall be welded together to give a continuously welded rail between expansion joints, the welded method shall be either by Flashbutt (resistance) or Aluminothermic method. The Contractor shall submit the necessary Welding Procedure Specification (WPS) and Welding Procedure Qualification Record (WPQR) for approval by the Engineer before commencing with the works.

Proprietary resilient soft mounting pads should be placed under the runway rails to allow for redistribution of concentrated wheel load, reducing impact, vibration and noise, and eliminate of fretting action. The pads shall be manufactured from a synthetic elastomer especially resistant to wear, shear and crushing as well as oil, grease, ozone, and ultra violet rays. The pad shall be reinforced using a high strength galvanised steel strip that covers at least 90% of the width of the pad, and fully vulcanised to the rubber.

Where applicable runway rails will be grouted into position in pre-formed slots after alignment on pre-installed bed plates (primary built-in parts) by the Contractor. The pre-installed parts, with details, shall be supplied by the crane manufacturer for installation by the Contractor.

31.3.8 Bridge Girders

Crane bridge girders shall consist of welded sealed sections with sufficiently reinforced construction, of approved design and supported on the end trucks and having ample stiffness in all directions. The maximum vertical deflection of the girders shall not exceed 0.002 times the effective span with the trolley carrying full load positioned at the centre of the span. The Contractor shall submit the necessary Welding Procedure Specification (WPS) and Welding Procedure Qualification Record (WPQR) for review by the Engineer if requested.

31.3.9 Trolley

The trolley shall be fabricated as an integral part of the hoisting mechanism or as an assembly bolted to a unit hoist. The trolley frame shall be of welded or cast steel construction. It shall furthermore be of rigid construction designed to transmit the imposed load to the bridge girders without undue deflection.

The trolley deck shall as far as practicable be covered with chequer plate for maintenance and access purposes. Hardened, heat treated, double-flanged steel wheels with anti-friction bearings shall be provided. The trolley shall be motor-driven through a suitable gear reducer. An electric brake shall be furnished on this drive. The drive shall be shock free on starting and stopping. The arrangement and details of the trolley shall be subject to the approval of the Engineer.

31.3.10 End Trucks

Each end truck shall be supplied with large diameter, heat treated, double-flanged steel wheels and shall be of the fixed axle type equipped with anti-friction bearings. The end trucks shall be one piece welded construction bolted to the bridge beam and designed so that the weight of the crane and its load is equally divided between the wheels. These shall incorporate suitable drop stops to limit the fall of the crane to less than 25 mm in the event of breakage of a track wheel, bogie or axle bringing the crane to a safe stop.

31.3.11 Bumpers

The bumpers shall have sufficient energy absorbing capacity capable of stopping the crane at each extreme end of the crane travel.

31.3.12 Hoists

The hoist units shall be of the electric top running motorised type and trolley combined in one unit providing accurate load positioning with a load capacity as specified in Clause 31.2, and lift range as indicated on the Drawings. The hook shall raise and lower vertically on centre.

Suitable load cells (minimum 125% of specified capacity) shall be incorporated in the main hoist design to reflect the true load being manipulated by the crane at any time.

The hoists shall have at least two independent means of braking, a holding brake which shall be applied automatically on power removal and controlled braking to prevent speeding when lowering the load.

31.3.13 Drums and Pulleys

The rope grooves in drums and pulleys shall be machined as follows:

The diameter of the drum measured at the bottom of the groove shall not be less than that given in the table below which is based upon the rope speed not exceeding 60 m per minute.

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**TABLE 31/1
DRUM DIAMETERS**

Rope construction	4 x 37	6 x 19	6 x 24	6 x 37	6 x 61
Drum diameter	27D	24D	22D	19D	17D

D = Diameter of rope

The contour at the bottom of the grooves shall be circular over an angle of approximately 120°.

The radius of the groove shall be larger than the radius of the rope and not less than that required by BS EN 12385-1:2002+A1:2008 or equivalent standard. The depth of the groove shall not be less than:

- Drums: 0.33 x diameter of rope;
- Pulleys: 1.05 x diameter of rope; and
- The edges shall have a radius.

The grooves shall be finished smoothly and be free from surface defects liable to damage the rope. The grooves on the drum shall be so pitched that there is a clearance of not less than 1.6 mm between the neighbouring turns of rope for 13 mm diameter rope, 2.5 mm for 13 mm to 28 mm and 3.2 mm for rope diameters above 28 mm.

The drums shall be of sufficient length to take the full amount of rope without overlapping when the load is at its highest position. When the load is in its lowest position, there shall be at least two full turns of rope remaining on each drum.

The method of anchoring the ropes, as described below, shall be such that in the event of a rope unwinding completely there shall be no danger of it becoming freed from the drum. The rope anchorage shall be readily accessible.

Pulleys in the sheave block shall be equipped with close-fitting guards that will prevent ropes from becoming fouled when the sheave block is lying on the ground with ropes loose.

All running pulleys shall be equipped with means of lubrication. Permanently lubricated, sealed and/or shielded bearings will be acceptable.

The inclination between the rope and the plane perpendicular to the axis of the drum or pulley shall not exceed 1 in 12.

Rope drums shall be adjustable for rope stretch if balancing pulleys are not used.

Particular attention shall be paid to the design and positioning of the rope drums(s) to ensure a centre lift over the lifting points for the sluice gates and fine screens when raising and lowering these items of Plant and that the ropes and sheave block do not foul the wall at the extreme point of lowering.

31.3.14 Sheave Block

The sheave block shall be designed to suit the load.

31.3.15 Rope

Ropes shall be capable of supporting the maximum loads during lifting and lowering operations. The minimum breaking strengths of the ropes shall not be less than 6 times the respective maximum load. The ropes shall be impregnated with grease to resist corrosion and wear.

Where more than one fall of rope is used for the support of the load, the tension in the various parts shall be equalised by means of a pulley or equalising bar.

Eye splices, sockets, thimbles and rope anchorages shall be capable of withstanding 90% of the guaranteed breaking strength of the ropes to which they are attached. The hoisting ropes and any slings shall be provided with a test piece to be cut for testing to destruction.

The rope end(s) shall be anchored by a clamp securely attached to the drum, or by a socket arrangement in an approved manner such that the tension of the rope comes on the anchor points as near tangentially as possible. Anchoring shall be of captive type, easily detached for changing and repair. Rope end(s) shall be tapered and fused.

The Contractor shall ensure that all the spin in the wire rope is removed prior to final fixing of the rope to the crane body or drum(s). To achieve this "spin free" state, he shall inter-alia, lower the sheave block to its bottom extreme as part of the installation procedure. All additional costs incurred by the Contractor to rectify spinning of the ropes and resultant damage during or after installation shall be for his account.

31.3.16 Crawl Beams (where applicable)

Crawl beams shall be designed to BS EN 1993-6:2007 including UK National Annexure to Eurocode 3. The capacity of each beam shall be displayed as described in Clause 31.2.1. Each crawl beam shall be equipped with removable stops at each end, a manually operated geared crawl with operating chain which shall correspond with the beam capacity and a manually operated block and tackle type chain hoist of the specified capacity.

31.3.17 Crane Speeds

The speeds of the various motions of the crane shall be as follows:

- a) Long and Cross travel - creep: 5 m/min;
- b) Long travel - fast: 35 m/min to 40 m/min;
- c) Cross travel - fast: 18 m/min to 25 m/min;
- d) Hoist - creep: 1.0 m/min to max 2.0 m/min; and
- e) Hoist - fast: 6 m/min to 10 m/min.

All hoisting motions shall be electronically "ramped" so as to minimise impact / acceleration loadings (see also Clause 31.4.9).

31.3.18 Auxiliary Hoists

A 2 ton auxiliary hoist unit shall be provided on the cranes for the purpose of handling Plant of lighter capacity and fine screens at the Diversion Works. This unit shall be mounted on the same trolley as the main hoist and shall be appropriately sized for handling one fine screen containing 80 kg of trash at a time, water cooling pumps / motors and smaller valves for general maintenance and operational use.

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The auxiliary hoist shall comply in all respects with the general requirements of this Section with the only exception that it does not require a load cell indicator. The lifting ranges shall be equal to that of the main hoist.

31.3.19 Gearing

Gears shall be designed so that all stresses are within the permissible limits when the hoists are handling the maximum load. Spur gears shall be of high-grade steel with precision cut, full depth teeth for accurate fit and splined for fitting to the mating gear. All gears shall be quiet in operation when rotating in either direction. The gears shall have a factor of safety of not less than 6 under operating conditions. For determining this factor of safety, the formula given in BS 436 or equivalent standard shall be adopted. If the gears are based on BS 436 they shall be calculated for not less than 4 working hours per day.

Where worm gearing is used as a first motion drive, it shall be at least equal to BS 721-2:1983 or equivalent standard and have the same lead and start time rating as the motor and the temperature rise of the oil bath shall not exceed 37°C above the ambient temperature. Worm wheels shall be of bronze with steel worms.

All gear wheels shall, where practicable, be a forced fit on the shaft and shall in addition be adequately secured to prevent any relative motion between the wheel and the shaft. Where gears and couplings are secured in position by means of keys, the keys shall be easily accessible for tightening or withdrawal. All keyways shall be machine cut and shall be at least equal to BS 46-3:1951 or equivalent standard. Couplings and collars shall be of the shrouded or protected type, free from projections of any kind. All shafts shall be of adequate diameter and of suitable material for the purpose and shall be turned where necessary. Where shoulders occur, they shall be provided with adequate fillets.

Gear-train assemblies shall be carried on antifriction bearings and enclosed in the hoist frame casting. The assemblies shall operate in a sealed oil bath. Frame casting shall be provided with lubrication fittings and inspection ports.

31.3.20 Canopy for Hoist Unit

The hoist units shall be covered by a weatherproof canopy to protect it from dust and rain, regardless whether it is installed indoors or outdoors.

The canopy shall be manufactured from aluminium or stainless steel. Its design shall incorporate lockable panels on the sides and at the top, which can hinge open to allow access for maintenance. Hinges shall be of stainless steel. The panels shall be lightweight in order to facilitate easy handling. Built-in struts shall be provided to keep flip-up covers in the open position.

31.3.21 Footwalks

Access ladders with safety cages shall be provided at both ends of the pumping stations, typically as indicated on the Drawings, allowing access to access platforms or the concrete roofs of the rooms inside the pumping station from floor level. Further access to the crane for maintenance purposes shall be with a ladder that forms an integral part of the crane bridge, to one of the footwalks. The conductor power rail system shall, from a safety point of view be secured on the opposite side of the building.

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For the portal crane, and access ladder with safety cage shall be provided, typically as indicated on the Drawing. The access trapdoor, if any, shall be fitted with a catch to lock it in the open position.

Full-length footwalks shall be provided on both sides of the crane bridge for access to the festoon cables, floodlights and to facilitate easy access to all maintenance points and electrical Plant. A cross-over platform secured to the trolley shall be provided between the two footwalks so as to allow safe access to the trolley between the two footwalks.

Footwalks shall be furnished complete with hand and knee railings and kick plates as required by the OHS Act and its regulations. The footwalks shall be provided such that personnel standing on them will not be exposed to the danger of colliding with obstructions due to the movement of the crane.

Footwalks shall be located to give headroom of not less than 1 990 mm. Footwalks shall be of rigid construction and designed to sustain a distributed load of at least 75 kg per square meter. Footwalks shall have a walking surface of anti-slip type, i.e. checker plate or similar and shall be continuous and permanently secured. Drainage holes of minimum 20 mm diameter shall be provided at the required locations to prevent the collection of water on footwalks and or platforms and the prevent corrosion.

Supply and installation of these footwalks, ladders and platforms form part of this Section.

31.3.22 Guards

If hoisting ropes run near enough to other parts to make fouling or chafing possible, guards shall be installed to prevent this happening.

Exposed moving parts such as gears, set screws, projecting keys, pulleys and reciprocating components which might constitute a hazard under normal operating conditions shall be guarded to prevent this happening.

31.3.23 Lubrication and Maintenance

Adequate provision shall be made for grease gun and oil lubrication and all lubricating points shall be easily accessible. Grease nipples shall be of the stainless steel button head type (1/8" BSP) and shall, together with oil filler caps or plugs, be painted red for easy identification.

Maintenance procedures shall be in full compliance with the Occupational Health and Safety Act (Act 85 of 1993) and its regulations.

Effective means shall be provided for lubricating all moving parts with either oil or grease.

Lubrication of all lifting ropes shall be in accordance with Section 37 - Painting and Corrosion Protection.

Refer to Clause 31.11 for services and maintenance required during period of initial use by the Contractor.

31.3.24 Bolts and Nuts

All exposed fasteners, including those used for the fixing of proprietary items to the crane girders and bridge, shall be of stainless steel grade 304 or better. Where strength requirements prohibit this, bolts shall be hot dip galvanised in accordance with SANS 121 and shall comply with Section 28 – Mechanical General.

31.3.25 Chevrons

For the portal crane, suitable luminous type chevrons shall be painted, or mounted with stainless steel bolts, on the two sides facing the direction of long travel of each portal frame leg. The chevrons, to be mounted on the portal legs, shall extend 2 m high from the bottom of the leg.

Suitable chevrons shall be neatly painted in a diagonally black-and-yellow stripe pattern on both sides of the sheave blocks of all cranes.

31.4 ELECTRICAL DETAILS AND REQUIREMENTS

31.4.1 General

The electrical systems of the crane and hoists shall be in accordance with Section 38 – Electrical General and as further described hereunder.

The electrical Plant shall comprise the operating motors with their controllers and resistances, brake-magnets, limit switches, lighting, main switches, fuses, anti-condensation heaters, crane bridge conductors and the collectors required for supplying power to the crane.

Control systems shall be designed to achieve the operational requirements stated. In particular the controllers shall allow smooth operation without jerk or snatch on all motions from standstill, each controller being provided with an adequate number of steps in either direction to achieve smooth acceleration or retardation.

All components of the control system shall operate with adequate safety margins to ensure reliable operation under all conditions of service with the minimum of maintenance.

31.4.2 Power Supply

The power supply available is 400 volt, 3 phase, 4 wire, 50 Hz.

The main isolator box with isolator shall form part of the general electrical installation to be provided by the Contractor. Cabling from this isolator box to the crane forms part of the scope of work for the components of this Plant item.

31.4.3 Power Transfer to Plant

All isolators for power transfer systems shall be heavy duty and suitable for outdoor service.

31.4.4 Crane Bridge and Runway Electrification

Electrical supplies to the portal crane shall be by means of a trailing cable system. The transfer system shall further be located along the long travel rail on the opposite side to the vehicle access (as indicated on the Drawings) in order to avoid damage caused by traffic coming onto the working area below the crane. A cable trailing trench as indicated on the Drawings shall be supplied to the requirements of the crane Supplier.

Power supply to the runway electrification of travelling cranes in the pumping stations shall be by means of bridge conductors and collector system. The transfer system shall further be located along the runway rail on the opposite side of the pumping stations to the access ladders as described above.

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The length of the power transfer mechanisms shall enable the crane to travel the full length of the area served by the particular crane.

The minimum requirements for the power transfer system, regardless of the type and crane location, shall be:

- a) Minimum of four conductors with separate earth conductor. Should it be required to have a neutral conductor due to possible phase imbalance, this must be provided;
- b) Weather resistant and suitable for outdoor service in a humid atmosphere;
- c) Trailing cables shall be provided with an automatic cable spooling reel with tensioning device and with a strain restrictor at each end of the cable;
- d) Conductor bars shall be one piece, copper conductor complete with thermoplastic insulation covers and end covers to provide adequate personnel safety features and shall be protected against falling objects. Protection covers shall be easily removable for maintenance purposes;
- e) The conductor rail systems shall be through longitudinal conductors with moving pick-up arms having physical and electrical properties complying with BS EN 50149: 2012. Collector shoes and assemblies shall be spring-loaded;
- f) A triple pole, metal clad, airbreak isolator switch incorporating "On", "Off" and "Earth" positions, shall be supplied for isolating the main power supply to the crane and for earthing the longitudinal conductors;
- g) All isolators for power transfer systems shall be heavy duty and suitable for outdoor service; and
- h) Conductors shall be accurately aligned to ensure positive electrical contact over the full length between the collector and the conductor.

31.4.5 Hoisting Trolley Electrification

Power supply to the hoisting trolley shall be by means of a multi-stranded, festooned flexible flat cable suspended from a catenary system on C-track. The festooned cable shall be connected to the termination box at one end of the bridge and to the pendant control unit on the C-track.

31.4.6 Electrical Distribution Box

A lockable 316L electrical distribution box, protected in accordance with IP 65 of SANS 60529:2013, shall be supplied and installed on the crane by the Contractor. It shall contain an isolator having provision for padlocking in the "OFF" position. It shall also have provision for the hanging of a "MAN WORKING" notice, which shall be included with the supply of the crane.

Three red indicating lamps, marked L1; L2 and L3 (one per phase and which shall illuminate when the supply is on), shall be provided on the distribution box. These indicating lamps shall be of the 230 V LED multi-cluster type and shall be clearly visible in normal daylight.

A danger sign shall be provided and fixed onto the distribution box.

31.4.7 Electric Motors

All motors shall be of the totally enclosed fan cooled squirrel cage type. Their characteristics and construction shall be suitable for outdoor crane service.

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Hoist motors shall be capable of continuous operation under full load at normal speed as well as limited duration operation on "inching" duty.

The three-phase motors of the crane shall have the correct phase rotation of the power supply after the Site wiring and connections have been completed.

Separate motors shall be provided for the hoisting, long and cross travelling motions, each motor being independent of the others.

31.4.8 Control Panel

All crane control gear shall be enclosed in a lockable 3CR12 cabinet mounted in an approved position on the crane in such a manner as will facilitate easy maintenance and inspection.

Control and operating circuit voltages shall not exceed 230 V AC. All motor control and starters shall make use of circuit breakers and thermal overloads. The supply to the control panel shall be 380 V plus neutral.

Contactors shall include for each drive a triple pole electrically and mechanically interlocked stator reversing contactor fitted with self-resetting adjustable inverse time characteristic over-current relays.

The electrical load on the three phases shall at all times be balanced.

31.4.9 Pendant and Remote Radio Control

The cranes shall be operated by means of a weatherproof pendant control by an operator standing on operating levels as indicated on the Drawings. The pendant shall be capable of being positioned at any point over the length of the girder independent of the trolley. The pendant unit shall be suspended from an independent wire rope. All the features required of the pendant control in this section shall also apply to the remote radio control. Precise control of all functions is required to facilitate the accurate positioning of heavy components.

The complete pendant with all switches, indicators, etc., shall be weatherproof to IP 65 of SANS 60529:2013.

Long and cross travel motions of the cranes shall be arranged so that these motions may be driven simultaneously or separately without causing shock to or vibration of the crane rails. It shall not be possible to travel or traverse while raising or lowering the main hoist.

The pendants shall be provided with a lockable on/off switch with appropriate indicator light.

Controls shall be interlocked to prevent dual activation of functions and each shall be clearly marked with its function. Labels that only rely on adhesive to stay in position shall not be acceptable. All motions shall be controlled by non-latching control buttons.

All motion control push buttons shall be of the two stage type. The initial depression of the button shall select the creep speed and full depression of the button shall select fast speed. Control features shall be included to prevent fast speed being selected without first having accelerated the Plant in the slow speed range.

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Where applicable, the following minimum controls shall be provided:

- a) On/Off switch;
- b) Main Hoist Up/Down - Slow/Fast push buttons;
- c) Auxiliary Hoist Up/Down - Slow/Fast push buttons;
- d) Cross Travelling Left/Right - Slow/Fast push buttons;
- e) Long Travel Left/Right - Slow/Fast push buttons;
- f) Emergency Stop mushroom head push button; and
- g) Floodlights On/Off.

For outdoor cranes, provision shall be made to store the pendant in a lockable weatherproof cabinet on the crane to prevent environmental damage when not in use. Refer Clause 31.4.12.5.

The load cell shall be able to be set so that the hoist motor trips out in the event the hook load exceeds the crane SWL, or exceeds such smaller load as may be desirable for security against instantaneous overload during hoisting.

During crane testing the load cell shall be able to be reset to 130% of SWL (via a key switch located in the crane hoist DB) to allow test loads of 125% SWL to be lifted.

In all cases, the directional orientation of the pendant horizontal motion controls (i.e. upstream / downstream; left / right) in relation to the appropriate crane shall be indicated by colour coding on the front panel of the pendant and on the crane. The colour coding on the crane shall be clearly visible from anywhere within the reach of the pendant and shall clearly contrast with the colour of the element on which it is mounted. Colour coding on the crane structure shall be by means of bolted-on metal plates according to the following colour codes:

- a) Upstream: Arctic Blue;
- b) Downstream: Brilliant Green;
- c) Left (looking in direction of flow): Golden Brown; and
- d) Right (looking in direction of flow): Signal Red.

31.4.10 Cabling

The cabling system on the crane shall be neatly routed and enclosed in non-corrodible ducts or cable trays with covers, securely fixed to the crane frame. Brackets, fasteners and cable tie-down straps shall also be of non-corrosive materials. Plastic type cable ties are not acceptable. All cables entering electric motors shall be protected in accordance with IP 65 of SANS 60529:2013, supported and sealed by means of a metal cable gland. The armouring shall be clamped between substantial tapered sections which form an integral part of the gland.

31.4.11 Wiring Code Numbers

Code numbers shall be clearly marked on all electrical cables, cable cores, wiring and terminal blocks inside switchgear panels and field devices, to enable maintenance staff to trace faults easily. The wiring diagrams to be supplied with the Operation Manual as specified in Section 1 - General shall have the same code numbers marked on them and shall be strictly in accordance with the actual wiring on the crane.

A laminated A3 sized print of the wiring diagram shall be fixed inside the electrical distribution cabinet panel for easy reference.

31.4.12 Controls and Safety Devices

31.4.12.1 General

The isolator switch shall be a quick break change over type to isolate all crane conductors and it shall be possible to lock and switch in the isolated and earthed positions.

The crane structure and metal cases of all electrical Plant, including conduit and trunking shall be effectively earthed. The Contractor shall supply longitudinal and crane bridge conductors for the earthing Plant.

Motion warning devices, both audible (buzzer) and visual (rotating lights) shall be provided and shall operate continuously with either bridge or trolley motion.

31.4.12.2 Brakes

Each motor(s) of each motion shall be provided with an externally adjustable, multiple friction electro-magnetic disk brake, which shall apply automatically when the power is interrupted. The brakes shall be arranged to release only after a time delay to ensure that the load is held by the drive motor before the brakes are released. There shall be no slipping of loads when the drive motor is stopped or the electricity supply fails.

31.4.12.3 Limit Switches

Over-hoisting and over-travelling limit switches shall be provided for all crane motions. All limit switches shall automatically reset allowing an opposite directional movement to be selected to that which activated the limit switch.

All lifting motions shall be equipped with slack rope and overload devices to cut out the hoist, preventing further rotation of the drums should the load jam for any reason while lowering or rising. This limit switch shall act as an upper limit switch and shall also prevent lowering the hook below a predetermined lower position by interrupting the hoist motor control. These over-travel limit switches shall be of the double protection type with automatically self-resetting action.

Creep speed only shall be available after operation of the over-travelling limit switches for long and cross travel motions, which will allow the crane to approach the end stops slowly.

A stack rope detector shall also be installed that detects ropes crossing over on the drum.

Hoists shall also be provided with an overload switch that stops the hoisting operation when the lifted load exceeds the rated working load limit of the hoist.

31.4.12.4 Lighting

At least two adjustable, waterproof floodlights shall be provided under the footwalks, which will enable safe operation at night or when required. These shall be suitably positioned to illuminate the whole area underneath the crane and down the openings to be serviced by the crane as to eliminate shadows. Facilities shall be provided for the easy replacement of lamps for maintenance purposes. Mounting brackets of the floodlights shall be of rigid construction as to avoid shuddering when the crane is in motion.

31.4.12.5 Weather Protection and Safety Guards

The crane shall be weatherproof regardless of whether it is intended for outdoor use or not.

The crane electrical distribution boxes and limit switches shall be weatherproof to IP 65 of SANS 60529:2013 and all moving machinery, including electric motors, shall be guarded to the satisfaction of the Engineer. Guards, however, shall be easily removable for access and maintenance purposes.

Since the cranes will work in a humid atmosphere, all external electrical fittings forming part of the electrical distribution panels shall be protected in accordance with IP 65 of SANS60529:2013. Push buttons shall be covered with rubber hoods. Isolators, switches and instruments mounted on the panel and limit switches shall have the necessary O-rings or rubber bushes for protection against a moist atmosphere. A space heater shall also be provided in the panel cabinet.

The crane shall be furnished with a weatherproof 3CR12 cabinet in which to store the operating pendant when the crane is not in use.

31.4.12.6 Lightning Surge Protection

All electronic and other Plant prone to lightning surge damage shall be protected in accordance with the guidelines detailed in the CSIR report No. *Elek - 165 – “a lightning protection guide for electronic installation”*.

All power and signal circuits shall be designed to separately cope with 65 kA, 5 kV, 1/50 microsecond pulses (0.5 joule), repeated 20 times per burst of pulses in a short period of time (of the order of 20 seconds).

Earth connection for lightning protection Plant shall have a minimum conductor section of 70 mm². A direct earth connection cable route to the building earth shall be provided.

31.5 CORROSION PROTECTION

All Plant supplied under this section shall conform to Section 37 - Painting and Corrosion Protection and Section 28 – Mechanical General.

The crane hoist units shall be completely weatherproof under all weather conditions applicable to the Site and the steelwork designed and detailed so as to obviate the possibility of rainwater entrapment prejudicing the life of the corrosion protection system employed. All control devices, pendants and electrical junction boxes shall be protected from the environment.

31.6 MATERIALS

See Sections 28 and 38 - Mechanical General and Electrical General respectively.

The following materials shall be used for the manufacture of hoist structures:

- a) Indoor and outdoor crane structures: coated mild steel; and
- b) Indoor and outdoor crawl beams: mild steel.

31.7 INSPECTION AND QUALITY CONTROL

Inspection and quality control shall be in accordance with Sections 28 and 38 for Mechanical General and Electrical General respectively.

31.8 OPERATION AND MAINTENANCE (O&M) MANUALS

Submission of O&M Manuals shall be as required under Clause 48.9.

31.9 FACTORY ACCEPTANCE TEST (FAT)

Testing the crane shall be strictly in accordance with SANS 4310:2002.

The crane shall be completely assembled for functional tests and inspection at the manufacturer's works.

Full mechanical (including welding preparation and welding) and corrosion protection inspection of the items shall be carried out at the manufacturer's works in the presence of an Inspector appointed by the Engineer. Workmanship and dimensional correctness shall be checked prior to corrosion protection procedures.

Preference is given to the load test being carried out in the manufacturer's works by his staff and with the test load he provides. If the Contractor, however, wishes to perform the load test at Site, then he/she shall be responsible for providing the test load (Working load + 25% overload) and arranging for such tests to be witnessed by the Engineer.

The following tests are required:

- i) All crane motions shall be tested under loads of 100% and 125% of the rated capacity for each hoist on the crane, and the crane must be able to safely handle the load equal to 125% of the rated capacity;
- ii) All limit-switches, brakes and other protective devices shall be tested when the crane is carrying 100% of the rated capacity;
- iii) Structural deflections shall be measured accurately with loads of 100% and 125% of the rated capacity and shall not exceed the allowable deflections specified under Clause 31.3.8;
- iv) The load shall be travelled over the full length of the bridge and trolley runways during the 100% and 125% load tests; and
- v) During crane testing the load cell shall be able to be reset to 130% of SWL (via key switch located in the crane hoist DB) to allow test loads of 125% SWL to be lifted.

The manufacturer shall provide a certificate of examination and test that shall be signed by the Engineer or his/her representative who witnessed the test.

The electrical installation of the completely assembled and installed crane shall be tested at Site for compliance to SANS 10142.

31.10 STORAGE, HANDLING AND TRANSPORT

Storage, handling and transport of Plant shall be in accordance with Sections 28 and 38 for Mechanical General and Electrical General respectively.

31.11 INSTALLATION AND PRE-COMMISSIONING

The Contractor shall be responsible for the installation of all Plant supplied in terms of this Section as well as for adjustments to ensure proper functioning of the complete unit as part of the pre-commissioning process.

The Contractor is allowed to commission and use the crane during construction under certain conditions as stipulated in Clause 48.5.2 of Section 48 – Tests on Completion. The final Tests on Completion shall be done in terms of Section 48 of the Specification.

31.12 APPLICABLE SPECIFICATIONS

The following Standards and Codes of Practice are referred to in this Section:

Fédération Européene de la Manutention (FEM), Rules for the Design of Hoisting Appliances, Section 1, Second Edition, 1970.

South African National of Standards

SANS 44:2009	:	Welding Consumables
SANS 121	:	Hot-dip galvanised coatings on fabricated iron and steel articles
SANS 142:2012	:	Narrow Elastic Fabrics and Strip
SANS 1431	:	Weldable Structural Steel
SANS 10044	:	Welding
SANS 1700	:	ISO metric precision hexagon-head bolts, screws and nuts (coarse thread medium fit series)
SANS 4310:2002	:	Cranes – Test Code and Procedures
SANS 60529:2013	:	Degrees of protection provided by enclosures (IP Code)

British Standards Institution

BS EN 50149:2012	:	Railway applications. Fixed installations. Electric traction. Copper and copper alloy grooved contact wires
BS 46-3:1951	:	Keys and keyways and taper pins. Specification for solid and split taper pins for general engineering purposes
BS 970-1:1996	:	Specification for wrought steels for mechanical and allied engineering purposes. General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels
BS 436-5:1997	:	Spur and helical gears. Definitions and allowable values of deviations relevant to radial composite deviations and runout information
BS 721-2:1983	:	Specification for worm gearing. Metric units
BS EN 1993-6:2006	:	Eurocode 3. Design of steel structures. Crane supporting structures
BS EN 1677-5:2001	:	Specification for higher tensile steel hooks for chains, slings, blocks and general engineering purposes
BS EN 13889:2003	:	Forged Steel Shackles for General Lifting Purposes
BS EN 13157:2004	:	Cranes. Safety. Hand powered lifting equipment
BS EN 12385-1:2002	:	Steel Wire Ropes. Safety and General Requirements
BS 1663:1950	:	High Tensile Steel Chain Grade 40 for Lifting Purposes

German Institute for Standardisation

- DIN 536-1 : Crane Rails, Hot Rolled Flat Bottom Crane Rails (Type A)
 DIN 15400 : Lifting hooks, materials, mechanical properties, lifting capacity, stresses
 DIN 15401: Part 2 : Lifting hooks for lifting appliances, single hooks
 DIN 15402: Part 2 : Lifting hooks for lifting appliances, rams horn hooks (double hooks)

American Welding Society

- AWS D14.1 : Welding of Industrial and Mill Cranes

American Society of Mechanical Engineers

- ASME HST-4 : Performance Standard for Overhead Electric Wire Rope Hoists
 ASME B30.2 : Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)

South African Electrolytic Corrosion Committee

Code of Practice No. SAECC/1

ANSI B31.3

When reference is made to a Code of Practice, Specification or Standard, the reference shall be taken to mean the latest edition or replacement at time of tender of the Code, Specification or Standard; including addenda, supplements, modifications and revisions thereto. Where a previous version is intentionally used, it will be indicated as such. Where reference is made to a Code, Specification or Standard that has subsequently been withdrawn and not replaced, the intended content will remain relevant unless confirmed otherwise in writing by the Engineer.

31.13 SPARE PARTS REQUIREMENTS

The Contractor shall list and price the spare parts considered to be necessary as required for the continued operation of all mechanical, electrical and electronic Plant based not only on a reliability analysis of the Plant, but also on the reliability and availability of local suppliers of spare parts. The lists shall also include all long lead maintenance items and special maintenance tools that will be required during the maintenance of the plant by the Contractor. The lists of additional critical spare parts must be submitted to the Engineer prior to achieving RFTO.

The total amount for spares derived from for each part of the Works shall be carried forward to the Bill of Quantities. A provisional sum will be allocated in the Bill of Quantity for the complete list of spare parts as listed by the Contractor.

31.14 MEASUREMENT AND PAYMENT

The rates provided for under this Section shall not include for the general obligations, Contractor's Equipment and work deemed to be covered by the items provided in Section 1 – General.

31.14.1 General

The following items shall, inter alia, be included in the rates:

- a) Supply of all design and pre-manufacture documentation and obtaining approval thereof;
- b) Procurement / manufacture of the crane with hoists and associated Plant items and delivery to Site;
- c) Installation of complete crane with hoists and associated Plant items and testing;
- d) Installation and testing of operation / control gear for the crane and its hoists, including all electrical requirements as specified in Clause 31.4; and
- e) Services required during period of initial use by the Contractor.

31.001 Design and documentation**Unit: lump sum (Sum)**

The rates tendered shall include for full compensation of all costs incurred in the preparation of design, pre-manufacture and other documentation for approval, including draft documentation for an operations manual which will include, inter alia, full details of maintenance requirements. Payment will only be effected after the design and associated documentation has been approved by the Engineer.

Measurement and Payment for the preparation and submission of O&M Manuals shall be covered under Clause 48.11 of Section 48 – Tests on Completion and paid elsewhere.

31.002 Supply and deliver to Site**Unit: number (No)**

The rates tendered shall include for full compensation of all costs incurred in the manufacture, procurement, inspections, quality assurance and quality control, Factory Acceptance Testing, corrosion protection, packaging and delivery to Site of the specified crane, hoists and associated Plant, i.e. all auxiliary Plant, electrical panels, cabling, etc. to complete a workable installation necessary for the operation of the installation.

The following will be included in the Factory Acceptance Test of the Plant supplied in terms of this Section:

- a) Factory load test;
- a) Factory deflection test;
- b) Factory functionality tests;
- c) Testing under no-load conditions; and
- d) Testing under full load conditions.

Payment will only be effected after full compliance with the specified delivery requirements as stipulated in Section 28 – Mechanical General and certification thereof by the Engineer.

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31.003 Installation of Plant

**Unit: Number (No)
or: sets (Sets)
or: pairs (Pairs)
or: lump sum (Sum)**

The rates tendered shall include full compensation for the installation of the Plant on Site including the provision of all labour, supervision, instruments, equipment, transport, on-site quality assurance and quality control, inspection and testing (including attendance at tests witnessed by the Engineer), materials and Temporary Works necessary to completely install, pre-commission and set to work the complete crane.

The rate shall also include the cost of the installation of all auxiliary Plant, electrical panels, cabling, etc., to complete a workable installation, supply of all consumables (electricity, fuel, oil and lubricants etc.) necessary for the operation of the installation until taken over by the Employer; the putting into service of the complete installation; remedial work and any other work as specified and necessary.

The rate shall also include for all preliminary testing and the provision of testing equipment therefore including all disruptions to installation caused by such testing.

The following will be included in the Pre-commissioning of the Plant on Site supplied in terms of this Section:

- a) Works load test (if not done at factory);
- b) Works deflection test (if not done at factory);
- c) Works functionality tests;
- d) Testing under no-load conditions; and
- e) Testing under full load conditions (if not done at factory).

Payment will only be effected after full compliance of the Plant items with this Section and associated documentation has been approved by the Engineer.

Measurement and Payment for Test on Completion shall be covered under Clause 48.11 of Section 48 – Tests on Completion and paid elsewhere.

31.004 Spares

Unit: Provisional sum (PS)

The cost of spares, considered to be necessary by the Contractor other than spares required by the Employer, delivered to Site and handed over will be paid as a lump sum. A Spare Part Schedule by the Employer is available in Section 48 – Tests on Completion, Table 48/2. The spares identified by the Contractor are to adhere to Clause 0 Spare Parts Requirements.

The actual lump sum to be paid shall be based on the unit rates priced in the Bill of Quantity for the actual spares ordered and supplied and the Employer is entitled to purchase all, some or none of the items listed. A provisional sum will be allocated in the Bill of Quantity for the complete list of spare parts as listed by the Contractor.

The rate tendered shall provide for the manufacture, supply, delivery to Site and handing over of the spares ordered and shall include permanent packing for long term storage. The spares shall be manufactured at the same time as the installed items.