WATER SUPPLIES DEPARTMENT

STANDARD SPECIFICATION EM-01-01

LIFTING APPLIANCES

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1. GENERAL DESIGN AND INSTALLATION STANDARDS

1.1 Water Supplies Department Standard Specifications

The following Standard Specifications shall be complied with:

E-00-01	Electrical Equipment - General
EM-00-01	Inspection, Testing and Reporting
EM-00-02	Site Installation and Testing of Mechanical, Electrical and Instrumentation Plant and Equipment
EM-00-03	General Requirements for Supply of Mechanical, Electrical and Instrumentation Plant and Equipment
EM-90-01	Drawing for Electrical and Instrumentation Equipment
EM-90-02	Instruction Manual for Mechanical, Electrical and Instrumentation Plant and Equipment

In case of discrepancy in technical requirements, this Specification shall take precedence over the above WSD Standard Specifications.

1.2 Standards

The design and installation of the lifting appliances shall comply with the latest version of relevant International Electrotechnical Commission (IEC), British Standards (BS), Codes of Practice or other equivalent standards issued by internationally recognized engineering institutions or organizations.

The following standards, in particular, shall apply where appropriate:

BS 88-2	Low-voltage fuses – Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)
BS 2853	Specification for the testing of steel overhead runway beams for hoist blocks

BS 4800	Schedule of paint colours for building purposes
BS 7262	Specification for automatic safe load indicators
BS 7671	Requirements for electrical installations
BS EN 13001	Cranes. General design
BS EN 14985	Cranes. Slewing Jib Cranes
BS EN 15011	Cranes. Bridge and gantry cranes
BS EN 50347	General purpose three-phase induction motors having standard dimensions and outputs. Frame numbers 56 to 315 and flange numbers 65 to 740
BS EN 60898-1	Electrical accessories – Circuit breakers for overcurrent protection for household and similar installations. Circuit breakers for a.c. operation.
BS EN ISO 14122	Safety of machinery. Permanent means of access to machinery.
BS ISO 4301	Cranes – Classification
IEC 60034-1	Rotating electrical machines – Part 1: Rating and performance
IEC 60034-30	Rotating electrical machines – Part 30: Efficiency classes of single-speed, three-phase, cage-induction motors (IE code)
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 60947-2	Low-voltage switchgear and controlgear – Part 2: Circuit-breakers
IEC 60947-3	Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units
IEC 60947-4-1	Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters
IEC 60269	Low-voltage fuses

The IEC, BS and other standards referred to in this Specification shall also mean the equivalent standards issued by internationally recognized engineering institutions or organizations. Manufacturers offering equipment complying with other standards shall provide duplicate copies of such standards in English, together with full details of any deviations from the standards referred to in this Specification.

1.3 Specialist Contractor for Installation

The installation of the lifting appliances shall be carried out by the Specialist Contractor under the category of “Mechanical Handling and Lifting Installation” included in the "List of Approved Suppliers of Materials and Specialist Contractors for Public Works".

2. MECHANICAL DESIGN

2.1 Classification of Crane and Mechanisms

For the crane as a whole and the mechanism, the group, state of loading and class of utilisation classifications shall be defined according to BS ISO 4301.

Unless otherwise specified in the Particular Specification, the following table shall apply:

Classification of Cranes and Mechanisms as per BS ISO 4301

Location/ Application	Class of Utilisation		State of Loading		Group Classification	
	Crane as a Whole	Mechanism	Crane as a Whole	Mechanism	Crane as a Whole	Mechanism
Pumping Station- Pumphall / Press house	U_3	U_3	Q_p5	$Q_{cp}5$	A5	A_c5
Workshop	U_4	U_4	Q_p5	$Q_{cp}5$	A6	A_c6
Chemical Handling	U_5	U_5	Q_p5	$Q_{cp}5$	A7	A_c7

2.2 General

The crane shall be designed and constructed in accordance with BS EN 13001 for overhead travelling cranes and BS EN 14985 for slewing jib cranes.

The lifting appliance shall be designed and manufactured to suit the building structure as stated in the Particular Specification.

The overhead travelling crane with safe working load (SWL) of more than 10 tonnes shall be of a double-girder construction with the hoist in crab type travelling on top of the girder, unless otherwise specified. The crane with SWL of 10 tonnes and below shall be of a single-girder construction, unless otherwise specified in the Particular Specification.

Facilities for converting downshop travel of overhead travelling crane and slewing of jib crane from electrically operated to manually operated on power failure shall also be provided. Conversion to manual operation shall be activated by a handwheel or lever.

The certified SWL shall be painted in a conspicuous manner on the girder of overhead travelling crane, the jib of slewing jib crane and the runway of monorail so as to be visible to persons at the station floor. Lettering shall be painted both in Chinese and English.

The supply of the lifting appliance shall also include grade 316 stainless steel anchors for fixing to the reinforced concrete structures, the girder rails and/or runways for overhead travelling cranes and the runways for monorail. The rails or runways shall be supplied complete with mounting supports/brackets, end stops and shall be suitable for connection to the earth.

2.3 Design Calculation

Calculations in accordance with BS EN 13001 for overhead travelling crane, BS EN 14985 for slewing jib crane and Code of Practice for the Structural Use of Steel for runway and other steel structures of lifting appliance verifying the stress and structural compatibility of the lifting appliance assembly shall be checked and certified by a qualified independent checking engineer. The certified calculations shall be submitted to the purchaser prior to the commencement of manufacture.

The design calculations shall verify the following:

(a) Vertical Deflection – Girder

The configuration of the girder shall be designed so that the vertical deflection caused by the weight of the crane assembly, the SWL and other horizontal loads due to crane motions in the central position shall not exceed 1/750 of the span.

(b) Vertical Deflection – Runway for Monorail and Crane

The maximum deflection of a runway beam under the SWL, relative to its supports, shall not exceed 1/500 of the span. For a jib or cantilever runway beam, the maximum deflection under the SWL, relative to its supports, shall not exceed 1/250 of the span.

2.4 Hoist Unit

Unless otherwise specified in the Particular Specification, electrically operated chain hoist shall be used for the lifting appliance of chemical handling application or installed direct above tank or pit and electrically operated wire rope hoist shall be used for all other applications.

The minimum duty cycle of the hoist unit shall be ISO M5 or equivalent.

The hoist shall be equipped with a brake release mechanism to allow manual lowering of the load in the event of power failure. The lifting hook must carry a self-activating safety latch.

For electrically operated chain hoist, all load chains shall be made of stainless steel grade 316 and proof tested to 1.5 times of the SWL specified for the hoist. Load chain collecting box shall be provided integral with the hoist.

For electrically operated wire rope hoist, the winding diameter of the hoist drum shall be not less than 20 times the nominal diameter of the wire rope. The winding drum of the hoist shall have deeply machined cable grooves. The factor of safety of the wire rope, which is determined by dividing the product of the minimum breaking strength of the rope and the number of falls by the SWL for the crane, shall be not less than 5.

2.5 Operational Speeds

Unless otherwise specified in the Particular Specification, the powered operating speeds of the lifting appliance shall be within the following ranges:

(Electrically Operated Wire Rope Hoist)	
Hoist Speed, high	3 – 5 m/minute
Hoist Speed, low	0.3 – 1 m/minute
Travel (Traverse)	2 – 6 m/minute
(Electrically Operated Chain Hoist)	
Hoist Speed, high	4 – 8 m/minute
Hoist Speed, low	0.7 – 1.5 m/minute
Travel (Traverse)	2 – 6 m/minute
(Overhead Travelling Crane)	
Downshop Travel (Long Travel), high	12 – 20 m/minute
Downshop Travel (Long Travel), low	2 – 6 m/minute
(Jib Crane)	
Slewing	1 – 2 rpm

2.6 Finishing and Painting

All surfaces of the structural steel work shall be thoroughly cleaned, dried, free from loose scale and blemishes, grit oil and grease before the application of first coat of primer.

Painting shall be applied to all surfaces to give the dry film thickness (DFT) in accordance with the following painting schedule:

Painting System	DFT per Coat
One coat of two-pack chemical-resistant primer	70 microns
One coat of two-pack chemical-resistant undercoat	100 microns
Two coats of two-pack chemical-resistant top coat	100 microns

The total DFT of the protection system shall not be less than 370 microns and the final

colour shall be to BS 4800 08E51 safety yellow. The coating system shall be applied by airless spray or in accordance with the paint manufacturer's instructions and recommendations. Brush or roller application shall be limited to the touch-up of small areas. Manufacturer's literatures for the coating system shall be submitted to the Engineer prior to application of the paint.

2.7 Working Platform for Lifting Appliance

A safe working platform shall be provided to enable access to the front and to both sides of electrical control cubicles, motors, brakes, limit switches and other areas where access to controls, maintenance or inspection will be required. The design of the platform and guard railings shall be in accordance with Clause 9 of Cap. 59J and other standard to be accepted by the *Project Manager* / Engineer.

For double-girder overhead travelling crane, steel, aluminum alloy or glass reinforced plastic chequer plate flooring shall be provided between the access point and the equipment over the whole of the exposed area. The flooring shall be not less than 450 mm wide and be securely supported and fenced with tubular guard rails of at least 1,000 mm high and toe boards of at least 200 mm provided along the outer edges of the platform. The flooring shall be designed to take a 5 kN/m^2 and resilient shock absorbing buffers at appropriate locations shall be provided. Access to the working platform shall be by a galvanized steel ladder to BS EN ISO 14122, with necessary safety hoops to be supplied with the crane for installation at one end of the building.

3 ELECTRICAL DESIGN

3.1 General

The electricity supply to the crane will be 380V 3-phase 50Hz with the neutral point solidly earthed. The electrical design shall be based on BS EN 15011:2011+A1:2014. The normal variation limits will be ±6% for supply voltage and ±2% for supply frequency.

The lifting appliance shall be electrically operated and motorised in all directions of travel. Lifting appliance control shall be by means of a single pendant control unit suspended from the crane bridge. The control pendant of crane shall be free to move along the girder or jib independent of the movement of the hoist unit suitable for operation from floor level.

Electrical equipment for the control of the lifting appliance shall be housed in control

cubicles mounted on the girder or the hoist unit as appropriate.

3.2 Power Supply

Power shall be supplied to the crane through a modular system of copper bar conductors enclosed in an earthed galvanised steel track or a PVC insulating shroud. The conductors shall have a nominal current rating not less than 63A. All associated fixing accessories shall include mounting brackets, hangers, fastening bolts and nuts etc.

A 4-pole (TPSN) on-load isolator switch of rating not less than 63A, lockable in the 'off' position, shall be provided for controlling the power supply to the conductors. This isolator switch is to be located close to the access ladder at a level between 900mm to 1500mm above finished floor level.

The current collectors shall be of the sliding contact type with replaceable contact shoes. The contact head shall be shrouded to prevent accidental contact and mounted on self-adjusting spring loaded arms to maintain constant contact with the conductor bars. The capacity of the contact head shall be compatible with the conductor.

The supply system shall have four conductors - three for the three-phase supply and one for the earth. Where a single phase supply is also required for the crane equipment, a fifth conductor shall be provided for the neutral connection.

The electrical connections along the girder or the jib shall be through PVC-insulated flat cables on rail-runners. Cables which require no movement shall be enclosed, positioned or constructed to protect against mechanical damages. All the cables and associated fixing accessories from the on-load isolator switch to the motors, limit switches and control cubicles shall be furnished with the crane.

3.3 Control of Travel

Each movement of the lifting appliance shall be operated by a separate motor. All movements shall start smoothly and inching in any direction shall be possible. If more than one driving motor is used for motion in any direction, the motors shall be synchronised.

Limit switches shall be provided for limiting long (down-shop) travel, cross travel, and vertical hook travel in both directions. Limit switches shall reset automatically on reversal of motion. The switch endurance test severity shall be one million operation at 120 on-load operating cycles per hour.

Control of travel shall be by means of push buttons in the pendant control unit. Constant pressure on the corresponding push button shall be required for the entire duration of travel in any direction, i.e. latching contacts shall not be provided in the motor starter circuits to bridge the control push buttons.

An emergency stop push button to interrupt the control supply to all motor circuits shall be provided at the pendant control unit. After the emergency stop push button is pressed, the pendant control unit shall only be operational after the pressing of a 'Reset' push button.

3.4 Pendant Control Unit

The pendant control unit shall be ergonomically designed for easy operation with one hand and its enclosure shall be made of die-cast metal or impact resistant plastic with a degree of protection of IP65 to IEC 60529. Push buttons shall be provided for the following functions:

Main hoist	:	Fast Raise, Slow Raise, Fast Lower, Slow Lower
Cross Travel	:	Left, Right
Long Travel	:	Fast Forward, Fast Reverse, Slow Forward, Slow Reverse
Slewing	:	Clockwise, Anti-clockwise
Control	:	Emergency Stop, Reset

The push button contacts for opposite motions shall be electrically interlocked.

Electricity supply to the pendant control unit shall not exceed 50V 50 Hz a.c..

The pendant control unit shall be suspended from a 316 stainless steel wire to prevent any strain on the supply/control cable. If this straining wire is integral with the cable, the wire shall be terminated in a crimped-on ring terminal rigidly fixed at both ends such that the weight of the pendant is not carried by the conductors of the cable at any time.

Labels shall be of laminated plastic with white engraved legends on black surface or black engraved legends on white surface.

3.5 Electrical Control Cubicles

The control cubicles shall be of 316 stainless steel sheet of minimum thickness 1.5

mm with a degree of protection of IP54 to IEC 60529.

The control cubicles shall be located in such a way that a front clearance space of not less than 450 mm shall be provided.

The arrangement of the cubicle components shall be such that all normal maintenance work can be carried out through a hinged and lockable front access door. The door shall be fitted with gaskets. Components shall be of robust construction to withstand the effects of intense vibration.

The power supply for the control cubicles shall be protected by an earth leakage moulded case circuit-breaker of sensitivity 300mA and of service breaking capacity not less than 6 kA to IEC 60947-2.

The control voltage shall not exceed 50V 50 Hz a.c., which shall be supplied from the secondary winding of an isolating transformer.

The control cubicle shall be fitted with an anti-condensation heater and an adjustable thermostat.

A control push-button, lockable with a key, shall be provided on the cover of the electrical control cubicle to preclude operation by the pendant control unit while retaining the main power supply to the control cubicle for circuit checking. A lockable isolator shall also be provided for the isolation of the main power supply.

Each component within the control cubicle shall be identified with an engraved label adjacent to the component. Labels at cubicle interior shall be fixed by screws or adhesive. Labels on the cubicle exterior shall be fixed with chromium plated screws or fixed by manufacturers standard method for components with integral labels.

3.6 Brakes

3.6.1 Brakes - General

Automatic spring held brakes shall be provided for all drives. Release of brakes shall be by electromagnetic means and designed for fail-safe operation.

The brakes shall be applied smoothly and automatically without snatching when the power supply to the driving motor is cut off and the braking torque shall be at least 200% of the full load torque of the motor. Where more than one motor is used to control motion in any direction, each motor shall have an individual brake with its release coil energised from the supply to that motor.

Brakes with more than one shoe shall be self-centering such that wear of the brake lining is evenly distributed between shoes.

Long travel (down-shop) and cross travel brakes may either be integral with each driving motor or be separate drum brakes. Hoist brake shall incorporate mechanical or hydraulic manual release facilities. Motor with integral brakes shall incorporate manual release devices for use during maintenance.

3.6.2 Release Coils

Electromagnetic release coils shall be of continuous rating and shall be suitable for the specified power supply.

Coils shall be vacuum impregnated with a non-hygroscopic insulating varnish or shall be epoxy resin encapsulated.

It shall be possible to replace a defective coil without dismantling the brake mechanism.

4. COMPONENT SPECIFICATIONS

4.1 Motors

The motors shall be of energy efficiency squirrel-cage induction motor to Class IE2 of IEC 60034-30. The motors shall operate at the electricity supply of 380V ±6% 3-phase 50 Hz ±2%.

Motor enclosures shall have a degree of protection of IP54 to IEC 60529.

Motor windings shall be of Class B or Class F insulation design with Class B maximum temperature rise limit at rated operating conditions.

Motors shall be rated for intermittent duty type S3 to IEC 60034-1, with a cyclic duration factor of not less than 40% at rated output and a starting class not less than that of the mechanism group classification specified for the crane.

Motor bearings shall be of standard ball or roller type with a minimum working life of 40,000 hours. Special bearings and Imperial bearings will not be accepted.

4.2 Motor Starters

Starters shall be mounted in the electrical control cubicles.

Reversing contactors shall have mechanical and electrical interlocks.

The utilization category for contactors shall be AC4 to IEC 60947-4-1. The electrical durability of the contactors shall be not less than 1 million operating cycles at an intermittent class not lower than 300 operating cycles per hour and 40% on-load factor.

Protection against thermal overload, single-phasing and earth fault shall be provided for each motor.

4.3 Cables

Minimum cross-sectional areas of conductors shall be 2.5 mm^2 copper for power cables and 1.5 mm^2 copper for control cables. All cables shall be PVC-insulated.

4.4 Electrical Auxiliaries

Miniature circuit-breakers shall comply with BS EN 60898 and shall have a breaking capacity not less than 6 kA.

Fuse switchgear and isolators shall comply with IEC 60947-3.

Fuses and fuse holders for short circuit protection shall be high breaking capacity (HBC) fuses to BS 88/ IEC 60269.

LED Indicating lamp units shall have a degree of protection of IP65 or better to IEC 60529. Push button units and limit switches shall have a degree of protection of IP65 to IEC 60529.

4.5 Earthing Requirement

Provisions of M10 stud terminals shall be made for the connection of earthing conductors to the rail, girder and hoist units. Each flat cable shall have a circuit protective conductor of the same material and size as the current carrying conductors.

4.6 Automatic Safe Load Indicator (ASLI)

4.6.1 General

The ASLI shall comply with the requirements of the Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations (CAP. 59 sub. leg.J) and BS 7262.

The ASLI shall function automatically once the crane is energized. The operation of

the ASLI shall be independent of the motion or combination of motions of the crane.

4.6.2 Design and Construction

The ASLI shall be sufficiently robust in construction and protected to prevent damage from shock vibration and the general rigours of crane duties including erection, rope changing, use and dismantling or maintenance on the crane.

The settings and functioning of the ASLI shall not be affected by mechanical shocks and vibration transmitted by the crane assembly during transportation and operation. The design and construction of the ASLI should also minimize the risk of accidental and inaccurate changing of any manual setting device.

The load transducers of the ASLI shall be of tension load cell type unless otherwise specified. The operation of the load transducers, associated conductors and connections shall be continuously monitored for out-of-range condition. Should a fault occur, the ASLI shall default to a safe condition.

The ASLI shall be designed and constructed to operate in an ambient temperature between 0^{o}C and 60^{o}C and relatively humidity up to 100%. It shall be protected against condensation, frost, dirt, dust and other adverse condition.

The installed ASLI shall enable overload testing of the crane without any disconnection or adjustment.

The enclosure of ASLI shall be fabricated to the same requirements of the electrical control cubicles.

4.6.3 Warnings and Indications

The ASLI shall be set to give warnings and indications of loads on the crane for all permitted crane motions, which have reached the pre-determined load settings as follows:

(a) Warning of Approach to Safe Working Load (SWL)

The ASLI shall give a clear and continuous warning when the load of the crane approaches 95% with a tolerance limit of ±2% of the SWL.

(b) Warning of Overload

The ASLI shall give a clear and continuous warning of overload when the load

of the crane exceeds 100% but not more than 105% of the SWL.

(c) Form of Warnings

The warning of approach to SWL and warning of overload shall be given in the following fashions:

Function	Audible Warning	Visual Warning
Approach to SWL	Intermittent Buzzer	Flashing Amber Lamp
Overload	Continuous Buzzer	Flashing Red Lamp

The warning signals shall continue to function until the load falls below the respective value at which it is initiated. The audible warnings for approaching SWL and overload shall be clearly distinguishable from each other and other environmental sound such as fire alarms which may exist within the plant room where the crane is to be installed. Manual-test push buttons or self-test function activated by switching on the power supply of ASLI for the audible and visual warnings shall be provided.

The audible warning for approaching SWL and overload shall be clearly audible by persons at 10 m away from the load being lifted under all conditions.

5. SPARES

The following spares, where applicable, shall be supplied with the equipment:

1 - Brake release coil for each type of driving motor
1 set - Brake shoes and linings for each driving motor
100% - HBC fuses
1 - Contactor for each type and size used
1 set - Power supply collector contact shoes
1 - Power supply collector contact head
1 - Timer for each type and range used
1 - Printed circuit board for each type used
1 - Limit switch for each type used
1 - Main brake spring
1 - Rope guide

6. WORKS TESTS, INSPECTION AND SITE TESTS

6.1 Works Tests

All electrical and mechanical equipment shall be tested in accordance with the appropriate International Standards at either the hoist and steel structure maker's or Contractor's works. Test certificates shall be submitted before dispatch.

In addition, all steel structures of the lifting appliance supplied shall be subject to inspection and tests duly arranged and carried out by the Contractor and witnessed by an Independent Inspection Body (IIB). The requirements associated with the inspection, testing of the crane and associated equipment and reporting thereon shall comply with the requirements stipulated in Water Supplies Department (WSD) Standard Specification EM-00-01.

All the costs associated with the appointment of IIB and the provision of the necessary equipment for the inspection and witnessed tests shall be borne by the Contractor.

The works inspection and tests requiring witness of IIB shall include, but are not limited to, the following:

(a) Dimensional verification against approved drawings of all the steel structures to be supplied;
(b) Verification of the correct use of materials;
(c) Verification of the correct quantities of components to be supplied, which shall include integral, loose items and spares;
(d) Correct painting process (where applicable) and the measurement of DFT of the painting system;
(e) Inspection on quality of weld joints and integrity of steel structures.

6.2 Site Tests

Upon completion of the installation of the lifting appliance at the Site , the Contractor shall arrange to carry out the functional, vertical deflection and overload tests of the lifting appliance.

The functional tests shall demonstrate the correct operation of the lifting appliance including lifting, lowering of the hook, travelling of the lifting appliance, functioning of the hoist, the travel limit switches and the ASLI.

The Contractor shall carry out a vertical deflection and an overload test of the lifting appliance installed. The tests shall fully conform to the current statutory

requirements as specified in the Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations (CAP. 59 sub. leg.J) of the Hong Kong Special Administrative Region. Test certificate shall be issued by an approved IIB and delivered to the Site within the specified period after the test.

The requirements associated with the inspection, testing of the lifting appliance and associated equipment at the Site and reporting thereon shall comply with the requirements stipulated in WSD Standard Specification EM-00-01.

The IIB for test at Site shall be appointed and nominated by the Contractor. All the costs associated with the appointment of IIB and the provision of necessary equipment for the tests and the issue of test certificate shall be borne by the Contractor.

- End of Specification -