

**WATER SUPPLIES DEPARTMENT**

**STANDARD SPECIFICATION EM-00-03**

**GENERAL REQUIREMENTS FOR**

**SUPPLY OF MECHANICAL, ELECTRICAL AND**

**INSTRUMENTATION PLANT AND EQUIPMENT**

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**GENERAL REQUIREMENTS FOR  
SUPPLY OF MECHANICAL, ELECTRICAL  
AND INSTRUMENTATION PLANT AND EQUIPMENT**

**1. GENERAL**

**1.1 Extent of Supply**

This Specification covers the general design, manufacture, works testing, packing, supply and delivery of mechanical, electrical and instrumentation plant and equipment for waterworks applications.

The Contractor shall supply all items necessary for a complete working unit irrespective of whether all required components are separately detailed in the Specification.

Particular attention is drawn to the necessity of equipment offered being suitable for the proposed installation and system as a whole, not as individual units, unless supply in loose items is specified.

An itemised list of recommended maintenance tools and spares shall be provided unless otherwise specified. Arrangement and ordering details of the recommended maintenance tools and spares are given in Clause 1.5 below.

**1.2 Equipment Approval**

Unless otherwise specified, within one (1) month after award of Contract, the Contractor shall submit for approval two (2) copies of submission including the make, model and rating of individual plant and equipment together with technical details, technical literature and standard drawings of the equipment manufacturer.

Within 21 days from the receipt of the said submission, comment/approval will be given. Within 14 days from approval or conditional approval of the submission, the Contractor shall forward four (4) copies of approved document stamped and certified by the Contractor as true copy, and incorporated with the stipulated amendments as required. If the submission is not approved, the Contractor shall suitably amend the submission without delay and resubmit two (2) copies of the amended submission for approval within 14 days from the receipt of the comments.

The ordering of manufacture of plant or equipment shall not commence before approval on the same is given.

**1.3 Drawing Approval**

Unless otherwise specified, within one (1) month after award of Contract, the Contractor shall submit for approval two (2) copies of drawings showing the general arrangement, the sectional details, process schematic diagrams and the necessary civil modification works required for the plant and equipment. Two (2) copies of the

drawings for individual equipment shall be submitted within one (1) month of equipment approval as stipulated in Clause 1.2.

Within 21 days from the receipt of the said drawings, comment/approval will be given. Within 14 days from approval or conditional approval of the drawings, the Contractor shall forward four (4) sets of approved drawings stamped and certified by the Contractor as true copy, and incorporated with the stipulated amendments as required. If the drawings are not approved, the Contractor shall suitably amend the drawings without delay and resubmit two (2) copies of the amended submission for approval within 14 days from the receipt of the comments.

For approved drawings used for the manufacture of the equipment, the drawings shall be resubmitted for approval if any change is required in the manufacturing stage.

The detailed requirements of drawings are stipulated in Water Supplies Department Standard Specification **EM-90-01**.

The Contractor shall note that the approval of drawings will not relieve his responsibility for the soundness of design and suitability of materials on supply of equipment in accordance with the Specification for the intended purpose.

#### 1.4 Inspection, Testing and Reporting

Plant and equipment supplied shall be subject to inspection, examination and tests witnessed by an Independent Inspection Body (IIB) at the manufacturer's works as required and in accordance with the Specification. The detailed requirements on inspection, testing and reporting by IIB are stipulated in Water Supplies Department Standard Specification **EM-00-01**.

#### 1.5 Recommended Maintenance Tools and Spare Parts

The Contractor shall provide a list of recommended maintenance tools and spare parts as required for the operation, testing and servicing of the plant and equipment, which may be ordered by the Employer in bulk or individually within the Contract Period.

Any parts ordered must be strictly interchangeable and suitable for use in place of the corresponding parts supplied under the Contract. They shall be suitably packed, marked and numbered for identification, and prepared for storage by greasing, painting or sealing to prevent deterioration.

#### 1.6 Instruction Manuals

At least two (2) months before delivery of the equipment, the Contractor shall forward one (1) set of draft manuals for approval. The detailed requirements of instruction manuals are stipulated in Water Supplies Department Standard Specification **EM-90-02**.

Within 21 days from the receipt of the draft manuals, comments/approval will be given. The Contractor shall supply further information within 14 days.

Within one (1) month from the delivery of the equipment, the Contractor shall supply four (4) sets of the final manuals incorporating all necessary amendments, record drawings and works test reports and certificates.

In addition to the manuals in paper form, the Contractor shall also supply a CD-ROM / DVD-ROM containing PDF files of the final manuals.

## **2. GENERAL TECHNICAL REQUIREMENTS**

### **2.1 Plant and Equipment Design**

The design and construction of the plant and equipment shall be in accordance with modern technology and the best current industrial practices to achieve energy efficiency and sustainability and shall facilitate ease of inspection, cleaning, lubrication and repair to ensure long life and satisfactory operation under the specified service conditions. It shall comply with Water Supplies Department Standard Specification **EM-00-05** for green procurement if applicable.

Unless otherwise specified, the plant shall generally be designed for round-the-clock continuous operation with maximum safety and efficiency at the duty conditions specified and minimum attendance by the operators. Routine maintenance and repair of the plant and equipment shall be kept to a minimum and, as far as possible, not require the services of highly skilled personnel.

The plant and equipment shall operate smoothly and without undue vibration. All parts shall be designed to withstand the maximum stresses imposed on them under the most onerous operation and severe test conditions.

The limiting sound pressure level of the plant and equipment supplied under the Contract shall not exceed 90 dB(A) measured at any point 1m away from the equipment unless otherwise specified.

Equipment which performs similar functions shall, as far as possible, be of a uniform manufacture, type and model series in order to facilitate maintenance and to minimise stocking of spare parts. Corresponding parts shall be interchangeable. The use of components made in small quantities to meet special requirements such as close-tolerance components shall be stated clearly by the manufacturer and one complete set of spares shall be supplied for such equipment.

Guards, electrical safety devices, thermal insulation, noise suppression devices, safety colour coding and the like shall be provided where needed. The requirements in the appropriate International Standards and statutory regulations shall be followed. Protection guards on machinery shall be rigid and securely fixed, and they shall not have to be removed during normal operation and routine inspection.

Except for consumable items such as gland packing, carbon brushes etc. requiring more frequent replacement, no part subject to wear shall have a life from new to

replacement or repair of less than five years of continuous normal operation.

## 2.2 Materials

Materials incorporated in the equipment shall be new and of first-class quality, free from imperfections and selected for long life and minimum maintenance. The materials shall be of suitable grade and robust construction for the intended purpose. Materials shall be selected to suit the operational environment without corrosion to ensure the designed life of the component parts is met. Materials shall have a high resistance to any change in their properties due to passage of time, exposure to light or any other cause which may have a detrimental effect on the performance or life of the components.

Where dissimilar materials are in contact or within the same proximity which can be bridged by an electrolyte producing a corrosive condition, the electrochemical potential difference between them shall not exceed 250 millivolts. In addition, where there is slight relative motion between two materials in contact, one or both being metals, suitable precaution shall be taken to prevent seizure by fretting.

Stainless steel pieces which are to be welded shall not be subject to intergranular corrosion.

Suitable inhibitors shall be incorporated in brass and bronze where dezincification or dealuminification may occur.

Cadmium plated parts shall not be exposed to weather and high temperature at 50°C or above. Cadmium plated parts shall not be in contact with potable water.

Chromium shall not be electro-plated directly onto ferrous parts. Metallic components (inclusive of legend plates) with chromium plating shall first be nickel plated to a minimum thickness of 0.03mm.

Glass fibre, composite or plastic components shall be of adequate design taking into account the effects of operating temperature, humidity and exposure to sunlight and they shall be resistant to flame propagation.

The use of organic materials shall be avoided as far as possible but where these have to be used, they shall be treated to make them fire resistant and non-flame propagating.

Asbestos material in any form shall not be used in any part of the plant and equipment supplied.

All materials in contact with potable water shall have been certified suitable for potable water applications under the Water Regulations Advisory Scheme (WRAS) of the United Kingdom or National Sanitation Foundation (NSF) of the United States. For materials complying with other standards, the Contractor shall submit the technical details of the materials, duplicate copies of the standards in English and the full details of any deviations from the WRAS and/or NSF for assessment and

approval.

## 2.3 Standards and Specification

Equipment offered shall comply with the requirements of the Specification, and shall be new, unused and manufactured to the highest commercial standards.

The equipment shall be designed, manufactured and tested in accordance with the latest editions of the relevant International Standards and the standards referred to in the Specification.

Manufacturers offering equipment to other standards shall supply duplicate copies of such standards in English or Chinese (if applicable) and S.I. units together with full details of any deviations from the relevant International Standards indicated.

## 2.4 Climatic Conditions

All plant and equipment shall be suitable for storage, installation and operation in a tropical climate with a maximum relative humidity of 100% and an average ambient temperature of 35°C over any 24 hour period and a maximum ambient temperature of 40 °C for 4 hours.

## 2.5 Qualifying Experience

Owing to the requirement for extreme reliability, only equipment of proven design and manufacture will be accepted. The manufacturer shall state his experience in the manufacturing of the equipment and systems on request and provide a list of installed schemes of similar types and sizes as the manufacturer proposes to offer for this application. Unless otherwise specified, the manufacturer shall have at least three (3) years of experience in the manufacture of the equipment or similar items.

## 2.6 Fluid Handled

### 2.6.1 Raw Water

When the plant and equipment is specified for raw water applications, the water to be handled will be untreated river water relatively free from solid particles. During high flows the water may contain large quantities of silt.

The chemical analysis of samples of the water is shown below:- (Units in mg/l unless otherwise stated)

pH	5.9 – 8.8
Colour (H.U.)	<5 – 80
Turbidity (F.T.U.)	0.4 - 50
Conductivity (µS/cm @ 20 °C)	25 - 200
Ammoniacal N	<0.01 - 3.62
Albuminoid N	<0.01 - 0.31
Nitrite N	<0.001 - 0.676

Nitrate N	<0.01 - 3.19
Oxygen Absorbed Value	<0.01 - 1.50
Total Dissolved Solids	15 - 130
Alkalinity (CaCO <sub>3</sub> )	2 - 39
Total Hardness (CaCO <sub>3</sub> )	4 - 45
Calcium (Ca)	0.4 - 15.2
Magnesium (Mg)	<0.1 - 2.4
Chlorides (Cl)	2 - 50
Sulphates (SO <sub>4</sub> )	1 - 20
Ortho - PO <sub>4</sub> (PO <sub>4</sub> )	<0.01 - 1.50
Fluorides (F)	<0.01 - 0.35
Iron (Fe)	<0.01 - 1.50
Manganese (Mn)	<0.01 - 2.00
Aluminium (Al)	<0.01 - 0.40
Silica (SiO <sub>2</sub> )	0.3 - 18.6
Temperature °C	13.0 - 31.0
Dissolved Oxygen	0.9 - 9.5

The water shows a faint opalescence with a slight yellow/brown deposit.

In general, the raw water is soft and low in mineral content, occasionally with some microscopic organisms such as zooplankton and phytoplankton. The raw water may be chlorinated to a free residue of 1.0 mg/litre.

## 2.6.2 Treated Water

When the plant and equipment is specified for treated water applications, the water to be handled will be potable, filtered and chlorinated.

The chemical analysis of samples of the water is shown below:- (Units in mg/l unless otherwise stated)

pH	6.4 - 9.2
Colour (H.U.)	<5 - 15
Turbidity (F.T.U.)	<0.1 - 2.5
Conductivity (µS/cm @ 20 °C)	33 - 266
Ammoniacal N	<0.01 - 0.05
Albuminoid N	<0.01 - 0.14
Nitrite N	<0.001 - 0.007
Nitrate N	<0.01 - 3.61
Oxygen Absorbed Value	<0.01 - 0.48
Total Dissolved Solids	26 - 160
Residual Chlorine	0.2 - 3.0
Alkalinity (CaCO <sub>3</sub> )	4 - 53
Total Hardness (CaCO <sub>3</sub> )	5 - 111
Calcium (Ca)	2.6 - 33.2
Magnesium (Mg)	0.2 - 10.2
Chlorides (Cl)	3 - 44



Sulphates (SO <sub>4</sub> )	4 - 32
Ortho - PO <sub>4</sub> (PO <sub>4</sub> )	<0.01 - 0.16
Fluorides (F)	0.05 - 1.11
Iron (Fe)	<0.01 - 0.10
Manganese (Mn)	<0.01 - 0.06
Aluminium (Al)	<0.01 - 0.19
Silica (SiO <sub>2</sub> )	3.0 - 17.9
Temperature °C	13.0 - 31.0

### 2.6.3 Salt Water

When the plant and equipment is specified for salt water applications, the salt water abstracted from sea may contain suspended solids and bacteria. The water is normally chlorinated for inhibiting marine growth in the supply system. The water is corrosive calling for the use of high quality materials in the manufacture of equipment.

The chemical analysis of samples of the water before chlorination is shown below:-  
(Units in mg/l unless otherwise stated)

Specific gravity	1.010 - 1.025
pH	7.4 - 8.9
Turbidity (F.T.U.)	0.3 - 20
Ammoniacal N	<0.01 - 1.0
Oxygen Absorbed Value	0.1 - 10
Chlorides (Cl)	6100 - 20900
Temperature °C	16.0 - 31.0

### 2.7 Nameplates, Rating Plates and Labels

Each item of the equipment shall have a label or labels permanently attached in a conspicuous position detailing its design performance, function, system identification and manufacturer's information.

All labels, nameplates, rating plates and notices shall be permanently marked in English unless otherwise specified. The proposed style, label material, inscription, location and means of fixing shall be submitted for approval before manufacture.

Where withdrawable or detachable equipment is provided, both the fixed and the moving or detachable portions shall be similarly labelled.

### 2.8 Waterworks Finish

All equipment supplied shall have "Waterworks Finish" as per Clause 2.9 prior to despatch from the manufacturer's works.

Unless otherwise specified, all equipment shall be thoroughly fettled and cleaned and applied with one flat priming coat to all surfaces. Ungalvanised cast iron and steel parts which are to be painted shall be prepared internally and externally by grit or shot blasting and primed within four hours of blasting. An undercoat shall be applied. Top

coats of final colour as specified in Clause 2.9 shall be applied. The colour of the undercoats shall be of slightly different shade to top coats.

All prominent fittings i.e. gland drains, plugs, cocks, etc. and small bore pipework are to be constructed in stainless steel and coating on these items is not required.

Workmanship and the general finish of the equipment shall be of first class quality and in accordance with the best code of practice and shall be performed by persons skilled in their respective trades. All the accessible surfaces, holes and edges of the plant and equipment shall be smoothed, deburred and rounded.

## 2.9 Final Colours for Plant and Equipment

<b>Plant/Equipment to be Painted</b>	<b>Coding Colour</b>	<b>Colour Reference to BS 4800</b>
Treated Water Pumps, Valves, Pipes and Fittings	Ultra Light Grey or Ultra Light Blue	18C31
Raw Water Pumps, Valves, Pipes and Fittings	Sky Blue	18E51
Salt Water Pumps, Valves, Pipes and Fittings	Green	12D45
Diesel Engines	To match the driven equipment	-
Exhaust Manifolds for Diesel Engines	Silver Aluminium	-
Bulk Fuel Oil Tank	Silver Aluminium	-
Fuel: Service Tanks, Pumps, Pipes and Fittings	Middle Brown	06C39
Lubricating Oil: Tanks, Pumps, Pipes and Fittings	Light Brown	08C37
Sump/Drain/Sludge Pumps, Pipes and Fittings	Black	00E53
Air Compressors	Light Grey/Silver Aluminium	18B21/-
Air Blower and Fans	Light Grey/Silver Aluminium	18B21/-
Air Receivers, Compressed Air and Scour Air Pipes and Fittings	White	00E55
Surge Vessels and Fittings	Silver Aluminium	-
Heat Exchanger	To match the equipment colour	-
Ventilation Ducts and Grilles	To match the wall colour	-
Ventilation Ducts for Equipment	To match the equipment colour	
Platforms and Ladders except Stainless Steel and Aluminium	Black	00E53

<b>Plant/Equipment to be Painted</b>	<b>Coding Colour</b>	<b>Colour Reference to BS 4800</b>
Alloy		
Handrailings except Stainless Steel and Aluminium Alloy	Sky Blue or To match the surrounding colour	18E51
Overhead Cranes	Yellow	08E51
Crane Hook Block	Red	04E53
Mixture of Air/Hydrogen and Mixture of Air/Flammable Gas Pipes and Fittings	White with Crimson stripes of 50 mm wide	00E55/04D45
Hypochlorite, Sodium Hydroxide and Concentrated Acid/Alkali Solution Pipes and Fittings	Violet with black/yellow stripes of 100 mm wide	22C37/10E53
Gas Insulated Vacuum Circuit Breaker High Voltage Switchboard	Light Grey	-
Low Voltage Switchboard	Light Grey	18B21
Motor	To match the driven equipment	-
Dry Type Power Transformer	Light Grey	18B21
Bulk Oil Power Transformer	Admiralty Grey	-
Battery and Charger Panels	Light Grey (External)	18B21
Capacitor Panels	Light Grey	18B21

### **3. PACKING AND SHIPPING**

#### **3.1 General**

All equipment and materials supplied shall be adequately protected and packed so as to arrive at site intact and undamaged. The method of protection and packing must be able to withstand any adverse climatic conditions during transit or at site. The packing shall also be able to withstand rough handling and long period of storage at outdoors in tropical climate unless otherwise approved.

Packing shall be suitable for opening up for inspection immediately on receipt and repacked for storage in the same packing without renewal of desiccants.

Unless otherwise specified, all packing cases and other materials necessary for the safe package, conveyance and delivery to the site shall be deemed to have been included in the tender price.

Each package or case shall be clearly marked so that it can be identified with the relevant advice note. It shall be securely attached with a water-proof packing list containing such details as the package number, identification marks and the weight. A duplicate copy of the packing list shall be submitted separately prior to arrival of the equipment.

### 3.2 Equipment Packing

Equipment ordered for multiple locations shall normally be packed such that each package or case shall contain materials for one location only unless otherwise specified.

Equipment liable to be damaged during delivery or storage, such as instruments and relays, shall be separately packed and individually enclosed in sealed polythene package.

Major electrical equipment such as pump motors, switchgear and control panels shall be packed in wooden containers regardless of whether these are shipped in freight metal containers or not. For tall or bulky equipment that cannot be fitted into a freight metal container, the Contractor shall submit for the approval the full details of the proposed alternative method of equipment package or delivery arrangement.

For shipment, each switchboard and control board shall be packed into transport section not exceeding 2600mm in length in any direction.

Bulk equipment, such as switchgear or control panels, shall be suitably packed for manual handling within the premises with nominal door opening dimensions of 1500 x 2400mm (b x h).

For items above 250kg, lifting eye-bolts shall be provided. For large items where the headroom is inadequate for transport by slings, a suitably designed spreader shall be provided.

For cables weighing more than 3000kg, steel cable drums shall be used. For smaller cable drums, robust wooden drums may be used. In all cases, cable drums shall be designed for outdoor storage for a period not less than 12 months. All exterior surfaces shall be suitably treated for the humid tropical climate. All cable ends shall be capped with heat-shrinkable watertight end-caps.

### 3.3 Component Packing and Protection

Bearings and parts susceptible to damage by vibration shall be fitted with transit guard or clamps to facilitate attendance to the equipment during temporary storage for operation, e.g. manual rotation by hand to avoid bearing brinnelling etc. A rotor locking device shall be supplied and fitted on each loose motor prior to shipment to prevent any possible damage during transportation.

Parts with grease/oil lubricated elements shall be charged with the correct type and

quantity of lubricant for normal operation prior to shipment unless recommended otherwise by the manufacturer. If the manufacturer recommends an alternative method of lubrication or protection for shipment and storage, its details shall be provided for approval.

### 3.4 Packing Containers

For electrical and instrumentation equipment, the packing containers shall be lined with waterproof paper and provided with a robust water vapour barrier, polyethylene sheeting of minimum thickness 0.5mm, to provide a desiccated package to BS 1133-19 for 6 months in tropical climate.

### 3.5 Wooden Containers for Packing

Wooden containers shall comply with BS 1133-8. The following additional requirements shall be applicable for cases or containers exceeding 250kg in weight or 2m<sup>3</sup> in volume:

- (a) Crush battens shall be used to prevent side crushing and to render additional support to the lid. One crush batten shall be used at each part likely to be handled by lifting-grabs.
- (b) Headers shall be used to distribute the load.
- (c) Corner posts shall be used in jointing sheathing elements.
- (d) Moisture content of timber used shall not cause moisture condensation when transported in freight containers and shall not exceed 20% in any event.
- (e) Skid or sill type base shall be provided.
- (f) Bottom sheathing shall be run in the shorter direction.
- (g) Blocking method shall be used to prevent movement of load during mechanical and manual handling.
- (h) Sharp projections shall be padded with cellulose or equivalent wadding fixed in position with adhesive tape.

### 3.6 Desiccated Package for Cases Exceeding 2m<sup>3</sup>

The amount of desiccant shall comply with BS 1133-19 with specific requirements as follows:

- (a) Desiccant shall undergo positive colour change or an indicator shall be provided for showing excessive moisture content.
- (b) Polyethylene bags of minimum 0.5mm thickness or another material of equal robustness and moisture repelling property shall be used.

- End of Specification -