WATER SUPPLIES DEPARTMENT

STANDARD SPECIFICATION EM-00-03

SUPPLY OF MECHANICAL, ELECTRICAL AND INSTRUMENTATION PLANT AND EQUIPMENT

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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. All equipment supplied shall be in accordance with the terms, conditions and specifications specified in the Contract.

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 Work Execution

This clause shall be applied for supply and installation contracts where execution of Works is not specified in the Specification. It does not apply for supply only contracts.

(a) Programme of Work

Within one (1) month from the date of acceptance of the Tender, the Contractor shall submit to the Purchaser or Engineer, whichever is appropriate, for approval a detailed programme showing the times of important activities and milestones, including design, ordering of materials and components, inspection, manufacture, testing and delivery to site and/or port for shipment of the various parts of the Works.

(b) Progress Report

Within two (2) months after acceptance of the Tender and at monthly intervals thereafter, the Contractor shall submit to the Purchaser/Engineer, with a copy to the Independent Inspection Body (IIB) if appropriate, a detailed progress report indicating the stages reached in design, ordering of materials, manufacture, inspection and despatch of the plant and equipment ordered. The report shall be accompanied by bar charts of critical path analysis diagram of an approved form as may be required by the Purchaser/Engineer.

The report shall be forwarded promptly to the Purchaser/Engineer, so that upon receipt of the report, the information contained therein shall be no more than seven (7) days out of date.

1.3 Equipment Approval

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

Within fourteen (14) days from approval of the submission, the Contractor shall supply up to three (3) copies of each approved document to the Purchaser/Engineer. The copies of approved submissions should be stamped and certified by the Contractor as true copy.

1.4 Inspection, Testing and Reporting

All plants supplied shall be subject to inspection, examination and test witnessed by an Independent Inspection Body (IIB) unless otherwise exempted. 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 in Schedule of Prices and Particulars.

The Purchaser/Engineer may order all or any of the recommended spare parts and tools at his discretion.

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

2. GENERAL TECHNICAL REQUIREMENTS

2.1 Plant Design

The design and construction of the plant shall be in accordance with modern technique and the best current practices to achieve energy efficiency and sustainability and shall facilitate operations, inspection, cleaning, lubrication and repair to ensure long life and satisfactory operation under all service conditions.

Unless otherwise specified, the plant shall generally be designed for 24 hours per day

continuous operation with minimum maintenance and maximum safety at duty conditions specified with minimum attendance by the operators. Routine maintenance and repair of the plant and equipment shall, as far as possible, not require the services of highly skilled personnel.

The plant 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 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 type and standard manufacture 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 supplied as part of each equipment.

Guards, electrical safety devices, thermal insulation, noise suppression devices, safety colours and the like shall be provided where needed. The requirements in the appropriate International Standards and regulations shall be followed. Protection guards on machinery shall be rigid, securely fixed and made so that they do 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. Where major dismantling is required to replace a part the life of such parts shall be not less than ten years.

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 for all component parts shall be selected to suit the operation environment without corrosion to ensure the designed life 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 upon 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 steels which are to be welded shall not be subject to intergranular corrosion.

Suitable inhibiters 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 should 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 and humidity and it 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 supplied.

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. On request of the Purchaser/Engineer, the manufacturer shall state his experience in the manufacturing of the equipment and

systems and provide a list of installed schemes of similar types and sizes as the manufacturer proposes to offer for this application.

2.6 Fluid Handled

2.6.1 Raw Water

When the plant 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 ($CaCO_3$)	2 - 39
Total Hardness ($CaCO_3$)	4 - 45
Calcium (Ca)	0.4 - 15.2
Magnesium (Mg)	<0.1 - 2.4
Chlorides (Cl)	2 - 50
Sulphates (SO_4)	1 - 20
Ortho - PO_4 (PO_4)	<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_2)	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 residual of 1.0 mg/litre.

2.6.2 Treated Water

When the plant 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 ($CaCO_3$)	4 - 53
Total Hardness ($CaCO_3$)	5 - 111
Calcium (Ca)	2.6 - 33.2
Magnesium (Mg)	0.2 - 10.2
Chlorides (Cl)	3 - 44
Sulphates (SO_4)	4 - 32
Ortho - PO_4 (PO_4)	<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_2)	3.0 - 17.9
Temperature °C	13.0 - 31.0

2.6.3 Salt Water

When the plant is specified for salt water applications, the salt water abstracted from sea may contain high suspended solids and at high bacterial levels. The water is normally chlorinated for inhibiting marine growth in the supply system. The water is highly 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 plant 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. The proposed style, label material, inscription, location and means of fixing shall be submitted to the Purchaser/Engineer 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 paragraph 2.9 shall be applied after the completion of works tests. 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.

2.9 Final Colours for Plant and Equipment

Plant/Equipment to be Painted	**Coding Colour**	**Colour Reference to BS 4800**
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

Plant/Equipment to be Painted	Coding Colour	Colour Reference to BS 4800
Diesel Engines	To match 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 equipment colour	-
Ventilation Ducts and Grilles	To match wall colour	-
Ventilation Ducts for Motor	To match motor colour	
Platforms and Ladders except Stainless Steel and Aluminium Alloy	Black	00E53
Handrailings except Stainless Steel and Aluminium Alloy	Sky Blue or To match 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	Submitted for approval	-
Low Voltage Switchboard	Light Grey	18B21

Plant/Equipment to be Painted	Coding Colour	Colour Reference to BS 4800
High Voltage Motor	To match driven equipment	-
Low Voltage Motor	Same as the pump	-

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 contain or securely attach thereon, 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 despatched to reach the Purchaser/Engineer prior to arrival of the equipment.

3.2 Equipment Packing

Equipment shall be packed such that each package or case shall contain materials for one location only.

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 where it cannot be fitted into a freight metal container, the Contractor shall submit for the approval by the Engineer 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 such as switchboard, control/instrument panels or motors above 250kg, lifting eye-bolts shall be provided. For large motors or equipment where the headroom is inadequate for transport by slings, a suitably designed spreader shall be supplied.

For cables weighting 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.

3.3 Components Packing

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.

Parts with grease/oil lubricated elements shall be charged with the correct type and quantity of lubricant for normal operations prior to shipment unless recommended otherwise by the manufacturer. If the manufacturer recommends an alternative method of lubrication for shipment and storage, its details shall be supplied.

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 $2m^3$ 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 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 $2m^3$

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

(a) Desiccant shall undergo positive colour change or indicator shall be provided for excessive moisture content.

(b) Polyethylene bags shall be of minimum thickness 0.5mm. Alternatively other material of equal robustness and moisture repelling property shall be used.

4. DRAWINGS AND INSTRUCTION MANUALS

4.1 Drawings

The drawings shall be prepared by the computer using "AutoCAD" software and produced in Adobe Acrobat's Portable Document Format (PDF). The format shall conform to the latest version of CAD Standard for Works Projects (CSWP) as posted on the web site of the Development Bureau of The Government of The Hong Kong Special Administrative Region "http://www.devb.gov.hk/cswp".

Dimensions of all drawings shall be in S.I. Units. The selection of drawing size shall take account of legibility, composition and complexity of the design. The final presentation of drawings on paper or equivalent media shall conform to the sheet sizes in BS EN ISO 5457. The preferable drawing sizes are B1, A1, A2, and A3. Sizes smaller than A3 will only be accepted subject to the approval of the Purchaser/ Engineer. The drawings shall be scanned with good quality at the resolution to 400 dots per inch (dpi) or higher in black and white or 2400 dpi or higher in colour.

Other than the requirements specified herewith, the drawings shall also comply with WSD Standard Specification E-90-01, E-90-11, E-90-12 and E-90-13 whichever is/are applicable.

Within one (1) month after award of Contract, the Contractor shall submit for approval two (2) copies each of the following drawings and on each drawing so submitted he shall certify that it has been checked for compliance with the Contract requirements.

(a) General arrangement drawings of the plant and all ancillary equipment to be supplied under the Contract which shall include dimensions, weights and recommended foundation details.

(b) Sectional drawings of plant items to be supplied under the Contract with parts

and materials lists.

(c) Detailed drawings or modification necessary to enable the design and construction of associated civil works to proceed, i.e. details of ducts, openings, trenches, foundations, foundation bolt holes, foundation bolts, etc.

(d) Fully dimensioned drawings of each item of plant.

(e) Diagram of connections for each item of electrical equipment together with a wiring diagram and/or cable schedule showing connections between the various items of equipment. The terminal markings on the diagrams shall correspond to those used on the equipment.

Within fourteen (14) days from approval of the drawings, the Contractor shall forward three (3) sets of approved drawings to the Purchaser/Engineer. The copies of approved drawings should be stamped and certified by the Contractor as true copy.

If the approval of any submitted or resubmitted drawings is subject to the incorporation of marked up comments or amendments, the Contractor shall, within fourteen (14) days, resubmit three (3) sets of the drawings incorporating the specified amendments to the Purchaser/Engineer.

Unless specific instructions are given by the Purchaser/Engineer in writing, no drawings other than the approved drawings shall be used for the manufacture of the equipment.

The Contractor should 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.

For Contracts which cover also installation and/or commissioning of the Works, the Contractor shall supply two (2) sets of draft record drawings for approval prior to his request for the issue of the certification of completion. The drawings shall incorporate all alterations and amendments authorised by the Purchaser/Engineer throughout the Contract period. Within three (3) months from the issue of the certificate of completion, the Contractor shall supply four (4) sets of the approved drawings as record drawings. In addition to the drawings in paper form, the Contractor shall supply a CD-R containing "AutoCAD" and PDF data files.

4.2 Instruction Manuals

4.2.1 General

The manual shall comply with the latest version of International Standards. The following standards, in particular, shall apply where appropriate:

BS 4884 Technical manuals

BS EN 61187 Electrical and electronic measuring equipment – Documentation

BS ISO/IEC 26514 Software and systems engineering. Requirements for designers and developers of user documentation

The contents of the instruction manuals shall comply with BS 4884-2. The requirements specified in Clause 4.2.3 and the presentation of the materials therein shall comply with BS 4884-3 and the requirements specified in Clause 4.2.4. Prints of documents and drawings shall be sufficiently clear to allow reproduction without loss of legibility by a digital scanning system.

For individual mass manufactured items covered in a supply contract, e.g. sluice valves, reflux valves, motorised butterfly valves, air blowers, air compressors and sump pumps, standard printed manuals from the manufacturer may be acceptable provided that the requirements of this Specification are generally met.

For custom assembled equipment, standard printed manuals shall be supplemented by specially prepared type-written document with technical description, operating and maintenance procedures, and trouble shooting of the system as a whole.

The manual shall contain information to facilitate testing, commissioning, operation and maintenance of the plant and equipment.

4.2.2 Submission

At least one (1) month before completion of erection of the plant (for supply and installation contracts) or prior to delivery of the equipment (for supply only contracts), the Contractor shall forward two (2) sets of draft manuals to the Purchaser/Engineer in Hong Kong for approval.

If, in the opinion of the Purchaser/Engineer, the information supplied is insufficient, the Contractor shall supply further information as required at no additional charge.

For supply only contracts, within three (3) months from the delivery of the equipment, the Contractor shall supply four (4) sets of the final manuals incorporating all necessary amendments.

For contracts which cover also installation and/or commissioning of the Works, the Contractor shall supply two (2) additional sets of revised draft manuals for approval prior to his request for the issue of the certificate of completion and four (4) sets of final manuals incorporating all necessary amendments shall be submitted within three (3) months from the issue of the certificate of completion.

In additional to the manuals in paper form, the Contractor shall also supply a CD-R containing electronic version of the final manual, including the drawings, in Adobe Acrobat format.

4.2.3 Contents

The contents of the instruction manuals shall include the following information :

(a) General Information

A front cover sheet and a spine of the binder showing the title of the Contract, order reference number, volume number, date of issue, name of the Contractor and location of plant shall be provided. The scope of the Contract and the application of the equipment shall be briefly described.

Names, postal and e-mail addresses and telephone and fax numbers of manufacturers and suppliers of each equipment item, the technical literatures, catalogues and data sheets shall be given in the manual.

(b) Design and Planning Information

The design and planning basic data such as background information, purpose, capability, performance, calculation, environmental impact, health and safety, etc. shall be included. The requirements for switchboard and control board, motors of 100kW and above and generators of 150kVA and above are specified as follows:

(i) Switchboard and Control Board

The manual shall contain a detailed description of each mode of control, monitoring and alarm and the calculation of protection settings for switchboard and control board. For motor starter circuits of the switchboard, their starting frequency limitation shall be specified. Operational data and settings of protective devices and timers shall be tabulated. For auto-transformer motor starter, the thermal withstand capability, utilisation category and percentage tapping of the auto-transformer shall be specified.

(ii) Motors of 100kW and above and Generators of 150kVA and above

System design information shall cover the stator and rotor winding, enclosure IP, ventilation, bearing construction and cooling media, drive shaft assembly and coupling, lubrication and cooling protective devices. The data sheets of accessories and auxiliaries equipment such as bearing, winding temperature detectors, space heater, cable box, capacitor, vibration detectors and monitor, electric valve actuator and flow switches where appropriate shall be provided.

For pump motors, the manual shall provide details of the starting frequency limitation, motor and pump torque speed curves (at minimum specified voltage and with delivery valve closed) and motor short-time overload withstand characteristic curves.

For diesel generators, the manual shall provide details of the operational data and settings of protective devices and timers. The permissible operating limits of power factor, over-current and unbalance load shall also be stated in the manual.

(c) Health and Safety Information

The health and safety information including precautionary measures in relation to the installation, testing, commissioning, operations and maintenance of the plant supplied under the Contract shall be included.

Instructions and procedures for the safe operation of product under normal, emergency and special conditions and methods and precautions to avoid risk of injury to people or damage to the product shall be provided.

(d) Operating Information

Description of the plant in general together with the principle of operations, performance, capacity and quantity of equipment supplied under the Contract shall be given. Reference to the design operating conditions and requirements for the safe use of the equipment shall be included.

A list of any by-products formed and the potential hazards during operation of the plant shall be described. A drawing/diagram showing all switches, adjustable controls, gauges, indications and alarms required for operating of the equipment shall be provided for use by operations and maintenance personnel.

Lists of any safety precautions, requirements on the setting and adjustment of interrelated equipment for start-up and shut-down shall be included. In additions, a step by step procedure for start-up and shut-down of the equipment for all modes of operations shall be provided.

Process element information, operation instructions, description of equipment, principles of operation, environmental conditions and system characteristics shall be comprehensive for the work being carried out by the operational and maintenance staff efficiently and effectively.

(e) Monitoring Information

A schedule showing the important parameters to be logged for monitoring of plant operations/performance shall be given. A sample log sheet with the parameters on a recommended recording time interval shall be provided.

Schedules of corrective measures stipulating the adjustments required for correcting the equipment performance deviation from pre-set values should be provided. Information including the adjustable ranges, the recommended

values, special tools and relevant instructions shall be given.

(f) Trouble-Shooting Information

A list of all alarms and their corresponding implications including their causes and rectification shall be provided. In providing the rectification instructions, a trouble-shooting chart detailing the fault diagnosis and step by step procedures for correction of faults should be made. Exploded view sketches showing the location of faulty items and repair should also be included.

(g) Technical Information

A collection of the equipment data sheet shall be made such that the search of information during inspection and maintenance can be carried out systematically and efficiently. The equipment data can be obtained from the approved schedule of technical particulars for supply contracts. If amendment of the equipment operating characteristics is made during the contract period, the equipment data sheet should be duly updated to reflect the information of the plant furnished under the Contract.

All operating characteristic tables or curves and software of the equipment supplied under the Contract shall be provided. The control methodologies and software programmes shall be documented.

(h) Handling, Installations, Storage and Transit Information

A list of required conditions, precautions and protective measures against deterioration and damage of the plant during transit and storage shall be mentioned. Clear instructions on unpacking of the equipment and the removal and safe disposal of protective and preservative packaging shall be stated.

With regard to the installation of equipment, instructions on proper handling of the equipment, drawings of lifting points and list of any special tools and treatments required for setting the equipment in position shall be stated. A step by step procedure for proper installation of the equipment incorporating the acceptance criteria shall be supplied.

A list of any short-term and long-term storage requirements and method before and after the use of the equipment shall be provided. To facilitate routine maintenance and overhaul of the equipment, in addition to the storage requirement, a step by step procedure supplemented with exploded view diagrams for proper dismantling of the equipment and list of any special tools and required treatments shall be included.

For items weighting over 100 kg, lifting points and details on the use of slings and spreaders shall be specified. Limit of storage life and storage environment of the product shall be specified. The installation procedures shall cover the information such as supply voltage, foundations and mounting requirements,

methods of connecting and protecting the product, a list of tools, tester and calibration equipment.

Any transit clamps or guards on switchboard and control board, protective relays or instrument against vibration for transport and storage shall be detailed. Recommended details on grouting of foundation bolts shall be provided. Mounting skirt/rails at panel fixing points shall be indicated.

For motors of 100kW and above and generators of 150kVA and above, any transit clamps or guards on moving parts (e.g. shaft and rotor), protective relays (if any) or instrument against vibration for transport and storage shall be detailed. The method, tools and equipment for lifting of the stator and rotor shall be specified. The method of installation such as foundation and sole plate requirement shall be detailed.

(i) Commissioning, Inspection and Calibration Information

A schedule of settings including the corresponding recommended values for controlling instruments shall be provided. If special tools and treatments are required for the initial start-up of the equipment, they shall be covered in this section. In additional to the start-up requirement, details shall also be given for tuning the furnished plant to achieve its optimal performance. All the methods used and special tools required in monitoring the performance shall be mentioned.

Any calibration curve used during site testing of the equipment shall be included in this section. A collection of the works test reports and certificates shall also be included.

(j) Maintenance Information

A schedule of recommended lubricants and frequency of application/changing, and a drawing showing all lubrication points shall be provided.

To facilitate scheduling of maintenance requirements, information shall be in the form of a preventive maintenance chart detailing all routine and major overhaul operations to be carried out with associated operational periods or running hours. Exploded view sketches shall be used to explain the dismantling procedures for component replacement and overhaul.

Procedures of fault diagnosis, commissioning, special tools, checklists, flow chart, communication protocol, set points, testing and inspection shall be detailed. The work instructions shall possess sufficient details and clarity to enable technicians to understand and maintain the product and to identify replaceable parts, all in an effective and expeditious manner without having to resort to extensive unguided search through other items of documentation.

The maintenance instructions for switchboard and control board shall include

the followings:

(i) A schedule of maintenance tools supplied with the contract e.g. test plug, circuit-breaker slow closing handle, circuit-breaker drawout handle, earthing gear, torque wrenches etc.;

(ii) A dismantling and re-assembly instruction with '*warning*' or '*caution*' information for the safe maintenance of the switchboard and control board;

(iii) A components maintenance instruction on the contacts for circuit-breakers, contactors and relays, moving mechanism of circuit-breakers and busbars; and

(iv) A panel repair information e.g. details of primer, undercoat and top coat of paint, method of application and curing.

The maintenance instructions for motors of 100kW and above and generators of 150kVA and above shall include the followings:

<u>Motors of 100kW and above</u>

- Detailed instructions on how to maintain the motor bearings including the white metal bearing and insulated bearing if applicable;
- Detailed instructions on how to disconnect the earth link and test the bearing insulation of the insulated bearing if applicable; and
- Detailed instructions on how to test and calibrate the auxiliary equipment such as embedded winding temperature detectors and monitor, vibration detectors and monitor.

<u>Generators of 150kVA and above</u>

- Detailed instructions on how to maintain the diesel engine; and
- Detailed instructions on how to maintain the battery system and other auxiliary equipment.

<u>Motors of 100kW and above and Generators of 150kVA and above</u>

- A schedule of maintenance tools supplied with the contract;
- A dismantling and re-assembly instruction with 'warning' or 'caution' information for the safe maintenance of the equipment;
- A stator and rotor rewinding information such as insulation system of coils and inter-coil connection details etc.;

- A dry-out method for stator and rotor;
- A recommended/anticipated polarisation index and tangent delta of windings;
- Detailed instructions on balancing a rotor; and
- Detailed instructions of removal a rotor from stator.

(k) Spare Part Information

A comprehensive spare parts and special tools list including cross-reference information with the equipment and components drawings shall be provided. The list shall be furnished with the names of the spare parts, brief descriptions, part numbers and the corresponding stock level for maintaining the plant for one year operation.

If the Contract is for the supply of equipment under different manufacturers, manufacturers' information including names, fax numbers, contact persons, etc shall be included in order to avoid undue delay for ordering of spares.

(l) Reports and Certificates

Type test certificates or reports called for in the contract shall form part of the manual with the following information:

(i) Particulars of test including the name and address of testing station, profile of the testing authority, date and time of test, witnessing authority.

(ii) Particulars of equipment tested including the manufacturer and model, rating, test objective and relevant IEC, BSEN Standards and other international standards.

(iii) Description of testing details and conditions as specified in relevant IEC, BSEN Standards and other international standards to conform test conditions are in compliance with these standards.

(iv) Certified copy of full size drawings showing the equipment assembly, insulating barriers, busbars/cable sizes and type, clearance and creepage, etc.

(v) For short-circuit testing, the current transformer mounting details, switchgear connection, partition type and thickness and ventilation arrangement shall be detailed.

(m) Other Information

A collection of print of each of the approved record drawings and a comprehensive plant equipment register detailing the individual equipment by giving its equipment number/tag number, description, capacity, operating range, setting, power requirement, serial number, etc shall be provided. The operation of a planned programme of inspection, cleaning and maintenance of the plant and equipment shall be detailed. Equipment operating parameters and control settings shall be given.

4.2.4 Presentation

Manuals shall be produced from A4 size papers, paginated and bound in heavy duty binders with hard covers and spines. The size of binders shall not exceed 320 x 240 x 90 mm (l x w x d). Where ring binders are to be used, fixing clips shall be provided to fasten the sheets in position.

The project title, order reference and scope of supply shall be shown on the front cover and the spine of the manual with printed letters or in the form of a printed slip enclosed in a plastic envelope.

Where more than one volume is provided, these shall be clearly identified. Each volume shall be contained in a separate binder. The contents in a binder shall not exceed 60 mm in thickness.

A contents/index section listing all sections and sub-sections of all volumes of the instruction manuals shall be provided. Each group of drawings shall be provided with a schedule giving drawings numbers used by both the manufacturer and the Contractor, date of issue, amendment number, and drawings description that would identify clearly the equipment and purpose of the drawing.

Each major topic, equipment or standard manual from manufacturers shall be in a section separated by tabbed, numbered or lettered dividers in the corresponding sequence being mentioned in the contents/index section. Each set of printed catalogues or manufacturer's manuals shall be in a separate sub-section.

For Contracts involving more than one location, separate instruction manuals shall be provided for the plant of each location. If common equipment forms part of the supply for Contracts covering more than one location, the instruction manuals of the common equipment shall be bound in each separate volume. Whereas identical equipment ordered under bulk supply contract, same volume may be used for all locations.

The provision of copies from stencil duplicators or wet type duplicating machines and photostat or Xerox copies of photographs shall not be acceptable.

Drawings prints larger than A3 size shall be neatly folded and placed in robust transparent plastic bags for binding into the manuals.

- End of Specification -