

WATER SUPPLIES DEPARTMENT
STANDARD SPECIFICATION EM-90-02

INSTRUCTION MANUAL FOR MECHANICAL, ELECTRICAL
AND INSTRUMENTATION PLANT AND EQUIPMENT

1. GENERAL

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

BS 4884	Technical manuals
IEC 62079	Preparation of instructions – Structuring, content and presentation
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 and the presentation of the materials therein shall comply with BS 4884-3. Prints of documents and drawings shall be sufficiently clear to allow reproduction without loss of legibility by a digital scanning system. The instruction manuals shall be in English unless otherwise specified.

For individual mass manufactured products, e.g. pipe fittings, valves, air blowers, air compressors and sump pumps, standard printed manuals from the manufacturer may be acceptable to form part of instruction manuals.

For custom assembled plant and 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.

2. CONTENTS

The instruction manuals shall contain information to facilitate testing, commissioning, operation and maintenance of the plant and equipment and replacement of individual items of equipment.

2.1 Identification 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.

2.2 Planning and Design Information

The scope of the Contract and the quantity of equipment supplied shall be briefly described.

The basic technical data such as background information, purpose and description of the plant in general together with the principle of operation, capability and performance requirements of key equipment shall be included.

2.3 Construction and Performance Information

A collection of the equipment data sheets shall be made such that the search of information during inspection and maintenance can be carried out systematically and efficiently. The equipment data shall be obtained from the approved schedule of technical particulars. If amendment of the equipment operating characteristics is made during the contract period, the equipment data sheet shall 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 programs shall be documented.

2.4 Health and Safety Information

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

2.5 Handling, Transit, Storage and Installation Information

A list of the 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. Any transit clamps or guards on switchboard and control board, protective relays or instruments against vibration for transport shall be detailed.

A list of short-term and long-term storage requirements and methods before and after the installation of the equipment shall be provided. Limit of storage life and storage environment of the spare parts shall be specified.

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. For items weighting over 100 kg, lifting points and details on the use of slings and spreaders shall be specified.

A step by step procedure for proper installation of the equipment incorporating the acceptance criteria shall be supplied. The installation procedures shall also cover the information such as supply voltage, foundation and mounting requirements, methods of connecting and protecting the product, a list of tools, tester and calibration equipment. Mounting skirt/rails at panel fixing points shall be indicated. Recommended details on grouting of foundation bolts shall be provided.

2.6 Site Testing and Commissioning Information

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. Equipment operating parameters and control settings shall be given.

A schedule of settings including the corresponding recommended values for control 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 addition to the start-up requirement, details shall also be given for tuning the plant to achieve its optimal performance. All the methods used and special tools required in monitoring the performance shall be mentioned.

A collection of the site test records and commissioning test reports shall be included as appropriate. Any calibration curve used during site testing of the equipment shall also be included in this section.

2.7 Operation Information

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

Instructions and procedures for the safe operation of the plant under normal, emergency and special conditions and methods and precautions to avoid risk of injury to people or damage to the equipment shall be provided. 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 the equipment shall be provided for use by operation and maintenance personnel.

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

2.8 Monitoring Information

A schedule showing the important parameters to be logged for monitoring of plant operation/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 deviation of the equipment performance from pre-set values shall be provided. Information including the adjustable ranges, the recommended values, special tools

required and relevant instructions shall be given.

2.9 Trouble-Shooting Information

A list of alarms and their corresponding implications including the causes and rectification actions shall be provided. 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 to be repaired shall also be included.

2.10 Maintenance Information

The operation of a planned programme for inspection, cleaning and maintenance of the plant and equipment shall be detailed.

To facilitate scheduling of maintenance works, information shall be in the form of a preventive maintenance chart detailing all routine and major overhaul operations to be carried out within specified operational periods or running hours. A step by step procedure supplemented with exploded view diagrams for proper dismantling of the equipment and a list of the special tools and required treatments shall be included.

Procedures of fault diagnosis, commissioning, use of special tools, checklists and flow charts, adjusting 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 equipment 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.

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

2.11 Works Test Reports and Certificates

Type test certificates and works test reports of the equipment called for in the Contract shall form part of the instruction manuals 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.

2.12 Spare Part Information and Contact List

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.

Names, postal and e-mail addresses and telephone and fax numbers of manufacturers and suppliers of each equipment item shall be given.

2.13 Drawings

A collection of print of each of the approved record drawings and the as-fitted drawings of the plant and equipment shall be included.

2.14 Additional Requirements for Specific Equipment

2.14.1 Switchboard and Control Panel

The instruction manuals shall contain a detailed description of each mode of control, monitoring and alarm and the calculation of protective relay settings, short circuit analysis and protective device coordination study 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.

The instruction manuals shall also include the following maintenance information:

- (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.
- (v) The wiring diagrams showing the connection details of the components.
- (vi) The calculations and discrimination curve of protection relay sensors.

2.14.2 Motor of 100kW and above and Generator of 150kVA and above

Machine 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 instruction 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, starting curves and damage curves.

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

The instruction manuals shall include the following maintenance information:

<u>Motor of 100kW and above</u>	<u>Generator of 150kVA 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 maintain the diesel engine; and
- Detailed instructions on how to disconnect the earth link and test the insulation of the insulated bearing if applicable; and	- Detailed instructions on how to maintain the battery system and other auxiliary equipment.
- Detailed instructions on how to test and calibrate the auxiliary equipment such as embedded winding temperature detectors and monitor, vibration detectors and monitor.	

The instruction manuals shall also include the following maintenance information:

- (i) The schedule of maintenance tools supplied with the Contract;
- (ii) Dismantling and re-assembly instructions with 'warning' or 'caution' information for the safe maintenance of the equipment;
- (iii) Stator and rotor rewinding information such as insulation system of coils and inter-coil connection details etc.;

- (iv) The dry-out method for stator and rotor windings;
- (v) The recommended/anticipated polarisation index and tangent delta of windings;
- (vi) Detailed instructions on alignment and levelling of the machine;
- (vii) Detailed instructions on balancing the rotor; and
- (viii) Detailed instructions of removal the rotor from stator.

2.14.3 Power Transformer

Transformer construction and installation information shall consist of windings, magnetic core structure, tank, rating plate, enclosure and method of cooling. The data sheets of accessories and auxiliaries equipment such as pressure relief device, cooling fans, embedded temperature detectors, temperature indicating devices, oil level indicator, tap changer, cable boxes, bushings, gas and oil actuated relays, protective relays, mechanical interlocks, valves and dehydrating breather, etc. where appropriate shall be provided.

The instruction manuals shall include the following maintenance information:

Oil-filled Transformer

- Detailed instructions on how to fill with oil, check for leaks, purify oil, etc.; and
- Recommended tests for analysis of oil in service such as dielectric test, water moisture content test, dissolved gas analysis, etc.

Dry-type Transformer

- Cleaning procedures.

The instruction manuals shall also include the following maintenance information:

- (i) The schedule of maintenance tools supplied with the Contract and recommended test equipment;
- (ii) Dismantling and re-assembly instructions with 'warning' or 'caution' information for the safe maintenance of the equipment;
- (iii) Information of rewinding and replacing the coils such as winding material, conductor insulation and connection details, etc.;
- (iv) The dry-out method for transformer core and coils;
- (v) The recommended/anticipated insulation resistance of windings;
- (vi) Detailed instructions on tap changer operation, assembly and maintenance;

- (vii) Detailed instructions on how to test and calibrate the auxiliary equipment such as embedded winding temperature detectors, etc.; and
- (viii) Transformer protection study including settings of protective relays, required value of stabilising resistor and selection of current transformers, etc.

2.14.4 Instrumentation and Control System

The instruction manuals shall describe the instrumentation and control of the complete process plant. The configuration and assembly of the control systems in the process flow diagram and the particulars of the instruments and communication network shall be fully documented in the narrative form.

Information for Supervisory Control and Data Acquisition (SCADA) systems, Programmable Logic Controllers (PLC) and Distributed Control Systems (DCS) shall include the following:

(a) Instrument and Input / Output Lists

Schedules of equipment and Process and Instrumentation (P&I) diagrams shall be provided to list all utilized Input / Output (I/O) address, internal relay addresses, timer, counters and register addresses and values, etc. The P&I diagrams shall show the physical process and equipment in the proper functional relation.

(b) Programmable Logic Controllers Programs

PLC programs shall be documented with extensive commentaries describing the process logic, P&I diagrams shall indicate major control logic elements by showing interconnected device functions and interlocks. Tag names and database containing scaling information, data type information and configuration parameters shall be provided.

(c) Communication Network

The selection of network topology to achieve a level of redundancy in a reliable communication system and information security adopted to ensure data protection shall be documented. Connections to SCADA / PLC / DCS networks shall be identified. For optical fibre network, calculation of modal bandwidth and attenuation shall be included.

(d) Human Machine Interface (HMI)

Hierarchical and graphical screen layouts configured for the menu navigation and process visualization shall be documented. Naming conventions, symbols and colour schemes of process monitoring and alarm classification, parameters and messages in the HMI screen diagrams shall be defined.

(e) Process Logic Diagrams

Control methodology in the form of control detail sheets, control function charts and logic diagrams and data flow diagrams showing the data transfer among processes and the logical storage in the control systems shall be provided.

The instruction manuals shall also include the following information:

- (i) Explanation and detailed analysis of the functions of systems, subsystems and major equipment.
- (ii) Functional descriptions of SCADA / PLC / DCS installed including programming software and the associated hardware required for operation and maintenance of all components of the monitoring and control system, networking and communication equipment.
- (iii) Description of the repair, adjustment or replacement of major items and the use of on-line test, network management software and diagnostic software and test equipment for monitoring data communication traffic, analysing communication faults and troubleshooting.
- (iv) A list of tools for monitoring and troubleshooting the PLC program.
- (v) Detailed instructions on how to locate faults down to the PLC modules and replace devices and components.
- (vi) Detailed instructions on how to load and use any software and equipment to test and diagnose hardware / software modules.

3. PRESENTATION

3.1 General

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.

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

3.2 Electronic Version of Manuals

The electronic manual shall be in pdf format with resolution of 300 dpi or better.

The electronic manual shall be processed with Optical Character Recognition (OCR) and the output style shall be searchable image in pdf format. The primary OCR language shall be English.

The electronic manual shall contain separate pdf files for content pages, sections, sub-sections, appendices and as-fitted drawings. All files shall be optimized and split into parts where necessary to keep individual pdf file size under 10 Mbytes. The content pages pdf file shall not exceed 2 Mbytes.

To make the electronic manual more accessible, the content page pdf file shall be embedded with relative document links to individual sections, sub-sections and appendices. The relative document links shall remain valid for opening and saving as long as all pdf files are stored in the same storage device.

3.3 Manuals for Site Work

Information, documents, drawings and records related to inspection, installation, testing and commissioning of the plant and equipment on site, where applicable, shall be contained in separate volumes of the instruction manuals arranged in the same sequence as those volumes for supply of plant and equipment.

3.4 Manuals for Different Locations

Unless otherwise specified, for a Contract involving more than one location, separate instruction manuals shall be provided for the plant of each location. The instruction manuals of common equipment shall be bound in a separate volume for ease of updating.

Copies shall be produced from dry type duplicating machines and photostat or Xerox copies of photographs shall not be acceptable.