

**WATER SUPPLIES DEPARTMENT**  
**STANDARD SPECIFICATION EM-90-01**  
**DRAWING FOR MECHANICAL, ELECTRICAL**  
**AND INSTRUMENTATION PLANT AND EQUIPMENT**

1 GENERAL

1.1 Standards

The drawings shall comply with the latest version of relevant British or other International Standards. The following British Standards, in particular, shall apply where appropriate:

BS 308	Technical drawings
BS 1553	Specification for graphical symbols for general engineering
BS 1635	Recommendations for graphic symbols and abbreviations for fire protection drawings
BS 1646	Symbolic representation for process measurement control functions and instrumentation
BS 2917	Graphic symbols and circuit diagrams for fluid power systems and components
BS 5070	Engineering diagram drawing practice
BS 5536	Recommendations for preparation of technical drawings for microfilming
BS EN ISO 5457	Sizes and layout of drawing sheets
IEC 60617	Graphical symbols for diagrams
IEC 61082	Preparation of documents used in electrotechnology

Computer-Aided-Drafting (CAD) drawings shall conform to the latest version of CAD Standard for Works Projects (CSWP) as posted on the Development Bureau (Works Branch) web site of the Government of Hong Kong Special Administrative Region.

1.2 Content

The drawings shall provide information in the simplest practical way for the managing, commissioning, use and maintenance of an installation or a system. They shall:

- (a) Describe all presentable and useful information of the installation, system or equipment;
- (b) Be accurate and concise;
- (c) Be easy to understand;
- (d) Suit the purpose for which it is intended; and
- (e) Be easy to handle and maintain such as photo copying, scanning, microfilming, electronic filing and editing.

### 1.3 Size

The selection of the drawing size shall take account of legibility, the composition and complexity of the design. The final presentation of the 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 if they are mass manufactured equipment stipulated in Clause 1.8.

### 1.4 Lines and Text

The lines and text shall be as follows for drawings prepared by manual drafting:

<i>Minimum Requirement</i>	
<i>Line</i>	0.25 mm thickness
<i>Line Spacing</i>	1 mm
<i>English Text</i>	2.5 mm height
<i>Chinese Text</i>	1 mm higher than English Text

Hard copy of drawings prepared by CAD shall also meet the above requirements.

### 1.5 Layout

The layout of a drawing shall be clear for easy understanding. For a circuit diagram, the signal flow direction shall be from left to right or, alternatively, from top to bottom. The arrangement of symbols and circuits shall emphasise either functional relationship or physical location. The functionally related circuits shall be arranged in groups of power supply, tripping, closing, alarm and indication etc. Numbered scale bar in metric unit shall be provided.

### 1.6 Graphical Symbols

The graphical symbols shall conform in order of priority to CSWP, IEC 60617, BS 1553, BS 1635, BS 1646 and BS 2917 that are appropriate for their applications. Non-standard symbols shall be defined in a legend table shown on the drawing.

### 1.7 Equipment Data

Data such as equipment particulars, component labels, parts number, material of construction, schedule of fuses, limit switches, alarms and protection settings etc. shall be clearly entered in the drawing and tabulated in alphanumeric order.

### 1.8 Drawing for Mass Manufactured Equipment

For mass manufactured items e.g. valves smaller than 300 mm, instruments, pumps and motors below 100 kW and electric valve actuators, offset prints of standard drawings from the manufacturers shall be acceptable provided that quality of these drawings complies with the requirements of this specification. Electronic copy of

these drawings shall be in image files of Portable Document Format (PDF).

### 1.9 Drawing for Non-mass Manufactured Equipment

For non-mass manufactured items e.g. pipework, specially assembled electrical and instrumentation control or switchgear panel, power transformers, pumps and motors of 100 kW & above and generators of 150 kVA & above, offset prints of standard drawings shall not be acceptable.

### 1.10 Reproductives

Drawing reproductives shall be prepared using computer software. The Contractor shall supply a CD-R containing 'AutoCAD' data files, PDF files and hard copies of the record and as-fitted drawings.

## 2 PARTICULAR REQUIREMENTS

### 2.1 Drawing for Mechanical Plant

#### 2.1.1 General

The following drawings shall be provided:

- (a) General arrangement drawings of the plant and equipment with dimensions, weights, dynamic loads and recommended foundation details.
- (b) Sectional drawings of plant and equipment with parts and material lists.
- (c) Detailed drawings 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.; and
- (d) Fully dimensioned drawings of each item of plant and equipment.

### 2.2 Drawing for Switchboard and Control Panel

#### 2.2.1 General

Drawings shall be provided to show:

- (a) Circuit logic and wiring details;
- (b) Exterior layout; and
- (c) Interior layout including the busbars of switchboard.

#### 2.2.2 Circuit and Wiring Diagrams

A single line diagram shall be provided for the switchboard. Circuits of an equipment

shall be grouped into a single circuit diagram for clarity. Circuits shall be grouped by function as follows:

- (a) Current and voltage transformer leads;
- (b) D.C. power supplies;
- (c) A.C. power supplies;
- (d) Tripping control;
- (e) Closing interlocks and control;
- (f) Indication and alarm;
- (g) Instrument lead; and
- (h) Spares.

In the circuit diagram, small wiring shall be identified by one-digit prefix, two to three digit numerals and one-digit suffix.

Small wiring prefix shall be as follows:

- |                                      |                                |
|--------------------------------------|--------------------------------|
| A – Pilot Wire Relaying (Switchgear) | B – Busbar Protection C.T.     |
| – Alarms (Instrument)                |                                |
| C – Protective / Measuring C.T.      | D – Precision Metering C.T.    |
| E – Voltage Transformer              | F – Voltage Control            |
| G – Synchronising                    | H – A.C. Power Supply          |
| J – D.C. Power Supply                | K – Closing / Tripping Control |
| L – Indication and Alarm             | M – Motor Auxiliary. Devices   |
| N – Tap Changer Control              | P – Busbar Protection Trip     |
| R – Interlock Circuits               | S – D.C. Instruments / Exciter |
| T – Pilot Conductors                 | U – Spares                     |
| W – Process / Instrument / Control   | X – Analogue Signals           |
| Y – Telephone / Telemetry            | Z – Local Area Network         |

The two to three digit numerals shall follow same format as those in Water Supplies Department Electrical / Instrument Standard Drawings. These drawings will be issued to the Contractor for reference upon request.

The use of suffix letters shall be as follows:

- |                    |    |              |
|--------------------|----|--------------|
| No. 1 – 6 Motor    | -- | Suffix A – F |
| Station Protection | -- | M            |

Using the ‘closing and tripping control circuit of motor no.2’ as an example, the small wiring marking of the first line shall be “K11B”, the second line “K21B” and the third line “K31B”, etc.

Wiring diagrams showing the connection details of individual circuit components shall be provided as record drawings.

### 2.2.3 Exterior Layout

Drawings of exterior layout shall show the following details:

- (a) Front and side elevation of panel or console fabrication details (e.g. dimensions, panel material, paint finish, door hinge, structural support, mounting details and lifting provision etc.);
- (b) Installation arrangement (e.g. components mounting arrangement and schedule of component labels etc.); and
- (c) Mounting and fixing arrangement of cable boxes and openings for cable entry and their gland plates.

### 2.2.4 Interior Layout

Drawings of interior layout shall show the following details as appropriate:

- (a) Installation arrangement (e.g. wiring routes, wiring channels and components mounting arrangement and schedule of component labels etc.);
- (b) Ventilation path, protective screens and cubicle / compartment segregation;
- (c) Arrangements and dimensions of main busbars, down-droppers, busbar mounted fuses and connection to switchgear; and
- (d) Materials of busbars and their jointing section, insulation and supports.

## 2.3 Drawing for Motor of 100kW & above and Generator of 150kVA & above

### 2.3.1 General

Drawings containing the following information shall be provided:

- (a) Stator and rotor winding diagram;
- (b) Exterior layout;
- (c) Sectional details;
- (d) Thermal withstand characteristics curve; and
- (e) Cable box arrangement.

### 2.3.2 Winding Diagram

Winding diagrams shall show the following details:

- (a) Material of conductors and number of turns per coil;
- (b) Insulation system of coils including materials of inter-turn, main wall and

- overhang insulation, slot wedges and spacers;
- (c) Dimensions of conductor, coil, core, slot and wedge;
- (d) Inter-coil and inter-winding connection details; and
- (e) Location of embedded temperature detectors, where fitted.

### 2.3.3 Exterior Layout

Drawings of exterior layout shall show the following details:

- (a) Front and side elevation of equipment fabrication details (e.g. weight, dimensions, material, paint finish, structural support, foundation and mounting details, lifting provision, etc.); and
- (b) Installation arrangement (e.g. cable boxes, marshalling boxes, detectors, gauges, desiccator, ventilation air-duct, stool/sole plate, half coupling, access ladder & platform, lubricating & cooling pipework, etc.).

### 2.3.4 Sectional Details

Drawings of sectional details shall show the following information:

- (a) Installation arrangement of sensors, insulated bearing assembly (if used), white metal bearing assembly (if used), air ventilation design, space heaters and air-gap between stator & rotor;
- (b) Assembly and fixing details of components; and
- (c) A tabulated component list with parts details.

### 2.3.5 Thermal Withstand Characteristics Curve

The maximum permissible motor current at fault versus time in seconds without permanent damage of the machine at cold and hot states shall be provided.

### 2.3.6 Cable Box Arrangement

Drawings of cable boxes shall show the following details:

- (a) Material and dimensions of cable boxes;
- (b) Insulation materials of terminals, supports, insulators and connectors;
- (c) Sectional and side elevation showing the phase segregation, clearance and creepage distances between phases and earth, pressure relief arrangement, cable glands and lugs;
- (d) Compound sealing, filling level and drain (if used);
- (e) Assembly and fixing details of components; and
- (f) A tabulated component list with parts details.

## 2.4 Drawing for Power Transformer

### 2.4.1 General

Drawings containing the following information shall be provided:

- (a) Winding diagram;
- (b) Exterior layout;
- (c) Sectional details;
- (d) Thermal withstand characteristics curve; and
- (e) Cable box arrangement.

### 2.4.2 Winding Diagram

Winding diagrams shall show the following details:

- (a) Materials and dimensions of conductors and core;
- (b) Insulation system of primary and secondary windings;
- (c) Winding connection and tapping details; and
- (d) Location of embedded temperature detectors, where fitted.

### 2.4.3 Exterior Layout

Drawings of exterior layout shall show the following details:

- (a) Front and side elevation of equipment fabrication details (e.g. weight, dimensions, material, paint finish, structural support, foundation and mounting details, lifting provision, etc.); and
- (b) Installation arrangement (e.g. cable boxes, marshalling boxes, detectors, gauges, desiccator, ventilation system, pressure relief device, Buchholz relay, oil conservator tank, oil pipework and valves of bulk oil transformer, key box and locks for enclosure doors of dry type transformer, etc.).

### 2.4.4 Sectional Details

Drawings of sectional details shall show the following information:

- (a) Installation arrangement of internal earthing, tap changer, internal cooling circuit, cable box connection to winding leads, sensors, ventilation design;
- (b) Assembly and fixing details of components; and
- (c) A tabulated component list with parts details.

#### 2.4.5 Thermal Withstand Characteristics Curve

The maximum permissible transformer current at overload or fault conditions versus time without permanent damage of the transformer at hot state shall be provided.

#### 2.4.6 Cable Box Arrangement

Same as Clause 2.3.6.

### 2.5 Drawing for Instrumentation and Control System

#### 2.5.1 General

Drawings containing the following information shall be provided:

- (a) Schematic diagram;
- (b) Process and Instrumentation (P&I) diagram;
- (c) System configuration; and
- (d) Equipment layout.

#### 2.5.2 Schematic Diagram

All controls shall be shown in de-energized state. Schematic diagrams shall show the following details:

- (a) All necessary functions for proper operation and protection of the system;
- (b) Ladder diagrams;
- (c) Descriptive operating sequences for:
  - Manual and automatic control modes;
  - Normal system conditions and modes of operation;
  - Contingency conditions;
  - All interlocks and permissive conditions; and
  - Identification of failure state of all outputs.
- (d) All necessary relay contacts for the control system;
- (e) Device and field connection terminal numbers and cable schedules; and
- (f) Manufacturers' equipment shop drawings including circuit diagrams and information such as symbols, designations and nomenclature for documentation of the control system.

#### 2.5.3 P&I Diagram

P&I diagrams shall show the following details:



- (a) The control relationships between mechanical, electrical and instrumentation equipment;
- (b) The equipment and instrument tags, loop number identifications and process legends; and
- (c) Detailed functional description of the equipment, signal flows and controls.

#### 2.5.4 System Configuration

System configuration shall show the following details:

- (a) Interface between the Supervisory Control and Data Acquisition (SCADA) system and the control system, etc.;
- (b) All Programmable Logic Controllers (PLC), workstations, servers, printers, communication devices and data communication links, etc.;
- (c) Mimic diagrams;
- (d) All ranges, set points, timers, values, counter values, etc.;
- (e) Contents of monitoring, alarm, interlock and control loops;
- (f) All PLCs with all real and virtual Input / Output (I/O) and control points, I/O address assignments; and
- (g) Cables required for data communication.

#### 2.5.5 Equipment Layout

The equipment layout shall show the following details:

- (a) The equipment locations on plans and elevations;
- (b) Spatial relationship to all other equipment;
- (c) Front, side and rear elevations, plan views; and
- (d) The dimensions, interior and exterior arrangements, mounting information and nameplate legend including text and size, etc. of control panels, consoles and cabinets.

#### 2.6 Drawing for Cabling and Station Earthing Work

Drawings shall be provided to show the following details of the cabling and earthing installations:

- (a) The routing, supporting and fixing arrangements;
- (b) The type, material and size against the loading, fault withstanding and voltage drop or signal attenuation requirements;
- (c) Cable termination schedules for multi-core control cables; and
- (d) Sectional views showing the typical arrangements of cable tray and support systems; and

- (e) Earth bonding and connection arrangements.

- End of this Specification -