

WATER SUPPLIES DEPARTMENT

STANDARD SPECIFICATION EM-00-02

SITE INSTALLATION AND TESTING OF MECHANICAL,

ELECTRICAL AND INSTRUMENTATION PLANT AND EQUIPMENT

- GENERAL

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**SITE INSTALLATION AND TESTING OF MECHANICAL,
ELECTRICAL AND INSTRUMENTATION PLANT AND EQUIPMENT**
- GENERAL

1. **SCOPE**

This Specification stipulates the general requirements for site installation, testing, commissioning and test on completion of mechanical, electrical and instrumentation plant and equipment in waterworks premises.

It shall be read in conjunction with the following WSD Standard Specifications:-

EM-00-03	Supply of Mechanical, Electrical and Instrumentation Plant and Equipment
EM-00-04	Site Safety, Health and Environmental Management of Mechanical and Electrical Works
EM-90-01	Drawing for Mechanical, Electrical and Instrumentation Plant and Equipment
EM-90-02	Instruction Manual for Mechanical, Electrical and Instrumentation Plant and Equipment

It shall also be read in conjunction with the following WSD Standard Specification for specific requirements on particular plant and equipment:-

E-00-02	Site Installation and Testing of Electrical and Instrumentation Plant and Equipment
E-00-05	Site Installation and Testing of Building Services Equipment

2. **EXECUTION OF SITE WORKS**

2.1 **Access to the Site**

- (1) Unless otherwise specified, vehicular access to the Site is available. However, the Plant may not be installed on the same floor of the vehicular access. The Contractor shall observe the headroom and loading limitations for delivery of plant and constructional plant required for the completion of Works.

- (2) Uninterrupted access shall be maintained for daily activities of the Site. Full attention and extreme care shall be required when driving in the Site. The Contractor's staff and vehicles may be required to log in and out of the Site at the entrance or apply for entrance permission in advance. They shall also wear approved means of identification for checking by the Engineer and his Representatives and the Employer's operational staff.
- (3) If the Contractor requires access to the Site for work other than during the normal working hours of the Employer's staff (09:00 to 17:00, Monday to Friday), he shall serve a notice together with a works programme and a list of staff for carrying out the work 3 days in advance to the Engineer for approval. The Contractor shall observe the general requirements and noise limitations stipulated in the relevant Noise Control Ordinances during and after normal working hours.

2.2 Possession of the Site

2.2.1 General

- (1) Possession of the Site will be given from time to time after commencement of the Works according to the works programme as notified. Except if and to the extent otherwise provided for in the Contract the Site shall not be used for purposes other than the execution of the Works.
- (2) The Contractor shall submit a request for possession of Site to the Engineer at least one (1) month in advance. The Engineer shall give the Contractor 7 days of notice in writing of the date of possession of the whole/part of the Site.
- (3) Possession of any parts of the Site shall not be exclusive to the Contractor. Access shall be provided to the Employer's staff for the daily operations of the relevant waterworks installation(s) or other purposes.
- (4) The Site and Works areas shall be fenced off by approved type barriers for the safety of other persons in the waterworks installation(s).

2.2.2 Site Storage Area

- (1) The Contractor shall make his own arrangements for storage of materials and equipment on the Site until they are required for installation or incorporation into the Works. Prior agreement of the Engineer shall be sought with regard to the storage location on the Site.
- (2) The Contractor shall be responsible for taking delivery of and transporting all items into and out of storage and distributing within the Site. The Contractor may, with the prior agreement of the Engineer's Representative and at no extra cost to the Employer, make arrangements for any other contractors on the Site or any other agent to take delivery of, unload and store the items on his behalf.

- (3) The Contractor shall be fully responsible for the safe custody of the plant, equipment, and materials delivered to Site and shall maintain the working area in good order to the satisfaction of the Engineer.
- (4) The Contractor shall be responsible for all access to his storage area and for fencing, guarding, lighting and watching. Sufficient watchmen shall be provided to safeguard the materials and equipment in the storage. The Contractor shall vacate the area designated for his site office and storage compound, and reinstate the conditions of the area to the satisfaction of the Engineer within one month after the issue of the Certificate of Completion.
- (5) All electrical and instrumentation equipment and materials likely to suffer from exposure, loss or damage under outdoor conditions shall be separately packed and kept in the Contractor's covered store.

2.3 Liaison with Others

- (1) All necessary arrangements and approvals shall be made with and obtained from Government departments, utility undertakings and other duly constituted authorities for carrying out the Works.
- (2) Prior to and during shutting down of any existing plant and system in other waterworks installations for facilitating connection/disconnection work or for execution of other Works, the Contractor shall liaise closely with the operational staff of the Employer and obtain prior approval from the Engineer on the proposed work sequence and the duration of the shutting down.
- (3) The Contractor shall maintain close liaison with other contractors employed by the Employer, utility undertakings or other authorities who are concurrently carrying out work on or adjacent to the Site for ensuring as far as possible that the progress of the Works is not adversely affected by the activities of other contractors.
- (4) The Contractor shall liaise on Site closely with the Employer's contractors for civil construction to ensure that the civil work so provided will suit his plant installation and the contract requirements.

2.4 Coordination of Works

- (1) Once access to the buildings and structures is available, the Contractor shall ensure that all operations and activities for the execution of the Works shall be carried out so as not to interfere with the activities of other contractors working on the Site. All necessary measures shall be taken to ensure that whenever interference is unavoidable, the materials and equipment delivery, storage, installation or testing shall be planned in consultation with the Engineer's Representative and the other contractors as appropriate.

- (2) The Employer's normal activities within the waterworks installation may affect the Contractor's work progress. The Contractor shall be deemed to have reasonably allowed for the interruption so caused to his work progress and shall adjust his work sequence to suit accordingly.
- (3) The Engineer's Representatives, upon the request of the Contractor, will convene necessary meetings with the Employer's staff and other contractors of the Employer as appropriate to discuss matters affecting or likely to affect the execution of the Works, including, but is not limited to access to the Site, availability of buildings and structures, delivery of materials and plant.

2.5 Photograph

- (1) The Contractor shall provide monthly of not less than 30 colour photographs of '4R' size complete with soft copies showing the progress of work on Site and the installed Plant and equipment. The time and date when each photograph is taken along with the title showing the equipment and the work concerned shall be included in the body of the photograph. The Contractor shall also provide sufficient albums, suitably embossed with details of the Contract to accommodate all the photographs. These albums shall be hard backed of size similar to A4.
- (2) All prints, soft copies/negatives shall become the property of the Employer. The Contractor shall ensure that no use is made of any soft copies/negatives or prints without permission from the Employer to whom all copyrights shall be transferred. The Contractor shall also ensure that no unauthorised photography is allowed on the Site.
- (3) The Contractor shall provide as and when required "instant" photographs of subjects selected by the Engineer.

2.6 Utilities

- (1) The Contractor shall exercise the greatest care to avoid damage to or interference with any utility services and shall be responsible for any such damage caused by him or his agents directly or arising indirectly from anything done or omitted to be done.
- (2) Where diversions to utility services are necessitated by the Works any work which may affect the existing services shall not be commenced until the diversions have been made. All diversions shall not be commenced until approval is given by the Engineer.
- (3) Where damage to utility services may be caused by operation of mechanical construction plant, the Contractor shall excavate by hand.

2.7 Progress Reports and Meetings

- (1) At monthly intervals after the date of acceptance of the Tender, the Contractor shall submit to the Engineer up to three copies of a written detailed progress report giving information on forecast and actual payment, and the progress in design, drawing/equipment/manual submission, ordering of materials, manufacture, inspection, delivery, installation, testing and commissioning. These reports shall be accompanied by critical path network diagrams and/or schedules in approved format, such that the actual progress to the end of the preceding month can be compared with the Contractor's work programme. The reports shall be forwarded promptly so that on receipt by the Engineer the information contained therein is not more than 7 days out of date.
- (2) From time to time the Engineer or his Representatives may call meetings, in his or at the Contractor's office or at the Site, as he deems necessary and normally at intervals of one month for the purpose of control of the Contract which shall include discussion on the progress of Works, Contractor's labour resources, workmanship and site safety and health matters.
- (3) The Contractor's agent shall attend, and shall arrange for the representatives of sub-contractors, Government departments, transport companies, utility undertakings and other contractors to attend meetings, when required by the Engineer or his Representatives.
- (4) The Contractor shall inform the Engineer 48 hours, or a shorter period agreed by the Engineer, before a meeting is to be held with Government departments, transport companies, utility undertakings and other contractors and shall give the Engineer and his Representatives the opportunity to attend such meeting.

2.8 Drawings

2.8.1 Drawings for the Contract

- (1) The Drawings as listed in the Particular Specification are provided to indicate the general arrangement of the Plant and system and to illustrate the Works required under the Contract.
- (2) The Contractor shall be responsible for verifying the actual as-built conditions and dimensions of the Site. Adjustment of the positions of Plant may be required to suit site conditions. Any adjustment of the Plant shall be at the Contractor's cost.
- (3) The numbers and sizes of the Plant or equipment shown on the Drawings are for illustration only. The Contractor shall check the numbers and sizes of the Plant and equipment given and make adjustment to suit the intended purpose.

- (4) In the case of any discrepancy arising between the Drawings and the Specification, the Contractor shall draw the attention of the Engineer for deciding which shall be followed.
- (5) Amended or supplementary Drawings will be issued from time to time as and when deemed necessary by the Engineer.
- (6) The arrangement and configuration of the plant equipment shown on the Drawings are for reference only. The Contractor shall be responsible for checking the actual arrangement and configuration of the plant equipment at site prior to commencement of the Works and make adjustment to the Plant to suit as necessary.

2.8.2 Drawings Provided by the Contractor

- (1) The Drawings to be provided by the Contractor for the Works shall be prepared and submitted in accordance with WSD Specifications EM-00-03 and EM-90-01.
- (2) All Drawings to be provided by the Contractor shall show the following particulars:
 - (a) Title of the project
 - (b) Contract number
 - (c) Title of Drawing
 - (d) Details of electricity supply (where applicable)
 - (e) Equipment serial number (where applicable)
 - (f) Scale of Drawing
 - (g) Date of Drawing
 - (h) Contractor's Drawing number
 - (i) Name of Contractor
- (3) The Engineer shall give his comment/approval on the Contractor's submission within 21 days from the receipt of the said submission. One copy of the submission, if approved, shall be duly stamped, signed and returned by the Engineer to the Contractor. If a Drawing is not approved, the Contractor shall suitably amend the Drawing without delay and resubmit within 14 days from the receipt of the Engineer's comments two (2) copies of the amended Drawing to the Engineer for approval. Non-approval of Drawings shall not entitle the Contractor to an extension of time. If a Drawing is in the opinion of

the Engineer acceptable subject to minor amendment, the Engineer shall give an approval subject to the Contractor's incorporation of all the marked up comments provided thereto.

- (4) Within 14 days from the issue of the notice of approval or conditional approval of Drawings, the Contractor shall supply to the Engineer four (4) copies of each approved Drawing. The copies of approved drawings supplied should be stamped and certified by the Contractor as true copy.
- (5) The Contractor shall submit two (2) sets of record Drawings of the Plant as constructed for the Engineer's approval prior to his request for the issue of the Certificate of Completion.
- (6) The Contractor shall supply for record purposes direct to the Engineer within one month from the issue of the Certificate of Completion five (5) complete sets of the final approved Drawings of the Plant as constructed. Four (4) sets of the final approved Drawings shall be on paper, one (1) set shall be in computer files in the format compatible to the CAD Standard for Works Projects document v1.02.00 (or later versions as agreed between the Engineer and the Contractor from time to time) as posted on the Development Bureau's web site "<http://www.devb.gov.hk/cswp>".
- (7) Payment of the final certificate will not be made until the final approved record Drawings, including all amendments to the satisfaction of the Engineer, have been supplied.
- (8) Approval by the Engineer of the Contractor's design or Drawings shall not relieve the Contractor of any of his obligations or liabilities under the Contract except in so far as provided for by the Conditions of Contract.

2.9 Operation and Maintenance Manual

- (1) Operation and maintenance (O&M) manual shall comply with WSD Standard Specifications EM-00-03 and EM-90-02.
- (2) The O&M manual shall be submitted in two parts. The Part 1 manual shall incorporate the general specification, maintenance requirements, spare part and special tools list and other information related to individual equipment of the Plant supplied by the manufacturers whilst the Part 2 manual shall incorporate the detailed overall description, design calculation, operation principle, control philosophy, record drawings and test reports of the Plant and system.
- (3) The Contractor shall submit two (2) sets of draft Part 1 manual not later than one (1) month before the delivery of the equipment to Site for approval/comment of Engineer.

- (4) Two (2) sets of draft Part 2 manual shall be submitted by the Contractor at least one (1) month before completion of erection of the Plant for approval/comment of Engineer.
- (5) During delivery and installation, the Contractor shall update, amend, modify and supplement the draft manuals taking into account the comments from the Engineer. The Contractor shall provide to the satisfaction of the Engineer three (3) sets of revised draft manuals within one (1) month after the equipment delivered to Site and prior to the issue of the Certificate of Completion for Part 1 and 2 manuals respectively.
- (6) The Engineer's approval to the draft manuals shall be a pre-requisite condition to satisfy the meaning of substantial completion leading to the issue of the certificate of completion.
- (7) Within one (1) month from the issue of the Certificate of Completion, the Contractor shall supply four (4) complete sets of the approved instruction manual as final instruction manual. The final instruction manuals shall be on paper form in bound and indexed volumes of A4 size. One additional electronic version of the complete set of final manual, including the as-fitted drawings shall also be supplied.
- (8) Payment of the final certificate will not be made until all the final instruction manuals, including all amendments to the Engineer's satisfaction, have been supplied.

2.10 Training of Employer's Staff

- (1) Where specified in the Contract, the Contractor shall provide full training and comprehensive instruction by the manufacturer's representative to the Employer's staff and personnel for the proper operation and maintenance of the Plant during the testing and commissioning of the Plant. A training programme with details of topics covering the operation and maintenance of the plant shall be submitted 30 days prior to the proposed commencement of training for the approval of the Engineer. The qualification and experience of the trainer(s) shall also be submitted in conjunction with the training programme for consideration by the Engineer.
- (2) The number of Employer's staff attending the training shall be up to 15 in each session. The Contractor shall arrange the required training sessions and provide sufficient sets of the necessary training notes/documentation for the attendees.

3. MATERIALS FOR SITE INSTALLATION

3.1 Flanges

- (1) All flanges shall comply with BS EN 1092, dimensioned and drilled to pressure rating of PN16 unless specifically stated otherwise.
- (2) All blank flanges and ring flanges shall be truly faced over their full width, and the bolt holes shall be drilled off centre lines, truly in line end to end with the longitudinal axis. All flanges shall have their jointing surfaces machine finished to comply with the requirements of BS EN 1092 or specified otherwise on the drawings.
- (3) Ring (loose) flanges shall be machined to a bore diameter of 4 ± 1 mm larger than the outside diameter of the pipe to which the flanges are to be welded on site.

3.2 Bolts, Tap Bolts, Studbolts, Tie Bolts, Nuts and Washers

- (1) Steel hexagonal headed bolts, tap bolts, and nuts shall comply with BS 3692 or BS 4190 and the strength grade designation for bolts shall be 4.6 and that for nuts shall be 4.
- (2) Studbolts and tie bolts threaded at each end with nominal diameter portion at centre shall comply with BS 4882.
- (3) Washers shall be standard normal series black steel washers complying with BS EN ISO 887 (formerly BS 4320).
- (4) Black cup and countersunk head bolts, screws and nuts shall be to BS 4933.
- (5) Zinc coated items of M10 and larger shall have the nuts cut oversize and shall be spun galvanized (or equivalent) to BS EN ISO 1461. Smaller zinc coated items shall be to BS EN ISO 2081.
- (6) Stainless steel bolts and nuts shall comply with BS EN ISO 3506-1 and 2, steel grade A4/316 and property class 80. Stainless steel washers shall comply with BS EN 10088, Grade 1.4401.
- (7) Bright (high tensile) items to Grade 8.8 of BS 3692 may be used instead of black items.
- (8) Bolts for pipes and fittings shall comply with the relevant requirements of BS EN 1515-1.
- (9) Bolt lengths shall be sufficient to ensure that nuts are full-threaded when tightened in their final position and that at least two but no more than four threads are protruded.

3.3 Rubber Insertions/Gaskets

- (1) Rubber insertions of 3 to 6 mm thick shall be used for connection of flange joints. The rubber insertions shall conform to BS 3063 and BS EN 1514

(formerly BS 4865). It shall be non-toxic and suitable for contact with raw, potable and salt water.

- (2) Gaskets shall be of “inside bolt circle” dimensions complying with BS EN 1514 (formerly BS 4865). It shall be manufactured from appropriate material suitable for raw, potable and salt water application.

3.4 Mild Steel Pipework

Mild Steel Pipeworks shall generally comply with WSD Standard Specification M-02-02.

3.5 Copper Pipework

Copper tubes shall be to BS EN 1057: Part 1 or Part 2 as appropriate. Copper pressure piping shall be to BS 1306. Compression fittings shall be to BS EN 1254-1 and BS EN 1254-2.

3.6 Nylon, Plastic and Other Pipework

- (1) All nylon, polythene or other plastic tubes and fittings shall conform to BS 5409 : Part 1, BS EN 12201 and BS 3506.
- (2) Nylon, polythene, or other plastic tubes shall not be fixed in any location where they are exposed to the possibility of degradation by ultra-violet light.

3.7 Galvanised Steel Pipework

- (1) Galvanised steel pipes shall comply with BS EN 10255 : Class C.
- (2) Galvanised steel pipes of 50 mm diameter and below may be supplied with screw and socketed joints. All other joints shall be made with screwed-on PN16 flanges. The screwed-on flanges and joints shall be protected with zinc chromate paint.

3.8 Instrumentation Piping

- (1) Piping for instrument air shall be PVC covered heavy gauge seamless copper of soft annealed type to BS EN 1057 and connected by compression joints. Pipe fittings shall be compatible with the materials, application and service conditions called for.
- (2) Piping shall be run neatly and cleared to the walls or PVC covered tray to prevent movement. Piping routes shall not obstruct traffic through process plant nor interfere with the accessibility or removal of plant. They shall be routed away from hot environments, places of potential fire risk or where they may be subjected to mechanical injury or vibration.

3.9 Fixing of Metal Work and Machinery

- (1) Where the type of fixings is not specified, approval shall be obtained to the type and position of fixing proposed before proceeding. Proprietary fixings supplied by reputable manufacturers will generally be allowed. The type selected shall suit the particular situation and loadings.
- (2) The installation of such fixings shall be strictly in accordance with the manufacturer's instructions or recommendations.

3.10 Fixing Bolts, Concrete Anchors etc.

- (1) Foundation (rag) bolts shall be to BS 4185: Part 9 or other type approved by the Engineer.
- (2) Concrete anchors suitable for fitting in drilled holes shall be of flush expanding type and of a make approved by the Engineer who may require tests to confirm their suitability.
- (3) Fixing bolts, nuts and washers of stainless steel when used for fixing aluminium items shall have non-metallic sleeve and under-washer or other approved insulating system.

3.11 Metal Work

- (1) Structural steel shall comply with BS EN 10025. Hot rolled sections shall comply with BS EN 10365, BS EN 10210-2, BS EN 10056-1 or BS EN 10067 as appropriate.
- (2) Stainless steel items, unless otherwise specified, shall be made from steel Grade 1.4401 to BS EN 10088 and BS EN ISO 9445 as appropriate.

3.12 Welding of Steel

- (1) Welding shall be carried out by the electric metal arc process to BS EN 1011 and all welders employed by the Contractor or his sub-contractors shall have satisfied the relevant requirements of BS 4872:Part 1.
- (2) Welders who carry out welding shall possess valid welder's certificates.
- (3) All plate edges to be welded shall be full 45° profile with all slag and spatter removed.
- (4) Electrodes shall be Vindex class E6003 to AWS (BS EN ISO 2560) or as recommended by the supplier and approved and they shall be stored in warm dry conditions.

- (5) Austenitic stainless steel shall be welded in accordance with BS EN 1011-3 and an argon arc shield shall be used.

3.13 Open Mesh, Chequered and Tread Plate Flooring

- (1) For open mesh flooring aluminium alloy shall be to BS EN 755, BS EN 573, Grade 6082 (formerly HE30TF) and to BS EN 485 HS30TF for chequer plate flooring.
- (2) Either type of flooring shall be designed to take a 5 kN/m² load, unless otherwise specified or required, and the mass of any individual panel shall not be greater than 25 kg.
- (3) All flooring shall be provided with matching curbing or frame, having lugs at 450 mm centres from each corner for casting in or by welding onto steel frames of equipment.
- (4) Intermediate supports shall be of aluminium alloy channel, hollow box or T beam section and where necessary shall be removable to leave a clear opening. Cut-outs in open mesh flooring shall be trimmed with flat bar as at the edge of a panel.
- (5) Where pipework and other items pass through metal flooring, cut-outs shall be sized to minimise clear openings and clearance shall generally not exceed 30 mm.
- (6) Open mesh flooring shall be secured with clips.
- (7) Chequer plate flooring shall be provided with lifting holes and secured with countersunk-head screws.
- (8) Toe boards of at least 200 mm height shall be provided wherever necessary.
- (9) All flooring panels shall bear an identification number.

3.14 Ladders and Safety Hoops

- (1) Steel ladders shall be to BS 4211 and manufactured in mild steel and galvanized. The stringers shall be 65 mm by 12 mm and spaced 375 mm apart. Their ends shall be turned over and drilled for fixing by M16 bolts.
- (2) The rungs shall be 25 mm diameter reduced to 20 mm at the ends and shall be spaced at 225 mm centres. They shall be fillet welded to the stringers.
- (3) Safety hoops on steel ladders shall be to BS 4211. They shall be of circular pattern and made from 50 mm x 10 mm steel.

- (4) Fixing shall be by M12 stainless steel countersunk bolts inserted from the inside of the composite assembly.

3.15 Guard Railing

- (1) Tubular handrails and standards shall be of 10 gauge thickness 32 mm nominal internal diameter galvanised mild steel tube.
- (2) The balls on the standards shall be of adequate size to accommodate the rails which shall be fixed by grub screws.
- (3) The stanchions shall be fitted with fixing plates approximately 150 mm x 65 mm x 16 mm thick.
- (4) Unless otherwise indicated in the Drawings, heights of guard railing shall be 1100 mm to centre of top rail, bases for the stanchions shall be top surface mounted.

4. REQUIREMENTS FOR SITE INSTALLATION

4.1 Supporting Steelwork, Plinths and Grouting

- (1) Supporting steelwork for mounting the plant shall be designed and provided where necessary and required.
- (2) The configuration, dimensions and pocket hole details of the concrete plinths/blocks/supports necessary for supporting the plant and equipment under the Contract shall be provided by the Contractor for the Employer's design and construction, where applicable.
- (3) Grouting to structural steelwork, machine bases, electrical and mechanical equipment and installations shall be provided and constructed by the Contractor and shall comply with the requirements as follows:
 - (a) The permission of the Engineer's Representative shall be obtained before any items or equipment is grouted. The Contractor shall inform the Engineer's Representative before grouting starts and shall allow the Engineer's Representative sufficient time to inspect the work which is to be grouted.
 - (b) The voids to be grouted shall be cleaned and thoroughly wetted immediately before grouting.
 - (c) The machine bases shall be properly and accurately levelled and aligned before any grout is poured.

- (d) The wedges and packing pieces shall provide at least 25 mm clearance for grouting. After correct alignment and levelling, the foundation bolts shall be nipped up to hold the machine firmly in position.
- (e) Grouting materials shall be of non-shrink type and shall be mixed and placed following strictly the methods recommended by the manufacturer. Manufacturer's technical literature on application of the grouting material shall be submitted.
- (f) After the grouting mixture has set, the foundation bolts shall be pulled up hard and the alignment and level rechecked. The Engineer's Representative shall be informed when any check on alignment and level is to be carried out so that he may witness the checks.
- (g) Exposed grout surfaces shall have a uniform, dense and smooth surface free from trowel marks and which is produced by steel trowelling the surface under firm pressure.

4.2 Holes and Recesses for Installations

- (1) The Contractor shall be responsible for the building-in of any items of plant or for the boxing out or cutting out and the subsequent back-filling of all openings, box-outs, rebates, etc. required in the concrete structure and indicated on the Contractor's approved Drawings.
- (2) Holes and recesses shall be left in structures for electrical and mechanical installations. Unless approved by the Engineer, holes and recesses shall not be cut in existing structures for mechanical and electrical installations.
- (3) Holes and recesses in internal floors, stairways and platforms shall be protected with temporary covers or by other methods agreed by the Engineer until installation work starts; holes and recesses in roofs, external walls and external floors shall be sealed with watertight temporary covers until the installation work starts.
- (4) Holes in structures shall be filled and made good after installations; holes left in structural elements designated as fire barriers shall be sealed to at least the same degree of fire resistance as the structural element.

4.3 Removal and Replacement of Trench Covers

- (1) Where installation of new equipment or cables in the service trenches, pipe ducts and draw-pits are required, the Contractor shall be responsible, at his own cost, for the breaking of sealing materials, removal of the concrete trench covers, manhole covers, etc., where necessary, for the execution of the Works.
- (2) The foreign materials such as building debris, surplus installation materials and other combustible items shall be prevented from entering or being left in

the service trenches and pipe ducts which are left open during installation work. The precautionary measures shall be taken to prevent flooding the trenches and ducts when covers have been removed for execution of the Works. Sand bags or other suitable kerbing materials shall be placed around all openings of outdoor trenches, which shall then be covered with planking and plastic sheeting to stop surface water and rain water from getting into the trenches.

- (3) In case of rainstorms, the Contractor shall also make available and operate temporary pumping facilities at any opened trenches to avoid ingress of rain water to the plant rooms.
- (4) Temporary sealant shall be applied as necessary to openings leading into plant rooms to avoid the possible flooding in case of rainstorms.
- (5) All the surplus installation materials and building debris left in service trenches, pipe ducts and draw-pits shall be removed after installation.
- (6) Upon completion of work inside service ducts, pipe trenches, draw-pits, etc., and completion of back filling of structural openings with fire resistant and water sealing materials, the Contractor shall serve notice to the Engineer's Representatives for inspection before covering up of the ducts, trenches, draw-pits. The Contractor shall be responsible for the reinstatement of all concrete trench covers, service duct and manhole covers. The gaps between covers shall be sealed up with bitumen or other suitable materials as may be approved by the Engineer.
- (7) The cutting or welding work shall be carried out in situ as necessary to modify the layout or dimensions of the covers so as to provide openings or access to cater for the mechanical and electrical equipment installed. Any such cut, opening and weld shall be made good by dressing and / or painting to the satisfaction of the Engineer's Representative.

4.4 Initial Charges of Oils, etc.

The initial charges of oil, grease and similar materials necessary for the correct setting to work and operation of the plant throughout the period of site testing shall be provided.

4.5 Fire Barrier

Internal fire barriers shall be constructed in service channels, service shafts and service ducts for electrical and mechanical installations at termination points and open ends.

4.6 Framed Drawings

The Contractor shall provide the as-fitted drawing showing the schematic block diagrams of all circuits, fire services layout plan and other operation instructions as

instructed by the Engineer on the framed glazed adjacent to the switchboard.

4.7 Lubrication

- (1) Adequate and as far as practicable automatic means of lubrication shall be provided for all moving parts. The position of all greasing and oiling points shall be readily accessible for routine maintenance and if necessary suitable extension pipes shall be installed.
- (2) If continual grease or oil feed is required the capacity of the lubricant reservoir shall be sufficient for not less than seven days continuous operation.
- (3) Lubrication grease points shall comprise hexagon headed nipples complying with BS 1486 : Part 1. Where the lubrication required is of a special nature, the lubrication points shall be fitted with metal labels to indicate the characteristics of the special lubricant required.
- (4) Where grease nipples are provided they shall be grouped on a common plate mounted in an accessible position. The plate and grease nipples shall be designated 'Multiple Greasing Unit'. Each grease pipes shall be 6 mm nominal bore flexible stainless steel of not more than 3 m overall length. If necessary, several Multiple Greasing Units shall be provided on each machine.
- (5) Where oil is used as a lubricant, drain, filter and level points shall be easily accessible. Where necessary, suitable stainless steel extension tubes shall be fitted to facilitate access. Lubrication pipes shall have continuous downward gradients.

4.8 Guarding of Machinery

- (1) All rotating shafts, couplings, gears, flywheels, belt drives, counter weight levers of reflux valve etc. shall be fully guarded to comply with PD 5304 (formerly BS 5304) and the Factories and Industrial Undertakings (Guarding and Operation of Machinery) Regulations.
- (2) Guards shall be designed to provide ready access to bearings, greasing points, thermometer pockets and other check points to allow routine observations to be made by the operating staff without danger or the need to dismantle any part of the guard. Hinged doors let into the guards with adequate fastenings shall be provided where necessary to facilitate access to the check points.
- (3) Guards shall be made of galvanised mild steel. Brackets and securing arrangements for guards shall be of rigid construction.
- (4) Drawings of guards shall form part of the equipment drawing to be submitted to the Engineer for approval before manufacture.

4.9 Access Platform

- (1) The Contractor shall provide access platform for the equipment installed at a level higher than 2m, which requires regular attendance and maintenance.
- (2) The access platform shall have adequate staircase or ladder, toe plates and handrailing necessary for the safe and convenient access to the equipment.
- (3) Safety chains shall be provided at the head of the staircase / ladder to prevent fall of person through the gap.
- (4) All open sides of the access platform shall be installed with handrails of 1100 mm high and completed with 200 mm toe plates to prevent tools or items being inadvertently pushed off the edge. Access platform and toe plate shall be fabricated from hot dip galvanised steel. Handrails shall be fabricated from stainless steel of grade 316.
- (5) The Contractor shall provide the design and layout of the platform to the Engineer for approval.

4.10 Painting and Protection of Steel and Ironwork

4.10.1 General

- (1) All metalwork, including structural steelwork, fabricated steel supports, steel welded pipe fittings shall be protected by an approved system.
- (2) Surface preparation and protective coatings shall be complying with relevant standards and conforming to the following schedules:
 - 1 - Surface Preparation
 - 2 - Materials and Application
 - 3 - Coating System
- (3) Proprietary items shall have all surface protection applied at the place of manufacture.
- (4) Tints and shades of final coats shall be in accordance with the colour schedule covered in the Standard Specification EM-00-03. Colours of undercoats shall be of slightly different shades to adjoining coats.

4.10.2 Surface Preparation

- (1) All surface defects in metals to be coated including cracks, surface laminations, shelling and deep pitting shall be made good. All fins at saw cuts, burrs and sharp edges shall be similarly removed. Where the specified coating system is preceded by blast cleaning and extensive grinding has been necessary, the

dressed areas shall be re-blasted to restore the surface to the required standard of cleanliness and roughness.

- (2) Where steelwork is to be zinc-dip coated all cutting and drilling shall be completed before surface preparation and coating.

4.10.3 Paints

- (1) Duplicate copies of manufacturer's data sheets shall be furnished for the paints proposed to use.
- (2) Protective and decorative paints including primers and undercoats with guarantees of coating compatibility shall be obtained from a single manufacturer. All containers of paints and other coating systems shall show date of manufacture, shelf life and pot life where applicable.
- (3) Only the paints which are delivered ready mixed for use, in sealed cans or drums bearing the manufacturer's name, properly labelled as to quality shall be used. In so far as it is possible, the paints shall be come from a single manufacturer.
- (4) Two pack or any similar chemically cured type paint shall not be used after expiration of the 'shelf life' stipulated by the manufacturer and such paints shall not be mixed with fresh paint.
- (5) Colouring pigments shall not contain lead compounds which may be affected by hydrogen sulphide or other gas likely to be found in waterworks premises.
- (6) The Volatile Organic Compound (VOC) content of all paint products shall comply with the VOC limits stipulated in the Air Pollution Control (Volatile Organic Compounds) Regulation.

4.10.4 Application of Paints

- (1) All paints shall be applied strictly in accordance with the directions of the manufacturer by skilled and experienced painters under constant supervision by qualified staff.
- (2) All surfaces to be painted shall be cleaned with white spirit or other appropriate cleaner immediately before painting.
- (3) All shop coatings shall be carried out under controlled conditions. The atmosphere shall be dust free and kept at a temperature of between 10 °C and 20 °C. The relative humidity should not exceed 80 per cent.
- (4) Items which are to be bolted or riveted together at the manufacturer's works shall have the priming coat applied before the parts are assembled. The mating surfaces of structural steel work shall be sealed with litharge and glycerine or

an approved putty during erection. The mating surfaces of aluminium shall be sealed with an approved sealer.

4.10.5 Conditions when Painting shall not Proceed

Paints shall not be applied under the following conditions:

- (1) When the ambient temperature falls below 4°C or the relative humidity rises above 80 per cent.
- (2) For outdoor work during the periods of inclement weather, e.g. rain, fog or mist, when condensation has occurred or is likely to occur on the surfaces to be painted.
- (3) When the surface temperature of the metal to be painted is less than 3°C above the dew point of the ambient air.
- (4) When in the opinion of the Engineer or his representatives, the amount of dust in the atmosphere and/or on the surface of the materials is such that the application of the paint would be unsatisfactory.
- (5) Two pack paints of epoxide resin type shall not be applied when the temperature is below 5°C or as stated in the paint manufacturer's instructions, nor shall such paints be applied when the temperature is likely to fall below the specified minimum during the curing period.

4.10.6 Dissimilar Metal Surfaces

Where dissimilar metals are mated, such as aluminium and steel, the mating surfaces shall be insulated to provide protection against galvanic or similar corrosion. Bolts, nuts washers and rivets shall be similarly insulated. The means of providing this protection shall be submitted for approval.

4.10.7 Repair to Damaged Surfaces

- (1) On delivery of items to site, any damage made to the shop-applied protective coatings shall be made good. The coated surfaces on site shall be protected from damage by weather or by subsequent operation and shall make good any defects as soon as they are discovered.
- (2) Immediately after erection, any damage to the shop-coating shall be made good in a manner acceptable to the Engineer and compatible with the paint system. Damage to coatings occurring at any time shall be made good within 7 days.
- (3) Damage to galvanised or metal sprayed coatings shall be made good by wire brushing followed by phosphate wash, followed by two coats of zinc or aluminium suspension paint.

- (4) Prior to repairs to coatings, the damaged and surrounding areas shall be degreased and abraded, and the edges of the original coating 'feathered'. Where the complete coating system has been damaged the damaged area shall be returned to a bright finish.

4.10.8 Other Surfaces

All machined, polished, or bright surfaces, both internal and external, shall be afforded adequate protection against corrosion, mechanical damage, etc., until the Plant is taken over.

4.10.9 Schedules

- (1) Schedule No. 1 - Surface Preparation

Notes:

- (a) All cutting and drilling shall be completed before surface preparation.
(b) Application of Systems SP1 and SP2 applies to all coats detailed in Schedule No. 3.

System	Surface Preparation	Description
SP1	Degreasing	Shop cleaning to remove contaminants in accordance with the approved standard.
SP2	Blast cleaning	Abrasive grit blast cleaning to remove rust and millscale, first quality finish for steel, second quality finish for cast iron. Blasting materials shall be free of deleterious substances. The maximum grade of abrasive permitted shall be in accordance with BS 7079. The maximum amplitude of the blast cleaned surfaces shall not exceed 0.1 mm. Surfaces shall except as otherwise specified be protected within 4 hours of having been blast cleaned.
SP3	Pickling	Chemical cleaning after blast cleaning by the Duplex or Footner process.
SP4	Shop treatment for aluminium	Shop treatment prior to anodising.
SP5	Pre-coat cleaning	Immediately before priming and before painting is commenced, all dirt, oil or grease shall be removed from the surface

System	Surface Preparation	Description
		with white spirit or an approved emulsion cleaner thoroughly and scrubbed in a continuous flow of clean fresh water and dried before coating.
SP6	Wire wool, abrasive cloth or sand paper	On site preparation to remove high spots and to provide key for primers and undercoats and finishing coats.
SP7	Powered wire brush	On-site preparation of welds in steel.

(2) Schedule No. 2 - Materials and Application

Notes:

- (a) Bracketed references are from BS 5493, Table 4A to 4M.
- (b) All cutting and drilling shall be completed before application of the specified materials.
- (c) Primer and first undercoats shall be brushed or roller application for these coats will not be permitted.
- (d) DFT means minimum dry film thickness in microns as determined by non-destructive magnetic flux and eddy current test methods covered in BS 5493 and BS EN ISO 12944 as appropriate.
- (e) For coatings containing micaceous iron oxide (MIO), pigments shall contain at least 80% MIO and have a lamellar particle shape, the pigment volume concentration shall be between 35% and 45%, solids volume not less than 64% and not more than 5% of anti-settling agent.
- (f) Select pretreatment primer and sealer P2(b) below to suit subsequent coatings as detailed in Section 11.2.2 of BS 5493 or appropriate section of BS EN ISO 12944.
- (g) For use of scheduled materials, see Schedule No. 3.
- (h) Delete MIO content if finished colour to be other than self colour.
- (i) The surface shall be sprayed with a zinc metal coating immediately after blast cleaning.

Reference	Material
P1	<p>Zinc Metallisation :</p> <p>(a) Zinc-dip coating (SB2), Table 4B nominal thickness 140 microns.</p> <p>(b) Zinc-spray coating (SC6Z), note subsequent pretreatment and sealing times in P2(b), Table 4C, Part 1, nominal thickness 150 microns.</p>
P2	<p>Pretreatment primers and sealers :</p> <p>(a) Etch primer (T-wash) for zinc-dip coatings, Section 11.3.2(c).</p> <p>(b) Pretreatment primers and sealers for zinc-spray coatings (CP2 and CP3 to CP6). Primer and sealer to be applied within 4 hours and 24 hours of zinc spraying respectively.</p>
P3	Zinc phosphate primer (FP2A or FP3A), DFT 35.
P4	<p>(a) Zinc phosphate/epoxy primer (KP1A), DFT 35.</p> <p>(b) Terephthalic or isophthalic polyester resin primer, DFT 35.</p>
P5	Drying oil under coat (FUL1A or FU2A), DFT 35.
P6	Drying oil/MIO (see Note v) undercoat (FU1B), DFT 40.
P7	Drying oil finishing coat (FF5B), DFT 35.

(3) Schedule No. 3 - Coating System

System No.	Material	Surface Preparation ¹	Coatings from Schedule No. 2									
			Shop Coating					Site Coating				
			1 st	2 nd	3 rd	4 th	5 th	1 st	2 nd	3 rd	4 th	5 th
(1)	Cast Iron ²	SP1 and SP2	P3	P5	-	-	-	P5	P7	-	-	-
(2)	Ductile Iron	SP1 and SP2	P1(a)	-	-	-	-	P2(a)	P3	P5	P7	-
	Steel ³		P1(b)	P2(b)	P3	P5	-	P5	P7	-	-	-
(3)	Steel	SP1 and SP2	P1(b)	P2(b)	Approved systems		-	-	-	-	-	-

Notes:

- 1 Surface preparation from Schedule No. 1
- 2 Apply to an environment of non-exposure to weather and dry atmosphere with decorative finish (other than items in System No. 3).
- 3 Refer to System No. 4 for surface preparation of electrical switchboard and motor control panels

5. REQUIREMENTS FOR SITE TEST AND COMMISSIONING

5.1 General

- (1) After completing the installation of the Plant and prior to setting to work, individual equipment shall be inspected and witness tested in the presence of the Engineer Representatives of his appointed staff.
- (2) Each individual item of the Plant shall be checked and tested to ensure that it performs in accordance with the specified requirements and is in working conditions to the satisfaction of the Engineer.
- (3) The Contractor shall notify the Employer and other contractors on the Site prior to performing site testing, and shall ensure safety of personnel at site and equipment undergoing tests.
- (4) Requirements for inspection and testing of the Plant on site are stipulated in the relevant WSD Standard Specifications and the Particular Specification, which shall include, but not limited to, the following:
 - (a) The installation is completed in accordance with all relevant Drawings, circuit diagrams and the specified requirements.
 - (b) All items of plant are adequately and correctly labelled and identified.
 - (c) All cables and individual conductors are labelled and ferruled as per the relevant Drawings.
 - (d) All pipelines shall be tested to ensure tightness of joints and connections to the pressure specified.
 - (e) Lubricating lines, sumps, tanks, etc. shall be adequately flushed to remove any foreign matter before being put into use.
 - (f) The insulation resistance and continuity of all conductors of cables, windings, coils, busbars, etc. are acceptable.
 - (g) The earthing arrangements are complete and a satisfactory value of earth loop impedance has been achieved.

- (h) All protection devices such as temperature detectors, no-flow switch, relays, thermostats etc. have been individually checked, tested and properly adjusted.
 - (i) Every circuit component such as relay contact, switch, circuit breaker, thermostat etc. is properly connected and operates in accordance with the relevant circuit diagram.
 - (j) The necessary on-load adjustments have been made to ensure that the equipment operates as intended.
 - (k) An independent trip test has been carried out to prove that all tripping and safety devices operate as designed.
 - (l) All errors, omissions, alterations and changes found during tests are rectified and details marked up on the relevant record Drawings.
 - (m) All settings of the equipment are properly adjusted, tested and recorded.
- (5) Where necessary or when required by the Engineer's Representative, the testing and commissioning of a particular item of plant or equipment shall be carried out jointly in the presence of the respective equipment supplier or manufacturer and the Contractor.
 - (6) Inspection/test results shall be recorded, verified and submitted immediately after the test. Individual items of plant shall not be released for commissioning with the whole system until it is proven as free from any defects and deficiencies and the Engineer has accepted the test results.
 - (7) When the above tests have been satisfactorily completed, the Contractor shall inform the Engineer in writing that commissioning of the Plant is ready to be made.
 - (8) The Engineer shall have the right to put any item of the plant into continuous running once it is satisfactorily tested for commissioning.

5.2 Test Procedures and Reports

- (1) A test schedule showing details of the proposed inspection complete with test procedures and format of test records for readings to be taken shall be submitted to Engineer's Representative for acceptance at least one (1) month prior to the scheduled commencement of testing and commissioning.
- (2) A Request Form shall be submitted for agreement of the test dates by the Engineer's Representative 7 days before the tests.
- (3) All site tests recommended by the manufacturers shall be carried out.

- (4) In the event that any item of the Plant fails to meet any specified requirements, immediate steps shall be taken to rectify the deficiencies.
- (5) Two copies of the inspection and test report giving details of the test readings, deficiencies encountered and rectified etc. shall be submitted for records within one week upon completion of the tests on an item of the Plant.
- (6) All items of the Plant shall be adequately and properly labelled, thoroughly cleaned and dried out where necessary prior to testing. The labels, equipment model and rating shall be checked for consistency with approved Drawings and manuals during the inspection. After completion of the tests, the equipment access covers, switches, operating devices, etc. shall be bolted or locked to prevent interference by unauthorised persons.

5.3 Testing Instruments and Equipment

- (1) Calibrated instruments and equipment shall be supplied for carrying out tests on site. The Engineer may require any instrument for rechecking and recalibration if he considers that such instruments are not in conditions to produce sound and accurate measurements.
- (2) Test instruments shall have been calibrated and certified by a HKAS accredited laboratory not more than 12 months before the tests. The instruments shall be sealed by the testing laboratory showing the date of calibration. Calibration certificates shall be submitted when requested.
- (3) Provision shall be made on the Plant for fitting test instruments for carrying out appropriate tests.
- (4) When performing hydraulic pressure test for pipes and equipment, in addition to the testing instruments provided by the Contractor, a pressure gauge provided by the Employer shall also be fitted in parallel with the Contractor's gauge. The readings of both gauges shall be recorded in the test report.

6. TEST ON COMPLETION

6.1 General

- (1) The Test on Completion (TOC) shall be the tests for the completed system or whole Plant. TOC shall only be performed when all testing and commissioning of individual items of Plant have been carried out and their results accepted by the Engineer.
- (2) During the TOC, the Contractor shall operate the plant continuously to prove its satisfactory performance under specified conditions. All modes of operation, control and monitoring of the process and electrical and mechanical functions shall be demonstrated to verify its performance. The Contractor

shall provide attendance throughout the TOC to ensure that any materials, plant or workmanship found not in compliance with the Contract are immediately rectified or, if necessary, removed and replaced. The Contractor shall provide round-the-clock fault attendance within reasonable time throughout the TOC.

- (3) To determine the plant performance, measurements and readings shall be recorded by the Contractor and verified by the Engineer's Representative at times and frequencies to be determined by the Engineer.
- (4) At least one month prior to the commencement of TOC, the Contractor shall submit a detailed proposal covering the intended schedule, test procedures, format of test records, testing equipment, etc. for the Engineer's comment.
- (5) If the TOC fails, the Contractor shall investigate the cause, rectify any defects, replace any faulty equipment and repeat tests. Upon request, the Contractor shall submit a proposal for rectification of the defects for the Engineer's approval. The Contractor shall restart the TOC upon agreement of the Engineer's Representative.
- (6) The Engineer shall have the full discretion of rejecting the plant if the plant fails to meet the performance requirements as specified in the Contract. The Contractor shall rectify all defects and deficiencies to the satisfaction of the Engineer.

- End of Specification -