

GENERAL SPECIFICATION

FOR

SWIMMING POOL WATER TREATMENT INSTALLATION

IN

GOVERNMENT BUILDINGS

OF

THE HONG KONG SPECIAL ADMINISTRATIVE REGION

2012 EDITION
(INCORPORATING CORRIGENDUM NO. GSSP02-2012)



ARCHITECTURAL SERVICES DEPARTMENT
THE GOVERNMENT OF THE HONG KONG SPECIAL ADMINISTRATIVE REGION

PREFACE

This General Specification aims to lay down the technical requirements of materials and equipment, the standards of workmanship, the requirements on testing and commissioning as well as requirements on document submissions for Swimming Pool Water Treatment Installation in Government Buildings of the Hong Kong Special Administrative Region (HKSAR).

The present edition (incorporating Corrigendum No. GSSP02-2012) of this General Specification was developed from the 2012 edition (incorporating Corrigendum No. GSSP01-2012) by the Air-conditioning Specialist Support Group that was established under the Building Services Branch Technical Information and Research & Development Committee of the Architectural Services Department (ArchSD). It incorporates updated international standards and codes as well as technological developments which find applications in Hong Kong. To be in line with the department's endeavour to reduce the environmental burden on our neighbours and to help preserving common resources while improving the quality of our service, the present edition has continued putting emphasis on green initiatives and initiatives for enhancement of client satisfaction on completed projects.

With the benefit of information technology, electronic version of this edition is to be viewed on and free for download from the ArchSD Internet homepage. As part of the Government's efforts to limit paper consumption, hard copies of this General Specification will not be put up for sale.

The draft of the 2012 edition has been circulated to stakeholders within and external to the Government before finalization. Nevertheless, the ArchSD welcomes comments on its contents at anytime since the updating of this General Specification is a continuous process for the inclusion of any developments that can help meeting the needs of our community.

DISCLAIMER

This General Specification is solely compiled for Swimming Pool Water Treatment Installation carried out for or on behalf of the ArchSD in Government buildings of the HKSAR.

There are no representations, either expressed or implied, as to the suitability of this General Specification for purposes other than that stated above. Users who choose to adopt this General Specification for their works are responsible for making their own assessments and judgement of all information contained here. The ArchSD does not accept any liability and responsibility for any special, indirect or consequential loss or damages whatsoever arising out of or in connection with the use of this General Specification or reliance placed on it.

The materials contained in this document may not be pertinent or fully cover the extent of the installation in non-government buildings and there is no intimated or implied endorsement of the sales, supply and installation of the materials and equipment specified in this General Specification within the territory of the HKSAR.

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SECTION A1

SCOPE OF SPECIFICATION

A1.1 INSTALLATIONS TO COMPLY WITH THIS GENERAL SPECIFICATION

The Swimming Pool Water Treatment Installation shall comply with this General Specification which details the intrinsic properties (including materials and workmanship) of the Installations, in so far as it is not overridden by the Conditions, Particular Specification, Drawings and/or written instructions of the Architect.

A1.2 SCOPE OF THE INSTALLATIONS

This General Specification, Particular Specification, Tender Equipment Schedule and Drawings detail the performance requirements of the Installations. The Installations to be carried out in accordance with this General Specification shall include the whole installation and supply of all materials necessary to form a complete installation including any necessary tests, adjustments, commissioning and maintenance as prescribed and all other incidental sundry components together with the necessary labour for installing such components, for the proper operation of the Installations.

A1.3 TERMS AND DEFINITIONS

In this General Specification, all words and expressions shall have the meaning as assigned to them under the Conditions unless otherwise provided herein. The following words or expressions shall have the meanings assigned to them except when the context otherwise requires:-

A1.3.1 Terms and Definitions

AC_GS	General Specification for Air-conditioning, Refrigeration, Ventilation and Central Monitoring & Control System Installation in Government Buildings of The Hong Kong Special Administrative Region
ACS	Automatic control system
ANSI	American National Standards Institute
Appointed Examiner	Refers to any person who has obtained a valid Certificate of Competency issued under Section 6 of the Boilers and Pressure Vessels Ordinance, (Cap. 56) of the Laws of Hong Kong
Architect	The Architect or the Maintenance Surveyor or the Supervising Officer as defined in the Contract as appropriate

ArchSD	The Architectural Services Department, the Government of the Hong Kong Special Administrative Region
BS EN	European Standard adopted as British Standard
BS	British Standards, including British Standard Specifications and British Standard Codes of Practice, published by the British Standards Institution
BSB	The Building Services Branch of the ArchSD, the Government of the Hong Kong Special Administrative Region
Building Contractor	The Contractor employed by the Employer for the execution of the Building Works or the Specialist Contractor separately employed by the Employer to execute the Specialist Works as appropriate
CIBSE	The Chartered Institution of Building Services Engineers
Conditions	The General Conditions of Contract for Building Works together with the Special Conditions of Contract as defined in the Contract, the Sub-contract for Building Works as defined in the Nominated Sub-contract as appropriate
DIN	German Industry Standard
E&M	Electrical & Mechanical
EE_GS	The General Specification for Electrical Installation in Government Buildings of The Hong Kong Special Administrative Region
EJMA	Expansion Joint Manufacturers Association
EMSD	The Electrical and Mechanical Services Department, the Government of the Hong Kong Special Administrative Region
EPD	The Environmental Protection Department, the Government of the Hong Kong Special Administrative Region
Equipment Schedule	Information sheets that contain all essential information and technical data of the equipment
FSD	The Fire Services Department, the Government of the Hong Kong Special Administrative Region
HKIE	The Hong Kong Institution of Engineers
I/O	Input/Output
IEC	International Electrotechnical Commission
IET	The Institution of Engineering and Technology
IEEE	Institute of Electrical and Electronics Engineers
Installations	The work or services for the Swimming Pool Water Treatment Installation forming parts of the Works to be installed, constructed, completed, maintained and/or supplied in accordance with the Contract and includes Temporary Works

LCSD	Leisure & Cultural Services Department, the Government of the Hong Kong Special Administrative Region
NAIMA	North American Insulation Manufacturers Association
NSF	National Sanitary Foundation, USA
ORP	Oxidizing Redox Potential
OSHA	Occupational Safety and Health Administration
PBSI	Project Building Services Inspector
Particular Specification	The Specifications drawn up specifically for the Installations of a Particular Project
Proprietary brand name materials or products	The phrase “or alternative materials having equivalent functions or performance” shall be deemed to be included wherever materials or products are specified by proprietary brand names. Alternative materials or products of different brands or manufacture having equivalent functions or performance may substitute for the specified proprietary brand name materials or products if prior approval from the Architect has been obtained. If the SP Contractor intends to use the intellectual property rights of another party in performing his obligations under the Contract, appropriate licences shall be obtained from the relevant rights owners.
RPE	Registered Professional Engineer under Engineers Registration Ordinance
SP Contractor	The Nominated Sub-contractor or the Specialist Sub-contractor employed by the Building Contractor or the contractor directly employed by the Employer as appropriate for the execution of the Installations in accordance with the Contract
Tender	The Contractor’s tender for the Contract or the Nominated Sub-contractor’s tender for the Nominated Sub-contract as appropriate
WHO	World Health Organization
WSD	Water Supplies Department, the Government of the Hong Kong Special Administrative Region
UL	Underwriters Laboratory, USA

A1.4 SINGULAR AND PLURAL

Words importing the singular only also include the plural and vice versa where the context requires.

SECTION A2

STATUTORY OBLIGATIONS AND OTHER REGULATIONS

A2.1 STATUTORY OBLIGATIONS AND OTHER REQUIREMENTS

The Installations shall conform in all respects with the following:-

A2.1.1 All Enactments and Regulations, in particular, the SP Contractor's attention is drawn to the followings:

- (a) Electricity Ordinance, (Cap. 406), and other subsidiary legislation made under the Ordinance;
- (b) Fire Service (Installations and Equipment) Regulations, Fire Services Ordinance, (Cap. 95), and other subsidiary legislation made under the Ordinance;
- (c) Noise Control Ordinance, (Cap. 400), and other subsidiary legislation made under the Ordinance;
- (d) Water Pollution Control Ordinance, (Cap. 358), and other subsidiary legislation made under the Ordinance;
- (e) Air Pollution Control Ordinance, (Cap. 311), and other subsidiary legislation made under the Ordinance;
- (f) Ozone Layer Protection Ordinance, (Cap. 403), and other subsidiary legislation made under the Ordinance;
- (g) Waste Disposal Ordinance, (Cap. 354), and other subsidiary legislation made under the Ordinance;
- (h) Environmental Impact Assessment Ordinance, (Cap. 499), and other subsidiary legislation made under the Ordinance;
- (i) Waterworks Ordinance, (Cap. 102), and other subsidiary legislation made under the Ordinance;
- (j) Dangerous Goods Ordinance, (Cap. 295), and other subsidiary legislation made under the Ordinance;
- (k) Places of Public Entertainment Ordinance, (Cap. 172), and other subsidiary legislation made under the Ordinance; and
- (l) Public Health and Municipal Services Ordinance, (Cap. 132), and all bylaws and regulations made under the Ordinance.

A2.1.2 Other Requirements

- (a) Code of Practice for the Electricity (Wiring) Regulations published by the EMSD;
- (b) Codes of Practice for Minimum Fire Service Installations and Equipment and Inspection, Testing and Maintenance of Installations and Equipment published by the FSD;
- (c) Requirements and Circular Letters issued by the FSD;
- (d) Code of Practice for Energy Efficiency of Building Services Installation issued by the EMSD, hereinafter referred as the “Building Energy Code” or “BEC”;
- (e) General Specification for Electrical Installation in Government Buildings, Hong Kong, issued by the ArchSD;
- (f) General Specification for Air Conditioning, Refrigeration, Ventilation and Central Monitoring and Control System Installation in Government Buildings, Hong Kong, issued by the ArchSD;
- (g) General Specification for Fire Service Installation in Government Buildings, Hong Kong, issued by the ArchSD;
- (h) Design Manual: Barrier Free Access 2008 published by the Buildings Department, the Government of the HKSAR;
- (i) Codes of Practice issued by the following international institutions:-
 - American National Standard Institute
 - American Society of Mechanical Engineers
 - American Society of Testing and Materials
 - Committee for European Normalisation
 - The Institute of Electrical and Electronic Engineers
 - International Organisation for Standardisation
 - Japanese International Standard
 - National Fire Protection Association
 - Prevention of Legionnaires’ Disease Committee, Hong Kong;
- (j) The Supply Rules and other requirements issued by the relevant local electricity supplier and water authority;
- (k) WHO, "Guidelines for Safe Recreational-water Environments. Vol. 2: Swimming Pools, Spas and Similar Recreational-water environments";

- (l) American National Standard/NSF International Standard Number 50 "Circulation System Components and Related Materials for Swimming Pools, Spas/Hot Tubs";
- (m) EWA "Code of Practice for Ozone Plant for Swimming Pool Water Treatment";
- (n) DIN 19643-1 to -4:2012, Treatment of water of swimming pools and baths;
- (o) ISO 10523:2008, Water quality – Determination of pH;
- (p) ISO 6107-1:2004, Water quality – Vocabulary; and
- (q) BS EN ISO 7027:2000, ISO 7027:1999 Water quality – Determination of turbidity.

A2.1.3 Safety Requirements

The supply, installation, and testing & commissioning of the entire swimming pool circulation, filtration and disinfection plant shall comply with all regulations on safety aspects issued by the Development Bureau, the Labour Department of Hong Kong Special Administrative Region and other authorities from time to time. These include but are not limited to the following:-

- (a) Occupational Safety and Health Ordinance, (Cap. 509), and other subsidiary legislation made under the Ordinance;
- (b) Factories and Industrial Undertakings Ordinance, (Cap. 509), and other subsidiary legislation made under the Ordinance;
- (c) Public Health and Municipal Service Ordinance, (Cap. 132), and other subsidiary legislation made under the Ordinance;
- (d) Construction Site (Safety) Regulations, Factories and Industrial Undertakings Ordinance, (Cap. 59);
- (e) Construction Site Safety Manual issued by the Environmental, Transport and Works Bureau, the Government of the HKSAR;
- (f) Public Works Programme Construction Site Safety Manual;
- (g) Dangerous Goods Ordinance, (Cap. 384);
- (h) Boilers and Pressure Vessels Ordinance, (Cap. 56);
- (i) Gas Safety Ordinance, (Cap. 51); and

- (j) Occupational Safety and Health Council Ordinance, Chapter 398, and other subsidiary legislation made under the Ordinance.

A2.1.4 Technical Standards

BS, BS EN, ISO Standards, IEC Standards and Codes of Practice, etc. shall be deemed to include all amendments, revisions and standards superseding the standards listed herein, which are published before the date of first tender invitation for the Contract or the Nominated Sub-contract (as appropriate) unless otherwise specified.

A summary of international standards quoted in this General Specification to which the Installations shall comply is listed in Annex I.

A2.2 CASE OF CONFLICT

The documents forming the Contract are to be taken as mutually explanatory of one another but in case of ambiguities or discrepancies the same shall be dealt with in accordance with the Conditions.

SECTION A3

EXECUTION OF INSTALLATIONS

A3.1 THE INTERNATIONAL SYSTEM OF UNITS (SI)

The International System of Units (System International d'Unites) of weights and measures shall be used for all materials, equipment and measurements.

A3.2 PROGRAMME OF INSTALLATIONS

The SP Contractor shall submit to the Architect a detailed programme of the Installations within 4 weeks from the acceptance of his Tender showing the intended method, stages and order of work execution in coordination with the building construction programme, together with the duration he estimated for each and every stage of the Installations. The programme shall include at least the following:-

- (a) Dates for the placement of orders for equipment and materials;
- (b) Expected completion dates for builder's work requirements, i.e. when work site needs to be ready;
- (c) Delivery dates of equipment and materials to the Site;
- (d) Dates of commencement and completion of every stage of the Installations in line with the building construction programme, i.e. each floor level and/or zone area;
- (e) Dates of documents/drawings submissions to relevant Government departments to obtain the necessary approvals;
- (f) Dates of requirement of temporary facilities necessary for testing & commissioning, e.g. electricity supply, water and town gas;
- (g) Dates of completion, testing and commissioning; and
- (h) Short term programmes showing the detailed work schedules of coming weeks and months shall also be provided to the Architect. Programmes shall be regularly updated to reflect the actual progress and to meet the SP Contractors' obligations under the Contract.

In addition, detailed submission schedules for installation drawings, equipment and testing and commissioning shall be submitted to the Architect for approval. The formats and information to be included in the schedules shall be as directed by the Architect.

A3.3 BUILDER'S WORK

All builder's work including openings or holes through building structure or partition walls; trenches, ducts and cutting; and all plinths, concrete bases, supports, ducts, etc. required for the Installations will be carried out as part of the building works by the Building Contractor at the expense of the Employer provided that the SP Contractor has submitted full details of such requirements within a reasonable time to the Architect for approval, so that due consideration may be given before the Building Contractor commences the building works in accordance with the building programme in the areas concerned. After obtaining the said approval of the Architect, the SP Contractor is required to mark out at the relevant locations of the Site the exact positions and sizes of all such works and to provide detailed information of such works to the Building Contractor to facilitate him to carry out the builder's works as the Works proceed.

All "cutting-away" and "making-good" as required to facilitate the SP Contractor's works will be carried out by the Building Contractor, except for minor provisions required for the fixing of screws, raw plugs, redhead bolts, etc. which shall be carried out by the SP Contractor. The SP Contractor shall mark out on Site and/or supply drawings of all "cutting-away" to the Building Contractor within a reasonable time.

All expenses properly incurred and losses suffered by the Employer as a result of the SP Contractor's failure to comply with the above requirements are recoverable by the Employer from the SP Contractor as a debt under the Contract or via the Building Contractor as if it is a debt liable to the Building Contractor under the Sub-contract as appropriate.

The SP Contractor shall ensure that such works are essential for the execution of the Installations. In the event that any of such works is proved to be non-essential, unnecessary and/or abortive, the SP Contractor shall bear the full cost of such works including but not limited to any unnecessary or incorrect cutting-away and making-good and all cost incurred in this connection are recoverable by the Employer from the SP Contractor as a debt under the Contract or via the Building Contractor as if it is a debt liable to the Building Contractor under the Sub-contract as appropriate.

Upon completion of the builder's works by the Building Contractor, the SP Contractor shall forthwith check and examine that all builder's works so executed have been completed in accordance with his requirements. If at any time it becomes apparent to the SP Contractor that any builder's works completed by the Building Contractor does not comply with his requirements in any respect whatsoever, the SP Contractor shall forthwith give notice in writing to the Architect and specify in details the extents and effects of such non-compliance in that notice. The SP Contractor is deemed to have satisfied with the builder's works after a period of 14 days from the date of completion of the builder's works if the above notice is not served to the Architect within such period. All additional expenditure properly incurred and all loss suffered in this connection by the Employer in having such works re-executed and rectified shall be recoverable by the Employer from the SP Contractor as a debt under the Contract or via the Building Contractor as if it is a debt liable to the Building Contractor under the Sub-contract as appropriate.

A3.4 COORDINATION OF CONTRACT INSTALLATIONS

The SP Contractor shall coordinate the Installations with those works of the Building Contractor and any other contractors and sub-contractors of the Building Contractor.

The SP Contractor shall note that the Drawings supplied to him only indicate the approximate locations of the Installations. He shall make any modification reasonably required of his programme, work sequence and physical deployment of his work to suit the outcome of work coordination or as necessary and ensure that all cleaning, adjustment, test and control points are readily accessible while keeping the number of loops, cross-overs and the like to a minimum.

The SP Contractor shall pay particular attention to the building works programme and shall plan, coordinate and programme his works to suit and adhere to the building works in accordance with the building programme.

Any significant problems encountered during the coordination work, which are beyond the SP Contractor's control, shall promptly be reported to the Architect.

A3.5 COOPERATION WITH OTHER CONTRACTORS

The SP Contractor shall cooperate at all times with the Building Contractor and all other contractors and sub-contractors of the Building Contractor in order to achieve efficient workflow on the Site.

Any significant problems beyond the SP Contractor's control shall promptly be reported to the Architect.

A3.6 SITE SUPERVISION

The SP Contractor shall keep on the Site a competent and technically qualified site supervisor to control, supervise and manage all his Installations on Site. The site supervisor shall be vested with suitable powers to receive instructions from the Architect.

The site supervisor shall be technically competent and have adequate site experience for the Installations. The SP Contractor shall also refer to the Particular Specification for other specific requirements, if any, on site supervision.

Approval by the Architect shall be obtained prior to the posting of the site supervisor on Site. The SP Contractor shall immediately replace any site supervisor whose experience, skill or competency is, in the opinion of the Architect, found to be inadequate for the particular work.

A3.6.1 Tradesmen and Supervision

All tradesmen must be experienced in the trade and the work carried out shall be consistent with good practice in Hong Kong and to the

satisfaction of the Architect. In this connection, the SP Contractor's attention is drawn to the Special Conditions of Contract under the Contract for the requirements relating to Qualified Tradesmen and Intermediate Tradesmen.

The SP Contractor shall keep on the Site a competent and technically qualified site Supervising Engineer to control, supervise and manage all his Works on Site. The Supervising Engineer shall be vested with suitable powers to receive instructions from the Architect.

The site Supervising Engineer shall be technically competent and have adequate site experience for the Works. The qualified and competent Supervising Engineer shall have minimum 5 years on site experience for similar type of installation works. The SP Contractor shall also refer to the Particular Specification for other specific requirements, if any, on site supervision.

Approval by the Architect shall be obtained prior to the posting of the Supervising Engineer on Site.

The SP Contractor shall also employ a full time competent foreman on Site for each trade. All trade foremen shall be registered tradesmen of the relevant trade.

The SP Contractor shall immediately replace any Supervising Engineer or trade foreman whose experience, skill or competency is, in the opinion of the Architect, found to be inadequate for the particular work.

A3.7 SAMPLE BOARD

Within 6 weeks of the acceptance of his Tender and prior to the commencement of the Installations, the SP Contractor shall submit to the Architect for approval a sample board of essential components proposed to be used in the Contract. However, the SP Contractor may request the Architect in writing for a longer period for the submission, if 6 weeks are practically insufficient.

Items displayed shall be deemed to be adequate for the Installations unless otherwise clearly indicated. Each sample, with clear numbering and labeling, shall be firmly fixed onto a rigid wooden or metal board. A list shall also be affixed on the sample board to show the item description, make and brand, country of origin and locations of installation (if not generally used). Samples rejected by the Architect shall be replaced as soon as possible. Upon approval of all items, the Architect will endorse the list on the sample board and the SP Contractor shall deliver the board to the site office of the Architect's Representative for reference.

The board shall contain samples of all 'compact' sized materials and accessories to be used in the Installations. Written approval of all samples and technical details shall be obtained from the Architect before commencement of any works.

In the context of this General Specification the term 'compact' means any item that will fit into a 300 mm cube.

The following items shall be included in the sample board as a minimum. Additional items may be required by the Architect and/or specified in the Particular Specification.

- (a) G.I. Trunking;
- (b) G.I. Adaptable Box;
- (c) LSOH Cable;
- (d) Galvanized Iron Conduit;
- (e) Flexible Conduit;
- (f) Gun Metal Puddle Flange;
- (g) Push Button;
- (h) Pilot Lamp;
- (i) Selector Switch;
- (j) PVC Ball Valve;
- (k) UPVC Pipe (Ozone Gas & Vent Pipe);
- (l) UPVC Pipe Fitting (Ozone Gas & Vent Pipe) 90° Elbow;
- (m) UPVC Pipe Fitting (Ozone Gas & Vent Pipe) Tee; and
- (n) GMS Pipe Bracket.

Additionally, the SP Contractor shall supply sufficient samples of material for those not listed in the Equipment Schedule or stated in the Particular Specification.

A3.8 ADVICE OF ORDER PLACED

The SP Contractor shall submit copies of all orders placed for major items of equipment and materials to the Architect for record.

A3.9 RECORD OF MATERIALS DELIVERY

All materials and equipment delivered to Site shall be accurately listed and recorded in the site record books maintained by the Architect's Representative on Site.

Materials and equipment delivered to Site are the Employer's property. Such materials and equipment shall not be removed from Site without the prior approval of the Architect in writing.

Where the Building Contractor is in overall control of the Site, the Building Contractor may also be required to record details of all incoming/outgoing materials. In this case, the SP Contractor shall comply with the Building Contractor's arrangements.

A3.10 PROTECTION OF MATERIALS AND EQUIPMENT

Unless the responsibility is clearly defined in the Contract that the protection on Site for delivered equipment, materials and installation is solely by other contractors, the SP Contractor shall be responsible for the safe custody of all materials and equipment as stored or installed by him. In addition, the SP Contractor shall protect all work against theft, fire, damage or inclement weather and carefully store all materials and equipment received on Site but not yet installed in a safe and secure place unless otherwise specified.

All cases of theft and fire must immediately be reported to the police, the Building Contractor, the Architect and the Architect's Representatives on Site with full details.

Where necessary the SP Contractor shall provide lockable steel container or other equally secure enclosures placed within a securely fenced-in compound provided by the Building Contractor on Site for the storage of materials and equipment.

The SP Contractor shall co-ordinate and arrange with the Building Contractor who shall provide clean, reasonably finished and lockable secure accommodation for the storage of sensitive and/or expensive items before installation.

If there is no Building Contractor, all the storage facilities and spaces shall be provided by the SP Contractor.

A3.11 OTHERS

A3.11.1 Materials and Equipment

A3.11.1.1 Materials and Equipment Standards

All materials, equipment and installation work shall be carried out by adoption of the best available quality anti-rust and anti-corrosive materials and workmanship and shall, where applicable, comply with the latest edition of the appropriate standards and/or codes of practice issued by the relevant international Institutes and Standards and as specified in this General Specification which are published before the date of first tender invitation for the Contract or the Nominated Sub-contract as appropriate. This requirement shall be deemed to include all amendments to these standards and codes up to the date of tendering.

A3.11.1.2 Compatibility of Materials and Equipment

Where different components of equipment are interconnected to form a complete system, their characteristics of performance and capacities shall be matched in order to ensure efficient, economical, safe and sound operation of the complete system.

A3.11.1.3 Equipment Catalogues and Manufacturer's Specifications

Equipment catalogue and manufacturer's specification related to proposed items of equipment shall be specific and shall include all information necessary for the Architect to ascertain that the equipment complies with this General Specification and/or the Particular Specification and Drawings. Data and sales catalogue of a general nature are not acceptable. Unless agreed to by the Architect in writing, all data and catalogues submitted must be in English and in pure SI units i.e. mm, m, kPa, m/s, Hz, kW, l/s, etc.

The SP Contractor shall submit catalogues and manufacturer's specification of the proposed equipment for the examination and approval by the Architect in writing before any equipment is ordered.

A3.11.1.4 Equipment Deviations

Subsequent to the award of the Contract or the Sub-contract as appropriate, and only in exceptional circumstances where it is demonstrated in writing by the SP Contractor that the original equipment offered cannot be obtained, the Architect may, subject to the Conditions, consider and accept, in writing, alternative equipment and materials having equivalent functions or performance proposed by the SP Contractor provided always that these are fully in compliance with the relevant Specifications and Drawings and do not impose any additional contractual or financial liabilities onto the Employer.

Any redesign, alteration, or abortive work of the structure, partitions, foundations, piping, ductwork, wiring or any other part of the mechanical, electrical or architectural layout as a result of the alternative equipment and materials proposed by the SP Contractor shall be agreed with the Architect under a supplementary agreement.

In the event that the approved alternative equipment or material is lower in price than the original offered equipment or material, the net difference in price between the original offered equipment or material and the approved alternative equipment or material with the executed quantities of the relevant work item shall be deducted from the Contract Sum in accordance with the Contract. The Contract Sum, however, shall not be adjusted where the approved alternative equipment or material is higher in price than the original offered equipment or material.

A3.11.1.5 Manufacturers' Technical Support in Hong Kong

All equipment listed in the Equipment Schedule shall be supplied through authorised agencies of the manufacturers in Hong Kong or through the Hong Kong offices of the manufacturers. These local agencies or offices shall have adequate technical staff to provide pre-sale and after-sale services to the SP Contractor. Unless otherwise specified in the Particular Specification, equipment supplied directly by the manufacturers which do not have local agencies or offices will not be accepted. Spare parts should also be available in the local market easily.

A3.11.2 Service Conditions

The following service conditions shall apply:-

- (a) Climate : Hong Kong (tropical)
- (b) Ambient Temperature : Peak -5°C to +40°C
(continuously 4 hours) Average
0°C to +35°C (over 24 hours)
- (c) Altitude : up to 2000 m above sea level
- (d) Relative Humidity : 99% maximum

A3.11.3 Voltage Covered by this General Specification

Unless otherwise specified, all apparatus, equipment, materials and wiring shall be suitable for use with a 3-phase and neutral, 4-wire, 380/220 V $\pm 6\%$, 50 Hz $\pm 2\%$ power supply.

A3.11.4 Design Criteria for Chemical Solution and Pool Water

Design criteria for chemical solution and pool water shall refer to Particular Specification.

A3.11.5 Labels and Related Instruction

In order to make cross reference to the Operation/Maintenance/Service Manuals and Schematic Drawings, etc., the SP Contractor shall provide labels for marking all valves, pipework, filtration tanks, fuses, terminals, lamps, switches, handles, keys, instruments, gauges, control and other equipment, etc. and elsewhere to facilitate maintenance or as directed by the Architect with engraved multi-layer formica or similar material. Wording shall be submitted to the Architect for approval before manufacture.

Instructions for oiling and/or greasing of all motors, etc. shall be attached to the relevant greasing or oiling points.

All labels shall be of adequate size as to give clearance between lettering and fixings to ensure an aesthetic arrangement on completion. Pipeline labels shall generally be not smaller than 100 mm x 20 mm. Where applicable, labels shall be fixed utilising brass round head bolts

and nuts or woodscrews. Adhesives or self tapping screws are not acceptable.

For pipelines or valves, where applicable, labels shall be fixed by means of a key ring attached to the upper corner of the pipe mounting bracket or the hand wheel of valves. The labels shall be suspended from brass or stainless steel chain loops over the relevant pipe.

All English lettering used on labels shall be "Bold" capitals (except otherwise directed) with black letters on white labels for normal purposes. Where special colours or details are required these shall be as specified or directed.

The SP Contractor shall submit a schedule for all labels, notices, identifications and instructions for the Architect's approval prior to order and installation. The information of the schedule shall include the description of the items, height and font type of the text, dimensions of the labels and material used.

All labels and instructions shall be in English complete with translation in Chinese characters. The Chinese translations shall be referred to the "Glossaries of Terms Commonly Used in Government Departments" issued by Civil Service Bureau of the Government of the HKSAR. Heights for the English lettering shall be as follows with that for Chinese characters to match:-

- | | |
|---|------|
| - Pipelines, valves, motor valves, fans, doors, etc | 8 mm |
| - Greasing instructions for motors, fan bearings, etc | 6 mm |
| - Thermostats, sensors, thermometers, pressure gauges, general instructions, etc. | 3 mm |

For electrical panels or other items, lettering shall be:-

- Black on white for normal purposes
- Red letters on white where connected to essential supply
- Green letters on white where operated by direct current

For electrical components the letter heights shall be as follows:-

- | | |
|--|------|
| - Identifying equipment in cabinets | 3 mm |
| - Door cabinets | 8 mm |
| - Switches & indicators on panel faces | 3 mm |

Where proprietary type, rail mounted terminals are utilised in electrical cabinets, the manufacturer's "clip-in" identification tabs shall be used.

A3.11.6 Coded Labels

Where appropriate, items such as valves, sensing points, etc. may also be identified by "Codes" on the labels which shall relate to the items as

detailed on plant room mounted diagrammatic drawings or the mimic diagrams on operational control panels. At the diagram or control panels, the function of each coded item shall also be detailed. Such systems of labelling and related diagrams shall be approved by the Architect before implementation.

Valves etc. required for emergency shutdown purposes must under all circumstances be fully detailed at the valve.

A3.11.7 Warning Notice

- (a) Warning notices shall be provided as required by the Electricity Ordinance, (Cap. 406) and the Code of Practice for the Electricity (Wiring) Regulations (Cap. 406E). In addition, the following warning notices in English and Chinese shall be provided at the appropriate positions:-

A label having minimum size of 65 mm x 50 mm marked with the words "DANGER - HIGH VOLTAGE" in red lettering not less than 5 mm high to be fixed on every container or enclosure of equipment for operating at voltages exceeding "Low voltage".

- (b) Warning labels shall be fixed in such a position that any person who may gain access to any moving parts of an item of equipment or enclosure will notice or be warned of such a danger.
- (c) A label to warn of probable ozone leakage and hydrogen leakage shall be fixed respectively outside the ozone generator room and the sodium hypochlorite tank room.

A3.11.8 Safety On Site

Work shall be carried out in such a manner as to conform in all respects with all the regulations, ordinances, etc.

A3.11.9 Guard and Railing for Moving or Rotating Parts of Equipment.

All moving or rotating parts of equipment shall be provided with an approved guard and railing complying with the Factories & Industrial Undertakings (Guarding an Operation of Machinery) Regulations (Cap. 59Q), together with any amendments made thereto.

Guards shall be rigid and of substantial construction and shall consist of heavy mild steel angle frames, hinged and latched with either heavy galvanised mild steel wire crimped mesh securely fastened to frames or galvanised sheet metal of 1.2 mm minimum thickness. All apertures shall be such that finger access to dangerous part is not possible. All sections shall be bolted or riveted. Railings shall be made of 32 mm dia. galvanised mild steel pipe and railing fittings.

A3.11.9.1 Temporary Guards

During the execution of work, the SP Contractor shall ensure that all moving parts are adequately guarded by temporary guards.

Adequate temporary guard railings, etc. around dangerous floor/wall openings in the vicinity of any work for the protection shall be provided.

For the safety of workers, guard railings, etc. are to be provided by the Building Contractor, but in case they are not provided, the SP Contractor shall immediately report the matter to the Architect.

A3.11.9.2 Permanent Guards on Plant

Unless specified otherwise in the Particular Specification, the SP Contractor shall provide removable guards or railing for protection from moving or rotating parts. The design and construction of safety guards for moving parts such as belt drives shall conform to the requirements laid down in the Factories & Industrial Undertakings (Guarding an Operation of Machinery) Regulations.

A3.11.10 Workmanship Standard

The installation works shall be in line with the good practice accepted by the local industry and verified by commissioning and testing results.

The installation works shall be in compliance with this General Specification, Particular Specification and Drawings.

The Installations shall be in compliance with the requirements as specified in Section A2 of this General Specification in respect of labour safety, fire safety, structural safety, electrical safety and environmental protection.

Apart from those requirements as stipulated in this General Specification and other statutory requirements, due care shall be taken to secure public safety and health both during the execution of the works and in the selection of equipment and materials for the Installations.

A3.11.11 Special Plant Room Co-ordination Work

Unless otherwise stated in the Contract, in the case of a plant rooms where the SP Contractor's equipment constitutes the major item involved, the SP Contractor shall be responsible for the co-ordination of other services/building details within these specific areas.

Where necessary, the foregoing plant room co-ordination requirement shall include the preparation of plant room co-ordination drawings which other contractors involved in the plant room are to comply with. The SP Contractor shall, carry out cross checking of other contractors' plant room installation drawings to ensure that there is no conflict between the working activities of the various contractor's working in the same plant room before any of his works thereon proceeds.

A3.11.12 Selection of Equipment

Selection of equipment shall be based on this General Specification, the Particular Specification, and the technical data on Drawings and Equipment Schedules.

Where items of equipment are interconnected to form an integral part of the complete Installations, their characteristics of performance and capacities shall be so matched as to give safe, reliable, efficient and economical operation.

A3.11.13 Tools and Instruments

Proper tools shall be used for the works. Adequate and accurate testing/measuring instruments shall be used to demonstrate compliance of the Installations with the relevant specifications and regulations. The Architect has the right to stop any work in which the correct tools and/or instruments are not used.

Instruments used for acceptance tests shall be calibrated at an interval time of 1 year unless otherwise as required in the Contract for a particular project.

A3.11.14 Submission of Testing and Commissioning Procedure

Upon completion of the Installations but prior to acceptance, the SP Contractor shall submit to the Architect in good time a schedule showing the appropriate testing and commissioning procedures to be carried out. The schedule shall be agreed by the Architect before any testing and commissioning work is carried out.

Detailed requirements for testing and commissioning shall be in accordance with the relevant Sections of this General Specification.

SECTION A4

DRAWINGS AND MANUALS

A4.1 DRAWINGS IN ELECTRONIC FORMAT

The SP Contractor shall provide drawings in electronic format as required in the following clauses. These drawings shall conform to the latest version of CAD Standard of Works Projects (CSWP) as posted in the web site of the Works Branch, Development Bureau and in accordance with the latest version of CAD Manual for ArchSD Projects. Should any technical conflict between the CSWP and the CAD Manual arise, the CSWP shall take precedence.

A4.2 INSTALLATION DRAWINGS

A4.2.1 Drawing Submission Schedule

The SP Contractor shall submit a detailed installation drawing submission schedule and programme to the Architect. The SP Contractor shall allow reasonable time in the programme for vetting of the installation drawings by the Architect and for drawing resubmissions as necessary.

The SP Contractor shall submit to the Architect a comprehensive "Submission Schedule" of installation drawings and builder's work drawings within 2 weeks after the acceptance of Tender, taking into account of the overall programme of the Installations including any Specialist Works and works by the utility undertakings. No equipment shall be delivered to the Site and no work shall be executed until the installation drawings have been approved by the Architect. The SP Contractor shall ensure that installation drawings and builder's work drawings are progressively submitted in accordance with the approved "Submission Schedule".

The SP Contractor shall provide at least 6 hard copies and one electronic copy, unless otherwise specified in the Contract or the Sub-contract as appropriate, of the approved installation drawings to the Architect for distribution.

A4.2.2 Size of Installation Drawings

Drawings submitted by the SP Contractor shall only be of standard sizes from A0 to A4 or B1 size as stipulated in ISO 5457:1999/Amd1:2010.

The drawings shall be prepared to the same sheet sizes and scales as used for the ultimate "As-built" record drawings.

A4.2.3 Contents of Installation Drawings

The SP Contractor shall ensure all installation drawings are accurate representation of the Installations, before submitting them to the Architect. All installation drawings shall be fully dimensioned and suitably scaled showing construction, sizes, weights, arrangements, operating clearances and performance characteristics.

4.2.3.1 "Installation Drawings" and/or "Shop Drawings" shall generally include, but not be limited to, the following:-

- (a) symbols and notations same as and compatible with the Standard adopted on the Standard Drawings and/or in the Drawings for the Installations;
- (b) complete layout/assemblies including all necessary minor items and accessories;
- (c) positions of all fixings, hangers and supports;
- (d) maintenance spaces for all withdrawable items, such as, thermometers, thermostats, pump shafts, detectors, removal of guards, etc.;
- (e) positions & sizes of all sensor pockets, thermometer pockets, bends and fittings, clearances to allow for the removal of inserted equipment where applicable;
- (f) outline of insulation and clearances to allow for application thereof;
- (g) outline of valve and similar insulation boxes and the clearances to be allowed for their removal thereof; and
- (h) lifting points and weights of each item. Note: These may be shown on separate drawings, if necessary, to avoid confusion.

A4.2.3.2 Pipework Installation Drawings

Prior to the commencement of any manufacture, fabrication, or installation, the SP Contractor shall submit to the Architect for technical appraisal Pipework Installation Drawings for the pipework installation. Generally, the drawings shall be drawn to a scale of not less than 1:50. Subject to the Architect's approval a scale of 1:100 may be adopted where the installation is a simple one.

The drawings shall indicate the location, with dimensions given, of all pipework in relation to the building structure and other pipework and equipment. The position of all valves, strainers, check valves, etc. shall be shown together with clearances necessary for removal of strainer baskets, internal parts of all valves, motors for motorized valves, solenoids, etc.

Positions and details of all hangers and supports shall be shown and the positions dimensioned. Positions of thermometers, sensor pockets and similar devices shall be shown and dimensioned including clearances required for their removal.

A4.2.3.3 Control and Wiring Diagrams Drawings

The SP Contractor shall prepare and submit schematic diagrams showing the control layout with each item clearly identified with all interlocking and related facilities.

These drawings shall include logic sequence and wiring diagrams showing full details including terminal and wire numbers, colour code, etc. for all items of electrical/electronic equipment and installations. Interlocking, reset or similar facilities shall be clearly shown.

Installation Drawings shall also be prepared and submitted for all physical wiring detailing positions, enclosures, fixings, support, protection, sizes and number of cores/tubes for all runs.

The Installation Drawings shall show positions in relation to the building structure and other plant, equipment and/or installations. In the context, the plant, equipment and/or installations shall to include the SP Contractor's own installed services and those installed by other contractors. For those services installed by others, the SP Contractor shall be responsible for obtaining sufficient details of relevant information from them in order to complete the drawings.

A4.2.3.4 Switchgear, Starter, Control/Instrumentation/Motor Control Drawings

Shop drawings/installation drawings shall show the physical construction and layout, internally and externally, of all panels/cabinets/cubicles including the physical arrangement of all major and important components, bus-bars, phase separation barriers, interconnecting wiring, labels, etc.

Wiring diagrams and schematic diagrams shall show all internal & external wiring/piping including all interlocks and connections from the panels to external equipment.

Operation and control philosophy shall also be included in the submission. The drawings shall include proposed full wording of all labels to be installed in both English and Chinese characters.

A4.2.4 Builder's Work Drawings

Unless otherwise approved by the Architect, the SP Contractor shall submit to the Architect in accordance with the approved "Submission Schedule", 6 copies of drawings showing details of all builder's work required e.g. the weight and the load on each support of equipment. Such drawings shall clearly indicate the details and positions of all openings, trenches, ducts and cutting required and construction details for plinths and equipment bases.

A4.2.5 Manufacturer's Shop Drawings

The manufacturer's shop drawings are drawings for equipment or plant to be manufactured by a specialist manufacturing supplier in their own workshops and places away from the Site.

The drawings shall show detailed construction, principal dimensions, weights and clearances for maintenance, etc. Immediately after placing of any order or at any event within 4 weeks unless otherwise approved in writing by the Architect, the SP Contractor shall forward to the Architect for comment, 4 copies of manufacturer's shop drawings, indicating detailed construction, principal dimensions and weights, clearances for withdrawals and/or cleaning, etc. No work shall proceed on or off Site unless drawings requiring approval are so approved in writing by the Architect.

A4.2.6 Drawings for Submission to Other Authority

The SP Contractor shall allow for, without extra charge, all necessary drawings for submission to other Authorities as required.

A4.3 AS-BUILT DRAWINGS

A4.3.1 Submission of As-built Drawings

The SP Contractor shall submit 3 sets of the first draft prints of as-built drawings within 28 days of the issuance of the certification of completion in accordance with the Contract to the Architect for checking. The Architect after checking the above draft prints shall return one set of the marked up copies of these as-built drawings to the SP Contractor within 42 days from the date of submission of the SP Contractor's draft prints with comments. The SP Contractor shall within a further 28 days from the date of receiving the Architect's

comments on the draft as-built drawings re-submit to the Architect for his approval another 3 sets of the second draft prints of as-built drawings with the Architect's comments incorporated. This process of submission and approval shall continue until the final approval of the Architect on these as-built drawing is obtained.

The final approved as-built drawings shall be in 3 sets of hard copies and 3 sets of electronic copies. These shall be submitted within 21 days from the date of final approval. Each electronic copy shall be in the form of CD-ROM, labelled, with cross reference to a printed list of files explaining the contents and purpose of each file and supplied in sturdy plastic containers.

The detailed requirements and the media of as-built drawings set out in the Contract shall be followed as appropriate.

A4.3.2 Size of As-built Drawings

As-built drawings shall only be of standard sizes of A0, A1 or B1 size as stipulated in ISO 5457:1999/Amd1:2010. Smaller size (A2 to A4) is acceptable for installation drawings.

A4.3.3 Content of As-built Drawings

The SP Contractor shall ensure all as-built drawings are accurate representation of the Installations, before submitting them to the Architect. The as-built drawings required to be provided by the SP Contractor for various types of BS/E&M installations shall include, but not limited to the following:-

- (a) filtration Plant Room layout plans such carbon filters, sand filters, circulation pumps, heat exchangers, ozonator equipment, chemical dosing equipment and oxidant generator equipment, piping arrangement, etc.;
- (b) system schematic diagrams, control diagrams and wiring diagrams;
- (c) conduit/trunking layout routing, etc.; and
- (d) installation details and assembly drawings such as LV cubicle switchboard layout, motor control cubicle layout, etc.

7 calendar days prior to commencement of any commissioning procedures on any section of the installation, the SP Contractor shall provide 2 (or more if required) preliminary copies of "As-built" drawings complete with all details. Any amendments noted on these drawings during the commissioning and testing stage shall subsequently be transferred to the original "As-built" drawings once the amendments have been accepted by the Architect.

A4.3.4 Framed Drawings

The SP Contractor shall provide and install in the relevant major plant room glass-framed, non-fading prints of the following:-

- (a) valve and damper charts consisting of schematic diagrams showing the layouts and positions and identification of all valves and dampers with record of final settings/adjustment for regulating devices; and
- (b) plant room record drawings showing all plant items, pipework, etc. including all electrical and control schematics and diagrams.

Glazing shall be polished plate of not less than 6 mm thickness mounted in natural finish, extruded and anodised aluminium frames with the prints mounted on acid free mounting board and the whole backed with marine grade plywood not less than 8 mm thick.

A4.4 OPERATION AND MAINTENANCE (O&M) MANUAL AND USER MANUAL

A4.4.1 General

The SP Contractor shall provide two types of manuals with all changes made to the Installations during the course of the Contract suitably incorporated.

The O&M Manual is for use by the maintenance agent of the completed Installations. It shall contain detailed technical information covering both operation and maintenance aspects of the Installations.

The User Manual seeks to give users of the completed Installations an overview of the essential information of the Installations. The contents of the manual should be concise and succinct for ease of comprehension by people with a non-technical background.

A4.4.2 Presentation

All manuals shall be written in English, unless otherwise specified. The text of descriptive parts shall be kept concise while at the same time ensure completeness. Diagrammatic materials shall also be supported by comprehensive descriptions.

The manuals shall comprise A4 size loose-leaf, where necessary, A3 size folded loose-leaves. The loose-leaf shall be of good quality paper that is sufficiently opaque to avoid "show-through". Unless otherwise specified in the Contract, the manuals shall be bound in durable loose-leaf four ring binders with hard covers. The manuals shall have labels or lettering on the front cover and spine. The Architect's approval shall be obtained on this at the draft manual stage. The

electronic copy of manuals including the technical literatures shall be in PDF format readable by Acrobat Reader Freeware.

A4.4.3 Checking and Approval

The SP Contractor shall submit 3 sets of the first draft of O&M Manuals together with a list of recommended spare parts for one year's operation and special tools, both complete with prices to the Architect for comment within 28 days of the issuance of the certificate of completion in accordance with the Contract.

The SP Contractor shall submit 2 sets of the first draft of the User Manual to the Architect for comment at least 56 days before the prescribed or extended date for completion of the Works.

The Architect will check the drafts and return them to the SP Contractor within 42 days from the date of submission with comments necessary for a final and approved set of document. The SP Contractor shall then make all necessary amendments to the documents and resubmit them to the Architect within 21 days from the date of receipt of comments.

The SP Contractor shall submit 3 sets of hard copies (one of which shall be the original) and one set of electronic copy of the final approved O&M Manuals in CD-ROM within 21 days from the date of approval by the Architect.

The SP Contractor shall submit 2 sets of hard copies and one electronic copy of the final approved User Manuals in CD-ROM within 21 days from the date of approval by the Architect.

A4.4.4 Structure and Content of O&M Manual

The detailed requirements, structure and contents of the O&M Manual shall be as specified in elsewhere in the Contract and shall include the following information under separate sections where appropriate:-

(a) Project Information

This shall include:-

Project title, site address, contract no., contract title, contractor/sub-contractor names, address, contact persons and their telephone/fax nos., contract commencement date, substantial completion date and expiry date of Maintenance Period.

(b) System Description

- type(s) of system(s) and equipment installed;
- design criteria, design data and parameters;

- locations of the system and major equipment, and what they serve;
- description of operation and functions of the system and equipment; and
- general operating conditions, expected performance and energy and resources consumption where applicable.

(c) List of Installed Equipment

Schedule of all items of equipment and plant stating the location, name, model no., manufacturer's serial or reference no., manufacturer's design duties and data.

(d) List of Spare Parts and Special Tools Lists

- List of Spare Parts supplied by the SP Contractor:
Item descriptions, supplied quantities, model nos., manufacturer's serial or reference nos. and storage locations; and
- Recommended Spare Parts List and Special Tools List:
Manufacturers'/suppliers' recommendations for spare parts and special tools with item description, unit rate, recommended stock quantities as well as the agents for the spare parts and special tools.

(e) Manufacturers' Certificates/Guarantees

- Manufacturers' certificates such as factory test certificates, laboratory test reports and guarantees and any others where required for the equipment and plants, etc.; and
- Originals of Statutory Inspection Certificate for various installations, including:-
 - Other equipment such as Surveyor's test certificates for high pressure vessel Surveyor's load certificates for lifting devices/appliances, etc.;
 - Electrical installations (Work Completion Certificate Form WR1); and
 - Dangerous Goods Licence.

(f) Safety Precautions for Operation and Maintenance

State, where applicable, hazard warnings and safety precautions of which the operation and maintenance staff need to be aware:-

- mandatory requirements relating to safety;
- known hazards against which protection measures shall be taken; and
- known features or operational characteristics of the installed equipment or systems which may cause hazard and the related safety precautions.

(g) Operation Instructions

Instructions for the safe and efficient operation, under both normal and emergency conditions, of the installed system which shall comprise:-

- an outline of the operating mode;
- control logic and data (sequence, effect, limits of capability, modes and set points);
- procedures and sequences for start-up and shut-down;
- interlocks between equipment/system;
- calling on of stand-by equipment;
- precautions necessary to overcome known hazards;
- means by which any potentially hazardous equipment can be made safe;
- estimation of energy consumption and energy costs;
- forms for recording plant running hours, energy consumption and energy costs; and
- operating data such as running current, operating pressure, operating flow rates, etc.

(h) Maintenance

- Maintenance instructions

Manufacturers' and the SP Contractor's recommendations and instructions shall be provided for the maintenance of the installed equipment. Clear distinction should be made between planned tasks (preventive maintenance) and fault-repair tasks (corrective maintenance). Instructions shall be given on each of the following, as appropriate:-

- nature of deterioration, and the defects to be looked for;
- isolation and return to service of plant and equipment;
- dismantling and reassembly;
- replacement of components and assemblies;
- dealing with hazards which may arise during maintenance;
- adjustments, calibration and testing;
- special tools, test equipment and ancillary services; and
- Maintenance schedules.

Proposed maintenance schedules for all the preventive maintenance tasks identified above. The schedules shall be based on both manufacturers' recommendations and other authoritative sources (e.g. statutory or mandatory requirements) and should include:-

- routine servicing;
- inspections;
- tests and examinations;
- adjustments;
- calibration; and

- overhaul.

The frequency of each task may be expressed as specific time intervals, running hours or number of completed operations as appropriate. Collectively, the schedules will form a complete maintenance cycle, repeated throughout the whole working life of the installation.

(i) Drawing Lists

- a complete list of as-built drawings identified with drawing number/reference;
- a complete list of manufacturers' shop drawings with drawing number/reference, where applicable; and
- a brief description of CD-ROM for these drawings.

(j) Technical Literatures

A complete set of manufacturers' literatures for all the plant and equipment installed in the system shall be provided. The contents of these literatures shall cover the following areas where applicable:-

- description of equipment with model numbers highlighted;
- performance - behavioural characteristics of the equipment;
- applications - suitability for use;
- factory/laboratory test reports, detailed drawings, circuit diagrams;
- methods of operation and control;
- operation instructions;
- cleaning and maintenance requirements;
- plants, materials and space required for maintenance;
- protective measures and safety precautions for operation & maintenance; and
- part lists.

(k) Contact addresses and telephone numbers of suppliers of major equipment.

A4.4.5 Structure and Content of User Manual

The detailed requirements, structure and contents of the User Manual shall include, where applicable, the following information:-

(a) Project Information

This shall include:-

Project title, site address, contract no., contract title, contract commencement date, substantial completion date and expiry date of Maintenance Period.

(b) System Description

- type(s) of system(s) and equipment installed, and their purposes;
- locations of major plant rooms and riser ducts;
- brief description of the operation and functions of the systems and equipment; and
- listing of set points which can be adjusted by the user to suit their operation needs.

(c) Schedule of Major Plant Rooms and Installed Equipment

- schedule of major plant rooms and riser ducts including their locations; and
- schedule of major equipment and plants including their locations and serving areas.

(d) Safety Precautions for Operation

Any safety precautions and warnings signals that the users shall be aware of in the daily operation of the various systems and equipment in the Installations including:-

- mandatory requirements relating to safety;
- features or operational characteristics of the installed systems or equipment which may cause hazard and the related safety precautions;
- protective measures and safety precautions for operation; and
- list of warning signals and the related meanings that the user shall be aware of and the actions to be taken.

(e) Operation Instructions

Instructions for the safe and efficient operation, under both normal and emergency conditions, of the installed system which shall comprise:-

- an outline of the operating mode;
- step by step operation instructions for systems and equipment that are to be operated by the user, including at least procedures for start-up and shut-down;
- means by which any potentially hazardous situation can be made safe; and
- cleaning and basic maintenance procedures.

(f) List of Statutory Periodic Inspections and Tests

A schedule of periodic inspections and tests that owner and/or user of the Installations have to arrange to achieve compliance with the requirements stipulated in the relevant Laws of Hong Kong. The frequency of such inspections and tests shall be expressed in specific time intervals.

(g) Drawings

A set of selected as-built drawings which shall be able to illustrate to the user the general layout of the completed Installations.

(h) Photographs

A set of photographs with suitable captions to illustrate to the user the appearance and locations devices which required their setting and operations.

A4.4.6 Intellectual Property Rights

The Government shall become the absolute and exclusive owner of the Operation and Maintenance Manuals and the User Manual and all intellectual property rights subsisting therein free from all encumbrances.

In the event that the beneficial ownership of any intellectual property rights subsisting in the above Manuals are vested in anyone other than the SP Contractor, the SP Contractor shall procure that the beneficial owner shall grant to the Employer a transferable, non-exclusive, royalty-free and irrevocable licence (carrying the right to grant sub-licences) to utilize the intellectual property rights in the manuals for the purposes contemplated in the Contract. For the avoidance of doubt such purposes shall, but not limited to, include providing free copying of the materials in the manuals by any subsequent owner or user of the Installations, and/or any party responsible for the operation and maintenance of the Installations in connection with any subsequent alteration, extension, operation and maintenance of the Installations.

PART B - INSTALLATION METHODOLOGY

SECTION B1

WATER CIRCULATION

B1.1 GENERAL

B1.1.1 Pool Water Circuits

A typical pool water treatment plant consists of the following aspects:-

- (a) water circulation;
- (b) filtration;
- (c) pH control and chemical treatment;
- (d) disinfection; and
- (e) optional heating.

A pool water circuit consists of pumps, filters, disinfection plant, chemical dosing system, and heating plant if heating is provided.

B1.1.2 Water Turnover Rate

Unless otherwise specified, the pool water turnover rate shall be not less than once in every 4 hours in the case of an indoor swimming pool or once in every 6 hours in the case of an outdoor swimming pool as required under Chapter 132 – Swimming Pools Bylaws Subsidiary Legislation, or revised turnover rate as revised by the HKSAR Government.

B1.1.3 Water Balancing

In the case that 1 circuit is used to serve more than 1 pool, water balancing for each pool is important to maintain the turnover rate and the water level of each pool. The use of level sensors, flow meters, surge or balance tank and automatic control system to maintain the water balancing shall be facilitated. Refer to the Particular Specification for the water balancing methodology to be used.

B1.1.4 Surge Tank

Surge tank is required to hold the displacement water via the perimeter overflow system. The retention capacity of the surge tank should be designed to cater for the maximum expected bather surge. Surge tank may be integral with the pool construction as trenches of a separate chamber into which the perimeter overflow is piped.

B1.1.5 Balance Tank, Level Control and Infill Tank

Balance tank is used to compensate automatically the loss of water through the perimeter overflows, backwashes, evaporation and water carried by bathers leaving the pool. It is desirable to restore water level in less than 2 minutes after a surge. The compensating function of a balance tank shall be achieved by an automatic level control mechanism, with manual bypass fill valve provided. The pumping rate shall be large enough to reduce the recovery time.

Automatic infilling fresh water shall also be provided to the balancing system. Manual infill shall be included in case of automation failure. Balance tank may be combined with the surge tank with automatic infill level control to measure a preset minimum water level in the surge tank.

B1.2 WATER PUMP

B1.2.1 Main Circulating Water Pump

(a) Type

- i) Pumps for pool water circulation or other fresh water pumping duties unless otherwise specified, shall be of one of the following types:-
 - centrifugal type with volute casing split on the centerline of the shaft with suction and delivery connections flanged and fitted to the non-removable half of the casing;
 - end suction type, the pump set shall be installed with spacer type coupling so that the pump impeller can be dismantled from the motor side for servicing without disruption of the pipe-work nor dismounting the motor; or
 - vertical centrifugal pump.
- ii) Where large static heads have to be pumped against, the end suction type or vertical centrifugal type shall be used in multi-stage configurations. Generally the type of pump required will be specified in the Particular Specification and/or in the Tender Drawings. However, if this is not so, the end suction type should be adopted.
- iii) The pneumatic booster pump set shall comprise of a duty and standby pump complete with a pneumatic vessel and control unit. The pumps shall be vertically mounted, with direct drive motors. If necessary, the pumps shall be of multi-stage construction and each stage/section shall be interchangeable.

(b) Materials of Construction

Unless otherwise specified, the materials of construction of the pumps shall be as follows:-

Description	Material
Casing	Bronze to BS EN 1982:2008 or Cast iron to BS EN 1561:2011
Impeller	Bronze to BS EN 1982:2008
Shaft	Stainless steel to BS EN 10088-3:2005
Sleeves	Stainless steel same as shaft or cast bronze
Wearing rings	Copper-tin alloy to BS EN 1982:2008

(c) Standards

i) Stuffing Boxes and Drain Piping :

Stuffing Boxes shall have material same as the casing. Housing of cast iron stuffing boxes shall comply with ISO 185:2005 or BS EN 1561:2011 and shall be of ample length with bronze lined gland and neck bush, fitted with approved packing and lantern ring water seal. Drain outlet and piping to remove gland leakage shall be provided. Alternatively, a mechanical seal may be offered. The mechanical seal shall be of leak free operation. The mechanical seal shall be the product of a specialist proprietor and the materials used shall be suitable for the pumped liquid.

ii) For vertical in-line pump, suction and discharge flanges shall be of equal size. The impeller shall be dynamically balanced. The shaft shall have stainless steel/bronze sleeves keyed to prevent rotation and secured against axial thrust. For multi-stage pump, each stage/section shall be interchangeable.

B1.2.2 Cooling Water Pump

In case the ozonator is water cooled, where pool water is pumped through the generator for cooling purpose, the cooling water pump shall be one of the above types as deemed necessary unless otherwise specified in the Particular Specification.

B1.2.3 Water Equipment Pumps

Pumps for water play equipment, make-up water, and other use shall be one of the above types as deemed necessary unless otherwise specified in the Particular Specification.

B1.2.4 Sewage Sump Pump

(a) Materials of Construction of Dry Pit Pump

Unless otherwise specified, the materials for dry pit non-clog pump shall be as follows:-

Description	Material
Casing	Cast iron to BS EN 1561:2011
Impeller	Cast iron to BS EN 1561:2011 or stainless steel to BS EN 10293:2005 grade 316
Shaft	Stainless steel to BS EN 10088-3:2005
Casing bolts	Stainless Steel
Cap screw and washer, impeller	Stainless steel
Key	Stainless Steel

(b) Materials of Construction of Submersible Pump

Unless otherwise specified, the materials for submersible non-clog pump shall be as follows:-

Description	Material
Casing	Cast iron to BS EN 1561:2011
Impeller	Cast iron to BS EN 1561:2011 or stainless steel to BS EN 10293:2005 grade 316
Shaft	Stainless steel to BS EN 10088-3:2005
Double Mechanical seals	Silicon Carbide; Carbon or ceramic faces
Discharge elbow	Cast iron to BS EN 1561:2011

(c) General Requirements

All bolts, nuts and fasteners shall be of stainless steel and electric cable entry shall be of watertight construction.

Materials for sump pumps shall be suitable for the pumping fluid being conveyed, such as, neither reacting to any parts in the pump by its fluid nor changing the content of the fluid by the pump. The sump pumps shall operate automatically by float level control. The guide bars for wet sump installation shall be of stainless steel of Grade 316.

Cable supports shall be of stainless steel. A safety provision shall be incorporated for automatic electrical disconnection of the supply in case of cable entry seal failure. Pumps for flammable zones shall be equipped with flameproof submersible motor in compliance with BS EN 60079-0:2012, BS EN 60079-1:2007 and IP 68 of BS EN 60529:1992.

B1.2.5 Bore Well Pumps

All bolts, nuts and fasteners shall be of stainless steel and electric cable entry shall be of watertight construction.

Bore well pumps unless otherwise specified shall be of all stainless steel construction. The stainless steel shall be of Grade 316 for fresh water application while Grade 316 stainless steel shall be used for other water applications.

The level switch shall be of the maintenance free mercury type or electrode type.

B1.2.6 Pump Base-plate

When pump base-plate is necessary, the base-plate should be proprietary made with the pump. The material of the base-plate shall be same as the pump.

B1.2.7 Pump Vibration Connectors

Vibration connectors shall be fitted to the inlet and outlet connections of other vibrating equipment as deemed necessary.

Vibration connectors shall be full line size of the equipment connection and fitted as close to the source of vibration as is practicable.

Vibration connectors shall be provided with end restraint to counteract the pressure thrust should the piping be subjected to longitudinal movement.

Manufacturers' recommendations on restraints, pressure, and temperature limits shall be strictly followed during the installation.

B1.2.8 Flexible Metallic Hose

For higher operating temperatures and pressures, vibration movement generated by pumps, shall be accommodated by braided flexible metallic hoses.

The lengths of the flexible metallic hoses shall be in accordance with manufacturer's recommendation.

Two hoses at right angles to each other shall be provided when major vibration motions to be isolated exist in two planes.

B1.2.9 Flexible Rubber Connectors

Flexible connector shall consist of a single or twin-sphere body manufactured with reinforced rubber, the ends of which are raised and wire reinforced to form the cuffs for sealing purposes. The cuffs shall be backed by floating steel flanges.

The rubber body shall be reinforced by multi-layered nylon tire cord fabric.

The rubber membranes shall have an indelible identification system to clearly identify the model and hence the suitability for the application and working conditions and have the date of manufacture moulded into the cover to ensure that no units that have exceeded the recommended shelf life are used.

Straight connectors shall be of the twin-sphere construction whilst elbow connectors shall be of the single-sphere construction.

Straight connectors connected to resiliently supported equipment shall be equipped with rods to prevent excessive elongation of the connectors if the system operating pressure is in excess of the value recommended by the manufacturer.

Acoustical control rods assembly shall consist of not less than 4 large triangle anchor plates, 2 control rods with large wedged-on end fittings and 13 mm thick acoustical washer bushings of sufficiently large load bearing area to isolate the end fittings, axially and laterally.

B1.3 GENERAL WATER PUMP INSTALLATION REQUIREMENTS

The installation details should be in accordance with the instruction prepared by the manufacturer.

Pumps at 5 kW motor capacity and above shall be "Type-tested" in accordance with the requirements of BS EN ISO 9906:2012 or approved equal. Test certificate for each pump shall be issued and signed by the manufacturer and submitted for checking. The certificate shall clearly record the pump model, serial number and the materials of the casing, shaft and impeller. Any certification with requirements not in strict compliance with BS EN ISO 9906:2012 shall be submitted to the Architect for approval prior to pump ordering.

Each pump or each batch of pumps shall also be provided with a certificate on their place of manufacture. The certificate shall be issued by a recognized Chamber of Commerce of the place of manufacture concerned. A certification issued by an organization other than the recognized Chamber of Commerce shall be submitted to the Architect for approval prior to pump ordering.

Pumps and their drives shall be segregated such that failure of pump seals shall not result in damage to the drive motors.

B1.3.1 Storage

The pump shall be stored in a dry space when they are delivered to site. Special rust preventive measures to protect the internal parts shall be applied if it must be stored for an extended period of time. Such provisions shall be removed completely before final installation and the bearings shall then be re-lubricated.

B1.3.2 Centrifugal Pump

(a) Driving Arrangement

The horizontal pump and motor shall be direct coupled and mounted on a substantial machined bedplate; accurately aligned, and fitted with guards. The whole assembly including the bedplate shall be designed and supplied by the pump manufacturer. Coupling with spacer shall be used for end suction pump so that the impeller may be dismantled from the motor side for servicing without neither disrupting the pipe-work nor dismantling the motor.

For vertical pump, the driving motor and the pump shall be factory aligned before shipment.

(b) Stand-by Pumps Arrangement

Where stand-by pumps are specified with automatic changeover provision, the changeover shall be initiated by means of flow sensing devices of an approved pattern. The necessary non-return valves shall be incorporated in the pipe-work to interconnect such pumps.

B1.3.3 Sewage Sump Pump

The sump pump shall be of vertical centrifugal design suitable for dry sump or wet sump installation. Each pump shall be constructed with double mechanical shaft seal and close-coupled to a submersible electric motor.

The sump pump shall operate automatically under level control with an alarm to alert the operator when high water level is being exceeded.

Each pump shall be equipped with factory built-in suspension device, and a factory mounted discharge elbow should be provided for wet sump installation. Cast iron or steel supporting base should be provided for dry sump installation. The pump unit itself shall be able to be easily removed from its base for inspection, repair and service. The pump for wet sump installation when lowered into the pit shall automatically be connected to the discharge piping, such that there shall be no need for the maintenance personnel to enter the wet pit to carry out the work.

The pump discharge shall be fitted with a resilient seal that provides a positive hydraulic seal for maximum pump efficiency. Each impeller shall be trimmed to meet the specified flow requirements.

For installation in flammable zones, each sliding guide bracket shall have non-sparking material to prevent ignition of explosive gases.

B1.3.4 Bore Well Pump

The bore well pump, normally used in water feature system, shall be vertical multi-stage centrifugal construction that is suitable for submersible installation. Each pump shall be of a single-shaft non-shaft-coupling type. The pump suction shall complete with a perforated strainer. The pump bearings shall be water lubricated and shall not cause any contamination to the water handled. The submersible motor shall be cooled by water moving around the motor casing.

Each pump shall be equipped with a non-return valve located between the pump discharge and rising main to prevent from the flow back of water in the rising main. A level switch shall be provided for the automatic cut-off of the pump as dry running protection when the water level inside the pit falls below the pump safety suction lift. The type of level switch shall be selected free from maintenance as practicable.

Except for water feature application, the bore well pump shall be installed vertically in the pit. No foundation shall be required for the pump on the bottom of the pit. Instead, the pump shall be hung from the pit cover which seals the pit and absorbs all stress resulting from the weight of the bore well pump, cable, rising main and water column. The length of each section of the rising main shall be limited to 3 m long to facilitate the withdrawal of the pump from the pit for maintenance.

The bore well pump for water feature application shall be installed as shown on Drawings or as instructed by the Architect.

B1.3.5 Plant Room Location

The SP Contractor shall check and assure that adequate working space must be provided to access for maintenance and sufficient headroom to lift the parts for repair is provided. For large pump, a hoist with travelling crane or other facility shall be provided over the pump location.

For an open loop system, the location of pump should be sited so that it will use the shortest and most direct suction and smallest vertical lift. Where possible, the pump centreline should be placed below the level of the liquid in the suction tank.

B1.3.6 Pump Foundation

- (a) The foundation shall be of sufficient size and rigidity to properly support the full area of the pump base-plate, to absorb any normal strains and to maintain correct alignment for the pump assembly.
- (b) Space between the pump unit and the foundation bolts shall be allowed in accordance with the manufacturer's recommendation.
- (c) For vertical pump, the foundation shall be of sufficient size and rigidity to properly support the full base area of the pump. The foundation shall be surrounded by 50 mm thick cork and housed in a 100 mm thick concrete plinth. The cork shall enclose the 4 sides and the bottom of the foundation to isolate vibration generated by the pump to the floor structure. The cork and the concrete plinth and foundation shall be filled up with bitumen.
- (d) For horizontal pump, an inertia block shall be provided, with minimum mass of concrete not less than 2.5 times the mass of the pump assembly and with at least 100 mm thick and 150 mm wider than the pump base-plate. Unless otherwise specified, the pump base shall be mounted on the raised housekeeping plinth using appropriate anti-vibration spring mountings. Each spring shall be individually selected according to load distribution and shall have an additional free travel equal to one half of the rated deflection. Spring mounts shall have a levelling bolt and shall be mounted to the concrete inertia block via height saving brackets that allows a base clearance of 50 mm. When the horizontal pump motor size is less than 5.5 kW and the pump is located in a pump room which is not susceptible to structural bond noise, the use of inertia block may not be necessary subject to Architect's approval.

B1.3.7 Pump Alignment

The pump unit shall be accurately aligned in accordance with the manufacturer's instructions prior to operation. The alignment shall be rechecked after the suction and discharge piping have been bolted to the pump to test the effect of piping strains. The pump and driver alignment shall be rechecked and adjusted correctly within ± 0.05 mm tolerance.

B1.3.8 Support for Piping

Suction and delivery pipes shall be supported independently of the pump. The connecting pipes to a pump shall not strain the pump. Pipes installation shall match up to the respective flanges without being strained into position. The faces of the coupling shall be checked with a straight edge to make sure that they are parallel and concentric.

B1.3.9 Connection Piping to Pump

(a) Suction Piping

The suction piping shall be properly installed for a satisfactory pump operation. This shall be achieved by keeping as direct and as short as practicably possible with a minimum number of bends, and by avoiding air pockets forming. Concentric reducers shall not be used on suction branch.

The size of the suction pipe shall be larger than the pump inlet and when applicable eccentric reducer may be used. If the source of supply is located below the pump centreline, the reducer shall be installed straight side up. If the source of supply is above the pump, the straight side of the reducer shall be at the bottom.

A straight section piping at least 4 to 6 diameters long at the pump inlet with long radius bend shall be used for suction pipeline installation to create less friction and provide more uniform flow distribution as deemed necessary.

(b) Delivery Piping

Unless otherwise specified, the size of the delivery pipe shall be at least one size larger than the pump delivery. The check valve shall be installed between the pump and the gate valve. The gate valve should be installed close to the pump discharge for pump priming and repairing.

Air release valves shall be installed at the highest points on each rise to allow accumulated air or vapour or other gases to escape from the pipe.

Adequate support and anchorage shall be provided if the pipes are laid above or below ground. For this purpose, it is acceptable to have thrust blocks in either corner type or puddle flange type that are designed to absorb reactions or turning forces to ensure no mechanical and hydraulic forces are imposed on the pump.

(c) Pipe Flanges

Pipe flanges shall match with the sizes of pump flanges with full-face gaskets.

(d) Expansion Joints

Expansion joints shall be installed in suction and delivery pipelines to avoid transmitting any piping strains. A suitable pipe anchor shall be installed between the expansion joint and the pump.

If expansion joints are not specified, expansion loops that are formed by looping the pipe shall be provided to prevent the transmission of strains to the pump.

(e) Intake

The installation work shall be carried out properly to prevent air being entrained as bubble within the water. The intake pipe shall run well below the sump tank level. High level entry into the sump should be avoided as air may be entrained by the falling jet.

Vortex inhibitor shall be installed inside the water tank to prevent air being drawn from bottom of vortex into the intake. No chemical or brine tank suction requires vortex inhibitor.

B1.3.10 Flushing Strainer

The suction strainer shall be installed as close as practicably possible to the pump. This suction pipe strainer should not be used for flushing the pipe. A temporary strainer fitted with a finer mesh than the permanent strainer should be used for flushing all piping and cleaning thoroughly all possible mill scale and other foreign matter. The temporary strainer shall be removed afterwards.

B1.3.11 Venting Valves for Pump-set

Venting valves shall be installed at one or more points of the pump-casing waterway to provide a means to escape for air or vapour trapped in the casing. These valves shall be connected so as not to endanger the operation staff in handling toxic, inflammable or corrosive liquid.

B1.3.12 Drains for Pump-set

All drain and drip connections shall be piped to a point where the leakage can be disposed of or collected for reuse if specified.

B1.3.13 Instrumentation

Each pump installation shall include pressure gauges and a gauge cock to measure the system pressures and pressure drop.

All measuring and isolation instruments, such as pressure gauge, check valve, globe valve, gate valve and strainer, etc., or as specified in the Particular Specification shall be installed properly to maintain a close check on control on the performance and condition of the pumps.

Instruments shall be mounted in a suitable location so that they can be easily observed.

B1.4 PIPEWORK

B1.4.1 Connections in Pipework

For non-welded pipework, connections shall be by means of screwed fittings, flanges or unions. The use of "long screws" will not normally be permitted.

Unless otherwise specified, flanges complete with appropriate gaskets, steel nuts, bolts and washers together with spring washers, all of stainless steel, shall be used to connect up all equipment, valve or device such that the pipework, equipment, valve or device can easily be removed for servicing or replacement.

B1.4.2 Change in Pipe Size

Change in pipe size can be facilitated at tees by reduction on branch or outlet. Reduction on bend elbow or by bush is not permitted without prior permission of the Architect. Reduction by means of straight through reducing socket is permitted.

Care must be taken in carrying out reduction to ensure that air is not entrapped at high points. In such case, it shall be necessary to install eccentric reducing sockets with the "flat" at the top for horizontal pipework and concentric reducer for vertical pipe riser.

B1.4.3 UPVC Pipe

- (a) Unplasticized polyvinyl chloride (UPVC) pipe shall comply to ISO 3127:1994 and ISO 1452-1:2009 to ISO 1452-5:2009, or DIN 8061:2009/DIN 8062:2009, or BS EN ISO 1452-1:2009 to BS EN ISO 1452-2:2009, BS EN ISO 1452-3:2010, BS EN ISO 1452-4:2009 to BS EN ISO 1452-5:2009 (300 mm diameter and below).

- (b) All pipes and fittings shall be manufactured by the same manufacturer of the same standard. Should different types of pipe are joined together; they shall be joined with suitable proprietary adaptor. Modification to the pipe or fitting to fit different pipe materials or standards is not acceptable. Bending of pipe to form elbow shall not be allowed.
- (c) When UPVC pipe is installed at outdoor, it shall be protected from ultra-violet radiation by shielding or painting with suitable primer to prevent degradation.
- (d) Where it is required to form a spring in the pipe run, the pipe shall be softened by immersion in (or by pouring on) heated brine, glycerine oil or water as recommended by the pipe manufacturer. The use of a naked flame on the pipe surface will not be accepted.
- (e) Joint and Fitting for UPVC Pipework
 - (i) Joint for UPVC pipe and fitting shall be solvent joint for pipes at 65 mm and below.
 - (ii) Within plant room, joint for UPVC pipe and fitting at 80 mm and above shall be flanged connection or of stub flange assembly. For pipes under pool deck, spigot and socket rubber ring joint shall be used, or otherwise as specified in the Particular Specification.
 - (iii) Flanged connection of pipework, for either chemical or non-chemical system, shall be of steel bolt, nut & washer together with spring washer, all of stainless steel.
 - (iv) Fittings shall be of the same material as the pipework to which they are joined. They shall be made or approved by the pipe manufacturers and suitable for the solvent welding process. Where screw threads are required (e.g. at connections to metal valves, strainers, etc.), a factory made threaded adapter shall be used. Adapters shall be made from heavy weight tube with an appropriate thread at one end; the other end shall form part of a socket and spigot solvent welded to the plastic pipe. As a general rule PVC pipe should only be made threaded and screwed into metal "Female" threaded fittings.
 - (v) Joints between pipe and pipe fittings shall be made by the solvent welding process. No cleaning fluid or solvent cement other than that supplied or recommended by the pipe manufacturer shall be used.
 - (vi) Unless otherwise specified, connections to items of plant such as pumps shall be made by means of flanged joints. The plastic pipe shall terminate with a socket

flange of the full face or stub type welded on by the solvent process and having a loose metal backing ring; the ring and the flange shall be drilled to match the mating flange. The joint shall be made with a neoprene or similar gasket.

- (vii) Where UPVC is used for inlet and outlet to pumps, it must be effectively isolated from the vibration of the machine. This shall be achieved by the insertion of flanged synthetic rubber vibration de-couplers installed between UPVC pipework and plant on all connections.

B1.4.4 Ductile Iron Pipe

- (a) Ductile iron pipe shall comply with one of the following standards subject to the applications:-

Standards	Description
ISO 2531:2009/Cor1:2010	Ductile iron pipes, fittings, accessories and their joints for water or gas applications
BS EN 545:2010	Ductile iron pipes, fittings, accessories and their joints for water pipelines. Requirements and test methods
BS EN 598:2007+A1:2009	Ductile iron pipes, fittings, accessories and their joints for sewerage applications. Requirements and test methods

- (b) Cement lining shall be provided for all ductile iron pipe and fitting. Lining inside shall be cement mortar lined in compliance with BS EN 545:2010, BS EN 598:2007+A1:2009, BS EN 969:2009, Type A – Portland pulverized fuel ash cement (PFAC) in accordance with BS EN 197-1:2011 with a minimum pulverized fuel ash content of 25%, or Type B – sulphate resisting cement (SRC) in accordance with BS 4027:1996.
- (c) Joints and Fittings for Ductile Iron Pipework:
Class K9 and K12 pipes joint shall either be flanges screwed or flanges welded-on subject to Architect's selection.

B1.4.5 Polyethylene Pipe

- (a) The following specifications apply to polyethylene pipes and fittings:-

Description	Specification	Nominal Size	Application
Medium Density Polyethylene Pipe (MDPE)	BS EN 12201-1:2011 to BS EN 12201-3:2011, BS EN 12201-4:2012, BS EN 12201-5:2011, ISO 4427-1:2007/Cor1:2008 and ISO 4427-2:2007, *WIS 4-32-17:2001	20 mm - 1000 mm	water pipe for underground and above ground (blue pipe and black pipe)
High Density Polyethylene Pipe (HDPE)	ISO 4427-1:2007/Cor1:2008 and ISO 4427-2:2007, *WIS 4-32-17:2001	90 mm – 1000 mm	water pipe for underground and above ground (blue pipe and black pipe)
Electrofusion fitting for use with MDPE pipe	*WIS 4-32-14:1995	20 mm – 355 mm	Fittings for underground and above ground (blue and black colours)
Spigot fitting for butt fusion or electrofusion jointing	*WIS 4-32-15:1995	63 mm – 315 mm	Jointing of pipe

*WIS is Water Industry Specification, Water Research Centre

- (b) The pressure rating of the MDPE and HDPE pipes should not be greater than 10 bar and 16 bar respectively.
- (c) When polyethylene pipes are installed at outdoor, they shall be protected from ultra-violet radiation by shielding or painting with suitable primer to prevent degradation.
- (d) **Joints and Fittings for Polyethylene Pipework:**
The polyethylene socket and spigot fittings, saddles and drawn bends for fusion jointing shall be in compliance with WIS 4-32-15:1995. When flanges and bolting for pipes, valves and fittings are used, they shall be in compliance with BS EN 1092-1:2007, BS EN 1092-2:1997 or BS EN 1515-1:2000.

- (e) Electrofusion of Pipes
 - i) Pipes and fittings can be joined by electrofusion. The socket of the fitting incorporates an electrical heating coil. When energized by electricity, the coil causes the material adjacent to it melt and fuses into contact with the surface of the pipe. The heating coil should be wound on to a moulded pre-form section of the fitting.
 - ii) An electrofusion control unit should be used to power the electrofusion process. The unit shall comply with that recommended by the pipe manufacturer or approved by the Architect.
 - (iii) Pipe ends that shall be jointed must be thoroughly scraped to remove the outer surfaces and burrs. Both scraped surfaces must be protected from contamination before jointing. Fit the electrofusion socket fitting into both pipe ends and connect the control unit leads to the terminals onto the fitting. Energize the control unit as guided by the manufacturer until the fusion process has been completed. Leave the joint cooling before use.
- (f) Butt-fusion jointing shall not be used unless as specified by the Architect.

B1.4.6 ABS Pipe

Acrylonitrile Butadiene Styrene (ABS) pipes shall have sizes detailed in ISO 161:1996 and ISO 727-1:2002 from 16 mm up to 315 mm outside diameter, which can be used under a wide temperature range from -40°C to $+80^{\circ}\text{C}$. Pipes and fittings shall be rated at or above 10 bar pressure at 20°C .

(a) Joint and Fitting:-

The pipe fitting joint shall be of solvent welding, flanges, stub flanges, shouldered pipe couplings, or unions and thread.

i) Solvent cement welding

This is done by chemically softening in the outside of the pipe and the inside of the fitting. The pipe end over a length equal to the depth of the socket fitting and the socket internal surface must be abraded thoroughly using clean coarse emery cloth. Remove dust from surface and apply solvent cement to both matching surfaces, and push fit the socket onto the pipe end by using longitudinal strokes.

ii) Thread joint may be applied to small diameter pipe that connect valve or fitting. The male threads should be wound by PTFE tape prior to jointing the fittings.

- iii) Flanges and bolting for pipe, valve and fitting shall be in compliance with BS EN 1092-1:2007, BS EN 1092-2:1997 or BS EN 1515-1:2000 .

B1.4.7 Copper Pipe

- (a) Copper tube shall be in accordance with BS EN 1057:2006+A1:2010 for pipe size smaller than 80 mm, capillary joint to BS EN 1254-1:1998, 1254-2:1998 & 1254-3:1998 for 50 mm and below, flange joint for 65 mm and above.
- (b) Copper tube up to and including 54 mm diameter bore shall be assembled with capillary fittings with solder suitable for pipe and water condition.
- (c) Joints on copper pipe and fitting of 67 mm diameter and over are to be made with copper slip-on bosses brazed to the pipes in accordance with BS EN 14324:2004, BS EN 12797:2000, BS EN 12799:2000, BS EN 13133:2000, BS EN 13134:2000 and copper alloy flanges of BS EN 1092-1:2007, BS EN 1092-2:1997 or BS EN 1515-1:2000 bolted together including bolts.
- (d) Flange shall be flushed and truly aligned and shall utilize full faced corrugated grooves.

B1.4.8 Stainless Steel Pipe

Stainless steel pipe shall comply with BS 6362:1990 or BS EN 10312:2002, all with material grade 316.

- (a) BS 6362:1990 stainless steel pipe ranging from 15 mm to 150 mm shall comply with the following:-

Nominal size (mm)	Designation of thread	Outside diameter (mm)		Nominal wall thickness (mm)
		Maximum	Minimum	
15	1/2"	21.8	21.0	2.6
20	3/4"	27.3	26.5	2.6
25	1"	34.2	33.3	3.2
32	1-1/4"	42.9	42.0	3.2
40	1-1/2"	48.8	47.9	3.2
50	2"	60.8	59.7	3.6
65	2-1/2"	76.6	75.3	3.6
80	3"	89.5	88.0	4.0
100	4"	115.0	113.1	4.5
125	5"	140.8	138.5	5.0
150	6"	166.5	163.9	5.0

- (b) BS EN 10312:2002 stainless steel pipe ranging from 15 mm to 54 mm shall comply with the following:-

Nominal size (mm)	Outside diameter (mm)		Nominal wall thickness (mm)
	Maximum	Minimum	
15	15.045	14.940	0.6
22	22.055	21.950	0.7
28	28.055	27.950	0.8
35	35.070	34.965	1.0
42	42.070	41.965	1.1
54	54.070	53.840	1.2

- (c) BS EN 10312:2002 stainless steel pipe covered with polyethylene and foam coating shall comply with the following:-

Nominal size (mm)	Outside diameter (mm)		Nominal wall Thickness (mm)	Polyethylene and foam coating thickness (mm)		
	Maximum	Minimum		Foam	PE	Total
15	15.045	14.940	0.6	1.5	0.8	2.3
22	22.055	21.950	0.7			
28	28.055	27.950	0.8			

- (d) Jointing for BS EN 10312:2002 stainless steel pipe shall be facilitated by suitable solvent cement as recommended by manufacturer. Jointing for BS 6362:1990 stainless steel pipe shall be of either argon welding, compression fittings or screwed fittings as recommended by manufacturer.

B1.4.9 Lined Galvanized Steel Pipe

Galvanized steel pipe shall be UPVC internally lined with screw joints for pipe connections. All fittings shall be beaded with built-in plastic core. Lined galvanized steel pipe shall comply with BS EN 10255:2004 medium grade.

Unions or flanged joint shall be used for joint subject to disconnection for future maintenance near to the connections of the equipment.

No yarn shall be permitted in any joint, plastic plumber's PTFE tape shall be used throughout the installation or as recommended by manufacturer.

For jointing of faucets, use faucet elbows and sockets of the same galvanized pipe manufacturer. Cutting of pipe shall be facilitated by metal saw, and no cutting of pipe by pipe cutter is allowed. When cutting, avoid over-speed the saw to damage the internal lining.

Threading of pipe shall follow the relevant standard of the pipe manufacturer. Pipe chamfering of the inner wall lining of pipe shall be facilitated by proprietary reamer or scraper specifically for the lined galvanized pipe.

Jointing of threaded pipe shall be facilitated with anti-corrosive sealant and seal tape.

B1.5 PIPEWORK INSTALLATION DETAILS

B1.5.1 General

- (a) The Tender/ Drawings indicate the size and general layout of the required pipework. The exact positions may not be indicated on the Drawings, as for the purpose of clarity, they are generally shown separately spaced out from one another as if they were at the same plan level. The SP Contractor shall accurately set out the various pipelines in the installation in compliance with the Particular Specification or so specified elsewhere in this General Specification.
- (b) Where the Employer's latest Guide Drawings & Details for pipework supports and brackets, vibration connectors, expansion joints and anchor points are issued with the Contract, the standard details referred shall be followed "in-principle" but adjusted as to the detail in order to suit the particular circumstances. Such adjustments shall be indicated on the SP Contractor's own Installation/Shop drawings and be approved by the Architect before work commences.
- (c) Generally, the clearance between pipework (or the lagging) and the wall and any other fixtures should not be less than 25 mm. Pipework should not run near to or above electrical appliances, cables, trunkings and conduits.
- (d) Where two or more pipe runs follow the same route, all pipes shall run parallel with one another and to the building structure. Any pipework which requires subsequent insulation shall be adequately spaced to allow for individual finish.
- (e) Movements of the pipework due to changes in temperature shall be accommodated by the natural flexibility of the pipework run or by bellow expansion joints, in either case allowable stress levels should not be exceeded.
- (f) Tubes shall be reamed after cutting and shall be free from burrs, rust, scale and other defects and shall be thoroughly cleaned before erection. Pipe ends left open during the progress of work shall be temporarily closed with purpose-made metal or plastic plugs or caps, or blank metal flanges and protect from corrosion.

- (g) Joints shall not be made in the thickness of any wall, floor or ceiling and pipework shall not be embedded in the structure of floors. Where pipework passes through walls, floors or ceilings, sleeves shall be provided. Pipework passing through floors shall, where specified, be provided with approved type floor and ceiling plates and fastened securely to the sleeve. Sleeves shall be of the same metal as the pipe. The space between pipework and sleeve shall be plugged with an approved sealant.
- (h) All entry and exit holes to or from a building for a pipework service shall be sealed and plugged. The sealant shall be a mastic compound or silicone rubber. Where the pipework enters the building through a large hole or duct, which cannot be backfilled, a mild steel blanking plate not less than 6 mm thick shall be built into the wall of the hole or duct. The service pipes shall pass through clearance sockets welded to the plate. The space between pipe exterior and socket interior shall be sealed and plugged.

B1.5.2 Elbows and Bends

- (a) Elbows shall be used, where practicable, in preference to bends. However, square elbows will not be permitted. Unless otherwise specified, long radius elbows shall be used in order to minimise hydraulic resistance.
- (b) For forming bends in small bore copper pipe up to size 25 mm, pipe bending springs may be used but again there must be no distortion of the pipe involved.
- (c) In the case of all bends formed in the pipe, these shall constitute long radius bends. Short radius elbows shall only be used at the discretion of the Architect where long radius elbows will not fit or are not manufactured.

B1.5.3 Jointing

- (a) Galvanized pipes which are to be screwed shall be galvanised before servicing. Pipes which are to fitted with welded flanges shall be flanged before galvanising. Galvanised treatment on all welding joints shall be required after welding.
- (b) Joints on all permanently concealed mild steel and galvanized pipework shall be welded unless otherwise agreed by the Architect. The other mild steel and galvanized pipework may be of screwed or welded joints. When the SP Contractor chooses to use screwed joints, at least one of the two engaging components shall be taper-threaded to ISO 7-1:2007 and the joints between them shall be made with approved jointing material, and selected to suit the appropriate type of services. For pipework without anti-rust threaded joints, it shall be

patched up with galvanized painting before making such joints.

- (c) Pipework connections to the suction and delivery outlets of pumps and other vibrating machines shall be isolated from such sources of vibration by means of anti-vibration connectors. The vibration connectors shall be capable of attenuating the vibration of the plant such that the bulk of the vibrations are prevented from being transferred to the pipework. Wherever vibration connectors are installed, the adjacent pipework shall be adequately supported by guide type brackets.
- (d) All flanged connections for pipeworks shall be fixed by stainless steel bolts, nuts & washers with spring washers.
- (e) At dismantling points or where the pipework is connected to an appliance, ground-in spherical seated unions shall be used for pipework up to 50 mm size, and flanges shall be used for pipework at 65 mm size and above. The flanges shall be to ISO 7005-1:2011 and ISO 7005-2:1998 or BS EN 1092-1:2007, BS EN 1092-2:1997, BS EN 1515-1:2000 of appropriate type. Flanged joints shall be made with flat ring gaskets suitable for the pressure and temperature and extending to the inside of the bolt circles.
- (f) Screwed fittings, other than sockets, shall be malleable cast iron, banded or beaded pattern. Standard but welding fittings shall be used on welded pipework. Use of mixed joints shall be prohibited.
- (g) Flanges for mild steel pipework shall be forged steel and machined over the raised or flat faces. Headers shall be of flanged mild steel tube with flanged outlets welded on, and spare outlets shall be blanked off with bolted flanges.
- (h) Where specified, and/or subject to the Architect's written agreement, in plant rooms and building ducts where pipework appearance is not considered so critical, mechanical pipe couplings may be employed for pipe connection.
 - i) Mechanical pipe couplings shall be self-centered, engaged and locked in place onto the grooved or shouldered pipe and pipe fitting ends. The pipe connection shall result in a positive watertight couple providing reasonable allowance for angular pipe deflection, contraction and expansion. The coupling housing clamps shall consist of two or more malleable iron castings or rolled steel segment holdings with a composition water sealing gasket so designed that the internal water pressure will increase the water tightness of the seal. The coupling assembly shall be securely held together by two or more trackhead square or

oval-neck heat treated carbon steel bolts and nuts. All pipe fittings connected to mechanical pipe couplings shall have groove and shouldered ends and shall be malleable iron castings. Flanged or threaded end valves may be used with grooved adapters.

- ii) Before couplings are assembled, pipe ends and outsides of gaskets shall be lightly coated with grease or graphite paste to facilitate installation.
- iii) Pipe grooving shall be formed in accordance with the pipe coupling manufacturer's latest specification. Pipes may be cut-grooved or roll-grooved except for those pipes with wall thickness less than the minimum recommended by the manufacturer. The cut-grooving shall be roll-grooved without the removal of any metal.
- iv) The entire coupling installation shall be in accordance with manufacturers' recommendations.
- v) Couplings or flange adapters for plain ended pipework shall be steel, slip-on type as approved by the Architect.
- vi) Coupling shall consist of sleeve (without centre register), end flanges, sealing rings and bolts and nuts.
- vii) Flange adapter shall consist of end flanges/sleeves, sealing rings, and studs and nuts.
- viii) To provide hard and durable protection against impact, abrasion, chemicals and low temperature, all couplings and flange adapters shall be coated with Rilsan Nylon 11, equal and approved, by either a dip process giving a coating thickness of 250-375 microns or an electrostatic spray process giving a coating thickness of 150-250 microns.

B1.6 PIPEWORK BRACKETS AND SUPPORTS

- B1.6.1 All outdoor brackets and supports for non-copper pipes shall be stainless steel except otherwise as specified in the Contract. The fixing bolts and nuts for the brackets and supports shall have the same materials with the brackets and supports that are used.
- B1.6.2 All indoor brackets and supports for non-copper pipes shall be hot dip galvanized iron except otherwise as specified in the Contract. The fixing bolts and nuts for the brackets and supports shall be galvanized.

- B1.6.3 Brackets for copper pipes shall be brass, which shall be mounted on stainless steel supports. Fixing of copper to steel shall be separated by insulated sheet to avoid the occurrence of galvanic corrosion. Details shall be submitted for Architect's approval.
- B1.6.4 Pipework shall be supported so as to permit free movement due to expansion and contraction. Pipework supports shall be installed as near as practicably possible to joints and changes in direction. Each support shall take its due proportion of the load. The spacing of the supports shall not exceed the centres given in clause B1.8. Where there are two or more pipes, the spacing shall be based on the centres required by the smallest bore pipework.
- B1.6.5 Vertical rising pipework shall be supported at the base or, as indicated, to withstand the total weight of the riser. Branches from risers shall not be used as a means of support for the riser. If such base has to be rested on an intermediate floor slab, the SP Contractor must draw particular attention to the Architect for structural reinforcement to the floor slab and also allow for additional treatment to the base as required by the Architect.
- B1.6.6 Where pipework up to 50 mm size is fixed to solid wall, brackets may be of the screw-on or long shank built-in type; in case the walls are plastered, only the long shank built-in type shall be used. For fixing to woodwork and lightweight partitions or walls, brackets shall be of the screw-on pattern of adjustable two-piece type. Brackets for copper pipework shall be brass or gunmetal. The upper half of the pipe clip shall be detachable without disturbing the fixing.
- B1.6.7 Brackets screwed to walls shall be secured by expanding plugs. Other purpose designed fixing devices shall be submitted for Architect's approval.
- B1.6.8 Unless otherwise specified, hangers for horizontal pipework at high level shall be supported from steel angle or channel sections or approved proprietary devices supplied by the SP Contractor, suitable for building-in or otherwise securing to the structure by the Building Contractor. Adjustable steel hangers shall be used. Pipe rings shall be of stainless steel or galvanized fabricated steel, made in halves and secured by bolts or screws of the same materials. Calliper type hooks will not be permitted.
- B1.6.9 Where pipework is fitted in service duct or trenches or where it is of 65 mm size or greater and supported from walls, the design of the pipe supports, guides and anchors shall be in accordance with the Drawings. Otherwise, the SP Contractor shall submit details and proposal to the Architect for approval. Where roller supports are required, they shall be of an approved type. If insulation is on the outer shelf, the preformed insulation shall be kept free of the rolling surface. Load-bearing insulation at supports, where required, shall be fitted by the SP Contractor at the time of erecting the pipework.

- B1.6.10 The SP Contractor shall supply, and fix in position ready for building-in, all cleats, brackets and steelwork required for anchor points. Anchor steelwork secured to the bottoms of ducts or trenches shall be coated with hot-poured bitumen to inhibit future corrosion.
- B1.6.11 Supports for non-metallic pipework may be of any approved pattern that prevents free axial movement of pipe at all temperatures and have radial edges to prevent cutting into the pipe. All bearing surface must be sufficiently wide to prevent indentation.
- B1.6.12 Valves, meters and other heavy "in-line" equipment must be rigidly supported or independently supported as deemed necessary.
- B1.6.13 Supports for pipes shall be such that no compression or deformation of the insulation occurs.
- B1.6.14 Provision for movement due to expansion and contraction shall be generally as indicated and/or shall be by changes in direction of the pipework, by loops or by other approved expansion devices. Supports and guides shall be arranged to ensure that all movement is taken up by the change in direction of the pipework or by the loop or device.
- B1.6.15 Cold bridge shall be prevented between the insulated pipework and the associated hangers and pipework supports.

B1.7 PIPEWORK EXPANSION JOINTS, ANCHORS AND GUIDES

B1.7.1 Expansion Joints

- (a) Where expansion joints are utilised, they shall be manufactured in accordance with the design philosophy for thin walled bellow membranes as laid down by the Expansion Joint Manufacturers Association (EJMA latest Edition).
- (b) Axial movement bellow expansion joints on all services shall comprise of thin wall multi-ply omega formed convoluted bellows of stainless steel material to BS EN 10029:2010, BS EN 10051:2010 and BS EN ISO 9445:2006 of appropriate type. Bellows should be argon arc welded to carbon steel end fittings utilising a stainless steel seal ring to reinforce the bellow cuff end.
- (c) The bellow expansion joint shall be provided with a close fitting stainless steel internal liner to reduce turbulent flow.
- (d) End termination of expansion joints shall be carbon steel threaded male to ISO 7-1:2007 or carbon steel flanges to ISO 7005-1:2011 and ISO 7005-2:1998 Standard to suit the line pressures.

- (e) For copper or non-ferrous pipework systems, expansion joints shall be manufactured in stainless steel throughout. The bellow expansion joints shall be installed with pre-cool/heat setting to their required length to suit the temperature condition at the time of installation. The joints shall be rated suitable for the required amount of designed axial movement. Mild steel outer protection sleeves shall be fitted to the bellows only when the units are open to the environment and exposed to risk of damage or when it is necessary to carry lagging over the joint.
- (f) Expansion joints should be installed in strict accordance with the manufacturer's recommendations. The manufacturers of the expansion joints shall be approved to ISO 9001:2008/Cor1:2009.
- (g) Expansion joints shall be designed to meet the required angular movement or the required movement in all directions perpendicular to the axis of the bellows.
- (h) Expansion joints shall be provided, wherever appropriate, with hinge and shackle or centre joining tube, tie bars and spherical nut arrangement, which shall be of carbon steel to ISO 9692-1:2003 and ISO 9692-2:1998 fully designed to contain the pressure thrust. End termination shall be flanged to ISO 7005-1:2011 and ISO 7005-2:1998 to suit the line pressures.

B1.7.2 Anchors

Anchors shall be installed according to the recommendations of the expansion joint manufacturer and the details shall be submitted to the Architect for approval before manufacture commences.

- (a) Allowances shall be made for anchors capable of withstanding the maximum stresses created within the pipework system, and have adequate safety margin. These shall be positioned as indicated on the layout drawings or as necessary shop drawing/details introduced by the SP Contractor.
- (b) On steel pipework, the pipe shall be welded to the anchors via heavy steel straps. On copper pipework, the pipe shall be brazed to the anchors via heavy copper straps.

B1.7.3 Guides - Axial Movement Pattern

- (a) The pipework shall be guided along its length and the guides shall be capable of withstanding not less than 15% of the maximum stresses created within the pipework system and have an adequate safety margin.

- (b) Guides shall be adjustable in both directions in the lateral plane, so that pipework can be accurately aligned with the expansion joint.
- (c) Each guide shall not be less than 2 pipe diameters long and shall have a minimum manufacturing clearance of the pipe diameter.
- (d) The distance from the expansion joint to the first guide must not be greater than 4 pipe diameters, and the distance between the first guide and the second guide must not be more than 14 pipe diameters. Guides thereafter should be spaced in accordance with normal pressure performance requirements as a minimum standard.

B1.7.4 Guides for Angular or Lateral Movement Pattern

Directional guiding shall apply, such as side plates, local to the expansion joint, the remainder of the pipework shall be supported in the nominal way, by roller or frictional supports, or pipework hangers.

B1.8 PIPEWORK SUPPORT SPACING

Support for pipework shall be spaced in accordance to the following:-

Table 1.8-(1) Supports for Steel Pipework

Size of tube	Intervals for Horizontal runs		Intervals for Vertical runs
	Bare	Lagged	Bare and Lagged
mm	m	m	m
15	1.8	1.8	2.4
20	2.4	2.4	3.0
25	2.4	2.4	3.0
32	2.7	2.4	3.0
40	3.0	2.4	3.7
50	3.0	2.4	3.7
65	3.7	3.0	4.6
80	3.7	3.0	4.6
100	4.0	3.0	4.6
125	4.5	3.7	5.5
150	5.5	4.5	5.5
200	8.5	6.0	8.5
250	9.0	6.5	9.0
300	10.0	10.0	10.0

Table 1.8 – (2) Supports for Copper Pipework

Size of tube	Intervals for horizontal runs		Intervals for vertical runs
	Bare	Lagged	Bare and lagged
mm	m	m	m
15	1.2	1.2	1.8
22	1.2	1.2	1.8
28	1.8	1.5	2.4
35	2.4	1.8	3.0
42	2.4	1.8	3.0
54	2.7	1.8	3.0
65	3.0	2.4	3.7
76	3.0	2.4	3.7
108	3.0	2.4	3.7
133	3.7	3.0	3.7
159	4.5	3.7	3.7

Table 1.8 – (3) Supports for Non-metallic Pipework

Nominal Bore of Pipe	Intervals for horizontal runs	Intervals for Vertical Runs
mm	m	m
15	0.75	1.5
22 to 28	1	1.8
28 to 35	1	2
42	1.2	2.4
53 to 65	1.4	2.8
76	1.8	3.5
108 and over	2	4

B1.9 WELDING AND BRAZING

B1.9.1 The procedure and the competence of the operator shall be in accordance with the recommendations contained in the following British HVCA publications:-

- (a) "Welding of Mild steel Pipework"; and
- (b) "Code of Practice - Brazing and Bronze Welding of Copper Pipework and Sheet".

B1.9.2 Welding operations which are beyond the scope of B1.9.1 shall comply in particular with:-

- (a) BS 2633:1987 and BS 2971:1991 - relevant subsections for metal-arc welding (steel pipe);
- (b) ISO 9692-1:2003 and ISO 15609-2:2001 - relevant subsections for gas welding (steel pipe); and
- (c) ISO 5187:1985 and ISO 10564:1993 - Brazing (copper pipe).

- B1.9.3 Where the visual inspections and tests reveal those welding joints which are reasonably believed to be unacceptable, the Architect shall be entitled to have such welding examined by radiography or other approved inspection method and independently assessed. The SP Contractor shall be responsible for the cost of the tests and subsequently remedy the work to the satisfaction of the Architect if tests prove the welding joints to be non-compliance with the specification.

B1.10 VALVES, COCKS AND STRAINERS

B1.10.1 General

- (a) All valves and fittings that are used for chemicals applications for swimming pool shall be capable to resist the corrosion of such chemicals. For pool water, all valves and fittings shall be capable of handling salt water application.
- (b) Provision such as a sprocket rim wheel and chain shall be provided for manually operated valves that are difficult to access.
- (c) All plant room valves and circuit control valves shall be provided with approved plastic labels.
- (d) A circuit control diagram of appropriate size showing the location of each isolating, regulating and control valve shall be provided and fixed in a glazed hardwood frame in a position indicated by the Architect.

B1.10.2 Ball Float Valve

- (a) Equilibrium ball valves to BS 1212-1:1990 & BS 1212-2:1990 shall be provided to the water tanks.
- (b) Fresh water ball valves up to 50 mm shall be bronze with copper ball float to BS 1968:1953. Fresh water ball valves 65 mm and above shall be cast iron with nickel alloy working parts and copper ball float.
- (c) Salt or pool water ball valves up to 50 mm shall be bronze, 65 mm and above shall have cast iron body and stainless steel or zinc free bronze trimming with construction entirely suitable for use with sea water. Ball float shall be in stainless steel or in zinc free bronze or rubber lined to prevent corrosion.

B1.10.3 Butterfly Valves

Butterfly valves shall have resilient seats which are (in-the-field) replaceable with moulded-in O-rings to serve as a flange gasket. For sizes of 50 mm diameter to 150 mm diameter inclusive, a notched plate handle shall be provided for the control of the valve and indication of disk position. For sizes of 300 mm diameter and above, gear actuator shall be used. All butterfly valves shall be capable of bubble tight shut off. Butterfly valves shall comply with the recognised international standards.

- (a) The manufacturer shall provide independent laboratory tests such as Underwriters Laboratory or Factory Mutual Research for pressure rating. All testing records and data shall be submitted to the Architect for approval.
- (b) Bodies shall be made of ductile iron grade 400-18, completely coated with polyamide or products having equivalent functions or performance against corrosion, suitable for the temperature range of 0°C to 50°C. The valve shall provide dead end service at maximum rating.
- (c) The discs shall be made of stainless steel to Grade 316.
- (d) The shafts stems shall be made of stainless steel to Grade 316.
- (e) The control handles and the gear operators shall be suitable for locking in any position. The micro switches shall be built in the actuators and factory adjusted at full or partly open and full closure. Manufacturer shall provide certificate of factory adjustment.
- (f) Valve electric operators shall be mounted on valves and tested at factory.
- (g) The valves shall have marking tag in accordance with ISO 5209:1977 standard.
- (h) The valves body and seat must be designed for the maximum working pressure of at least 10 bar.
- (i) The SP Contractor is to ensure that the valve disc can protrude into the pipework on either side of the valve without damaging the disc or the lining on the pipes. Pipework either side of the valve shall be so designed that the valve can be removed even when jammed in the fully open position.
- (j) Where specified for manual operation valves shall be provided with hand wheels fitted with reduction gearing to enable one man to operate the valve, in a reasonable time, when it is subjected to the maximum unbalance pressure.

- (k) Grooved ends butterfly valves shall be bubble tight closing to ISO 5208:1993 standards, enabling quick assembly with mechanical grooved coupling on ISO standard pipes.

B1.10.4 Isolating Valves

- (a) Pool Water and Non-fresh Water Application

- i) Up to and including 50 mm bore

PVC diaphragm valves to BS EN 13397:2002 with reinforced spindle, rising stem. All parts of the valve shall be suitable for use with salt water equivalent to sea water. Ends of the valves shall be suitable for flanged connection to PVC pipe flanges.

- ii) Above 50 mm bore

Full way gate valves shall be constructed of cast iron body with zinc free bronze trim, bolted cast iron bonnet, malleable iron hand wheel, zinc free bronze stuffing box, gland, thrust, plate, yoke, wedge, seat and yoke sleeve with nickel alloy faces, stainless steel spindle with outside screw of rising stem or of inside screw of non rising stem, whichever is specified, gunmetal nuts, and graphite packing compressed fibre packing.

- (b) Fresh Water Application

- i) Up to and including 50 mm bore

Full way gate valve of bronze body construction to BS EN 12288:2010 wedge and valve seat shall be in bronze, non-rising spindle and screw collar in high tensile bronze. Valves shall have screwed female ends for taper treads to BS EN 10226-1:2004.

- ii) Above 50 mm bore

Full way gate valve of bronze body construction to BS EN 12288:2010 bolted bonnet, wedge and valve seat in bronze, rising or non-rising spindle and screw collar in high tensile bronze. Valves shall have flanged connection to BS EN 1092-1:2007, BS EN 1092-2:1997 and BS EN 1515-1:2000.

B1.10.5 Regulating Valves

Regulating valves in fresh water systems shall have gunmetal body to BS EN 12288:2010 with screwed female connections for sizes up to 50 mm bore, and shall be of flanged connections for size above 50 mm.

Regulating valves in salt water system shall be similar materials as the cast iron gate valves and suitable for use with sea water. Valves shall have parabolic shaped discs to give a "straight line" characteristic of water flow to spindle lift. All valves shall be lock-shield type.

B1.10.6 Motorized Control Valves and Solenoid Valves

- (a) For pool water application, valve suitable for sea water application is required.
- (b) Motorized valves shall be of the modulating type with a turn down ratio of at least 50 to 1. Valve bodies shall be cast gunmetal, brass cast iron or as otherwise indicated. Seat and inner valve material shall be brass, stainless steel or as otherwise indicated. Valve sizes 50 mm and smaller shall be screwed and supplied with union fittings. Valve sizes 65 mm and larger shall be flanged. Valves shall be of the straight-through type as required by the sequence or shown on the Drawings. Valves actuator shall be equipped with manual opener to allow manual positioning of valve in the absence of control power. Valves shall have authority of at least 0.5 (50%) and shall have suitable actuator to close against full pump head. Valve body shall be rated for differential pressure stroke less than 20 mm.
- (c) For valves that are incorporated within the system or units, they shall fit for the purpose and applications.
- (d) Valves schedules for all valves modulations/on-off shall be submitted detailing the maximum allowed and actual pressure drops, authority, turndown ratio, maximum pressure the actuator will close against and other valve data.

B1.10.7 Check Valves

- (a) The body of the check valves shall be made of cast iron to BS EN 1561:2011 and ISO 185:2005 while the flaps/discs shall be made of bronze to ISO 197-4:1983 or ductile cast iron. The discs of swing check valves shall be of light construction and pivot on a spindle secured by 2 phosphor-bronzed hangers. Each valve shall be fitted with a stop to prevent undue movement of the flap and shall be as silent as possible in operation.
- (b) The discs of lift check valves shall be provided with means of guiding the discs and preventing components from becoming detached in services.

- (c) Recoil check valves with size 100 mm and above should have removable cover on top of the outlet body casing to facilitate inspection of bearings and movement door.
- (d) Silent check valves shall have large bearing surfaces, functions equally well in all positions, drop-tight seating, and stainless steel trim.
- (e) For chemical handling, ball type UPVC check valves at 50 mm diameter or below may be used.

B1.10.8 Stainless Steel Valves and Accessories

Where stated in the Particular Specification, valves and accessories for use with ozone or ozonated water such as valves and accessories for reaction tanks, carbon filter tanks, etc. shall be made of stainless steel materials to Grade 316 (BS EN10088-3:2005). This includes body, stem, disc, cover and spring of gate valves, check valves, globe valves and other accessories as specified in the Particular Specification. The gasket shall be made of PTFE. Butterfly valves shall be in accordance with the requirements of clause B 1.10.3 of this General Specification.

B1.10.9 Cocks

- (a) Cocks, taps and other accessories shall be of the type and working pressure suitable for the applied system and shall be supported by valid documents with approval from the appropriate authority. They shall be in accordance with the appropriate ISO Standard with marks.
- (b) Bodies of cocks of up to and including 50 mm size shall be of cast gunmetal or bronze; approved valves having hot-pressed bodies may be offered as an alternative. For carbon and reactions tanks, size of drain cock shall be 50 mm and above which shall be of UPVC cocks with UPVC pipes below union end.
- (c) Except otherwise specified all cocks that convey ozonized or chemical fluid shall be chemical resistant types.

B1.10.10 Strainers

- (a) Strainers shall be of screwed thread connection for bores of up to and including 50 mm, and of flanged connection for bores of 65 mm and above.
- (b) Strainers of up to 50 mm shall be of gunmetal or bronze. The bodies of single strainers of 65 mm bore and above and all double strainers shall be of cast iron.
- (c) Strainer cages and their supporting structure shall be stainless steel with 1.5 mm diameter perforations or as specified in the Particular Specification. Cage shall be at least 5 times the cross-sectional area of the pipe.
- (d) Double strainers shall incorporate a changeover device to enable either strainer to be selected and to isolate the idle strainer from the fluid flow.
- (e) In case where the strainers have to be frequently cleaned, such as the strainers for the main circulation pumps, a bucket type strainer with clamp type cover to facilitate quick removing of cages without the need for wrench or other special tool shall be used. The flanged cast iron bucket type strainers shall have grade 316 stainless steel screen cage with perforations to suit fluid handled. The SP Contractor shall provide 1 set each of spare screen cages for alternate replacement.

B1.10.11 Foot Valves with Strainers

Foot valves with strainers shall be used for chemical dosing systems when diaphragm pumps have been used. The body shall be corrosive resistant material and strainers shall be stainless steel to resist the chemical fluids.

B1.10.12 Automatic Air Vents

- (a) Automatic air vents for general venting of air shall have gunmetal or brass bodies, non-ferrous or stainless steel floats and guides, and non-corrodible valves and seats. Each automatic air vent shall be controlled by a lock-shield valve. Air release pipes shall be run to discharge at the nearest suitable and visible point and agreed by the Architect.
- (b) Whether indicated on the drawings or not, the SP Contractor shall install automatic air vent at the top of all risers as well at high points in pipework systems.

- (c) For venting of ozone at carbon and reaction tanks, automatic air vent complete with cocks shall be provided at all high points on water circulating pipework and tanks. Body of the automatic air vents shall be of stainless steel. The venting capacity and operating pressure shall meet the venting requirements of the ozonators as informed by the manufacturer.
- (d) Proprietary made automatic venting system for carbon and reaction tanks may be accepted subject to the approval of the Architect.
- (e) Automatic air vent on UPVC pipe shall be protected by guard. The SP Contractor shall submit the guard details for Architect's approval.
- (f) Devices for air venting shall be provided at all high points in the pipework. They shall be installed in the highest points of the sections where they are intended for venting.
- (g) Vent valves from reaction and carbon tanks shall discharge gas to outdoor through an ozone destroyer.

B1.10.13 Sight Glass

The sight glasses shall be corrosion resistant type which shall be securely fixed to the pipework. Inline inspection glasses shall be corrosion resistant type which shall be installed at the discharge of each chemical feed pumps. Protective guard shall be installed to protect the sight glass. The SP Contractor shall submit details for Architect's approval.

B1.10.14 Valves for Drain

For flushing down cock or valve, 15 mm diameter key-operated drain cocks with hose unions shall be fitted to the lowest accessible points of the system pipework and also on individual items of plant to ensure complete drainage.

Larger drain valves will be required for rapid flushing down in connection with water tanks.

Drain valves for back washing of sand filters or carbon tanks shall have diameter equal to the inlet and outlet pipes.

B1.10.15 Pressure & Temperature Gauges, Orifice Plate, Flow Meter and Energy Meter

(a) Pressure Gauges

Pressure gauges fitted to plant and pipework shall comply with BS EN 837-1:1998 calibrated in kPa from zero to not less than 1.3 times and not more than twice the operating pressure of the respective equipment/system and shall be accurate to 1.5% of full scale reading, unless otherwise specified. Gauges for ozone or chemical application shall be stainless steel.

The dials of gauges shall not be less than 100 mm diameter and the cases shall be of polished brass or chromium-plated mild steel with optical sight glass.

Pressure gauges used solely to indicate the head and pressure of water shall be provided with an adjustable red pointer set to indicate the normal working pressure or head of the system.

(b) Thermometers shall be of the mercury-in-glass type of at least 150 mm long with accuracy of $\pm 0.5^{\circ}\text{C}$. Thermometers shall be complete with cylindrical brass case, be of straight or angle type, and be installed in pockets. Unless otherwise specified, material of thermometer pocket shall be of stainless steel grade 316.

(c) Where orifice plate metering are to be installed, the orifice plates shall be of stainless steel and of proven performance characteristics in compliance with ISO 5167-1:2003 and ISO 5167-2:2003. The resistance across the orifice shall not exceed 5 kPa. The plate shall have 2 stainless steel valve tappings for connection to manometer or responder meter.

(d) Electromagnetic and Ultrasonic Flow Meters

i) The flow meter shall be of the direct reading type, i.e. in l/s, and shall be suitable for the chemical and physical properties of the fluids to be measured and suitable for both horizontal and vertical installations.

ii) Each flow meter shall consist of the flow sensor, an integral signal converter/transmitter and a digital display unit. The flow sensor shall be installed on the water pipework without obstructing the flow. The protection class of the sensor and converter/transmitter housing shall be at least to IP 67 and IP 65 respectively. The flow meter shall have a constant accuracy to a maximum error of $\pm 0.5\%$ of the actual flow for flow velocity of greater than or equal to 0.5 m/s. The Installations of the flow meter shall be as per the manufacturer's recommendation with sufficient length

of straight pipe run both at the upstream and downstream piping.

- iii) The flow meter shall conform to BS EN 61000-6-1:2007, BS EN 61000-6-2:2005, BS EN 61000-6-3:2007+A1:2011 and BS EN 61000-6-4:2007+A1:2011 or similar international standards on Electromagnetic compatibility (EMC) compliance for industrial and commercial applications.

(e) Energy Meters

The calculation of water enthalpy shall be based on flow rate and change of water temperature. The energy meter shall calculate and display digitally the water enthalpy consumption in kWh with accuracy to a maximum error of $\pm 1.5\%$ throughout the range of measurement. The number of digits of accumulated enthalpy consumption display shall not be less than 6. The housing protection for the microprocessor and calculator unit shall not be less than IP 54. The requirement for the temperature sensors and the flow meter shall be as specified elsewhere in this General Specification.

Signal connection facilities to the central control shall be provided for displaying the energy consumption computed and the flow rate and temperature readings.

B1.11 FIBRE GLASS WATER TANKS

B1.11.1 General

- (a) Wherever indicated on the drawings, all water storage tanks constructed by concrete shall be cast by the Building Contractor. All non-concrete tanks shall be supplied and installed by the SP Contractor.
- (b) All fibre glass water tanks shall be of removable panel construction and bolted to form the required tank size by flanges.
- (c) Each tank shall be provided with the following:-
 - i) one 500 x 500 mm or 500 mm diameter access opening with lockable cover to prevent the ingress of dirt;
 - ii) the required numbers of inlets, outlets, drains, vents, overflow and electrode connections, positions of which shall be determined by the SP Contractor and submit for approval; and

- iii) one internal and external cat ladder for maintenance.
(Ladders shall be constructed in stainless steel)
- (d) All connections in the tanks shall be made by flanges to BS EN 1092-1:2007, BS EN 1092-2:1997 and BS EN 1515-1:2000 and the materials of the flanges shall be identical to that of the pipework to be connected.
- (e) All bolts, nuts and washers used in the tanks, whether or not in contact with water, shall be of stainless steel and shall not deteriorate due to chemical or atmospheric actions.
- (f) Proper gaskets shall be used in all joints at panel flanges and pipe flanges. Details of gaskets shall be submitted for approval by the Architect.
- (g) When submission to the Water Supply Department is required, the tank construction shall follow the Department's requirements.
- (h) The SP Contractor shall supply and install tank fittings including puddle flange for all necessary pipe work connections and controls.
- (i) The SP Contractor shall be responsible for ensuring that all cast-in fittings are correctly positioned.
- (j) The dimension of the tanks shown on the drawings are indicative only, exact sizes of all tank shall be adjusted to suit site conditions as well as to suit the manufacturing tolerance.
- (k) Materials of the fibre glass tanks shall be of the type approved by Water Authority, Buildings Department and FSD. Details of materials shall be submitted for approval.
- (l) Details of construction method of non-concrete tanks shall be submitted for approval.

B1.11.2 Tank Panels

- (a) In general, each panel of the tank shall have uniform dimensions of 1000 x 1000 mm or 1000 x 500 mm or 500 x 500 mm modules and shall be interchangeable between tanks for the same application.
- (b) The panel pattern shall be of "F" panel design to give extra strength to the wall of the panel to withstand water pressure. Alternative patterns may be considered and must be submitted for approval.

- (c) Thickness of each panel shall be adequate to withstand at least 3 times the static pressure likely to be created by the depth of the water stored therein. Adequate bracings shall be provided to maintain the tanks in shape when fully charged with water. Any leakage/rectification work resulted from inadequate bracing/supports shall be at the SP Contractor's costs. Damages to other trades and to the owner's properties resulted from flooding will also be chargeable to the SP Contractor.
- (d) Tank panel shall be of reinforced glass fibre with a minimum thickness of 10 mm. The material of the tank shall not deteriorate due to chemical, atmospheric or thermal action when in contact with water treated with relevant chemicals for disinfection. Special attention shall be paid to the temperature of the water which will be as high as 35°C. The jointing material shall also be suitable for the chemical and temperature conditions of the water.

B1.11.3 Supports

- (a) Adequate supports shall be made to all connecting pipework from the building structure. The tank body shall not be used for supporting the pipework in any case.
- (b) In general, tanks shall be supported on steel channels placed on top of concrete plinths. The steel channels shall be anchored to the concrete plinths and in turn bolted to the flanges of the panels as shown on the Drawings.
- (c) Fibre glass tanks shall only be supported at the panel flanges and adequate anchoring points shall be provided to prevent movement.
- (d) Adequate bracing shall be provided in the fibre-glass tanks to eliminate vibration caused by the closing float valves and any other external sources.

B1.12 POOL FITTINGS

B1.12.1 Inlet Fittings

The inlet fitting for swimming pool shall be of adjustable type with full range of flow adjustment by turning the internal plate. Total opening area of the grating should not be less than cross-section area of the connection pipe. It shall be constructed of ABS or chrome plate cast bronze.

The inlet fitting for water feature shall be of chrome plate cast bronze construction, adjustable "eyeball" type with smooth rounded exposed surface. The minimum orifice diameter shall be 25 mm.

B1.12.2 Hydro Spa Jet

Hydro spa jet shall be provided inside Spa pool to create an agitation on water surface. The hydro spa jet shall be complete with socket end or threads for pipe connection. The hydro spa jet shall be of ABS constructed, the intensity of flow shall be fully adjustable from front with minimum 25 mm connection for water supply and 25 mm for air inlet. The flow of hydro spa jet shall be capable to be deflected at 15° at any direction to the horizontal axis.

B1.12.3 Gutter Drains

Gutter dome scum drain shall be installed wherever so specified, in the gutter channel. Gutter dome scum drain grating shall have opening area 1.5 times the cross-section area of the connection pipe. The grating shall be designed to prevent entrapment of bather's toes or fingers. It shall be constructed of ABS or chrome plated cast bronze.

B1.12.4 Main Drain Grating

Wherever so specified, main drain grating shall be installed and be of square type.

The main drain grating shall be installed on a concrete sump pit constructed by Building Contractor. It shall be installed at the lowest point of the swimming pool, water features and spa pool, of adequate size and design to allow precision flow control down to 4 l/s at a maximum velocity of 0.5 m/s.

The opening area in the grates shall be of such design to prevent vortex and physical entrapment of fingers, toes, etc. The cover for the main drain grating shall be designed so that it cannot be removed except with tools. The main drain grating shall be constructed of ABS or chrome plated cast bronze. Twin drain outlets should be provided in accordance with CIBSE Guide.

B1.12.5 Vacuum Fitting

The vacuum fittings shall consist of body and plug. The fittings shall be constructed with ABS or chrome plated cast bronze and shall have connection for flexible vacuum hose. The plug shall be provided with mating threads at the hose adaptor connection and shall have 2 integral cast recessed finger gripping ribs for ease of removing from body. The selected adaptor shall be PVC or ABS construction with 38 mm FIP for connection to pipework, or as specified by the Architect.

B1.12.6 Overflow Drain

Overflow drains shall be provided in form of skimmer box at location shown on the Drawings. All drain outlets shall be of streamlined ABS gratings, and completed with thread for UPVC overflow drain pipes connection, or as specified by the Architect.

B1.12.7 Channel Outlets

The selected outlets and the associated gratings shall be of PVC or ABS construction with 50 mm diameter connection. The grate free area of the drain grating shall be minimum 1.5 times the transverse area of the connecting pipe, or as specified by the Architect.

B1.12.8 Skimmers

Skimmers shall be installed as indicated on the Drawings. This shall be moulded type of 5 mm thick rugged ABS construction, or as specified by the Architect.

B1.12.9 Pool Ladders and Water Depth Indicators

Unless otherwise specified, pool ladders constructed of grade 316 stainless steel tubing shall be provided by the Building Contractor. The number and the arrangement of the ladders for the main pool will be as shown in the Drawings. The width of ladder will be 508 mm, unless otherwise specified.

Water depth indicators would be provided on the side walls of the pool by the Building Contractor.

SECTION B2

SAND FILTER

B2.1 GENERAL REQUIREMENTS

Sand filter shall be air scoured sand pressure type. Each sand filter shall comprise a steel electrically welded shell complete with supported nozzle, balance tank, adequate strength stainless steel nozzle plate and filtering media supports, internal distribution and draw-off trough, flanged inlet and outlet, wash-in, drain and air connections, adequately sized "McNeil" type manholes (minimum 4 nos. for each filter), filter supporting feet, necessary filtering media and sundry accessories. The design and position of manholes shall be convenient for maintenance staff entering the shell to service, replace internal parts and repaint the internal surface wherever necessary. For each horizontal filter, two numbers of 250 mm diameter hand doors complete with shell fixing bolts shall be provided along the longitudinal side just above the nozzle plates. For each vertical filter, two numbers of 250 mm diameter hand doors complete with shell fixing bolts shall be provided on the opposite sides just above the nozzle plates. Sight glasses shall also be provided just above the level of filtering media. Detailed Drawings with design stress calculation of sand filters construction (at least 2 times above design working pressure) including the tank, nozzles, tank supports and sand filter bed & supports shall be submitted to the Architect for approval. Special attention shall be given to the methods of supports for the nozzle plates. These shall have adequate supports so that no bending of any of the support members will occur.

The tanks shall be treated as follows:-

(a) Interior Surface

i) Surface Preparation:-

Blast cleaning shall be carried out in accordance with BS EN ISO 12944-1:1998 to BS EN ISO 12944-4:1998, BS EN ISO 12944-5:2007, BS EN ISO 12944-6:1998 to BS EN ISO 12944-8:1998 and BS EN ISO 14713-1:2009 to BS EN ISO 14713-3:2009. The quality of blast-cleaning shall be to second quality as given in BS 7079:2009 "General introduction to standards for preparation of steel substrates before application of paints and related products ".

ii) Coating System:-

Primer: one coat of heavy duty epoxy paint up to a dry film thickness of 80 microns. It should be epoxy orange primer or approved.

Undercoat: one coat heavy duty epoxy paint with light yellow finish. It should have a dry film thickness up to 100 microns, and epoxy white primer (undercoat) or approved.

Finish: two coats of heavy duty epoxy paint with blue finish. It should have a dry film thickness up to 30 microns per coat and epoxy sky blue or approved.

(b) Exterior Surface (unexposed)

Before placing the filter tank in position on the concrete plinths, the areas that will be in contact with the concrete shall be wire brushed and applied a thick coat of bitumen. For horizontal tank, the tank shall be laid on a pack of bituminous felt such that the interface between concrete and filter tank is adequately protected against corrosion for all times. Any bitumen between remaining on the exposed areas outside the interface shall be cleared off in preparation for the protection described below.

(c) Exterior Surface (exposed)

On completion of filter tank fabrication, wire brush the whole of the external surface thoroughly to remove all scale rust, dirt and grease. The outer surfaces and attachments shall be treated as follow:-

Primer: as for interior;

Undercoat: one coat of good qualities undercoat paint of colour consistent with finishing coat; and

Finish: one coat of good quality heavy duty epoxy green paint or approved.

(d) Painting Precaution

Submit detailed painting methods and procedures recommended by the paint manufacturer. These instructions must then be followed without deviation unless instructed by the Architect. These instructions shall be submitted to the Architect for approval. All paints used shall be of the same brand from the same manufacturer. All shot-blasted surfaces shall be inspected by site representative of the Architect immediately after blasting. Primer shall be applied immediately after the inspection.

(e) Tank Assembly

Factory assembled, pressure tested and certified filter tanks to be offered as practical as possible. Unless, in view of the actual difficult site conditions and to the approved of the Architect, the tanks may be shipped in small plates formed and ready for electrical welding on Site. Finished filter tanks shall be subjected to a pressure test for 6 hours of not less than 2 times the design working pressure or 600 kPa whichever is higher, in the presence of a Registered Professional Engineer (Mechanical) appointed by the SP Contractor and the Architect's Representative on Site.

(f) Test Certificates

Test certificates issued by an Appointed Examiner under the Boilers and Pressure Vessels Ordinance, (Cap. 56) and other testing documentation as required by Labour Department and other relevant authorities shall be submitted to the Architect for each filter tank. Detailed design report of the filter tank regarding its strength shall also be submitted to the Architect for approval before fabrication which shall be certified by the Appointed Examiner.

B2.2 FILTER SUPPORT

All horizontal filter tanks shall be designed to rest on concrete supports embracing the lower portion of the tank at the support position without legs. Provide anchor fixing bolts for fixing the tanks/vessels after putting in place on the concrete supports. Submit full details of dimensions and operating weights of all tanks/vessels and the exact position and construction details of the concrete supports to the Architect for approval prior to manufacture or ordering.

B2.3 FILTER TANK ACCESSORIES

Each filter tank shall be equipped with automatic and bulk air release valves, water control valves, wash water sight glasses, inlet and outlet pressure gauges, differential pressure sensor (for auto-control backwash) for filtering and backwashing operations, flow meters and associated panels, drain pipe and valves, draw-off cocks for taking samples of raw and filtered water and can be individually manually back washed. To allow efficient distribution of water in the filter, the inlet and outlet distribution pipe shall be designed to cross the whole length of the filter for horizontal tank and cross the whole diameter of the filter for vertical tank.

One set of flow meter shall be provided on the inlet to each filter. A sight glass shall be provided at the backwash discharge pipe of each filter.

B2.4 FILTER BED

Filter bed shall consist of at least two but preferably more layers of filter media, each having a different particle size properly supported by a suitable under drain. Where nozzles are provided as a form of under drain, they shall be completely manufactured from poly-propylene or UPVC screwed into a high quality heavy gauge steel plate and shall not have any metal screws or holding bolts. The steel plate shall have adequate support and must be strong enough to withstand the weight of the filter bed plus the water pressure differential across the bed when dirty. A margin should be provided to take the additional pressure in the event that any other filter is temporarily valved off. Manufacturer's fully dimensioned shop drawings together with details of the nozzles and filter media must be submitted for approval prior to fabrication. 10% spare nozzles shall be provided for each filter tank.

B2.5 FILTERING MEDIA

The filtering media shall consist of accurately and even graded quartz sand with at least one layer of 0.4 to 0.8 mm grain and one layer of 0.71 to 1.25 mm grain. The depth of sand shall be sized according to the plant capacity and the manufacturer's recommendation for low to medium filtering rate. 0.3 mm water free board shall be provided above the sand.

B2.6 WELDING REQUIREMENTS

- (a) All welding shall be carried out by metal arc or gas process and shall conform to the requirements to BS 2971:1991, BS 4515-1:2009 and BS 2633:1987. Undercutting and hammering of completed welds are not permitted. Arc welding of carbon and carbon manganese steels shall conform to BS EN 1011-2:2001. The welding process shall be submitted to the Architect for approval.
- (b) All welder employed shall be holder of a valid certificate of competency which has been issued by an approved authority. Copies of these certificate shall be submitted for inspection before any welding is to be proceeded.
- (c) Allow 5% of the total welds when selected by the Architect be examined by X-ray non-destructive test carried out by an independent testing body approved by the Architect. All test result shall be submitted. In the event of any welds proving unsatisfactory, the SP Contractor shall rectify the weld by approved welding process until a satisfactory test result is obtained. Extra cost for the repair and non-destructive X-ray test shall be borne by the SP Contractor.

B2.7 OTHER REQUIREMENTS

- (a) In the case the filter tanks/vessels are manufactured outside Hong Kong, the hydraulic pressure test and X-ray test shall still be required to be carried out on Site after delivery. In addition, the SP Contractor shall submit test report and certificate endorsed by the manufacturer professional engineer that hydraulic pressure test and X-ray test to the same requirements as that on Site have been carried out in the factory before delivery and all test results are satisfactory. The SP Contractor shall rectify all defects on the vessels found on Site after delivery. Where defects are found on any vessel which in the opinion of the Architect is substantial, the SP Contractor shall remove and replace the whole filter vessel at no extra cost. Rectification on Site shall not be accepted.

- (b) Service platform and cat ladders shall be designed and provided by the SP Contractor for all filter tanks. The platforms and cat ladders shall be designed and painted by the SP Contractor for future maintenance of all instruments and parts of vessels and access to the manholes. The platform and cat ladders shall be made of mild steel, steel chequer plates and accessories of adequate strength to facilitate servicing. Details of these fabrications and shop drawings shall be submitted to the Architect for approval prior to erection. The platforms and cat ladders shall be painted in accordance to Part C of this General Specification.

- (c) Internal inspection of each of the filter tanks shall be required towards the expiry of Maintenance Period. The SP Contractor shall allow for and arrange at the expiry of the free Maintenance Period to drain down and open up to facilitate this inspection at no cost. Any defects found at this stage shall be rectified at no additional cost to the Employer. For the purpose of this inspection it will not be required to remove the filter media unless it is found to be in an unsatisfactory condition.

SECTION B3

OZONE GENERATION SYSTEM

B3.1 GENERAL REQUIREMENT AND PRINCIPLE

- B3.1.1 The SP Contractor shall supply and install the ozone generating system comprising of ozonator, mixing equipment, ozone analyzer, reaction tank, carbon filter tank/vessel, control panel, and associated piping & wiring for the system.
- B3.1.2 Disinfection of the filtered water shall be achieved by inducing ozone gas into an injected water supply to form ozonated water and then into the delivery main of pool. Ozone is generated by passing an oxygenated gas (commonly air) through a high- energy electric field of corona discharge. It is then introduced into the circulated pool water in the plant room and given sufficient time to react with the contaminants. Any residual ozone is removed by means of activated carbon filters following the ozonation process before passing back into the pool area.
- B3.1.3 Ozone generator shall comply with DIN 19627:1993. Ozone concentration in the ozonated air mixture shall be in accordance with the requirement of the Particular Specification. Ozone shall be added constantly to water while the system is in operation, at a concentration according to the Particular Specification. The reaction time of ozone after mixing with water shall exceed 3 minutes.
- B3.1.4 Ozone leakage alarm system and devices shall comply with Dangerous Goods Ordinance, (Cap. 384). Ozone detectors shall be located at low level inside the ozone generator room and near the destructor. Local alarm in the plant room and remote alarm shall be provided.
- B3.1.5 The ozone leakage alarm system inside the ozone generator room shall be activated if the ozone concentration reaches 0.1 ppm inside the room. Activation of the ozone leakage alarm system shall automatically switch off the ozone generator and switch on the mechanical ventilation system inside the room.
- B3.1.6 Manual switches with clear labels and instructions shall be provided outside the ozone generator room for direct on/off control of the ozone generator and mechanical ventilation system inside the room during emergency.

B3.2 OZONATOR

- B3.2.1 Unless otherwise specified, ozonator shall be of full vacuum unit. Ozone production and transport should be effected under vacuum to exclude any risk of ozone escaping from the system such that in the event of breakage of pipe containing ozone, air is sucked in rather than ozone escaping. The ozonator shall comprise the following:-

- (a) Two air dryers (one duty one standby) shall be used to remove any contaminants and moisture from the ambient air prior to the ozone generation process. Two dryers shall be operated in such a way that one is operating in drying mode for a preset period of time while the second is in regenerating mode to expel the absorbed moisture with an automatic change-over function. The dryer shall be designed such that regeneration of the dryer can be in operation even when the ozonator is stopped. Air supplied to the air drier will be through an air duct.
- (b) Ozone Generator shall consist of electrodes to which a high alternating voltage is applied. For tubular type electrode, the grounding or earthing electrode shall be formed by the cooling media surrounding the dielectric gap of glass/ceramic through which dried air is drawn under vacuum. A proper design for protecting glass tubes from potential damage due to thermal stress induced by the contact with coolant is to be featured. The SP Contractor shall include the supply of one spare ozone generator module.
- (c) High Tension Transformers of air cooled, dry type to provide high voltage for the electrodes in order to produce corona discharge across the dielectric gap rendering bi-atomic oxygen molecules O_2 to regroup to form tri-atomic ozone molecules O_3 . The variable ozone production shall be achieved by varying the input to the high tension transformer so as to vary its output. In any case, no harmonic frequency shall be generated from the transformer, which could adversely affect the operation of the generator.
- (d) Control panel with control components for automatic air-drying, ozone generation and safety features as depicted in Clause B3.2.5.

B3.2.2 The ozonator shall have controls to allow automatically adjustment of ozone output in response to the redox signal from ozone sensor placed after the discharge of reaction tank by varying the transformer output voltage. Manual adjustment of ozone output by same principle shall also be facilitated.

B3.2.3 The ozonator shall be of compact construction cabinet with lockable doors at the front, side and/or rear for access to all parts for maintenance. All panels shall be easily removable. Voltmeter, ammeter, indications lamps and control switches shall be provided on the front panel with polycarbonate windows for continuous observation and monitoring of the operation of the ozone generation units, air dryers and air flow indication. All individual units, such as dryers/absorbers, ozone generators, and transformers shall be separated from one another by safety compartmentation. Moreover, the compartment housing the electrical equipment and air drier shall be

separated from compartment housing the ozone generator. The generator shall be suitable for operation up to a room temperature of 40°C and suitable for continuous operation. Materials in contact with ozone shall be resistant to ozone attack.

B3.2.4 The dielectric glass tube housing the electrodes in the ozonator shall be of robust and reliable construction to withstand the temperature and thermal stress during discharge. It shall be of a proven design with little chance of glass tube breakage and/or control failure. The SP Contractor shall allow for and shall be responsible to replace the whole ozonator at no extra cost if glass tube breakage occurs for more than two times during the Maintenance Period. During glass tube breakage in any one glass tube module/bank, the ozonator shall be able to allow for individual isolation of the module/bank of glass tubes to allow the generator to continue to function. The SP Contractor shall supply not less than 20% of total numbers of new glass tubes per ozone system as spare, which shall be handed over to the Employer 1 month before expiry of Maintenance Period.

B3.2.5 The following minimum controls and safety features are required for the ozonator with visual indications, regardless of whether shown on Drawings or not:-

(a) Ozonator shall shut down completely on the following conditions:-

- i) air drier failure;
- ii) air flow failure;
- iii) cooling water (if applicable) failure and/or high water temperature;
- iv) excess air pressure or loss of vacuum in the air and ozone lines;
- v) excess or low current;
- vi) low water flow in main water stream/stopping of main water circulation pumps;
- vii) glass tube breakage (on one unit);
- viii) activation of the external cut-off device of the generator; and
- ix) other abnormal conditions that may lead to abnormal function of the ozonator.

(b) Interlock shall be provided such that ozonator can only be energized after the main circulation pumps are energized.

(c) Interlock with the cabinet door shall be provided to shut down power supply to the high tension transformer in case the cabinet door is opened.

B3.2.6 A cooling circuit shall be included to cool down the ozone generator for water- cooling unit. The cooling water shall come from the main flow and return to the pump header. Allow for the supply of cooling water pumps as recommended by manufacturer. The SP Contractor

shall allow for additional chiller units for cooling as recommended by the manufacturer to maintain the temperature within acceptable limit. Make allowance for any decrease of generator capacity due to high cooling water temperature from swimming pool in hot summer weather and increase the plant capacity accordingly.

- B3.2.7 In addition to the local control panel provided on the ozonator, the signals of the ozonator shall be wired to the supervisory control panel in the control room wherever so specified to indicate the following:-
- (a) Fault indication lamps for each ozone generator which shall light up with buzzer alarm when there is any fault/tripping/stopping of the ozone generator (buzzer alarm can be muted); and
 - (b) Start/stop switches for each ozone generator with visual indication.
- B3.2.8 A warning lamp with buzzer shall also be provided on the supervisory control panel wherever so specified to warn operators to shut down or to reduce ozone output of the ozone generator in case the ozone sensor located at pool supply pipe detects ozone after deodorization.
- B3.2.9 The system control shall be incorporated with an earth leakage detector, which shall provide fail-safe protection for bathers, and system operators working on the equipment.

B3.3 MIXING EQUIPMENT

- B3.3.1 After the ozone is produced in the ozone generator, it shall be mixed with the water flow through an injector stream which shall then mix with the main flow. The mixing equipment shall consist of a mixer, a sight glass in the mixing chamber, an ozone eductor, booster pumps, manometers, piping, valves and accessories to help mixing and dissolving ozone into the water stream. The mixer shall be of material resistant to ozone attack such as reinforced UPVC, PTFE, or stainless steel Grade 316 (low carbon) as specified in the Particular Specification. The sight glass shall be able to withstand the test pressure of the system.
- B3.3.2 The eductor shall comprise of a nozzle followed by a venturi. A proportion of the water to be treated shall be drawn off by a suitable booster pump and fed under pressure and a high velocity to the nozzle. The emerging jet of water shall cause a vacuum which in turn draw air through the ozone generator where it is entrained in the venturi together with the water jet. The quantity of ozone gas to be mixed with water by suction can be regulated by means of the flow regulating and shut off valve in the gas line at the eductor. There shall be 2 non-return valves on both side of the shut-off valve and other safety protections to prevent water from entering the gas line. Pressure gauge shall be fitted upstream and downstream of the eductor.

B3.4 ORP ANALYZER

An ORP analyzer including a sensor shall be provided to measure the ozone concentration in the water and control the ozone generation of the ozonator. The reading shall be shown on a liquid crystal display. Extra output should be provided to transmit the ozone concentration and water temperature signals to the supervisory panel wherever so specified.

B3.5 REACTION TANK

- B3.5.1 The reaction tank shall be made of electrically welded mild steel of sufficient thickness to withstand the system pressure.
- B3.5.2 The reaction tank shall be designed to allow ozonated water to stay in the vessel for at least 2 minutes with careful planning of the inlet and outlet piping position. It shall be made of materials suitable for contact with ozonated water and must be resistant to electrolytic corrosion and chemical attack. Some acceptable materials are:-
- (a) Electrically welded mild steel with proper coating, the coating manufacturer's recommendation on pre-treatment procedures must be strictly followed; or
 - (b) Stainless steel Grade 316 (low carbon)
- B3.5.3 The surface of tank shall be required to undergo the same pressure test and test standard on electrical welding for steel tank as the pressure sand filter tank.
- B3.5.4 Test certificates issued by an Appointed Examiner under the Boilers and Pressure Vessels Ordinance, (Cap. 56) shall be submitted to the Architect for approval. All other tests and certificates as required by Labour Department and other relevant authorities shall as well be done and provided.
- B3.5.5 The reaction tank shall also comply with all other requirements of sand filter tanks where relevant except with no nozzle plate and sand. The reaction tank shall be complete with all necessary accessories such as stainless steel automatic air vent connected to ozone destroyer, drain, valves, flow meter at inlet and outlet pipe, maintenance platform, supports, etc., all similar to sand filter tank.

B3.6 CARBON FILTER TANK

- B3.6.1 The carbon filter tank (deozonising filter) shall have pellet activated carbon for complete removal of all ozone in water. It shall be made of approved material resistant to the attack of ozonated water same as reaction tank. It shall comprise an electrically welded shell with adequate strength nozzle plate on which carbon are placed, internal distribution, filtering media supports, flange inlet and outlet, drain, air connection and manholes for maintenance. The internal and external surface shall be treated as the reaction tank. Distribution inlet and outlet pipes which cross the whole length of filter shall be UPVC pipes with holes.
- B3.6.2 The SP Contractor shall be responsible to select the pellet activated carbon filter for complete removal of ozone in water including the carbon depth, carbon media and filtration rate. Dimensions shown on the drawings are minimum requirements only.
- B3.6.3 The volume of carbon shall be adequate to ensure the ozone removal time within 1.5 minutes.
- B3.6.4 The pellet activated carbon shall have diameter 3 – 4 mm with 4 – 8 mm mesh, hardness greater than or equal to 95%, moisture content less than or equal to 5%, iodine number greater than or equal to 950 mg/g, carbon tetrachloride activity (CTC) 45 - 55, specific surface area 800 - 850 m²/g, ash content less than or equal to 15%, bulk density 450 – 550 g/litre, and pH value 7 - 9.
- B3.6.5 The carbon filter tank shall be required to undergo the same pressure test and test standard on electrical welding for steel tank as the pressure sand filter tank. Test certificates issued by an Appointed Examiner under the Boilers and Pressure Vessels Ordinance, (Cap. 56) shall be submitted to the Architect for approval. All other tests and certificates as required by Labour Department and other relevant authorities shall as well be done and provided.
- B3.6.6 The carbon filter tank shall also comply with all other requirements of sand filter tanks where relevant. The carbon filter tank shall be complete with all necessary accessories such as stainless steel automatic air vent connected to ozone destroyer, drain, valves, pressure gauges, flow meter at inlet and outlet pipe, strainer, sight glass at filter media level, maintenance platform, supports and so on similar to sand filter tank.

B3.7 RESIDUAL OZONE AND EXHAUST GAS TREATMENT

- B3.7.1 The air and undissolved ozone escaping from the vents and air release valves of the reaction tanks and deozonising carbon filter tanks shall pass through the ozone destroyer (residual ozone catalytic/chemical converter) to remove the ozone in the air and the condensate shall drain down via a water trap. The ozone destroyer shall contain activated carbon filling, thermal or a heated catalytic destructor. It shall be of sufficient capacity of maintaining 8 to 12 months operation at design flow without replacement. The actual duration will be specified in the Particular Specification. The SP Contractor may need to install more than one ozone destroyer for each group/bank in the system (for periodic switch over after 2 to 3 months or similar) in addition to those shown on the Drawings to meet the 8 to 12 months operational criteria. Submit detailed calculation to the Architect for approval to prove this before ordering. In addition, the SP Contractor shall supply and install 1 ozone destroyer in each group/bank as standby which shall be used to maintain system operation if any one ozone destroyer in the bank has to be refilled/regenerated for any reason.
- B3.7.2 The exhaust vent pipe after ozone destroyer shall be led to an open position for exhaust. Locations as shown on the Drawings are schematic only. Co-ordinate with other relevant parties on exact location of exhaust and allow for any change on Site to meet the exhaust criteria.
- B3.7.3 The vents of the reaction tanks and the deozonising carbon filter tanks shall also have a bypass to a separate ozone destroyer; the destroyer shall be provided & installed by the SP Contractor. This bypass will normally be closed and shall assist the air bleed off on system start-up as required.

B3.8 TESTING AND COMMISSIONING

This procedure is intended to lay down the general testing and commissioning requirements to be carried out by the SP Contractor for the ozone generator system prior to handing over.

Apart from the recommended procedures as suggested from the product manufacturers and the BSB Testing & Commissioning Procedure for Swimming Pool Water Treatment Installation in Government Buildings, HK as published by ArchSD, the following additional inspection, testing and commissioning requirements shall be satisfied.

B3.8.1 Ozone Generating Module

- (a) check the cleanliness of the dielectric glass tube;
- (b) check the cleanliness of the electrode;
- (c) check the cleanliness of the stainless steel liner tube;
- (d) check the O-ring for spacer, glass tube & liner tube;
- (e) check ozone generating module leakage; and
- (f) check any leakage of pipework.

B3.8.2 Drying System

- (a) check the solenoid valve diaphragm;
- (b) check the function of the air blower;
- (c) check the cleanliness of the air filter; and
- (d) check the proper adjustment of the cam timer and micro-switch.

B3.8.3 Air Supply System

- (a) check the proper adjustment of the air flow rate; and
- (b) functional test for the air flow switch.

B3.8.4 Cooling Water System

- (a) check the proper adjustment of the water flow rate;
- (b) check the solenoid valve diaphragm; and
- (c) check the proper adjustment of the water flow temperatures.

B3.8.5 Dew Point Monitoring

- (a) check the proper adjustment of the dew point monitor p.c. board; and
- (b) check the cleanliness of the dew point sensor.

B3.8.6 Pipework & Accessories

- (a) check the leakage of any pipework;
- (b) check all the strainers; and
- (c) check all the valves.

B3.8.7 Electrical Equipment

- (a) check the tightness of the main power switch;
- (b) check the tightness of all wire terminals;
- (c) check the function of all the indication lamps;
- (d) check the tightness of the wiring of motorized variable transformer;
- (e) check the tightness of the high tension transformers; and
- (f) check the function of all safety devices.

B3.8.8 Testing

- (a) check the proper function of the whole system.

B3.8.9 Control Panel

- (a) general check for the panel;
- (b) check & test the power supply;
- (c) check & test the section control circuits;
- (d) check the tightness of the wiring terminals;
- (e) check & test the induction lamps;
- (f) check the function of the cooling fans;
- (g) check the cleanliness of the panel;
- (h) check the control fuse or MCB;
- (i) check the function of the emergency stop;
- (j) check the function of the meters; and
- (k) functional test for the panel.

SECTION B4

SODIUM HYPOCHLORITE GENERATION SYSTEM

B4.1 GENERAL REQUIREMENT AND PRINCIPLE

- B4.1.1 The SP Contractor shall supply and install sodium hypochlorite generator, rectifier/transformer, chemical metering pump, brine storage tank, hypochlorite storage tank, automatic pH & chlorine controller, control panel and all necessary piping & wiring for the system.
- B4.1.2 The electrolytic hypochlorite generation shall work on the basis of partial electrolysis of sodium chloride contained in the brine solution flowing through the generating cells with DC current energizing at the anodes and cathodes of the cells. Successive chemical reactions will take place in the brine solution between the products of the electrolysis.
- B4.1.3 In such chemical process, the brine solution shall be totally dissociated into Sodium and Chloride ions. Free chlorine shall be generated at the anode while hydrogen shall be evolved at the cathode with the corresponding formation of hydroxide ion. The migrated hydroxide ion from cathode shall be reacted with Sodium and Chloride ions near the anode to produce Sodium Hypochlorite solution.
- B4.1.4 The electro-hypochlorite generator shall be mounted on a separate pedestal assembly consisting of water flow meters with low-flow set point, brine flow meter with low-flow set point, water pressure regulating valve, cell electrolyte level switch, cell temperature switch, valve connections for acid cleaning and draining of cell, back pressure valve for brine inlet and epoxy-coated steel structural frame with points for securing to floor.

B4.2 ELECTROLYTIC CELL

- B4.2.1 The cell body shall be constructed of non-corrosive and electrically non-conductive moulded polypropylene with integral inlet and outlet flanges. A transparent cell cover shall be provided to allow easy inspection of cell internals. Dimensionally stable anodes (DSA) such as anode of titanium substrate with ruthenium oxide coating, and corrosion resistant cathode such as hastelloy-C cathode shall be provided to minimize power consumption.
- B4.2.2 The cell is designated for one flow direction and high velocity flow to minimize hardness deposit.

- B4.2.3 Means shall be provided to prevent the cell from operating on low solution flow by having a flow switch at the outlets of the electrolytic cell. Flow switch shall be suitable for operation in the solution. (Flow switch made of stainless steel is not acceptable as it may suffer from pitting by the sodium hypochlorite solution generated.) The wetted surface of the flow switch shall be limited to hastelloy C viton or similar equivalent.
- B4.2.4 The cell shall be of plate type. Tube type is not acceptable as it requires high velocity of the flow switch which leads to erosion of the cell body easily. Transparent acrylic cell cover shall be used for visual inspection of the cell internals and also to check the effectiveness of the acid cleaning operation. (Non transparent cell cover or casing shall not be acceptable.)

B4.3 RECTIFIER/TRANSFORMER

- B4.3.1 Power for the electrolysis of brine shall be provided by a solid-state controlled forced-air-cooled transformers/water-cooled rectifier.
- B4.3.2 The transformer/rectifier shall be of heavy duty industrial type suitable for input voltage of 380 V, 3-phase and 50 Hz.
- B4.3.3 The rectifier shall include self monitoring with alarm contact output for cell voltage, thermal overload and internal faults.
- B4.3.4 The rectifier shall allow infinite adjustment of the hypochlorite production rate from zero to 100% of the rated capacity.
- B4.3.5 The transformer/rectifier shall be housed in a control cubicle c/w control components, measuring instruments, indicating lamps, etc.
- B4.3.6 Devices for high temperature and over current protection shall be incorporated for automatic shut down of the electrolytic chlorinator.

B4.4 BRINE INJECTION PUMP

- B4.4.1 The brine injection pump shall be of bellows-type with adjustable stroke/diaphragm type with variable output.
- B4.4.2 The discharge volume shall be preset at the factory for normal operation but can be adjusted to fit different site operational conditions.

B4.5 BRINE STORAGE TANK

- B4.5.1 The brine storage tank shall be constructed from reinforced concrete, reinforced fibreglass or high density polyethylene or equivalent materials.
- B4.5.2 The size of the tank shall be based on the numbers of working days, operating hours, circulation flow rate and chemical dosing concentration.
- B4.5.3 The tank shall be complete with outlets, valves, overflows to drain and accessories. Level indication such as level glass tube shall be provided.

B4.6 METERING PUMP FOR HYPOCHLORITE & BRINE FEED

- B4.6.1 The hypochlorite metering pump shall be of the positive displacement type with a mechanically actuated diaphragm.
- B4.6.2 The pump shall be constructed with plastic and complete with clear plastic moulded cartridge-type check valves to facilitate service and provide integral sight flow indication. (Conventional threaded valves and external sight flow indicators are not acceptable.)
- B4.6.3 The pumping diaphragm shall be fabric-reinforced elastomer with an imbedded steel backing plate to ensure accurate repeatability for each stroke.
- B4.6.4 The output capacity for the chemical pump shall be manually infinitely controlled from 0-100% via a built in control knob.
- B4.6.5 The pump shall be complete with suction hose and accessories.

B4.7 WATER SOFTENER

- B4.7.1 Water softener shall be an ion exchange resin that removes calcium and magnesium from the source water to reduce the deposits on the cathodes.
- B4.7.2 The softened water shall be used for dissolving salt in the brine tank, cooling the rectifiers and diluting the concentrated brine solution.
- B4.7.3 An automatic three-way control valve shall be provided for regeneration of the resin with the salt solution from brine storage tank.
- B4.7.4 A time delay flow switch in the outlet line from the water softener shall be installed to shut down the unit if the required flow is not present for a 5-second period.

B4.8 HYPOCHLORITE STORAGE TANK

- B4.8.1 The hypochlorite storage tank shall be constructed from reinforced concrete, reinforced fibreglass or high density polyethylene or equivalent materials.
- B4.8.2 The tank shall be designed for ambient temperature and atmospheric pressure and suitable for indoor/outdoor installations.
- B4.8.3 The size of the tank shall be based on the numbers of working days, operating hours, circulation flow rate and chemical dosing concentration.
- B4.8.4 The tank shall be complete with outlets, valves, overflows to drain and accessories. Level indication such as level glass tube shall be provided.
- B4.8.5 The flanged connections for the inlet and outlet from the air dilution blower shall be provided.
- B4.8.6 Safe level control for start-stop operation of electro-hypochlorite generator, overflow alarm, low storage level alarm, stop operation of metering pump induced by low storage level alarm and disable metering pump signal shall be provided.

B4.9 HYDROGEN BLOWER

- B4.9.1 The hydrogen blower shall be installed to force-ventilate the solution tank, reducing the concentration of hydrogen gas in the tank and interlock with electro-chlorinator.
- B4.9.2 A standby blower shall be installed to automatically start if the primary blower fails. Both blowers shall be connected with a 'Y' piece to a common entry into the storage tank.
- B4.9.3 The blower shall be air-cooled explosion-proof type and the motor shall be of requisite size running at 1450 r.p.m. of the drip proof squirrel type totally enclosed.
- B4.9.4 Supply and fit range of PVC piping shall be complete with all necessary fittings between the air blower, filters and sodium hypochlorite tank, non-return valves and air inlet filters.
- B4.9.5 Automatic control shall be incorporated to shut the electro-chlorinator in the event of the failure of both blowers.
- B4.9.6 The blower shall at least remain operation for 15 minutes when the electro-chlorinator system is shut down.
- B4.9.7 The power supply cabling shall be of explosion-proof type.

B4.10 HYDROGEN GAS DETECTION SYSTEM & AIR VENT

B4.10.1 Hydrogen gas detection system shall be provided in sodium hypochlorite tank room. The required performance of the hydrogen gas detector shall be as follows:-

- (a) Measurement Range : 0-100% of lower explosion limit of hydrogen (i.e. 4%) with initial alarm set to be 0.05% of hydrogen in air.
- (b) Life Expectancy : 5 years
- (c) Operating Temperature : -5°C to +40°C (±10%.)
- (d) Humidity : 0-99% RH

B4.10.2 The air vent for the hydrogen gas shall be installed with the air flow sensor which would provide actuation for the standby blower via a control panel in case of the failure of the primary blower.

B4.10.3 The automatic air vent shall incorporate with no built-in valve and the discharge pipe shall be run to the nearest agreed terminal with mesh outlet in accordance with the Architect's instruction.

B4.10.4 The system completion shall be incorporated with explosive-proof type extraction fan and its accessories in accordance with FSD statutory requirement.

B4.11 CHEMICAL CLEANING SYSTEM

B4.11.1 An acid cleaning system shall be complete with recirculation pumps, fibreglass or PE chemical storage tank and other accessories to clean the electrolytic cell in a convenient manner.

B4.11.2 All pipework connected shall be constructed of materials suitable for chemical resistance.

B4.12 AUTOMATIC pH & CHLORINE CONTROLLER

B4.12.1 The automatic chlorine and pH controller shall be installed to monitor and control the concentration of free chlorine and pH level within the specified range stated in the Particular Specification.

B4.12.2 The automatic chlorine and pH controller shall be either installed at the return water pipe from the pool or be complete with the pH and ORP sensors at numerous sampling water return points at regular intervals around pool for the measurement purpose.

- B4.12.3 Standby pump with auto changeover shall be incorporated to ensure system reliability.
- B4.12.4 Alarm shall be provided upon failure of pump.

B4.13 OTHER ACCESSORIES

- B4.13.1 The alarm sensors of the electrolytic assembly shall be complete with high & low temperature alarm, low electrolytic level, low dilution water flow and low brine flow.
- B4.13.2 PVC Y-type strainer shall be installed at the inlet of the electro-hypochlorite generator to filter any incoming water with particle size of 1 mm or more.
- B4.13.3 A pressure gauge and flow indicator shall be installed to show the electrolytic assembly system pressure and flow rate.
- B4.13.4 Ammeter and voltmeter shall be provided to display the electrolytic assembly current and voltage.
- B4.13.5 PVC pressure relief valve shall be installed to protect the electrolytic assembly from over-pressure.
- B4.13.6 Motorized/solenoid valves shall be installed at the inlet of the electro-hypochlorite generator to stop the incoming water flow through the cell when the system is switched off.
- B4.13.7 Sample valves shall be provided at the electro-hypochlorite generator outlet to facilitate the measurement of chloride concentration.
- B4.13.8 A local control panel shall be provided to provide on, off & modulating control, change-over control, and functions monitoring & status indication of the system components and to generate alarm signals. Control panel shall be incorporated with an earth leakage detector, which shall provide fail-safe protection for bathers, and system operators working on the equipment.

B4.14 TESTING & COMMISSIONING

This procedure is intended to lay down the general testing and commissioning requirements to be carried out by the SP Contractor for the chemical dosing system prior to handing over.

Apart from the recommended procedures as suggested from the product manufacturers and the Testing & Commissioning Procedures as published by ArchSD, the following additional inspection, testing and commissioning requirements shall be satisfied.

B4.14.1 General

- (a) check if the emergency stop button is released;
- (b) check if sodium hypochlorite line is connected to the Hypochlorite Tank;
- (c) check if fresh water supply is connected to the system;
- (d) check if all the alarms are reset;
- (e) check and allow the system to run for 15 minutes;
- (f) check if the DC voltage is below the rated value at full load; and
- (g) check if the status of the pressure regulators and gauges in controlling the water supply to the dosing system is in proper condition.

B4.14.2 Electrolytic Cell

- (a) check for any damage or cracks on the cell box and clear acrylic cover;
- (b) check whether the gasket of cell cover is in proper and secure position and any compression for the gasket under the faceplate;
- (c) check whether the cell box bolts are tightened;
- (d) check for any deposits and sludge accumulation in the cell; and
- (e) check if the water flow meter readings are unchanged from the pre-set value.

B4.14.3 Transformer/Rectifier

- (a) check for any damage on the cabinet panels and meter faces;
- (b) check if all the wirings are in proper connections;
- (c) check if rectifier control panel is turned to "On" position;
- (d) check the auto start of rectifier when the desired brine concentration has been achieved at the hypochlorite delivery point; and
- (e) check the shutdown operator of rectifier upon the indication of high cell temperature or low water level.

B4.14.4 Brine Injection Pump

- (a) check the injection pump to ensure it is rotating;
- (b) check if brine pump stops when level in Brine Tank reaches LOW LEVEL;
- (c) regulate the concentrated brine flowrate via the pump dial; and
- (d) check if the brine concentration has been achieved at the hypochlorite delivery point.

B4.14.5 Brine Storage Tank

- (a) check any impact damage for the tank and tank lid;
- (b) check if the brine level assembly are in place and undamaged;
and
- (c) check if the mixing condition in the Brine Storage Tank is satisfactory.

B4.14.6 Metering Pump for Hypochlorite & Brine Feed

- (a) check if hypochlorite pump starts when the level in hypochlorite tank reaches its pre-determined operating level;
and
- (b) check if hypochlorite pump starts when the level in hypochlorite tank falls below its pre-determined cut-off level.

B4.14.7 Water Softener

- (a) check the shut down operation of the water softener when the required flow is not present for the pre-set period of the time delay flow switch; and
- (b) check the time based operation of the auto control valve in regenerating softener into the unit.

B4.14.8 Hypochlorite Storage Tank

- (a) check the operation of the high/low liquid level for the Hypochlorite Storage Tank;
- (b) check any impact damage for the tank and tank lid; and
- (c) check if the brine level assembly are in place and undamaged.

B4.14.9 Hydrogen Dilution Blower

- (a) check and start the air blower; and
- (b) check if hydrogen gas air vent connection to the atmosphere is proper.

B4.14.10 Chemical Cleaning System

- (a) check whether the cell is overfilled with acid cleaning solution;
- (b) check if the acid level is just covering the top of the electrodes;
and
- (c) check the shut down operation of the acid pump when the liquid level in the cell is low.

B4.14.11 Automatic pH & Chlorine Controller

- (a) ensure the proper calibration of the pH and ORP sensors; and
- (b) check pump start/stop operation when the pH level and free chlorine concentration fall within the pre-determined cut-in and cut-off levels.

SECTION B5

MIXED OXIDANT DISINFECTION SYSTEM

B5.1 GENERAL REQUIREMENT AND PRINCIPLE

- B5.1.1 The SP Contractor shall supply and install the mixed oxidant generation system. The principle of mixed oxidant disinfection takes the advantage of various oxidant species to overcome the shortcoming of a single oxidant.
- B5.1.2 The mixed oxidant shall be generated by electrolysis of NaCl and the solution shall be safe and contain chloro-oxygen species with disinfection efficiency in term of CT values less than 120. (CT value is the function of disinfection concentration x time, the lesser the better.)
- B5.1.3 The mixed oxidant generator shall have proven history of satisfactory application in swimming pools. The tenderer shall submit the job reference of the manufacturer for assessment with the tender.

B5.2 GENERATION SYSTEM

- B5.2.1 The mixed oxidant generation system shall include electrolytic cell capable of providing streams of mixed oxidant and control panel with automated control system and diagnostic system for fault indication.
- B5.2.2 The mixed oxidant generator shall also include twin tower (one duty one stand by with auto change-over) softener, brine generator tank suitable of receiving salt and providing brine solution, pressure switch, solenoid valve, pressure regulator, oxidant tank and associated piping & wiring.

B5.3 ELECTROLYTIC CELL

- B5.3.1 Mixed oxidant solution shall be generated by passing brine solution through an electrolytic cell. Flow control to cell shall be provided by solenoid valve.
- B5.3.2 The electrolytic cell shall be fully enclosed and constructed of plates composed of a suitable conductive metal with a catalytic coating contained within a plastic housing. The cell shall contain no membrane.
- B5.3.3 Brine shall be pumped to the electrolytic cell using a variable speed positive displacement gear pump. The material of construction for brine pump components in contact with brine shall be hastalloy for corrosion resistance. Mixed oxidant solution will be drawn from both anode and cathode side of the cell.

- B5.3.4 Prior to entry into the electrolytic cell, the saturated brine shall be diluted to the proper concentration for oxidant generation.
- B5.3.5 The mixed oxidants generated shall be stored in a holding tank and fed into the main water line by a venturi injection system or by metering pump system.

B5.4 MIXED OXIDANT SOLUTION

- B5.4.1 The mixed oxidant solution generated shall include various chloro-oxygen oxidant species (e.g. hypochlorous acid is one of the various constituent) with disinfection function CT value less than 120 or equivalent proven disinfection capability.
- B5.4.2 The mixed oxidant solution shall be safe and not classified as dangerous good under FSD regulations. Material safety data sheet must be provided for approval.

B5.5 CONTROLS

B5.5.1 General

- (a) The system control for the mixed oxidant generator shall automatically monitor system functions by means of a discrete logic controller and provide fault indications and electrical contacts for alarm system operation. A local control panel shall provide on, off & modulating control, change-over control, functions monitoring & status displays of the system components and generate alarm signals & displays. The control panel shall also have a display which monitor cell performance and indicate system operation and faults.
- (b) Amperage drawn by the cell shall be monitored by the discrete logic controller. In the event the amperage drawn by the cell falls outside acceptable operating limits, the logic controller shall cause the amperage drawn to return to within these limits.
- (c) Control voltage to operate the system will be provided by a transformer generating 24 V DC current.
- (d) Monitoring signal point and control points shall be provided to allow remote indication of fault condition and remote start/stop.

B5.5.2 Diagnostics

Where specified in the Particular Specification, when an alarm condition has been activated, or a fault has been detected in the system, a diagnostics routine shall be executed from the control to determine the conditions of each of the inputs to the system.

B5.5.3 Datalogging

Where specified in the Particular Specification, the logic controller shall include an on-board datalogging capability which supports 9600 baud streaming serial data. The datalogging captures key operating parameters shall include cell amperage, brine pump signal voltage, cell voltage, and other operational parameters including a date and time stamp. The purpose of this datalogging is to capture long-term operational data that can be useful in diagnosing long-term trends in system operation.

B5.5.4 Serial Data Port

Where specified in the Particular Specification, the controller shall have a serial data port that can transmit any data shown on the display as well as all fault indications and data not shown on the display.

B5.6 BRINE TANK

The capacity of brine tank shall be capable for 2 weeks operation. The tank shall be equipped with float valve for high and low level control. The material of brine tank shall be reinforced concrete or high density polyethylene material. Overflow port shall be located at the top of the tank.

B5.7 MIXED OXIDANT SOLUTION TANK

B5.7.1 The sized of mixed oxidant storage tank shall have the capacity of providing at least 4-hour consumption unless otherwise specified.

B5.7.2 The material of mixed oxidant solution tank shall be reinforced concrete or high density polyethylene material. The tank shall be equipped with liquid level switch for high and low level control.

B5.7.3 Supply for mixed oxidant to the tank shall enter at the top and be fed through a drop tube to the bottom. Supply tube inlet shall include a vent at the entrance to the tank for venting. UPVC piping shall be attached to the top of the tube for venting to the atmosphere outside the building. A solution level indication tube and tank drain shall be provided.

B5.8 SOFTENER

- B5.8.1 The softener shall be of automatic twin tower and self-backwash operation type. It shall provide continuous soft water and instantaneous switching of tanks. Check valve shall be provided to prevent backflow of water from the softener to the brine tank.
- B5.8.2 The water source shall be city main water. Other sources including pool circulating water shall not be used as water source. The feed water temperature shall be maintained between 10°C and 38°C.

B5.9 HYDROGEN BLOWER

- B5.9.1 The hydrogen blower shall be installed to force ventilate the solution tank, reducing the concentration of hydrogen gas in the tank and interlock with mixed oxidant generator.
- B5.9.2 A standby blower shall be installed in parallel to the duty blower, which shall be connected with a 'Y' piece to a common entry into the storage tank. Control valves to enable the choice of air transfer from either one of the blowers shall be facilitated.
- B5.9.3 The blower shall be of air-cooled explosive-proof type and the motor shall be of requisite size running at 1450 r.p.m. of the drip proof squirrel type totally enclosed.
- B5.9.4 Supply and fit range of PVC piping shall be complete with all necessary fittings between the air blower, filters and mixed oxidant tank, non-return valves and air inlet filters.
- B5.9.5 Automatic control shall be incorporated to shut the generator in the event of the failure of both blowers.
- B5.9.6 The blower shall at least remain operation for 15 minutes when the generator system is shut down.
- B5.9.7 The power supply cabling shall be of explosion-proof type.
- B5.9.8 Hydrogen gas detection system shall be provided in mixed oxidant generation room. The required performance of the hydrogen gas detector shall be as follows:-
- (a) Measurement Range : 0-100% of lower explosion limit of hydrogen (i.e. 4%) with initial alarm set to be 0.05% of hydrogen in air.
 - (b) Life Expectancy : 5 years
 - (c) Operating Temperature : -5°C to +40°C (±10%)

(d) Humidity : 0-99% RH

- B5.9.9 The air vent for the hydrogen gas shall be installed with the air flow sensor which would provide actuation for the standby blower via the control panel in case of the failure of the primary blower.
- B5.9.10 The automatic air vent shall incorporate with no built-in valve and the discharge pipe shall be run to the nearest agreed terminal with mesh outlet in accordance with the Architect's instruction.
- B5.9.11 The system completion shall be incorporated with explosive-proof type extraction fan and its accessories in accordance with FSD statutory requirement.

B5.10 OTHER REQUIREMENTS

- B5.10.1 The salt used for generating mixed oxidant solution shall be sodium chloride 99.5% pure coarse granular salt without additives or preservatives. Concentrations of calcium (Ca) shall be less than or equal to 0.03%, magnesium (Mg) be less than or equal to 0.02%, and manganese (Mn) be less than or equal to 0.005%.
- B5.10.2 The system control cabinet shall be incorporated with an earth leakage detector, which shall provide fail-safe protection for bathers, and system operators working on the equipment.

B5.11 TESTING AND COMMISSIONING

- B5.11.1 The SP Contractor shall commission and test the system in compliance with the manufacturer's recommendation.
- B5.11.2 The testing and commissioning procedure are to be submitted to the Architect at least 6 weeks prior to the commencement of commissioning and testing.
- B5.11.3 Provide all necessary tools, equipment and labour for testing and commissioning of the system.
- B5.11.4 Measurements such as production rate of mixed oxidant with average concentration shall be taken.

SECTION B6

ULTRA-VIOLET DISINFECTION SYSTEM

B6.1 GENERAL REQUIREMENT AND PRINCIPLE

- B6.1.1 The SP Contractor shall supply, and install the in-line type Ultraviolet Disinfection System (hereafter called "UV system") for use in disinfection and deozonisation, where applicable, of swimming pool water.
- B6.1.2 Ultra-violet (UV) is located in that part of the electromagnetic spectrum which extends beyond violet light, UV is invisible and kills micro-organism by destroying their DNA. In the wavelength region between 240 nm to 280 nm, UV is effective against bacteria, viruses, moulds and their spores. When swimming pool water is treated by an UV system capable of producing UV, the risk of transmission of stomach, skin and respiratory tract infections to bathers can be reduced. UV can also initiate photo-chemical and photo-oxidation reactions which destroys chloramines, a range of compounds responsible for unpleasant smells in swimming pools.
- B6.1.3 The UV system shall be capable of performing the above-mentioned requirements to suit the design swimming pool water turnover rate. UV wavelength shall cover spectrum 220 nm to 400 nm.
- B6.1.4 The UV system shall have proven history of satisfactory application in swimming pools.

B6.2 UV CHAMBER

- B6.2.1 The UV system shall consist of a UV disinfection chamber (hereafter called "UV chamber"); the chamber shall be a self-contained unit including the following:-
- (a) system control cabinet;
 - (b) flow and output safety control;
 - (c) an UV medium pressure arc tube capable of producing UV energy in wavelength from 220 nm to 400 nm;
 - (d) a quartz sleeve mounted axially to house the UV arc tube which permits replacement without interrupting the flow inside the UV chamber;
 - (e) an automatic, adjustable, electric motor driven quartz sleeve cleaning system; and

- (f) an UV dose control system for controlling the quantity of UV delivered to the swimming pool.
- B6.2.2 The UV chamber shall be capable to operate continuously under a pressure rating at 10 bar. The UV chamber shall be hydraulically factory tested at 15 bar prior to delivery.
- B6.2.3 Unless otherwise stated, all materials exposed to UV light and in contact with water shall be stainless steel grade 316. The wetted surfaces shall be chemically inactive with all welds grounded to minimize corrosion.
- B6.2.4 Unless otherwise stated, the UV chamber shall be incorporated with the following features:-
- (a) A temperature sensor shall be provided to turn off the UV arc tube automatically when there is inadequate water flow across the UV chamber.
 - (b) An UV intensity monitor shall be provided for monitoring the UV dosing level. The UV intensity monitor shall display real time UV lamp intensity on the system control cabinet in unit mW/cm^2 , and initiate an alarm when the preset UV dosing level for proper operation cannot be achieved.

The UV intensity monitor shall be wet probe type, wavelength specific to 240 nm - 280 nm and allow monitor probe to be cleaned by automatic wiper mechanism. Relative type UV intensity monitoring device or dry-probe type will not be accepted. The UV intensity monitor shall have been pre-calibrated against a traceable UV standard.
 - (c) UV chamber end plate where electrical cables accommodate shall be protected by a stainless steel cover. (Plastic cover or cap will not be accepted.)
 - (d) Water flow inside the UV chamber shall be laminar in order to provide maximum efficiency in the transfer of UV to the water. (Baffle plates or similar devices which create turbulent flow and dead spots inside the UV chamber will not be accepted.)
- B6.2.5 The connection of the inlet and outlet shall be flange type to PN 16 to BS EN 1092-1:2007, BS EN 1092-2:1997 or BS EN 1515-1:2000.

B6.3 AUTOMATIC CLEANING SYSTEM

- B6.3.1 The quartz sleeve and the UV sensor probe for the UV chamber shall be cleaned periodically by an automatic cleaning system. The SP Contractor shall submit the arrangement, operation principle and all the necessary technical details for the automatic cleaning system for approval by the Architect.
- B6.3.2 The automatic cleaning system shall travel the full length of the quartz sleeve twice per cleaning cycle.
- B6.3.3 The cleaning frequency shall be variable and nearly infinitely adjustable from 15 to 480 minutes to suit actual operational requirements.
- B6.3.4 The automatic wiper in its "parked" position shall not cover any portion of the arc tube that affects the efficiency of the UV lamp or create a "hot" spot on the arc tube.

B6.4 ULTRA-VIOLET LAMP

- B6.4.1 The UV lamp shall be of medium-pressure high intensity type capable of emitting a continuous UV spectrum from 220 nm to 400 nm into the water.
- B6.4.2 Each lamp shall be capable of producing an UV spectral output at 245 nm, 297 nm and both 260 nm and 336 nm for destroying monochloramine, dichloramine and trichloramine respectively. A manufacturer's spectral certificate to demonstrate the accuracy shall be submitted to the Architect for approval prior to delivery. Each lamp shall be individually identified by part number and serial number.
- B6.4.3 The power per unit length of the UV lamp should be limited to minimizing risk of quartz sleeve shattering due to solarization.
- B6.4.4 The SP Contractor shall provide warranty for the performance of the UV lamps. The rated life of the UV lamp shall be a minimum of 4,000 hours, including the case when intermittent on/off occurs within the same day.

B6.5 CONTROL AND MONITORING PROVISION

- B6.5.1 A system control panel shall be provided to provide on, off & modulating control, change-over control, and functions monitoring & status displays of the system components and to generate alarm signals & displays.
- B6.5.2 The system control panel shall be manufactured from stainless steel grade 316 and installed with cooling fan, louver and replaceable filter for ventilation purpose.

- B6.5.3 The system control panel shall be protected to IP 55. Provision shall be made to ensure that power supplies to the control circuitry will cut off automatically when the panel door is being opened.
- B6.5.4 All internal wirings inside the system control panel shall be properly harnessed and the UV arc tube shall be powered via a constant wattage transformer.
- B6.5.5 The system control panel shall be provided with a microprocessor driven control module offering:-
- (a) data logging of UV dosed, UV lamp operating hour, UV lamp intensity up to 12 months;
 - (b) a menu-driven interface;
 - (c) Local/Remote operation;
 - (d) digital display screen with real time display of performance parameters which shall include, but not be limited to the followings:-
 - power on;
 - UV intensity in either % or mW/cm^2 ;
 - UV dose in mJ/cm^2 ;
 - fluid flow rate inside the UV chamber in m^3/hr ;
 - UV arc tube ready; and
 - automatic wiper system status and alarm;
 - (e) membrane key pad for system configuration; and
 - (f) capability of downloading with RS232 interface.
- B6.5.6 The system control panel shall be incorporated with an earth leakage detector, which shall provide fail-safe protection for bathers, and system operators working on the equipment.

B6.6 TESTING AND COMMISSIONING

This procedure is intended to lay down the general testing and commissioning requirements to be carried out by the SP Contractor for the UV System prior to handing over the Installations to the Employer.

Apart from the recommended procedures as suggested from the product manufacturers and the Testing & Commissioning Procedures as published by ArchSD, the following additional inspection, testing and commissioning requirements shall be satisfied.

B6.6.1 General

- ensure the chamber is free from damage;
- check that the cabinet is located satisfactory with respect to operation and safety;
- remove all quartz ware and check for damage; and
- earth continuity checks on system components.

B6.6.2 UV Chamber

- with the system in operation, ensure that water passes through the chamber;
- check the water system for leaks;
- check that the water is flowing in the right direction;
- check that bleed valves are fitted correctly; and
- record voltage and current when UV lamp is at full power.

B6.6.3 Automatic Wiper System

- check that the wipe cycle programme is in accordance with the specified requirements;
- check that the limit switches are in the correct linear position;
- check that the limit switches are correctly wired;
- check that the motor is correctly wired;
- check that the wiper flap is the correct distance from the monitor probe tip;
- check that all safety guards are in place; and
- when in operation ensure all wiper features respond correctly.

B6.6.4 Control & Monitoring

- check that all interconnecting wiring is satisfactory;
- check that the temperature thermostat/sensor is correctly wired and positioned;
- check that system settings are correct; and
- carry out functional check on Control Cabinet and ensure it performs satisfactorily.

SECTION B7
CONTROL SYSTEM

B7.1 GENERAL

B7.1.1 Scope of Work

- (a) The scope of work shall include, but not be limited to the design, supply, delivery, Installations, testing & commissioning and maintenance during the Defects Liability Period of the control system including all the associated hardware, software, accessories, instrumentation and all the ancillary equipment & devices as specified in the Particular Specification and Drawings and as necessary for the satisfactory operation and maintenance of the swimming pool water circulation, filtration and disinfection plants and systems.
- (b) The SP Contractor shall supply, install and terminate the interconnecting wirings among various control panels, equipment, pumps, valves, meters, and devices installed under this Contract. Manual override to automatic control shall be provided on local control panels of all equipment and pumps, unless such is not desirable for reason of safe operation.
- (c) The control points under the control system shall include but not be limited to the points indicated in the Control Point Schedule in the Appendix to this Section of General Specification. Local control panels for disinfection equipment shall be as specified in Section B3 of this General Specification. The SP Contractor shall advise the Architect of any additional points that are needed to provide the desired functions as specified, and include these points in the Installations.

B7.1.2 Functions

- (a) The control system shall serve to enable the entire swimming pool water circulation, filtration and disinfection installations to function as specified in the Particular Specification, Drawings, and this General Specification unless otherwise indicated. The functions of each equipment, pump, valve, meter and device of the Installations shall include its start, stop, modulating operation wherever appropriate, and indications of start, stop and fault. The functions shall also include the sequenced start, stop and modulating operation of each equipment, pump, valve, meter and device whenever such sequence is required for the proper operation of the entire Installations; and the sequence shall, other than for a single equipment, pump, valve, meter, and device, include the

operation of all other equipment, pumps, valves, meters, devices affected by the operation of the said equipment, pump, valve, meter and device.

- (b) The SP Contractor shall be responsible for the design and determination of the exact numbers of I/O points for the control system to provide the operation & maintenance functions of the entire swimming pool installation. The functions will be indicated in the Particular Specification or shown on Drawings.
- (c) Control facilities shall be provided to maintain the required pool surface water levels through control of valves and pumps.
- (d) The SP Contractor shall allow 20% additional I/O points and wiring to facilitate the I/O in the control system for future extension.

B7.1.3 Operation Voltage

The control system shall be operated on single-phase mains voltage or on extra low voltage such as 12 V or 24 V. Where a particular manufacturer's system is offered and accepted, the Installations shall be installed to comply with that manufacturer's recommended technical details and methods of Installations.

B7.1.4 Sensors and Controllers

- (a) The sensors shall be placed in transparent chambers, one chamber for each sensor, at various locations as shown on the Drawings and the flow rate shall be adjusted to meet with manufacturer's recommendation. For chamber installed on the return water pipe and sampling lines, y-type strainer shall be provided. The sensors shall detect and sense the return water of the pools in the sampling lines, in return water, after mixing chambers, after reaction tanks and before discharge to pool. Allow for all necessary equipment, piping and accessories to provide the control and indication functions including running of pipes and/or wiring to the sensors.
- (b) All indication on controller shall be of LED type. Dial reading gauge is not acceptable. Measurement of chlorine and ozone level shall be made by redox potential philosophy or chemical means. Sensors shall be able to measure the chemical concentration as ppm. Running life of all sensors shall be of at least 1 year with no maintenance.
- (c) Indicator meters for pool water quality shall be suitable for analogue input.

- (d) The pH sensors and controllers shall be set at settings specified in this specification, with measurable range adjustable from 2-12. The residual free chlorine sensors and controllers shall be set at settings specified in this specification, with measurable range adjustable from 0.0-10.0 ppm, 0.0-5.0 ppm and 0.0-2.0 ppm with selection. The ozone sensors and controllers shall be able to be set at 0.4 ppm after reaction tank and 0.1 ppm before discharge to pool with measurable range adjustable from 0.0-3.0 ppm. All sensors and indication on controllers shall be able to give measurement down to 2 places after decimal point i.e. 0.01.
- (e) Extra output signals shall be provided to transmit the temperature signals and chemical levels such as residual chlorine and ozone concentration and pH value to the supervisory control panel if such panel is specified.
- (f) Sensors shall also be included to measure ozone concentration in gas after ozone generator.
- (g) Elements sensing liquid temperature in pipework shall be:-
- i) provided with means for withdrawal for calibration, servicing, etc., without the need for draining the system;
 - ii) positioned so that the active part of the element is wholly within the liquid;
 - iii) positioned so that the element is not less than 10 pipe diameters downstream from a point of mixing, unless otherwise recommended by the manufacturer;
 - iv) positioned so that sufficient length of flexible conduit can be allowed to permit complete withdrawal of the element; and
 - v) positioned downstream from the valve, after the pumps, for the control of mixed flow temperature using mixing valves.
- (h) Elements sensing liquid flow in pipework shall be positioned so that:-
- i) the element is mounted in a section of pipe where there is a straight run of at least 5 diameters on each side of the flow switch;
 - ii) the element is mounted so that the terminals or wire leads are easily accessible for wiring; and
 - iii) the element must not be subjected to water hammering. If a fast-closing valve is located downstream of the element, a suitable water hammer arrester must be used.

- (i) Sensing elements shall in all cases be installed in accordance with the manufacturer's latest recommendations and instructions.
- (j) For sensors exposed to view, the precise location shall be approved by the Architect.
- (k) All sensors shall be arranged to give convenient access for servicing.
- (l) Suitable support and easy access facilities shall be equipped for all sensors, monitoring and measuring equipment. Suitable protection guard against damage shall be provided for equipment exposed to public contact. Temperature setting scales shall be clearly marked in °C.

B7.1.5 Control Panels

- (a) Pump control panels shall be provided beside the group of pumps, for start & stop control and indication of fault. Push buttons shall be provided for start & stop, and LED lamps shall be provided for indications.
- (b) Panels to house the controllers for monitoring the water quality, alarms for detection of gas leakage, and control accessories for controlling of pool water level controls shall be provided. The panel material shall be stainless steel to Grade 316.

B7.2 LEVELS OF CONTROL

There are 3 different levels of control, and the level to be adopted shall be as specified in the Particular Specification. The 3 levels of control are as follows:-

Level 1- Basically manual control;
Level 2- Centralized control; and
Level 3- Computer assisted centralized control.

B7.2.1 Basically Manual Control

- (a) All swimming pool water circulation, filtration and disinfection equipment shall be complete with local control panels for manual start/stop and control. The electrical and, if applicable mechanical, interlocks for maintaining the required sequence of operation of all the equipment, pumps, valves and devices shall be facilitated for proper starting, stopping, controlling, safety-alarming of pool water circulation, filtration, disinfection and heating (if heating is specified) in accordance to the pool performance requirements specified in the Particular Specification and the requirements for relevant equipment, valves and devices stipulated in this General Specification.
- (b) Start & stop of equipment and pumps shall be facilitated on the corresponding local control panels. Push buttons shall be used, unless other means are required as recommended by the manufacturer or necessitated due to operational or safety needs. Electrical interlocks to ensure smooth start-up, stop and safe operation shall be provided.
- (c) Remote fault indications shall be provided for all equipment, including disinfection systems and pumps. Remote fault indications shall be provided for all faults and alarms, as indicated in the Control Point Schedule in the Appendix. The remote fault indications shall be at designated locations approved by the Architect. A panel shall be provided to house the indications. The panel shall be of stainless steel construction of 1.6 mm thick with side hinged opening with key lock. The SP Contractor shall co-ordinate with other relevant parties on detail arrangement to make a neat and tidy Installations to the Architect's approval. Details of the layout and construction of the panel shall be submitted to the Architect for approval prior to fabrication and Installations. Buzzer alarms and visual indications shall be provided. Buzzer alarm for a fault shall be able to be muted by silencing switches while the visual indication remains on until the fault signals are rectified and the system is reset.

B7.2.2 Centralized Control

- (a) Level 2 control includes the manual controls in Level 1 and a central supervisory control. Wherever so indicated in the Particular Specification or Drawings, the SP Contractor shall supply and install a supervisory control panel in a designated location. The supervisory control panel, which incorporates the functions of the panel to house fault indications stipulated in B7.2.1, shall be able to fully communicate with the local control panels for individual equipment. The supervisory control panel shall have all major indications, controls, and alarm functions. The supervisory control panel shall house all visual and audible indications and controls for the proper

functioning of the pool circulation, filtration and disinfection systems, controllers for monitoring the water quality, and alarm system for detection of gas leakage. Electrical interlocks to ensure smooth start-up, stop and safe operation shall be provided.

- (b) The centralized control shall involve an automatic control system (ACS), which controls and monitors the proper, effective and efficient operation of the pool water circulation, filtration and disinfection equipment & devices. The ACS shall also control and monitor the operation of the heating equipment and associated pumps & accessories. The ACS shall incorporate the I/O provisions and functions indicated in the Control Point Schedule in the Appendix.
 - i) The ACS shall comprise of an electronic programmable logic controller (PLC) with built-in real time clock for scheduling. The PLC controller shall be located inside the supervisory control panel. The appropriate ACS shall be so designed to meet the requirements and operational needs of pool operation & management. The ACS shall have adequate capacity for scheduling all the operation needs per the Particular Specification.
 - ii) The main function of the ACS is for on/off controls, monitoring of operation status and alarms generation of the water circulation, filtration and disinfection equipment & devices. Comprehensive system controls and monitoring functions of individual equipment shall be carried out by the system controller of individual equipment. The ACS shall be so designed to achieve a reliable control in performing the control and monitoring functions set in the design criteria and shall be of micro-processor based electronic or direct digital control type.
 - iii) All pool equipment and devices specified shall be able to be turned on and off in accordance with the time schedules pre-set in the built-in program of the ACS including any holiday and special schedules so required by the users. A monitoring and alarm system shall be incorporated in the PLC in giving audio and visual status and alarm of faults for each equipment and device.

- (c) The controllers serving different equipment shall be able to fully communicate with each other via the ACS to provide the functions as specified for the entire swimming pool Installations. The ACS shall be able to perform, but not be limited to, the following functions:-
- high speed logic control;
 - full capability to handle PID loops as well as other control logic;
 - real time multi-tasking and multi-programming functions;
 - safety interlocking;
 - analog alarm function;
 - powerful floating-point calculation functions;
 - connection to industrial Ethernet (redundant network);
 - redundant I/O channel medium;
 - full set electrical I/O modules, analog I/O modules and relative intelligent modules;
 - clock instructions;
 - analogue I/O shall support 4-20 mA;
 - expandable to accept spare I/O; and
 - operated from a voltage source of 220 V AC 50 Hz with sufficient output to support the requirement of the PLC plus the specified spare capacity.
- (d) For easy programming, user-friendly I/O devices shall be provided for the setting and re-setting of the pool water quality and pool operation schedules.
- (e) To prevent malfunctioning of the real time clock and losing of memory, 7-day back-up battery with power healthy indicator and alarm shall be provided.
- (f) Indicators of pool water quality including pH level and free chlorine level shall be provided.
- (g) The supervisory control panel shall be of stainless steel construction of 1.6 mm thick with side hinged opening with key lock. The SP Contractor shall co-ordinate with other relevant parties on detail arrangement to make a neat and tidy Installations to the Architect's approval. Buzzer alarms and visual indications shall be provided. Buzzer alarm for faults shall be able to be muted by silencing switches while the visual indication remains on until the fault signals are rectified and the system is reset. A mimic diagram with the entire system pool and piping schematic shall be engraved on the panel. Graphic of all pools, main piping, equipment, pumps, main valves, flow meters, enthalpy meters, thermometers, pool water quality indicators shall be shown on the mimic. LED lamps showing ON, OFF, malfunction, alarm, etc. for all equipment, pumps, motorized valves shall be provided on the mimic. Indication of duty/standby for relevant equipment and pumps shall be provided. Details of the layout and

construction of the panel shall be submitted to the Architect for approval prior to fabrication and installation.

- (h) Unregulated power supplies shall be filtered. Shielded cable shall be used when it is necessary to install DC signal leads in the same control wiring conduit.
- (i) The SP Contractor shall submit to the Architect for approval the detailed design of the control system before ordering and fabrication.

B7.2.3 Computer Assisted Centralized Control

Level 3 control includes the Level 2 controls and ACS, with the man-machine interface of the supervisory control panel carried out by a personal computer with LCD screen, keyboard and printer. Central interface with the control system shall be via the keyboard and graphic buttons or scales on computer graphics. On-screen graphics of system schematics shall be provided, including all pools, main piping, equipment, pumps, main valves, flow meters, enthalpy meters, thermometers, pool water quality indicators, etc. ON, OFF, malfunction, alarm, duty/standby status, equipment healthy status, power supply healthy status, etc. for all equipment, pumps, motorized valves, etc. shall be provided.

The computer configuration shall be as specified in the control section of the AC_GS.

Appendix to Sub-section B7 - Control Point Schedule

description	analogue input (AI)		digital input (DI)		Analogue output (AO)		digital output (DO)		purpose	sensing/control device	equipment/device being controlled
	points	Mode & Remark	points	Mode & Remark	Points	Mode & Remark	points	Mode & Remark			
pool level			2				2		monitor & control water level	level sensor	nil
make up water			2				2		monitor & control make up water	level sensor	nil
valves for pool level and make up water			2				2	from pool water level and make up water	monitor & control make up water	nil	valves, depending on design
Surge/balance tank water level			4	hi, mid, low levels, overflow			2		control motorized valves and other controls	level sensors	valves, depending on design
strainers status			1	dirty			1 *	* only for auto-backwash	monitor block/clean status	differential pressure sensor	backwash if auto strainer
main circulation pump			3	on/off fault status			2	ON/OFF control	monitor & control pump on/off/fault	contactors/relays	pump
pump flow switch			2	Standby / duty pump operation					monitor and control pump	flow switch	nil
flocculation			1	if turbidity meter used					flocculation	turbidity meter	injection pump
alum tank level			1	low level alarm					monitor alum level	level sensor	injection pump
alum dosing pump			3	On / off/ fault status			1	stops alum dosing pump when low level or water is not turbid	on/off control dosing pump	contactors/relays	injection pump
backwash sand filter			1	differential pressure across sand filter			no. of points depending on valves quantity	open/close respective valves with timer	open/close respective valves for backwash	differential pressure sensor	valves and air compressor
compressor for back wash			3	on/off/fault status			1	start/stop compressor with timer	control compressor for back washing	contactors/relays	on/off compressor
ozone booster pump			3	on/off/fault status			1	booster pump can operate only if main pump is running	monitor & control pump	contactors/relays	booster pump
Ozone generator	3	O ₃ quantity; no. of generators in operation; cooling air/water temperature condition, etc.	5	on/off/fault; cooling air/water temperature too high; no suction; air dew point temperature too high, etc.	1	control O ₃ output	1	on/off control, and shut-off generator in case of O ₃ leakage	monitor & control O ₃ generator status and control O ₃ output	ORP controller (mV); other status by contactors/relays	ozone generator

description	analogue input (AI)		digital input (DI)		Analogue output (AO)		digital output (DO)		purpose	sensing/control device	equipment/device being controlled
	points	Mode & Remark	points	Mode & Remark	Points	Mode & Remark	points	Mode & Remark			
oxidizing redox potential meter (ORP)	1	measure ions in water							monitor oxidizing level (mV) for O ₃ concentration indication	ORP controller	Ozone generator
ozone monitor			1	detect any ozone in water			2	stop main pump & O ₃ generator and sound alarm	monitor ozone level in water	ozone monitor	pump & O ₃ generator
flow meter	1	measure water flowrate in main pipe							measure water flowrate in main pipe	flow meter	nil
calorifier for pool heating	2	measure inlet and outlet temperature							monitor I/O temperatures and energy calculation	temperature sensors	heat source equipment
flow meter for heating	1	measure flow rate for pool heating purpose							energy calculation	flow meter	nil
heat source equipment					1	to moderate heat source equipment	1	ON/OFF signal to heat source equipment	control and moderating heat source equipment	moderating device in heating source equipment	nil
pH and residual chlorine measurement	2	pH and residual Cl level							monitor & control pH & residual Cl	pH/Cl controller	NaOCl, HCl or NaOH dosing pumps with timer-set alarm
salt water level in brine saturator			1	DI for low level of salt water level					monitor salt water level	level sensor	electrochlorinator and brine pump, with timer-set alarm
water softener			2	ON/OFF status if available					monitor water softener operation	contactors/relays	nil
brine pump			2	ON/OFF status			1	cut off pump in case of low salt water level; when NaOCl tank is full	monitor & control brine pump	contactors/relays	brine pump
Electro-chlorinator			3	ON/OFF; fault status			1	cut off electrochlorinator in case of brine pump stop; when H ₂ content >1%	monitor NaOCl system operation on/off/fault	contactors/relays	electrochlorinator and brine pump
NaOCl dosing pump			3	ON/OFF; Fault status			1	cut pump in case of tank low level; when residual Cl reach its preset value.	on/off control dosing pump	contactors/relays	NaOCl dosing pump
HCL level			1	Low level alarm					monitor HCL level	level sensor	nil

description	analogue input (AI)		digital input (DI)		Analogue output (AO)		digital output (DO)		purpose	sensing/control device	equipment/device being controlled
	points	Mode & Remark	points	Mode & Remark	Points	Mode & Remark	points	Mode & Remark			
HCl dosing pump			3	ON/OFF; Fault status			1	cut pump in case of tank low level; when pH reaches its preset value.	on/off control dosing pump	contactors/relays	dosing pump
NaOH level			1	Low level alarm					monitor NaOH level	level sensor	nil
NaOH dosing pump			3	ON/OFF; Fault status			1	stop pump when NaOH level low; when pH reaches its preset value	on/off control dosing pump	contactors/relays	dosing pump
ozone leakage detector			3	3 levels leakage alarm depend on manufacturer product. To cut ozonator when leaking					monitor plant room if any ozone leakage	O ₃ leakage detector	stops O ₃ generator and sounds alarm
hydrogen detector			1	give alarm when H ₂ level >1%; to cut electro chlorinator					monitor NaOCl tank room if H ₂ present >1%	H ₂ detector	stops electrochlorine generator and sounds alarm
pool water temperature	1	measure pool water temperature							modulate heating plant output	temperature sensor	heat source equipment
hydrogen blower			2	Operating / stop					monitor blower on/off & control el-plant	differential pressure switch	electrochlorinator
NaOCl tank level			3	high level to cut off brine pump; low level to give alarm; further low level to cut dosing pump					monitor level & control electrochlorinator & dosing pump	level sensors	electrochlorinator and dosing pump
backwash carbon tank			1	DI for differential pressure across carbon filter					open/close respective valves	differential pressure Switch	valves on/off
pump for footbath			3	ON / OFF / fault status			1	stop pump when main pump off	footbath shower curtain	contactors/relays	pump

SECTION B8

ANCILLARY INSTALLATIONS

B8.1 UNDERWATER LIGHTING INSTALLATION

- B8.1.1 Underwater lighting system shall comprise water proof and vandal proof light fittings, submersible cables, watertight junction boxes with neoprene gaskets, steel conduit and accessories, PVC cables, isolation transformers, RCCB, etc. as indicated on the Drawings and in compliance with BS 7671:2008+A2:2013.
- B8.1.2 The submersible light fittings shall be made of cast bronze or equivalent and complete with 12 V/24 V lamp bulbs. It shall be of IP 68, BS EN 60529:1992 and suitable for operation at the water depth as indicated on the Drawings. Light fittings shall be installed tilting upward at an angle about 10° to the vertical. The whole light fitting shall be easily demountable in water for bringing up the fitting to deck surface for lamp replacement. A flexible water tight conduit shall be provided connecting the light fitting with power supply system.
- B8.1.3 The colour lens or fittings shall be made of cast tempered glass, convex and heat resistance. The lens shall be mounted on neoprene gaskets. The whole frame of the light fitting shall be smooth with no sharp corner. It shall be installed in recessed position. The whole light fitting shall also be easily demountable in water for bringing up the fitting to deck surface for lamp replacement.
- B8.1.4 The isolation transformers shall be double wound, single phase, rated at appropriate kVA and housed in a metal enclosure outside pool areas. Tapping shall be provided on the secondary winding to give the suitable voltage ratios for supply of 12 V/24 V system. The primary winding and the secondary winding shall be so constructed that there is no possibility of any connection between the windings. The transformers shall be tested to BS EN 60076-1:2011, BS EN 60076-2:2011, BS EN 60076-3:2001, BS EN 60076-5:2006 and BS IEC 60076-8:1997 where applicable by a recognised independent body.
- B8.1.5 The secondary winding and the circuits connected to it shall not be connected to earth. Separate insulated earthing wire from each lighting fitting shall be brought back to the residual current devices or RCCB. In case of any short circuit fault, the RCCB shall operate to trip the supply.

A 24-hour programmed timer switch shall be provided and serve to control the "ON" and "OFF" operation of the underwater lighting system. Also, an overriding facility shall be provided.

B8.2 WATER TESTING EQUIPMENT

- B8.2.1 Water testing equipment shall be able to determine the chlorine residual and pH value of the pool water. The equipment shall be of portable type and suitable for field testing.
- B8.2.2 For residual free chlorine testing, plain Diethyl-p-phenylenediamine tablets and colour disc shall be provided. For pH value testing, phenol red solution and colour disc covering range of 6.8 - 8.4 shall be provided. The equipment shall be contained in a robust portable case suitable for carrying out field tests. At least 2 sets of testing equipment shall be provided.

B8.3 PORTABLE POOL CLEANING EQUIPMENT

The cleaner shall be completely self-contained, with chassis & casing, removable filter, self-contained removable bag, pump & motor, mechanical drive system, control system, vacuum head, power cord, hand-held control box, etc. and operate without the need for piping connection.

The cleaner shall be of submersible type that can clean the bottom of pool without draining of any pool water, and perform cleaning by sucking up dirt and debris while roving both the bottoms and walls. It shall be fully automatic with driving wheels, and able to run in straight and parallel paths and in free-form-shape pool. It shall have the ability to avoid being caught when meeting obstacles, through the provisions and profiles of its wings, flaps & shoes, and operate quietly with constant and balanced water flow. The cleaner shall be complete with a cart for free moving between storage and pool. All materials of the cleaner shall be resistant to swimming pool water.

The removable filter shall be of cartridge type with porosity not greater than 20 microns, which could be cleaned with an ordinary hose. The pump motor shall operate on 220 V AC, 50 Hz, and the length of power supply cord shall be 31 m minimum. The SP Contractor shall advise the Architect the type of power socket for connection before ordering. The cleaner shall be complete with a wireless remote control system such that it can move around in the pool by operating a hand-held control box.

B8.4 ELECTRICAL INSTALLATIONS

B8.4.1 General

- (a) Unless otherwise specified, the SP Contractor shall provide and install all low voltage electrical equipment necessary for the complete installation under the Contract and shall carry out all necessary wiring from the points of power supply provided by others as indicated on the Drawings.
- (b) All electrical work shall be carried out by registered electrical workers. Submit Work Completion Certificate in compliance with the Electricity Ordinance, Laws of Hong Kong.

- (c) The SP Contractor shall be responsible for the accuracy of all installation and shop drawings and wiring diagram and for the correct internal wiring of all pre-wired equipment supplied under the Contract.
- (d) Unless otherwise specified, all electrical equipment, wiring and installation work shall comply with the relevant parts of the EE_GS, Code of Practice for the Electricity (Wiring) Regulations issued by EMSD, BS 7671:2008+A2:2013, the Supply Rules of the electricity supply authority, and the respective recommended installation practices and standards of the equipment manufacturers. The Installations shall be to the satisfaction of the Architect.
- (e) The supply voltage shall be 380 V three phase or 220 V single phase, 50 Hz, unless otherwise specified.
- (f) The Clauses in this Section related with control and metering shall be read in conjunction with the relevant parts of this Specification on control and metering.

B8.4.2 Cable Termination

The SP Contractor shall be responsible for the final termination of the power cables for main supply to the motor control cubicle and for liaison with other relevant parties on sequence of works and programme. All electrical Installations for equipment provided by the SP Contractor, commencing from the motor control cubicle, shall be supplied and installed by the SP Contractor, including cabling, switches, wiring, earth bonding, etc.

B8.4.3 Equipment Sizing

All equipment and installations shall be sized with continuous ratings at the designed duties with minimum acceptable temperature rise.

B8.4.4 Wiring in Conduit/Trunking

The electrical wiring shall be installed in trunking and conduit system and all conduits shall be concealed. Whenever possible, all wiring shall be grouped and laced together in a neat and tidy manner. Surface conduits/trunkings are acceptable only in plant rooms. All conduits for dangerous good stores, sodium mixed oxidant generation and storage rooms, ozone generator room and hydrochloric acid shall be concealed and shall be of galvanised steel metal conduits. Power and Control wiring shall be in separate conduits. All electrical Installations in rooms classified as Dangerous Goods Store shall comply with FSD requirements, whether shown on the Drawings or not.

B8.4.5 Conduit

Both surface and concealed conduit system shall be galvanized steel conduits as specified in EE_GS. Submit conduit run drawings for the electrical and control work to the Architect for approval before installation. All concealed conduit work shall be done in good time prior to concreting work in the corresponding area, and tie up with the overall programme. Check the building programme and ensure that all concealed conduit are installed prior to concreting.

B8.4.6 Circuit Identification

For control and auxiliary circuit wiring in particular, different colours shall be provided to distinguish the various circuits. In any circumstances, all wires shall have at both ends a coded ferrule permanently marked with suitable characters and codes for identification purpose. Each connection shall terminate at an approved type of terminal block, which shall also be suitably labelled.

B8.4.7 Wiring to Moving Parts

Wiring from the fixed part of the circuits within control panels, starter panels, etc. to the movable parts, such as hinged front plates of the panels, shall be grouped together in a proper manner and be enclosed in flexible PVC tubing strong enough for mechanical protection, and yet flexible enough that the hinged plates can be opened and closed with ease. The wiring from the fixed part to the movable part shall also be long enough to allow the hinged front covers to swing through at least 180 degrees from their normally closed positions.

B8.4.8 Earthing

The SP Contractor shall provide proper earthing for exposed conductive parts of all his equipment and equipotential bonding for all extraneous conductive parts thereof, as described in the EE_GS, the Code of Practice for the Electricity (Wiring) Regulations and so called for by the as BS 7671:2008+A2:2013, to the main earthing system of the electrical system. All metal parts of equipment provided by the SP Contractor within the swimming pool zone have to be bonded to the pool earthing grid system. All bonding wires shall be supplied and installed by the SP Contractor for connection to earth termination points near the equipment or within the zone to be bonded. Allow for and co-ordinate on exact location of termination points.

B8.4.9 Conductive Moving Parts

All conductive moving parts such as hinged front doors of panels, battery and charger cabinets, etc. shall be properly and sufficiently earthed by suitably sized flexible insulated cables to the fixed conductive parts of the panels which are in turn electrically earthed as necessary.

B8.4.10 Electrical Motor

- (a) Maintenance Access and Safety
- i) Adequate access to the motors and their associated facilities shall be allowed such that the necessary periodical testing, cleaning and maintenance can be carried out. The motors shall not be installed in a position where surrounding plant or building work may obstruct in meeting such requirements.
 - ii) Each electric motor, electric air heater battery or other electrical device which is controlled from the main control panel and is so situated that the panel is at a distance and/or out of sight from the equipment. shall be provided with a local "stop-lock" control circuit switch (where there is a separate control circuit), plus a local main power supply circuit isolator in all such cases.
- (b) Exception for armoured cables, all other cables appearing above floor level shall be enclosed in approved trunking, solid or flexible conduit, with approved provision for movement of the motor. The terminal boxes for cable connection shall be suitably arranged to make a neat joint with the conduits or cables.
- (c) The anti-condensation heater shall be controlled such that the heater shall be de-energised when the starter is switched on and vice versa. Heaters shall be wired from the motor control panel.
- (d) Pulleys shall be correctly aligned and any holding down bolts or fixings shall be positioned to ensure correct alignment.
- (e) Slide rails shall be provided for all motors driving through belts. Purpose-made adjusting devices shall be provided to adjust the belt tension and to secure the motors.
- (f) The protective guards shall be rigidly constructed. It shall not be possible to remove any guard without the aid of a tool.
- (g) Motor arranged for automatic restart shall have a label of durable material permanently fixed to it and in a prominent position clearly inscribed with the legend:-

DANGER : THIS MOTOR IS AUTOMATICALLY CONTROLLED AND MAY START WITHOUT WARNING. ISOLATE BEFORE INSPECTION.

A Chinese translation of the above shall also be provided on the same label.

B8.4.11 Low Voltage Motor Switchgear, Starter and Control Panel

(a) General

Motor switchgear, starters and controls shall be supplied and installed to perform the operation and control of the swimming pool circulation, filtration and disinfection equipment to be provided. The starters and controls shall be housed in wall-mounted local motor control panels, or floor-standing motor control switchboard as required. The control panels or switchboard shall incorporate all control devices, timers, accessories and wiring necessary for proper operation.

(b) Local Motor Control Panel

The local motor control panel shall be of wall-mounted type, unless otherwise specified, to house the motor starter and switchgear.

(c) Motor Control Switchboard

i) The motor control switchboard (hereafter called the "Switchboard") shall be a free-standing floor-mounted low voltage switchboard to group centrally the motor starters, controls and switchgear for the swimming pool circulation, filtration and disinfection equipment, etc.

ii) The switchboard shall be installed on a raised concrete "housekeeping" base provided by others. Precautions shall be taken to prevent damage or deterioration of panels during transit and to afford physical protection on site prior to final acceptance.

iii) Unless otherwise specified in this Specification or the Particular Specification, the Switchboard shall comply with the requirements as stipulated in the EE_GS.

iv) Automatic power factor correction capacitor

The capacitor bank shall be wall or floor mounting cubicle-type, built up from static primary capacitor unit. The capacitor bank together with its associated equipment shall not be installed inside the switchboard, where practicable. However, if it is not practical due to physical constraint or other justified reasons, the equipment shall be installed in a separate compartment segregated from the rest of the switchboard.

B8.4.12 High Voltage Installation

All the high voltage electrical installation work shall be carried out by a Registered Electrical Contractor and Worker for Grade H electrical work as required by the Electricity Ordinance, (Cap. 406). After the completion of the electrical installation works, it shall be inspected, tested and certified by a Registered Electrical Worker to confirm that the requirements of the Electricity (Wiring) Regulations have been met. The Registered Electrical Worker and Contractor shall sign the Work Completion Certificate for the individual high voltage electrical installation and submit to the Architect before the electrical installation is energised.

B8.5 COMPRESSED AIR SUPPLY AND BACKWASHING SYSTEM

- B8.5.1 The compressors shall be air-cooled rotary air compressor with pressure lubrication system and direct couple motor. The compressor shall provide compressed air for scouring the filter beds of sand filter prior to backwashing. The compressor shall deliver sufficient quantity of oil free compressed air scouring 1 filter bed at a time in each system. Number of compressors shall be as shown on the Drawings or Equipment Schedule. The compressor shall be fitted with delivery air pressure gauge, oil pressure gauge, suction filter and silencer, air-oil separator, oil heater and ancillary control accessories. The compressor motor shall be selected for non-overloading characteristic. The compressor shall be designed for quiet operation and if noise level exceeds the EPD's requirements, an acoustic enclosure shall be provided for housing each compressor.
- B8.5.2 The air compressor for the sand filter tank shall be sized to give 50 m/h per unit filter area of air flow through filter during backwashing of each filter.
- B8.5.3 The compressed air supply and backwashing system shall comprise of 2 air compressors, one duty and one standby. All interconnecting pipeworks and fittings, valves including commissioning valves, shut-off valves, flow switches, flexible connections, etc. to all filters, controls and interlocks, required for proper backwashing as specified shall be provided no matter shown on Drawings or not.
- B8.5.4 The SP Contractor shall be responsible for the supply and install of the backwashing system with necessary valves and drains to meet the system requirements. The backwash operation of the sand filter shall be designed for both manual and automatic operation. The Installations shall allow for the filter backwashing activity to be carried out while the swimming pool water treatment system is in operation, i.e. one filter shall be put out of operation in the system. The carbon filter shall not be backwashed by ozone-containing water. A by-pass pipe from the sand filter discharge shall be provided for backwashing of carbon filter.

- B8.5.5 Backwashing water velocity of sand filter shall be in accordance with manufacturer's recommendation according to sand grain size and depth. The water velocity chosen shall be effective in cleaning the filter in duration of 7 minutes for sand filter excluding the air scouring time.
- B8.5.6 The air pressure safety valve on the air compressor shall be safety checked and sealed by a competent person. Certificate shall be issued by the competent person certifying that the operation of the safety valve are checked and sealed properly.
- B8.5.7 Motor, coupling and compressor shall be mounted on a common base plate supported on vibration isolation mountings.
- B8.5.8 The SP Contractor shall provide a local control panel adjacent to the air compressor such that the plant attendant can manually perform the air scouring operation. All control buttons shall be operated on 12 V/24 V DC.

B8.6 LIFTING FACILITIES

- B8.6.1 The SP Contractor shall check and ensure that all the equipment in the filtration plant rooms are well arranged and can be easily accessed for maintenance and operation.
- B8.6.2 If there is any equipment that cannot be easily removed for maintenance, the SP Contractor shall propose eyebolts, lifting I-beams, chain hoists, access openings and other lifting facilities for use during servicing and maintenance of the installed equipment for approval by the Architect, as builder's works requirements will be carried out in the Building Part of this Contract. The SP Contractor shall allow for sufficient maintenance lifting facilities in the builder's works requirements for proper servicing and maintenance of all equipment on Drawings so that they can be incorporated in the Building Part of this Contract at early stage of project. The SP Contractor shall be responsible to carry out and bear all cost for the provision of access openings, maintenance and lifting facilities if additional numbers of them are found required during acceptance of the installation by the Architect.
- B8.6.3 The SP Contractor shall supply and install electric driven lifting chain hoists for handling of salt bags for the sodium hypochlorite generation system and the mixed oxidant generation system.
- B8.6.4 The SP Contractor shall supply and install electric driven lifting chain hoists for handling of large pump motors.
- B8.6.5 The SP Contractor shall supply and install electric driven lifting facilities to lift and transfer the automatic swimming pool cleaner from storage to pool and vice versa should it be over a certain weight beyond a single operator's lifting capability.

- B8.6.6 The lifting height of the hoists shall suit the site condition, loading limit of I-beams and eyebolts and weight of the equipment/chemicals. They will provide normal operating purpose such as maintenance, delivery and relocation of materials and equipment. I-beams and eyebolts will be provided in the Building Part of this Contract.
- B8.6.7 The SP Contractor shall select and order chain hoists that can be mounted on the I-beam installed. Details of hoists shall be submitted to Architect for approval before ordering.
- B8.6.8 The load chain shall be of malleable quality, electrically welded, pitched and of calibrated steel complying with BS EN 818-1:1996+A1:2008 and BS EN 818-7:2002+A1:2008 and proof tested to twice the safe working load specified for the hoist. Test certificate shall be submitted to the Architect.
- B8.6.9 The hooks shall comply fully with BS EN 1677-5:2001+A1:2008. They shall be able to rotate upon ball or roller bearings for ease of swivelling, and provided with a catch to prevent displacement of wire rope from the hook.
- B8.6.10 All moving parts of the hoist shall be greased or oiled by the SP Contractor after installation. Ball or roller bearings shall be packed with appropriate grease to the approval of the Architect.
- B8.6.11 The SP Contractor shall ensure that the construction of the stoppers of the I-beams is suitable to stop the trolley motion outside the working range.
- B8.6.12 The SP Contractor shall arrange a qualified surveyor to carry out the formal test under load conditions. The hoist shall be tested to a proof load of at least 125% of safe working load on site in the presence of the Architect or his representative.
- B8.6.13 All the lifting requirements and access openings shall be submitted as builder's work drawings to be approved by the Architect.

B8.7 SUPPORTING CHEMICAL TREATMENT

- B8.7.1 Chemical treatment, other than disinfection purpose, of the pool water shall comprise of dosing of aluminium sulphate (alum) to the raw water to form floc and dosing of hydrochloric acid (HCL) solution to correct alkalinity imparted to water by disinfectants and soda ash (NaOH) to correct the acidity. Centralised preparation and storage tanks shall be provided which shall be designed with a capacity to store for 16 to 24 hours of continuous operation for at least 4 days.
- B8.7.2 Each chemical dosing system shall have 2 tanks, each can be operated independently while the other is in service. Both tanks are connected and would be used together under normal situation.

- B8.7.3 The chemical tanks of dosing systems shall be used as combined preparation and storage type and shall be made from reinforced fibreglass or high-density polyethylene, or equal and approved. Each tank shall be complete with outlets, valves, overflows to drains and accessories. Level indication such as level glass tube shall also be provided for all tanks. For alum dosing system, stainless steel with rubber lining is also acceptable and each tank shall be complete with stainless steel dissolving tray and electric stirrers.
- B8.7.4 The SP Contractor shall be responsible to supply and install pipings from make up tank to provide water supply for the chemical tanks where required for the normal operation of the system.
- B8.7.5 Individual chemical metering pumps shall be provided to inject the chemical solutions into the filtration plant. The chemical dosing pumps shall be plastic diaphragm variable output type complete with totally enclosed fractional horsepower motor. The pumps shall also have facilities for manually adjusted stroke length from 30% to 100% and stroke rates. Starters for the chemical pumps shall be of the direct on line push button type with no volt release and magnetic overload protection. Each group of pumps for corresponding pool shall have 2 duty pumps and 1 standby pump, both having same characteristics, with selector switch enabling the choosing of any one of the pumps as the lead, bag or standby pump. Electrical supply and control facilities shall be such that all pumps can operate simultaneously under manual mode.
- B8.7.6 For alum system, 1 of the duty pump shall operate continuously when the carbon filters are in operation. The maximum dosing rate shall be 2.5 ppm of alum in main flow of water with 1 duty pump or as indicated in the Particular Specification. Initially, the stroke length shall be set to give 1 ppm of alum in main flow of water. The second duty pump is used to raise the alum level manually if required.
- B8.7.7 All level electrodes used for chemical dosing system shall be of corrosion resistant type suitable for submersing in the chemicals being used or measured.
- B8.7.8 Details of all equipment, pumps, tanks, controls and calculation shall be submitted to the Architect for approval before ordering.
- B8.7.9 It should be noted the HCL room is classified as Dangerous Goods stores. All equipment and devices installed in this room shall comply with FSD's requirements. All electrical equipment used shall be of flammable proof and explosion proof type where required by FSD.

- B8.7.10 Clear and concise notices and instructions on the operation procedures for the chemical dosing system shall be posted by SP Contractor besides the equipment of the systems. Warning notices shall also be posted to warn operators in handling the chemicals. The notices and instructions shall be made from permanent materials with easily reading characters in red, in both English and Chinese.
- B8.7.11 The SP Contractor shall provide 2 sets of safety plastic gloves, face mask, goggle, footwear and 1 set of plastic protective clothing for handling of chemicals in each of the alum room and HCL room.

B8.8 POOL HEATING

B8.8.1 Pool Heating Equipment

Pool heating is provided by a gas-heated boiler or an electric boiler or a heat rejection plant. Refer to the Particular Specification for the type of heating plant to be adopted.

B8.8.2 Heat Exchanger

- (a) In case when indirect heating is adopted, a plate type heat exchanger shall be used. Heat exchangers shall consist of most energy efficient metal plates pressed into a "Herring Bone" pattern and securely clamped between nitrile rubber gaskets by the pressure end plates of the steel framework. Plates shall be stainless steel or titanium for pool water. The plates shall be suspended from the top bar of the framework and located on the bottom guide bar. No part of the steel framework shall be in contact with the heat transfer fluids.
- (b) Heat transfer plates shall be clamped by lateral bolts between a stationary frame plate and a movable pressure plate such that opening of the plate heat exchangers can be done without removing any connecting pipes.
- (c) Heat exchanger shall be designed to give a high heat transfer efficiency to achieve close approach temperatures as low as 1°C.
- (d) Heat exchanger frame shall be of mild steel and shall be suitable for bolting to a horizontal deck. The frames shall be arranged such that when the tie bars are loosened, full access to all plate surfaces is provided for cleaning and maintenance. The entire framework and all parts of the units shall be factory treated to prevent corrosion such that the heat exchanger shall be capable of corrosive environment. All holding down bolts shall be of high tensile carbon steel with plastic tube protection. Each shall be equipped with bearing boxes and a locking washer enables the bolts to be opened from the fixed cover. No welded parts are allowed.

- (e) Inlet and outlet ports shall be rubber lined or metal lined constructed on the fixed frame plate only.
- (f) The heat transfer plates shall be corrugated pattern with thickness of 0.6 mm minimum, and pressing depth of about 3.20 mm with pressure rating a minimum of 1000 kPa or other rating to suit system design as specified. Maximum plate pack length shall not exceed 45% of the total framework length. Double gaskets shall be provided around the bypass port on each plate, with a drain hole between the gaskets to facilitate leak detection.
- (g) Distribution area shall be "chocolate pattern" and the flow pattern shall be "counter-flow". Gasket shall be on every plate to eliminate inter-leakage between media.
- (h) The heat exchanger units shall be pressure tested in the factory prior to delivery. The plate heat exchanger shall have a working pressure range of 1000 to 2500 kPa and shall be tested with a minimum pressure of 1500 to 3500 kPa for 24 hours suitable to the system design application as specified. Full certification of test results and guarantee for 5-year performance free from leakage by the manufacturer shall be provided.
- (i) The heat exchanger for hot water application shall be properly insulated with optimum efficiency and robust insulation against heat loss. The insulation panels shall be of the double skin aluminium or stainless steel cladding with handles suitable for easy removable for plates access for inspection and maintenance.
- (j) The installation shall be in accordance with the manufacturer's recommendations and shall be easily accessed for maintenance and repair.

B8.8.3 Thermal Insulation

Thermal insulation shall be applied to pool heating pipes and equipment. Thermal insulation types, properties, workmanship of insulation materials and finishes shall be as specified in the Particular Specification and relevant clauses in the AC_GS.

B8.8.4 Control Panel

A grade 316 stainless steel control panel shall be provided. The panel shall provide the monitoring of the operation of the heat provision system including start & stop, indication of water flow rates and temperatures through both primary side and secondary side of the heat exchanger, and indication whenever an energy meter is specified of accumulative thermal energy being used.

PART C - PAINTING, FINISHING AND PROTECTIVE TREATMENT

C.1 GENERAL

All surfaces, unless otherwise specified, shall be finished in accordance to the requirements in this section. All surfaces, other than those indicated to be left self finished such as stainless steel, PVC, anodized aluminium, shall be finished in first class paint work. All metallic surfaces shall be wire-brushed and cleaned to make it free from rust, scale, dirt and grease prior to painting. All work shall be carried out by qualified tradesmen.

Water based paints with reduced volatile and preservative content or paints with reduced solvent content formulated for minimal Volatile Organic Compound (VOC) emissions complying with reputable international standards and the General Specification for Building, 2007 Edition shall be used in occupied areas and renovated areas without good natural ventilation. In addition, all paints shall contain no mercury, lead, hexavalent chromium or cadmium compounds.

All painting works shall be completed and left in ventilated environment for at least 1 week, or the curing period recommended by the paint manufacturer whichever is longer, before occupation or handover of the renovated area to minimize VOC exposure.

All surfaces shall be painted and finished as specified in the Particular Specification to meet and match the aesthetic architectural design as required.

C.2 COPPER PIPE AND FITTING

Copper pipes and fittings without insulation/shielding shall be polished bright by sanding, wiped with mineral spirits and coated with an approved heat resisting clear synthetic varnish.

C.3 IDENTIFICATION OF PIPELINES

All pipework in the plant/machinery rooms shall be finished generally in accordance with ISO 3864-1:2011. All pipework, where exposed on surfaces outside the plant/machinery room, shall be painted either as in the plant/machinery room or to match the surrounding surface with distinguishing colour code bands plus flow arrows in the specified colour scheme as directed by the Architect.

Pipes and pipelines shall be painted in colours either in accordance with ISO 3864-1:2011: or as directed by the Architect completed with the identification colour code indicators. The basic identification colour or the decoration colour shall be applied over the whole length of the pipe with colour code indicators placed at all junctions, at both sides of valves, service appliances, bulkheads, wall penetrations and at any other places where identification is necessary as directed by the Architect.

Valves may be painted in the same colour as the associated pipework. However, if the pipeline is part of the fire services installation and has been coded only with the safety colour, the valves involved shall be fully painted "safety-red".

The direction of flow of fluid shall be indicated by an arrow over the basic identification colour and painted white or black in order to contrast clearly with the basic identification colour.

C.4 MACHINERY AND PIPEWORK

All machinery, unless otherwise specified, shall be finished in a colour as instructed by the Architect at the time of installation. The SP Contractor shall seek the Architect's instructions in good time to obtain the materials required. In the event that no instruction is given, the plant shall be painted in opal green with black relief on flanges in accordance with BS EN 60073:2002.

C.5 NUMBER OF PAINT COATS REQUIRED

All painted surfaces are to receive at least one primer coat and two coats of the finishing colour. Ferrous surfaces shall receive one primer coat of red zinc or zinc chromate, one under-coat and two finishing coats.

Where painting is carried out in occupied areas with central air-conditioning or areas without good natural ventilation, pre-painting preparation and primer coat shall be carried out off-site and only the finishing coats shall be painted on-site.

C.6 PIPES

The final external treatment for insulated pipes shall be as indicated in the Particular Specification or as directed on site by the Architect.

Pipes concealed in false ceiling need not be painted, unless otherwise specified in the Particular Specification but appropriate colour code identifications shall be applied.

Insulated pipes running in visual positions shall be plastered or otherwise finished as specified. They shall be painted in the appropriate identifying colour or as directed by the Architect in another colour plus identifying colour code bands.

Uninsulated pipes running in visual areas shall be painted in the appropriate colour throughout or painted in another colour as directed by the Architect but identified with appropriate colour code bands.

Unless specified in the Particular Specification or Drawings, painting shall not be applied to piping of UPVC, polyethylene, ABS and stainless steel.

C.7 PROTECTION OF PLANT, EQUIPMENT, PIPEWORK, ETC.

C.7.1 Temporary Dehumidifiers and/or Air Conditioners

For temperature and/or humidity sensitive electrical or electronic control panels and equipment, the SP Contractor shall where necessary protect them against high humidity and/or temperature by operating portable or temporary dehumidifiers and/or air conditioners in the enclosures containing this equipment.

In order to protect this equipment against dust infiltration, the SP Contractor shall store them in a dust free room or enclose them in heavy duty PVC sheets or bags. Where necessary, filters shall be provided in the temporary air conditioning systems.

C.7.2 Metal Surface

All stainless steel parts shall be covered with PVC wrapper or tape until handover. All ferrous parts shall be painted or greased (whichever is most suitable). All bright parts (chrome plates, polished stainless steel or aluminium, etc.) which are liable to deterioration shall be covered with tallow or a suitable protective coating during the progress of work. Upon completion of work, the protective coating shall be removed and the parts polished as appropriate.

Any damage to the primer or protective coatings shall be made good. When it is necessary to remove, or partly remove the protection for installation or making connections, the SP Contractor shall ensure that the standard of protection provided originally is re-applied at the earliest possible time.

C.7.3 Rust and Foreign Matter

All plants, pipes valves, and fittings shall be, as far as possible, thoroughly cleaned and cleared of rust and other foreign matters both before erection and before subjection to pressure tests.

C.8 PROTECTIVE MEASURES AGAINST CORROSION

Where normal painting is not practicable, all possible measures to prevent corrosion to the plant shall be applied such as special protective coverings, special anti-corrosive paints, etc. as recommended by the supplier or specified in the Particular Specification.

C.9 SCHEDULE OF COLOURS

Make reference to colour schedule in the AC_GS, complying with BS 4800:2011 for ready mixed paints. The SP Contractor shall agree with the Architect the coding scheme.

PART D - INSPECTION, TESTING AND COMMISSIONING

D.1 GENERAL

Throughout the execution of the Installations, the SP Contractor shall be responsible for ensuring compliance with the Regulations included in Section A2 and shall notify the Architect of any infringement which directly or indirectly detracts from the safe and satisfactory operation of the Installation(s) whether or not such infringement relates to the works covered in the Installations or to those associated with others.

D.1.1 Standards and requirements for the testing and commissioning works should be in accordance to:-

- (a) Statutory obligations and other requirements, specifications and standards specified in Section A2 of Part A;
- (b) Building Services Branch Testing and Commissioning Procedures for Swimming Pool Filtration Plant Installation in Government Buildings Hong Kong; and
- (c) Manufacturers' recommendations and specifications.

D.1.2 The SP Contractor is required to appoint a competent and experienced testing and commissioning engineer responsible for the overall planning, organizing, coordinating, supervising and monitoring of the testing and commissioning works and also certifying all results and reports from the testing and commissioning works. The SP Contractor shall submit, at the commencement of the Contract, information detailing qualification and experience of the testing and commissioning engineer for the Architect's approval.

D.1.3 The SP Contractor is required to provide, at no cost to the Employer, all necessary equipment, apparatus, tools and materials for carrying out of testing and commissioning works.

- (a) Master Programme of Testing and Commissioning Works

The SP Contractor is required to submit a programme for testing and commissioning works at the commencement of the Contract, usually within the first three months. The programme shall indicate the tentative dates of all tests and commissioning works that will be carried out throughout the Contract and all necessary submissions and approval relating to testing and commissioning and ensure that the testing and commissioning programme matches the master programme for construction

and that all testing and commissioning works are complete before the prescribed or extended date for completion of the Works.

(b) Inspection, Testing and Commissioning Methods and Procedures

The SP Contractor is required to submit detailed inspection, testing and commissioning methods and procedures together with report formats for reporting inspection, testing and commissioning results for the Architect's approval at least four months before commencement of testing and commissioning works, or four months after the commencement of the Contract, whichever is earlier.

(c) Labour and Materials

The SP Contractor is responsible for provision of all labour and both consumable and non-consumable materials for carrying out testing and commissioning works at their expenses. Electricity supply and water shall also be arranged and provided by the SP Contractor at no cost to the Employer.

(d) Supply of Inspection, Measuring and Testing Equipment

The SP Contractor is required to supply the calibrated equipment and instrument for testing and commissioning works in accordance with the requirements as specified in the Particular Specification.

(e) Readiness for Commissioning and Testing

The SP Contractor is required to check the completion of the works to be tested or commissioned, the associated builder's works and the associated building services installations to ensure that testing and commissioning can be proceeded in a safe and satisfactory manner without obstruction.

(f) "Type-test" Certificate

"Type-test" for equipment shall be carried out at the manufacturers' works or elsewhere appropriate in order to demonstrate their compliance with the Regulation or requirements. "Type-test" certificates together with the corresponding drawings, sketches, reports and any other necessary documents shall be submitted to the Architect for approval before delivery of the equipment.

D.1.4 The SP Contractor is required to provide advanced notice for inspection, testing and commissioning works as follows:-

(a) Off-site Inspection and Testing

An advanced notice of at least one week before commencement of the inspection or test shall be provided.

(b) On-site Inspection, Testing and Commissioning

An advanced notice of at least 4 days before commencement of inspection, testing or commissioning shall be provided.

D.1.5 Documentation and Deliverables

The SP Contractor shall record all commissioning information and testing results at the witness of the Architect or his Representatives. Commissioning and testing record shall be properly checked and certified by SP Contractor's testing and commissioning engineer and signed by the Architect or his Representative who has witnessed the testing or commissioning before submission to the Architect. The SP Contractor shall submit full commissioning and testing report to the Architect within 14 days after completion of the commissioning and testing of the Installations.

D.2 COMMISSIONING AND TESTING - DEFINITIONS

For the purpose of this General Specification the following definitions shall apply:-

D.2.1 Commissioning: the advancement of an installation from the stage of static completion to full working conditions and to meet the specified requirements. This shall include setting into operation and regulation of the Installation.

D.2.2 Setting to work: the process of setting a static system into motion.

D.2.3 Off-site Tests: tests carried out on items of equipment at manufacturer's works or elsewhere to ensure compliance with the requirements of Specifications and/or relevant Standards or Codes of Practice (or other standards specified).

D.2.4 Site Tests: tests on static plant and systems (e.g. inspection and testing of welds, hydraulic testing of pipework, etc.) to ensure correct and safe installation and operation.

D.2.5 Regulation: the process of adjusting the rates of fluid flow and heat transfer in a distribution system within specified tolerances as stated in the relevant CIBSE Commissioning Code.

- D.2.6 Performance Testing: the measuring and recording of the performance of the commissioned installation.
- D.2.7 Testing and Commissioning Procedures for Electrical Installation in Government Buildings, HKSAR issued by BSB, ArchSD.
- D.2.8 Testing and Commissioning Procedures for Swimming Pool Water Treatment Installation in Government Buildings, HKSAR issued by the BSB, ArchSD.

D.3 COMMISSIONING AND TESTING - GENERAL

- D.3.1 Any defects of workmanship, materials and performance, maladjustments or other irregularities which become apparent during commissioning or testing shall be rectified by the SP Contractor at no cost to the Employer and the relevant part of the commissioning or testing procedure shall be repeated at the SP Contractor's expenses.
- D.3.2 The entire commissioning and testing procedure shall be undertaken by the SP Contractor's own competent specialist staff or by a competent Independent Commissioning Specialist nominated by and acting for the SP Contractor and approved by the Architect.
- D.3.3 Where specified in the Particular Specification, the SP Contractor shall nominate a competent independent Specialist to conduct commissioning work.
- D.3.4 Where specified in the Particular Specification, the SP Contractor shall employ the approved specialist commissioning and testing firm submitted for approval.
- D.3.5 At the appropriate time in the Contract, usually within the first 3 months, the SP Contractor shall furnish a provisional commissioning and testing programme, methods, procedures and formats of test records to the Architect. This shall be updated as the work progresses towards completion.
- D.3.6 Unless otherwise indicated, all electricity, main water and other fuels, such as town gas, necessary for the operation of the plant during preliminary runs and for full adjustments and commissioning tests will be provided at no cost by the SP Contractor unless otherwise specified in the Contract.
- D.3.7 If considered appropriate, the SP Contractor shall be required to carry out demonstration to dismantle those parts/components of the Installations which are considered difficult/impossible for maintenance access. The SP Contractor shall be responsible for carrying out all necessary modification work at no extra charge to the Employer to alleviate the difficulties associated with dismantling or maintenance access.

D.4 GENERAL COMMISSIONING REQUIREMENTS

D.4.1 Systems shall be properly commissioned to demonstrate that all the equipment deliver the designed capacities in accordance with the design.

(a) Checking Procedures on Builder's Work:-

- (i) Plant rooms are completed and free of construction debris.
- (ii) Relevant plant room doors are fitted and lockable.
- (iii) Permanent power supply of sufficient capacity is available and the Building Contractor is operating a security access procedure to all plant areas to prevent unauthorised switching of plant.

(The normal security access system is one of "Permit to Work" arrangement and procedure proposed by the SP Contractor in accordance with the latest guidelines on "Permit to Work" issued by the Labour Department.)

- (iv) Relevant builder's work and building services installations in association with swimming pool water treatment systems are satisfactorily completed.
- (v) Relevant glazing works are completed and all windows closed.
- (vi) Relevant building fabric are completed and reasonably water-tight.
- (vii) Relevant external doors, all stairs and lobbies, and toilet doors are completed and securable.
- (viii) Relevant ceiling works are completed, unless specifically agreed, with the exception of those access areas required to be left open for final adjustment and testing of high level building services equipment during the commissioning period.

(b) Checking Procedures on Building Services Installation

The SP Contractor should ensure that:-

- (i) Floor gullies and drainage traps are clear.
- (ii) Ventilating system necessitated for the operation of disinfection system are switched on.

- (iii) All electrical wiring circuits (power, lighting and controls) are completed, or will be completed at the correct stage during the commissioning period.
- (iv) All electrical panels are commissioned and clean.
- (v) Lighting systems are switched on.
- (vi) Permanent power supply is available at the electrical panels, and all the connected equipment can be switched on.
- (vii) Plant room access is restricted to authorised personnel only.
- (viii) All functional and safety devices are installed and operational.

D.4.2 Progressive Commissioning

The SP Contractor shall not wait for completion of every part of the work but shall arrange for a progressive commissioning programme to achieve practical overall completion and have the whole work ready to be handed over by a date to suit the Contract completion date or any other agreed programme date.

D.5 GENERAL TESTING REQUIREMENTS

D.5.1 Contractor to Inform Architect

The Architect shall be informed in good time of all site tests for plant and piping.

D.5.2 Witness by Architect

The final tests shall be carried out in the presence of the Architect or his Representative, in accordance with the requirements of witness testing and commissioning as stipulated in the latest BSB Instructions. The SP Contractor shall give at least 72 hours notice, in writing, when any part or parts of the installation will be tested.

D.5.3 Test Equipment and Labour

The SP Contractor shall allow for providing all skilled labour, testing gear and attendants for all tests including those by Specialist employed by the SP Contractor. The SP Contractor shall be solely responsible for the proper filling, emptying and flushing of the plants and pipes to be tested and shall make good any defects emerging from the tests, or made manifest under testing or re-testing, until the whole of the plant is free from defect and is in complete working order to the satisfaction of the Architect.

D.5.4 Tests under Operating Conditions

The SP Contractor shall include the hydraulic and functional performance tests under operating conditions, on the whole installation to the entire satisfaction of the Architect.

D.6 OFF-SITE TESTS

Where the specified Standards or Codes of Practice stipulate, "type-tests" on items of equipment to demonstrate compliance shall be carried out at the manufacturer's works or elsewhere as appropriate. In all cases, "type-tests" Certificates shall be submitted in duplicate to the Architect. Cases where appropriate, "type-tests" Certificates will be accepted are as follows:-

- D.6.1 Pumps: "type-tests" Certificates for head, discharge, speed and power input (BS EN ISO 9906:2012 as appropriate).
- D.6.2 Electric motors: "type-tests" Certificates in accordance with BS EN 60034-1:2010, IEC 60072-1:1991, IEC 60072-2:1990 and IEC 60072-3:1994.
- D.6.3 Low voltage starter switchgear and control gear assembly: "type-tests" Certificates for starter and control panels assembly as a whole in accordance with IEC 60439-1:2005.
- D.6.4 Other electrical equipment, such as air heaters (but excluding thermostatic control equipment): "type-tests" Certificates in accordance with BS EN 60335, BS EN 60669-1:1999+A2:2008, BS 5733:2010+A1:2014 and BS EN 60670-22:2006 as appropriate.

D.7 SITE TESTS

- D.7.1 The SP Contractor shall carry out "on-site" tests in respect of all static systems to ensure safe and proper operation as conforming to the design intent. Such tests shall include test of welds and pressure tests on the hydraulic systems.
- D.7.2 In addition to the testing of the function and performance of the system, the SP Contractor shall be responsible to carry out peak load test for the whole plant and water quality test on a hot sunny day after the system has been put into operation for 3 to 6 months, exact time as instructed by the Architect. In the peak load test, all key parameters of the filtration, disinfection and chemical dosing plant shall be measured.

The peak load water quality test shall include a chemical distribution test in pools and micro-organism test in pools. In the chemical distribution test, the SP Contractor shall take water samples at every grid points at a pre-determined depth of pools for a pre-determined grid system (approx. 3-4 m grid) which covers the whole surface area of all pools; the water samples shall be tested for pH values and residual chlorine concentration. In the micro-organism test, the SP Contractor

shall take water samples at 3 pre-determined locations for each pool and carry out laboratory tests on micro-organism check such as presence of amoebae, E-coli, Pseudomonas, Legionellas, bacteria count and other disease described in all relevant bylaws and regulations made under the Public Health & Municipal Services Ordinance, (Cap. 132).

The SP Contractor shall submit 3 copies of test reports after test.

D.8 INSPECTION AND TESTING DURING CONSTRUCTION PERIOD

D.8.1 Periodic Site Tests

Site inspections of "work in progress" will be made by the Architect or his Representatives from time to time. The Contractor shall keep such inspection record for checking from time to time. Works to be permanently covered up shall be subjected to inspection and test before cover up. During the inspection, if the Architect discovers any work that has been covered up before inspection and testing, this work shall be uncovered for inspection and testing to the Architect's satisfaction. The cost involved in uncovering the work, inspecting, testing and re-concealing the work together with any consequential losses shall be paid by the SP Contractor at no additional cost to the Employer.

D.8.2 Tests at Factory

The SP Contractor shall note that the Architect may require to witness tests and inspections of locally and/or overseas manufactured equipment during construction at the manufacturer's works. Where this requirement is indicated in the Contract, the SP Contractor shall allow for making the necessary arrangements; including and indicating the Architect's travel and subsistence expenses in the Bill of Quantities or the Schedule of Rates as appropriate.

D.8.3 Factory Test Certificates

Certificates of all hydraulic and other manufacturers' tests carried out at the manufacturers' works (e.g. ozone generator, electro-chlorinator, ultra-violet disinfection system) shall be forwarded in duplicate to the Architect for approval. This approval shall be required before the materials or apparatus are dispatched from the manufacturer's works.

Where specified, the SP Contractor shall subject certain materials and equipment to be tested by the recognized institutions or laboratories and submit the type test certificates to the Architect for approval.

D.9 ELECTRICAL TESTS

D.9.1 Electrical Tests on Motor Control Switchboard

- (a) The tests shall be carried out before and after connection of power supply. The tests shall follow the requirements as stipulated in the EE_GS for L.V. Cubicle Switchboard.
- (b) The tests to be carried out for the high voltage motor control switchboard shall strictly follow the tests as recommended by the equipment manufacturer.

D.9.2 Electrical Tests on Motors

(a) Required Tests

The SP Contractor shall carry out the following tests on all electrical motors and provide test certificates in duplicate:-

- (i) check motor nameplate voltage;
- (ii) check motor rotation and speed, prior to connection of the driven equipment;
- (iii) ascertain maximum kW absorbed by pump at the most demanding point of the pressure/volume characteristic curve at the specified pump speed;
- (iv) check the earth continuity loop resistance for every motor starter;
- (v) check the insulation to earth resistance for every motor starter taken with 500 V "Meggar" tester;
- (vi) test the full load current taken by all motors on each phase;
- (vii) test the tripping time of starter overloads set to 10% above the motor nameplate rating;
- (viii) test the function of each control unit in accordance with the specification (e.g. selector switches correctly wired, high or low circuit cut-out operates, level switches correctly operating);
- (ix) check motor temperature in accordance with BS EN 60034-1:2010 as applicable; and
- (x) check starting current of each motor.

(b) Type Tests

Type tests and abbreviated tests shall meet the requirements of IEC 60072-1:1991, IEC 60072-2:1990 and IEC 60072-3:1994. The Architect has the discretion to agree or accept type-test results for performance in place of individual unit tests but these will not be accepted in place of practical on site, pressure, insulation, resistance tests which shall still be carried out on individual units.

(c) Contractor's Responsibility

Approval of test certificates shall not absolve the SP Contractor from providing motors capable of driving the various items of plant under the conditions of loading stated in the contract.

D.10 FILLING WATER SYSTEMS AND VENTING

D.10.1 Testing of Tanks

All water tanks shall, after erection, be filled with water and shall remain filled for at least 24 hours during which all joints shall be carefully examined. Any defect shall be rectified immediately and the test repeated.

D.10.2 Flushing of Water Systems

Before finally charging, the water systems shall be thoroughly flushed and all strainers, filters, etc. cleaned or replaced.

D.10.3 General Procedure

The water systems shall be properly charged with water (which shall be treated where specified). The filling process shall be from the bottom of the system upwards. Careful examination shall be conducted to the state of valves and air vents before and during filling to avoid air locks and excessive spillage.

When the whole system is filled, the SP Contractor shall disconnect the source, open the permanent supply and adjust the tank levels.

D.11 HYDRAULIC TESTING FOR WATER DISTRIBUTION PIPEWORK SYSTEMS

D.11.1 General

All water distribution pipework systems shall be hydraulically tested in sections as installation work progresses and before thermal insulation if any is applied.

D.11.2 Test Pressure

The hydraulic test pressure shall be one and a half times the total working pressure.

D.11.3 Precautions

Before hydraulic tests are carried out, all safety valves, gauges, etc. shall be effectively isolated or removed. This safety equipment shall be effectively tested at their design working pressure during commissioning of the installation.

D.11.4 Method of Testing

For a satisfactory and acceptable test, the pressure shall be maintained for a period of 24 hours or as otherwise stated in the Particular Specification, without loss of pressure after all weak joints, defective fittings and pipes disclosed by the initial application of the test are rectified. During the final testing period the Architect or the representative shall be invited to witness the tests. All sections of the work under test shall be accessible for inspection and selected welds shall be hammer tested.

D.11.5 Hydraulic Test Certificates

Certificates of all hydraulic tests made on Site shall be forwarded to the Architect for approval and such approval shall be obtained before any thermal insulation if any is applied. A separate and duplicated set of the SP Contractor's installation/shop drawings shall be provided for the purpose of keeping accurate record of site tests. 1 copy will be kept by the Architect's Representative on Site and the other retained by the SP Contractor.

D.11.6 Details on Test Certificate

All test certificates shall be signed by the SP Contractor's authorized site representative and by the Architect or his Representative who has witnessed the test. All test certificates shall contain the following particulars:-

- date of test;
- apparatus or section under test;
- makers number (if any);
- nature, duration and conditions of test;
- result of test;
- name of Contractor's representative (in block letter) in charge of test; and
- name of Architect's Representative at witness the test.

A blank test certificate form shall be submitted by SP Contractor for Architect's approval prior to carrying out the actual test on Site.

D.12 DOCUMENTS AND DATA REQUIRED FOR HANDOVER MEETING

D.12.1 General

The SP Contractor shall note that the system cannot be handed over until all the foregoing requirements (where applicable) have been carried out to the satisfaction of the Architect.

D.12.2 Test Certificates

Before the handover inspection, the SP Contractor shall provide the following test/record certificates where applicable:-

- (a) copies of manufacturer's works tests/record certificates on plant items comprising heat exchangers, tanks, motors, pumps, ozone generator, electro-chlorinator, ultra-violet disinfection system etc.;
- (b) copies of hydraulic and pressure test/record certificates for works carried out on Site;
- (c) copies of boiler plant or heat pump, if any, efficiency test/record certificates;
- (d) copies of Certificates of Fitness for Pressure Vessels issued by an Appointed Examiner as stipulated in the Boilers and Pressure Vessels Ordinance, (Cap. 56);
- (e) copies of all performance test/record certificates. These certificates shall be accompanied with all appropriate charts and diagrams; and
- (f) copies of all noise test/survey records on every noise emitting plant and machineries, individual room/space and a statement of compliance with the statutory requirements under the current Noise Control Ordinance, (Cap. 400).

D.12.3 "As-built" Drawings

This shall mean all necessary copies of "As-built" drawings as detailed in the Contract and this General Specification. As-built drawings shall be submitted in the media of prints, reproducible copies and CD-Rom, all as specified in the Contract.

D.12.4 Operation and Maintenance and Services Manuals

This shall mean all necessary copies of Operating and Maintenance Manuals as detailed in the Contract and this General Specification. The SP Contractor shall include functional spare parts and contact lists of the suppliers in the manual.

D.12.5 Manufacturer's Name Plate

Every item of plant supplied by a manufacturer shall be fitted with a clearly engraved, stamped or cast manufacturer's name plate properly secured to the plant item and showing:-

- manufacturer's Name;
- serial and/or Model No.;
- date of Supply;
- Rating/Capacity; and
- Test and Working Pressure (where applicable).

D.12.6 Labels and Related Instructions

Provision of all labelling and the related instructions shall comply with Clauses A3.11.5 and A3.11.6 of this General Specification.

D.13 TESTING AND COMMISSIONING PROCEDURES

For Testing and Commissioning Procedures, please refer to:-

Testing and Commissioning Procedure for Swimming Pool Water Treatment Installation in Government Buildings of The Hong Kong Special Administration Region issued by BSB, ArchSD.

PART E - MAINTENANCE AND TRAINING REQUIREMENTS

E.1 MAINTENANCE PERIOD

The SP Contractor shall provide free service and maintenance for the entire swimming pool water treatment plant installed under this Contract for a period of 12 months from the date of practical completion. This maintenance shall include systematic and monthly examination, adjustment, cleaning and lubrication of all equipment. Repair the electrical and mechanical parts of the equipment whenever required, and only genuine standard parts produced by the manufacturer of the equipment shall be used. All works under this maintenance provision shall be performed by competent personnel under the supervision and in direct employment of the SP Contractor. At the expiry of the free Maintenance Period complete inspection and tests shall be carried out on the plant by the SP Contractor with the presence of the Architect's Representative, any defects found shall be rectified by the SP Contractor without charge to the Employer.

A log book shall be provided and kept in the plant room to record all faults, rectification works and services carried out by the SP Contractor during the Maintenance Period.

During the Maintenance Period, the SP Contractor shall provide a team of competent technicians to station on Site for a period of 1 month, who will carry out daily operation of the filtration plant, maintenance, testing and commissioning of the installation. At the same time the team shall give thorough instruction and demonstration to the swimming pool operation staff on the operation and maintenance of the installation. All activities shall be recorded in the log book.

The SP Contractor shall allow for providing all spare parts for equipment which require replacement during Maintenance Period, e.g. sensors. At the expiry of Maintenance Period, the SP Contractor shall provide/replace with a complete new set for the whole system. Equipment with operation life longer than the Maintenance Period need not be replaced.

E.2 TRAINING

The SP Contractor shall provide 2 training courses for the Employer's staff on the philosophy, operation and maintenance of the whole water circulation, filtration and disinfection system and other auxiliary systems. One training course will be aimed for operational staff and/or maintenance staff which covers detailed operational procedures and steps and precautions. Training notes/manuals are required in both English and Chinese. The second training course will be aimed for management staff and/or non-technical staff which covers brief philosophy of the system and precautions e.g. response during alarm. At least 5 seats shall be given to the Employer's staff for each training course. Training Venue shall be on Site or provided by the Employer.

The SP Contractor shall also attend and answer to all queries raised by the operational staff during initial stage of operation. The SP Contractor shall allow for sending to site a qualified engineer to inspect and to answer any query raised

by the operational and maintenance staff if they cannot be dealt with or solved over telephone.

E.3 SPARE PARTS AND SPECIAL TOOLS

For plant and/or equipment included in the Tender, the SP Contractor shall provide the types of spare parts generally wherever these are appropriate to the plant and/or equipment involved plus any additional items for the particular plant and/or equipment.

Unless otherwise specified, within 4 months of acceptance of Tender, or in such period of time as has been agreed by the Architect in writing, the SP Contractor shall submit in respect of the proposed plant and/or equipment a list of the manufacturer's recommended spare parts that are likely to prove necessary to service the plant and/or equipment during the first year's operation and parts required immediately following the expiry of the contract Maintenance Period. Spare parts should also be available in the local market easily.

The spare parts submission shall include diagrams or catalogue details of the parts concerned. Unless specified in detail, the criteria by which the SP Contractor shall judge the need for spare parts to be included in the Schedule shall be any part or component of the plant or equipment that is subject to frictional wear, vibration or temperature fatigue, rupturable to safety (or otherwise), corrosion, erosion, unacceptable deposits and/or saturation by contaminants (such as for filters), normal fair wear and tear and is likely to fail or reach an unacceptably low performance level within a period of 3 years or less from its commencement of operation.

The schedule shall include at least the following items where they are part of the Installations:-

- (a) springs, valves, valve plates, etc.;
- (b) bearings or bearing bushes;
- (c) electric carbon brushes;
- (d) electrical main and arcing contacts;
- (e) driving belts in matched sets;
- (f) standard and special replaceable type air or liquid filter media;
- (g) gaskets and jointing;
- (h) seals, gland packings, etc.;
- (i) rupturable safety devices;
- (j) replaceable heat exchanger tubes;
- (k) sight glasses;
- (l) plug in relays;
- (m) indicator light lamps;
- (n) non-standard fuse cartridges;
- (o) flexible hoses and similar;
- (p) unit to house an assembly of generator cells and sundry items;
- (q) complete cell set for electro-chlorinator; and
- (r) Ultra-Violet lamp.

Any of the above spare parts and/or disposable items which are required to replace defective or prematurely worn out parts that arise during the free

Maintenance Period shall be replaced by the SP Contractor at no cost to the Employer before the Maintenance Certificate is issued. The above items shall not be exhaustive. The SP Contractor shall be responsible for the replacement of other parts and components for normal operation of the Installations.

Additionally the SP Contractor shall submit within the same period a priced schedule for the supply of any special tools necessary for servicing and maintenance of any part of the Installations. Instructions for purchase of any special tool shall be issued separately but the basis for charging shall be similar to that for the SP Contractor's equipment manufacturer's recommended spare parts.

The purchase of the needed spare parts and tools shall be secured by Architect's Instruction for which a Provisional Sum shall be provided in the Contract.

The exact types and quantities shall be determined by the Architect based on the SP Contractor's best advice and at the most appropriate time during the Contract when requirements can be most realistically assessed taking account of the Installations as installed or still being installed.

ANNEX I

LIST OF TECHNICAL STANDARDS QUOTED IN THIS GENERAL SPECIFICATION

Standard	Description	Part and Clause No.
BS 1212-1:1990	Float operated valves. Specification for piston type float operated valves (copper alloy body) (excluding floats)	B1.10.2(a)
BS 1212-2:1990	Float operated valves. Specification for diaphragm type float operated valves (copper alloy body) (excluding floats)	B1.10.2(a)
BS 1968:1953	Specification for floats for ballvalves (copper)	B1.10.2(b)
BS 2633:1987	Specification for Class I arc welding of ferritic steel pipework for carrying fluids	B1.9.2(a), B2.6(a)
BS 2971:1991	Specification for class II arc welding of carbon steel pipework for carrying fluids	B1.9.2(a), B2.6(a)
BS 4027:1996	Specification for sulfate-resisting Portland cement	B1.4.4(b)
BS 4515-1:2009	Specification for welding of steel pipelines on land and offshore. Carbon and carbon manganese steel pipelines	B2.6(a)
BS 4800:2011	Schedule of paint colours for building purposes	C.9
BS 5733:2010+A1:2014	General requirements for electrical accessories. Specification.	D.6.4
BS EN 60670-22:2006	Boxes and enclosures for electrical accessories for household and similar fixed electrical installations. Particular requirements for connecting boxes and enclosures	D.6.4
BS 6362:1990	Specification for stainless steel tubes suitable for screwing in accordance with BS 21 'Pipe threads for tubes and fittings where pressure-tight joints are made on the threads'	B1.4.8, B1.4.8(a), B1.4.8(d)
BS 7079:2009	General introduction to standards for preparation of steel substrates before application of paints and related products	B2.1(a)(i)

Standard	Description	Part and Clause No.
BS 7671:2008+A2:2013	Requirements for electrical installations. IET Wiring Regulations. Seventeenth edition	B8.1.1, B8.4.1(d), B8.4.8
BS EN 197-1:2011	Cement. Composition, specifications and conformity criteria for common cements	B1.4.4(b)
BS EN 545:2010	Ductile iron pipes, fittings, accessories and their joints for water pipelines. Requirements and test methods	B1.4.4(a), B1.4.4(b)
BS EN 598:2007+A1:2009	Ductile iron pipes, fittings, accessories and their joints for sewerage applications. Requirements and test methods	B1.4.4(a), B1.4.4(b)
BS EN 818-1:1996+A1:2008	Short link chain for lifting purposes. Safety. General conditions of acceptance	B8.6.8
BS EN 818-7:2002+A1:2008	Short link chain for lifting purposes. Safety. Fine tolerance hoist chain, Grade T (Types T, DAT and DT)	B8.6.8
BS EN 837-1:1998	Pressure gauges. Bourdon tube pressure gauges. Dimensions, metrology, requirements and testing	B1.10.15(a)
BS EN 969:2009	Ductile iron pipes, fittings, accessories and their joints for gas pipelines. Requirements and test methods	B1.4.4(b)
BS EN 1011-2:2001	Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels	B2.6(a)
BS EN 1057:2006+A1:2010	Copper and copper alloys. Seamless, round copper tubes for water and gas in sanitary and heating applications	B1.4.7(a)
BS EN 1092-1:2007	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges	B1.4.5(d), B1.4.6(a)(iii), B1.4.7(c), B1.5.3(e), B1.10.4(b)(ii), B1.11.1(d), B6.2.5
BS EN 1092-2:1997	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Cast iron flanges	B1.4.5(d), B1.4.6(a)(iii), B1.4.7(c), B1.5.3(e), B1.10.4(b)(ii), B1.11.1(d), B6.2.5

Standard	Description	Part and Clause No.
BS EN 1254-1:1998	Copper and copper alloys. Plumbing fittings. Fittings with ends for capillary soldering or capillary brazing to copper tubes	B1.4.7(a)
BS EN 1254-2:1998	Copper and copper alloys. Plumbing fittings. Fittings with compression ends for use with copper tubes	B1.4.7(a)
BS EN 1254-3:1998	Copper and copper alloys. Plumbing fittings. Fittings with compression ends for use with plastics pipes	B1.4.7(a)
BS EN ISO 1452-1:2009	Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure. Unplasticized poly(vinyl chloride) (PVC U). General	B1.4.3(a)
BS EN ISO 1452-2:2009	Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure. Unplasticized poly(vinyl chloride) (PVC U). Pipes	B1.4.3(a)
BS EN ISO 1452-3:2010	Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure. Unplasticized poly(vinyl chloride) (PVC U). Fittings	B1.4.3(a)
BS EN ISO 1452-4:2009	Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure. Unplasticized poly(vinyl chloride) (PVC U). Valves	B1.4.3(a)
BS EN ISO 1452-5:2009	Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure. Unplasticized poly(vinyl chloride) (PVC U). Fitness for purpose of the system	B1.4.3(a)
BS EN 1515-1:2000	Flanges and their joints. Bolting. Selection of bolting	B1.4.5(d), B1.4.6(a)(iii), B1.4.7(c), B1.5.3(e), B1.10.4(b)(ii), B1.11.1(d), B6.2.5
BS EN 1561:2011	Founding. Grey cast irons	B1.2.1(b), B1.2.1(c)(i), B1.2.4(a), B1.2.4(b), B1.10.7(a)
BS EN 1677-5:2001+A1:2008	Components for slings. Safety. Forged steel lifting hooks with latch. Grade 4	B8.6.9

Standard	Description	Part and Clause No.
BS EN 1982: 2008	Copper and copper alloys. Ingots and castings	B1.2.1 (b)
BS EN 10029:2010	Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape.	B1.7.1(b)
BS EN 10051:2010	Continuously hot-rolled strip and plate/sheet cut from wide strip of non-alloy and alloy steels. Tolerances on dimensions and shape.	B1.7.1(b)
BS EN 10088-3:2005	Stainless steels. Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes	B1.2.1(b), B1.2.4(a), B1.2.4(b), B1.10.8
BS EN 10226-1:2004	Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads	B1.10.4(b)(i)
BS EN 10255:2004	Non-alloy steel tubes suitable for welding or threading. Technical delivery conditions	B1.4.9
BS EN 10293:2005	Steel castings for general engineering uses	B1.2.4(a), B1.2.4(b)
BS EN 10312:2002	Welded stainless steel tubes for the conveyance of aqueous liquids including water for human consumption. Technical delivery conditions	B1.4.8, B1.4.8(b), B1.4.8(c), B1.4.8(d)
BS EN 12201-1:2011	Plastics piping systems for water supply, and for drainage and sewerage under pressure. Polyethylene (PE). General	B1.4.5(a)
BS EN 12201-2:2011	Plastics piping systems for water supply, and for drainage and sewerage under pressure. Polyethylene (PE). Pipes	B1.4.5(a)
BS EN 12201-3:2011	Plastics piping systems for water supply, and for drainage and sewerage under pressure. Polyethylene (PE). Fittings	B1.4.5(a)
BS EN 12201-4:2012	Plastics piping systems for water supply, and for drainage and sewerage under pressure. Polyethylene (PE). Valves	B1.4.5(a)
BS EN 12201-5:2011	Plastics piping systems for water supply, and for drainage and sewerage under pressure. Polyethylene (PE) . Fitness for purpose of the system	B1.4.5(a)

Standard	Description	Part and Clause No.
BS EN 12288:2010	Industrial valves. Copper alloy gate valves	B1.10.4(b)(i), B1.10.4(b)(ii), B1.10.5
BS EN 12797:2000	Brazing. Destructive tests of brazed joints	B1.4.7(c)
BS EN 12799:2000	Brazing. Non-destructive examination of brazed joints	B1.4.7(c)
BS EN 13133:2000	Brazing. Brazer approval	B1.4.7(c)
BS EN 13134:2000	Brazing. Procedure approval	B1.4.7(c)
BS EN 13397:2002	Industrial valves. Diaphragm valves made of metallic materials	B1.10.4(a)(i)
BS EN 14324:2004	Brazing. Guidance on the application of brazed joints	B1.4.7(c)
BS EN 60034-1:2010	Rotating electrical machines. Rating and performance	D.6.2, D.9.2(a)(ix)
BS EN 60073:2002	Basic and safety principles for man-machine interface, marking and identification. Coding principles for indicators and actuators	C.4
BS EN 60076-1:2011	Power transformers. General	B8.1.4
BS EN 60076-2:2011	Power transformers. Temperature rise for liquid-immersed transformers	B8.1.4
BS EN 60076-3:2001	Power transformers. Insulation levels, dielectric tests and external clearances in air	B8.1.4
BS EN 60076-5:2006	Power transformers. Ability to withstand short circuit	B8.1.4
BS EN 60079-0:2012	Explosive atmospheres. Equipment. General requirements	B1.2.4(c)
BS EN 60079-1:2007	Explosive atmospheres. Equipment protection by flameproof enclosures “d”	B1.2.4(c)
BS EN 60335	Specification for safety of household and similar electrical appliances.	D.6.4
IEC 60439-1:2005	Low-voltage switchgear and controlgear assemblies. Type-tested and partially type-tested assemblies	D.6.3

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BS EN 60529:1992	Specification for degrees of protection provided by enclosures (IP code)	B1.2.4(c), B8.1.2
BS EN 60669-1:1999+A2:2008	Switches for household and similar fixed electrical installations. General requirements	D.6.4
BS EN 61000-6-1:2007	Electromagnetic compatibility (EMC). Generic standards. Immunity for residential, commercial and light-industrial environments	B1.10.15(d)(iii)
BS EN 61000-6-2:2005	Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments	B1.10.15(d)(iii)
BS EN 61000-6-3:2007+A1:2011	Electromagnetic compatibility (EMC). Generic standards. Emission standard for residential, commercial and light-industrial environments	B1.10.15(d)(iii)
BS EN 61000-6-4:2007+A1:2011	Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments	B1.10.15(d)(iii)
BS EN ISO 7027:2000	Water quality. Determination of turbidity	A2.1.2(q)
BS EN ISO 9445:2006	Continuously cold-rolled stainless steel narrow strip, wide strip, plate/sheet and cut lengths. Tolerances on dimensions and form	B1.7.1(b)
BS EN ISO 9906:2012	Rotodynamic pumps. Hydraulic performance acceptance tests. Grades 1, 2 and 3	B1.3, D.6.1
BS EN ISO 12944-1:1998	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. General introduction	B2.1(a)(i)
BS EN ISO 12944-2:1998	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments	B2.1(a)(i)
BS EN ISO 12944-3:1998	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Design considerations	B2.1(a)(i)

Standard	Description	Part and Clause No.
BS EN ISO 12944-4:1998	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Types of surface and surface preparation	B2.1(a)(i)
BS EN ISO 12944-5:2007	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Protective paint systems	B2.1(a)(i)
BS EN ISO 12944-6:1998	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Laboratory performance test methods	B2.1(a)(i)
BS EN ISO 12944-7:1998	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Execution and supervision of paintwork	B2.1(a)(i)
BS EN ISO 12944-8:1998	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Development of specifications for new work and maintenance	B2.1(a)(i)
BS EN ISO 14713-1:2009	Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures. General principles of design and corrosion resistance	B2.1(a)(i)
BS EN ISO 14713-2:2009	Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures. Hot dip galvanizing	B2.1(a)(i)
BS EN ISO 14713-3:2009	Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures. Sherardizing	B2.1(a)(i)
BS IEC 60076-8:1997	Power transformers. Application guide	B8.1.4
DIN 8061:2009	Unplasticized polyvinyl chloride pipes - General quality requirements and testing	B1.4.3(a)
DIN 8062:2009	Unplasticized polyvinyl chloride (PVC-U, PVC-HI) pipes; dimensions	B1.4.3(a)
DIN 19627:1993	Ozone-plants for water treatment	B3.1.3

Standard	Description	Part and Clause No.
DIN 19643-1:2012	Treatment of the water of swimming-pools and baths - Part 1: General requirements	A2.1.2(n)
DIN 19643-2:2012	Treatment of water of swimming pools and baths - Part 2: Combinations of process with fixed bed filters and precoat filters	A2.1.2(n)
DIN 19643-3:2012	Treatment of water of swimming pools and baths - Part 3: Combinations of process with ozonization	A2.1.2(n)
DIN 19643-4:2012	Treatment of water of swimming pools and baths - Part 4: Combinations of process with ultrafiltration	A2.1.2(n)
IEC 60072-1:1991	Dimensions and output series for rotating electrical machines - Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1080	D.6.2, D.9.2(b)
IEC 60072-2:1990	Dimensions and output series for rotating electrical machines - Part 2: Frame numbers 355 to 1000 and flange numbers 1180 to 2360	D.6.2, D.9.2(b)
IEC 60072-3:1994	Dimensions and output series for rotating electrical machines - Part 3: Small built-in motors - Flange numbers BF10 to BF50	D.6.2, D.9.2(b)
ISO 7-1:2007	Pipe threads where pressure-tight joints are made on the threads -- Part 1: Dimensions, tolerances and designation	B1.5.3(b), B1.7.1(d)
ISO 161-1:1996	Thermoplastics pipes for the conveyance of fluids -- Nominal outside diameters and nominal pressures -- Part 1: Metric series	B1.4.6
ISO 185:2005	Grey cast irons -- Classification	B1.2.1(c)(i), B1.10.7(a)
ISO 197-4:1983	Copper and copper alloys -- Terms and definitions -- Part 4: Castings	B1.10.7(a)
ISO 727-1:2002	Fittings made from unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C) or acrylonitrile/butadiene/styrene (ABS) with plain sockets for pipes under pressure -- Part 1: Metric series	B1.4.6

Standard	Description	Part and Clause No.
ISO 2531:2009/Cor 1:2010	Ductile iron pipes, fittings, accessories and their joints for water or gas applications	B1.4.4(a)
ISO 3127:1994	Thermoplastics pipes -- Determination of resistance to external blows -- Round-the-clock method	B1.4.3(a)
ISO 3864-1:2011	Graphical symbols -- Safety colours and safety signs -- Part 1: Design principles for safety signs and safety markings	C.3
ISO 4427-1:2007/Cor 1:2008	Plastics piping systems. Polyethylene (PE) pipes and fittings for water supply. General	B1.4.5(a)
ISO 4427-2:2007	Plastics piping systems. Polyethylene (PE) pipes and fittings for water supply. Pipes	B1.4.5(a)
ISO 5167-1:2003	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full -- Part 1: General principles and requirements	B1.10.15(c)
ISO 5167-2:2003	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full -- Part 2: Orifice plates	B1.10.15(c)
ISO 5187:1985	Welding and allied processes -- Assemblies made with soft solders and brazing filler metals -- Mechanical test methods	B1.9.2(c)
ISO 5208:2008	Industrial valves -- Pressure testing of valves	B1.10.3(k)
ISO 5209:1977	General purpose industrial valves -- Marking	B1.10.3(g)
ISO 5457:1999/Amd 1:2010	Technical product documentation -- Sizes and layout of drawing sheets	A4.2.2, A4.3.2
ISO 6107-1:2004	Water quality -- Vocabulary	A2.1.2(p)
ISO 7005-1:2011	Pipe flanges -- Part 1: Steel flanges for industrial and general service piping systems	B1.5.3(e), B1.7.1(d), B1.7.1(h)
ISO 7005-2:1998	Metallic flanges -- Part 2: Cast iron flanges	B1.5.3(e), B1.7.1(d), B1.7.1(h)
ISO 7027:1999	Water quality -- Determination of turbidity	A2.1.2(q)

Standard	Description	Part and Clause No.
ISO 9001:2008/Cor 1:2009	Quality management systems. Requirements	B1.7.1(f)
ISO 9692-1:2003	Welding and allied processes -- Recommendations for joint preparation -- Part 1: Manual metal-arc welding, gas-shielded metal-arc welding, gas welding, TIG welding and beam welding of steels	B1.7.1(h), B1.9.2(b)
ISO 9692-2:1998	Welding and allied processes -- Joint preparation -- Part 2: Submerged arc welding of steels	B1.7.1(h)
ISO 10523:2008	Water quality -- Determination of pH	A2.1.2(o)
ISO 10564:1993	Soldering and brazing materials -- Methods for the sampling of soft solders for analysis	B1.9.2(c)
ISO 15609-2:2001	Specification and qualification of welding procedures for metallic materials welding procedure specification - Part 1: Arc welding	B1.9.2(b)
WIS 4-32-14:1995	Electrofusion fittings	B1.4.5(a)
WIS 4-32-15:1995	Specification for PE 80 and PE 100, spigot fittings and drawn bends for normal sizes up to and including 1000	B1.4.5(a), B1.4.5(d)
WIS 4-32-17:2001	Polyethylene pressure pipes for pressurised water supply and sewerage duties	B1.4.5(a)

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2012	Codes of Practice for Minimum Fire Service Installations and Equipment and Inspection, Testing and Maintenance of Installations and Equipment	A2.1.2(b)
2009	Code of Practice for the Electricity (Wiring) Regulations	A2.1.2(a), A3.11.7(a), B1.9.3(d), B8.4.8
2012	Code of Practice for Energy Efficiency of Building Services Installation	A2.1.2(d)
2012	Code of Practice for Prevention of Legionnaires' Disease Committee, Hong Kong	A2.1.2(i)