

**TESTING AND COMMISSIONING PROCEDURE**

**FOR**

**SWIMMING POOL WATER TREATMENT INSTALLATION**

**IN**

**GOVERNMENT BUILDINGS**

**OF**

**THE HONG KONG SPECIAL ADMINISTRATIVE REGION**

2007 EDITION



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

## **PREFACE**

This Testing and Commissioning (T & C) Procedure aims to lay down the minimum testing and commissioning requirements to be carried out on swimming pool water treatment installation in Government Buildings of the Hong Kong Special Administrative Region (HKSAR). Such requirements are applicable to both new installations upon completion and existing ones after major alteration.

The present edition was developed based on its 2000 edition by the Air-conditioning Specialist Support Group that was established under the Building Services Branch Technical Information and Research & Development Committee. With the benefit of information technology, electronic version of this new edition is to be viewed on and free for download from the Architectural Services Department (ArchSD) Internet homepage. As part of the Government's efforts to limit paper consumption, hard copies of this T & C Procedure will not be put up for sale.

The Architectural Services Department welcomes comments on its contents at anytime since the updating of this T & C Procedure is a continuous process to tie in with technological advances.

## **DISCLAIMER**

This T & C Procedure is solely compiled for use on 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 T & C Procedure for purposes other than that stated above. The material contained in this T & C Procedure may not be pertinent or fully cover the extent of the installation in non-government buildings. Users who choose to adopt this T & C Procedure for their works are responsible for making their own assessments and judgement of all information contained here. The Architectural Services Department does not accept any liability and responsibility for any special, indirect or consequential loss or damage whatsoever arising out of or in connection with the use of this T & C Procedure or reliance placed on it.

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# **Testing and Commissioning Procedure Swimming Pool Water Treatment Installation**

## **1 Introduction**

The procedures stated in this document cover the activities in preliminary tests and inspections, functional performance tests and the commissioning of newly completed installations and existing ones after major alteration. They are so compiled to facilitate the work of Project Building Services Engineer (PBSE) and Project Building Services Inspector (PBSI) in the following aspects with respect to testing and commissioning (T & C):-

- (i) to vet and approve the T & C procedures proposed and submitted by the Contractor;
- (ii) to witness those T & C procedures as specified; and
- (iii) to accept the T & C certificates and other supporting data.

The Contractor shall carry out the T & C works as detailed in this document. Supplementary T & C plans may be proposed by the Contractor as appropriate and agreed by PBSE, e.g. for special equipment supplied and/or installed by the Contractor.

The administrative requirements for T & C works are in general as specified in the latest General Specification for Swimming Pool Water Treatment Installation (the General Specification) issued by the Architectural Services Department. If there is any discrepancy between this procedure and the General Specification, the General Specification shall take precedence.

## **2. Objectives of the T & C Works**

The objectives of the T & C works are:-

- (i) to verify proper functioning of the equipment/system after installation;
- (ii) to verify that the performance of the installed equipment/systems meet with the specified design intent through a series of tests and adjustments; and
- (iii) to capture and record performance data of the whole installation as the baseline for future operation and maintenance.

For the avoidance of doubt, depending on the specific demands of individual installation, the PBSE may require additional or substitute T & C works in regard to any elements in the installation other than those indicated in this Procedure.

### **3. Scope of the T & C Works**

#### **3.1 Tests and Inspections during Construction**

The purpose of these tests is to ensure that all components and systems are in a satisfactory and safe condition before start up. Preliminary adjustment and setting of equipment at this stage shall also be carried out at the same time to pave way for the coming functional performance tests.

Before carrying out any test, the Contractor shall ensure that the installation complies with all relevant statutory requirements and regulations. The T & C works shall also comply with all site safety regulatory requirements currently in force namely:-

- (i) Occupational Safety and Health Ordinance, Chapter 509, and other subsidiary legislation made under the Ordinance;
- (ii) Factories and Industrial Undertakings Ordinance, Chapter 59, and other subsidiary legislation made under the Ordinance;
- (iii) Construction Site (Safety) Regulations;
- (iv) Construction Site Safety Manual issued by the Environment, Transport and Works Bureau, the Government of the HKSAR;
- (v) Public Works Programme Construction Site Safety Manual;
- (vi) Fire Services Ordinance, Cap 95;
- (vii) Dangerous Goods Ordinance, Cap 384;
- (viii) Waste Disposal Ordinance, Cap 354;
- (ix) Boilers and Pressure Vessels Ordinance, Cap 56;
- (x) Gas Safety Ordinance, Cap 51;
- (xi) Occupational Safety and Health Ordinance, Cap 398;
- (xii) Electricity Ordinance, Chapter 406, and other subsidiary legislations;
- (xiii) Code of Practice for the Electricity (Wiring) Regulations published by Electrical and Mechanical Services Department, the Government of the HKSAR;
- (xiv) IEC 60364 - Electrical Installations of Building; and
- (xv) Electricity supply rules of the relevant power supply companies.

### 3.2 Functional Performance Tests

The purpose of functional performance tests is to demonstrate that the equipment/installation can meet the functional and performance requirements as specified in the General/Particular Specifications. Functional performance test should proceed from the testing of individual components to the testing of different systems in the installation.

The Contractor may have to make temporary modifications as the test proceeds. The specific tests required and the order of tests will vary depending on the type and size of systems, number of systems, sequence of construction, interface with other installations, relationship with the building elements and other specific requirements as indicated in the General/Particular Specifications. The testing of systems may have to be carried out in stages depending on the progress of work or as proposed by the Contractor.

Part of the tests may be required to be carried out in suppliers' premises in accordance with the provisions in the General/Particular Specification.

Any performance deficiencies revealed during the functional performance tests must be evaluated to determine the cause and whether they are part of the contractual obligations. After completion of the necessary corrective measures, the Contractor shall repeat the tests.

If any test cannot be completed because of circumstances that are beyond the control of the Contractor, it shall be properly documented and reported to the PBSE, who shall then liaise with the relevant parties to resolve the situation. The Contractor shall resume his testing work immediately upon the attainment of a suitable testing environment.

### 3.3 Commissioning and Statutory Inspections

Commissioning is the advancement of an installation from the stage of static completion to full working conditions and to meet the performance requirements as specified in the General/Particular Specification. This will include setting into operation and regulation of the installation. It is expected that fine-tuning of the commissioned system shall be done by the Contractor to match system performance to the actual needs of the building occupier more closely.

Where necessary, after the proper testing and commissioning of the Swimming Pool Water Treatment Installation, the Contractor shall notify the appropriate authority, through the PBSE of the completion of the installation and its readiness for final inspection.

### 3.4 Documentation and Deliverables

The Contractor shall submit his proposed T & C procedures together with the Testing and Commissioning Progress Chart shown in Annex I to PBSE for approval.

All inspection and T & C results shall be recorded by the Contractor in the

appropriate test record forms, the reference of which is shown against each individual test. A complete set of these forms can be found in Part 3 and 4 of Annex II.

Data recorded in other formats may also be acceptable subject to agreement between the PBSE and the Contractor. Upon completion of all the required T & C works, the Contractor's project engineer shall complete and sign a testing and commissioning certificate as shown in Part 1 and 2 of Annex II to the effect that the agreed T & C works have been duly carried out.

A functional performance test report covering all measured data, data sheets, and a comprehensive summary describing the operation of the system at the time of the functional performance tests shall be prepared and submitted to the PBSE. Deviations in performance from the General/Particular Specifications or the design intent should be recorded, with a description and analysis included.

Where required in the General Specification, the Contractor shall conduct a final evaluation of the performance of the Swimming Pool Water Treatment Installation, the results of which shall be included in the commissioning report.

#### **4. T & C Procedures**

Where tests are required to be witnessed by the PBSE/PBSI, the Contractor shall give due advance notice (usually not less than 3 days) and provide details of date, time and type of tests to be performed.

Upon completion of such T & C procedure, the Contractor shall complete and sign a testing and commissioning certificate as at Annex II, to the effect that agreed T & C procedure have been duly carried out.

The Contractor shall employ trained, experienced engineer to carry out the T & C procedure and for specialized items such as gas chlorination system, ozone dosing, boiler system, etc., they may be carried out by the manufacturer's own testing and commissioning engineers if necessary.

Before operating the system to carry out T & C, the Contractor shall follow steps as listed below:-

- (a) obtain design drawings and specifications and become thoroughly acquainted with the design intent;
- (b) obtain copies of approved shop drawings of all water handling equipment, outlets (supply, return), boiler, gas chlorinator, chemical dosing system, etc.;
- (c) compare design to installed equipment and field installation;
- (d) walk through the system from the water and other fluid handling equipment to the terminal units to determine any variations of installation from design; and
- (e) obtain schematic diagrams of system and as-built piping layouts to facilitate reporting.

## 4.1 Tests and Inspections during Construction

Certain tests will be carried out on different systems of the installation during construction to ensure their suitability for operating at the design conditions. Certificates of such tests have to be issued together with certificates of any work tests.

### 4.1.1 Works Tests

- (i) Works tests shall follow the procedure normally associated with the specific item of equipment and to the standards as laid down in the Specification and the Conditions of Contract.
- (ii) Works static pressure tests will be carried out on such items of plant and equipment as pressure vessels, water coils, heat exchangers, filter bed tanks, and all items of plant or equipment if provisions have been made in the specification and the Conditions of Contract.
- (iii) Dynamic rotation tests will be carried out on items such as fan impellers and drives, pump impellers and drives. Tests shall be conducted through the entire rotational speed range up to a maximum of 150% designed operating speed if the provision has been made in the Conditions of Contract. When items of plant are purchased ex-stock, a manufacturers test certificate will suffice.
- (iv) Rotational test on electric motors will not be carried out if the equipment are constructed to the requisite current British Standard or any other approved international standards.
- (v) Operational test on the chlorine gas leakage detection system.
- (vi) Water quality test.
- (vii) Operational test on the loose supplied items such as pool cleaners and pool covers.

### 4.1.2 Pressure Testing and Welding Test on Piped Services

For this part of test, refer to the relevant section(s) of the "Testing and Commissioning Procedure for Air-conditioning, Refrigeration, Ventilation and Central Monitoring & Control System Installation."

## 4.2 Pre-commissioning Check

### 4.2.1 Water Distribution System

Check the following items with reference to the corresponding sections in the "Testing and Commissioning Procedure for Air-conditioning, Refrigeration, Ventilation and Central Monitoring & Control System Installation" :-

- (a) System Cleanliness;
- (b) State of System;
- (c) System Readiness before Filling up;
- (d) Mechanical Checks for Pumps, Motorized Valves and Float Switches;
- (e) System Filling; and
- (f) Electrical Checks With and Without all Electrical Supplies Isolated.

#### 4.2.2 Filtration System

Normally for conventional type pool filtration system, filtering of the water is by sand bed filters. For other systems reference should be made to the particular equipment manufacturer's published instructions.

##### State of System

Check that :-

- (i) filter beds are set on concrete kerb or slab and are level;
- (ii) the correct grade and depth of sand has been installed against the manufacturer's filter data label;
- (iii) pump strainer basket is in proper position and lid is properly secured; and
- (iv) all inspection doors are properly closed after inspection and that all valves are set in their proper position for initial starting up.

#### 4.3 Functional Performance Tests

The Contractor shall carry out the tests and inspections as shown in Part 3 of Annex II and record the test results on Part 4 of Annex II and as agreed by the PBSE.

The Contractor shall provide all necessary staff, labour, materials and equipment for a thorough test and examination of the installation.

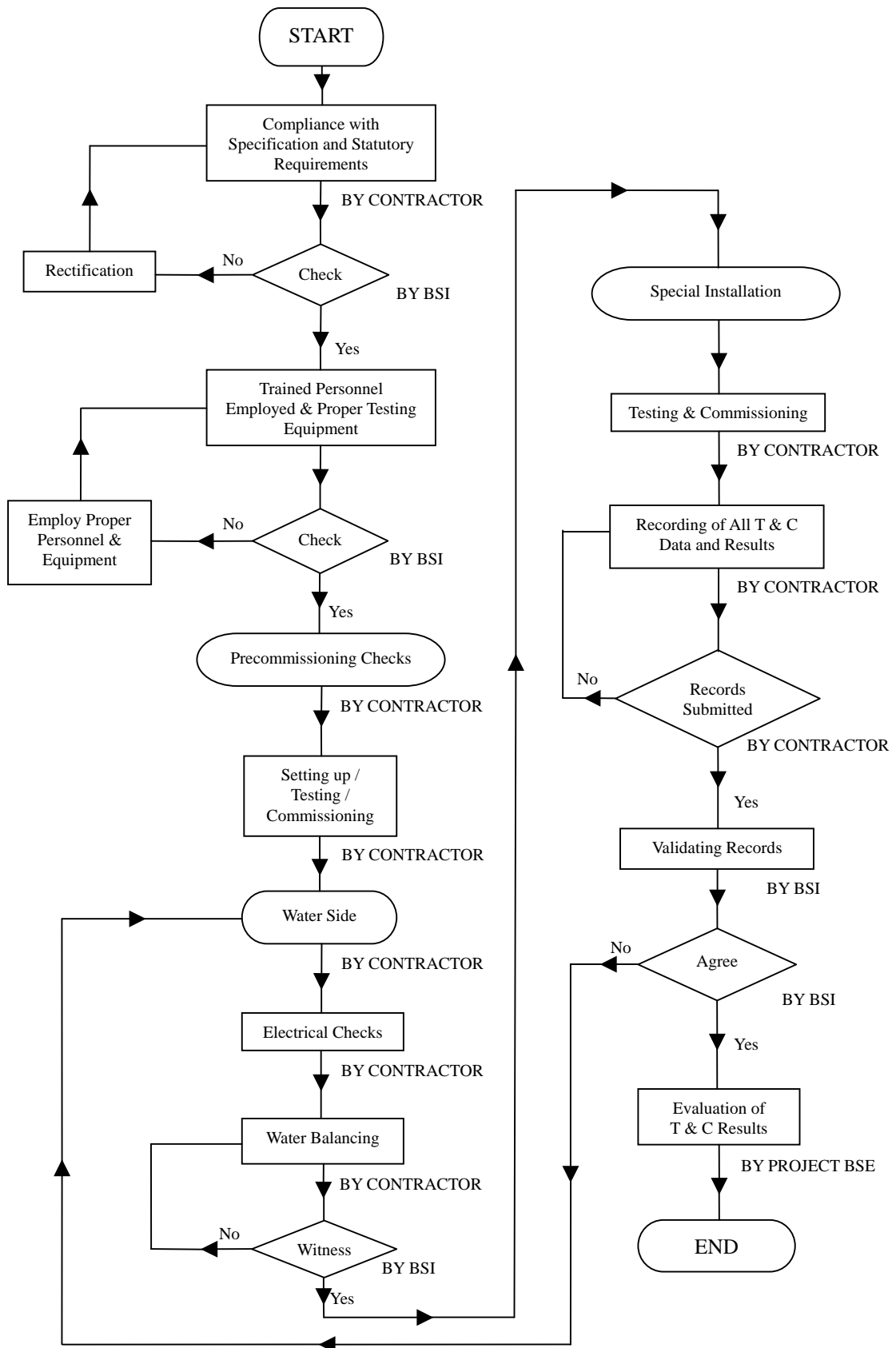
The Contractor is required to carry out a full T & C process for the equipment and the complete system to ascertain that the equipment and the system are operating in accordance with the design objectives. This shall include but not limited to:-

- (a) the balancing of water distribution;

- (b) adjustment of total system flow to provide designed quantities;
- (c) electrical measurements;
- (d) verification of performance of all equipment and automatic controls;  
and
- (e) sound and vibration measurements.

## Flow Chart

The flow-chart below provides guidelines for the sequence of T & C for the Swimming Pool Water Treatment Installation:-



#### 4.3.1 Water Distribution System

(a) General

It is not possible to embody every type of plant and piping layout for pool water flow patterns usually employed in swimming pool installations. The procedure given here may have to be adapted to suit the particular arrangement.

(b) Procedure

The procedure required to achieve a water distribution system working satisfactorily and be regulated appropriately shall refer to the relevant and appropriate sections in the "Testing and Commissioning Procedure for Air-conditioning, Refrigeration, Ventilation and Central Monitoring & Control System Installation".

(c) Checks Prior to Pump Start-Up

(d) Initial Starting and Running of Electrically Driven Centrifugal Pump Set

(e) Regulation of Water Flow

- Initial Checking on System Flow Rates
- Final Regulation

(f) Other Regulating Valves

#### 4.3.2 Filtration System

(a) Initial Starting-up

After the water has been filled to the correct pool level and that all mechanical and electrical checks on the circulating pumps are completed to satisfaction, initial start-up of the filter beds could then commence.

- (i) Set the corresponding valves in "filter" positions.
- (ii) Switch on the circulation pump and run for approximately 5 minutes.

N.B.

During this filtering cycle some remnant construction debris and pipe dirt will be carried and directed into the top of the filter and then trapped in the filter. The pressure across the filter bed as reflected in the differential pressure gauge provided will increase.

- (iii) After the prescribed time lapsed, turn off the pump and set all the necessary valves to "backwash" position.
- (iv) Run the backwash pump and air compressor and backwash for 6 to 8 minutes or until the water appears to be clean through the sight glass. The air supply must be kept at the manufacturer's recommended value and should not be exceeded.
- (v) After "backwash" process is completed, turn off the pump and reset all necessary valves to their "filter" position for normal operation.

#### 4.3.3 Disinfection System

There are several different systems for water disinfection, e.g. ozone generation system, sodium hypochlorite generation system, mixed oxidant disinfection system, and ultra violet light disinfection system.

This procedure concentrates on the above types of disinfection systems.

##### Check Prior to Start up

- (a) Ozone generation system
  - (i) Check that all pipework and their associated connections are tight, all the strainers are free of dirt, all the valves are in the correct positions and flow alignment, their connections are tight and that all other relevant fire services as well as occupational safety and health requirements of the gaseous ozone or ozonated water and the ozone generator room are complied with.
  - (ii) Check the power and control cables to all equipment and controllers in the system for correct material, sizing and installation, and the provision of all necessary earth terminals and their interconnections are tight and tally with the details on the approved shop drawings, then carry out Meggar test on the metal casing of all equipment and for every motor starter to ensure that they are properly earthed in particular for the door earth strap and earth terminals of the casing, and finally test the proper function of the power supply of the whole system for electrical safety protection.

- (iii) Check any air blowers in the system and the associated equipment by hand for smooth running, and then examine all equipment mounting for safety and integrity.
- (iv) Check the ozone generating module for the nameplate data such as the rated ozone output, the full load current and wattage, the required input voltage and wattage, air and water flow rate, serial numbers of generator and its associated power supply unit (transformer/rectifier) and incoming power isolating switch and record them on a test record; then examine the cleanliness of the dielectric glass tube, the cleanliness of the electrode, the cleanliness of the stainless steel liner tube, the tightness of the O-rings, the overall tightness of the module, and the tightness of tubing.
- (v) Check the drying sub-system for the fitness of the solenoid diaphragm, the function of the air blower, the cleanliness of the air filter, and the proper adjustment of the cam timer and micro-switch.
- (vi) Commission the air flow rate and perform functional test for the air flow switch of the air supply sub-system.
- (vii) Check that the Hartford Loop, the check valve and the injector are provided and interconnected tightly in the ozone supply line to prevent ozone from flowing back into the generator.
- (viii) Check that all manual valves in the water line operate freely, ensure that all pipe joints are water-tight, all connections are made, and all water leakage tests have been satisfactorily completed. Then close all drain valves and open all manual valves and the regulating valves in the water flow and return lines to admit water returned from the filtration system (and bypassed the heating system where provided). Check the fitness of the solenoid valve diaphragm and the cleanliness of the filter media in the cooling water system in case of a water-cooled power supply unit.
- (ix) Calibrate the dew point sensor, the oxygen concentration sensor, the pH sensor, the dissolved ozone analyzer, the ORP sensor, and the gaseous ozone leakage sensor, and check their cleanliness from the monitor of the control panel.
- (x) Check the control panel for the correct layout as the approved shop drawings, the availability of mains AC power supply and equipment terminal AC/DC power

supplies at required operating voltages, the section control circuits, the tightness of its wiring terminals, the indication lamps (flash lights) and alarm buzzers (sirens), the cooling fans, the general cleanliness, the control fuse or MCB, and test the emergency stop, the sensing devices and measuring instruments, and the control functions. Ensure that the control unit has been set to proper levels of mV for oxidation reduction potential and a minimum contact time value for minimum combined residual level.

- (xi) Pre-commission the water lines by filling, flushing and refilling with main's fresh water as well as cleaning the strainers and replacing the filter media. Commission the water flow rates for the generator cells by adjusting the regulating valves to ensure adequate water supply is available to system water inlets at the normal operating flow rate and the desirable ranges of water flow temperatures for full load output of the generator, and perform functional test for the water flow switches.
  - (xii) Turn on the ozone injector and the power supply. Test and commission the proper function of the whole system for accomplishing system working pressure, gas tightness, interlocking function, running status, running current, and range of operation parameters of the system, and record measurement results.
  - (xiii) Perform disinfectant production performance test at full load current, and record the output ozone concentrations by the dissolved ozone analyzer as well as take down the air/water flow rate readings from flow transmitters for calculation of the production rate of disinfectant.
- (b) Sodium hypochlorite (mixed oxidant) generation system
- (i) Check that all pipework and their associated connections are tight, all the strainers are free of dirt, all the valves are in the correct positions and flow alignment, their connections are tight and that all other relevant fire services as well as occupational safety and health requirements of the electrolytic cell (mixed oxidant generator) room are complied with.
  - (ii) Check the power and control cables to all equipment and controllers in the system for correct material, sizing, and installation, and the provision of all necessary earth terminals and their interconnections are tight and tally with the details on the approved shop drawings, then carry out Meggar test on the metal casing of all equipment and for every motor

starter to ensure that they are properly earthed in particular for the door earth strap and earth terminals of the casing, and finally test the proper function of the power supply of the whole system for electrical safety protection.

- (iii) Check any air (hydrogen) blowers and injection pumps in the system and the associated equipment by hand for smooth running, and then examine all equipment mounting for safety and integrity.
- (iv) Check the electrolytic cell for any damage or cracks, the nameplate data such as the rated hypochlorite (mixed oxidant) output, the full load current and wattage, the required input voltage and wattage, water level, serial numbers of electrolytic cell and its associated power supply unit (transformer/rectifier) and incoming power isolating switch and record them on a test record.
- (v) Check the brine storage tank, the hypochlorite (mixed oxidant) tank, and the water softener tank for sufficient storage capacities (minimum 2-week continuous consumption), any impact damage and whether their liquid level assemblies are in place and undamaged. Ensure that the feed water source of the softener tank is derived from the city mains fresh water.
- (vi) Check that the sodium hypochlorite (mixed oxidant) line is connected to the hypochlorite (mixed oxidant) tank.
- (vii) Check that the check valves are provided to prevent the softener from flowing back into the brine tank.
- (viii) Check that all manual valves in the water line operate freely, ensure that all pipe joints are water-tight, all connections are made, and all water leakage tests have been satisfactorily completed. Then close all drain valves and open all manual valves and the regulating valves in the water flow and return lines to admit water returned from the filtration system (and bypassed the heating system where provided). Check the fitness of the solenoid valve diaphragm and the cleanliness of the filter media in the cooling water system in case of a water-cooled power supply unit.
- (ix) Calibrate the liquid level sensors, the brine concentration sensor, the pH sensor, the free chlorine (mixed oxidant) analyzer, the ORP sensor, and the gaseous hydrogen leakage sensor, and check their cleanliness from the monitor of the control panel.

- (x) Check the control panel for the correct layout as approved shop drawings, the availability of mains AC power supply and equipment terminal AC/DC power supplies at required operating voltages, the section control circuits, the tightness of its wiring terminals, the indication lamps (flash lights) and alarm buzzers (sirens), the cooling fans, the general cleanliness, the control fuse or MCB, and test the emergency stop, the sensing devices and measuring instruments, and the control functions. Ensure that the control unit has been set to proper levels of ppm for breakpoint chlorination condition and for minimum combined residual level and pH value.
  - (xi) Pre-commission the water lines by filling, flushing and refilling with main's fresh water as well as cleaning the strainers and replacing the filter media. Commission the water flow rates for the electrolytic cell by adjusting the regulating valves to ensure adequate water supply is available to system water inlets at the normal operating flow rate and the desirable ranges of water flow temperatures and water pressures for full load output of the electrolytic cell, and perform functional test for the water flow switches and pressure regulators.
  - (xii) Turn on the power supply. Test and commission the proper function of the whole system for accomplishing system working pressure, safety and operation interlock, running status, running current, and proper range of operation parameters of the system, and record measurement results.
  - (xiii) Perform disinfectant production performance test at full load current, and record the output pH level and free chlorine (mixed oxidant) concentrations by the pH sensor and free chlorine (mixed oxidant) analyzer as well as take down the water flow rate readings from flow transmitter for calculation of the production rate of disinfectant.
- (c) Ultra violet light disinfection system
- (i) Check that all pipework and their associated connections are tight, all the strainers are free of dirt, all the valves are in the correct positions and flow alignment, their connections are tight and that all other relevant occupational safety and health requirements of the ultra violet light chamber room are complied with.
  - (ii) Check the power and control cables to all equipment

and controllers in the system for correct material, sizing, and installation, and the provision of all necessary earth terminals and their interconnections are tight and tally with the details on the approved shop drawings, then carry out Meggar test on the metal casing of all equipment and for every motor starter to ensure that they are properly earthed in particular for the door earth strap and earth terminals of the casing, and finally test the proper function of the power supply of the whole system for electrical safety protection.

- (iii) Check the UV chamber and all UV quartz bulbs for any damage or cracks, the nameplate data such as the rated output, the full load current and wattage, the required input voltage and wattage, cooling water flow rate, serial numbers of UV chamber and its associated power supply unit(transformer/rectifier) and incoming power isolating switch and record them on a test record.
- (iv) Check whether the UV quartz bulb wipers and their associated limit switches and motors, and the safety guards are in proper place and undamaged. Ensure that the feed water source of the water-cooled power supply unit is derived from the city mains fresh water.
- (v) Check that all manual valves in the water line operate freely, ensure that all pipe joints are water-tight, all connections are made, and all water leakage tests have been satisfactorily completed. Then close all drain valves and open all manual valves and the regulating valves in the water flow and return lines to admit water returned from the filtration system (and bypassed the heating system where provided). Check the fitness of the solenoid valve diaphragm and the cleanliness of the filter media in the cooling water system in case of a water-cooled power supply unit.
- (vi) Calibrate the temperature thermostat, and check their cleanliness from the monitor of the control panel.
- (vii) Check the control panel for the correct layout as approved shop drawings, the availability of mains AC power supply and equipment terminal AC/DC power supplies at required operating voltages, the section control circuits, the tightness of its wiring terminals, the indication lamps (flash lights) and alarm buzzers (sirens), the cooling fans, the general cleanliness, the control fuse or MCB, and test the emergency stop, the sensing devices and measuring instruments, the cycling frequency of the wipers and the control functions. Ensure that the control unit has been set to

proper dosages.

- (viii) Pre-commission the water lines by filling, flushing and refilling with main's fresh water as well as cleaning the strainers and replacing the filter media. Commission the water flow rates for the UV chamber by adjusting the regulating valves to ensure adequate water supply is available to system water inlets at the normal operating flow rate and the desirable ranges of water flow temperatures for full load output of the UV chamber, and perform functional test for the water flow switches.
- (ix) Turn on the power supply. Test and commission the proper function of the whole system for accomplishing system working pressure, safety and operation interlock, running status, running current, and proper range of operation parameters of the system, and record measurement results.
- (x) Carry out UV light intensity performance test at full load current, and record the output UV light intensity concentrations by the UV light intensity analyzer as well as take down the water flow rate readings from flow transmitter for calculation of the production intensity of UV light.

#### 4.3.4 Hot Water Boiler and Calorifier System

Testing and commissioning of hot water boilers and calorifiers shall follow the Testing and Commissioning Procedure Steam Boiler and Calorifier 2007 issued by the Architectural Services Department.

#### 4.3.5 Portable Pool Cleaning Equipment

These are loose items usually to be ordered and specified in the General or Particular Specification. Visual check on the correctness of the equipment offered and simple performance check against the equipment descriptive brochure will suffice.

#### 4.3.6 Performance Tests

After the system has been commissioned, its performance shall be observed and checked under normal conditions, both winter and summer while making all required adjustments to automatic controls, until all performance requirements are met.

#### 4.3.7 Noise and Sound Tests

For these tests, refer to the relevant section(s) of the "Testing and Commissioning Procedure for Air-conditioning, Refrigeration, Ventilation and Central Monitoring & Control System Installation".

#### 4.3.8 Vibration Tests

For these tests, refer to the relevant section(s) of the "Testing and Commissioning Procedure for Air-conditioning, Refrigeration, Ventilation and Central Monitoring & Control System Installation".

#### 4.4 Commissioning and Statutory Inspections

After the proper testing and commissioning of the Swimming Pool Water Treatment installation, the Contractor shall notify the appropriate Authority, through the PBSE, on the completion of the installation and its readiness for inspection and testing.

## Testing and Commissioning Progress Chart for Swimming Pool Water Treatment Installation

Contract No. : \_\_\_\_\_

Contract Title : \_\_\_\_\_

Name of Contractor/Sub-contractor : \_\_\_\_\_

Contract Period : \_\_\_ / \_\_\_ /20 to \_\_\_ / \_\_\_ /20 \* Revised/Actual Completion Date : \_\_\_ / \_\_\_ /20

Testing and Commissioning Progress Chart for Swimming Pool Water Treatment Installation (Rev. ) <sup>(1)</sup>																			
		Dates <sup>(2)</sup>																Remark	
Activities	Refer to T & C Procedure	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
1.	Filtration System Activities																		
1.1	Cleanliness & State Check	Section 4.2																	
1.2	Mechanical Check	Ditto																	
1.3	Electrical Check	Ditto																	
1.4	Check Filter Bed	Ditto																	
1.4.1	Check Filter Bed Properly Installed	Ditto																	
1.4.2	Check Correct Grade and Depth of Sand Properly Installed	Ditto																	
1.4.3	Check Pump Strainer Basket Properly Installed and Lid Secured	Ditto																	
1.4.4	Filtration Media Included	Ditto																	
1.4.5	Backwashing of Filter Bed	Section 4																	
1.4.6	Pressure Test of Welding of Pipe	Section 4.1																	
1.4.7	Pressure Test of Filter	P.S. <sup>(3)</sup>																	
	Submission of Record of Test																		

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	

## Testing and Commissioning Progress Chart for Swimming Pool Water Treatment Installation

Testing and Commissioning Progress Chart for Swimming Pool Water Treatment Installation (Rev. ) <sup>(1)</sup>																			
		Dates <sup>(2)</sup>																Remark	
Activities		Refer to T & C Procedure		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
2.	Disinfection System Activities																		
2.1	General Check																		
2.1.1	Cleanliness & State Check	Section 4.3.3																	
2.1.2	Mechanical Check	Ditto																	
2.1.3	Electrical Check	Ditto																	
2.1.4	Check Compliance of Fire Services and Occupational Safety and Health Requirements	Ditto																	
2.1.5	Check Pipe Work are Properly Connected and Intact	Ditto																	
2.2	Flow Check																		
2.2.1	Commissioning of Disinfectant Flow Tubing/Injector/ Manifold	Ditto																	
2.2.2	Commissioning of Air Blower/Water Pump/Injection Pump	Ditto																	
2.3	Functional Check																		
2.3.1	Calibrating Sensors and Analyzers	Ditto																	
2.3.2	Setting Control Unit for Proper Range of Operation Parameters	Ditto																	
2.3.3	Turn On the System for Testing the Equipment	Ditto																	
2.4	Performance Check																		

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	

## Testing and Commissioning Progress Chart for Swimming Pool Water Treatment Installation

<b>Testing and Commissioning Progress Chart for Swimming Pool Water Treatment Installation (Rev. )<sup>(1)</sup></b>																				
		Dates <sup>(2)</sup>																	Remark	
Activities	Refer to T & C Procedure		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
2.4.1	Taking Water Samples Periodically	P.S. <sup>(3)</sup>																		
2.4.2	Testing on Water Sample for Proper Residual Chlorine/ Ozone/ORP/Mixed Oxidant and pH Level are Maintained	Ditto & Section 4.3.3																		
2.5	Noise & Sound Check	Section 4.3.7																		
2.6	Vibration Check	Section 4.3.8																		
	Submission of Record of Test																			
3.	Water Distribution System Activities																			
3.1	Cleanliness & State Check	Section 4.2.1 & 4.3.1																		
3.2	Mechanical Check	Ditto																		
3.3	Check System before Filling	Ditto																		
3.4	Electrical Check	Ditto																		
3.4.1	Electrical Supplies Isolated	Ditto																		
3.4.2	Electrical Supplies Available	Ditto																		

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	

## Testing and Commissioning Progress Chart for Swimming Pool Water Treatment Installation

Testing and Commissioning Progress Chart for Swimming Pool Water Treatment Installation (Rev. ) <sup>(1)</sup>																			
		Dates <sup>(2)</sup>																Remark	
Activities	Refer to T & C Procedure	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
3.5	Initial Running of Pump Set	Ditto																	
3.5.1	Pump Discharge Rate	P.S. <sup>(3)</sup>																	
3.5.2	Pump Suction Pressure	Ditto																	
3.5.3	Pump Discharge Pressure	Ditto																	
3.5.4	Pump Motor Speed	Ditto																	
3.5.5	Pump Motor Current	Ditto																	
3.5.6	Supply Voltage	Ditto																	
3.5.7	Non-return Valve Operation	Ditto																	
3.5.8	Isolation Valve Operation	Ditto																	
3.5.9	Flexible Joint	Ditto																	
	Submission of Record of Test																		

### Notes

\* Delete if not applicable

- (1) Insert revision no.
- (2) Insert additional columns as necessary  
S - schedule % completion  
A - actual % completion
- (3) Particular Specification

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	

## Testing and Commissioning Certificate for Swimming Pool Water Treatment Installation

### Part 1 : Details of Project

- 1.1 Project title (with location) :
- 1.2 \* P.W.P. / Project No. :
- 1.3 \*Contract/Sub-contract/Quotation No. :
- 1.4 \* Contractor/Sub-contractor :
- 1.5 PBSE :
- 1.6 PBSI :

### Part 2 : Declaration

- 2.1 I certify that the Swimming Pool Water Treatment Installation as specified in the Contract/Sub-contract/Quotation at the above location has been inspected, tested and commissioned in accordance with this procedure and/or any other procedure(s) agreed between the PBSE and the Contractor. The results are satisfactory in the aspects as mentioned in Part 3 and/or as recorded in Part 4 of this Certificate, except as indicated in the COMMENTS items.
- 2.2 I also certify that site tests have been performed in accordance with the requirements set out in this procedure and that the results are satisfactory. A record of the tests has been prepared and submitted to the PBSE.

(Name of Contractor's Representative)	Signature -		Post :	
			Tel. No. :	
		( )	Date :	
(Designation of Contractor's Representative)	Signature -		Post :	
			Tel. No. :	
		( )	Date :	
(Name and Stamp of Contractor)	Signature -		Post :	
			Tel. No. :	
		( )	Date :	

Note : This certificate must be signed by a person authorized by the Firm/Company.  
\* Delete if not applicable

**Part 3. Items Inspected and Tested**

3.1	General Requirement as indicated in the T & C procedure have been complied	*Yes/No	*Yes/No
3.2	<u>Pre-commissioning Checks</u>		
3.2.1	<u>Water Distribution System</u>		
3.2.1.1	The system has been properly cleaned, flushed and filled with water.	*Yes/No	*Yes/No
3.2.1.2	The equipment associated with the system has undergone mechanical and electrical checks and the results are satisfactory.	*Yes/No	*Yes/No
3.2.2	<u>Filtration System</u>		
3.2.2.1	The filter beds have been properly installed and are level.	*Yes/No	*Yes/No
3.2.2.2	Correct grade and depth of sand has been installed according to the manufacturer's recommendation.	*Yes/No	*Yes/No
3.2.2.3	The pump strainer basket has been properly closed and the lid secured.	*Yes/No	*Yes/No
3.2.2.4	All inspection doors have been properly closed and all valves have been set in their proper positions.	*Yes/No	*Yes/No
3.3	<u>Setting to Work &amp; Balancing</u>		
3.3.1	<u>Water Distribution System</u>		
3.3.1.1	The water pumps have been commissioned in accordance with this procedure and the pumps are operating satisfactorily.	*Yes/No	*Yes/No
3.3.1.2	The water flow rates of the system have been regulated and balanced in accordance with this procedure. The results satisfy the specified requirements.	*Yes/No	*Yes/No
3.3.2	<u>Filtration</u>		
3.3.2.1	The water pumps have been commissioned in accordance with this procedure and the pumps are operating satisfactorily.	*Yes/No	*Yes/No

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	

Annex II

Items tested  
checked by  
Contractor  
\*Yes/No

Items witnessed  
by  
PBSE/PBSI  
\*Yes/No

- 3.3.2.2 The water pumps have been commissioned in accordance with this procedure and the pumps are operating satisfactorily. \*Yes/No \*Yes/No
- 3.3.3 Ozone Generation System
- 3.3.3.1 All pipework has been checked and are found intact. \*Yes/No \*Yes/No
- 3.3.3.2 The relevant occupational safety and health requirements for the ozone generator room have been complied with. \*Yes/No \*Yes/No
- 3.3.3.3 The ozone injector and tubings have been commissioned according to manufacturer's recommendation and are working satisfactorily. \*Yes/No \*Yes/No
- 3.3.3.4 The air blowers and water pumps have been commissioned in accordance with this procedure and the air blowers and water pumps are operating satisfactorily. \*Yes/No \*Yes/No
- 3.3.3.5 The dew point sensor, the oxygen concentration sensor, the pH sensor, the dissolved ozone analyzer, the ORP sensor, and the gaseous ozone leakage sensor are calibrated properly. \*Yes/No \*Yes/No
- 3.3.3.6 Setting and functional checking of the control unit for proper levels of oxidation reduction potential and a minimum contact time value and ppm level for minimum combined residual level. \*Yes/No \*Yes/No
- 3.3.3.7 Turn on the ozone injector and the power supply for testing the equipment is operating satisfactorily. \*Yes/No \*Yes/No
- 3.3.3.8 The pool water has been tested for proper ozone concentration, oxidation reduction potential and pH level. \*Yes/No \*Yes/No
- 3.3.4 Sodium Hypochlorite (or Mixed Oxidant) Generation System
- 3.3.4.1 All pipework has been checked and are found intact. \*Yes/No \*Yes/No
- 3.3.4.2 The relevant fire services as well as occupational safety and health requirements for the electrolytic cell room have been complied with. \*Yes/No \*Yes/No

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	

**Annex II**

		Items tested checked by <u>Contractor</u> *Yes/No	Items witnessed by <u>PBSE/PBSI</u> *Yes/No
3.3.4.3	The chlorine solution supply line has been commissioned according to manufacturer's recommendation and is working satisfactorily.	*Yes/No	*Yes/No
3.3.4.4	The air (hydrogen) blowers and water pumps have been commissioned in accordance with this procedure and the air blowers and water pumps are operating satisfactorily.	*Yes/No	*Yes/No
3.3.4.5	The liquid level sensors, the brine concentration sensor, the pH sensor, the free chlorine (mixed oxidant) analyzer, the ORP sensor, and the gaseous hydrogen leakage sensor, are calibrated properly.	*Yes/No	*Yes/No
3.3.4.6	Setting and functional checking of the control unit for proper levels for breakpoint chlorination condition and for minimum combined residual level and pH value.	*Yes/No	*Yes/No
3.3.4.7	Turn on the power supply for testing and the equipment is operating satisfactorily.	*Yes/No	*Yes/No
3.3.4.8	The pool water has been tested for proper residual chlorine (or mixed oxidant) level and pH level.	*Yes/No	*Yes/No
3.3.5	<u>Ultra Violet Light Disinfection System</u>		
3.3.5.1	All pipeworks have been checked and are found intact.	*Yes/No	*Yes/No
3.3.5.2	The relevant occupational safety and health requirements for the ultra violet light chamber room have been complied with.	*Yes/No	*Yes/No
3.3.5.3	The temperature thermostat is calibrated properly.	*Yes/No	*Yes/No
3.3.5.4	Setting and functional checking of the control unit for proper dosages.	*Yes/No	*Yes/No
3.3.5.5	Turn on the ozone injector and the power supply for testing the equipment is operating satisfactorily.	*Yes/No	*Yes/No
3.3.5.6	The pool water has been tested for acceptable microbiology and pH level.	*Yes/No	*Yes/No

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	

## Annex II

		Items tested checked by <u>Contractor</u>	Items witnessed by <u>PBSE/PBSI</u>
3.3.6	<u>Hot Water Boiler &amp; Calorifier System</u>		
3.3.6.1	The hot water boiler and calorifier system have been commissioned and tested.	*Yes/No	*Yes/No
3.3.7	<u>Pool Cleaning Equipment</u>		
3.3.7.1	The pool cleaning equipment as specified has been provided and the performance of these equipment have been checked.	*Yes/No	*Yes/No
3.3.7.2	Other associated facilities required for the operation of these equipment have been provided.	*Yes/No	*Yes/No
3.4	<u>Performance Tests</u>		
3.4.1	A full-load performance test has been carried out. The results are satisfactory.	*Yes/No/N.A.	*Yes/No/N.A.
3.4.2	A full-load performance test has NOT been carried out but it will be carried out during the maintenance period.	*Yes/No/N.A.	*Yes/No/N.A.
3.5	<u>Record of Tests</u>		
	A record of tests as indicated in Annex II Part 4 of this procedure has been completed and submitted to the PBSE.	*Yes/No	*Yes/No

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	



4.1 Test Data

4.1.1 Plant performance can be substantiated only when the test data has been recorded and validated against the design data. Proforma for recording such data can be found in the succeeding pages and these should be properly filled in before submission to the PBSE with any relevant comments related to site conditions.

4.1.2 Water Distribution System4.1.2.1 Pumps

Location	No.	Design	Test
Volume	(l/s)		
No Flow Head	(kPa)		
Full Flow Discharge Head	(kPa)		
Full Flow Suction Pressure	(kPa)		
Full Flow Differential	(kPa)		
Motor Type			
Motor Speed	(rev/s)		
Motor Full-load Current	(amperes & volt)		

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	

4.1.2.2 Filter Beds (Sand)

Location	No.	Design	Test
Filter Area	(m <sup>2</sup> )		
Entering Water Pressure	(kPa)		
Leaving Water Pressure	(kPa)		
Differential Pressure	(kPa)		
Water Quantity	(l/m <sup>2</sup> )		
Equipment Full-load Current	(amperes & volt)		

4.1.2.3 Water Distribution in Pipeworks

Use the water schematic diagram indicating the design figures for flow rate, measure the temperature and insert the test figures in brackets.

4.1.3 Chemical Metering Pumps

Location	No.	Design	Test
Fluid Handling			
Manufacturer			
Model/Type			
Chemical Feed Rate	(l/s)		
Automatic Timer Setting			
Equipment Full-load Current	(amperes & volt)		

4.1.4 Ozonators

Location	No.	Design	Test
Manufacturer			
Model			
Type			
Ozone Generation Rate	(g/s)		
Ozone Concentration	(ppm)		
Equipment Full-load Current	(amperes & volt)		

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	

4.1.5 Sodium Hypochlorite (or Mixed Oxidant) Generators

Location	No.	Design	Test
Manufacturer			
Model			
Type			
Disinfectant Feed Rate	(1/s)		
Disinfectant Concentration	(ppm)		
Equipment Full-load Current	(amperes & volt)		

4.1.6 UV Light Disinfection Systems

Location	No.	Design	Test
Manufacturer			
Model			
Type			
Water Feed Rate	(1/s)		
UV Dosage Rate	(MWs/c m <sup>2</sup> )		
Equipment Full-load Current	(amperes & volt)		

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	

4.1.7 Water Quality

Location of water samples taken :

Manufacturer/model no. of temperature sensor :

Manufacturer's name &amp; model no. of testing kit used :

Time and the date of		pH value		Residual Chlorine Left (ppm) or Oxidation Reduction Potential (mV)	
Measurement Taken	Water Temperature	Design	Test	Design	Test

Tested / Checked by : (Name of Contractor's Representative)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	
Witnessed by : (Name(s) of *PBSE/PBSI)	Signature -  ( )	Post :	
		Tel. No. :	
		Date :	



## List of Calibrated Instruments Necessary for the T & C Works

1. The Contractor shall supply calibrated equipment as stipulated in the Specification of the Contract for the inspection, measuring and testing of the installation. The equipment shall be calibrated by laboratories accredited by the Hong Kong Laboratory Accreditation Scheme (HOKLAS) or other laboratory accreditation schemes as approved by the PBSE.
2. A list of equipment proposed to be used for testing and commissioning must be provided prior to commissioning the work. All equipment that require periodic calibration shall have this carried out before the work is commenced and data sheets on such test instrument indicating the manufacturer's name, model number, latest date of calibration and correction factors shall be submitted to the PBSE for approval. If any item requires re-checking of its accuracy because of the time has elapsed since the previous calibration, this shall be carried out prior to commencing the work.
3. The suggested minimum equipment and instruments necessary to carry out the objectives are:-
  - (a) combination inclined and vertical manometer 0-2000 Pa is generally the most useful;
  - (b) pitot tubes (usually 450 mm and 1200 mm long tube cover most balancing requirements);
  - (c) a tachometer, which should be the high quality, direct contact, self-timing type;
  - (d) clamp-on ampere meter with voltage scales;
  - (e) dial and glass stem thermometers;
  - (f) pressure gauges (Manifold & Single);
  - (g) water pH value colour testing kits; and
  - (h) chlorine gas leakage detector.