

**SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF TEN (10)
LABORATORY ANALYTICAL INSTRUMENTS FOR WATER QUALITY OFFICE OF PUB**

	Page
1. Content Page	TS-1
2. General Specifications	TS-2
3. Technical Specifications	TS-4
Specifications for Schedule I	TS-4
Specifications for Schedule II	TS-7
Specifications for Schedule III	TS-9
Specifications for Schedule IV	TS-12
Specifications for Schedule V	TS-17
Specifications for Schedule VI	TS-23
Specifications for Schedule VII	TS-26
Specifications for Schedule VIII	TS-30
Specifications for Schedule IX	TS-32
Specifications for Schedule X	TS-38

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF TEN (10) LABORATORY ANALYTICAL INSTRUMENTS FOR WATER QUALITY OFFICE OF PUB

GENERAL SPECIFICATIONS

1. GENERAL

- a. This tender consists of **Ten (10)** Schedules of supply. **The Tenderer is invited to take part in any of the Schedules.**
- b. The General Specifications for all Schedules in this Contract shall be read in conjunction with the Specifications for each of the Schedules I to X as stated in the listed pages in previous content page.

2. SCOPE OF TENDER

The tender calls for the supply, delivery, installation and commissioning of ten (10) laboratory analytical instruments to Water Quality Office at 82 Toh Guan Road, WaterHub, Singapore 608576.

3. SCHEDULES OF SUPPLY

The ten (10) Schedules of supply in this tender are as follows:

Schedule I	Supply, Delivery, Installation and Commissioning of One (1) Unit of Automatic Crypto & Giardia Filtration and Elution System
Schedule II	Supply, Delivery, Installation and Commissioning of One (1) Unit of Vertical Steam Sterilizer
Schedule III	Supply, Delivery, Installation and Commissioning of One (1) Unit of Double Beam Spectrophotometer
Schedule IV	Supply, Delivery, Installation and Commissioning of One (1) Unit of High Resolution/Accurate Mass Gas Chromatograph-Mass Spectrometer (HR/AM GC-MS) System
Schedule V	Supply, Delivery, Installation and Commissioning of One (1) Unit of Ultra High Performance Liquid Chromatograph System (UHPLC)
Schedule VI	Supply, Delivery, Installation and Commissioning of One (1) Unit of Ultrapure Water Purification System for Cell Culture and Molecular Biology Work
Schedule VII	Supply, Delivery, Installation and Commissioning of One (1) Unit of Ultrapure Water Purification System for Elemental Analysis
Schedule VIII	Supply, Delivery, Installation and Commissioning of One (1) Unit of Automatic Sample Preparation Unit for Existing Total Organic Halogens (TOX) Analyser

Schedule IX	Supply, Delivery, Installation and Commissioning of One (1) Unit of Inductively Coupled Plasma with Optical Emission Spectrometer (ICP-OES) System
Schedule X	Supply, Delivery, Installation and Commissioning of One (1) Unit of High Pressure Ion Chromatograph (IC) System

4. DEVIATIONS

The Technical Specifications should be strictly complied with and any deviations shall be clearly stated by the Tenderer in the **Schedule of Deviations**. Absence of comment in the Tenderer's submission shall be deemed as compliance with the requirements of the Technical Specifications.

5. INSURANCES AND CLAIMS PROCEDURE

- a) The Contractor shall note that the Board has made special arrangements under the Contract for the following insurances:
 - i. Contractor's All Risks including Third Party Insurance; and
 - ii. Work Injury Compensation Insurance
- b) In the event of any claims, the Contractor shall comply with the Claims Procedure for Contractors' All Risks and Work Injury Compensation Insurances included in Supplement 1

TECHNICAL SPECIFICATIONS

1. SPECIFICATIONS FOR SCHEDULE I

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF ONE (1) UNIT OF AUTOMATIC CRYPTO & GIARDIA FILTRATION AND ELUTION SYSTEM

The automatic Crypto & Giardia filtration and elution system supplied shall include scope of work specified in clause 1.1 and the system shall comply with the technical specifications specified in clause 1.2.

1.1 SCOPE OF WORK

The scope of work shall include but not limited to the following:

- 1.1.1 Supply, delivery, installation and commissioning of one unit of automatic Crypto & Giardia filtration and elution system
- 1.1.2 Provision of all necessary consumables, spare parts and accessories for setup, calibration and training of the automatic Crypto & Giardia filtration and elution system
- 1.1.3 Provision of comprehensive hands-on training for the Board's laboratory officers on-site at the PUB Water Quality Laboratory at the Contractor's own cost. The training program shall at least include hands-on operation, trouble shooting and routine maintenance of the automatic Crypto & Giardia filtration and elution system
- 1.1.4 Carrying out all other work not specified herein for the successful commissioning of the entire system

1.2 TECHNICAL SPECIFICATIONS

- 1.2.1 The automatic Crypto & Giardia filtration and elution system shall provide an automatic and fast technology solution for the filtration and elution of crypto oocysts and giardia cysts in various water matrices samples. The main part of the system, Pressure Elution Station, shall comply with the following specifications:
 - a. The system is accepted by the standard Crypto & Giardia method of US EPA 1623
 - b. Effectively capture and recover Crypto oocysts and Giardia cysts from a wide range of water matrices
 - c. Designed for use with 10 – 1,000 L water samples
 - d. Automatic elution of Crypto oocysts and Giardia cysts from foam filter module in less than 2 minutes
 - e. Uses air pressure to force a specifically developed elution buffer through the filter
 - f. Pressure elution system comes with outlet diverter (5-pack), power cord, hose kit, buffer reservoir bottles (one 10 L bottle and one 4 L bottle) and accessory kit
 - g. Filter modules are used with a reusable housing with fittings, housing tools, and sampling kit
- 1.2.2 The filter module part of the system shall comply with the following specifications:
 - a. Comprises of 40 reticulated foam discs with diameter of 5.5cm, and 39 discs with a diameter

of 4.0cm. All discs are 1cm in depth

- b. Discs are stacked alternately to a height of 79cm, then compressed to a height of 3.0cm
- c. A retaining bolt maintains the compression, with the outer region at a 13.3X compression ratio, and an inner core with a compression ratio of 26.6X
- d. Outer region of filter module acts as a pre-filter, inner core acts as a barrier
- e. Majority of target organisms become trapped at interface between the inner and outer regions, with larger particulates caught in the pre-filter

1.2.3 The peristaltic pump part of the system shall comply with the following specifications:

- a. Includes LoadSure Marprene 6.4 mm quick release element, and 15 m Marprene tubing (15 m x 8.0 mm (ID) x 2.4 mm (WT))
- b. Colour display and intuitive menu structures with visual status indication and minimal key presses
- c. Choice of flow-rate or speed display
- d. Full calibration with choice of flow units
- e. Flow rates up to 1,500 mL/min at 4 bar peak pressure
- f. Quick-release industrial Tri-clamp LoadSure elements for 2-4 bar operation
- g. 2200:1 speed control range from 0.1 to 220 rpm in 0.1 rpm increments
- h. 3-level security PIN lock
- i. IP31

1.2.4 The air compressor part of the system shall comply with the following specifications:

- a. Oil free
- b. Automatic stop/start controls
- c. Four-pole motor eliminates high-pitched whine normally associated with direct drive compressors
- d. Sound insulation
- e. Motor overload protection
- f. Lightweight design

1.2.5 The Contractor shall also supply all consumables and accessories necessary for the start-up, calibration and use of the automatic Crypto & Giardia filtration and elution system including, but not limited to, the following consumables and accessories:

- a. 4 sets of sampling kit;
- b. 4 sets of housing with fittings;
- c. 2 sets of housing tools;
- d. 10 packs of filter modules

1.3 WARRANTY

The system supplied shall be guaranteed against inaccuracy, poor performance and workmanship used for a period of **twelve (12) months** from the date of successful commissioning of the system. During the warranty period, the Contractor shall provide unlimited on-site breakdown services, and supply and replacement of parts (excluding consumable parts). All labor costs shall be included in the tender sum.

1.4 POWER REQUIREMENT

All cables, plugs and wires necessary for the equipment to function must be supplied. The power supply should be 230V and 50Hz AC, 13A electrical line directly or suitable to be connected to the existing power point of the laboratory where the automatic Crypto & Giardia filtration and elution system will be placed. External transformer is not acceptable.

1.5 TRAINING

The Contractor shall provide hands-on comprehensive training either at the PUB laboratory or at their local training centre at the Contractor's own cost. The training program shall at least include hands-on operation, trouble shooting and routine maintenance of the automatic Crypto & Giardia filtration and elution system. One set of training materials (softcopy or hardcopy) shall be provided for each trainee in the beginning of the training. **Details of the training program and schedule** shall be submitted together with the tender.

1.6 AFTER SALES SERVICES

The Contractor shall provide full **details of after sales services** and response time in the supply, replacement, repairing and servicing of the automatic Crypto & Giardia filtration and elution system supplied. Tenderer without the proper license, facility or experience to carry out the **after sales services** for the automatic Crypto & Giardia filtration and elution system would not be considered under this tender.

1.7 SCHEDULE OF DEVIATIONS

The specifications shall be strictly complied with and any deviations shall be clearly stated by the Contractor in **the Schedule of Deviations**. Absence of comment in the Contractor's submission shall be interpreted as acceptance and compliance with the requirements of the specifications. Details of these deviations shall be furnished in the Deviations.

1.8 PLACE AND PERIOD OF DELIVERY

The Contractor shall deliver, install and commission the automatic Crypto & Giardia filtration and elution system complete with accessories and consumable materials as specified under the Scope of Work and Technical Specifications to Public Utilities Board, 82 Toh Guan Road East, WaterHub, Level 2, #C2-04, Singapore 608576, within **4 months** from **Date of Commencement** as specified in the **Letter of Acceptance**.

2. SPECIFICATIONS FOR SCHEDULE II

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF ONE (1) UNIT OF VERTICAL STEAM STERILIZER

The Vertical Steam Sterilizer supplied shall include scope of work specified in clause 2.1 and the system shall comply with the technical specifications specified in clause 2.2.

2.1 SCOPE OF WORK

The scope of work shall include but not limited to the following:

- 2.1.1 Supply, delivery, installation and commissioning of one unit of vertical steam sterilizer with digital printer device as specified in 2.2.1
- 2.1.2 Provision of all necessary consumables as specified in 2.2.2 including steam generation, vacuum pump, drying cycle and accessories required for the installation and commissioning of the system, when necessary.
- 2.1.3 Carrying out all other works not specified herein for the successful commissioning of the system

2.2 TECHNICAL SPECIFICATIONS

2.2.1 Vertical Steam Sterilizer

The vertical steam sterilizer shall consist of the following features:

- a. Up loading
- b. Pre & post vacuum sterilizer
- c. Capacity : 133 liters
- d. Chamber size : at least 500mm ϕ x 680mm D
- e. External size : approx. 686mmW x 1034mmH x 870mmD
- f. Automatic open/close lid by one butto
- g. Automatic water fee
- h. With floating sensor
- i. With digital printer
- j. With USB connector
- k. Safety interlock mechanism
- l. Programmable auto-start
- m. Programmable time for air removal
- n. Power supply : AC 380-440V, 50/60Hz, 3-phase
- o. Standard compliance : ISO 9001/13485/14001for the safety of autoclave

- p. The system shall come with one year warranty
- q. The supplier shall provide the MOM application and registration for the unit

2.2.2 Accessories

The Contractor shall provide necessary accessories required for the successful installation and commissioning of the vertical steam sterilizer system.

2.3 TRAINING

The Contractor shall provide hands-on comprehensive training either at the PUB laboratory or at their local training centre at the Contractor's own cost. The training program shall at least include hands-on operation, trouble shooting and routine maintenance of the system. One set of training materials (softcopy or hardcopy) shall be provided for each trainee in the beginning of the training. **Details of the training program and schedule** shall be submitted together with the tender.

2.4 POWER REQUIREMENT

All cables, plugs and wires necessary for the equipment to function shall be supplied. The power supply shall be AC 410V 3 phase – 32 amp.

2.5 WARRANTY

The system supplied shall be guaranteed against inaccuracy, poor performance and workmanship used for a period of **twelve (12) months** from the date of commissioning of the systems.

2.6 AFTER SALES SERVICES

The Contractor shall provide full **details of after sales services**, respond time and price in the tender proposal for the supply, replacement, repairing and servicing of the vertical steam sterilizer supplied. The Tenderer without the proper facility or experience to carry out the after sales services for the system would not be considered under this tender.

2.7 SCHEDULE OF DEVIATIONS

The specifications shall be strictly complied with and any deviations shall be clearly stated by the Contractor in **the Schedule of Deviations**. Absence of comment in the Contractor's submission shall be interpreted as acceptance and compliance with the requirements of the specifications. Details of these deviations shall be furnished in the Deviations.

2.8 PLACE AND PERIOD OF DELIVERY

The Contractor shall deliver, install and commission the vertical steam sterilizer complete with accessories as specified under the Scope of Work and Technical Specifications to Public Utilities Board, 82 Toh Guan Road East, WaterHub, Level 2, #C2-04, Singapore 608576, within **4 months** from **Date of Commencement** as specified in the **Letter of Acceptance**.

3. SPECIFICATIONS FOR SCHEDULE III

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF ONE (1) UNIT OF DOUBLE BEAM SPECTROPHOTOMETER

The supply of one unit of Double Beam Spectrophotometer shall include scope of work specified in clause 3.1 and the system shall comply with the technical specifications specified in clause 3.2.

3.1 SCOPE OF WORK

The scope of work for the unit shall include but not limited to the following:

- 3.1.1 Supply, delivery and commissioning of a double beam spectrophotometer to PUB (Public Utilities Board)
- 3.1.2 Provision of all necessary consumables and accessories, calibration and performance check of the double beam spectrophotometer.
- 3.1.3 Carrying out all other works not specified herein for the successful commissioning of the entire system.

3.2 TECHNICAL SPECIFICATIONS

3.2.1 Double Beam Spectrophotometer

- a. The spectrophotometer must be double beam design.
- b. The system must have concave holographic grating with 1053 lines/mm.
- c. Wavelength range of 190 to 1100nm.
- d. Bandwidth should be variable from 0.5, 1, 2 and 4 nm.
- e. Wavelength accuracy should be +0.1nm at D2 peak, 656.1 nm.
- f. Wavelength reproducibility should be +0.05nm at D2 peak, 656.1 nm.
- g. Photometric accuracy should be + 0.003A at 1 A, measured with NIST 930D filters
- h. Stray radiation should be less than 0.01%T at 220 (NaI), 340 (NaNO₂) and 370 (NaNO₂) nm
- i. Photometric reproducibility should be less than 0.001 A (maximum deviation of 10 measurements at 1 A)
- j. Photometric stability should be less than 0.00015 A/ hour (stability at 1 A, at 500 nm with 2-sec response time)
- k. Photometric noise at 500 nm (RMS) should be less than 0.00005 A
- l. Baseline flatness at 1nm slit should be +0.001 A
- m. Photometric system must be of double beam optics type and lens-free system to reduce chromatic aberrations
- n. The instrument should include one set of holmium oxide glass filter for wavelength accuracy that covers wavelength 279, 361, 453, 536 and 638 nm. The glass filter should come with a NIST traceable DAkkS certificate
- o. The instrument should have a compatible fiber optic probe module which includes the dip probe body and coupler and 3 units of replaceable tips in standard pathlengths of 10 mm

- p. The instrument must include fully integrated Scan, Timedrive, Wavelength program data collection modes with real-time spectral display
- q. The software should include the following methods as standard: Warburg-Christian Assay for Protein and Nucleic Acid concentration, Bradford Protein Assay and Lowry Protein Concentration
- r. The software must have macro to allow the user to automatically process their user-defined calculations
- s. The instrument must be able to connect to and compatible with existing workstation installed with Microsoft® Windows® 7 Professional 64 bit

3.3 SERVICE AND WARRANTY

- a. Tendered price should include delivery, installation, commissioning and training.
- b. Twelve (12) months on-site comprehensive warranty against defective parts (inclusive of parts, labor, transport, etc.) from the date of commissioning of the system.**
- c. Twelve (12) months free on-site technical support and maintenance service (inclusive of transport & manpower) from the date of commissioning of the system.**
- d. Contractor to provide service guarantee: The Tenderer must have a back-up unit that is available for users to use in the event of instrument down-time or replacement of instrument for free in three working days.**
- e. The Contractor must have a local dedicated team of support from direct manufacturer for optimum support of the system

3.4 TRAINING

- a. The Contractor has to oversee overall systems integration, site preparation, installation and necessary configuration of the system.
- b. The Contractor must provide on-site familiarization.
- c. The Contractor must provide on-site training for the users. The training programme shall at least include hands-on operation, trouble shooting and routine maintenance.
- d. The Contractor must provide additional classroom training at the Contractor's site.
- e. Details of the training program and schedule** shall be submitted together with the tender.

3.5 POWER REQUIREMENT

All cables, plugs and wires necessary for the equipment to function must be supplied. The power supply should be 230 V and 50Hz AC, 13A electrical line directly or suitable to be connected to the existing power point of the laboratory where the spectrophotometer and accessories will be placed. External transformer is not acceptable.

3.6 SCHEDULE OF DEVIATIONS

The specifications shall be strictly complied with and any deviations shall be clearly stated by the Contractor in the **Schedule of Deviations**. Absence of comment in the Contractor's submission shall be interpreted as acceptance and compliance with the requirements of the specifications. Details of these deviations shall be furnished in the Deviations.

3.7 AFTER SALES SERVICES

The Contractor shall provide full **details of after sales services**, response time and price quoted in the supply, replacement, repairing and servicing of the spectrophotometer. Tenderer without the proper licence, facility or experience to carry out the after sales services for the spectrophotometer would not be considered under this tender.

3.8 PLACE AND PERIOD DELIVERY

The Contractor shall deliver, install and commission the spectrophotometer with accessories and consumable materials as specified under the Technical Specifications to Public Utilities Board, 82 Toh Guan Road East, WaterHub, Level 2, #C2-02, Singapore 608576, within **4 months** from **Date of Commencement** as specified in the **Letter of Acceptance**.

4. SPECIFICATIONS FOR SCHEDULE IV

SUPPLY, DELIVERY AND COMMISSIONING OF ONE (1) UNIT OF HIGH RESOLUTION/ACCURATE MASS GAS CHROMATOGRAPH-MASS SPECTROMETER (HR/AM GC-MS) SYSTEM

The High Resolution/Accurate Mass Gas Chromatograph-Mass Spectrometer (HR/AM GC-MS) system supplied shall be capable of identifying non-targeted and quantifying targeted organic contaminants at ultra-trace level in water samples using accurate mass and high resolution. The supply of HR/AM GC-MS system shall include scope of work specified in clause **4.1** and the system shall comply with the technical specifications specified in clause **4.2**.

4.1 SCOPE OF WORK

The scope of work shall include but not limited to the following:

- 4.1.1 Supply, delivery and commissioning of one HR/AM GC-MS system complete with gas chromatograph system with one unit of split/splitless inlet, liquid autosampler, high resolution/accurate mass Mass Spectrometer with electron ionization mode and chemical ionization mode, software for instrument control, data acquisition, storage, processing and reporting, two PCs, printer, instrument installation relevant work including instrument configuration, gas line configuration and bench configuration, accessories and consumables.
- 4.1.2 Provision of starter and calibration kit, all necessary accessories and consumables for commissioning, calibration and performance check of the HR/AM GC-MS system.
- 4.1.3 Provision of hands-on comprehensive training for at least 4 laboratory officers either at the PUB laboratory or at their local training centre at the Contractor's own cost. The training programme shall at least include hands-on operation, trouble shooting and routine maintenance of the HR/AM GC-MS system. One set of training materials (softcopy or hardcopy) shall be provided for each trainee in the beginning of the training. Details of the training programme and schedule shall be submitted together with the tender.
- 4.1.4 Carrying out all other work not specified herein for the successful commissioning of the entire system.

4.2 TECHNICAL SPECIFICATIONS

4.2.1 Gas Chromatograph

4.2.1.1 Split/splitless Inlet

- a. The GC should be supplied with one unit of split/splitless inlet.
- b. Must be suitable for all capillary columns.
- c. Split ratio set point up to 7500:1.
- d. Must support up to 2 operating modes: split, splitless.
- e. Maximum operating temperature up to 400°C.
- f. Electronic pneumatic controls, which are integral part of injector and detector modules, are needed to operate electrical valves, and deliver carrier, detector and make-up gases to

injectors and detectors. The digital carrier gas controller allows operating in constant and programmed flow and pressure modes.

- g. Should have gas saver mode to reduce gas consumption without compromising performance.
- h. Inlet sealing system is built in standard with each inlet for quick, easy, injector liner changes.
- i. Chemical de-activated inert inlet must be available together with suitable inert consumable supplies (inert liner and inert gold seal etc) to improve data/peak quality and reduce the system maintenance.

4.2.1.2 Oven

- a. Oven operating range can be from ambient temperature + 4°C or + 3°C to 450°C.
- b. Oven temperature set point resolution must be 0.1°C.
- c. Oven cools down 450°C to 50°C in less than 4.0 min.
- d. Oven power must turn-off automatically when the lid/door is opened.

4.2.1.3 Liquid Autosampler

- a. Must be able to house at least 150 2-mL sample vials.
- b. Must allow installation and automation of syringes featuring volumes from 0.5 to 500 µL.
- c. Must have the capability to rinse the syringe both pre and post injection with 2 separate solvents, A & B, for each solvent.

4.2.2 High Resolution/Accurate Mass Spectrometer

4.2.2.1 Ionization Source

- a. The mass spectrometer must include sources capable of electron ionization, positive ion chemical ionization and negative ion chemical ionization.
- b. The ion sources include dual filaments, programmable from 50 to 350 °C.
- c. The user of the mass spectrometer must be able to remove all MS parts that require routine cleaning without venting manifold.
- d. The mass spectrometer must be able to change from a dedicated electron ionization source to a dedicated chemical ionization source within two minutes without venting manifold.

4.2.2.2 Sensitivity

EI Full Scan MS:

- a. 1 µL of 100 fg/µL octafluoronaphthalene (OFN) will produce a minimum signal-to noise of 10,000:1 at a minimum resolution of 50,000 (FWHM) and a mass error of less than 1 part per million (ppm) while scanning from m/z 50 to m/z 300.
- b. 1 µL of 10 fg/µL octafluoronaphthalene (OFN) will produce a minimum signal-to-noise of 1,000:1.
- c. The area precision of eight sequential injections of 1 µL, 10 fg/µL OFN will result in an instrument detection limit (IDL) of 6 fg or less (OFN) derived at the 99% confidence level.

4.2.2.3 Mass Resolution

The mass spectrometer must have a maximum resolution of at least 50,000 (FWHM) at m/z 272 for all scan modes and both polarities.

4.2.2.4 Mass Accuracy

The mass spectrometer must provide mass accuracies of less than 3 ppm of average mass error.

4.2.2.5 Dynamic Range

The mass spectrometer must have quantitative dynamic range of $>10^5$.

4.2.2.6 Mass range

The mass spectrometer must operate in the mass range of 50 – 3000 m/z.

4.2.2.7 Scan rate

The mass spectrometer must operate at scan rate up to 18 Hz at 12,500 resolution (@272 m/z) or can be selectable from 1 to 50 spectra/sec.

4.2.2.8 Polarity Switching

The mass spectrometer must be capable of switching between positive and negative chemical ionization during successive scans.

4.2.2.9 Vacuum System

The mass spectrometer must have a differentially-pumped vacuum system in ion source and mass analyzer regions.

4.2.3 Data System, PC and Printer

The system must include a Windows®-based data acquisition and editing software package that incorporates a graphical user interface utilizing multi-pane windows for easy data acquisition and analysis. The results generated from the HR/AM GC-MS system must be able to be captured by the lab's existing STARLIMS data management system seamlessly.

4.2.3.1 Data System

- a. The supplied software must support quantitation, targeted and non-targeted screening, and high resolution de-convolution with accurate mass library search.
- b. NIST spectral library and the environmental contaminants accurate mass library created by the Contractor should be provided.
- c. The system software must provide the creation of custom compound databases as well as the utilization of databases provided by the Contractor.

4.2.3.2 PC and Printer

Two sets of desktop PCs must be supplied and setup with the following minimum requirements and configurations, one for data acquisition, the other one for data processing.

a. PC

- 1) Latest Generation Core i7 (6700) CPU (or better)
- 2) Memory: minimum 16 GB RAM
- 3) Hard Drives: 2 x 1TB hard disk drives or better
- 4) DVD RW
- 5) Minimum of 6 USB (2.0 & 3.0) Ports
- 6) Minimum of 2 Ethernet connections

- 7) Microsoft® Windows® 7 Professional (64 Bit) or better; software free upgrade to Windows 10 whenever available
- 8) 23" LCD monitor
- 9) Microsoft office software installed
- 10) System documentation kit
- 11) USB Optical Scroll Mouse
- 12) Internet Keyboard

b. Laser printer

- 1) Print speeds up to 42 ppm (Letter) & 40 ppm (A4).
- 2) Fast Resolution 1200 (up to 1200 x 1200 dpi).
- 3) Processor speed 800 MHz, memory 256 MB.
- 4) Hi-Speed USB 2.0. Std.
- 5) Must have double side print function

4.2.4 Others

4.2.4.1 GC Mass Spectrometer must come with following accessories:

- a. Kit for GCs gas purifiers, Includes leak detection fluid, swage-type fittings, copper tubing, syringes, screw-drivers and wrenches.
- b. Universal Helium trap.
- c. Oven exhaust deflector to deflects the oven hot-air exhaust in the back of the GC from a horizontal direction to an upward direction and allows connection to a venting system

4.2.4.2 Chromatography Columns

- a. HP-5MS UI Capillary Column (30 m x 0.25 mm x 0.25 µm) or equivalent, 6 units
- b. Evaluation results (such as sensitivity, resolution, mass accuracy of analytes) provided by vendors for tested samples will be taken into consideration.

4.2.4.3 Technical and Applications Support

The Contractor must provide **local** technical and application support to minimize downtime of the HR/AM GC-MS system and ensure high productivity of the lab.

4.3 WARRANTY

The system supplied shall be guaranteed against inaccuracy, poor performance and workmanship used for a period of **twelve (12) months** from the date of successful commissioning of the system. During the warranty period, the Contractor shall provide unlimited on-site breakdown services, and supply and replacement of parts (excluding consumable parts). All labour costs shall deem to be included in the tender sum.

4.4 POWER REQUIREMENT

All cables, plugs and wires necessary for the equipment to function must be supplied. The power supply should be 230V and 50Hz AC, 13A electrical line directly or suitable to be connected to the existing power point of the laboratory where the HR/AM GC-MS system will be placed. External transformer is not acceptable.

4.5 AFTER SALES SERVICES

The Contractor shall provide full **details of after sales services** and response time in the supply, replacement, repairing and servicing of the HR/AM GC-MS system supplied. Tenderer without the

proper license, facility or experience to carry out the after sales services for the HR/AM GC-MS system would not be considered under this tender.

4.6 TRAINING

The Contractor shall provide hands-on comprehensive training either at the PUB laboratory or at their local training centre at the Contractor's own cost. The training program shall at least include hands-on operation, trouble shooting and routine maintenance of the system. One set of training materials (softcopy or hardcopy) shall be provided for each trainee in the beginning of the training. **Details of the training program and schedule** shall be submitted together with the tender.

4.7 SCHEDULE OF DEVIATIONS

The specifications shall be strictly complied with and any deviations shall be clearly stated by the Contractor in **the Schedule of Deviations**. Absence of comment in the Contractor's submission shall be interpreted as acceptance and compliance with the requirements of the specifications. Details of these deviations shall be furnished in the Deviations.

4.8 PLACE AND PERIOD OF DELIVERY

The Contractor shall deliver, install and commission the HR/AM GC-MS system complete with accessories as specified under the Scope of Work and Technical Specifications to Public Utilities Board, 82 Toh Guan Road East, WaterHub, Level 4, #C4-04, Singapore 608576, within **4 months** from **Date of Commencement** as specified in the **Letter of Acceptance**.

5. SPECIFICATIONS FOR SCHEDULE V

SUPPLY, DELIVERY AND COMMISSIONING OF ONE (1) UNIT OF ULTRA HIGH PERFORMANCE LIQUID CHROMATOGRAPH SYSTEM (UHPLC)

The system must come from a reputable brand in the market with direct manufacturer support engineer, application and logistics locally. It must have a strong track record for reliability, robustness and reproducibility.

The ultra-high performance liquid chromatograph system (UHPLC) supplied shall be capable of performing target quantitative analysis, non-target screening for organic contaminants in water samples. The supply of UHPLC system shall include scope of work specified in clause 5.1 and the system shall comply with the technical specifications specified in clause 5.2.

5.1 SCOPE OF WORK

The scope of work shall include but not limited to the following:

- 5.1.1 Supply, delivery and commissioning of a UHPLC system complete with UHPLC pump with built-in sample introduction system, solvent delivery system, DAD detector, column oven, solvent degasser, software for instrument control, one computer system for hardware control and data handling, printer, instrument installation relevant work including instrument configuration, gas line configuration and bench configuration, accessories and consumables.
- 5.1.2 Provision of starter and calibration kit, all necessary accessories and consumables for commissioning, calibration and performance check of the UHPLC system.
- 5.1.3 Provision of hands-on comprehensive training for at least 4 laboratory officers either at the PUB laboratory or at their local training centre at the Contractor's own cost. The training programme shall at least include hands-on operation, trouble shooting and routine maintenance of the UHPLC system. One set of training materials (softcopy or hardcopy) shall be provided for each trainee in the beginning of the training. Details of the training programme and schedule shall be submitted together with the tender.
- 5.1.4 Carrying out all other work not specified herein for the successful commissioning of the entire system.

5.2 TECHNICAL SPECIFICATIONS

5.2.1 HIGH PERFORMANCE LIQUID CHROMATOGRAPH

5.2.1.1 Sample Introduction system

- a. The autosampler design should be a flow through design with variable injection volume
- b. Injection volume: 0.1 – 100 µL in 0.1 µL increment
- c. Injection precision: < 0.25% RSD from 2- 20 µL
- d. Operation Pressure range: up to 1200 bar at 2 ml/min
- e. Must be capable of very fast injection time of 10 sec/sample
- f. injection cycle time: < 25 s with need wash

- g. Sample carryover: < 0.005%
- h. Should be able to use four different solvents for effective rinsing
- i. Controlled sample environment over a range of 4 – 40 °C.
- j. Number of samples to be processed automatically, random, up to at least 100 for 1.5ml
- k. Should have safety features like leak sensor and automatic rack and vial recognition. Maintenance kit should be available

5.2.1.2 Solvent Delivery System

- a. Pump system: Ultra High-Pressure Binary gradient pump
- b. Hydraulic system: two dual pistons in series pumps
- c. Flow range: 0.001 – 2 mL/min, in 1 uL/min increments
- d. Flow precision: less than $\pm 0.07\%$ RSD or 0.005 min SD, whatever is greater
- e. Flow accuracy: $\pm 1\%$ or 10 μ L/min whatever is greater
- f. Maximum operating pressure: 1200 bar up to 2 mL/min
- g. Pressure pulsation: <1% amplitude or <5 bar whichever is greater
- h. Compressibility compensation: automatic, pre-defined, based on mobile phase selection
- i. pH range: 1.0 — 12.5
- j. Composition range: settable range: 0.0 – 100.0%
- k. Composition precision: < 0.15 % RSD or 0.01 min SD whatever is greater
- l. Composition accuracy: $\pm 0.35\%$ absolute from 5-95%
- m. Integrated Degassing Unit: 2 channels
- n. Materials in contact with solvent: Teflon AF, PEP, PPS
- o. Supply maintenance kit, reservoir tray (with 4 solvent bottles complete with fittings) & automatic rinsing kit
- p. Must have a leak sensor as safety feature
- q. Should have functions for maintenance and validation which are accessible by a dedicated operation button

5.2.1.3 Column Compartment

- a. Should be uniform temperature distribution with a quick feedback mechanism to maintain constant temperature when power source voltage fluctuate
- b. Temperature range: 10 °C above ambient to 80 °C in 0.1°C steps
- c. Temperature stability: ± 0.05 °C for flow rates between 0.2 and 2 ml/min
- d. Temperature set point accuracy: ± 0.8 °C
- e. Heat-up rate: within 5 min from ambient to 40 °C
- f. Can house up to minimum 2 columns with built in column switching valve
- g. Should have built-in slots for valve control function
- h. Should be able to handle column length from 10-250 mm
- i. The oven should have temperature limit device and temperature fuse and a solvent leak

sensor.

5.2.1.4 Solvent Degasser

- a. On-line vacuum type
- b. Maximum flow rate: 2 ml/min per channel
- c. Should have at least 2 independent channels
- d. Error status should be fed back to system software
- e. Must have a leak sensor as a safety feature
- f. Should include a drain pan
- g. Should be equipped with Self-cleaning capacity that extends vacuum pump life by drawing in air when the pump is running

5.2.1.5 Diode Array Detector

- a. Multiple wavelength and full spectral detection with up to 80 Hz data rates allows precise identification, quantification and purity analysis at trace levels for ultra-fast LC separations
- b. Deuterium light source
- c. Wavelength range should be from 190-500 nm, accuracy should be ± 1 nm, self calibration with deuterium lines
- d. Diode width: 0.5 nm and slit width should be 4nm (fixed)
- e. Wavelength bunching programmable 2-400 nm, in steps of 1 nm
- f. Data analysis software for spectra evaluation, including spectral libraries and peak purity function
- g. Extensive diagnostic, error detection and display, leak detection, safe leak handling, leak output signal for shutdown of pumping system
- h. Electronic temperature control for complete optical unit

5.2.2 COMPUTER SYSTEM FOR HARD WARE CONTROL AND DATA HANDLING

The system must include a Windows®-based data acquisition and editing software package that incorporates a graphical user interface utilizing multi-pane windows for easy data acquisition and analysis. The results generated from the UHPLC system must be able to be captured by the lab's existing STARLIMS data management system seamlessly.

5.2.2.1 System control and data handling software

- a. Must be able to provide fully integrated control for both the ultra-high performance liquid chromatograph (UHPLC) system.
- b. Should acquire up to 24 hours for one analysis.
- c. Has on-line help for instrument control programs as well as user manual in PDF file format.
- d. It should cover digital instrument control, qualitative and quantitative processing, report creation, self-diagnosis.
- e. Zoom scan capability for achieving higher resolution of chromatography.
- f. The self-diagnosis feature of the software should enable diagnosis of the detector and all connected LC units.

- g. Method file should be capable to save all analysis parameters, data processing parameters and report format.
- h. The setting parameters of data acquisition and data analysis/ reporting for existing/remaining compounds should not be affected by the addition or deletion of compounds.
- i. Auto Start up and shutdown of the UHPLC should be possible using a single key operation.
- j. Sample schedule wizard function should be standard.

5.2.2.2 Minimum requirements of computer and printer

- a. Latest Generation Core i7 (6700) CPU (or better)
- b. Memory: minimum 8 GB RAM
- c. Hard Drive: 1TB hard disk drive or better
- d. DVD RW
- e. Minimum of 6 USB (2.0 & 3.0) Ports
- f. Minimum of 2 Ethernet connections
- g. Microsoft® Windows® 7 Professional (64 Bit) or better; software free upgrade to Windows 10 whenever available
- h. 21" LCD monitor
- i. Microsoft office software installed
- j. System documentation kit
- k. USB Optical Scroll Mouse
- l. Keyboard
- m. Laser jet printer with specification of
 - Print speeds up to 42 ppm (Letter) & 40 ppm (A4).
 - Fast Resolution 1200 (up to 1200 x 1200 dpi).
 - Processor speed 540 MHz, memory 128 MB.
 - Hi-Speed USB 2.0. Std.

5.2.2.3 Others

- a. UHPLC tool kit
- b. Plastic tubing cutter
- c. Different capillary tubing which is :
 - from column to DAD cell (2 pieces)
 - port valve to column (2 pieces)
- d. Peek tubing:
 - ID 0.18mm, length 1.5m (4 pieces)
 - ID 0.13mm, length 1.5m (4 pieces)
- e. Column cartridge for following HPLC column (3 units)
- f. Chromatography Columns
 - HPLC column (C18, 2.6 μ m, 4.6 x 150mm) or equivalent, 2 units).

- HPLC column (C8, 2.6 um, 4.6 x 100mm or equivalent, 2 units).
 - HPLC column (C8, 2.6 um, 2.1 x 150mm or equivalent, 4 units)
- g. System includes installation kit and maintenance kit.
- h. System shall have a ten year value guarantee such that vendor shall have ten years' guaranteed parts and comprehensive service available or give residual value credit for replacement.

5.3 TRAINING

The Contractor shall provide hands-on comprehensive training either at the PUB laboratory or at their local training centre at the Contractor's own cost. The training program shall at least include hands-on operation, trouble shooting and routine maintenance of the system. One set of training materials (softcopy or hardcopy) shall be provided for each trainee in the beginning of the training. **Details of the training program and schedule** shall be submitted together with the tender.

5.4 NOMINAL AND APPLICATIONS SUPPORT

The Contractor must provide **local** technical and application support to minimize downtime of the UHPLC system and ensure high productivity of the lab

5.5 WARRANTY

The system supplied shall be guaranteed against inaccuracy, poor performance and workmanship used for a period of **twelve (12) months** from the date of successful commissioning of the system. During the warranty period, the contractor shall provide unlimited on-site breakdown services, and supply and replacement of parts for repairs (excluding consumable parts). All labour costs shall deem to be included in the tender sum.

5.6 POWER REQUIREMENT

All cables, plugs and wires necessary for the equipment to function must be supplied. The power supply should be 230V and 50Hz AC, 13A electrical line directly or suitable to be connected to the existing power point of the laboratory where the UHPLC system will be placed. External transformer is not acceptable.

5.7 AFTER SALES SERVICE

The Contractor shall provide full **details of after sales services** and response time in the supply, replacement, repairing and servicing of the UHPLC system supplied. Tenderer without the proper license, facility or experience to carry out the after sales services for the UHPLC system would not be considered under this tender.

5.8 SCHEDULE OF DEVIATIONS

The specifications shall be strictly complied with and any deviations shall be clearly stated by the Contractor in **the Schedule of Deviations**. Absence of comment in the Contractor's submission shall be interpreted as acceptance and compliance with the requirements of the specifications. Details of these deviations shall be furnished in the Deviations.

5.9 PLACE AND PERIOD OF DELIVERY

The Contractor shall deliver, install and commission the UHPLC system complete with accessories as specified under the Scope of Work and Technical Specifications to Public Utilities Board, 82 Toh

Guan Road East, WaterHub, Level 4, #C4-04, Singapore 608576, within **4 months** from **Date of Commencement** as specified in the **Letter of Acceptance**.

6. SPECIFICATIONS FOR SCHEDULE VI SUPPLY, DELIVERY, INSTALLATION, AND COMMISSIONING OF ONE (1) UNIT OF ULTRAPURE WATER PURIFICATION SYSTEM FOR CELL CULTURE AND MOLECULAR BIOLOGY WORK

The Ultrapure Water Purification System supplied shall be capable of producing type I ultrapure water for cell culture and type II pure water for molecular biology work. The Ultrapure Water Purification System shall include scope of work specified in clause **6.1** and the system shall comply with the technical specifications specified in clause **6.2**.

6.1 SCOPE OF WORK

The scope of work shall include but not limited to the following:

- 6.1.1 Supply, delivery and installation of one unit of Ultrapure Water Purification System complete with consumables and accessories.
- 6.1.2 Provision of commissioning, performance check and training of the Ultrapure Water Purification System.
- 6.1.3 Provision of hands-on comprehensive training for at least 4 laboratory officers
- 6.1.4 To carry out all other work not specified herein for the successful commissioning of the entire system

6.2 TECHNICAL SPECIFICATIONS OF ULTRAPURE WATER PURIFICATION SYSTEM

- a. The system shall have the capability to deliver purified water to at least 3 dispensing points at different locations.
- b. The system shall have the capability to dispense through an ultrafilter cartridge, type II grade water (resistivity: 5MΩ-cm at 25°C, TOC: < 30ppb, bacteria: < 1cfu/ml, pyrogen Level : <0.001Eu/ml, Rnases: <0.01ng/ml, Dnase:<4pg/ul) at the flow rate of 10 L/hour.
- c. The system shall also have the capability to dispense through an ultrafilter cartridge, type I grade water (resistivity: 18.2 MΩ-cm at 25°C, TOC: < 5ppb, bacteria: < 0.1cfu/ml, pyrogen level : <0.001Eu/ml, Rnases: <0.01ng/ml, Dnase:<4pg/ul) at the flow rate of 2 L/minute.
- d. The system shall comprise of reverse osmosis, electrodeionization (EDI), ion-exchange, activated carbon technologies and polishing device.
- e. The system shall require no additional softener to process the water after the EDI module and the ion exchange resins in the EDI module shall not require maintenance due to its ability to regenerate the resins using an electrical current.
- f. The system dispenser shall be able to display all the important parameters (resistivity, TOC, temp, alarms).

- g. The system dispenser shall have a flexible dispenser arm to ensure dispensed water is within most range and allow fixed volume dispensing, by adjusting settings from the remote dispenser itself
- h. The system shall include blow molded Polyethylene 60L tank (as the reservoir for type II grade water) which has as low as 14 µm for surface roughness (Ra) and a Cylindrical shaped, conical bottom with distribution valves and a 254nm UV lamp to prevent the growth of bio-film.
- i. The system shall include a tank vent filter (Soda lime for CO₂ removal, activated carbon for VOC removal, hydrophobic 0.65 µm filter for particle and bacteria removal) and a sanitary overflow device.
- j. The system shall consist of a built-in TOC monitor for detection of organics complying with USP 24 pharmacopoeia specifications and the detection range of 1 to 999 ppb for accurate analysis. Calibration certificate with traceable ability shall also be supplied with the TOC monitor.
- k. The system shall include a pretreatment pack contains anti-scaling compound to protect the reverse osmosis membrane from scaling.
- l. The system consumables shall be provided with certificates of quality.
- m. The system shall be able to reset its timer automatically after cartridge change, UV replacement and sanitization.
- n. The system shall include 2 separate UV lamps with a two years life time, one UV lamp with exposure of dual wavelength emission of 254nm (bacteria reduction) and 185nm (Total Organic Carbon reduction) and one UV lamp with exposure of single wavelength emission of 254nm (bacteria reduction).
- o. The system shall include a choice of point-of-use final filter options (for both Type I & II water), including a 0.22 micron final filter, a point-of-use ultrafilter, and an FDA-registered medical device, to meet individual needs.
- p. The system shall include a 1.0µm prefilter as the pretreatment for the water going into the system
- q. The system shall be validated and supplied with full documentation and certification upon user requests.
- r. The system and all of its components shall be manufactured and assembled in ISO 9001 & ISO 14001 certified environments. System Certificate of Quality have to be provided to ensure compliance.
- s. The system shall include a software that allows electronic recording for paperless archives of system performance.
- t. The system software shall be capable of data traceability, reliable access to system history with customized reports containing up to one year of data.
- u. The system shall be able to operate within the feed water pressure range of 1 bar to 6 bar.
- v. The system shall come with twelve (12) months supply of all consumables.**

6.3 WARRANTY

The system supplied shall be guaranteed against inaccuracy, poor performance and workmanship used for a period of **twelve (12) months** from the date of successful commissioning of the system. During the warranty period, the Contractor shall provide on-site breakdown services, and supply and replacement of parts. All labour and transportation costs involved will not be charged. **One preventive maintenance (PM) service shall be conducted by the Contractor near the end of the warranty. One set of PM kit shall be provided for the PM service.**

6.4 TRAINING

The Contractor shall provide hands-on comprehensive training for at least 3 laboratory officers either at the PUB laboratory or at their local training centre at the Contractor's own cost. The training program shall at least include hands-on operation, trouble shooting and routine maintenance of the Ultrapure Water Purification System. One set of training materials (softcopy or hardcopy) shall be provided for each trainee in the beginning of the training. **Details of the training program and schedule** shall be submitted together with the tender.

6.5 AFTER SALES SERVICES

The Contractor shall provide full **details of after sales services** and response time in the supply, replacement, repairing and servicing of the System supplied. Tenderer without the proper facility or experience to carry out the after sales services would not be considered under this tender.

6.6 SCHEDULE OF DEVIATIONS

The specifications shall be strictly complied with and any deviations shall be clearly stated by the Contractor in **the Schedule of Deviations**. Absence of comment in the Contractor's submission shall be interpreted as acceptance and compliance with the requirements of the specifications. Details of these deviations shall be furnished in the Deviations.

6.7 PLACE AND PERIOD OF DELIVERY

The Contractor shall deliver, install and commission the Ultrapure Water Purification System complete with accessories and consumables as specified under the Scope of Work and Technical Specifications to Water Quality Office at 82 Toh Guan Road East, WaterHub, Level 4, #C4-12, Singapore 608576 within **4 months** from **Date of Commencement** as specified in the **Letter of Acceptance**.

7. SPECIFICATIONS FOR SCHEDULE VII

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF ONE (1) UNIT OF WATER PURIFICATION SYSTEM FOR ELEMENTAL ANALYSIS

One unit of Water Purification System supplied shall include scope of work specified in clause 7.1 and the system shall comply with the technical specifications specified in clause 7.2.

7.1 SCOPE OF WORK

The scope of work shall include but not limited to the following:

- 7.1.1 Supply, Delivery, Installation and Commissioning of One (1) Unit of Water Purification System for Elemental Analysis
- 7.1.2 Provision of all necessary consumable and accessories such as pre-filter set, all cartridges, UV lamps, water dispensers, cables, adaptors, wire extensions and etc.
- 7.1.3 Comprehensive training on the operation/maintenance of the Water Purification System at site by authorized specialist from the manufacturer.
- 7.1.4 To carry out all other work not specified herein for the successful installation of the entire system.

7.2 TECHNICAL SPECIFICATIONS

7.2.1 General

- a. The Water Purification System supplied shall be of laboratory bench-top system with small footprint complete with laboratory facilities, accessories and consumable material
- b. The Water Purification System shall be comprised of a single water purification unit containing advanced reverse osmosis, electro-deionization, ion-exchange and activated carbon technologies and polishing device
- c. 1.0 um pre-filter shall be installed as the pretreatment before the local tap water going in to the Water Purification System. Multi-component pretreatment pack shall also be installed as the first purification step inside the system to remove particles and chlorine from feed water and to protect RO membrane from scaling
- d. EDI module shall be able to use electrical current to continuously regenerate ion-exchange resins without need for special maintenance or chemical regeneration that would deteriorate the resin beads. No additional softener is required for the Water Purification System. Equivalent technique is also acceptable
- e. The Water Purification System should have automatic reset function of timer after cartridge change, UV replacement and sanitization
- f. The Water Purification System should integrate built-in TOC monitor for detection of organics compound. TOC Monitor must have a detection range from 1 to 999 ppb for accurate analysis and supplied with calibration certificate with traceable ability
- g. The system should have temperature control feature and built-in speed adjustable booster pump to ensure constant flow rate. The internal pumps should be low voltage DC pumps for virtually silent operation
- h. The Water Purification System will have at least 1 year life time built-in UV lamps with emission at 185 and 254 nm wavelengths. One for total organic carbon (TOC) reduction

effects and one for bacteria reduction at the pretreatment. (totally 3 UV lamps including the UV lamp for the polyethylene reservoir tank)

- i. The Water Purification System shall have programmed memory to store data. Data traceability, reliability and access to system history with customized reports containing up to one year of data as well as easy archiving shall be included. Data should include the water quality produced based on TOC and resistivity measured
- j. A fully comprehensive, graphic color LCD display to provide information 1) on system status and performance parameters, 2) on routine maintenance needs, and 3) on alarms for troubleshooting in the event of system malfunction. Graphic icons and operating control is provided as standard
- k. The system should have auto test function that continuously validates its water quality measurement system to give a more reliable and accurate result
- l. The Water Purification System must be manufactured in ISO 9001 & ISO 14001 certified environments. System Certificate of Quality shall be provided

7.2.2 Reservoir Tank

- a. The Water Purification System should include a moulded polyethylene reservoir tank with low surface roughness, cylindrical shaped and conical bottom with distribution valves. Internal surface of the storage tank should be able to be cleaned by physical method and the dirty water must be drained off totally from the bottom of the tank
- b. The polyethylene reservoir tank should include advanced tank vent filter (Soda lime for CO₂ removal, Activated carbon for VOC removal, Hydrophobic 0.65 µm filter for particle and bacteria removal) and sanitary overflow device. It should also include one 254 nm UV lamp to prevent the biofilm development

7.2.3 Dispenser

- a. The dispenser has to be able to display all the important parameter such as resistivity, total organic carbon (TOC), temperature, maintenance and alarms prompts for ease of user
- b. Hand-free delivery of ultrapure water dispenser should be controlled by foot switch to avoid contamination from the hands
- c. The dispenser shall have the flexibility arm for ease of user to dispense the purified water with at least 50cm range and allows two mode of dispense: variable flow and volumetric dispensing
- d. The height and shape of the Water Purification System delivery unit will be designed so that the volumetric dispense of ultrapure water in containers as high as a 5 L calibrated flask and in a 2 L graduated cylinder can be performed without the need for the user to hold the glassware

7.2.4 Specifications for 3 types of water

The Water Purification System shall be able to produce and deliver 3 type of water, i.e., pure water (type II), ultrapure water (type I) and ultra-trace elemental water directly from tap water, with connection of up to 3 dispensing points (max.) in different locations

a. Specifications for Type II water:

- Resistivity: $\geq 5\text{M}\Omega\text{-cm}$ at 25°C
- Total Organic Carbon (TOC): $< 30\mu\text{g/L}$
- Particulates & Bacteria: $< 1\text{cfu/mL}$
- Pyrogen Level : $< 0.001\text{Eu/mL}$
- Rnases: $< 0.01\text{ng/mL}$

- Dnase: <4pg/uL
- Production rate: ≥ 10.0 L/hr
- Size of the polyethylene reservoir tank : 60L

b. Specifications for Type I water:

- Resistivity: 18.2 MΩ-cm at 25°C
- Total Organic Carbon (TOC): < 5µg/L
- Particulates: <1cfu/mL
- Bacteria: < 0.1cfu/mL
- Pyrogen Level : <0.001Eu/mL
- Rnases: <0.01ng/mL
- Dnase: <4pg/uL
- Product Flow: ≥ 2 L/min

c. Specifications for Ultra trace elemental water:

- Levels of metals: shall be not higher than the levels listed in Table 1
- Should meet all the specifications as type I water
- The supply must show testing reports or other evidence of the product water quality

Table 1. Specifications of metal impurities in Ultra trace elemental water

Element	ng/L	Element	ng/L
Aluminium	2	Iron	1
Antimony	0.4	Magnesium	0.4
Arsenic	1	Manganese	0.2
Barium	1	Mercury	0.4
Beryllium	0.4	Molybdenum	0.4
Boron	9	Nickel	1
Cadmium	0.8	Lead	0.2
Calcium	1	Selenium	2
Chromium	0.8	Sodium	10
Cobalt	0.4	Silver	0.6
Copper	0.8	Tin	1
Uranium	0.2	Vanadium	1
Zinc	0.8		

- Both Type II and Type I water shall be from one system unit. Type II pure water can be collected from storage tank. Type I ultrapure water can be collected from dispenser
- The system should have built-in high precision resistivity meter with very low cell constant for detection of trace ionic contaminants and with water quality early alarm. Resistivity reading can show 3 modes as 1.Normalized, 2.Real-timed, 3.Non-temperature compensated
- Ultra trace elemental water should be delivered only through high grade validated polyethylene tubing
- Special polyethylene cartridges are to be used to provide maximum removal of ions for ultra-trace elemental water
- Final filter for ultra-trace elemental water should be less than 0.2µm

7.3 SERVICE AND WARRANTY

- 7.3.1 Twelve (12) months on-site comprehensive warranty against defective parts (inclusive of consumables parts, labour, transport, etc.) from the date of commissioning of the system
- 7.3.2 Twelve (12) months free on-site technical support and maintenance service (inclusive of transport & manpower) from the date of commissioning of the system
- 7.3.3 Twelve (12) months' supply of all consumables should be included in this tender without any extra charge to the Board

7.4 TRAINING

The Contractor shall provide comprehensive training for the Board's laboratory officers on-site at the PUB laboratory after delivery and start-up commissioning of the system. The training programme shall at least include hands-on operation, trouble shooting and routine maintenance. One set of training materials (softcopy or hardcopy) shall be provided for each trainee at the beginning of the training. **Details of the training programme and schedule** shall be submitted together with the tender.

7.5 POWER REQUIREMENT

All cables, plugs and wires necessary for the equipment to function must be supplied. The power supply should be 230 V and 50Hz AC, 13A electrical line directly or suitable to be connected to the existing power point of the laboratory where the Water Purification System will be placed. External transformer is not acceptable.

7.6 AFTER SALES SERVICES

The Contractor shall provide full **details of after sales services** and response time in the supply, replacement, repairing and servicing of the system supplied. Tenderer without the proper license, facility or experience to carry out the after sales services for the system would not be considered under this tender.

7.7 SCHEDULE OF DEVIATIONS

The specifications shall be strictly complied with and any deviations shall be clearly stated by the Tenderer in **the Schedule of Deviations**. Absence of comment in the Contractor's submission shall be interpreted as acceptance and compliance with the requirements of the specifications. Details of these deviations shall be furnished in the Deviations.

7.8 PLACE AND PERIOD OF DELIVERY

The Contractor shall deliver, install and commission the Water Purification System complete with accessories and consumable materials as specified under the Technical Specifications to Public Utilities Board, 82 Toh Guan Road East, Level 1, #C1-23, WaterHub, Singapore 608576 within **4 months** from **Date of Commencement** as specified in the **Letter of Acceptance**.

8. SPECIFICATIONS FOR SCHEDULE VIII

SUPPLY, DELIVERY & COMMISSIONING OF ONE (1) UNIT OF AUTOMATIC SAMPLE PREPARATION UNIT FOR AN EXISTING TOTAL ORGANIC HALOGENS (TOX) ANALYZER

One (1) unit of automatic sample preparation unit (ASPU) for existing total organic halogens (TOX) analyzer supplied shall include scope of work specified in clause **8.1** and the system shall comply with the technical specifications specified in clause **8.2**.

8.1 SCOPE OF WORK

The scope of work shall include but not be limited to the following:

- 8.1.1 Supply, delivery, & commissioning of one unit of ASPU for existing Anaytik jena Multi X 2500 TOX Analyzer
- 8.1.2 All Items shall comply fully with the specifications specified in Clause 8.2 and all deviations have to be stated in Schedule of Deviations

8.2 TECHNICAL SPECIFICATIONS

- a. The ASPU should be able to operate for sample preparation by “two- column” method for measurement of TOX or adsorbable organic halogens (AOX) in water
- b. The ASPU should comply with ISO/FDIS Standard 9562:2004(E), USEPA Method 1650, USEPA Method 9020 B or equivalent
- c. All operation parameters including adsorb volume (10-100 mL), flow rate (3 ml/min), sample position, etc., should be set and controlled on a control panel.
- d. The APSU should have XYZ design to avoid multi-port valve system
- e. Individually pre-selectable sample and washing volumes should be possible
- f. The sample preparation procedure includes sample adsorption, sample wash and tubing cleaning.
- g. Should be suitable for overnight operation without manual intervention
- h. The APSU should be a two-channel system which allows two samples be prepared at the same time
- i. At least 28 sample positions on the sample rack, with at least 28 positions for quartz duplex column containers
- j. Short and direct pass to minimize the amount of maintenance
- k. Built-in stirring function for every sample should be provided
- l. The following items should also be included in the Schedule without any extra cost to PUB
 - At least 28 glass sample vials (100 mL)
 - At least 28 sets of quartz duplex column containers
 - Two pieces of sample injection needle completed with adaptors, screws & joints, if applicable
 - Plastic waste container, 5 L with waste hose
 - Glass container for nitrate solution

- 30 pieces of magnetic stirring bar, PTFE, 15mm x 6mm
- Tubing kit including tubing and connectors

8.3 TRAINING

The Contractor shall provide comprehensive training for the Board's laboratory officers on-site at the PUB laboratory after delivery and start-up commissioning of the system. The training programme shall at least include hands-on operation, trouble shooting and routine maintenance. One set of training materials (softcopy or hardcopy) shall be provided for each trainee at the beginning of the training. **Details of the training programme and schedule** shall be submitted together with the tender.

8.4 AFTER SALES SERVICES

The Contractor shall provide full **details of after sales services** and response time in the supply, replacement, repairing and servicing of the system supplied. Tenderer without the proper license, facility or experience to carry out the after sales services for the system would not be considered under this tender.

8.5 SCHEDULE OF DEVIATIONS

The specifications shall be strictly complied with and any deviations shall be clearly stated by the Tenderer in **the Schedule of Deviations**. Absence of comment in the Tenderer's submission shall be interpreted as acceptance and compliance with the requirements of the specifications. Details of these deviations shall be furnished in the Deviations.

8.6 PLACE AND PERIOD OF DELIVERY

The Contractor shall deliver, install and commission the Water Purification System complete with accessories and consumable materials as specified under the Technical Specifications to Public Utilities Board, 82 Toh Guan Road East, Level 1, #C1-23, WaterHub, Singapore 608576 within **4 months** from **Date of Commencement** as specified in the **Letter of Acceptance**.

9. SPECIFICATIONS FOR SCHEDULE IX

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF ONE (1) UNIT OF INDUCTIVELY COUPLED PLASMA OPTICAL EMISSION SPECTROMETER (ICP-OES) SYSTEM

This schedule shall include scope of work specified in Clause **9.1** and the ICP-OES system shall comply with the technical specifications specified in Clause **9.2**.

9.1 SCOPE OF WORK

The scope of work shall include but not limited to the following:

- 9.1.1. Supply, delivery, installation and commissioning of an ICP-OES system including radio frequency (RF) generator, gas controller, sample introduction system, spectrometer, auto-sampler, nebulizer, thermostated chiller and data processing system
- 9.1.2. Provision of all necessary accessories and consumables, such as sample vials, peristaltic pump tubing, calibration standard materials, required for commissioning, calibration, performance check and training of the ICP-OES system
- 9.1.3. Provision of comprehensive training for at least four (4) Board's staff on the use of ICP-OES system for high throughput sample analysis for elements.
- 9.1.4. Carry out all other work not specified herein for the successful commissioning of the entire system

9.2 TECHNICAL SPECIFICATIONS

The ICP-OES shall be a robust, full wavelength coverage, simultaneous reading for axial and radial view, and high performance system for water and environmental samples. The specifications shall include the following:

9.2.1 Radio frequency (RF) generator

- a. Free-running solid-state RF generator using ~27 MHz, ~40 MHz or other frequency, shall provide better than 75% power efficiency
- b. The power output shall be continuously variable in increments of 1 W and adjustable in a minimum range of 1000 to 1350 W
- c. The generator shall be shielded to meet United States Federal Communications Commission (FCC) or equivalent certification requirements for RF emission
- d. Efficient cooling system with built-in coolant re-circulator shall be included for the RF generator

9.2.2 Sample introduction system

- a. One unit of glass cyclonic spray chamber and one unit of hydrofluoric acid (HF)-resistant Scott-type spray chamber shall be included in the system.
- b. One unit of concentric glass nebulizer and one unit of corrosion-resistant cross flow nebulizer shall be included in the system for the routinely handling acidic solutions (up to 20% HNO₃ + HCl, 10% HF).

- c. The system shall be configured with demountable one- or two- piece quartz torch and replaceable sample injector tubes with 1.8 mm or wider diameter. Two sets of torches and injectors shall be included in the system (one set for common acidic aqueous solution and the other for HF-containing solution)
- d. The torch shall not require realignment after dismantling
- e. Easy changeover for sample introduction components between the applications for different sample matrices
- f. All parts of the sample introduction components of the ICP-OES system must be corrosion resistant to all acids.
- g. There shall be at least 3 channels available on the peristaltic pump
- h. An on-line internal standard mixing kit shall be provided.

9.2.3 Spectrometer and detector system

- a. The spectrometer shall consist of an echelle grating-based polychromator, optimized for wavelength range at least from 167 to 782 nm
- b. It shall be able to simultaneously measure all desired elements in one analytical reading. Sequential detection is not acceptable
- c. The resolution of the optical system at 200 nm shall be 0.007 nm or better
- d. The spectrometer must be thermostatted and shock-proof for thermal and mechanical stability
- e. Plasma view shall cover the full wavelength range at least from 167 nm to 782 nm in one single run
- f. The ICP-OES system must be able to reduce material deposition on the entrance optic as well as to reduce self-absorption and other physical interferences
- g. The detector shall be high performance solid state detector(s), based on CCD (charge coupled device), CID (charge injection device) or SCD (segmented-array CCD), integrated and matched to the optical system
- h. The entire spectrometer system shall be enclosed in a thermostated and Nitrogen or Argon-purged optical enclosure
- i. The spectrometer system shall not be in vacuum status which need use of a rotary or turbo pump
- j. The ICP-OES system shall have a wavelength correction system to automatically correct every measurement made to ensure optical stability
- k. The signal stability shall be less than 1.5% over 8 hours or better (without the use of internal standardization or any form of drift correction)

9.2.4 Gas flow control

- a. Argon gas flow into the system, including plasma gas, auxiliary gas and nebulizer gas, should be regulated by computer-controlled solenoid valves or mass flow controllers.
- b. Nebulizer gas flow of the system should be at least be in the range of 0 to 1.5 L/min in 0.01 L/min increments
- c. Gas cleaning/drying kits for argon, nitrogen and compressed-air shear gas flows shall be provided and installed to ensure the system performance.

9.2.5 Autosampler for ICP-OES

- a. A random access autosampler under full software control from the ICP-OES system computer shall be provided with all interconnecting cables required for automated operation

- b. It shall be able to do online auto-dilution
- c. It shall incorporate a high speed sample uptake pump, close-coupled multi-port switching valve to increase sample throughput via discrete sampling
- d. It shall have a capacity of at least 10 standard or QC positions, and at least 120 sample positions in 3-4 racks (for ≥ 10 -ml plastic vials)
- e. It shall have a built-in enclosure to minimize contamination from the environment
- a. The sample probe shall be metal-free and shall return to an integral rinse reservoir
- b. In addition to rinsing between samples, it shall be possible to program an extended rinse/wash-out at the end of an automated analysis prior to shutting down the ICP-OES or commencing a new batch of samples

9.2.6 Water chiller

- a. An air-cooled water chiller with the capacity to cool the components of the ICP-OES system (even room temperature at 30°C) shall be provided. A heat exchanger is not acceptable.
- b. It shall have temperature and pressure/flow rate digital display
- c. It shall have low flow alarm, high and low temperature alarms
- d. It shall be of quiet operation (noise < 60dB) and simple maintenance
- e. Temperature range shall be settable

9.2.7 Software and computer

- a. The software shall run under Microsoft Windows 7 or higher operating system
- b. The software shall offer complete control of the instrument, including access to all method parameters and enhanced functionality, monitor system status, RF power, gas supplies, instrument temperatures, electrical systems and cooling system, and shut down the plasma automatically and safely if any of the safety check fails
- c. It shall have the function of automatic ignition and shutdown of the plasma at user-specified time
- d. It shall allow user to create analytical methods by choice of instrument parameters like RF power, nebulizer flow rate, wavelengths of elements, viewing height, sampling time, and background correction, etc.
- e. It shall enable the user to collect all data on the detector array or user-selected wavelengths
- f. There shall be a choice of all the elements normally analyzable by ICP-OES with their multiple prominent / secondary wavelengths
- g. It shall enable user to select background correction for all the elements at different wavelength intervals and these measurements must be done simultaneously as the emission intensities are measured
- h. It shall provide the function of data re-processing after sample analysis and the following options shall be used during data re-processing:
 - Alternate interference wavelength
 - Background correction intervals
 - Calibration standard concentration
 - Multi-component spectral fitting
- i. It shall be able to compute statistical values, such as mean, standard deviation and relative standard deviation (coefficient of variation)

- j. It shall include online self-help function to troubleshoot any problems encountered during sample analysis
- k. User menu/guide for the instrument software shall be provided
- l. It shall allow multiple applications windows to appear concurrently on the display for easy viewing
- m. The computer shall have an interface to connect to the ICP-OES system
- n. The computer shall provide the connectivity to Laboratory Information Management System (LIMS)
- o. A Laserjet printer with double-side printing function shall be provided.
- p. Minimum requirements of the PC and its accessories
 - CPU: Intel Pentium Core i7 (vPro) CPU (or better), or equivalent
 - Operation system: Microsoft Windows 7 (64 bit) or better; software free upgrade to Windows 10 whenever available
 - 8 GB RAM
 - Two Ethernet (LAN) connections
 - Hard disk drive: high speed, 500GB
 - 6 USB (2.0 or 3.0) Ports
 - Monitor: 21 inch LCD flat panel display, resolution 1920×1080
 - Three-year on-site warranty for the PC, including labour, parts and accessories
- q. The Contractor shall install, configure and commission the following software items with complete documentation:
 - The software package and accompanying modules. The software shall be able to run normally and correctly on a user account without administrator rights
 - Operating system and necessary server components
 - Antivirus software (provided by the Board)
 - Backup software

9.2.8 Instrument detection limit

- a. The ICP-OES system's Instrument Detection limit (IDL), shall be estimated by following United States Environmental Protection Agency (USEPA) Method 6010D "Inductively Coupled Plasma Optical Emission Spectrometry" (Revision 4, July 2014), Para 9.3 "Instrument detection limits", as the mean of the blank results plus three times the standard deviation of 10 replicate analyses of the reagent blank solution. (Use zero for the mean if the mean is negative).
- b. IDL shall be or lower than the following value (mg/L) in axial view analysis mode:

Element	IDL (mg/L)	Element	IDL (mg/L)
Aluminum	0.002	Manganese	0.002
Antimony	0.001	Molybdenum	0.004
Arsenic	0.003	Mercury	0.002
Barium	0.002	Nickel	0.003
Beryllium	0.001	Potassium	0.004
Boron	0.002	Phosphorus	0.005
Calcium	0.005	Selenium	0.005
Cadmium	0.0005	Strontium	0.004
Chromium	0.005	Tin	0.003

Copper	0.002	Titanium	0.002
Iron	0.003	Vanadium	0.002
Lead	0.002	Zinc	0.004

9.2.9 Requirement to connect to Starlims

The results generated from the ICP-OES system shall be able to be captured by the Board's existing Laboratory Information Management System (i.e. STARLIMS v11.0) seamlessly

- a. The ICP-OES shall connect to a workstation with software installed. The ICP-OES operation software shall be able to generate a file with results and put (or save) in a specific folder
- b. The best location to store the instrument result files is a shared folder in the server
- c. STARLIMS will then capture these files from the shared folder and update to the system
- d. The ICP-OES result file shall be in a text format (i.e. .txt or .csv or a non-proprietary file format that can be read via text readers such as Microsoft® Notepad) or text-based pdf format (not scanned pdf file which is an image)

9.2.10 Use of virus-free electronic media

- a. The Contractor shall warrant that all storage media and software capable of being stored on such media supplied as software or used in performance of the service shall not contain any unauthorised code.
- b. The Contractor shall conduct a complete and thorough scan for unauthorised code using anti-virus software packages on all software and materials provided under this Contract.
- c. The Contractor shall indemnify the Board fully against all costs incurred in the course of or incidental to removing the unauthorised codes and recovering any lost or damaged data or software.
- d. In Clause a: "Unauthorised Code" means any virus, Trojan Horse, worm logic bomb or other software routine or hardware components designed to permit unauthorised access, to disable, erase, or otherwise harm software, hardware or data or to perform any such actions.

9.2.11 Exhaust system, gas lines, and electrical points

The ICP-OES system will be installed on a bench in the laboratory (82 Toh Guan Road East, WaterHub, #C2-01, Singapore 608576), previously for a PerkinElmer Optima 5300 ICP-OES system. The Contractor shall check the available exhaust extraction system, electrical points, gas lines with pressure regulators and outlet shut off valves, and make necessary alteration and addition without any extra cost to PUB for the installation and commissioning of the ICP-OES system.

9.2.12 Accessories and consumables

The following accessories and consumables shall be provided:

- a. Provision of all necessary consumables and/or accessories, such as drainage tank, calibration standards and sample vials, and wavelength calibration solution standard materials required for commissioning, calibration, performance check and training of the ICP-OES system
- b. One set of maintenance tools for the ICP-OES system
- c. One set of internal standard, Yttrium, 500 ml, at least 100 mg/L
- d. One set of calibration standards of multiple elements (at least including Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Sn, Sr, Ti, Tl, V, Zn), 500 mL, at least 100 mg/L

9.3 TRAINING

The Contractor shall provide comprehensive hands-on training for at least four (4) of the Board's laboratory officers on-site at the PUB laboratory or at their local training centre at the Contractor's own cost. The training programme shall at least include hands-on operation, trouble shooting and routine maintenance of the ICP-OES system. One set of training materials (softcopy or hardcopy) shall be provided for each trainee at the beginning of the training. The Tenderer shall fill up the **Details of the Training Programme and Schedule** and include it in the tender submission.

9.4 WARRANTY

The system supplied shall be guaranteed against inaccuracy, poor performance and workmanship used for a period of **twelve (12) months** from the completion date of commissioning of the system. The desktop PC shall be **under 3-year full warranty** and accompanied with their system recovery CDs or DVDs.

9.5 AFTER SALES SERVICES

The Tenderers shall fill up the **Details of the Provision of after Sales Services** with full details, including technical team composition/qualifications, response time and the quotation of an annual comprehensive maintenance and service (CMS) contract for the ICP-OES system supplied. The CMS contract need include on-site troubleshooting visit and repair, service/technical support call, any parts replacement required for repair, single preventive maintenance service per year, various calibration required, labour and transport charges (**NOTE: Preventive maintenance kits shall be included**). Tenderer without the proper facility or experience to carry out the after sales services for the ICP-OES system may not be considered under this tender.

9.6 SCHEDULE OF DEVIATIONS

The specifications shall be strictly complied with and any deviations shall be clearly stated by the Contractor in **the Schedule of Deviations**. Absence of comment in the Contractor's submission shall be interpreted as acceptance and compliance with the requirements of the specifications. Details of these deviations shall be furnished in the Deviations.

9.7 PLACE AND PERIOD OF DELIVERY

The Contractor shall deliver, install and commission the ICP-OES system as specified in Clause 9.2 Technical Specifications to Public Utilities Board, 82 Toh Guan Road East, WaterHub, Level 2, #C2-01, Singapore 608576 within **4 months** from **Date of Commencement** as specified in the **Letter of Acceptance**.

10. SPECIFICATIONS FOR SCHEDULE X

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF ONE (1) UNIT OF HIGH PRESSURE ION CHROMATOGRAPHY (IC) SYSTEM

The Ion Chromatography (IC) system supplied shall include scope of work specified in clause **10.1** and the system shall comply with the technical specifications specified in clause **10.2**.

10.1 SCOPE OF WORK

The scope of work shall include but not limited to the following:

- 10.1.1. Supply, delivery and commissioning of an integrated IC system complete with detectors, autosampler, suppressors, columns, eluent pumps and data handling system
- 10.1.2. Provision of all necessary consumables and accessories, such as eluent reservoirs, sample vials, peristaltic pump tubing, wire extension, adaptor, etc and standard materials required for commissioning, calibration and performance check of the IC system
- 10.1.3. Provision of comprehensive training for at least five (5) lab staff on the use of IC system for all related analysis
- 10.1.4. Carrying out all other work not specified herein for the successful commissioning of the entire system

10.2 TECHNICAL SPECIFICATIONS

10.2.1 General Requirement

- a. The IC system shall be a robust, integrated and reliable system, complete with at least two sets of eluent pumps, separation columns, suppressors and detectors.
- b. It shall be able to run as two independent modules (Module I & Module II), both for analysis of anions in various water matrices. The target anions include Fluoride, Chloride, Chlorite, Chlorate, Bromate, Bromide, Nitrate, Nitrite, Phosphate, Sulphate, Acetate, Oxalate, Formate, Citrate, Perchlorate and Iodide.
- c. Module I and Module II shall be configured as two separate systems with separation and detection functions, but can share autosampler, computer and data analysis system.
- d. The two modules shall be able to run simultaneously for two methods.
- e. The system shall be able to run high pressure gradient analysis (by increasing the concentration of the eluant anion during the run)
- f. Flow pass should be metal free to reduce possibility of corrosion
- g. One of the two modules shall be able to run sample separation for detection of nine anions (Fluoride, Chlorite, Chloride, Nitrate, Nitrite, Bromide, Chlorate, Phosphate and Sulphate) at a total running time (including sample equilibration, sample injection and separation on column) of not more than 15 min per sample when an analytical column of 2mm x 150mm or longer is used.
- h. Application support must be provided to set up high pressure gradient elution
- i. The system shall be able to use carbonate or hydroxide as eluents
- j. Tenderers shall provide evidence of separation and detection limit of all the anions mentioned in the tender specification, e.g., chromatogram, calibration graph, calibration range, detection limit, precision, and spike recovery. All these shall be submitted as supports together with the tender documents

- k. Tenderers may be required to run QC and spiked samples provided by PUB during the tender evaluation period
- l. No gas shall be required for the operation of the IC system
- m. Leak sensor shall be included to allow fast response to system leaks.

10.2.2 Pump system

- a. Two high pressure pumps, each pump for Module I and Module II
- b. Able to perform gradients for both Modules
- c. Flow rate: 0.001 - 10 mL/min
- d. Maximum pressure: 0 - 35MPa
- e. The pump housing shall be able to accommodate at least two independent pumping systems
- f. Flow rate accuracy: <0.1%
- g. Pulsation: <1%
- h. Shall be of dual piston design
- i. Pumps shall be made of non-metallic material to reduce possibility of corrosion
- j. Pumps shall have user-settable pressure limits to automatically stop flow in the event of leaks or flow restrictions
- k. Must have a built-in vacuum degas assembly which provides in-line degassing of eluents, ensuring reproducibility and protection of eluents from contamination and decomposition. Control of the degas operation must be able to be automated to sense when degassing is required.

10.2.3 Suppressors

- a. Two suppressors shall be provided, each for Module I and Module II.
- b. Shall be based on membrane, column or gel replacement, to remove the counter cations
- c. The suppressors shall operate in a continuous suppression mode to reduce background noise
- d. Suppressors shall be covered under warranty terms, and if their performance become deteriorated within warranty period, they shall be replaced with new units without extra cost to PUB. All chemicals, cartridges, gels and other consumables related to suppressors shall be with the warranty of 12 months period, if applicable

10.2.4 Conductivity Detectors

- a. Two conductivity detectors, each for Module I and Module II
- b. Measuring range: 0-15000 μ S
- c. The detector shall be compatible with extreme eluents, i.e., eluents at pH 0-14
- d. Working temperature: 20-50° C
- e. Measuring frequency: 10Hz
- f. Baseline noise: <0.2 nS/cm
- g. Electronic noise: <0.1 nS/cm

10.2.5 Separation Column Set I

- a. A separation column set shall include one guard column and one analytical column

- b. Separation column set I shall be configured for analysis of following anions in different water matrices with the following required detection limit (mg/L) or better
 - Fluoride: 0.02
 - Chlorite: 0.01
 - Chloride: 0.02
 - Nitrite-N: 0.01
 - Bromide: 0.04
 - Chlorate: 0.04
 - Nitrate-N: 0.01
 - Phosphate: 0.08
 - Sulphate: 0.04
- c. **One** set of Separation Column Set I shall be included
- d. It shall withstand at least 3000 psi pressure
- e. It shall be high capacity, with analytical column of 150 mm or longer
- f. The total running time (including sample equilibration, sample injection and separation on column) of one sample with complete separation of the anions in Clause “10.2.5 b” should be less than 20 min

10.2.6 Separation Column Set II

- a. A separation column set shall include one guard column and one analytical column
- b. Separation column set II shall be configured for analysis of following anions in different water matrices with the following required detection limit (mg/L) or better
 - Acetate: 0.01
 - Fluoride: 0.05
 - Formate: 0.01
 - Oxalate: 0.01
- c. **One** set of Separation Column Set II shall be included
- d. It shall withstand at least 3000 psi pressure
- e. For any of the analysis, no extra cartridges shall be used in sample preparation

10.2.7 Autosampler

- a. The autosampler shall be shared by Module I and Module II
- b. Autosampler vials shall be composed of polymeric material
- c. Shall be able to perform both full loop and partial loop injection
- d. Shall be able to perform dilution function without additional hardware
- e. Shall have at least 120 sample positions
- f. Shall be capable of modifying a run sequence anywhere within the sampler during the run without interrupting analysis
- g. Eluent reservoirs (2-5 L each, for two modules) shall be included.
- h. Shall be controlled by the instrument software
- i. Shall have injection volume of 20 µL to 2.0 mL, based on different sample loops
- j. At least two sets of sample loops of 20, 50, 200, 500, 1000 µL shall be provided

10.2.8 Eluent Generator

- a. No daily preparation shall be required. Concentrated eluent solution shall be automatically injected into the IC system with additional pump or eluent generators. Pump(s) for gradient generation or 2 eluent generator cartridges shall be included
- b. Concentration increments shall be as low as 0.01 mmol/L which is required to optimize chromatographic peak resolution and separation time.

10.2.9 Software and PC

- a. The software licence to the Board shall be provided without extra charge.
- b. It shall provide fully automatic control of the process of analyzing samples, including acquiring data, quantitation, and producing report
- c. Calibration curves shall be generated using a variety of curve fitting functions as linear, quadratic, etc
- d. Shall allow real time integration monitoring
- e. Shall allow urgent or priority analysis after sequence starts
- f. Shall allow customization of report format and content
- g. It shall be able to compute statistical values, such as mean, standard deviation and relative standard deviation (coefficient of variation)
- h. It shall include online self-help function to troubleshoot any problems encountered during sample analysis
- i. User menu/guide for the instrument software shall be provided
- j. It shall provide feature to ensure no data is lost in the event when the computer breaks down or operating system hangs
- k. It shall allow multiple applications windows to appear concurrently on the display for easy viewing
- l. It shall have the function of auto-shut down, delay starting, smart start-up etc
- m. Automatic shutdown function available upon reaching the pressure limit
- n. Other software required for proposed system to function fully if necessary
- o. A Laserjet printer with double-side printing function shall be provided.
- p. The Contractor shall install, configure and commission the following software items with complete documentation:
 - The software package and accompanying modules. The software shall be able to run normally and correctly on a user account without administrator rights
 - Operating system and necessary server components
 - Antivirus software (provided by the Board)
 - Backup software
- q. Minimum requirements of the PC and its accessories
 - CPU: Intel Pentium Core i7 (vPro) CPU (or better), or equivalent
 - Operation system: Microsoft Windows 7 (64 bit) or better; software free upgrade to Windows 10 whenever available
 - 8 GB RAM
 - Two Ethernet (LAN) connections
 - Hard disk drive: high speed, 500GB

- 6 USB (2.0 or 3.0) Ports
- Monitor: 21 inch LCD flat panel display, resolution 1920×1080
- Three-year on-site warranty for the PC, including labour, parts and accessories

10.2.10 Requirement to connect to Starlims

- The results generated from the IC system shall be able to be captured by the Board's existing Laboratory Information Management System (i.e. STARLIMS v11.0) seamlessly
- The IC shall be connect to a workstation with software installed. The IC operation software shall be able to generate a file with results and put (or save) in a specific folder
- The best location to store the instrument result files is a shared folder in the server
- STARLIMS will then capture these files from the shared folder and update to the system
- The IC result file shall be in a text format (i.e. .txt or .csv or a non-proprietary file format that can be read via text readers such as Microsoft® Notepad) or text-based pdf format (not scanned pdf file which is an image)

10.2.11 Use of virus-free electronic media

- The Contractor shall warrant that all storage media and software capable of being stored on such media supplied as software or used in performance of the service shall not contain any unauthorised code.
- The Contractor shall conduct a complete and thorough scan for unauthorised code using anti-virus software packages on all software and materials provided under this Contract.
- The Contractor shall indemnify the Board fully against all costs incurred in the course of or incidental to removing the unauthorised codes and recovering any lost or damaged data or software.
- In Clause a: "Unauthorised Code" means any virus, Trojan Horse, worm logic bomb or other software routine or hardware components designed to permit unauthorised access, to disable, erase, or otherwise harm software, hardware or data or to perform any such actions.

10.2.12 Electrical Points and Others

If necessary, the Contractor shall provide all the renovation work and material required for the installation and commissioning of the IC system in the laboratory (82 Toh Guan Road East, #C2-20, Singapore 608576). The renovation and installation work carried shall not affect the operation of equipment in the laboratory. The Contractor shall not generate any extra cost to PUB for fully installation and commissioning of the IC system

10.2.13 Consumables and Accessories

The Contractor shall supply the following consumables and accessories at his own cost:

- One set of maintenance tools for the IC system
- Provision of all necessary consumables and/or accessories, such as sample trays for autosampler, waste/drain tubing, and calibration standard materials required for commissioning, calibration, performance check and training of the IC system
- At least 1000 sample vials with caps shall be included in this tender
- One set of operation manual

10.3 WARRANTY

The system supplied shall be guaranteed against inaccuracy, poor performance and workmanship used for a period of twelve **12 months** from the completion date of commissioning of the system. During

the warranty period, the Contractor shall provide unlimited on-site breakdown services, and supply and replacement of parts (excluding consumable parts). All labour costs shall be included in the tender sum. One preventive maintenance (PM) service shall be conducted by the Contractor in the warranty, and one set of PM kits shall be provided for the PM service.

10.4 TRAINING

The Contractor shall provide hands-on comprehensive training course for at least five (5) laboratory staffs either on-site at the PUB laboratory or at their local training centre at the Contractor's own cost. The training program shall at least include hands-on operation, trouble shooting and routine maintenance of the IC system. One set of training materials (softcopy or hardcopy) shall be provided for each trainee in the beginning of the training. Details of the training program and schedule shall be submitted together with the tender.

10.5 AFTER SALES SERVICES

The Contractor shall provide full details of after sales services in his submission, including response time and price for the supply, replacement, repairing and servicing of the system supplied. The Tenderer must demonstrate that it has a proven appropriate setup and capability to provide after-sales service efficiently and effectively. Tenderer without the proper facility or experience to carry out the after sales services for the IC system would not be considered under this Tender.

10.6 SCHEDULE OF DEVIATIONS

The specifications shall be strictly complied with and any deviations shall be clearly stated by the Tenderer in **the Schedule of Deviations**. Absence of comment in the Tenderer's submission shall be interpreted as acceptance and compliance with the requirements of the specifications. Details of these deviations shall be furnished in the Deviations.

10.7 PLACE AND PERIOD OF DELIVERY

The Contractor shall deliver, install and commission the IC system as specified in Clause 10.2 Technical Specifications to Public Utilities Board, 82 Toh Guan Road East, WaterHub, Level 2, #C2-20, Singapore 608576 within **4 months** from Date of Commencement as specified in the Letter of Acceptance.