

Equipment 4: Liquid Chromatography – Quadrupole High Resolution Accurate Mass Spectrometer (LC-HRMS/MS) System Location: CML Quantity: 1	Compliances (Yes/ No) <i>**If No, please indicate reason of non-compliances.</i>
<u>Technical Specifications</u>	
(A) General	
1) The Tenderer shall supply, deliver, install and commission one unit of Liquid Chromatography- Quadrupole High Resolution Accurate Mass Spectrometer (LC-HRMS/MS) System.	Yes/ No
2) The LC-HRMS/MS system is intended for the quantification of both low concentration protein (as low as 1 pmol/L) in biological matrices and small organic molecules with a wide concentration range in different matrices. The LC-HRMS/MS system must contain one quadrupole high resolution accurate mass spectrometer (HRMS/MS), one nanoflow liquid chromatograph (NLC), and one analytical high performance liquid chromatograph (HPLC).	Yes/ No
3) The NLC and HPLC must be connected with the HRMS/MS at the same time. Must allow user to switch between the two LC (NLC and HPLC) by controlling computer, and no manual connection is required.	Yes/ No
4) The LC-HRMS/MS system must be bench top with the entire system including HRMS/MS NLC, HPLC and controlling computer within the dimension of 280 cm (L) × 85 cm (D) × 100 cm (H).	Yes/ No
(B) High Performance Liquid Chromatograph	
(B1) Binary Gradient Pump	
1) Must offer a high pressure binary pump system to enable at least 4 individual solvent lines to be utilised concurrently.	Yes/ No
2) Must be able to switch among four different mobile phases (at least two of the four) by programmable software, allowing the switch between two different installed columns using at least two of the four mobile phases.	Yes/ No
3) Must offer integrated diagnostic functions that pre-empts system malfunction.	Yes/ No
4) Must offer an integrated internal degassing unit.	Yes/ No
5) Must enable settable flow range set points from 0.002- 5 mL/min, in 0.001mL/min increments.	Yes/ No
6) Must offer flow precision of $\leq 0.1\%$ Relative Standard Deviation (RSD) or ≤ 0.02 minute Standard Deviation (SD), whichever is greater; based on retention time at constant room temperature.	Yes/ No
7) Flow accuracy must be within $\pm 1\%$.	Yes/ No
8) Operating pressure (with LC column) must be able to reach 800 Bar.	Yes/ No
9) Must offer selectable compressibility compensation, based on mobile phase compressibility.	Yes/ No
10) Must be able to support and function in the pH range of 1.0 – 12.5.	Yes/ No

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11) Must permit gradient formation such as low pressure binary mixing/gradient capability using high-speed proportioning valve.	Yes/ No
12) Must offer user-selectable flow composition ranges from 0 – 100 % in 0.1% increment.	Yes/ No
13) Must offer composition precision of ≤ 0.2 % RSD or ≤ 0.04 min SD, whichever is greater.	Yes/ No
14) Must offer software and local control functions.	Yes/ No
15) Must offer safety and maintenance features to support extensive diagnostics, error detection and display, leak detection, safe leak handling, leak output signal for shutdown of the pumping system. Low voltage in major maintenance areas.	Yes/ No
16) Must be able to notify the lab when the maintenance is due, early maintenance feedback to be provided for continuous tracking of system usage in terms of seal wear and volume of pumped mobile phase with predefined and user settable limits and feedback messages. Electronic records of maintenance and errors shall be provided.	Yes/ No
(B2) Auto-Sample Injector	
1) Sample injection volume must be variable between 0.1 μ L to 50 μ L inclusive, with zero sample loss during injection.	Yes/ No
2) Must be able to process automatically the number of samples and random access for a minimum of 80 positions for 2 ml vial volume.	Yes/ No
3) Must be able to perform customised continuous analyses according to the conditions specified for each sample, including pre-treatment, injection and analysis conditions. Priority samples must be allowed to be inserted in the queue during automated run.	Yes/ No
4) Flow line rinse capability both before and after sampling must be possible.	Yes/ No
5) Carry over must be $\leq 0.1\%$.	Yes/ No
6) Injection precision must be $\leq 0.25\%$ of RSD value.	Yes/ No
7) The injection accuracy must be $\leq 1\%$	Yes/ No
8) Must have a leak sensor, automatic rack and vial recognition as safety feature.	Yes/ No
9) Sample holder must have cooling capability with temperature range covering 5°C to 20°C	Yes/ No
(B3) Column Compartment	
1) Must have uniform temperature distribution that can maintain constant temperature level even when power source voltage fluctuates.	Yes/ No
2) Must allow a column temperature range covering 30°C to 80°C	Yes/ No

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3) The temperature set point accuracy must be within $\pm 0.5^{\circ}\text{C}$.	Yes/ No
4) The temperature stability must be within: $\pm 0.15^{\circ}\text{C}$	Yes/ No
5) Must have temperature limit device and temperature fuse.	Yes/ No
6) Must be capable of temperature programming in linear and step programmes.	Yes/ No
7) Must be able to accommodate at least two columns with a minimum length of 30 cm.	Yes/ No
8) Must have a user programmable rotatory selector valve head for switching between columns.	Yes/ No
(C) Nano Liquid Chromatograph	
1) Must be able to switch between two different mobile phases	Yes/ No
2) Must offer integrated diagnostic functions that pre-empts system malfunction.	Yes/ No
3) Must enable settable gradient flow range set points from 20 - 2000 nL/min, in 1 nL/min increments.	Yes/ No
4) Retention time reproducibility must be $\leq 0.5\%$ RSD.	Yes/ No
5) Flow accuracy must be within $\pm 3\%$	Yes/ No
6) Operating pressure (with nano LC column) must be able to reach 1200 Bar.	Yes/ No
7) Must support and function in the pH range of 1.0 – 12.5.	Yes/ No
8) Must permit gradient formation such as low pressure binary mixing/gradient capability using high-speed proportioning valve.	Yes/ No
9) Must offer user-selectable flow composition ranges from 0 – 95 % organic mobile phase in 0.1% increment.	Yes/ No
10) Gradient delay volume must be below 1 μL	Yes/ No
11) Sample injection volume must be variable between 0.1 μL to 15 μL inclusive or wider.	Yes/ No
12) Flow line rinse capability both before and after sampling must be possible.	Yes/ No
13) Injection precision must be $\leq 0.5\%$ of RSD value.	Yes/ No
14) Carry over must be $\leq 1\%$ for 100 fmol peptide or protein injection	Yes/ No
15) Sample holder must have cooling capability with temperature range covering 5°C to 20°C	Yes/ No
16) Sample tray must be able to hold no less than 40 HPLC sample vials (vial volume 2 mL).	Yes/ No

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Sample tray must be able to hold microtiter plate (MTP) with no less than 300 wells (well volume 105 µL).	
17) Must have a leak sensor, automatic rack and vial recognition as safety feature.	Yes/ No
18) Must allow a column temperature range covering 30°C to 60°C	Yes/ No
19) Must be able to perform customised continuous analyses according to the conditions specified for each sample, including pre-treatment, injection and analysis conditions. Priority samples must be allowed to be inserted in the queue during automated run.	Yes/ No
20) Must offer safety and maintenance features to support extensive diagnostics, error detection and display, leak detection, safe leak handling, leak output signal for shutdown of the pumping system. Low voltage in major maintenance areas.	Yes/ No
21) Must be able to notify the lab when the maintenance is due, early maintenance feedback to be provided for continuous tracking of system usage in terms of seal wear and volume of pumped mobile phase with predefined and user settable limits and feedback messages. Electronic records of maintenance and errors shall be provided.	Yes/ No
(D) Quadrupole High Resolution Accurate Mass Spectrometer (LC-HRMS/MS) System	
1) The system must be a high sensitivity, bench top quadrupole high resolution accurate mass spectrometer (LC-HRMS/MS) system. The system must have unique features which allow both qualitative and quantitative analyses to be carried out in a single experiment. It must also support fast chromatography applications with a large number of analytes.	Yes/ No
2) The mass spectrometer must have a minimum mass range (m/z) of 50-5000 Da.	Yes/ No
3) The mass spectrometer must have a maximum scan rate of 15 scans per second or after in Full Scan.	Yes/ No
4) Buspirone 1 pg on column must yield S/N≥200:1 or Reserpine 1 pg on column S/N ≥ 200:1	Yes/ No
5) The highest resolution must be ≥ 200,000 (full width at half maximum FWHM) for all scan modes under both positive and negative polarities	Yes/ No
6) Mass accuracy must be within ±3 ppm RMS (Root mean square) for external calibration over 24 h and without any kind of mass recalibration, and must be within ±1 ppm RMS for internal calibration.	Yes/ No
7) The mass spectrometer must be capable of fast ionization polarity switching to perform one positive mode full scan and one negative mode full scan within one second while maintaining mass accuracy in one injection	Yes/ No
8) The minimum dynamic range must be > 5000:1	Yes/ No
9) The mass spectrometer must be able to:	Yes/ No

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a) perform multiple precursor ion isolation b) do data-dependent or data-independent MS/MS fragmentation of isolated ions with adjustable energy levels and with high resolution accurate mass detection c) do targeted MS/MS scan at specified time d) SIM scan or timed SIM scan e) do all ion fragmentation scan	
10) The ESI source probe must be provided as standard with the system. The ESI probe must be able to allow effective optimization of ionization with minimal adduct formation. a) The ionisation source must be capable of flow rate (without splitting) in the range of 0.05 µL/min to 2000 µL/min or wider. b) The solvent compatibility for the ion source must be from 100% aqueous to 100% organic, with full gradient capability. c) The ESI nebulizer gas must be user selectable covering the range of 0 to 90 psi (0 to 0.62 MPa). d) The desolvation temperature must be user selectable covering the range from ambient temperature to at least 600°C. e) All ion source parameters except sprayer positioning must be computer-controllable. f) The cleaning and maintenance of desolvation line must be simple and must be able to carry out without breaking the vacuum. g) The source must be able to be removed from the host system without breaking the vacuum. h) Must incorporate a safety interlock switch to turn off voltages when the ion source is removed from source housing.	Yes/ No
11) The MS must have ability to preserve and analyse intact proteins, and provide isotopic resolution of intact proteins up to 28 kDa	Yes/ No
12) Programmable software-controllable flow switching valve for diverting the flow to waste must be available.	Yes/ No
13) Differentially pumped vacuum system with final vacuum must be $<1 \times 10^{-9}$ Torr	Yes/ No
14) Rotary rough pump must be supplied with sound insulation box to reduce noise	Yes/ No
15) The pump must be able to automatically shut down after power failures	Yes/ No
16) Auto-tuning must be standard with a syringe pump that delivers accurate calibrant injection under full workstation control in both positive and negative modes. Manual tuning must also be allowed.	Yes/ No
17) Provide a built-in or external mechanical infusion system/syringe pump to support real-time data acquisition for MS method optimisation. A minimum infusion flow rate at 1 µL/min must be achieved.	Yes/ No
18) A LC-MS start-up kit must be supplied as standard.	Yes/ No

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19) The LC-MS/MS must be able to analyse peptide/protein in low abundance level. Tenderers will be provided with some samples and the samples must be tested without further manipulation and using the conditions provided in the <i>Instruction on Sample Analysis</i>. The details for the identity of the samples will be provided upon sample collection. Sample Collection Details: Shortlisted Tenderers are required to collect the <i>Instruction on Sample Analysis</i> and samples between 0830 to 1200 7 days upon receipt of email notification from the Authority at: Health Sciences Authority, 1 Science Park Road, #01-05/06, The Capricorn, Singapore Science Park II, Singapore 117528. Contact number: 6775 1605 ext 121 The sample must be analysed on the system proposed in this tender. The sample result (raw data and processed) shall be submitted via email (in an EXCEL file) not later than 2 weeks from sample collection date. - The sample testing results (data analysis by CML using raw data) must meet the following requirements:(1) List of peak areas in a Microsoft Excel spreadsheet and (2) raw data in the form of chromatograms with peak areas shown in the graphs for all injections.	Yes/ No
(E) Software and computer	
1) Minimum configuration: 3.2 GHz dual core processor or equivalent, 32GB RAM, 4 x 2 TB hard drives, wireless modem 802.11a/b/g/n/ac , USB 3.0, DVD RW (CD RW capable), mouse and keyboard, high resolution 21 inch flat screen color monitor.	Yes/ No
2) Must provide Windows 10 Professional Operating System and Microsoft Office and any other computer interfaces, cables and software drivers for the system to be usable at optimum conditions.	Yes/ No
3) Single software platform must be provided for a seamless control of all the modules of LC and MS/MS.	Yes/ No
4) The software must allow the generation of sample run sequence table through the use of cut/paste function from MS Excel.	Yes/ No
5) The software must be able to generate both standard and customisable reports to suit different needs.	Yes/ No
6) The software must be able to generate the result reports of chromatograms during and after the sample sequence run.	Yes/ No
7) The software must be able to perform manual integration of single and group peaks capability for better peak identification.	Yes/ No

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8) The software must be able to perform automatic integration of single and group peaks with both standard perimeters and user settable perimeters.	Yes/ No
9) The software must be able to generate numeric data compatible with Microsoft Excel for plotting chromatogram.	Yes/ No
10) For injection of mixture of intact proteins, the software must be able to sum up Q1 MS spectrum within the defined period of retention time (e.g. 6 min – 7 min). The software must be able to construct protein MS profile based on the above Q1 MS spectrum.	Yes/ No
11) Free software upgrade must be provided throughout the warranty period. If the upgraded software is not compatible with the existing computer and/or existing operation system, new/upgraded computer and/or operation system must be provided free-of-charge.	Yes/ No
12) The PC(s) must be under 3-year full warranty and accompanied with their system recovery CDs or DVDs. Laser jet printer must be provided.	Yes/ No
<u>(F) Miscellaneous</u>	
1) The system shall consist, but not be limited to, the above listed major components, complete with all the accessories and interfacing necessary to make a fully functional and operable system.	Yes/ No
2) The power supply must be suitable for use in Singapore.	Yes/ No
3) The Tenderer must provide for any tables/trolleys (suitable for clean room) to facilitate the placement of the entire system (computer, HPLC, NLC, MS system and any other necessary equipment necessary for the complete operation of the system) free-of-charge.	Yes/ No
4) The Tenderer must provide a portable exhaust for the solvent trays of the HPLC and NLC free-of-charge.	Yes/ No
5) The Contractor must provide for any potential necessary modifications to the system (e.g extra/ longer vacuum lines) for the system to be operational at free-of-charge.	Yes/ No
6) Prices quoted must include installation, commissioning, initial calibration and operator training [a maximum of up to ten (10) personnel can be trained after the commissioning of system] at Chemical Metrology Laboratory. The system must come with a minimum 1 year warranty and the PC(s) must come with 3-year warranty. The warranty must include: - unlimited breakdown calls and on-site support services during Office Hours from 8:00 am to 5:30 pm Monday to Friday excluding Saturday, Sunday and Public Holidays; - Provision of at least 1 preventive maintenance (PM). Any PM kit, wear and tear parts/consumables and replacement parts that required to complete the PM must be provided at no additional cost; - Supply of all replacement of parts;	Yes/ No

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- Supply of all consumables that required for repair; and - Provision of software upgrade or revisions and include Clause E(11)	
7) Tenderer is required to quote for the option to exercise 3-year post warranty comprehensive maintenance contract in <u>Annex C - Price and Submission Information</u>. The post warranty comprehensive maintenance contract shall minimally include the following: a) Unlimited breakdown calls and on-site support services during Office Hours b) All replacement parts (both electronic and mechanical in nature), required consumables and labour during preventative maintenance and all non-scheduled maintenances and breakdown. c) 1 PM ((includes both labour, all required consumables and replacement parts, both electronic and mechanical in nature) per year, and cover the overall system (both hardware and software) per year with PM kit (inclusive of any tuning solution, if applicable) provided free-of-charge. d) Update of software revision whenever available and include Clause E(11)	Yes/ No
8) Standard consumables that are required for the set up and commissioning of the system must be provided. In addition to the standard consumables, the Tenderer <u>must provide</u> the list of consumables parts required for preventive maintenance or non-scheduled maintenance and the frequency of change of such part, for the respective modules as follow in the format set out in <u>separate form, preferably to be submitted together with the proposal or upon request.</u>	Yes/ No
9) A declaration of Conformity certificate must be provided upon commissioning of equipment.	Yes/ No
10) The delivery of the equipment must be coordinated with the Laboratory.	Yes/ No
11) The Contractor must be able to provide after-sales support from engineers and application chemists based in Singapore. 12) Direct engagement with engineer for maintenance and breakdown through phone call and on-site. Immediate instruction for trouble shooting by telephone must be able to be provided. Please provide the contacts (non-call centre number/ handphone number and email) of at least two engineers experienced with the system in Annex C – Price and Submission Information: 13) Tenderer must have sold at least 3 units of the proposed LC-HRMS/MS system in the tender or other LC-HRMS/MS by the same manufacturer in Singapore in 2017 to 2020. Track record(s) of the installation sites to be provided at Annex C – Price and Submission Information – Track Records.	Yes/ No
13) Tenderer shall guarantee that the spare parts, consumables and services for the system will be available for a period of at least eight (8) years from the date of discontinuation of the system and shall further undertake to locally supply or make available these parts/consumables for the said period.	Yes/ No

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14) Contractor must be able to provide on-site system operation and user maintenance training by certified engineer(s). The certificate(s) shall be provided upon request.	Yes/ No
15) PERFORMANCE OF SERVICES The Contractor shall perform the Services in the manner as specified in the Contract in order to maintain the Equipment in Good Working Order. The Services to be performed by the Contractor shall consist of Preventive Maintenance and Corrective Maintenance as described below. (I) Preventive Maintenance: - The Preventive Maintenance shall consist of routine maintenance of the equipment, including but not limited to the testing of functions and inspecting of the condition of the equipment in order to keep the equipment safe for use and in good working order; and Adjustment and/or repair of any defect in or malfunction of the equipment discovered by the Contractor's representatives during the course of routine maintenance checks. - The Preventive Maintenance performed shall be in compliance with the manufacturer's recommendation. - The Preventive Maintenance shall be carried out and completed during Operating Hour. (II) Corrective Maintenance: Upon receipt of oral or written notice from the Authority, the Contractor shall use its best endeavours to ensure that suitably qualified and duly authorised representative(s) attends to the Authority onsite. That is, the Contractor must be able to meet the following four requirements when the Authority requests the contractor to meet all or any of these requirements: 1) The suitably qualified and duly authorised representative(s) shall attend to the Authority onsite within the response time of not more than 24 hours upon receipt of oral/written notification if the urgent request (e.g. project with strict deadline) is made on a Working Day. 2) The representative shall provide immediate instruction for trouble shooting by telephone, when requested. 3) If the urgent request (e.g. project with strict deadline) is made on a non-working day, the Contractor shall respond onsite within the first 24 hours of the beginning of the next Working. 4) For urgent breakdowns (e.g. project with strict deadline), the Contractor shall complete any on-site service, repair, or replacement or adjustment of components within 2 working days when parts are available in Singapore, within 5 working days when parts are not available in Singapore and are needed to be ordered from overseas from and including the date on which the Contractor was given notice pursuant to requirements (1) to (3) in Clause II.	Yes/ No
16) REPLACEMENT AND PURCHASE OF COMPONENTS a) The Contractor shall inform the Authority of any part or component of the Equipment that needs to be replaced. Prior written approval must be issued by the Authority before the replacement may be effected unless the	Yes/ No

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replacement required is deemed urgent by the Authority in which case a verbal approval (which shall subsequently be confirmed in writing) obtained from an authorised officer of the Authority shall suffice. b) The Contractor shall use all reasonable endeavours to supply only original or genuine replacement components, which are required to maintain the Equipment in Good Working Order. All replacement components shall be provided free-of-charge during the period of warranty period and post warranty comprehensive maintenance contract.	

Please indicate any non-compliance to requirement specifications here should there be any.

Reference To	Remarks