

PART 2

REQUIREMENT SPECIFICATIONS

1. SCOPE OF TENDER

The scope of this tender is for the Supply, Delivery, Installation and Commissioning of:

- (i) one unit of high resolution quadrupole time-of-flight tandem mass spectrometry system with liquid chromatography system and accessories; and
- (ii) one unit of triple quadrupole tandem mass spectrometry system with liquid chromatography system and accessories

to the Department of Biological Sciences, National University of Singapore.

Tenderers shall quote a new and/or used system for both (i) and (ii). The used system must be certified by the manufacturer to be in good condition. Good condition is defined as the ability to meet the specifications of a working system in the field, as specified by the Instrument Evaluation Test (see section 3.1).

2. TECHNICAL SPECIFICATIONS

2.1 High resolution quadrupole time-of-flight tandem mass spectrometry system with liquid chromatography system and accessories

2.1.1 Ion source

- a) The source shall be removable from the instrument without breaking the vacuum.
- b) The source shall be equipped with electrospray ionization (ESI) and atmospheric pressure chemical ionization (APCI) probes.
- c) The source shall have direct (non-split) flow rate compatibility in ESI mode ranging from at least 5 µl/min to 2000 µl/min.
- d) The source shall have options for direct (non-split) flow rate compatibilities for capillary flow (at least 1 – 100 µl/min) and nano flow (at least 100 – 800 nl/min) in a single source.
- e) The source shall have solvent compatibility for gradients ranging from 100% aqueous to 100% organic.

2.1.2 Mass analyzer

- a) The instrument shall comprise at least a direct atmosphere-to-vacuum interface with curtain gas barrier, followed by a quadrupole mass filter, followed by a quadrupole collision cell, and followed by a time-of-flight mass analyzer.
- b) The instrument shall have tandem mass analyzers, capable of performing full scan MS and MSMS, as well as Product Ion Scan, Precursor Ion Scan and Q1 scan.
- c) The instrument shall be capable of more than 30,000 (FWHM) resolution for MS.
- d) The instrument shall be capable of more than 15,000 (FWHM) resolution for MSMS.
- e) The instrument scan speed shall be capable of collecting at least 50 MSMS spectra per second in data-dependent acquisition mode, and at least 150 MSMS spectra per second in data-independent acquisition mode.
- f) The instrument mass accuracy shall be less than or equal to 1.0 ppm error with internal calibration, and less than or equal to 2.5 ppm error with external calibration

- g) The instrument shall have a system to deliver calibration solutions directly to the ion source.

2.1.3 Liquid chromatography system

- a) The system shall be able to deliver direct (non-split) capillary and nano flow in a single system for high-resolution chromatographic separations.
- b) For nano flow, the system shall be able to deliver flow rates of at least 150 – 1000 nl/min.
- c) For capillary flow, the system shall be able to deliver flow rates of at least 1 – 50 µl/min.
- d) The system shall be able to withstand maximum pressures of at least 9000 psi.
- e) The system autosampler shall be capable of injecting samples volumes ranging from at least 0.5 – 10 µl, with less than 2% relative standard deviation (RSD) and less than 0.02% carry-over between injections.
- f) The system shall include a column oven which is capable of maintaining temperatures from at least 5°C above ambient to 50°C.

2.1.4 Software and operating system

- a) The system shall include a Windows-based data acquisition and analysis software package.
- b) The system shall be installed with either Microsoft Windows 10 Professional 32-bit or 64-bit, or at least Microsoft Windows 7 Professional 32-bit or 64-bit with a Windows 10 upgrade included.
- c) The system shall be installed with Microsoft Office.
- d) The system shall be compatible with a variety of commercially available liquid chromatography pumps, autosamplers, manual injectors and detectors.
- e) The system shall be able to perform dynamic accumulation of MSMS spectra in data-dependent acquisition mode, enabling real-time management of MSMS acquisition time based on intensities of the selected precursors.
- f) The system shall be capable of automatically optimizing collision energy for samples chemically-labelled with stable isotopes.
- g) The system shall be able to perform data-independent acquisition, where high resolution MSMS data spectra are generated for all precursor masses over a specified mass range. This could involve a resolving Q1 window stepped across a mass range, with high resolution and accurate MSMS spectra obtained at each mass step. The system should be able to acquire at least 150 windows per cycle with variable window width from at least 1-2000 amu as defined by the user.
- h) The system software shall be capable of automated mass calibration for maintaining mass accuracy over long sample runs.
- i) The system software shall be able to generate contour plot displays of mass and chromatogram spectra.
- j) The system software shall include the capability to interpret mass fragmentation patterns.
- k) The system software shall be capable of comprehensive protein identification, QC and characterization, as well as comprehensive metabolite identification and statistical analysis.
- l) The system software shall be capable of generating and searching spectral libraries.

- m) The system software shall be able to process data-independent acquisition data for quantification of extracted ion chromatograms using a spectral library as input.
- n) The system software shall be capable of searching against accurate mass and nominal compound libraries.
- o) The system software shall include the capability for automated searches of accurate mass MS, isotope pattern and assigned chemical formula against online databases.

2.1.5 Gas generator

- a) The system shall be able to meet all the gas supply requirements of the mass spectrometry system.
- b) The system shall have some form of insulation to reduce noise and vibration.

2.2 Triple quadrupole tandem mass spectrometry system with liquid chromatography system and accessories

2.2.1 Ion source

- a) The source shall be removable from the instrument without breaking the vacuum.
- b) The source shall be equipped with electrospray ionization (ESI) and atmospheric pressure chemical ionization (APCI) probes.
- c) The source shall have direct (non-split) flow rate compatibility in ESI mode ranging from at least 5 µl/min to 2000 µl/min.
- d) The source shall have options for direct (non-split) flow rate compatibilities for capillary flow (at least 1 – 100 µl/min) and nano flow (at least 100 – 800 nl/min) in a single source
- e) The source shall have solvent compatibility for gradients ranging from 100% aqueous to 100% organic.

2.2.2 Mass analyzer

- a) The instrument shall comprise at least a direct atmosphere-to-vacuum interface with curtain gas barrier, followed by a quadrupole mass analyzer, followed by a quadrupole collision cell, and followed by a quadrupole mass analyzer and/or linear ion trap.
- b) The instrument shall be capable of performing full scan MS and selected ion monitoring for both Q1 and Q3, with at least the following scan modes: product ion scan, precursor ion scan, neutral loss or gain scan, selected reaction monitoring (SRM) or multiple reaction monitoring (MRM) and MS3 scan.
- c) The instrument shall at least have a mass range of 50-2000 Da.
- d) The instrument shall be capable of scan speeds of at least 10,000 Da/sec.
- e) The instrument shall be able to switch ionization mode polarities continuously and require no more than 25 msec settling time between polarities.
- f) The instrument shall have a dynamic range of at least 6 orders of magnitude.

2.2.3 Liquid chromatography system

- a) The system shall be able to deliver direct (non-split) capillary and nano flow in a single system for high-resolution chromatographic separations.

- b) For nano flow, the system shall be able to deliver flow rates of at least 150 – 1000 nl/min.
- c) For capillary flow, the system shall be able to deliver flow rates of at least 1 – 50 µl/min.
- d) The system shall be able to withstand maximum pressures of at least 9000 psi.
- e) The system autosampler shall be capable of injecting samples volumes ranging from at least 0.5 – 10 µl, with less than 2% relative standard deviation (RSD) and less than 0.02% carry-over between injections.
- f) The system shall include a column oven which is capable of maintaining temperatures from at least 5°C above ambient to 50°C.

2.2.4 Software and operating system

- a) The system shall include a Windows-based data acquisition and analysis software package.
- b) The system shall be installed with either Microsoft Windows 10 Professional 32-bit or 64-bit, or at least Microsoft Windows 7 Professional 32-bit or 64-bit with a Windows 10 upgrade included.
- c) The system shall be installed with Microsoft Office.
- d) The system shall be compatible with a variety of commercially available liquid chromatography pumps, autosamplers, manual injectors and detectors.
- e) The system software shall be capable of accepting a simple list of compound names, SRM/MRM transitions, and expected retention times for automated scheduling of dynamic acquisitions of SRM/MRM transitions, such that only compounds that elute in a specified retention time window are monitored.

3. OTHER REQUIREMENTS

3.1 Instrument Evaluation Test Report – Applicable for Used System Only

This section is only applicable if the Tenderer wishes to propose a used instrument. The Tenderer must provide as part of its tender submission an Instrument Evaluation Test report (including the range of acceptable performance criteria and values), so as to demonstrate working condition of the instrument. The Instrument Evaluation Test report shall detail the results of the Instrument Evaluation Tests stated in sections 3.1.1 and 3.1.2.

3.1.1 Instrument Evaluation Test Criteria for instrument (i) high resolution quadrupole time-of-flight tandem mass spectrometry system with liquid chromatography system. The Instrument Evaluation test shall include, but not limited to:

- a) For the mass spectrometry system:
 - i. Detector condition
 - ii. Vacuum pressure parameters
 - iii. Quadrupole ion transmission test
 - iv. Quadrupole mass isolation test
 - v. Resolution test
- b) For the liquid chromatography system:
 - i. Flow rate test
 - ii. Leak test
 - iii. Autosampler pickup test

3.1.2 Instrument Evaluation Test Criteria for instrument (ii) Triple quadrupole tandem mass spectrometry system with liquid chromatography system. The Instrument Evaluation Test shall include, but not limited to:

- a) For the mass spectrometry system:
 - i. Detector condition
 - ii. Vacuum pressure parameters
 - iii. Quadrupole ion transmission test
 - iv. Quadrupole mass isolation test
- b) For the liquid chromatography system:
 - i. Flow rate test
 - ii. Leak test
 - iii. Autosampler pickup test

3.2 Utilities Requirement

Utilities requirement for the system(s) should be specified in detail in the tender submission. The tenderer is required to be accurate and specific in specifying all the equipment consumption and emission ratings (for example, electrical input current rating, water supply, compressed air supply, exhaust ratings, etc., where applicable).

3.3 Safety Requirements

At all times in its performance of the works, the Contractor shall comply with all safety rules and regulations stipulated by the relevant authorities as well as and in accordance with industry best practices. At all times in its performance of the works, the Contractor shall possess and maintain (and shall ensure all its employees or contractors performing the works shall possess) all relevant certificates and permits required under law for its performance of the works, including any certificates or legal documents required by NUS. Tenderers are to submit all relevant certificates and permits required under law as part of tender submission, and during the period of the Contract, shall provide copies of such certificates at NUS' request from time to time.

3.4 Price

- a) Pricing shall include freight and insurance to the delivery location at NUS' premises.
- b) All software to enable the proper functioning and use of the system to meet the requirements of NUS will be supplied together with the equipment. The license fees for all software shall be included within the Contract price. Contractor and/or its software licensor shall grant and NUS shall have the perpetual right and licence to use the software and such right and license shall be transferable upon the transfer or sale of the system.

3.5 Export and Import licenses

Export / Import licenses if required, should be clearly indicated.

The Tenderer shall provide any export/import licenses to NUS as may be required. The Tenderer shall make its own arrangements regarding import and export licenses, custom and import duties and all related matters from their manufacturing/production origination to the NUS designated site.

3.6 Site Preparation

The Tenderer shall provide in its tender submission the information with regard to the dimensions and weights of the various component parts of the system(s) as well as any specific site or environmental requirements. Within one month of the award of tender, the Contractor shall supply to NUS such information and assistance as may be necessary to enable NUS to conduct site preparation for the installation of the system.

3.7 Installation, Commissioning and Training

a) **Installation**

Equipment should be installed without disruption to normal operations. The Contractor shall warrant that upon its delivery and installation, each item of the system(s) shall be in good working order and will conform to the Requirement Specifications and the Contractor's official published specifications. The Contractor shall provide all tools and equipment necessary for the installation of the system at no additional charge.

b) **Commissioning**

Equipment commissioning should be carried out for full functionality of hardware, software and process.

c) **Training**

Training should be carried out after the commissioning of the equipment for at least three (3) personnel. The training should cover software and hardware operation, as well as the standard maintenance requirements.

3.8 Site Acceptance Test (SAT)

- a) The Site Acceptance Test is to be inspected by at least one (1) personnel from NUS.
- b) The Tenderer should provide as part of its tender submission the Site Acceptance Test protocol as recommended by the manufacturer so as to demonstrate full compliance to Specifications, including the range of acceptable performance criteria and values. NUS reserves the right to amend the protocol as it deems necessary. The Tenderer agrees to perform the acceptance test as agreed, to the satisfaction of NUS.
- c) Site Acceptance Test Criteria for instrument (i) high resolution quadrupole time-of-flight tandem mass spectrometry system with liquid chromatography system. The site acceptance test shall include, but not be limited to:
 - i. Mass spectrometry system:
 - i. Vacuum pressure parameters
 - ii. Quadrupole ion transmission
 - iii. Quadrupole ion transmission test
 - iv. Quadrupole mass isolation test
 - v. Resolution test
 - ii. Liquid chromatography system
 - i. Flow rate test
 - ii. Leak test
 - iii. Autosampler pickup test

- d) Site Acceptance Test criteria for instrument (ii) triple quadrupole tandem mass spectrometry system with liquid chromatography system. The site acceptance test shall include, but not be limited to:
 - i. Mass spectrometry system:
 - i. Vacuum pressure parameters
 - ii. Quadrupole ion transmission
 - iii. Quadrupole ion transmission test
 - iv. Quadrupole mass isolation test
 - ii. Liquid chromatography system:
 - i. Flow rate test
 - ii. Leak test
 - iii. Autosampler pickup test

3.9 Documentation

- a) Two (2) sets of operation and maintenance service manuals (hardcopy or softcopy) for each system in English should be provided.
- b) One (1) set of Site Acceptance Test report in English (hardcopy or softcopy) for each system shall be submitted within two (2) working days upon satisfactory completion of site acceptance test.

3.10 Support and Maintenance

- a) During the warranty period, the Tenderer should provide on-time support for system maintenance, software and hardware troubleshooting. "On-time support" refers to response/help within 24 hours after NUS calls or email; or, if actual physical support at NUS's site is required, it is attendance within two (2) business days if system fails to be back into operation with remote support.
- b) The Tenderer should provide the contacts (mobile number and email) at least two (2) engineers experienced in the system(s).
- c) Tenderers shall ensure availability of critical spare parts and consumables for at least six (6) years. A list of recommended preventive maintenance guidelines shall be provided as part of the tender documentation.

3.11 Warranty

- a) The system should have a minimum 48 months on-site comprehensive warranty. The warranty shall include at least one (1) preventive maintenance per year and all cost of repairs, including but not limited to unlimited breakdown calls and onsite services, spare parts, labour, transport and accommodation. The warranty period shall commence upon commissioning.
- b) The Tenderer shall ensure availability of parts during the warranty period, such that when necessary, replacement of parts can be performed within two (2) business days if parts are available in Singapore, or within five (5) business days if the parts need to be ordered from overseas.

3.12 Track Record

Tenderers shall provide track records and references of past projects for similar system installations in the past five (5) years.

For clarifications on technical specifications listed herein, tenderers may contact:

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EVALUATION CRITERIA

The following criteria will be used in the evaluation of this tender.

1. Critical Criteria:

Tenderers must satisfy the following critical criteria before their tender proposal will be further evaluated:

- a) Tenderers shall not be debarred from participating in NUS tenders.
- b) For used system proposals only - Certification by manufacturer that the system is in good condition.

2. Other Criteria:

Tenders shall be evaluated based on a Price versus Quality matrix of 30% to 70%.

- a) Competitive Pricing (30%)
- b) Compliance with Requirement Specifications (50%)
- c) Possess a valid registration certificate with the appropriate Government Registration Authority (5%)
Supply Head Reference: EPU/LTE/10 (Laboratory Testing And Survey Equipment and Laboratory Testing Services) or EPU/LAB/30 (Laboratory Equipment and accessories)
Financial Grade: S6 or higher
- d) Track record (10%)
- e) Ability to meet delivery schedule (5%)