

PART 2

REQUIREMENT SPECIFICATIONS

1. SCOPE OF TENDER

The scope of this tender is for the Supply, Delivery, Installation and Commissioning, Testing and Training of Liquid Chromatography High Resolution Mass Spectrometer System to the Department of Food Science & Technology, National University of Singapore

2. TECHNICAL SPECIFICATIONS

The LC should have the following configuration:

1. Solvent Delivery System with Integrated Degasser
2. Autosampler with cooler
3. Column oven
4. Hi Res Mass Spectrometer System
5. Software and Workstation
6. N2 Generator (optional)
7. Accessories
8. Training
9. Others

The liquid chromatography high-resolution mass spectrometer system must consist of (ultra) high performance liquid chromatography and a high resolution mass spectrophotometer. It must be from single vendor to ensure seamless integration.

2.1. Solvent Delivery System with Integrated Degasser

- Instrument should be equipped with quaternary or binary mixing solvent delivery system with Integrated Degasser for high accuracy.
- Must support and function in the pH range of 1.0 – 12.5.
- Operating pressure range of the binary pump should be at least from 0-15,000PSI.
- Flow rate at least up to 2 mL/min with flow precision: $\leq 0.08\%$ RSD or ≤ 0.02 min Standard Deviation (SD), whatever is greater. Flow accuracy: $\pm 1\%$ or lower.
- Must come with automatic seal wash.
- Equipped with leak sensors for leak safe handling.
- Gradient formation: at least 2 solvents.
- Composition precision and accuracy as low as possible: $<0.15\%$ RSD or 0.02 min SD, whatever is greater. Composition accuracy: at least $\pm 0.35\%$
- Low delay volumes of less than 375 μ L.

2.2. Autosampler with cooler

- The auto sampler must come with flow through injection design with variable injection volume
- The injection linearity is 0.9999 in the range of 0.1 – 100 µL.
- The auto sampler should have an injection volume range of at least 0.1 – 20 µL in 0.1 µl increments without any hardware changes
- Providing cooling and heating in the range at least from 4 ° C - 40 °C, temperature settable in 1 °C increments.
- Lowest Carryover < 0.002%
- Able to accommodate 2mL vial container.

2.3. Column oven

- The temperature range is at least from ambient to 90 ° C.
- High temperature accuracy is $\pm 0.5^{\circ}$ C or better
- High temperature precision is 0.05° C or better
- Able to accommodate at least 2 columns.
- Able to tighten the column without using any tools.

2.4. High Resolution Quadrupole Time-Of-Flight Mass Spectrometer System

- Minimum mass range: 50-10,000 and above
- The system should preferably have built-in calibrant delivery system for automated introduction of reference masses and carry out real-time internal reference mass correction for MS and MS/MS operation for better mass accuracy.
- The mass analyzer must consist of a quadrupole mass filter, a quadrupole collision cell.
- The mass analyzer must be able to perform full scan MS and MS/MS, data independent acquisition and multiple reaction monitoring (MRM).
- The mass measurement accuracy of the instrument should be better than 1 ppm RMS.
- The sensitivity at positive MS mode with 1 pg injection of reserpine, while maintaining maximum mass resolution shall preferably be at least 500:1 RMS signal-to-noise ratio.
- The sensitivity at positive MS/MS mode with 1 pg injection of reserpine, monitoring the most intense product ions while maintaining maximum mass resolution shall preferably be at least 1,500:1 RMS signal-to-noise ratio.

- The sensitivity at negative MS mode with 1 pg injection of chloramphenicol, while maintaining maximum mass resolution shall preferably be at least 500:1 RMS signal-to-noise ratio.
- The sensitivity at negative MS/MS mode with 1 pg injection of chloramphenicol, monitoring the most intense product ions while maintaining maximum mass resolution shall preferably be at least 1,500:1 RMS signal-to-noise ratio.
- Instrument should have low-noise analogue-to-digital (ADC) acquisition system for wide dynamic range accurate mass measurement.
- The tuning solution should preferably be fully integrated with the built-in automated tuning system that enables optimization of ion optics and full mass axis calibration.
- The mass resolution must be at least >30,000 FWHM
- The dynamic range must be equal to or greater than 4 orders of magnitude without loss of mass resolution.
- The spectral acquisition rate at MS mode shall be at least 40 spectra/second and at least 25 spectra/second acquisition rate at MS/MS mode shall be while maintaining a mass resolution unchanged.
- Instrument should preferably have excellent Isotope fidelity with Relative Isotopic Abundance (RIA) error less than <5 %

2.5. Software and Workstation

- 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 software should preferably allow several users to access to process and evaluate their data at the same time.
- One PC is for data acquisition and another for data processing.
- Must be able to provide fully integrated control for both the (ultra) high-performance liquid chromatography (UHPLC) and the hi-res mass spectrometer system
- Has on-line help for instrument control programs as well as user manual in PDF file format
- 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
- It should cover digital instrument control, qualitative and quantitative processing, report creation, self-diagnosis and auto- tune.

- Auto tuning with sensitivity and resolution optimization for both positive ion and negative ion should be standard.
- The proposed solution must be single point data system method capability with full control for HPLC system and HRMS and communication between the two such that if the HPLC or MS experiences a “not ready” condition, error, or leak, the system stops injecting the sample.
- Data acquisition software should feature single point method capacity with full control for HPLC modules at all times during LC run. Software should be of single software program from single manufacturer.
- Software must incorporate molecular feature extraction, molecular formula confirmation and molecular formula generation tools.
- Software should have the capability to determine the molecular formula from accurate mass measurement and isotope fidelity (including both isotope spacing and isotope distribution) information.
- Software should have the ability to predict the molecular formula of fragment ion from accurate mass information at MS/MS level.
- Software should have “Personal Compound Database Library (PCDL) Manager” a user creatable & editable accurate mass retention time database with MS/MS library spectral information. Scoring should be based on monoisotopic mass, isotopic spacing and isotopic ratio distribution for MS search and option to choose reverse & forward score for MS/MS spectral match.
- Software should have “Structure Correlator” capabilities, which can predict and match experimental fragments into proposed structure via a “novel systematic bond breaking approach.

Software should have capability to:

- Perform multivariate chemometric analysis and advanced statistical analysis such as post-hoc test for two or more sample conditions.
- Support ICPMS, GC/MS and LC/MS data format or generic file on a single platform.
- Support data visualization through heatmaps, correlation plots.
- Perform pathway analysis using open-source or customizable pathway database on a single platform
- Method file should be capable to save all analysis parameters, data processing parameters and report format.
- 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

- Comes with a powerful chemometrics software or omics data processing software with many advanced statistical and visualization tools that allow getting biological insight from complex data faster and easier or omics data.

2.6. Nitrogen Generator (optional)

- Nitrogen Flow Rate supply is at least 70L/Min
- Operation Outlet Pressure at least 100 psi
- Operates with Oil free Compressor based solution, such that generator can run on its own without the need for an external source of air
- Contain at least 4 Oil Free Compressor and offer Compressor Redundancy. In the event if 1 of the compressor is faulty, the remaining compressor can still produce Nitrogen Gas at 70L/min.
- Compressor must be installed in insulated chamber to minimize noise and vibration with Thermal Management to optimize internal air flow and system ventilation
- Gas will be supplied on demand
- Fitted Touch Screen Full colour user interface with on-boards service scheduling and system diagnostic
- Ability to power down all compressor, reducing overall energy consumption
- Ultra-fast Start up, not more than 30 minutes to operating purity from installation
- Internal Status Check on start-up
- Generator supplied must be tested & approved by LC/MS manufacturer
- Generator must be fitted with wheels for easy mobility
- Noise level <60 dB(A)
- Generator must have declaration of conformity, which declare relates in conformity with the applicable European Commission (EC) Directives, harmonized standards, and other normative requirements
- Generator must be fully compliant with all applicable certification standards and tested to comply with current Electromagnetic Compatibility requirement
- Generator must be tested to delivered Nitrogen of suitable quality for the LCHRMS system.

2.7. Safety Features

The instrument should have undergone testing under the Consumer Protection Safety Requirements and bear the Safety Mark for use in Singapore.

2.8. Options

Tenderers shall quote for the following options in the Schedule to Form of Tender. These options shall be exercisable by NUS within validity period if agreeable.

- a) Yearly comprehensive preventive maintenance for the next 5 years
- b) Further discount or provision can be offered if working on collaborative mode on Foodomics for food safety, sustainability, functional nutrition and Health
 - i. assist in method development or applications
 - ii. allow vendor's to access facilities

3. OTHER REQUIREMENTS

3.1. Utilities Requirement

Utilities requirement for the system 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).

3.2. Safety Requirements

At all times in its performance of the works described above, 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 described above, 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 described in above, 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.

3.3. Factory Acceptance Test (FAT)

- a) The Tenderer should provide as part of its tender submission the factory acceptance test protocol as recommended by the manufacturer so as to demonstrate full compliance to the Specifications. 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.
- b) Factory Test Acceptance Test Criteria. The factory acceptance test shall include, but not limited to:
 - i. Pass all relevant safety compliance
 - ii. Performance tests meet according to the specification

3.4. Delivery

The Contractor shall be fully responsible for all transport required for the delivery of the Goods to NUS designated site. The Contractor shall also arrange for all insurance

required including coverage for loss of or damage to the Goods during conveyance or transportation to NUS designated site, at no additional cost and expense to NUS.

Refer to Annex A-1 of Conditions of Contract in Part 1 of Tender Document for the delivery schedule and location.

3.5. Price

- a) Pricing shall include freight and insurance to the delivery location.
- 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.

3.6. 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.

3.7. 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 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.

3.8. Pre evaluation sample analysis

Three samples will be given to the tenderer to do an evaluation on their LCHRMS.

3.9. 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 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.

Site survey must be conducted by the vendor and a site survey report must be produced by the vendor at no extra cost. In case where the site doesn't

meet the required specification, recommendations about how to improve must be clearly suggested in the report by the vendor.

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 3 personnel. The training should cover software and hardware operation, as well as the standard maintenance requirements.

For each system, the tenderer shall provide comprehensive on-site training for at least 5 users on the system startup, usage, maintenance, quality control, trouble shooting, etc. at no extra cost.

3.10. **Site Acceptance Test (SAT)**

- a) The Site Acceptance Test is to be inspected by 2 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. 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. The site acceptance test shall include, but not limited to:
 - i. Power supply requirement
 - ii. User safety
 - iii. Other safety requirement

3.11. **Documentation**

- a) Operation and maintenance service manuals in English should be provided.
- b) Factory Acceptance Test report in English (softcopy) shall be submitted within 10 working days upon satisfactory completion of factory acceptance test.
- c) Site Acceptance Test report in English (hardcopy and softcopy) shall be submitted within 10 working days upon satisfactory completion of site acceptance test.

3.12. **Support and Maintenance**

- a) 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 3 business days if system fails to be back into operation with remote support.
- b) Tenderers shall ensure availability of critical spare parts and consumables for at least 10 years. A list of recommended preventive maintenance guidelines shall be provided as part of the tender documentation.

3.13. Warranty

The system should have a minimum 12 months on-site comprehensive warranty. The warranty shall include all cost of repairs, including but not limited to spare parts, consumables, labour, transport and accommodation. The warranty period shall commence upon satisfactory completion of the Site Acceptance Tests.

3.14. Extended Warranty (Option)

Tenderers shall quote for an optional extended warranty package for 48 months. This option shall be exercisable by NUS 4 weeks before the base warranty period expires.

3.15. Comprehensive Service Contract (Option)

- a) Tenderer shall quote for an optional comprehensive service package of 5 years (inclusive of labour, parts, shipping costs of parts etc.) commencing from the end of the warranty period of 1 year. This option shall be exercisable by NUS 4 weeks before the warranty period expires.
- b) If any of the services performed is found to be deficient, the Tenderer shall, at its own cost and expense (including transportation costs), at the written notification of NUS, re-perform the same, within 14 working days, which shall commence from the said notification and end upon the acceptance of the re-performed services.
- c) Any checks or repairs should be made on-site by a qualified and trained engineer.
- d) The Tenderer shall inform NUS on the repairs required before proceeding with the repairs.
- e) Service reports should be provided after the servicing or repair has been completed.

3.16. Track Record

Tenderers shall provide track records and references of past projects for similar system installations in the past 3 years.

The tenderer must demonstrate that it has a proven appropriate set-up and capability to provide after-sales service efficiently and effectively.

3.17. Delivery Timeline

Tenderers shall provide the delivery timeline.

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

Name : Lew Huey Lee
Tel Number : 66017405
Email : hueylee@nus.edu.sg

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) Compliance with the Technical Specifications listed in Sections 2.1 to 2.5.

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, excluding the Technical Specifications listed in Critical Criteria 1(b) (50%)
- c) Possess a valid registration certificate with the appropriate Government Registration Authority (5%)
Supply Head Reference: EPPU S4
Financial Grade: up to S\$500,000 and above
EPU/LAB/30 - Laboratory equipment and accessories or
EPU/LTE/10 – Laboratory Testing and Survey Equipment
- d) Track record in Section 3.16 (10%)
- e) Ability to meet delivery schedule (5%)