

Should your offer be accepted, the Requirement Specifications as set out in this Part and shall govern the Contract between the Authority and your company.

Equipment 2: Inductively Coupled Plasma-Mass Spectrometer (ICP-MS) System Location: Chemical Metrology Laboratory (CML) Quantity: 1	Compliances (Yes/ No) <i>**If No, please indicate reason of non-compliances.</i>
<u>General</u>	
1) The system shall consist of a computer-controlled inductively coupled plasma mass spectrometer (ICP-MS) for the analysis of trace metals in a wide range of sample types. The system shall include all equipment necessary for the maintenance of high vacuum and the introduction of samples by conventional solution nebulization.	Yes/ No
2) The ICP-MS mainframe must be bench top (not floor standing) with single floor mounted rotary pump, due to limitations in lab space. The system mainframe dimensions must not be larger than 900 mm width, 1250 mm depth, and 1550 mm height in order to fit into the cleanroom material "shower". The system must have a stainless steel chassis to ensure durability when exposed to acid fumes or organic solvent vapors. The ICP-MS system (including auto-sampler enclosure) shall be able to fit on the laboratory existing bench top (1700 mm length and 750 mm width).	Yes/ No
3) The system must have safety interlocks to allow safe shutdown, so that the system will not be damaged in the case of loss of power, gas supply, water cooling, or other system malfunction. In addition, all events must be automatically logged to a user-retrievable electronic error file and must include event description, time and date.	Yes/ No
4) The system must operate from one 30-32A single phase electrical supply. All other components, including the chiller must run from standard 110/240V power outlet.	Yes/ No
5) The ICP-MS must employ a single exhaust vent with flow $\leq 7.0 \text{ m}^3/\text{min}$. This is important to keep a positive air pressure in the cleanroom laboratory without overloading the existing air handling system.	Yes/ No
6) The ICP-MS must maintain optimum performance under the following conditions: Temperature: between 18 °C and 30 °C inclusive (maximum rate of change 2 °C /hr). Humidity (non-condensing): between 40% and 70 % inclusive.	Yes/ No
<u>Major hardware and software components (ICP-MS)</u>	
7) The ICP-MS system shall minimally consist of, but not be limited to, the following major components, complete with all software/hardware and interfacing necessary to make a fully integrated system: a. Sample introduction system b. Inductively coupled plasma source c. ICP-MS Interface d. Ion focusing system e. Mass analyzer f. Collision/reaction Cell	Yes/ No

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31) For optimum performance the mass analyzer must be able to operate at high RF frequency ≥ 2.7 MHz for optimum resolution of overlapping matrix peaks.	Yes/ No
32) The system must be capable of analysing mass ranging from at least 2 – 260 amu.	Yes/ No
33) Scan speed (Li to U, plus data collection at 40 intervening masses): ≥ 3000 amu/sec or better.	Yes/ No
34) Mass calibration stability of ≤ 0.05 amu over eight hours of continuous operation must be sustained.	Yes/ No
35) Safety interlocks shall shut off power to the mass analyser under any system conditions that could cause damage to the mass analyser and detector assembly.	Yes/ No
36) The system must feature a collision/reaction cell (CRC) device for removal of polyatomic interferences.	Yes/ No
37) The system must be able to operate in CRC mode for all analytes, not only a small set of 3-4 analytes. It is essential that collision/reaction cell must be simple to setup for routine operation, using consistent conditions for multi-element analysis in variable sample matrices containing Cl, SO ₄ , organic content, without the need for any mathematical interference correction equations.	Yes/ No
38) The system must also be able to operate in CRC mode for semi-quantitative analysis of all analytes in unknown samples without the need for correction equations.	Yes/ No
Sample Testing Requirement: 39) The ICP-MS must be capable of analyzing all interference prone elements, such as selenium. The systems must be able to analyse selenium isotopes in variable high matrix samples without the need of interference correction equations. Shortlisted Tenderers are required to perform sample testing upon request. The protocol for the analysis of the sample will be provided upon sample collection. Sample Collection Details: Shortlisted Tenderers are required to collect the samples between 0830 to 1200 within 7 days upon receipt of email notification from the Authority at: Venue (Address): 1 Science Park Road, #01-05/06, The Capricorn, Singapore Science Park II, Singapore 117528. Contact number: 6775 1605 ext 103 The sample must be analysed on the model proposed in this tender. The sample result (raw data) shall be submitted via email (in an EXCEL file) not later than 2 weeks from sample collection date.	Yes/ No
40) To reduce routine maintenance when analyzing high matrix samples, the collision/reaction cell must be protected from contamination by either an off-axis	Yes/ No

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ion lens or photon stop. It is not acceptable for the reaction cell to be located in line with the skimmer cone orifice, without a physical barrier to prevent deposition of sample matrix.	
41) The collision/reaction cell must include at least 1 cell gas line with the option of adding up to a total of 3 cell gas line to cover all possible applications. It is not acceptable to use an external gas manifold for the addition of a 3rd cell gas as dead volume is increased and changeover between externally-controlled cell gases cannot be automated within a run (please indicate which collision/reaction cell gasses are required). Tenderer is also required to quote for the option to add an additional cell gas line. Please state the collision/reaction cell gas required in Annex C – Price and Submission Information	Yes/ No
42) The ICP-MS shall have a three-stage vacuum system consisting of a high efficiency pump, to achieve the required operating vacuum to help reduce random background. A mechanical rotary pump must back the pump. The vacuum must be continuously monitored by the data system, using at least three independent vacuum gauges. The expansion vacuum must be monitored so that the software can alert the operator if the interface pressure becomes higher due to interface degradation. The mechanical pump shall be outside the system cabinet, able to be located up to 3 m away from the system and mounted on wheels to facilitate routine oil changes. Ideally, the system shall remain under vacuum even when it is in standby mode.	Yes/ No
43) The vacuum system must have an isolation gate valve between interface and high vacuum area, to allow rapid routine maintenance, sample and skimmer cone changes, etc., with no loss of high vacuum. The valve must be solenoid operated so that it will close in the event of a power failure during operation, and not be dependent on sufficient gas supply pressure to protect the system in the event of failure. During full system shutdown or power failure, the analyzer vacuum chamber shall be completely protected from oil back-streaming from the backing pump by an automatic isolation valve or similar features in the backing line.	Yes/ No
44) The ion detector assembly shall minimally consist of a solid state, discrete dynode electron multiplier simultaneously operating in both pulse counting and analog modes (dual mode). Critical detector electronics must be temperature controlled to ensure stability.	Yes/ No
45) The minimum time required for data acquisition by the detector must be 100 μ s or better in both the pulse and analog mode, to ensure no loss of analytical signal when measuring fast transient signals, such as those from laser ablation or chromatographic analysis. Detector systems which require significantly longer acquisition times in either mode are not acceptable, since this will compromise the acquisition of data when both high and low concentrations are measured at the same time.	Yes/ No
46) The detector shall cover at least a full 11 orders of linear dynamic range (real concentration measurement range, not detector electronic response range) automatically measuring analog and pulse counting signals for multiple elements over the entire mass range in a single scan. Detector mode selection for each mass must be fully automatic and transparent to the user, and not require any prior knowledge of the sample composition.	Yes/ No

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47) Cross calibration of detector modes must be fully automated and performed by the software. To minimize system setup time, detector response in both counting modes shall be linear, enabling detector cross calibration to be performed by measurement at only one signal intensity, using only one multi-element standard. This speeds up the calibration process, enabling cross calibration to be performed automatically for all required analytes. The detector must be automatically protected against damage due to high ion flux.		Yes/ No
48) The system must be capable of measuring concentrations of elements such as Na, K and Ca up to at least 1000 ppm, to minimize sample dilutions, and elements like Zn, Cu, Mn, Be and Hg at low ppt levels, using the standard sample introduction system and standard interface without the need to reduce mass analyzer resolution from the normal setting, or changing the detector setting or calibration.		Yes/ No
49) The system must include a recirculating water chiller or heat exchanger with the cooling capacity to cool all components of the ICP-MS system. The system spray chamber temperature must be independently controlled from that of the water chiller system.		Yes/ No
50) The ICP-MS system must come with a fast and high precision auto-sampler, including an acrylic enclosure with HEPA filter (to reduce the risk of environmental contamination).		Yes/ No
51) The auto-sampler must be close to the ICP-MS mainframe to reduce the sample up taking time, reduce possible carry over from the tubing and allow sample uptake by peristaltic pump.		Yes/ No
52) The sample probe must be metal-free and must return to an integral rinse port, where it is continuously rinsed by fresh wash solution between samples.		Yes/ No
53) The auto-sampler must have flexible rack configurations, allowing loading of at least 120 sample vials (15 mL), and 42 sample vials (50 mL) at the same time.		Yes/ No
54) A Reset/Stop Switch shall be available to prevent sample wastage in the case of an emergency.		Yes/ No
55) The system shall feature an on-board microprocessor (system controller) to control the system independently of the data system, so that system control and safety interlocks are not compromised shall the data system fail. The system controller must monitor system status, RF power, gas supplies, instrument temperatures, electrical systems, vacuum system and cooling systems.		Yes/ No
56) A high-speed on-board multi-channel analyzer must perform data acquisition, so that data acquisition is never compromised during multi-tasking of the data system. At minimum the system must have the demonstrated ability to acquire data from a sample sequence, run a separate data processing session, automatically update a sample data table, create control charts and be communicating via LAN/cable all at the same time.		Yes/ No
57) The on-board multi-channel analyzer must be fast enough to enable the multi-element acquisition of fast transient signals. Data acquisition shall be flexible to		Yes/ No

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allow for the widest range of applicability, including the handling of fast transient signals such as those arising from chromatography and laser ablation.																								
58) As a minimum, the following modes shall be available: a. Mode 1 - the normal acquisition mode, used to acquire intensity vs. mass data from continuous signals. b. Mode 2 - for fast, multi-element analysis of transient signals. Multi-element data is acquired in user defined time slices, and a time vs. intensity plot is generated for every mass. This mode must be able to handle any transient signal, with no limit on the number of masses acquired. The software must be able to display several masses on the monitor at the same time, during the acquisition. c. Mode 3 - to handle data from complex chromatography applications. Allows operating parameter and analyte selection changes to be programmed during a time resolved acquisition for full flexibility and to handle ICP-MS data collection from gradient elution chromatography. d. Mode 4 - for both isotope ratio and isotope dilution studies. This mode employs very fast scanning to optimize precision on isotope ratio measurements.	Yes/ No																							
59) In all modes, the acquisition display screen shall show the data being acquired in real time. The capability to perform real-time manipulation of the data during acquisition, such as the capability to save and process partially completed time resolved data acquisitions for laser or chromatography.	Yes/ No																							
60) The system must meet the following performance specification: <table border="1" data-bbox="228 1310 1177 1910"> <thead> <tr> <th colspan="2">Performance Specification</th></tr> </thead> <tbody> <tr> <td colspan="2">Sensitivity</td></tr> <tr> <td>Li (7)</td><td>≥ 50 Mcps/ppm</td></tr> <tr> <td>Y (89)</td><td>≥ 300 Mcps/ppm</td></tr> <tr> <td>Tl (205)</td><td>≥ 200 Mcps/ppm</td></tr> <tr> <td>Oxide (CeO⁺/ Ce⁺)</td><td>≤ 1.5%</td></tr> <tr> <td>Doubly charged: (Ce²⁺/ Ce⁺) or (Ba²⁺/Ba⁺)</td><td>≤ 3.0%</td></tr> <tr> <td rowspan="2">Background (9 amu)</td><td>≤ 1 cps (no gas mode)</td></tr> <tr> <td>≤ 0.5cps (cell gas mode)</td></tr> <tr> <td>Short term stability (RSD)</td><td>≤ 2%</td></tr> <tr> <td>Long term stability (RSD)</td><td>≤ 3% (2 h)</td></tr> <tr> <td>Isotope Ratio precision (RSD)</td><td>≤ 0.1%</td></tr> </tbody> </table>	Performance Specification		Sensitivity		Li (7)	≥ 50 Mcps/ppm	Y (89)	≥ 300 Mcps/ppm	Tl (205)	≥ 200 Mcps/ppm	Oxide (CeO ⁺ / Ce ⁺)	≤ 1.5%	Doubly charged: (Ce ²⁺ / Ce ⁺) or (Ba ²⁺ /Ba ⁺)	≤ 3.0%	Background (9 amu)	≤ 1 cps (no gas mode)	≤ 0.5cps (cell gas mode)	Short term stability (RSD)	≤ 2%	Long term stability (RSD)	≤ 3% (2 h)	Isotope Ratio precision (RSD)	≤ 0.1%	Yes/ No
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<u>System Software and Computer</u>																								
61) Minimum configuration: 3.8 GHz dual core processor or equivalent, 16 GB RAM, 2 TB hard drives, USB 3.0, DVD RW (CD RW capable), mouse and keyboard,	Yes/ No																							

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high resolution 24 inch (minimum) flat screen color monitor. Laser-jet printer with automatic duplex printing must be provided.		
62) 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
63) The software shall provide real time graphics during analysis		Yes/ No
64) The software shall have a built-in database with which the system selects/recommends the best isotope mass for analysis for each sample.		Yes/ No
65) The software shall minimally allow creation of analytical methods using parameters such as choice of prominent isotope mass, RF power, nebulizer argon flow, integration/sampling time, and background correction. One set of operating parameters can be set for all elements in the method or for individual elements in the method for optimum results. These parameters shall be adjusted automatically, without operator intervention.		Yes/ No
66) The software must be capable of internal standard correction, background correction, drift correction, weight correction and dilution correction automatically, or similar features that address possible interferences.		Yes/ No
67) The software shall have features and protocols for method development and method diagnosis.		Yes/ No
68) The software must have the capability to reprocess all stored data – samples and standards without having to rerun the solutions again.		Yes/ No
69) The software shall also compute statistical values such as mean standard deviation and relative standard deviation (i.e. coefficient of variation).		Yes/ No
70) An off-line version of the software shall be able to be run while the automated analysis is in progress to allow for data reprocessing, examining and manipulation of data, and creation of new methods etc.		Yes/ No
71) The software shall be compatible with Microsoft Office applications that includes Microsoft Excel and Microsoft Words. Data from Microsoft Excel and Microsoft Words can be directly copied and paste or import/ export on the sequence list of the software.		Yes/ No
72) The ICP-MS software must allow the lab to control the ICP-MS during the acquisition and processing of data. Full integration between the ICP-MS and any peripheral components (that minimally include auto-sampler, chromatography) is essential.		Yes/ No
73) The software must allow addition of samples into the sequence during an analysis without having to stop and restart the sequence.		Yes/ No
74) The software must have a full graphical system control and tune window with the ability to display multiple system parameters concurrently in real time. Fully automated system starts up and shutdown must be available via the instrument control window, and automated, unattended shutdown must also be provided. A real time graphics mode, for monitoring of instrument tuning must be available.		Yes/ No

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and shall display several masses or mass ratios (e.g. oxide ratio) simultaneously, giving real time readout in counts or a ratio (%). Ratios of oxide or doubly charged species must be user selectable. Real time display of signal RSD's must also be provided.	
75) The software must be able to store an electronic record of the tuning report, including all meter values and tuning parameter values. The option to run the tune solution as a QC sample during a sample sequence, allowing QC actions to be taken in the event of tuning checks not being met shall also be available.	Yes/ No
76) All tuning parameters, including plasma torch position, must be able to be stored on disk in a tune file that can be recalled at any time. Full auto-tune capability must be provided, including automatic optimization of plasma position (x-, y- and z-axis), ICP parameters, ion lenses (if applicable), mass calibration, and detector. The auto-tune software must be able to simultaneously optimize the ion signal while adjusting the plasma parameters to reduce interferences and background. Tune report generator to automatically assess all aspects of system performance and generate a detailed, time stamped record for audit trail purposes.	Yes/ No
77) The software must perform internal diagnostics including error checking and a complete fault log. A continuous run time clock shall be included, to keep track of system component usage hours and total current for the electron multiplier, to enable scheduling of preventive maintenance.	Yes/ No
78) Software must be able to perform interference correction in all measurement modes to correct for isobaric and polyatomic interferences. Equations must be user-editable.	Yes/ No
<u>Installation, Commissioning, Training and Warranty</u>	
79) Prices quoted must include installation, commissioning, initial calibration and operator training (for 6 to 10 staffs). The system must come with a minimum 1 year warranty. The warranty must cover the overall system (both hardware and software) that minimally include: a. Unlimited breakdown calls and on-site services during Operating Hours i.e. 8 am to 5.30 pm from Monday to Friday, b. Supply of replacement of parts and repair consumables; c. At least 1 PM per year with PM kit; and d. Provision of software revisions. - The PC and its installed software must come with at least 3-year warranty and accompanied with their system recovery CDs or DVDs. - Contractor is required to oversee and ensure successful systems integration, site preparation, installation and necessary configuration of the system.	Yes/ No
80) Option to purchase: Tenderer is required to quote comprehensive maintenance contract for additional 3 years after the warranty period. The comprehensive maintenance contract shall cover the overall system including hardware and software. The price quoted shall minimally include the following: a. Provision of unlimited breakdown calls and on-site services during Operating Hours;	Yes/ No

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b. Supply of replacement of parts and repair consumables; c. To provide 1 preventive maintenance per year with PM kit; and d. Provision of software revisions at no additional cost.	
81) Tenderer shall quote the unit prices of essential wear and tear consumables parts in Annex C – Price and Submission Information - Schedule of Rates (SOR) : nebuliser, spray chamber, torch, injector, nickel and platinum cones (skimmer and sample cones).	Yes/ No
82) A declaration of Conformity certificate and System Validation certificate must be provided upon commissioning of equipment. All systems proposed must be GLP compliant.	Yes/ No
83) The Contractor shall coordinate with the Laboratory for the delivery of the equipment. A Risk Assessment Report in 5x5 matrix must be provided prior to the delivery.	Yes/ No
84) The quote shall include any cost involved for the application of the import license for ICP-MS. Contractor shall facilitate the application of the import license.	Yes/ No
85) Contractor is required to provide after-sales support from engineers and application chemists in Singapore. The following information shall be provided in Annex C – Price and Submission Information : a) The contacts (handphone number and email) of at least two engineers experienced with ICP-MS system; b) Immediate instruction for trouble shooting by telephone when requested; c) Contractor must have sold at least 3 units of the proposed ICP-MS system in the tender or other ICP-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
Performance of Services	
86) The Contractor shall perform the services in the manner as specified in the tender 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: a. 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. b. The Preventive Maintenance performed shall be in compliance with the manufacturer's recommendation.	Yes/ No

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c. The Preventive Maintenance shall be carried out and completed during Operating Hour. (II) Corrective Maintenance: a. 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 representatives attends 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. The representative shall provide immediate instruction for trouble shooting by telephone, when requested. 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. b. For urgent breakdowns (e.g. project with strict deadline), the Contractor is to 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 Clause II(a) unless the Authority had agrees in writing to have the time period extended.	
Replacement of Components	
87) 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 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. 88) 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.	Yes/ No

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

Reference To	Remarks