

## CHAPTER - 4

### Technical Specifications of Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

<b>Corrigendum Technical Specifications for ICP-MS</b>	
ICP-MS system for elemental analysis which is the latest in the category and capable to deliver <b>sub-ppb level analysis of elements ions</b> . System should be bench top model.	
<b>Purpose:</b> Trace and ultra-trace elemental analysis (ppm, ppb and ppt) in a single aspiration and in a single method. Detailed specifications are as follows:	
S.No.	Technical specifications
1.	Sample introduction system should comprise of peristaltic pump, nebulizer (Quartz or better), and spray chamber.
2.	A peristaltic pump with $\geq 10$ rollers multi-channel (3 channel or more ) which can support variable flow rates.
3.	It must include quartz nebulizer as standard having high resistance to acids.
4.	Peltier-cooled, temperature controlled quartz spray chamber.
5.	Quartz torch with 2.5 mm ID injector.
6.	Fully automated software controlled adjustment of the position of torch with independent movements in all three X, Y and Z directions.
7.	Three or more software controlled gas mass flow controllers or equivalent technology for control of plasma gas lines (nebulizer, plasma and auxiliary gas flow). Additional MFC for organic solvent usage should also available.
8.	Argon gas dilutions system like AGD/UHMI/AMS without any manual intervention should be quoted.
9.	Sample introduction system must be able to handle samples containing high TDS of ranging in between 20 to 40% through software controlled AGD/UHMI/AMS. All necessary accessories required for running High matrix high TDS samples should be included as standard supply.
10.	The ICPMS must have software controlled RF generator operating between 25 to 40 MHZ. The RF power range of ICP-MS should be operating at range 500 to 1600W or better for automatic control of torch ignition, shutdown and system warm up.
11.	Automatic shutdown of the plasma by the system after completion of analysis.
12.	Suitable water cooled interface vacuum and with standard high performance Ni sampling and Ni skimming cones for high matrix samples with minimal matrix condensation to suit all applications.
13.	The ICP-MS system should have one or more cones/interface should be to achieve all desired performance specifications of the instrument. In combination with all parts of the instrument guaranteed specification can be achieved.
14.	Lens /cones system should be outside the vacuum system to reduce down time.

15.	The ion focusing system capable of removing all neutrals & photons from the ion path without causing any wear and tear to any part of the optics. For maintenance, free optics ICPMS system should have horizontal/off axis or quadrupole optics. The ion optics/quadrupole optics must be covered in warranty for 10 years of operation with approx. 40,000 sample.
16.	(A). <b>Sensitivity</b> specifications are as follows: (UOM): MCPS/ppm <ul style="list-style-type: none"> <li>• <math>^9\text{Be}</math> or Li: 5 or better</li> <li>• <math>^{115}\text{In}</math> or Y: 90 or better</li> <li>▪ <math>^{238}\text{U}</math> or Tl: 70 or better</li> </ul> (B). <b>Detection limit</b> : as follows <ul style="list-style-type: none"> <li>• <math>^9\text{Be}</math> or Li: 1 ppt or better</li> <li>• <math>^{115}\text{In}</math> or Y: 0.5 ppt or better</li> <li>▪ <math>^{238}\text{U}</math> or Tl: 0.5 ppt or better</li> </ul>
	(C). <b>Following points should also be met:</b> <ul style="list-style-type: none"> <li>• <b>Oxide ratio (%) CeO/Ce <math>\leq 2.5</math> or better</b></li> </ul>
17.	<b>Mode of operation:</b> ICP-MS shall be capable of three modes of operation: Standard Mode, Collision Cell Mode and Reaction Cell to utilize a wide variety of gases like, $\text{H}_2/\text{O}_2/\text{CH}_4$ (Min two gas) in pure and/or pre-mixed gas as per hardware requirement. The system should run Standard mode, KED mode and reaction mode simultaneously in single run. System should have dedicated and separated gas line for helium and minimum two dedicated gas line for reactive gas with mass flow controller as per hardware requirement to comply the application. Fully automated and software controlled change over between standard, collision and reaction modes.
18.	<b>Control:</b> Fully automated and software driven switching of reaction and collision gases or pre-mix gas. Unit will have the flexibility of applying both gases using single method for removal of interferences. The Cell should possess factory fitted mass flow control (MFC) or an equivalent technology for collision as well as reaction or mixed gas according to the system requirement. The cell should be able to perform Mass shift/proton shift reaction.
19.	The mass range should be from 5-280 amu or better.
20.	Quadrupole based Ion detector with RF 2 MHz or higher
21.	Mass scan speed should be $\geq 3000$ amu/s or better
22.	The analyser must have the ability to discretely control the resolution of selected mass regions dynamically without affecting the overall nominal resolution of the system.
23.	True linear dynamic range ion detection should be 10 or more orders of magnitude.
24.	Vacuum system: Should have rotary pump or turbo molecular pump corrosion resistant for extremely high gas throughput.
25.	Auto sampler: Auto sample should hold 100 vials or more. It should control by same software provided by the manufacturer of ICP-MS. It should have free X, Y, Z movement, washing & random access to all sample vials.

26.	System controller and operating system & printer: The ICPMS and other attached supporting system shall be driven from a dedicated computer system (branded PC with i7 or better processor with appropriate RAM) having the latest hardware and operating system) with LCD/LED touchscreen of 32 inch or more along with wireless keyboard and mouse & Branded compatible printer for offline data analysis The software shall provide fully integrated operation of the machine and sample inlet system. There should be a facility of automatic data transfer from the ICP-MS PC to the desired location as per customer's choice.
27.	Vendor should also offer an additional latest branded PC to support the system and sufficient storage (to keep the data for 10 yr) with LCD/LED touchscreen of 32 inch or more along with wireless keyboard and mouse & Branded compatible printer for offline data analysis with min 01 off-line licenses of the software to perform off-line activity.
28	Standards to supply: Individual/Multi Trace Metal standards (1000ppm, 100ml) with certificate of analysis for elements and 2 year expiry such as: Chromium, Cobalt, Copper, Manganese, Molybdenum, Selenium, Zinc, Calcium, Sodium, Potassium, Mercury, Cadmium, Iron, Nickel, Platinum, Selenium, Silver, Thallium, Arsenic, Antimony, Aluminium, Beryllium, Silicon, Iodine, Platinum.
29	<b>Speciation studies:</b> The system should be capable of performing speciation studies of following ions: As, Cr, Hg, Se. The columns (Two each) for speciation of As, Cr and Hg should be quoted. An integrated /inbuilt LC-ICP-MS interface to be provided which should include quaternary pump , degasser, flow cells, column heater, speciation column for As, Cr, Hg, Se(two each ) with all required accessories. The full configuration of HPLC-ICP-MS and transfer valve must be under one single software control.
30.	The analysis of ions mentioned along with speciation is essential to be shown at the time of installation.
31	The system should be capable of nanoparticles concentration estimation. Dwell time of detector should be 100 microseconds or better
32	Dual magnetron, and 1800 watt Microwave digestion system should be provided for sample preparation. Temperature range: 230 degree or better Pressure: 25 bar or more No. of vessels:12 or more should be put in single run Each vessel size should be 50ml or more
<b>Additional Consumables &amp; Spares</b>	
33.	Additional Consumables & Spares/ accessories to be quoted apart from 1 qty. each which comes by default. for <ul style="list-style-type: none"> <li>- Ni Sample cone-5 Nos.</li> <li>- Ni Skimmer/hyperskimmer Cone-05 Nos.</li> <li>- Quartz Spray Chamber-05 Nos.</li> <li>- Quartz Torch-05 Nos.</li> <li>- Quartz injector-03 Nos.</li> <li>- Standard spray chamber- 03 set</li> <li>- Peristaltic Pump Tubing for samples – uptake-150 Nos.</li> <li>- Peristaltic Pump Tubing - Drain- 150 Nos.</li> </ul>

	<ul style="list-style-type: none"> <li>- Internal STD kit with Peristaltic Pump Tubing for ISTD- 150 Nos.</li> <li>- Auto sampler uptake Probe- 03 Nos.</li> <li>- Pump oil – for 10 years of operation</li> <li>- Preventive maintenance kit- 05 Nos.</li> <li>- Platinum sample cones- 3 set</li> <li>-Cone cleaning solution – 2 gallon(if required)</li> <li>-Swab cotton tipped both ends- 300 Nos. (if required)</li> <li>- Alumina powder- 100 gm- 5 set (if required)</li> <li>- ICPMS autosampler vials-2000 Nos</li> <li>- Organic solvent tubing complete set sample &amp; drain(15 Nos each)</li> <li>- Quartz Nebulizer: 05 Nos.</li> <li>- Screw, spacer and O-ring for cell - 02 sets</li> <li>- Fluid filter for chiller - 02 sets</li> <li>- Fluid for chiller - 07 L</li> <li>- Rf coil/equivalent technology-3 No.</li> <li>- Sheild torch/plasma lock or equivalent technology - 5 No</li> <li>- PFA/Inert sample and rinse tubing - 02 sets</li> <li>- Oil Element for Outlet Mist Filter -05 set</li> <li>- Replacement cartridge for oil mist filter for Rotary pump -05 set</li> <li>- Graphite gasket for Sampling cone- 25 Nos.</li> <li>- Sample tubing for nebulizer, 0.5mm id (30 set)</li> <li>- Tubing for spray chamber drain (20 Mtr)</li> <li>- Standard autosampler probe and complete tubing set - 10 sets</li> <li>● HF/Inert kit with dedicated nebulizer, spray chamber, tubing set, inert torch and platinum cone set</li> </ul> <p><b>Note: Apart from above consumables vendor should offer any other consumables if required. Any consumable not required for particular instrument may be omitted.</b></p>
34.	The institute shall provide partitioned cabin (Aluminium frame, glass and ACP partition) for instrument; other specifications for site preparation are to be fulfilled by the vendor only for successful installation. The vendors may visit the site for tentative expenditure.
35.	Only the principle company may participate in tender. All the agreements shall be done with principle company only.
36.	<p><b>Items for installation requirement:</b></p> <ul style="list-style-type: none"> <li>● All necessary pre-installation requisites/consumables including chemicals, acids, gases and standards for complete installation and demonstration of the instrument need to be supplied.</li> <li>● Gas cylinders with regulators (minimum number of cylinders required are mentioned here): Argon - 08 Nos., Helium - 02 Nos., reaction gas cylinders: Methane/Oxygen/Hydrogen – 02 Nos. (min. two gas) as per system requirement to comply with all applications and regulations. Gas Panel as per requirement</li> <li>● Manifold with four cylinder capacity for Argon. Gas line installation.</li> <li>● Argon manifold for 4 cylinder with auto change over, valves, regulator and gas purification panel-01 no.</li> <li>● Suitable exhaust fume hood assembly for both ICP-MS and microwave digestion system.</li> <li>● Compact and low-noise chiller unit(s) as per manufacturer’s recommendation.</li> </ul>

	<ul style="list-style-type: none"> <li>• Inorganic Speciation standards and columns for As, Cr, Hg and Se.</li> <li>• Auto-tuning standards.</li> <li>• Single nanoparticles standards for Au and Ag (three concentrations each)</li> <li>• ICP-MS Grade suprapure Acids: 5L Nitric acid, 5L Hydrochloric acid, 2 Ltr Hydrogen Peroxide, 4 Ltr Hydrofluoric acid.</li> <li>• Suitable granite-top tables for ICP-MS &amp; LC unit and desktop.</li> <li>• Suitable online 20KVA UPS for a minimum backup for 1-2 hr(including MCBs, wires and all fittings etc.)</li> <li>• 1.5 ton A.C with installation-2Nos</li> </ul> <p>Vibration free table with granite top to keep the system and one separate computer table to keep the PC and printer</p>
37.	<p><b>Warranty</b> for ICP-MS: Three years of comprehensive warranty from the date of installation without any additional cost to the purchaser. The warranty should cover ICP-MS, speciation unit, microwave digestion system, UPS, fume hood, and other items including all accessories and spare parts. Warranty of ICPMS should be from manufacturer with OEM part number. All accessories/spare parts shall be warranty from OEM with part number within a period of 3 years after commission, any accessory/spare part is proved to be defective then such product shall be replaced by the manufacturer/supplier. Such replacement shall be sole obligation of the manufacturer/supplier, including payment of charges for freight delivery, custom duty and transportation, if any. In case of breakdown during the warranty period, a competent Service Engineer of the supplier should make as many visits as are required to rectify the problem and replace the faulty parts, without any liability of cost. Service response time must be less than <b>3-5 working</b> days for small issues and less than 10-15 working days for major breakdown/hardware changeover; otherwise, the warranty period shall automatically be extended by the time taken to rectify the defects. Also, one maintenance &amp; annual calibration visits every year (within the warranty period) by authorized service engineers are required.</p>
38.	<p><b>1) Non-technical requirements:</b></p> <ul style="list-style-type: none"> <li>• The supplier must have sold, installed and provided support for 03 LC-ICP-MS systems across India. A list with corresponding details must be provided.</li> <li>• Specifications claimed must be supported by published OEM literature/document from the company.</li> <li>• The supplier of the instrument must confirm in writing that spares for the entire instrument (including additional units and accessories) will be available for at least a period 10 years after the model of equipment supplied has been phased out. For frequently required spares, there should be adequate inventory available with the Indian agency of the company.</li> <li>• Supplier must have proven capability and trained manpower to troubleshoot equipment both in terms of hardware and software.</li> <li>• Bidders must furnish documentary evidence (client's certificate) in support of satisfactory operation of the instrument.</li> <li>• Suitable and essential tool kit is to be supplied with the instrument for required maintenance.</li> <li>• Accessories that are needed for the operation of the instrument, but not mentioned in the Technical Specifications list, must be quoted by the vendor.</li> </ul>

	<p>The instrument should be installed and commissioned at site. Site requirements must be provided by the supplier. Complete technical details of pre-installation requirements should be furnished along with the technical bid. NIPER Lucknow will only provide the installation room and required electrical outlets. Vendor must supply all other infrastructure accessories, facilities and services required for successful installation and operation of the instrument. Vendor may conduct site survey prior to installation at no additional cost.</p>
39.	<p>Training: The supplier must provide one-week comprehensive training on operation, application and maintenance of the instrument after installation at NIPER, Lucknow</p>