MASS SPECTROMETER HELIUM LEAK TESTING & INTEGRITY SOP

Systematic Local Spraying, Hood Enclosures, and Quantitative Sniffer Protocols per DIN EN 1779 / ISO 20485

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1. Purpose, Scope & Standards Compliance

This Standard Operating Procedure defines the precise protocols for quantitative mass spectrometer helium leak detection (MSLD) across ultra-high vacuum (UHV), high vacuum (HV), and foreline systems. The procedure incorporates systematic local spray testing (DIN EN 1779 Method A1), integral vacuum hood accumulation (Method A2), and positive-pressure sniffer testing (Method B1). All protocols ensure ALCOA+ data defensibility and full compliance with ISO 20485, DIN EN 1779, and EPA Quality Assurance Project Plan (QAPP) requirements.

2. Safety, PPE & Equipment Setup

EHS & PPE Requirements: Personnel must wear 6 mil powder-free nitrile gloves to prevent skin oil outgassing, ANSI Z87.1 approved safety glasses, and cleanroom apparel. Compressed Helium cylinders must be double-chained to wall restraints with primary delivery regulators set to ≤0.5 bar (7.2 psi).
Instrument Calibration: Prior to testing, connect the Mass Spectrometer Leak Detector (MSLD) to its internal calibrated Helium leak standard (e.g., $1.2 \times 10^{-8}\text{ mbar}\cdot\text{L/s}$). Calibrate mass peak alignment ($m/z = 4.0\text{ amu}$ at 70 eV) and verify background signal cleanup stabilization below $1.0 \times 10^{-9}\text{ mbar}\cdot\text{L/s}$.

3. Systematic Local Spray Probe Protocol (Method A1)

Local spray testing isolates individual seals, welds, and mechanical joints while the chamber is under vacuum connected to the MSLD:
• **Bottom-to-Top Execution Sequence:** Always spray from the lowest physical point of the vacuum chamber working upward. Because Helium gas is less dense than air and rises rapidly, spraying top joints first creates false-positive signals on lower seals.
• **Fine Nozzle Control:** Maintain a micro-orifice nozzle gas flow of 2–5 sccm. Hold nozzle 2–5 mm from joint faces for 3–5 seconds per location.
• **Target Inspection Locations:** ConFlat (CF) copper-gasket flanges, ISO-KF Viton O-rings, welded bellows, electrical feedthrough pins, liquid cooling feedthroughs, viewports, and valve stem packings.
• **Dwell Time & Response:** Allow 2x system response time ($t_r = V / S$) between spray locations to allow Helium to clear the detector cell.

4. Integral Vacuum Hood & Sniffer Protocols (Methods A2 / B1)

Integral Vacuum Hood Testing (Method A2): Enclose the entire vacuum vessel or sub-assembly in a sealed polyethylene envelope. Evacuate chamber via MSLD, purge envelope with 100% Helium for 5 minutes, and record total integrated leak rate.
Sniffer Probe Testing (Method B1): Pressurize vessel with 10% He / 90% N2 mixture to 1.2 bar absolute. Sweep sniffer probe across seams at ≤10 mm/s holding probe tip within 1–2 mm of surface.

5. Quantitative Acceptance Criteria & Thresholds

ystem / Component Type	Test Method	Max Allowable Leak Rate	Corrective Action Threshold	
rocess Chamber (CF Flanges)	Method A1 Spray / A2 Hood	$< 5.0 \times 10^{-9}$ mbar·L/s	Replace copper gasket; bake flange	<ParagraphStyle 'TbB

cessing Bay (KF Viton)	Method A1 Local Spray	< 1.0×10^{-7} mbar·L/s	Clean Viton O-ring, re-grease LVO 100	<ParagraphStyle 'TbB
e / Roughing Piping	Method A1 Spray / B1 Sniff	< 1.0×10^{-5} mbar·L/s	Retighten KF clamps, inspect centered ring	<ParagraphStyle 'TbB
elivery Manifolds	Method B1 Sniffer (1.2 bar)	< 1.0×10^{-6} mbar·L/s	Re-weld VCR fitting; replace nickel gasket	<ParagraphStyle 'TbB

6. Authorization & Document Control Sign-Off

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