

STANDARD OPERATING PROCEDURE VACUUM SYSTEM FILTER & CONSUMABLES SERVICING

PREVENTIVE MAINTENANCE, REPLACEMENT PROTOCOLS &
INTEGRITY TESTING FOR VACUUM CONSUMABLES

Document ID: SOP-VAC-2021-08
Effective Date: November 12, 2021
Revision: 1.2 (Periodic Review)
Lead Specialist: Kadeem Manning
Role: Tier II Vacuum Lab Tech
Facility: High Vacuum Lab B

1. PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) defines the mandatory technical requirements, inspection schedules, and replacement workflows for air intake filters, exhaust coalescing oil mist eliminator elements, external spin-on oil filters, foreline sorption traps, and mechanical wear consumables (diaphragms, flapper valves, dry scroll tip seals, and Viton/FKM gaskets) across all laboratory backing and roughing vacuum pumps. Compliance with this procedure ensures peak pumping speed, eliminates hydrocarbon backstreaming into vacuum chambers, prevents environmental aerosol discharge, and satisfies EPA air quality and OSHA laboratory safety mandates.

2. SAFETY PROTOCOLS, EHS & PPE REQUIREMENTS

CRITICAL SAFETY MANDATES (OSHA 29 CFR 1910.147 & EPA Guidelines):

- **Mandatory PPE:** Technicians must wear 6 mil powder-free nitrile gloves and ANSI Z87.1 approved safety eyewear at all times. Powder-free gloves are mandatory during internal filter or chamber contact to prevent skin oil outgassing.
- **Lockout / Tagout (LOTO):** Always isolate the pump motor electrical supply, attach LOTO padlocks, and safely vent internal housing pressure to atmospheric pressure before removing filter housings or access covers.
- **Thermal & Pressure Hazards:** Vacuum pumps operate at 60°C to 80°C. Allow components to cool for 20 minutes prior to servicing. Never open pressurized filter housings.
- **Hazardous Waste Disposal:** Used oil-saturated mist filter elements, spent sorbent media, and contaminated wipes must be logged and sealed in heavy-duty chemical waste drums for licensed EPA hazardous waste disposal.

3. CONSUMABLES SPECIFICATIONS & REPLACEMENT MATRIX

Consumable Category	Component / Part Type	OEM Specs & Material	Service Target Threshold
Intake Filtration	Paper/Polyester Inlet Element	5 µm media, KF-25/KF-40 flanged housing	Monthly inspection / Tap out debris; replace < 6 mos
Intake Protection	Inlet Screen / Wire Mesh	316 Stainless steel, 100-mesh grid	Clean with solvent bath at every oil service
Exhaust Filtration	Coalescing Mist Eliminator	Micro-fiberglass media, < 0.01 µm aerosol trap	Replace annual or when backpressure exceeds 3 psi
Lube Circuit Filter	External Spin-On Oil Filter	Synthetic media, 10 µm rating with bypass valve	Replace at every full oil change (500–2,000 hrs)
Foreline Sorption	Molecular Sieve / Alumina Trap	Activated alumina / 13X synthetic zeolite	Bake-out monthly @ 200°C or replace media annually

Diaphragm Backing	Diaphragm & Flapper Valves	Reinforced PTFE / Viton elastomeric valves	Replace annual (or 18 months per Method 2.10)
Dry Scroll Backing	PTFE Tip Seals	Formulated PTFE/Teflon blend tip seal kit	Replace every 8,000–10,000 operating hours
Seals & Gaskets	Service Port O-Rings	Viton / FKM fluoroelastomer (thin grease film)	Replace whenever housing is disassembled

4. STEP-BY-STEP CONSUMABLES SERVICING WORKFLOW

Phase 1: Pre-Service System Isolation & LOTO

1. Close the inline foreline/roughing isolation valve to isolate the pump from the main vacuum chamber.
2. De-energize the pump motor, disconnect the main power feed, and apply Lockout/Tagout (LOTO) safety padlocks.
3. Safely open the manual bleed valve to relieve residual vacuum pressure and return the pump housing to atmospheric pressure.

Phase 2: Air Intake Filter & Screen Maintenance

1. Unclatch the KF flanged clamp or unscrew the filter housing top cover.
2. Remove the paper/polyester filter cartridge. Inspect media under bright light for tears, pinholes, or heavy loading.
3. For reusable elements, tap gently against a clean surface or blow outwards using low-pressure dry N₂ (15 psi). If media is oil-soaked, discolored, or torn, discard immediately and replace.
4. Remove the inlet wire mesh screen and immerse in an ultrasonic bath with isopropyl alcohol (IPA) for 10 minutes. Blow dry thoroughly with dry N₂.
5. Wipe the interior filter housing with lint-free wipes. Inspect the Viton sealing O-ring for compression set or cracking. Apply a transparent film of vacuum grease and reassemble housing securely.

Phase 3: Exhaust Coalescing Mist Eliminator Servicing

1. Unscrew the exhaust filter retaining cap or housing bolts on the oil mist eliminator assembly.
2. Carefully extract the saturated fiberglass coalescing filter element. Allow trapped oil to drain back into the pump reservoir if equipped with an auto-return line.
3. Inspect the oil return float valve or internal oil drain tube for particulate blockages. Flush oil return lines with clean vacuum oil.
4. Clean the internal housing walls using a lint-free cloth. Install a fresh coalescing filter element, ensure internal alignment gaskets are seated flat, and hand-tighten the housing cap to OEM torque limits.

Phase 4: External Spin-On Oil Filter Replacement (Pressurized Lube Pumps)

1. Place a chemical drain pan beneath the filter assembly.
2. Using a dedicated filter wrench, turn the spin-on filter counter-clockwise to detach. Drain residual oil into the waste pan.
3. Clean the filter mounting header pad on the pump casing.
4. Lightly lubricate the rubber sealing gasket on the new spin-on filter using fresh, clean vacuum oil.
5. Thread the new filter onto the header pad by hand until gasket contact is made, then apply an additional 3/4 turn. Do not overtighten.

Phase 5: Diaphragm, Flapper Valve & Dry Scroll Tip Seal Replacement

1. *Diaphragm Backing Pumps:* Unbolt the pump head plates. Inspect diaphragms and flapper valves for cracking, stiffening, or tearing. Replace as a complete set annually (or every 18 months per EPA Method 2.10). Re-torque head bolts in a star pattern.
2. *Dry Scroll Pumps:* When operating hours reach 8,000–10,000 hours or ultimate pressure degrades past 10⁻² Torr, unbolt the scroll housing. Remove worn PTFE tip seals using plastic tweezers, clean scroll channels with IPA, and press new tip seal strips firmly into grooves. Install fine particulate downstream traps upon reassembly.

Phase 6: Foreline Sorption Trap Servicing & Regeneration

1. Inspect molecular sieve / activated alumina foreline traps positioned upstream of oil-sealed pumps.
2. If media appears dark or hydrocarbon backstreaming is suspected, remove spent zeolite charge and refill with fresh 13X

molecular sieve pellets, or execute an inline bake-out sequence at 200°C for 2 hours under dry N₂ purge flow.

Phase 7: Re-Commissioning & Performance Verification

1. Remove LOTO padlocks, reconnect power supply, and close manual inlet bleed valves.
2. Start the pump with the inlet isolated and allow it to run for 5 minutes.
3. Verify zero oil mist aerosol emission from the exhaust port during operation.
4. Measure ultimate base vacuum at the isolated inlet using a calibrated convection/Pirani gauge. Confirm ultimate pressure reaches < 100 mTorr (10–20 microns) for dual-stage oil pumps or < 10⁻² Torr for dry scroll pumps.
5. Conduct an external helium leak-check around serviced filter housings using a sniffer/mass spectrometer to verify seal integrity (< 80.1 mL/min external leak limit).

5. PREVENTIVE MAINTENANCE SCHEDULE & INTERVALS

Frequency / Interval	Servicing Action Required	Acceptance Criteria & Target Range
Daily / Per-Run	Visual sight glass oil level & exhaust mist check	Level 1/2 to 3/4 full; zero oil mist visible
Weekly (168 Run-Hrs)	Inlet filter visual & gas ballast de-aeration run	Filter clear of heavy debris; de-aerate 5 mins
Monthly (500 Run-Hrs)	Clean/tap intake filter element & check trap media	Filter AP < 0.5 psi; trap media clean
Semi-Annual (2,000 Hrs)	Replace intake element & external spin-on filter	New elements installed; zero fluid leaks
Annual (4,000 Run-Hrs)	Replace coalescing mist element & diaphragm/valves	Base pressure < 100 mTorr; zero mist carry-over
8,000–10,000 Run-Hrs	Complete dry scroll tip seal kit replacement	Base pressure < 10-2 Torr; zero tip seal binding

6. TROUBLESHOOTING & QA VERIFICATION MATRIX

Observed Anomaly	Likely Root Cause	Diagnostic Check & Corrective Action
Degraded Pumping Speed / Long Evacuation	Clogged air intake filter or clogged wire screen	Measure filter AP. Tap out dust or replace paper/polyester element. Clean inlet wire screen in IPA bath.
Excessive Oil Mist / Smoke at Exhaust	Saturated or torn coalescing exhaust mist element	Inspect mist eliminator housing. Replace coalescing element. Verify oil auto-return line is unclogged.
Hydrocarbon Backstreaming into Chamber	Saturated foreline molecular sieve or failed anti-suckback valve	Check RGA for m/z = 41, 43, 55, 57 cracking peaks. Replace molecular sieve charge; verify anti-suckback valve closes < 20 ms.
High Housing Backpressure / Motor Trip	Exhaust filter blocked or frozen exhaust line	Relieve exhaust backpressure. Replace clogged exhaust filter element; inspect exhaust ducting for obstructions.
Base Vacuum Stalls @ 10-1 Torr (Scroll)	Worn PTFE tip seals or particulate accumulation	Disassemble scroll housing. Inspect tip seal height. Replace tip seal kit and install downstream particulate trap.

7. DOCUMENT CONTROL & AUTHORIZATION SIGN-OFF

This technical Standard Operating Procedure has been authored, peer-reviewed, and authorized in accordance with High Vacuum Laboratory QA/QC protocols and EPA Quality Assurance guidelines:

Authored & Validated By:	Reviewed & Approved By:	QA Quality Assurance By:
 Kadeem Manning Tier II Vacuum Lab Tech Date: 11/12/2021	 Mark Tigges Field Operations Manager Date: 11/14/2021	 Genevieve Lariviere QA Program Manager Date: 11/15/2021