AIR RESOURCE SPECIALISTS / VACUUM LAB	STANDARD OPERATING PROCEDURE
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ROTARY VANE & MECHANICAL ROUGHING PUMP FLUID SERVICING & MAINTENANCE PROCEDURE

Comprehensive Technical Operating Procedure for Vacuum Oil Replacement, Flushing, Consumable Maintenance, and Quality Control Verification

1.0 PURPOSE & SCOPE

This Standard Operating Procedure (SOP) defines the non-negotiable protocols for performing routine oil changes, internal fluid flushing, filter element replacements, and post-service performance verification on dual-stage rotary vane and mechanical roughing vacuum pumps. Roughing pumps serve as the critical primary vacuum stage across high-vacuum laboratory systems, evacuating vacuum chambers from atmospheric pressure down to the rough vacuum regime (<100 mTorr) and backing high-vacuum turbomolecular or diffusion pumps.

Adherence to this procedure ensures optimal pump ultimate vacuum performance (10–20 microns / <100 mTorr), prevents premature vane and shaft seal wear, eliminates hydrocarbon backstreaming into process chambers, and maintains complete audit-proof quality control compliance per laboratory QA/QC standards.

2.0 SAFETY PROTOCOLS & PERSONAL PROTECTIVE EQUIPMENT (PPE)

HAZARD ALERT & MANDATORY PPE

CRITICAL SAFETY WARNING: Vacuum pump oil traps toxic chemical residues, heavy organometallics, condensable process acids, and hazardous solvent vapors during normal operation. Direct skin contact or aerosol inhalation poses severe health risks. Always execute Lockout/Tagout (LOTO) prior to servicing.

- **Mandatory PPE:** Safety glasses with side shields (ANSI Z87.1 approved), chemical-resistant heavy nitrile gloves (minimum 6 mil thickness), lab coat, and closed-toe safety footwear.
- **Hazardous Energy Control (LOTO):** De-energize the pump motor, disconnect the main 115V AC power supply plug, and apply a Lockout/Tagout padlock and lockout tag per OSHA 29 CFR 1910.147 guidelines before opening any fluid drain or maintenance port.
- **Thermal Hazards:** Rotary vane pumps operate at elevated temperatures (60°C to 80°C / 140°F to 176°F). Allow the pump casing to cool to a safe handling threshold (~45°C) before servicing while maintaining sufficient fluid warmth for rapid draining.
- **Fluid Disposal Compliance:** Spent vacuum pump oil contains hazardous chemical residues and must be collected in labeled chemical-resistant waste containers and disposed of strictly per EPA and local municipal hazardous waste regulations.

3.0 REQUIRED EQUIPMENT, TOOLS & CONSUMABLES

Item Category	Approved Specification / Part Number	Operational Function
Vacuum Pump Fluid	Hydrocarbon ISO VG 68 (KJLC Semi-Synthetic / FJC #2200) or Inert PFPE (Fomblin Y LVAC)	Internal rotor sealing, lubrication, and heat dissipation.
Flushing Fluid	Hydrocarbon Flushing Oil (KJLC TKO-FF or equivalent)	Flushes sludge, varnish, and particulates during heavy servicing.
Exhaust Mist Filter	OEM Replacement Coalescing Element (KJLC EFS / Edwards / Pfeiffer)	Captures oil mist aerosols from pump exhaust stream.
Seals & Washers	Viton O-Rings / Copper Sealing Washers for drain & fill plugs	Ensures leak-tight vacuum sealing at drain/fill access ports.
Diagnostic Gauges	Calibrated Pirani / Convection Gauge or Digital Micron Gauge	Measures ultimate base pressure and vacuum pull-down curves.
Service Hand Tools	Oil caddy, drain catch pan, filter wrench, lint-free Kimwipes	Clean fluid containment, filter removal, and wipedown.

4.0 STEP-BY-STEP FLUID SERVICING PROCEDURE

Phase 1: System Isolation & Fluid Warm-Up

1. Close the primary roughing valve isolating the pump from the main vacuum chamber or foreline manifold.
2. Turn on the roughing pump and allow it to run for **10 to 15 minutes** with the gas ballast valve closed. Warm fluid lowers oil viscosity and suspends particulate contaminants, sludge, and trapped moisture for thorough evacuation.
3. Shut off the pump motor using the main power switch.

Phase 2: Electrical Isolation & Pressure Relief (LOTO)

1. Disconnect the main AC power cord from the wall receptacle and apply a Lockout/Tagout (LOTO) device.
2. Slowly open the manual inlet vent valve to bleed the pump suction line to atmospheric pressure. *Warning: Never open the drain plug while the pump housing is under vacuum.*

Phase 3: Draining Spent Vacuum Fluid

1. Position a chemical-resistant oil drain catch pan directly beneath the pump drain plug.
2. Remove the top oil fill cap first to prevent vacuum locking and allow free atmospheric air venting.
3. Unscrew the lower oil drain plug using the appropriate wrench. Allow dirty oil to drain completely into the catch vessel.
4. Gently tilt the pump casing forward (10° to 15° angle) toward the drain port to evacuate stagnant oil trapped in internal rotor pockets and reservoir corners.
5. Inspect the drained fluid for visual failure markers: *Dark brown/black color* (thermal oxidation), *milky/cloudy appearance* (water emulsification), or *particulate metallic glitter* (vane/bearing mechanical wear).

Phase 4: Fluid Flushing Cycle (Mandatory for Heavy Oxidation)

1. If the drained oil exhibits heavy sludge, discoloration, or chemical contamination, perform a full flush.
2. Reinstall the drain plug hand-tight. Pour approximately **100 to 150 mL** of fresh flushing fluid (KJLC TKO-FF) through the top fill port.
3. Temporarily restore power and run the pump for **3 to 5 minutes** under no-load conditions with the inlet isolated.

4. Re-apply LOTO, remove the drain plug, and drain the flushing fluid completely.
5. Clean the drain plug threads, fit a **new Viton O-ring or sealing washer**, and reinstall the drain plug securely (torque to 4.5 N·m / 40 in-lbs; do not overtighten).

Phase 5: Exhaust Filter & Consumables Maintenance

1. Remove the exhaust mist filter housing cover. Inspect the internal coalescing filter element.
2. Replace the exhaust filter element if saturated, discolored, or if operating backpressure exceeds manufacturer limits.
3. Wipe down the internal filter housing and oil return valve deck using lint-free Kimwipes.
4. If the pump is equipped with an external spin-on oil filter, unscrew the old cartridge with a filter wrench, coat the rubber gasket of the new filter with clean vacuum oil, and hand-tighten until snug.

Phase 6: Refilling Fresh Vacuum Fluid

1. Insert a clean, dedicated funnel into the top oil fill port.
2. Slowly pour fresh, certified vacuum fluid (e.g., KJLC Semi-Synthetic or FJC #2200) into the pump.
3. Monitor the oil level sight glass continuously. Stop filling when the fluid meniscus reaches exactly the **3/4 mark** (between the Min and Max full level indicators).
4. Inspect the fill cap O-ring, replace if compressed/cracked, and reinstall the top fill plug securely.

Phase 7: Re-Commissioning, De-Aeration & QA Verification

1. Remove LOTO devices, restore main electrical power, and switch the pump motor ON with the inlet isolated.
2. Open the gas ballast valve slightly for **2 to 3 minutes** while running to purge micro-bubbles and de-aerate the new oil, then close the gas ballast valve tightly.
3. Allow the pump to operate for 5 minutes, then check the sight glass level. Top off if new filter elements absorbed fluid.

4. Connect a calibrated Pirani or digital micron gauge directly to the pump inlet flange. Measure and record the ultimate base pressure. **Acceptance Criterion: Ultimate pressure must reach <100 mTorr (10–20 microns) within 5 minutes.**

5.0 PREVENTIVE MAINTENANCE SCHEDULE & CRITERIA

Service Interval	Required Maintenance Action	Acceptance Threshold / Standard
Daily / Per-Run	• Sight glass fluid level & clarity check • Visual inspection for casing leaks & oil mist • Listen for abnormal mechanical noise/cavitation	• Level between 1/2 and 3/4 sight glass • Color: Clear to light amber (no cloudiness) • No oil residue on housing or exhaust
Weekly	• Inspect intake filter screen for dust/particulates • Verify gas ballast valve smooth rotation & sealing • Check electrical power cord for jacket abrasion	• Intake filter clean & unblocked • Gas ballast seats tightly when closed • Power cord undamaged
2,000–4,000 Hours (or Monthly)	• Complete vacuum fluid drain & refill • Replace exhaust oil mist coalescing element • Clean cooling fins & motor fan shroud	• Fresh oil filled to 3/4 sight glass • Exhaust backpressure normal • Motor temperature <70°C under load
Annual (12 Months)	• Full overhaul & internal reservoir cleaning • Replace shaft seals, valve deck gaskets, O-rings • Measure motor operating amperage against spec	• Ultimate base pressure <100 mTorr • Motor amps within nameplate rating • Zero-leak integrity confirmed

6.0 TROUBLESHOOTING & DIAGNOSTIC DECISION MATRIX

Observed Symptom	Likely Root Cause	Diagnostic Check & Corrective Action
Pump fails to reach ultimate base pressure (>100 mTorr)	1. Contaminated/degraded vacuum fluid 2. Gas ballast valve open or leaking 3. External inlet flange gasket leak 4. Worn internal vanes or shaft seals	1. Perform complete fluid change & flush. 2. Close gas ballast valve tightly. 3. Isolate pump with inline valve to test standalone ultimate vacuum. 4. Inspect/replace shaft seals and vanes.
Excessive noise, rattling, or hydraulic knocking	1. Low oil level causing dry vane contact 2. Water overload / hydraulic oil flooding 3. Worn motor bearings or rotor misalignment	1. Check sight glass; add fresh fluid to 3/4 mark. 2. Run with gas ballast open for 15 min to purge moisture. 3. Inspect bearings/coupling; rebuild if needed.
Fluid turns dark brown or cloudy rapidly	1. Excessive process moisture ingestion 2. Exposure to corrosive chemical acids 3. High temperature operation (>80°C)	1. Increase gas ballast purge frequency. 2. Switch to inert PFPE/Fomblin fluid. 3. Clean motor cooling fins and improve room airflow.
Excessive oil mist escaping from exhaust	1. Saturated or damaged exhaust filter 2. Overfilled oil reservoir (>Max line) 3. High inlet pressure operation (>10 Torr)	1. Replace exhaust coalescing mist element. 2. Drain excess fluid to 3/4 sight glass mark. 3. Avoid prolonged operation at high rough pressures.

7.0 DOCUMENT CONTROL & AUTHORIZATION SIGN-OFF

This Standard Operating Procedure has been authored, technically reviewed, and validated for official execution across all vacuum laboratory facilities operated by Air Resource Specialists. Any deviation from this procedure requires written authorization from the QA Manager.

Prepared & Executed By:	Technical Review & Approval:	Quality Assurance Sign-Off:
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