

STANDARD OPERATING PROCEDURE & TECHNICIAN CHECKLIST

TURBOMOLECULAR VACUUM PUMP PRE-START, POWER-UP & PUMP-DOWN PROCEDURES

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Revision / Status:	Rev 3.2 / Approved	Target Equipment:	TMP Systems (ISO/CF Flange)

1. Purpose, Operational Scope & Risk Management

This Standard Operating Procedure (SOP) specifies mandatory operational steps, verification criteria, and safety protocols for pre-start inspection, power-up, and pump-down execution of High-Vacuum Turbomolecular Pump (TMP) systems. Turbomolecular pumps operate with rotor blades spinning at extremely high rotational speeds (30,000 to 90,000 RPM / 500–1,500 Hz) to impart directional momentum to gas molecules. Because of the immense kinetic energy stored in the rotor assembly, strict compliance with pre-start safeguards and sequencing is required to prevent catastrophic blade degradation, mechanical shock, or contamination backstreaming.

SAFETY WARNING — ROTOR SHATTER & MECHANICAL PROTECTION

HIGH KINETIC ENERGY & MECHANICAL HAZARD: Never start or operate a turbomolecular pump without a fine wire-mesh splinter guard installed at the ISO/CF high-vacuum inlet flange. Dropped hardware, wafer shards, or foreign debris entering the inlet will cause violent rotor destruction. Never subject an active pump to sharp physical shocks or sudden positional orientation shifts. Never vent the pump to atmosphere at full rotational speed unless using a dedicated, flow-restricted venting valve.

2. System Pre-Requisites & Utility Configuration

Subsystem / Utility	Required Technical Specification & Operational Boundary	Grounded Source Standard
Inlet Protection	Fine wire-mesh splinter guard installed securely at the ISO-K/CF high-vacuum inlet flange.	Leybold Vacuum Manuals
Cooling Infrastructure	Forced air fan operating OR liquid cooling water active with flow rate ≥ 1 L/min (feed temp 18–25°C, 4–6 bar).	Pfeiffer / Leybold Catalogs
Purge Gas System	Dry N ₂ purge supply connected to lower bearing housing set at nominal 2.8 bar(g) (permissible 2.8–4.5 bar(g)). Mandatory for reactive/dusty gases.	Pfeiffer / Leybold Catalogs
Primary Backing Pump	Two-stage rotary vane or dry scroll backing pump operational. TMPs cannot start against atmospheric pressure and require forevacuum.	Agilent Vacuum / Lesker
Thermal Safety / LOTO	Switch off & cool forepumps to room temp before physical handling; wear heat protective gloves if warm. Verify zero electrical energy state prior to wiring.	Orbitrap Operating Manual

3. Step-by-Step Power-Up & Pump-Down Execution

Step #	Phase / Operation	Detailed Action Protocol & Critical Parameters	Target Threshold
1.1	Chamber Isolation	Verify that the main chamber vent valve and purge bypass valves are fully closed. Inspect all flange clamp bolts.	Zero Leakage
1.2	Forepump Activation	Power on the primary backing pump (rotary vane or dry scroll) and open the foreline isolation valve.	Motor Active
1.3	Rough Vacuum Phase	Evacuate the main chamber and foreline piping. Reduce system pressure below the rough vacuum threshold.	$< 1 \times 10^{-1}$ Torr (100 mTorr / ~1 mbar)
2.1	TMP Controller Power	Energize the electronic frequency converter (inverter). Ensure controller communications (RS232/X1) read READY state.	Display READY
2.2	Rotor Acceleration	Start turbo rotor drive. The frequency converter feeds steadily increasing voltage and frequency to accelerate the motor smoothly.	100% Nominal Speed ($< 5\text{--}10$ min ramp)
2.3	Drive Current Check	Monitor controller current display. Confirm drive current drops from initial starting surge down to baseline low idle amperage.	Baseline Low Idle Amps
3.1	HV Transition	Slowly open the main high-vacuum chamber gate valve once pressure reaches forevacuum threshold ($\sim 10^{-1}$ mbar).	Gate Valve OPEN
3.2	Gauge Energization	Delay energizing high-vacuum ionization gauges until pressure drops below safety threshold to prevent filament burnout.	$< 1 \times 10^{-3}$ Torr (1×10^{-3} mbar)
3.3	Base Pressure Check	Confirm system achieves ultimate base vacuum pressure and verify current draw remains stable.	10^{-6} to 10^{-9} Torr (10^{-10} mbar UHV)
3.4	Acoustic & Vibration Audit	Perform visual and audible inspection. A healthy pump generates a smooth high-pitched hum. Investigate any grinding or whining.	Smooth Hum

4. Field Technician Verification & Execution Checklist

Instructions for Technician: Complete all verification checks in order. Measure and record quantitative parameters in the readback column. Mark [X] PASS or [X] FAIL for every item. Any failure requires immediate escalation to supervisor.

Item	Inspection Task / Checkpoint	Acceptance Standard	Measured Value / Readback	Status
P-01	Inlet Splinter Guard	Clean wire-mesh guard present & seated	Visual Check: ☐ Verified	☐ PASS ☐ FAIL
P-02	Cooling Water / Fan Flow	Water flow ≥ 1 L/min OR fan active	Flow Rate: _____ L/min	☐ PASS ☐ FAIL
P-03	N ₂ Purge Gas Supply	Regulated dry N ₂ at 2.8 bar(g)	Supply Pressure: _____ bar(g)	☐ PASS ☐ FAIL
P-04	Forepump Oil Sight Glass	Oil level between min/max midpoint, clean	Oil Color: ☐ Clear ☐ Dark	☐ PASS ☐ FAIL
P-05	Electrical & Grounding	Cable insulation intact, ground resistance ok	Visual / Ground Check: ☐ OK	☐ PASS ☐ FAIL
E-01	Chamber Vent Valve Isolation	Chamber vent valve 100% closed & sealed	Valve Position: ☐ CLOSED	☐ PASS ☐ FAIL
E-02	Foreline Evacuation	Backing pump active, foreline valve open	Foreline Valve: ☐ OPEN	☐ PASS ☐ FAIL
E-03	Rough Vacuum Level	Pressure $< 1 \times 10^{-1}$ Torr (100 mTorr / 1 mbar)	Readout: _____ mbar/Torr	☐ PASS ☐ FAIL
E-04	TMP Frequency Converter	Power ON, no fault codes on display	Status Display: ☐ READY	☐ PASS ☐ FAIL
E-05	Rotor Acceleration Ramp	Reaches 100% rotational speed < 5 -10 min	Speed: _____ % Ramp: _____ min	☐ PASS ☐ FAIL
E-06	Motor Drive Current Draw	Current drops from start surge to baseline	Motor Current: _____ A	☐ PASS ☐ FAIL
H-01	HV Chamber Gate Valve	Slowly opened at $\sim 10^{-1}$ mbar forevacuum	HV Gate Valve: ☐ OPEN	☐ PASS ☐ FAIL
H-02	Ion Gauge Energization	Ionization gauge ON only below 10^{-3} Torr	Gauge ON Pressure: _____ Torr	☐ PASS ☐ FAIL
H-03	Ultimate Base Vacuum	Achieves target base pressure (10^{-6} to 10^{-9} Torr)	Base Vacuum: _____ Torr	☐ PASS ☐ FAIL
H-04	Acoustic & Vibration Audit	Smooth high-pitched hum, no whining/grinding	Audible State: ☐ Smooth Hum	☐ PASS ☐ FAIL

5. Field Execution Authorization & Sign-Off Block

By signing below, the lead field technician certifies that all pre-start checks, power-up routines, and pump-down steps were executed strictly in accordance with SOP-TMP-2020-042, and that all recorded parameter values fall within baseline operating limits.

Lead Technician Signature:	_____	Date:	____ / ____ / 2020
Technician Name (Printed):	Kadeem Manning	Employee ID:	TECH-88412
Vacuum Supervisor Signature:	_____	Approval Date:	____ / ____ / 2020
System Operating Status:	☐ RELEASED FOR PRODUCTION ☐ HOLD / SERVICE REQ.	Work Order #:	WO-90421