Vacuum System Pump-Down & Vent Procedure

Standard Operating Procedure — Rotary Vane / Turbomolecular Vacuum Systems

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1. Purpose & Scope

This procedure describes the general sequence for evacuating (pumping down) and returning to atmosphere (venting) a vacuum chamber served by a mechanical roughing pump backing a turbomolecular pump. It applies to general-purpose deposition and process chambers. Exact valve names, crossover pressures, and interlocks vary by manufacturer — always confirm against the specific system's manual before performing this procedure independently.

> This document is a training/reference aid, not a substitute for site-specific, signed-off SOPs or manufacturer documentation.

2. Key Components Referenced

Component	Function
Roughing pump	Brings chamber from atmosphere to low/medium vacuum (~10■³ Torr)
Turbomolecular pump	Extends vacuum from rough range to high vacuum (10■■–10■■ Torr)
Roughing valve	Connects roughing pump directly to the chamber
Foreline valve	Connects roughing pump to the turbo pump's exhaust (foreline)
Gate valve	Isolates the turbo pump from the chamber
Vent valve	Admits dry N2 or filtered air to bring chamber to atmosphere
Pirani / convection gauge	Reads rough vacuum range pressure
Ion gauge	Reads high vacuum range pressure (damaged if powered at high pressure)

3. Pump-Down Sequence (Atmosphere → High Vacuum)

3.1 Pre-Check

- Confirm chamber is properly loaded and sealed; check viewports, feedthroughs, and door seal for obstructions.
- Verify all valves are in their closed/off starting position.
- Check roughing pump oil level (if oil-sealed rotary vane) and turbo pump status indicator.

3.2 Rough Pumping

- 1. Ensure foreline valve is closed (isolates turbo from the roughing line).
- 2. Ensure chamber-to-turbo gate valve is closed (isolates turbo from chamber).

- 3. Open the roughing valve to admit the chamber to the roughing pump.
- 4. Start the roughing pump.
- 5. Monitor pressure on the Pirani/convection gauge as the chamber pumps down from atmosphere.
- 6. Wait until chamber reaches the turbo pump's specified crossover pressure (commonly ~50–100 mTorr — confirm exact value for your system).

3.3 Transition to High Vacuum

- 1. Close the roughing valve to the chamber.
- 2. Open the foreline valve so the roughing pump now backs the turbo pump.
- 3. Start the turbo pump; many systems require foreline pressure within spec before the turbo will spin up.
- 4. Once the turbo reaches full speed (check tachometer/status indicator), slowly and gradually open the gate valve between turbo and chamber.

> Open the gate valve gradually, not all at once. A sudden pressure differential across the turbo can stress the blades or trip a protective interlock.

3.4 Monitor High-Vacuum Pump-Down

- Switch to the ion gauge once pressure is low enough for accurate reading (typically below ~10■³ Torr — check gauge manual).
- Watch pressure decrease over time; note the base pressure achieved and time taken.
- Compare against the system's historical baseline — a notably slower pump-down signals a possible leak or contamination.

> Never energize the ion gauge above its rated pressure threshold — doing so can burn out the filament.

3.5 Confirm Readiness

Once target base pressure is reached and stable, the chamber is ready for process (deposition, etc.). Record the base pressure and time-to-pressure in the run log.

4. Venting Sequence (High Vacuum → Atmosphere)

4.1 Prepare to Vent

- Turn off the ion gauge before venting — never vent with it powered; the filament will burn out on contact with air.
- Close the gate valve between turbo and chamber.

4.2 Spin Down Turbo

- Turn off the turbo pump and allow it to fully spin down — this can take several minutes.
- Never vent while the turbo is still spinning; residual rotation combined with incoming atmosphere can damage the blades.
- Close the foreline valve once the turbo has fully stopped.

> Venting into a spinning turbo pump is one of the most common and most expensive tech errors — it can destroy bearings and blades outright.

4.3 Vent the Chamber

- Slowly open the vent valve (dry nitrogen or filtered air) to bring the chamber back to atmosphere.
- Vent gradually — a fast vent can stir up particulates inside the chamber or disturb loosely mounted samples.

4.4 Shut Down

- Once chamber is at atmosphere, the roughing pump may be turned off — some labs leave it running to maintain vacuum on its own internal lines; follow site-specific SOP.
- Return all valves to their closed/off starting position for the next cycle.

5. Common Sequencing Errors & Consequences

Error	Consequence
Venting into a spinning turbo pump	Destroyed bearings/blades — costly repair or replacement
Opening chamber-to-turbo gate valve before turbo is at speed	Turbo pump stall; atmospheric gas surge into high-vacuum side
Running ion gauge at high pressure	Burned-out filament
Skipping the roughing step, going straight to turbo	Turbo pumps cannot pump from atmosphere and require roughing first
Fast venting	Particulates disturbed inside chamber; risk to samples/optics

6. Note on Automated Systems

Many modern vacuum systems use software-controlled sequencing with hardware interlocks that prevent invalid valve states (e.g., blocking gate-valve opening until turbo speed is confirmed). Understanding the

manual logic above is what allows a technician to recognize when an automated system is behaving abnormally, rather than simply trusting the software without question.
