

Cleanroom Environmental & Contamination Control SOP

ISO Class 6 / Class 7 Environmental Monitoring, Gowning, and Contamination Mitigation

Document ID: SOP-ENV-2021-17	Effective Date: December 20, 2021	Revision: 2.0 (Annual Review)
Lead Specialist: Kadeem Manning (Tier II Vacuum Tech)	Ops Manager: Mark Tigges	QA Manager: Genevieve Lariviere
Facility Suite: Cleanroom Suite B-102 (ISO 6/7)	Compliance: ISO 14644-1 / EPA QAPP / ALCOA+	Classification: Controlled Lab Document

1. Purpose & Scope

This Standard Operating Procedure establishes non-negotiable operational guidelines for maintaining environmental integrity, gowning compliance, and contamination control within Cleanroom Suite B-102 (ISO Class 6 laminar flow hoods and ISO Class 7 ambient processing bay). Strict adherence is required to protect vacuum chamber optics, turbomolecular pump rotors, planar microwave resonators, and thin-film substrates from airborne particulate deposition, skin oil contamination, organic outgassing, and electrostatic discharge (ESD). All technicians, research staff, and maintenance engineers must comply prior to entering the controlled envelope.

2. Cleanroom Gowning & PPE Protocol (3-Zone Sequence)

Gowning must be performed sequentially in the designated Antechamber (Zone 1) prior to crossing the sticky threshold into the Cleanroom Processing Bay (Zone 2):

- Zone 1 Step 1 (Footwear Wiping):** Step onto the heavy-duty tacky/sticky mat in the outer vestibule, performing a 3-step boot-wipe to capture coarse soil before entering the gowning bench area.
- Zone 1 Step 2 (Head Cover & Mask):** Don a cleanroom-grade bouffant cap ensuring 100% hair coverage (including sideburns). Attach a facial mask and beard cover if applicable.
- Zone 1 Step 3 (Primary Glove Donning):** Sanitize hands with 70% IPA dispenser and don the 1st pair of powder-free 6 mil nitrile gloves.
- Zone 1 Step 4 (Garment Donning):** Unfold a clean, lint-free polyester cleanroom coverall/jumpsuit without allowing the legs or sleeves to contact the floor. Zip fully to the collar.
- Zone 1 Step 5 (Booties & Snaps):** Step over the gowning bench into the clean zone while pulling high-top cleanroom boots over jumpsuit legs. Fasten boot snaps securely.
- Zone 2 Step 6 (Secondary Glove & Eyewear):** Don the 2nd pair of 6 mil powder-free nitrile gloves, extending the cuffs over jumpsuit wrist bands. Put on ANSI Z87.1 safety glasses.
- Zone 2 Step 7 (ESD Grounding):** Attach a calibrated ESD wrist strap linked to the 1.0 MΩ grounding bus before touching electronic equipment, substrate wafers, or vacuum chambers.

3. Environmental Parameter Monitoring & ISO Thresholds

The environmental control system continuously monitors airborne particulates, differential pressure, temperature, and relative humidity. Readings must be logged twice daily on Form CHK-ENV-2021-17:

Parameter / Metric	ISO Class 6 (Hoods)	ISO Class 7 (Main Bay)	Action / Alarm Threshold
Particulates ≥0.5 µm	≤ 35,200 / m³	≤ 352,000 / m³	> 30,000 / m³ (Hold / Recalibrate)
Particulates ≥5.0 µm	≤ 293 / m³	≤ 2,930 / m³	> 250 / m³ (HEPA Audit Required)
Differential Pressure (ΔP)	≥ 25 Pa (vs. Bay)	≥ 15 Pa (vs. Antechamber)	< 12 Pa (Check Air Lock / Blower)
Room Temperature	20.0°C ± 1.0°C	20.0°C ± 2.0°C	< 18°C or > 23°C (HVAC Fault)
Relative Humidity (RH)	40% ± 3% RH	40% ± 5% RH	< 30% (ESD Risk) or > 50% (Corrosion)
Laminar Airflow Velocity	0.45 m/s ± 20%	N/A (Dilution)	< 0.35 m/s (Replace HEPA Filters)

4. Material Transfer & Contamination Mitigation Protocols

Direct transfer of raw packaging or uncleaned tooling into the cleanroom is strictly forbidden. Follow these controls:

- Pass-Through Air Lock Box:** All raw substrates, replacement seals, target materials, and hand tools must enter via the interlocked Pass-Through Box. Double-door interlocks prevent simultaneous opening.

- **Solvent Wiping Protocol:** Prior to transfer, wipe all external chemical containers, tool handles, and transport boxes with 99.9% electronic-grade Isopropanol (IPA) using a lint-free polyester cleanroom wipe.
- **Prohibited Materials:** Cardboard, paper, wood-pencil, cosmetics, food/drink, and non-ESD synthetic plastics are 100% prohibited inside Suite B-102. Use synthetic cleanroom notebooks (SOP-LOG-2021-14).
- **Substrate & Optics Handling:** Never touch substrates, vacuum chamber walls, or optical viewports with bare hands or cuffed gloves. Use Teflon-coated edge-clamping tweezers (≤ 1.0 mm contact) or vacuum wands.

5. Hygiene Schedules & Environmental Excursion Protocol

Housekeeping routines must follow a strict frequency matrix to prevent particulate accumulation:

Frequency	Cleaning Task / Target Area	Approved Agent / Equipment	Responsible Party
Daily (Start/End)	Wipe stainless steel workbenches, hood decks, & pass-throughs	99.9% IPA + Polyester Wipes	Lab Technicians
Daily (Per Shift)	Peel top tacky layer from Antechamber & Cleanroom sticky mats	Manual Peel at 45° angle	Lab Technicians
Weekly	Vacuum floors & gowning bench areas	HEPA-Filtered Cleanroom Vacuum	Facility Specialist
Weekly	Damp-mop sealed cleanroom floor panels	Ultra-Pure DI Water + IPA Solution	Facility Specialist
Monthly	Wipe wall panels, door frames, & acrylic hood baffles	Dilute Neutral Detergent + DI Water	Maintenance Team
Semi-Annual	Inspect HEPA filter pressure drops & perform particle audit	Laser Particle Counter (3500 L/min)	QA Metrology Team

6. Authorization & QA Sign-Off

By signing below, the lead technician and management certify that this protocol meets all ALCOA+ defensibility and ISO 14644-1 quality criteria for cleanroom operations.

Lead Vacuum Lab Technician:	Kadeem Manning	Signature: <i>Kadeem Manning</i>	Date: Dec 20, 2021
Field Operations Manager:	Mark Tigges	Signature: <i>Mark Tigges</i>	Date: Dec 20, 2021
QA Program Manager:	Genevieve Lariviere	Signature: <i>Genevieve Lariviere</i>	Date: Dec 20, 2021