AI-04500 CMP Technician 1 Training and Lesson Plan

Create a comprehensive entry level Samsung Austin Semiconductor CMP Technician 1 Training and Lesson Plan

Here is a comprehensive 12-week onboarding and lesson plan designed for an entry-level **Chemical Mechanical Planarization (CMP) Technician 1** in a high-volume 300mm semiconductor fabrication environment.

This curriculum bridges foundational semiconductor theory with hands-on fab floor execution, prioritizing safety, yield protection, tool availability, and operational compliance.

Program Overview

- **Target Role:** CMP Equipment / Process Technician 1 (Entry-Level)
- **Duration:** 12 Weeks (Structured Progression)
- **Goal:** Shift-ready technician capable of independently executing routine daily operations, consumable swaps, standard preventive maintenance (PM), basic tool recovery, and statistical process control (SPC) monitoring under minimal supervision.

12-Week Training Progression

1.Phase 1: Safety, Cleanroom Protocols & Fab Foundations: Weeks 1–2.

Focuses on Environmental Health & Safety (EHS), ISO Class 1 cleanroom protocol, chemical safety, and basic fab communication.

- **Chemical Safety & EHS:** Hazardous material handling, Safety Data Sheets (SDS) for CMP slurries (alkaline/acidic) and cleaning chemistry (NH_4OH, HF, organic acids), PPE protocols (chemical aprons, face shields, double-gloving).
- **Cleanroom Dynamics:** Gown-up procedures, ESD protocols, wafer handling etiquette (FOUPs, cassettes, manual wand control), and protocol for handling broken/shattered wafers.
- **Fab Systems Basics:** Navigation of MES (Manufacturing Execution System), SPC charting software, and OCAP (Out-of-Control Action Plan) standard procedures.

2.Phase 2: CMP Process & Equipment Fundamentals: Weeks 3–4.

Establishes core technical knowledge of how planarization works and the mechanical architecture of CMP polishing tools.

- **Theory of CMP:** Material removal mechanism combining chemical etching and mechanical abrasion (Preston's Law: $MRR = K_p \cdot P \cdot V$), planarization efficiency, selectivity, and oxide vs. metal CMP (W, Cu, STI, ILD).
- **Tool Anatomy & Subsystems:** Platen assembly, carrier heads (membrane pressure zones), slurry delivery loops (loops, pumps, flow meters), diamond disk conditioner arms, and post-CMP cleaner stations (brush boxes, megasonics, spin-rinse dryers).
- **Metrology & Inspection Basics:** Optical thickness measurements, sheet resistance (4-point probe), defect classification (scratches, slurry residue, coring, dishing, erosion).

3.Phase 3: Daily Operations & Consumable Management: Weeks 5–8.

Hands-on execution of daily floor tasks alongside a mentor/qualified technician.

- **Consumable Replacements:** Polishing pad break-in and qualifying, diamond conditioner disk replacement, retaining ring wear inspection, and brush module replacement.
- **Slurry & Chemical Delivery Systems:** Loop line flushing, slurry filter changes, specific gravity/pH verification, and pump calibrations.
- **Qual Wafers & SPC Monitoring:** Running daily thickness/uniformity quals (thk/unif), interpreting X-bar and R control charts, qualifying tools post-PM, and halting tools on SPC violations.

4.Phase 4: Preventive Maintenance & Tool Recovery: Weeks 9–12.

Transitioning to autonomous execution of routine PMs and first-line troubleshooting.

- **Minor & Major PM Execution:** Platen cleaning, head rebuilds/membrane changes, pneumatic calibration, sensor alignment, and brush alignment.
- **Basic Error Recovery:** Clearing wafer transfer errors (robot lockups, vacuum errors), resolving slurry delivery flow faults, and recovering from power-off states.
- **Final Practical Evaluation:** Independent execution of a full PM sequence, SPC qualification, and oral board review with senior engineers and technicians.

Core Knowledge Domains & Technical Competencies

1. The Four Pillar Mechanics of CMP

Technicians must master how the core inputs interact to achieve target material removal:

```
[ Slurry Chemistry ] + [ Polishing Pad ] + [ Conditioner Disk ] + [ Carrier Head Pressure ]
                                    |
                                    ▼
                [ Controlled Material Removal & Planarization ]
```

- **Slurry Mechanics:** Particle types (Silica, Ceria, Alumina), pH buffers, oxidizers (H_2O_2), and selectivity agents.
- **Pad Dynamics:** Polyurethane foam structure, pad hardness, grooving patterns (concentric, XY grid) for slurry transport, and pad conditioning (diamond disk dressers).
- **Kinematics & Delivery:** Platen/head rotation speeds (RPM), downforce pressures (psi), slurry flow rates (mL/min), and temperature control.
- **Post-CMP Cleaning:** Mechanical scrubbing (PVA brushes), megasonic acoustic agitation, and chemical passivation to prevent corrosion/staining.

Assessment & Certification Checklist

To achieve official **CMP Tech 1 Qualification**, the candidate must pass three evaluation gateways:

Gateway	Format	Requirement
EHS & Chemical Safety	Practical & Written	100% score on chemical spill response, SDS navigation, and emergency shut-off (EMO) procedures.
Consumable & PM Execution	Evaluated Work	Complete a pad change, conditioner swap, and post-PM qualification within target MTTR (Mean Time to Repair) without protocol violations.
Fab Operations & SPC	Scenario-Based Oral Board	Correctly diagnose an out-of-spec wafer trend, execute the correct OCAP, isolate the faulty platen/head, and log the maintenance ticket in MES.

Write a detailed Step-by-Step Standard Operating Procedure (SOP) for performing a CMP polishing pad replacement and break-in procedure.

Standard Operating Procedure: CMP Polishing Pad Replacement & Break-in

- **Document ID:** SOP-CMP-042
- **Revision:** 3.1
- **Target Equipment:** 300mm CMP Polishing Tool (Platen Assembly)
- **Skill Level Required:** Tech 1 (Supervised) or higher

1. Safety & PPE Requirements

> **WARNING:** Chemical and mechanical hazard zone. Alkaline and acidic CMP slurry residues may cause chemical burns or respiratory distress. Platen rotation and head mechanism present pinch-point hazards.

- **Mandatory PPE:**
  - Cleanroom gowning (ISO Class 1 compliant)
  - Heavy-duty chemical gloves (nitrile outer layer over inner ESD gloves)
  - Face shield over safety glasses (during platen washdown)
  - Chemical apron (during chemical rinse phases)
- **Required Tools & Consumables:**
  - New pre-grooved polyurethane CMP polishing pad
  - Pad removal tool (non-scratching scraper / plastic edge)
  - Isopropyl Alcohol (IPA) / Deionized Water (DIW) cleaning wipes
  - Plastic pad roller (bubble-removal tool)
  - New Diamond Conditioning Disk (if scheduled concurrently)
  - Pad break-in dummy wafers (high-roughness / oxide dummy stock)

2. Pre-Maintenance Preparation & Tool Interlock

1. **System Status Change:**
   - In the **MES (Manufacturing Execution System)**, update tool state from `PRODUCTIVE` to `SCHEDULED_PM`.
   - Clear any remaining production wafers from the loader/cleaner modules using the software UI.
2. **Lockout/Tagout (LOTO) & Access:**
   - Abort active slurry delivery loops to the target platen using the chemical delivery software interface.
   - Engage software maintenance lockout on the targeting platen and head assembly. Ensure interlocks prevent platen rotation during manual contact.

- Open the platen chamber enclosure doors.

3. Step-by-Step Procedure

1.1. Old Pad Removal & Platen Surface Prep: Estimated Time: 15–20 mins.

- Turn off slurry flow and switch to local DIW spray wand.
- Carefully lift the edge of the spent pad using a non-scratch plastic scraper.
- Peel the old pad off the aluminum platen surface at a **45-degree angle**, pulling steadily to minimize residual adhesive transfer.
- Apply IPA to the bare platen surface to dissolve residual pressure-sensitive adhesive (PSA).
- Wipe clean with lint-free cleanroom wipes until the metal platen is smooth, completely dry, and 100% free of debris, slurry crust, or sticky residue.
- **Inspection Gate:** Visually inspect the aluminum surface under bright light for nicks, scratches, or trapped particles. Any particle larger than 10 µm can cause pad micro-bumps and wafer non-uniformity.

2.2. New Pad Installation: Estimated Time: 15 mins.

- Remove the new polishing pad from its cleanroom protective sleeve. Inspect the surface for pre-existing grooves, tears, or embedded foreign matter.
- Peel back approximately **1/3 of the protective backing paper** from the PSA layer on the underside of the new pad.
- Align the center hole of the pad precisely with the platen center spindle / alignment guide pins.
- Press the exposed adhesive edge down onto the platen, ensuring perfect concentric alignment.
- Slowly pull away the remaining backing paper while unrolling the pad flat onto the platen, working from the center toward the outer edge.
- Using a weighted plastic pad roller, roll over the entire surface in a **spiral pattern from center to edge** to expel all trapped air pockets.

3.3. Pad Break-in (Conditioning Phase): Estimated Time: 30–45 mins.

- Lower the Diamond Conditioning Disk arm onto the new pad.
- Set initial break-in parameters on the local tool controller:
  - **Platen RPM:** 90–100 RPM
  - **Conditioner Downforce:** 7.0–9.0 lbs (High force for initial conditioning)
  - **Sweeps:** Full radial sweep (10% to 95% of platen radius) at 15 sweeps/min
  - **DIW Flow Rate:** 200–300 mL/min continuous rinse
- Execute the **Pad Break-in Recipe** for 30 minutes. This process removes the glossy skin layer of the new polyurethane pad, opens the micro-pores, and creates consistent surface roughness (S_a).

4.4. Dummy Wafer Polish & Chemical Conditioning: Estimated Time: 20 mins.

- Switch fluid delivery from DIW to target process **Slurry** at $150–200\text{ mL/min}$.
- Load 2x **Dummy Oxide Wafers** into the carrier heads.
- Run a dummy polish routine (5–10 minutes) under standard process pressures ($2.5–3.5\text{ psi}$) to allow slurry chemicals to wet out and react with the micro-grooves of the new pad.
- Remove dummy wafers and verify no abnormal friction spike or vibration occurred during the run.

5.5. Qualification Run & SPC Verification: Estimated Time: 30 mins.

- Load 1x **Thickness Qualification Wafer** (e.g., Thermal Oxide film stock).
- Run standard 60-second process recipe.
- Measure post-CMP film thickness using the inline optical metrology tool (49-point or 81-point polar map).
- **Calculate Metrics:**
  - **Material Removal Rate (MRR):** Target within $\pm 3\%$ of baseline.
  - **Non-Uniformity (WIWNU %):** Must be $< 3.5\%$ (1-sigma).

4. Post-Procedure Verification & Hand-off

Parameter	Target Value	Action if Out of Spec
Pad Visual Inspection	Zero air bubbles, concentric alignment within $\pm 1.0\text{ mm}$	Re-roll pad; if bubbles persist, remove and discard pad.
Platen Temperature	Stable ($20–25^\circ\text{C}$ nominal)	Check backing plate chiller loop and DIW temperature.
WIWNU (Non-Uniformity)	$< 3.5\%$	Re-run conditioning break-in cycle for 10 minutes; re-qualify.
Material Removal Rate	Target $\pm 3\%$	Adjust conditioner downforce or check slurry flow rate.

1. **Clean-Up:** Wipe down tool chamber housing, remove LOTO tags, and close chamber doors.
2. **MES Logging:**
   - Attach the qualification wafer metrology report to the maintenance ticket.
   - Input the pad lot number, installation timestamp, and initial break-in parameters into the MES consumable tracking module.
3. **Tool Return:** Update tool status from `SCHEDULED_PM` to `PRODUCTIVE`.

Create a detailed troubleshooting guide for CMP Technicians detailing root causes and corrective actions for scratches, dishing, and slurry residue.

CMP Defect Troubleshooting Guide

- **Document ID:** TSG-CMP-018
- **Target Audience:** Equipment & Process Technicians (CMP Module)
- **Scope:** 300mm Oxide, Copper (Cu), and Tungsten (W) Planarization Modules

Defects in CMP directly impact die yield, electrical performance, and downstream lithography alignment. Use this guide to systematically isolate root causes and apply corrective actions when Out-of-Control Action Plans (OCAPs) are triggered.

1. Defect Category: Micro-Scratches & Chatter Marks

> **Impact:** Micro-scratches breach dielectric layers or cause electrical opens/shorts in interconnect lines.

```
[ Contaminated Slurry / Dried Crust ]
[ Damaged Conditioner Disk / Diamond Loss ]  ⟶ [ High Shear / Mechanical Gouging ] ⟶
Scratch Defect
[ Foreign Particle on Pad ]
```

Root Causes

- **Slurry Agglomeration / Large Particles:** Slurry drying out around nozzle tips, causing agglomerated grit to drop onto the pad surface.
- **Pad Conditioner Damage:** Missing, fractured, or loose diamond particles peeling off the conditioning disk and becoming trapped under the carrier head.
- **Filter Bypass:** Slurry delivery line filters blown out ($>0.5\,\mu\text{m}$ filter failure) or operated past lifetime limits.
- **Post-CMP Brush Contamination:** Dried slurry or foreign debris embedded in PVA brushes drag across the wafer surface during cleaning.

Corrective Actions

1. **Immediate Quarantine:** Halt platen/head on the affected channel. Inspect the last wafer under high-intensity spotlight or unpatterned surface inspection tool (e.g., KLA/Surfscan).
2. **Filter Replacement & Flush:** Check slurry loop pressure drops across point-of-use (POU) filters. Replace filters if differential pressure (ΔP) is out of spec, and perform a 5-minute High-Pressure DIW Flush.
3. **Conditioner & Pad Inspection:**

- Perform optical inspection on the diamond disk for missing diamonds or chipped edges. Replace disk if worn or damaged.
- Perform a **Dummy Scratch Run** on a test wafer. If scratches persist, replace the polishing pad immediately.

4. **Nozzle Cleaning:** Perform ultrasonic or IPA cleaning on slurry dispense nozzles to remove dried crust build-up.

2. Defect Category: Dishing & Erosion (Metal CMP)

> **Impact:** Dishing (over-polishing metal lines below dielectric level) and Erosion (dielectric loss between dense metal lines) cause high line resistance (R_s), signal delay, and top surface topology variation.

Root Causes

- **Over-Polishing / End-Point Failures:** Optical or motor-torque Endpoint Detection (EPD) system failure leading to excessive clearing time.
- **Excessive Carrier Downforce:** Over-pressurization of carrier head zones (Center, Middle, Edge) relative to target process window.
- **Chemical Over-Etching:** High oxidizer (H_2O_2) concentration or high slurry pH causing chemical dissolution of metal faster than mechanical removal.
- **Pad Degradation:** Pad becoming too soft/worn, flexing down into wide metal trenches rather than maintaining a planar bridge over them.

Corrective Actions

1. **Recalibrate Endpoint Detection (EPD):** Verify signal thresholds on motor torque or optical reflectance curves. Perform baseline EPD window alignment.
2. **Review Slurry Chemistry Metrics:** Test chemical delivery room (CDR) parameters for H_2O_2 concentration and pH. Re-balance slurry delivery ratios if chemical activity is elevated.
3. **Carrier Pressure Adjustment:** Audit zone pressures (P_1 through P_n) in the active recipe. Reduce center/edge downforce by $0.2\text{--}0.5\text{ psi}$ if dishing is localized.
4. **Pad Hardness/Life Audit:** Check pad usage counters (total polish hours / total wafers). If pad life exceeds 85% of rating, perform pad replacement.

3. Defect Category: Slurry Residue & Staining

> **Impact:** Unremoved slurry particles (SiO_2, CeO_2, Al_2O_3) or chemical stains cause defects in downstream photolithography and thin-film deposition steps.

Root Causes

- **Hydrophobic Wafer Surface / Wafer Drying:** Wafer surface drying out during transfer between polish platen and post-CMP cleaner module.
- **PVA Brush Degradation:** PVA (Polyvinyl Alcohol) brush wear, incorrect brush gap/compression distance, or insufficient brush loading with cleaning chemistry (e.g., NH_4OH or organic acids).
- **Megasonic Inefficiency:** Low megasonic transducer power or incorrect fluid flow across the megasonic cleaning bar.
- **Spin-Rinse-Dryer (SRD) Failure:** Incorrect N2 knife blow-off angle, inadequate spin speed, or dirty exhaust manifold.

Corrective Actions

1. **Verify Water-Wall & Transfer Jets:** Inspect DIW spray nozzles in the wet transfer modules. Ensure 100% wet surface coverage on wafers waiting for cleaner loading—never allow a wafer to dry.
2. **PVA Brush Alignment & Replacement:**
   - Inspect brush gaps; adjust brush compression to $1.5\text{--}2.0\text{ mm}$ against test wafers.
   - Run auto-clean routine for PVA brushes; replace brushes if run-count exceeds target lifetime or if residue persists.
3. **Chemical Delivery Check:** Verify flow rates of post-CMP cleaning chemicals (NH_4OH, citric acid, or proprietary cleaning agents) to brush boxes.
4. **Megasonic & SRD Audit:** Check megasonic generator wattage output (ensure baseline power). Clean SRD chamber and inspect N2 blow-dry nozzles for clogging.

Quick Reference Matrix

Defect Type	Primary Mechanism	First Action on Floor
Micro-Scratch	Mechanical Gouging / Particle Contamination	Stop platen, inspect conditioner disk & flush slurry nozzle
Dishing / Erosion	Over-polish / Chemical Imbalance / Soft Pad	Check EPD signals & verify slurry oxidizer (H_2O_2) ratio
Slurry Residue	Poor Post-CMP Clean / Wafer Drying	Check transfer water jets, inspect PVA brushes & chemical flows

Create a cleanroom shift handover and passdown template tailored for CMP equipment and process technicians.

CMP Module Shift Handover & Passdown Template

- **Document ID:** TMP-CMP-004

- **Shift Rotation:** 12-Hour compressed work week (Day / Night Shift)
- **Target Audience:** Incoming & Outgoing CMP Equipment & Process Technicians
- **Retention Policy:** Digital log retention (30 days) / MES Passdown Module

1. Shift Summary & High-Level KPIs

Metric	Target	Actual Shift Output	Variance / Delta
Total Wafer Moves (Outs)	_____ Wafers	_____ Wafers	_____
Tool Availability (Overall)	$\ge 92.5\%$	_____ $\%$	_____
Unscheduled Downtime (USDT)	$< 4.0\text{ hrs}$	_____ hrs	_____
Out-of-Control (OOC) Events	0 Events	_____ Events	_____
Scrapped / Broken Wafers	0 Wafers	_____ Wafers	_____

2. Tool-by-Tool Status & Active Operations

Fill out the status for each platen/tool set in the module. Indicate status as **PROD** (Productive), **ENG** (Engineering), **PM** (Preventive Maintenance), or **DOWN** (Unscheduled).

Tool / Platen Status Matrix

Tool ID	Status	Current Recipe / Layer	Active Issues / Recent Interventions	Next Action Required
CMP-01	`[PROD/ENG/PM/DOWN]`	(e.g., Cu Bulk / Oxide)		
CMP-02	`[PROD/ENG/PM/DOWN]`			
CMP-03	`[PROD/ENG/PM/DOWN]`			
CMP-04	`[PROD/ENG/PM/DOWN]`			

3. Consumable Status & Tracking Log

Track pad life, conditioner disk life, brush counts, and chemical loop levels to prevent unexpected tool stops during the incoming shift.

```
[ Platen Pad Life ]  ──► Threshold: 85% Max Polish Hours ──► Schedule PM
[ Slurry Filter ΔP ] ──► Threshold: > 15 psi Differential ──► Change Filter
[ PVA Brush Count ] ──► Threshold: 10,000 Wafers          ──► Replace Brushes
```

Tool & Platen	Consumable Item	Usage Count / Hours	Remaining Life (%)	Action Needed This Shift?
CMP-01 / P1	Polishing Pad	_____ Hours	___ %	`[ Yes / No ]`
CMP-01 / P2	Conditioner Disk	_____ Wafers	___ %	`[ Yes / No ]`
CMP-02 / Cleaner	PVA Brushes (Box 1/2)	_____ Wafers	___ %	`[ Yes / No ]`
Chemical Loop	Slurry Filter (ΔP)	_____ psi	--	`[ Replace / OK ]`

4. SPC, Yield & OCAP Escalations

Detail any active Out-of-Control Action Plan (OCAP) triggers, thickness/uniformity drift, or defect trends logged during the shift.

- **Tool ID:** _____
- **Parameter Drift / Out-of-Spec:** `[ MRR High/Low | WIWNU > 3.5% | Micro-Scratches | Residue ]`
- **Root Cause Identified:** _____
- **Intervention Completed:** _____
- **Pending Qual / Baseline Verification:** _____

5. Work-in-Progress (WIP) & Action Items for Incoming Shift

Priority Tasks (Next 12 Hours)

- [ ] **Task 1:** _____
- [ ] **Task 2:** _____
- [ ] **Task 3:** _____

Open Maintenance Tickets

> **Ticket #:** _____ | **Tool:** _____ | **Status:** In Progress / Waiting on Parts
>
> **Summary:** _____

6. Handover Sign-off

Role	Outgoing Tech Name / ID	Incoming Tech Name / ID	Time / Date
Equipment Tech	_____	_____	____ : ____ / _____
Process Tech	_____	_____	____ : ____ / _____

Create a daily (24-hour) preventive maintenance (PM) checklist for a 300mm CMP polishing module.

Daily (24-Hour) Preventive Maintenance Checklist: 300mm CMP Polishing Module

- **Document ID:** PM-CMP-D24
- **Target Frequency:** Daily (Every 24 hours ± 2 hrs)
- **Estimated Execution Time:** 45–60 Minutes
- **Tool State Required:** `SCHEDULED_PM` (Module offline, local LOTO engaged where required)

1. Safety & Pre-PM Protocol

- [ ] **Tool State:** Update tool status in MES to `SCHEDULED_PM`. Ensure all wafer handlers are empty and parked in home positions.
- [ ] **PPE Checklist:**
  - Cleanroom safety glasses + face shield (for wet chamber work)
  - Double nitrile gloves (chemical outer layer)
  - Cleanroom chemical apron (during slurry nozzle/cup washdown)
- [ ] **Interlocks:** Engage local maintenance interlocks for platen rotation, carrier head motion, and slurry pumps.

2. Daily Maintenance Tasks

Zone A: Polishing Platens & Conditioning Assemblies

- [ ] **Pad Surface Inspection:** Visually inspect all polishing pads under high-intensity LED light for deep scoring, uneven wear, or embedded foreign objects.
- [ ] **Conditioner Disk Check:** Inspect diamond conditioner disks for physical chips, excessive wear patterns, or loose diamond grit.
- [ ] **Platen Drain & Slurry Ring Cleaning:** Rinse accumulated slurry crust from the inner platen walls, splash guards, and drain troughs using DIW spray wand.

- [ ] **Retaining Ring Inspection:** Check carrier head retaining rings for burrs, uneven wear, or slurry buildup along the outer contact bevel.

Zone B: Slurry & Chemical Delivery Systems

- [ ] **POU Filter Inspection:** Check Point-of-Use (POU) slurry filter pressure gauges.
  - Record differential pressure (ΔP): _____ psi (Threshold: $\le 15\text{ psi}$).
- [ ] **Dispense Nozzle Maintenance:** Inspect slurry and chemical dispense nozzles for dried salt/slurry crust ("stalactites"). Clean nozzles using IPA cleanroom wipes or ultrasonic spray bath.
- [ ] **Slurry Flow Rate Verification:** Perform a 60-second volumetric check on active slurry lines:
  - Platen 1 Target: $150\text{--}200\text{ mL/min}$ | Actual: _____ mL/min
  - Platen 2 Target: $150\text{--}200\text{ mL/min}$ | Actual: _____ mL/min
- [ ] **Peristaltic Pump Tubing:** Inspect pump tubing for fatigue, cracking, or flattening. Replace if run-hours exceed target limit.

Zone C: Post-CMP Cleaner & Megasonic Modules

- [ ] **PVA Brush Box Audit:**
  - Inspect PVA brushes for tearing, glaze, or foreign matter contamination.
  - Verify brush gap/compression distance against standard gauge ($1.5\text{--}2.0\text{ mm}$).
- [ ] **Megasonic Transducer Check:** Inspect megasonic cleaning bar and spray manifold for clogged orifices or uneven fluid curtain flow.
- [ ] **Water-Wall & Transfer Jets:** Verify DIW spray coverage in wet transfer stations to ensure zero wafer drying during transfers.
- [ ] **Spin-Rinse-Dryer (SRD):** Check N2 knife pressure, inspect rotor pins for wear, and verify bowl drain is free of standing water.

Zone D: Pneumatics, Sensors & Utilities

- [ ] **Air/N2 Supply Pressures:** Verify main pneumatic gauge readings ($80\text{--}90\text{ psi}$ nominal).
- [ ] **Vacuum Line Inspection:** Check carrier head membrane vacuum lines for liquid draw-back or moisture contamination.
- [ ] **Exhaust Differential Pressure:** Record module exhaust reading: _____ in. W.G. (Ensure within baseline limits).

3. Post-PM Qualification & Return to Operations

1. **Rinse & Dry Cycle:** Run 3-minute chamber auto-clean cycle to flush all platens and cleaner modules with DIW.
2. **Qual Wafer Execution:**

- Load **1x Thermal Oxide Qualification Wafer**.
- Execute standard daily 60-second qual recipe.

3. **Metrology & SPC Gate:**
   - Measure film thickness/sheet resistance on inline metrology tool.
   - **Removal Rate (MRR):** Within baseline target $\pm 3\%$.
   - **WIWNU %:** $< 3.5\%$.
4. **Sign-off & System Log:**
   - Log PM completion, filter ΔP, and flow rates in MES.
   - Return tool status from `SCHEDULED_PM` to `PRODUCTIVE`.

Tech ID / Signature	Shift	Date / Time
_____	`[ Day / Night ]`	____ / ____ / 2026 — ____ : ____