AI-04721 FMEA Samsung New Hire

Multiple

#cmp

Perform an FMEA of a new hire at Samsung CMP as technician 2 . I want to see all the possible failure modes and effects to produce a better training model.

FMEA: New Hire — Samsung CMP Technician 2

Purpose: Build a practical training model that anticipates how a newly hired **CMP Technician 2** could fail, what those failures could affect, how they might be detected, and what training controls would prevent recurrence.

> **Scope note:** This is a generalized semiconductor CMP FMEA, not an official Samsung internal procedure. Actual equipment names, recipes, chemical concentrations, control limits, escalation paths, and qualification requirements must come from Samsung's approved SOPs, safety procedures, and area-specific training documents.

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1. FMEA Framework

FMEA = Failure Mode and Effects Analysis

The central question is:

> **"How can this new technician fail at each stage of the job, what happens if the failure reaches the next process step, and how do we design training to prevent it?"**

Process flow being analyzed

Training lifecycle:

Enter cleanroom → Verify readiness → Receive assignment → Prepare equipment/materials → Execute process → Monitor → Inspect/verify → Handle wafers → Document → Respond to abnormal conditions → Handoff

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2. Rating System

This FMEA uses a conventional **1–10 rating scale**.

Rating	Severity (S)	Occurrence (O)	Detection (D)
1–2	Negligible effect	Rare	Almost certain detection
3–4	Minor rework or delay	Uncommon	High likelihood of detection
5–6	Moderate quality, productivity, or equipment impact	Occasional	Moderate detection
7–8	Major lot impact, equipment damage, safety exposure, or significant downtime	Frequent enough to require controls	Low likelihood of detection
9–10	Potential serious injury, major contamination, substantial production loss, or critical process failure	Highly likely without controls	Very difficult to detect before effect

RPN = Severity × Occurrence × Detection

- **High RPN:** Prioritize for additional controls.
- **High Severity:** Must be controlled even if occurrence is low.
- **High Detection score:** A dangerous failure may remain hidden until it affects wafers, equipment, or people.

Important: RPN is a prioritization aid—not a substitute for safety judgment. Any credible chemical, electrical, mechanical, or contamination hazard requires appropriate controls regardless of RPN.

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3. Executive FMEA Summary

The following are the major failure categories a new CMP Technician 2 should be trained against.

#	Failure Category	Primary Consequence	Priority
1	Safety and chemical handling	Injury, exposure, emergency event	Critical
2	Wafer identification and traceability	Wrong lot, lost genealogy, incorrect processing	Critical
3	Equipment setup and readiness	Equipment fault, wafer damage, process interruption	High
4	Recipe and parameter control	Out-of-spec process, scrap, rework	Critical
5	Consumables and slurry management	Defects, scratches, nonuniformity, contamination	High
6	Wafer handling and transfer	Broken wafers, contamination, lot mix-up	Critical
7	Process monitoring	Drift reaches multiple wafers before detection	Critical
8	Inspection and metrology response	Defects escape downstream	Critical
9	Alarm and abnormal-condition response	Equipment damage, safety event, extended downtime	Critical
10	Documentation and communication	Repeated failures, poor handoff, hidden abnormalities	High
11	Maintenance and cleaning	Contamination, equipment degradation, injury	High
12	Human factors and qualification	Overconfidence, shortcuts, inconsistent execution	Critical

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4. Detailed FMEA

A. Safety, Cleanroom, and Chemical Handling

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Current / Expected Controls	S	O	D	RPN	Training Counter measure
A1	Enter cleanroom	Incorrect gowning or PPE	Particle contamination; chemical exposure risk	Incomplete training; rushing	Gowning SOP, observation, access requirements	7	4	4	**112**	Demonstrate-return-demonstrate gowning qualification
A2	Chemical handling	Incorrect chemical identification	Exposure, incompatible chemical use, process contamination	Similar containers; poor labeling discipline	Labels, SDS, chemical training, approved containers	10	3	3	**90**	Mandatory chemical identity verification before handling
A3	Chemical transfer	Incorrect connection or transfer procedure	Spill, exposure, equipment contamination	Inexperience; bypassing procedure	Closed-transfer systems, SOP, PPE, supervision	10	3	4	**120**	Hands-on supervised chemical-transfer qualification
A4	Chemical storage	Improper storage or incompatible chemicals	Chemical reaction, spill, exposure	Poor segregation knowledge	Chemical compatibility matrix, labeled storage	10	2	3	**60**	Chemical compatibility and storage drill
A5	Spill response	Attempts unauthorized cleanup	Exposure, spread of contamination, delayed response	Panic; unclear escalation path	Spill SOP, emergency response, area contacts	10	3	5	**150**	Scenario-based spill response: **stop, isolate, notify, follow SOP**

A6	PPE response	Removes PPE incorrectly after chemical contact	Secondary exposure	Poor decontamination knowledge	Emergency shower/eyewash training	10	2	4	**80**	Chemical exposure response demonstration
A7	Cleanroom conduct	Brings unauthorized materials into area	Particle contamination; process impact	Inadequate cleanroom discipline	Material restrictions, audits	7	4	4	**112**	Cleanroom contamination-control checklist
A8	Ergonomics / movement	Improper movement around tools	Dropped materials, collision, injury	Rushing; unfamiliar layout	Area orientation, material-handling rules	7	3	4	**84**	Tool-room movement and material-transfer walkthrough

Training emphasis

Never train the new hire to "work faster" before they can work safely and consistently.

B. Assignment, Lot Identification, and Traceability

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Controls	S	O	D	RPN	Training Counter measure
B1	Receive assignment	Misunderstands work priority	Wrong lot processed first; schedule disruption	Poor communication	Dispatch system, shift briefing	6	4	5	**120**	Read-back assignment confirmation
B2	Lot identification	Selects wrong lot	Incorrect lot processing; potential scrap	Similar lot IDs; distraction	Barcode/scanner, system verification	9	3	4	**108**	Two-point lot verification
B3	Wafer identificat	Misidentifies wafer	Incorrect handling	Inexperience;	SOP, carrier/slo	8	3	5	**120**	Wafer/slot

	ion	orientation or position	or processing	poor visual verification	t controls					identification practical
B4	Lot transfer	Fails to verify destination	Lot mix-up or lost traceability	Wrong FOUP/carrier; rushed transfer	Automated tracking, barcode checks	9	3	5	**135**	Scan–match–confirm–transfer sequence
B5	Hold status	Processes a lot on hold	Unauthorized processing; quality event	Does not check status	MES status, hold controls	9	2	5	**90**	"No status, no process" rule
B6	Priority change	Fails to recognize updated priority	Delay, wrong dispatch sequence	Poor handoff or system awareness	Dispatch updates, supervisor communication	6	4	5	**120**	Shift-start priority review
B7	Traceability	Fails to record required lot/equipment information	Inability to reconstruct event	Assumes system captured everything	MES/log requirements	8	3	6	**144**	Traceability completion audit

C. Equipment Readiness and Setup

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Controls	S	O	D	RPN	Training Countermeasure
C1	Equipment startup	Starts equipment without confirming readiness	Equipment fault, wafer damage, downtime	Checklist skipped	Equipment status, startup SOP	9	3	4	**108**	Pre-start checklist with signoff
C2	Equipment selection	Loads lot into incorrect	Wrong process condition	Tool similarity; dispatch error	Tool assignment and	9	2	5	**90**	Tool/chamber identification drill

		tool/chamber	s; quality impact		recipe controls					
C3	Equipment status	Ignores maintenance or hold status	Equipment damage or unreliable processing	Poor status awareness	Equipment status display, lockout/hold controls	9	3	4	**108**	“Verify available, qualified, released”
C4	Fixture/carrier	Installs carrier incorrectly	Wafer misalignment, breakage, equipment fault	Incorrect orientation or seating	Mechanical poka-yoke, SOP	9	3	5	**135**	Carrier installation practical
C5	Consumable setup	Installs incorrect pad/conditioning component	Defects, process instability	Wrong part; poor identification	Part-number verification, approved materials	8	3	6	**144**	Consumable recognition and verification
C6	Equipment condition	Fails to recognize abnormal wear/leakage	Equipment damage, contamination, safety risk	Inexperience; normalization	Pre-use inspection, PM controls	9	3	6	**162**	Visual abnormality recognition training
C7	Interlock	Attempts to bypass interlock	Serious injury, equipment damage	Misunderstanding; production pressure	Interlocks, access control, policy	10	1	2	**20**	Zero-bypass policy and consequence training
C8	Calibration/status	Uses equipment with overdue calibration or	Incorrect process/metrology results	Does not verify status	Calibration and qualification status	8	2	6	**96**	Status-screen verification exercise

		qualification								

D. Recipe, Parameter, and Process Control

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Controls	S	O	D	RPN	Training Counter measure
D1	Recipe selection	Selects incorrect recipe	Incorrect removal, profile, or process result	Similar recipe names; poor verification	Approved recipe list, access control	10	3	4	**120**	Recipe selection using lot/product attributes
D2	Recipe execution	Manually changes a controlled parameter without authorization	Out-of-spec wafers; process drift	Misunderstanding; shortcut	Recipe permissions, change control	10	2	3	**60**	Parameter-control policy and simulation
D3	Parameter entry	Enters incorrect value/unit	Excessive or insufficient process action	Unit confusion; data-entry error	Limits, interlocks, review	9	3	4	**108**	Unit and parameter interpretation exercise
D4	Recipe verification	Fails to verify recipe against traveler/dispatch	Wrong process condition	Assumes default is correct	MES recipe matching	9	3	5	**135**	Independent verification before start
D5	Process endpoint	Misunderstands endpoint indication	Over-processing or under-processing	Inadequate process knowledge	Endpoint monitoring, alarms	9	3	6	**162**	Endpoint theory + abnormal trend examples
D6	Process timing	Starts/stops process	Thickness/profile	Distraction; poor	Automated sequenci	8	3	4	**96**	Sequence rehearsal

		at wrong time	variation; defects	sequence control	ng, timer controls					and checklist
D7	Parameter drift	Fails to recognize gradual drift	Multiple wafers affected before discovery	Focus on single wafer rather than trend	SPC, control charts, process monitoring	9	4	7	**252**	**Trend recognition is a priority skill**
D8	Unauthorized experimentation	Tries an unapproved adjustment	Uncontrolled process variation	Curiosity; pressure to solve problem	Change-control policy, escalation	10	2	3	**60**	"Do not troubleshoot by changing production parameters"

Key insight: A technician may execute the same incorrect recipe perfectly. **Execution accuracy does not compensate for incorrect process selection.**

E. Slurry, Pad, Conditioning, and Consumables

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Controls	S	O	D	RPN	Training Counter measure
E1	Slurry identification	Uses wrong slurry type	Incorrect process chemistry; wafer defects	Similar containers/labels	Material verification, barcode controls	9	3	4	**108**	Slurry identification and verification
E2	Slurry preparation	Incorrect dilution or preparation	Removal-rate variation, defects, waste	Calculation or procedure error	Approved preparation SOP, checks	9	3	5	**135**	Calculation + supervised preparation
E3	Slurry delivery	Fails to verify flow or delivery	Nonuniformity, scratches, process instability	Blockage, setup error	Flow monitoring, alarms	8	4	6	**192**	Slurry-flow abnormality scenarios
E4	Slurry condition	Uses expired, degraded	Defects, process drift	Poor inventory discipline	Shelf-life and	8	3	6	**144**	Material status

		, or improperly stored slurry			storage controls					verification
E5	Pad identification	Installs wrong pad or pad variant	Removal/ profile variation; defects	Part similarity	Part-number controls	8	3	5	**120**	Pad identification practical
E6	Pad condition	Fails to recognize glazing, damage, or abnormal wear	Nonuniformity, scratches, unstable process	Inadequate visual knowledge	Inspection criteria, PM schedule	8	4	7	**224**	Defect-to-pad-condition correlation training
E7	Conditioning	Incorrect conditioning sequence or status	Pad performance degradation	Skipped step; misunderstanding	Equipment sequence controls	8	3	6	**144**	Conditioning verification checklist
E8	Consumable change	Fails to document change	Poor traceability; repeated process issue	Assumes maintenance records capture it	Consumable log	7	3	7	**147**	Change documentation audit
E9	Contamination	Introduces foreign material into slurry or process area	Defects, contamination, yield loss	Poor handling or housekeeping	Clean handling procedures	9	3	6	**162**	Contamination-source identification exercise

F. Wafer Handling, Transfer, and Contamination Control

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Controls	S	O	D	RPN	Training Counter measure
F1	Wafer loading	Loads wafer incorrectly	Wafer damage, misalignment,	Poor technique	Robot/handler SOP,	9	3	4	**108**	Demonstrate-return-demonstr

			equipment fault		supervised training					ate loading
F2	Wafer unloading	Removes wafer incorrectly	Breakage, scratches, contamination	Rushing; poor technique	Handling SOP, tools	9	3	4	**108**	Controlled unloading practice
F3	Wafer orientation	Places wafer in incorrect orientation	Process or inspection error	Inadequate visual confirmation	Orientation markings, fixtures	8	3	5	**120**	Orientation verification test
F4	Wafer surface contact	Touches or contacts active surface	Scratches, contamination, defects	Improper handling	Gloves, handling tools, SOP	8	4	4	**128**	Surface-contact awareness drill
F5	Wafer transfer	Drops or mishandles wafer	Wafer breakage, equipment contamination	Poor grip; awkward transfer	Approved carriers, handling rules	9	3	4	**108**	Transfer practice with supervised observation
F6	Carrier/FOUP	Uses wrong or contaminated carrier	Lot contamination or mix-up	Poor carrier control	Carrier ID, cleanliness controls	9	3	5	**135**	Carrier identity and cleanliness check
F7	Wet-to-dry transfer	Allows improper drying or transfer sequence	Watermarks, corrosion, contamination	Sequence error	Approved post-CMP flow	8	3	6	**144**	Post-process transfer sequence training
F8	Lot segregation	Combines or stages lots incorrectly	Lot mix-up, traceability failure	Workspace organization failure	Designated staging, barcode controls	9	3	5	**135**	One-lot-at-a-time discipline
F9	Damaged wafer	Fails to identify/r	Further damage,	Fear of reporting;	Damage criteria	9	3	6	**162**	Damage recogniti

		eport damage	equipment contamination	poor criteria	and escalation					on and stop-work authority

G. Process Monitoring and In-Process Control

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Controls	S	O	D	RPN	Training Counter measure
G1	Monitor equipment	Fails to observe abnormal status	Equipment or process issue continues	Distraction; task fixation	Equipment displays, alarms	8	4	5	**160**	Monitoring expectations by process phase
G2	Monitor process	Ignores alarm or warning	Process continues out of control	Alarm fatigue; uncertainty	Alarm response SOP	9	3	4	**108**	Alarm classification and response drill
G3	SPC review	Does not review required control data	Drift not detected	Assumes process is stable	SPC rules, shift review	9	4	7	**252**	SPC interpretation qualification
G4	Trend interpretation	Treats abnormal trend as one-off noise	Multiple wafers affected	Weak statistical/process understanding	Trend limits, engineering support	9	4	7	**252**	“Trend vs. single point” case studies
G5	Inspection result	Misreads or misunderstands result	Defect escapes; wrong disposition	Inadequate inspection training	Inspection standards, peer review	9	3	6	**162**	Defect recognition and disposition quiz
G6	Process interruption	Restarts without confirming safe state	Repeat fault, wafer damage, unsafe condition	Pressure to resume	Restart SOP, supervisor approval	9	3	5	**135**	Restart decision tree
G7	Sampling	Skips or incorrectl	Delayed detection	Time pressure;	Sampling plan,	8	3	7	**168**	Sampling rationale

		y performs required sample	of process issue	unclear sampling plan	MES prompts					and execution check
G8	Data integrity	Records incorrect or incomplete process data	Poor decisions; loss of genealogy	Manual entry error	Electronic records, review	8	3	6	**144**	Data-entry and verification training

H. Inspection, Metrology, and Defect Response

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Controls	S	O	D	RPN	Training Counter measure
H1	Inspection setup	Uses incorrect inspection program	Wrong or incomplete defect detection	Similar program names	Program verification	8	3	6	**144**	Program-selection verification
H2	Inspection execution	Skips required inspection	Defects escape	Rushing; misunderstood requirement	MES/inspection checklist	9	3	6	**162**	Inspection completion gate
H3	Defect classification	Misclassifies scratches, particles, stains, or nonuniformity	Wrong corrective action	Limited experience	Defect library, mentoring	8	5	7	**280**	**Image-based defect classification training**
H4	Result interpretation	Misinterprets measurement or inspection output	Incorrect lot disposition	Weak metrology knowledge	Acceptance criteria, engineering review	9	3	7	**189**	Metrology interpretation qualification
H5	Out-of-spec result	Continues processin	Additional wafers affected	Unclear stop criteria	Hold/escalation	10	3	4	**120**	Explicit “stop and

		g without escalation			procedure					notify" triggers
H6	Defect trend	Fails to recognize repeated defect signature	Systemic issue persists	Focus on individual lot	Defect trending, SPC	9	4	8	**288**	Defect signature recognition and trend review
H7	Disposition	Releases questionable material	Defective material moves downstream	Pressure, uncertainty	Quality release controls	10	2	4	**80**	Release authority and hold rules
H8	Retest	Repeats test without understanding cause	Masks issue; wastes time	"Try again" mentality	Retest criteria, engineering guidance	8	3	7	**168**	Retest decision tree

Highest training concern: The technician does not need to become a process engineer immediately—but must recognize **when a pattern is abnormal and when to stop.**

I. Alarm, Abnormal Event, and Emergency Response

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Controls	S	O	D	RPN	Training Counter measure
I1	Alarm response	Acknowledges alarm without understanding it	Hazard or process fault continues	Alarm unfamiliarity	Alarm response SOP	9	3	5	**135**	Alarm-to-action mapping
I2	Equipment fault	Attempts unauthorized troubleshooting	Injury, equipment damage, extended downtime	Overconfidence	Authorized troubleshooting boundaries	10	2	3	**60**	"What technician may / may not do" matrix
I3	Leak detection	Fails to recognize	Chemical exposure,	Poor visual	Leak detection	10	3	5	**150**	Leak recogniti

		or report leak	contamination, equipment damage	awareness	and escalation SOP					on scenarios
I4	Wafer breakage	Continues operating after breakage	Additional damage, contamination, equipment fault	Unclear response	Breakage response SOP	9	3	4	**108**	Wafer-break response simulation
I5	Unexpected noise/vibration	Ignores abnormal equipment behavior	Mechanical damage, process failure	Normalization of deviance	Abnormal condition criteria	9	3	7	**189**	Audio/visual abnormality examples
I6	Power/utility interruption	Restarts equipment prematurely	Equipment fault, wafer damage	Incomplete recovery procedure	Recovery SOP, authorization	9	2	5	**90**	Recovery decision-tree drill
I7	Chemical alarm	Treats alarm as nuisance	Exposure or chemical event	Alarm fatigue	Safety interlocks and response rules	10	2	3	**60**	Critical alarm recognition
I8	Escalation	Delays notifying lead/engineer	Small event becomes major event	Fear of blame; uncertainty	No-blame reporting, escalation matrix	9	4	6	**216**	"Early escalation is successful behavior" training

J. Documentation, Handoff, and Communication

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Controls	S	O	D	RPN	Training Countermeasure
J1	Logbook/MES	Fails to record	Loss of traceabilit	Assumes memory	Electronic logs,	8	4	6	**192**	Documentation

		required activity	y; repeated error	is sufficient	audit					checklist
J2	Documentation	Enters incorrect lot, tool, or parameter information	Incorrect genealogy; poor investigation	Data-entry error	Required fields, verification	8	3	6	**144**	Read-back and record verification
J3	Handoff	Fails to communicate abnormal condition	Next shift repeats unsafe or incorrect action	Incomplete handoff	Shift handoff template	9	4	7	**252**	Structured **SBAR-style technical handoff**
J4	Handoff	Communicates verbally but not electronically	Information lost	Assumes verbal transfer is enough	Required documentation	8	4	6	**192**	"If it matters, document it"
J5	Escalation	Does not report near miss	Systemic risk remains	Fear of blame; normalization	Near-miss reporting	8	3	8	**192**	Near-miss reporting culture
J6	Work completion	Closes task without confirming final state	Incomplete work; next operator inherits issue	Task-focused behavior	Completion checklist	7	4	6	**168**	End-of-task verification
J7	Communication	Does not ask clarifying question	Wrong action	Fear of appearing inexperienced	Mentoring, psychological safety	8	5	6	**240**	Normalize "pause and verify"

K. Cleaning, Maintenance Support, and Housekeeping

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Controls	S	O	D	RPN	Training Countermeasure

K1	Routine cleaning	Skips required cleaning step	Contamination, defects, equipment degradation	Time pressure	Cleaning SOP, checklist	8	4	6	**192**	Cleaning verification checklist
K2	Cleaning materials	Uses wrong material/tool	Surface damage, contamination	Similar supplies	Approved-material controls	8	3	5	**120**	Cleaning-material identification
K3	Maintenance support	Performs task beyond authorization	Injury, equipment damage	Unclear boundaries	Lockout/tagout, authorized maintenance	10	2	3	**60**	Role-boundary training
K4	Lockout/tagout	Fails to follow energy-isolation rules	Serious injury or fatality	Inadequate safety understanding	LOTO training and authorization	10	1	2	**20**	Formal LOTO qualification
K5	Housekeeping	Leaves slurry, water, or materials in unsafe condition	Slip, contamination, equipment issue	Poor closure discipline	Housekeeping standards	8	4	4	**128**	End-of-task area reset
K6	Waste handling	Disposes of chemical/process waste incorrectly	Exposure, environmental noncompliance	Poor waste segregation knowledge	Waste SOP, labeled containers	10	2	4	**80**	Waste segregation practical
K7	Maintenance observation	Fails to report recurring equipment issue	Repeat downtime, process instability	Assumes someone else knows	Maintenance notification system	8	4	7	**224**	“Report symptoms, not diagnoses” training

L. Human Factors, Qualification, and Work Discipline

ID	Process Step	Potential Failure Mode	Potential Effect	Potential Cause	Controls	S	O	D	RPN	Training Counter measure
L1	Learning	Memorizes steps without understanding purpose	Poor adaptation to abnormal conditions	Checklist-only training	Theory + practical training	8	5	7	**280**	Explain **why** each critical step exists
L2	Qualification	Performs task before qualification is complete	Quality or safety event	Staffing pressure; unclear authorization	Training matrix, signoff	10	2	3	**60**	Qualification gates
L3	Production pressure	Skips verification to save time	Wrong lot, wrong recipe, defect escape	Perceived productivity pressure	Supervisor expectations, audits	9	4	6	**216**	Teach that correct execution is productivity
L4	Overconfidence	Stops asking questions too early	Hidden errors, unsafe decisions	Early success; false confidence	Mentoring, audits	8	4	7	**224**	Progressive autonomy with observation
L5	Underconfidence	Avoids necessary action or escalation	Delays, unresolved abnormalities	Fear of blame	Clear authority and support	8	4	6	**192**	Decision confidence training
L6	Fatigue	Misses verification or alarm	Quality/safety risk	Shift work, inadequate rest	Work-rest policy, supervision	8	4	6	**192**	Fatigue awareness and self-reporting
L7	Distraction	Loses sequence or lot context	Wrong step, wrong lot,	Interruptions, multitasking	Standard work, visual cues	8	5	6	**240**	Interruption recovery procedure

			handling error							
L8	Normalization of deviance	Accepts small abnormalities as normal	Gradual deterioration; major event	"It always does that" culture	Escalation rules, audits	9	4	8	**288**	Abnormality recognition and stop-work authority
L9	Peer influence	Copies an unsafe shortcut	Repeated unsafe behavior	Informal workarounds	Leadership modeling, audits	9	3	7	**189**	Standard-work adherence training
L10	Feedback	Does not seek or accept coaching	Repeated failure; slow development	Defensive mindset; unclear feedback	Coaching and qualification reviews	7	4	7	**196**	Weekly feedback loop

5. Highest-Priority Failure Modes

The following failures deserve special attention because they combine **high consequence**, **reasonable likelihood**, or **poor detectability**.

Priority	Failure Mode	RPN	Why It Matters
1	Defect trend not recognized	288	Multiple wafers may be affected before action
2	Normalization of deviance	288	Small abnormalities become accepted as normal
3	Defect misclassification	280	Incorrect classification leads to incorrect action
4	Learning steps without understanding purpose	280	Technician cannot adapt safely to abnormal conditions
5	Process drift not recognized	252	Gradual drift can affect multiple lots
6	Incomplete technical handoff	252	Next shift may repeat the same failure
7	Failure to ask clarifying question	240	Uncertainty becomes an incorrect action
8	Distraction / interruption error	240	Common source of sequence and identification errors

9	Escalation delay	216	Minor abnormalities can become major events
10	Skipping verification under production pressure	216	Creates latent process and traceability failures

Important interpretation

These rankings are **training-model priorities**, not actual Samsung production risk rankings. Actual occurrence and detection scores should be established using:

- Internal incident and near-miss data
- Equipment alarm history
- Scrap/rework data
- Defect Pareto charts
- Training qualification results
- Audit findings
- Technician feedback
- Process engineering input

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6. The New Hire’s Most Dangerous Failure Pattern

A single mistake is not always the main problem. The more dangerous pattern is a **chain of small failures**.

Example: Wrong recipe reaches production

```
New hire receives assignment
        ↓
Does not verify lot/product identity
        ↓
Selects similar-looking recipe
        ↓
Assumes default recipe is correct
        ↓
Starts equipment
        ↓
Does not review initial process indicators
        ↓
Fails to recognize abnormal trend
        ↓
Processes additional wafers
        ↓
Inspection detects out-of-spec result
        ↓
Multiple wafers require hold/review/rework/scrap
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FMEA lesson

The goal is not merely:

> “Teach the technician to select the correct recipe.”

The goal is:

> **Build multiple independent barriers so that one human error does not become a production event.**

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7. Recommended Training Model: 6 Layers of Protection

Layer 1 — Knowledge

The technician understands:

- CMP purpose and basic process physics
- Wafer structure and planarization objectives
- Slurry, pad, conditioning, and polishing concepts
- Common defect mechanisms
- Equipment architecture and process flow
- Safety and chemical hazards
- Why critical parameters matter

Failure prevented: "I followed the steps but did not understand what I was doing."

Layer 2 — Standard Work

The technician can consistently execute:

- Gowning and cleanroom entry
- Lot identification
- Tool readiness checks
- Recipe verification
- Wafer loading/unloading
- Slurry and consumable verification
- Inspection and documentation
- End-of-task closure

Failure prevented: Variation caused by inconsistent execution.

Layer 3 — Recognition

The technician can recognize:

- Abnormal equipment sounds, vibration, leakage, or status
- Incorrect material or recipe
- Wafer damage
- Unusual slurry behavior
- Pad/conditioning abnormalities
- Defect signatures
- SPC trends
- Unexpected process results

Failure prevented: Abnormal conditions continuing unnoticed.

Layer 4 — Decision-Making

The technician knows when to:

- Continue
- Pause
- Hold the lot
- Stop the process
- Notify the lead
- Escalate to engineering
- Request maintenance
- Initiate safety response

Failure prevented: "I noticed something wrong but did not know what to do."

Layer 5 — Communication

The technician can clearly communicate:

- What happened
- Which lot/tool was affected
- When it happened
- What was observed
- What action was taken
- What remains uncertain
- Who was notified
- What the next shift must not assume

Failure prevented: Repeated errors caused by incomplete handoff.

Layer 6 — Feedback and Continuous Improvement

The technician participates in:

- Daily coaching
- Qualification reviews
- Defect Pareto discussions
- Near-miss reporting
- Corrective-action learning
- Refresher training
- Cross-shift learning
- Periodic requalification

Failure prevented: Repeated failures becoming normalized.

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8. Suggested 90-Day Training Roadmap

Phase 1: Days 1–14 — Safety and Controlled Familiarization

Objective: No unsafe actions; understand the environment.

Training Area	Qualification Evidence
Cleanroom entry and gowning	Direct observation
Chemical safety and SDS	Written/practical test
Emergency response	Scenario drill
Equipment area orientation	Walkthrough
Lot and carrier identification	Identification test
Basic CMP process flow	Knowledge assessment
Stop-work and escalation rules	Scenario assessment

Release condition: The technician can identify unsafe conditions and knows when not to proceed.

Phase 2: Days 15–30 — Standard Work Under Direct Supervision

Objective: Execute routine tasks consistently.

Training Area	Qualification Evidence
Tool readiness	Checklist completion
Recipe verification	Zero-error observed repetitions
Wafer handling	Practical demonstration
Consumable verification	Identification test
Routine process execution	Supervisor observation
Documentation	Audit with no critical omissions
Normal alarm response	Scenario drill

Release condition: The technician performs routine work without skipping critical checks.

Phase 3: Days 31–60 — Process Awareness and Abnormality Recognition

Objective: Recognize when normal work becomes abnormal.

Training Area	Qualification Evidence
CMP defect fundamentals	Defect quiz
Pad/slurry abnormality recognition	Image/sample exercise
SPC and trend interpretation	Case-study test
Equipment abnormality recognition	Scenario drill
Lot hold and escalation	Decision-tree test
Handoff communication	Structured handoff evaluation

Release condition: The technician can identify an abnormality and select the correct escalation path.

Phase 4: Days 61–90 — Controlled Autonomy

Objective: Perform qualified work independently while maintaining escalation discipline.

Training Area	Qualification Evidence
Routine assigned production work	Audit / observation
Multi-step task execution	Error-free qualification runs
Abnormal event response	Simulation
Defect classification	Minimum accuracy threshold
Documentation and handoff	Audit
Safety and quality behavior	Supervisor signoff
Independent decision boundaries	Scenario assessment

Release condition: The technician demonstrates reliable execution, recognition, communication, and escalation—not merely speed.

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9. Qualification Gate Model

A new hire should not be considered "trained" merely because they completed classroom material.

Use four qualification gates:

Gate	Question	Evidence
G1 — Know	Can the technician explain the task and hazards?	Written/oral assessment
G2 — Show	Can the technician demonstrate the task correctly?	Direct observation
G3 — Recognize	Can the technician identify abnormal conditions?	Scenario/defect test
G4 — Decide	Can the technician make the correct stop/escalate decision?	Decision simulation

Qualification principle

> **Do not grant independent execution authority until the technician can both perform the normal task and respond correctly when the task is no longer normal.**

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10. FMEA-to-Training Traceability Matrix

This is the most useful part for building a training system.

FMEA Risk	Training Module	Practical Assessment	Failure-Proofing Control
Wrong lot	Lot traceability	Identify and verify simulated lots	Barcode + two-point verification
Wrong recipe	Recipe control	Select correct recipe from scenarios	Restricted recipe access

Incorrect wafer handling	Wafer handling	Load/unload demonstration	Standard carrier/handling method
Chemical exposure	Chemical safety	Spill-response scenario	PPE, interlocks, escalation
Slurry error	Consumable control	Identify material and status	Barcode, label, inventory control
Pad abnormality	Consumable condition	Compare normal vs. abnormal examples	Inspection checklist
Process drift	SPC	Interpret control chart scenarios	Automated alerts + review
Defect escape	Inspection	Classify defect images	Acceptance criteria + peer review
Alarm mishandling	Alarm response	Choose correct action	Alarm response matrix
Incomplete handoff	Communication	Deliver structured handoff	Required handoff fields
Unauthorized adjustment	Change control	Decide what may be changed	Access restrictions
Normalization of deviance	Safety culture	Identify unsafe “normal” behavior	Stop-work authority
Failure to escalate	Decision-making	Select escalation level	Clear escalation matrix
Documentation error	Data integrity	Complete simulated record	Required fields + audit

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11. Recommended Daily BKM — Best Known Method

CMP Technician 2: “STOP–VERIFY–EXECUTE–CONFIRM–REPORT”

1. STOP

Before acting, pause long enough to establish the task.

- What am I being asked to do?
- Is the equipment released?
- Is the lot correct?
- Is the process authorized?
- Are there any abnormal conditions?

2. VERIFY

Confirm the critical inputs.

- Correct lot / carrier
- Correct tool / chamber
- Correct recipe
- Correct consumables
- Correct process status
- Correct PPE and safety conditions

3. EXECUTE

Follow the approved standard work.

- No unauthorized shortcuts
- No unapproved parameter changes
- No bypassing interlocks
- No improvisation around chemical or equipment controls

4. CONFIRM

Verify the result and equipment state.

- Did the process complete normally?
- Are the indicators within expected conditions?
- Is the wafer/lot status correct?
- Are inspection or sampling requirements complete?
- Is the equipment ready for the next action?

5. REPORT

Communicate and document.

- Record required information
- Report abnormality
- Place material on hold when required
- Notify the appropriate person
- Provide a complete handoff

> **A good technician does not hide uncertainty. A good technician makes uncertainty visible early.**

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12. Supervisor Coaching Model

A new CMP Technician 2 should be evaluated on more than production output.

Balanced performance scorecard

Category	Suggested Weight	What to Observe
Safety compliance	25%	PPE, chemical handling, stop-work behavior
Process accuracy	20%	Correct tool, lot, recipe, sequence
Quality awareness	20%	Inspection, defect recognition, hold decisions
Equipment discipline	10%	Readiness checks, alarms, abnormality reporting
Documentation	10%	Traceability and accurate records
Communication	10%	Handoff, escalation, questions
Learning behavior	5%	Coachability, curiosity, improvement

Do not allow high production speed to compensate for unsafe or unreliable behavior.

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13. Example Training Scenario: The “Almost Normal” CMP Event

Scenario

A new technician notices:

- Slurry flow appears slightly different from the normal visual pattern.
- The tool has not generated a critical alarm.
- The first wafer’s result is within specification.
- The next wafer shows a small change in measured performance.
- A more experienced operator says, “It sometimes does that.”

Possible novice failure

> Continues processing because there is no critical alarm and the first result passed.

Correct trained response

1. Recognize that the condition may represent a developing trend.
2. Verify the approved monitoring requirements.
3. Pause or hold according to the applicable SOP.
4. Notify the designated lead/engineering contact.
5. Document the observation and affected lot/tool.
6. Do not independently adjust controlled parameters.
7. Resume only when authorized and the required checks are complete.

FMEA failures being tested

- G3: Failure to monitor
- G4: Failure to recognize trend
- E3: Slurry delivery abnormality
- I8: Escalation delay
- L8: Normalization of deviance
- J3: Incomplete handoff

This is the kind of scenario that separates a technician who memorizes procedures from one who can protect the process.

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14. The 12 Core Competencies to Train

A complete CMP Technician 2 training model should establish competency in:

1. **Cleanroom discipline**
2. **Chemical and equipment safety**
3. **Lot and wafer traceability**
4. **Equipment readiness**
5. **Recipe and parameter control**
6. **Wafer handling**
7. **Slurry, pad, and consumable management**
8. **Process monitoring**
9. **Defect and metrology awareness**
10. **Alarm and abnormal-event response**

1. **Documentation and shift handoff**
2. **Stop-work, escalation, and continuous improvement**

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15. Final FMEA Conclusion

The most important failure mode for a new CMP Technician 2 is not simply:

> **"Makes a mistake."**

It is:

> **"Makes a mistake, fails to recognize it, continues processing, and does not communicate it."**

Therefore, the strongest training model must build **four capabilities simultaneously**:

Execute correctly

Follow the approved process.

Recognize abnormality

Know what normal looks like—and what does not.

Make the right decision

Continue, pause, hold, stop, or escalate appropriately.

Communicate clearly

Make the event visible so it does not repeat.

The ultimate training objective

> **Produce a technician who is safe, repeatable, quality-conscious, traceability-driven, and confident enough to stop when something is wrong.**

That is the foundation for a successful first year at Samsung CMP—not merely completing tasks, but becoming a reliable part of the manufacturing control system.