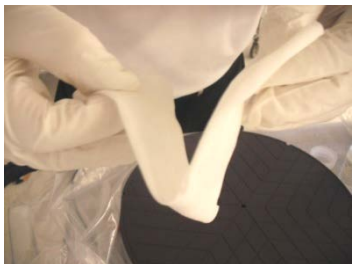


Contamination Control of Manufacturing Practices Using Critical Wipers

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Agenda

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- Introduction to Clean Manufacturing
- Contamination Sources
- Value of Critical Wipe Test
- Critical Wipe Test Procedure
- Case Studies
- Contamination Mapping
- Contamination Risk Assessment
- Summary

Why is Clean Manufacturing Important?

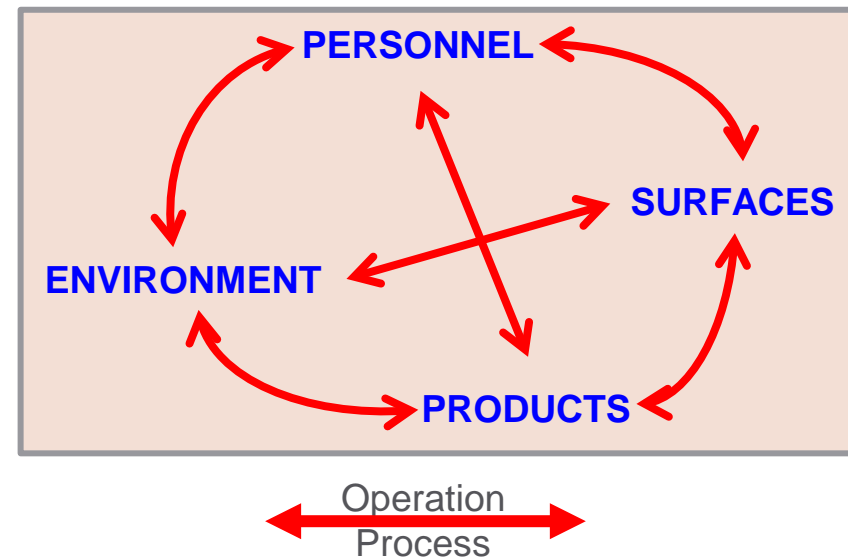
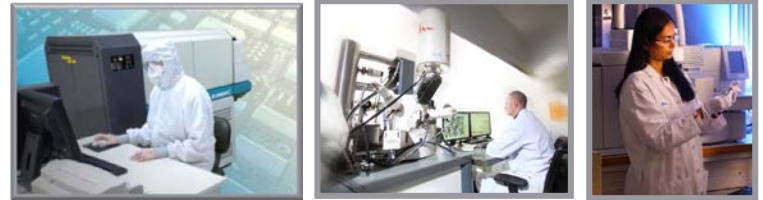
- Clean Manufacturing (Operation) is a **prerequisite** to successful manufacturing
- It is often **overlooked** because it is a culture and it is considered a hindrance to the production process and schedule
- But it is important because it can **impact**:
 - Product line down time
 - Quality and delivery issues
 - Not sharing of Best Practices
 - Planning delays
 - Overtime cost



Clean Manufacturing is a culture of doing it right when no one is looking or checking

What is Needed for Clean Manufacturing?

- **Analytics** provide insight to cleanroom operation and manufacturing that are affecting product quality
- **Monitor and understand the sources of contamination** during cleanroom operations, procedures and activities
- **Contamination control systems** for effective control of physical and environmental parameters and process-to-process interactions
- **Effective wipe down** to improve surface cleanliness by removing contaminants that can originate from
 - People
 - Environment
 - Parts and equipment



Primary Contamination Sources

- **Facility** - gas, water, chemicals and infrastructure
 - **Cleanroom environment** - cleanroom, laminar flow hood
 - **Cleanroom consumables** – garments, gloves, bags, wipes, packaging
- **People** - contamination generator and mechanism for transfer
- **Manufacturing materials** – lubricants, detergents, polishing agents.
- **Supplier** – in addition, any process steps completed by an external supplier must also be evaluated



Value of Critical Wipe Test

- IC devices vary greatly in complexity and application
- When processing advanced IC devices it is important to know the cleanliness state of normal cleanroom operation, before and after facility upgrade and process tool PM
- Critical wipe monitoring can provide valuable insight to the cause of a contamination event affecting the product quality; contamination sources have unique signatures

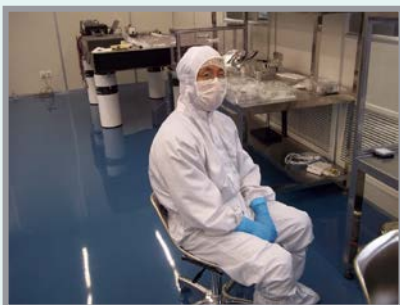


Value of Critical Wipe Test

The metals monitored by Critical Wipe Test can be associated with People, Process Equipment and the condition of the Facility

People

Element	RL
■ Sodium (Na)	10 Total ng/wipe
■ Potassium (K)	50 Total ng/wipe



Process/Equipment

Element	RL
■ Nickel (Ni)	10 Total ng/wipe
■ Iron (Fe)	50 Total ng/wipe
■ Copper (Cu)	10 Total ng/wipe
■ Chromium (Cr)	10 Total ng/wipe
■ Aluminum (Al)	10 Total ng/wipe



Facility

Element	RL
■ Magnesium (Mg)	10 Total ng/wipe
■ Calcium (Ca)	50 Total ng/wipe

Contaminants

Galvanized steel,
Fe, Ni, Zn

People, Na

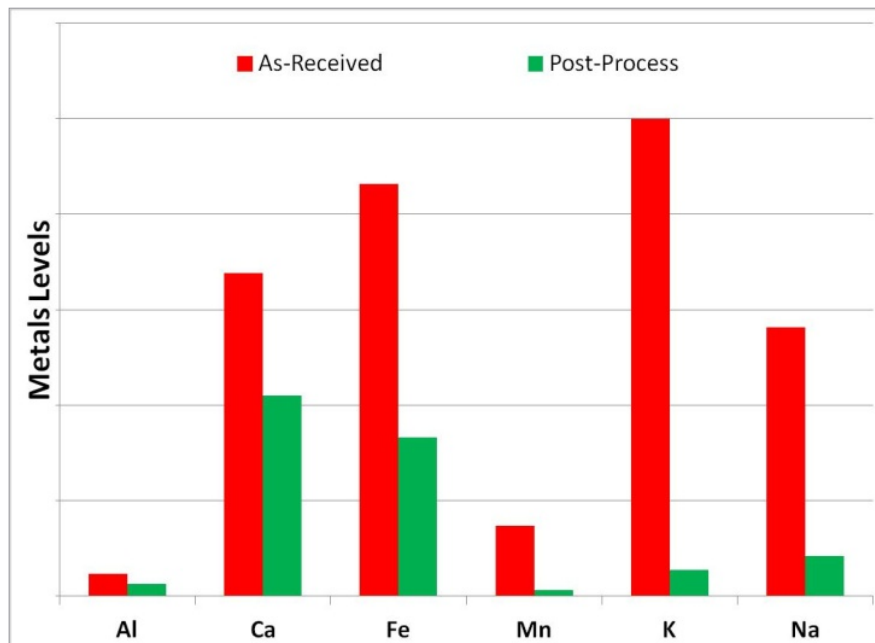
Gypsum = CaSO_4 ,
 Ca/MgCO_3 , Na/KCl,
 FeS_2

Dirt = SiO_2 (quartz),
 CaCO_3 (limestone),
Na, K, Mg, P, S, Fe,
and Mn



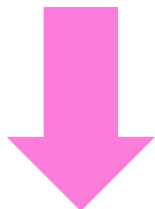
Critical Wipe Test Procedure

- Balazs pre-cleaned wipers are used for critical wipe test
- A surface should be swiped two (2) times in the same location using a fresh wipe surface
- Target surface area sampled is 16 cm²

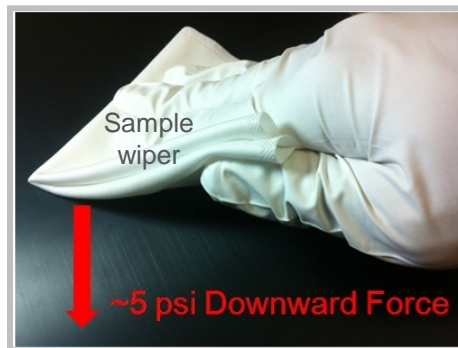


Critical Wipe Test Procedure

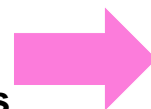
Double glove. Clean
outer glove using IPA.



Critical wiper bottle
containing wiper for
Control and **Sampling**



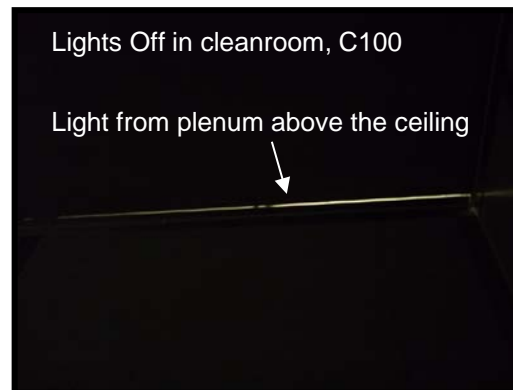
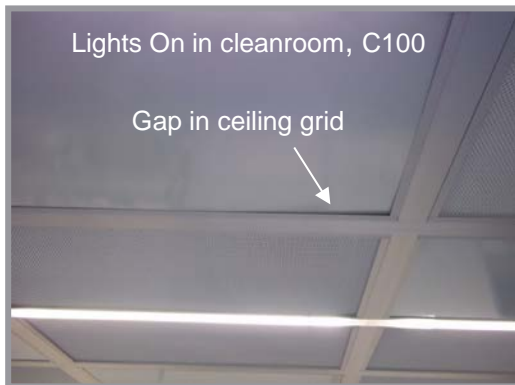
- i. Control wiper to sample cleanroom
environment
- ii. Sample **surfaces** using the Sample Wipers
- iii. Return wipers into their containers



Wipers ready for
ICP-MS analysis

Critical Wipe Test Results from the Wall

- Based on this critical wipe test result, one can establish usage and activity levels; adherence of protocol, e.g. if frequency of wipe down was performed; and track contamination carry over

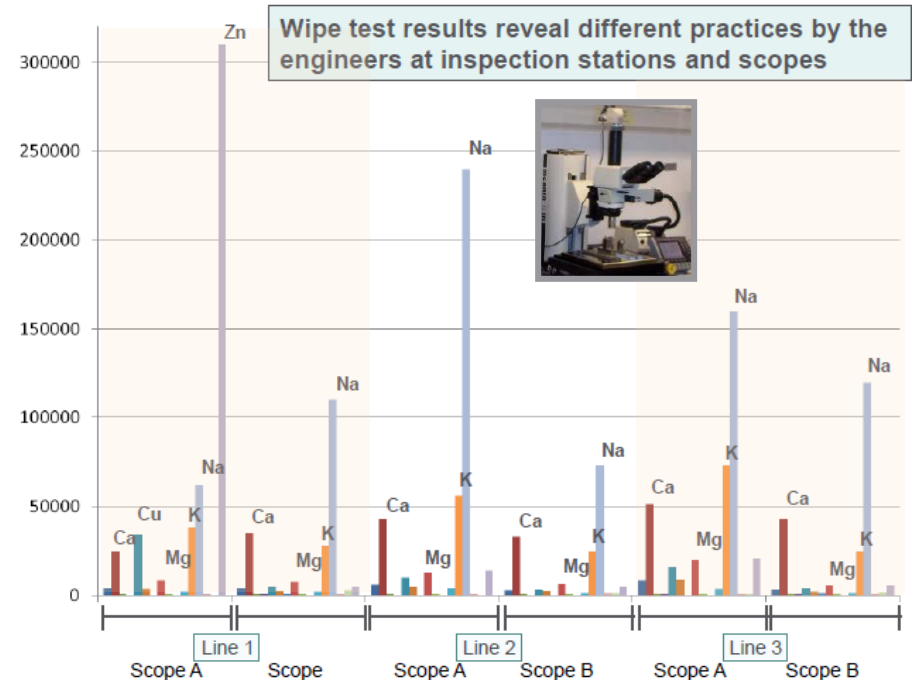


11/13	12/13	Diff.	
1500	2300	800	Ca
80	81	1	
33000	*75000*	42000	
100	90	-10	Fe
490	*900*	410	
2500	*3800*	1300	
120	100	-20	Mg
8400	16000	7600	
7700	12000	4300	
*	50	50	K
170	200	30	
8900	17000	8100	
46000	*74000*	28000	Na
640	740	100	
170	290	120	
2200	3200	1000	
111970	205751	93781	

Gypsum = CaSO_4 ,
Ca/MgCO₃. Na/KCl, FeS₂

Critical Wipe Test Results from Equipment

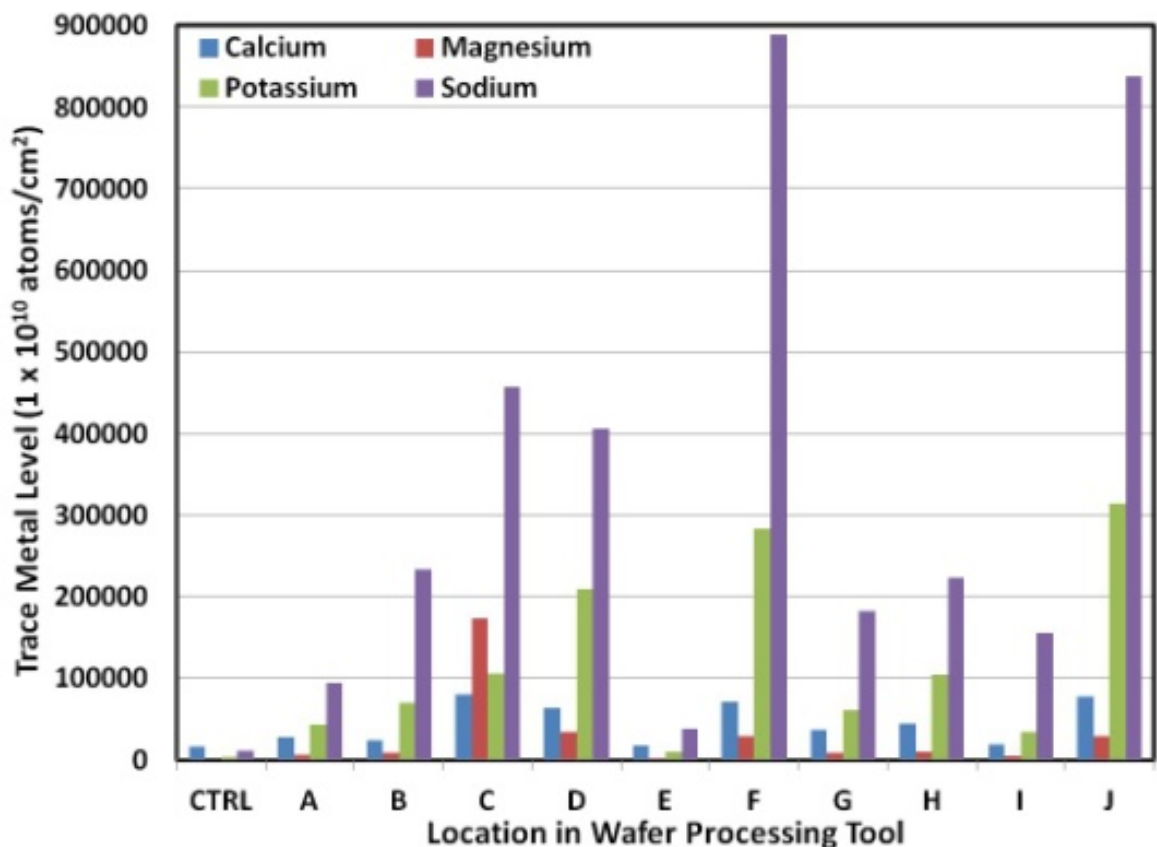
- The critical wipe test result of inspection scopes can establish usage and activity levels; adherence of protocol, e.g. if frequency of wipe down was performed; and contamination carry over



	Start of Shift	Mid-Shift	End of Shift
Working Surfaces	Yes	After lunch	Yes
Equipment Tools	Yes	Prior to use for each step	Yes
Microscopes	Yes	Not required	Yes
Fixtures	Prior to use	Not required	Not required

Critical Wipe Test Results from Process Tool

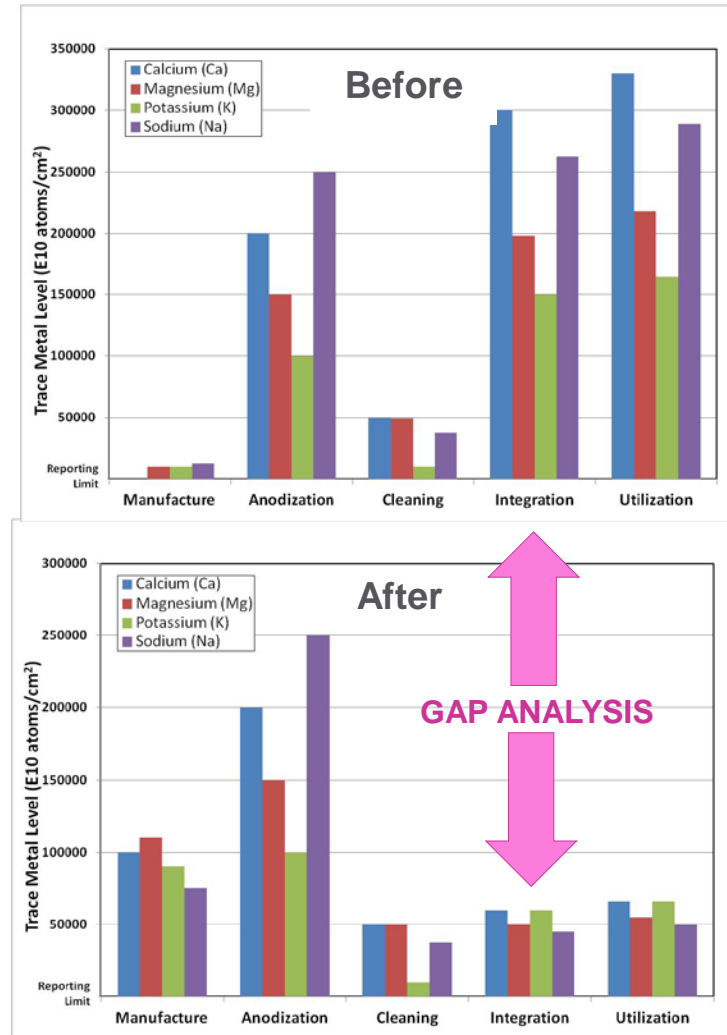
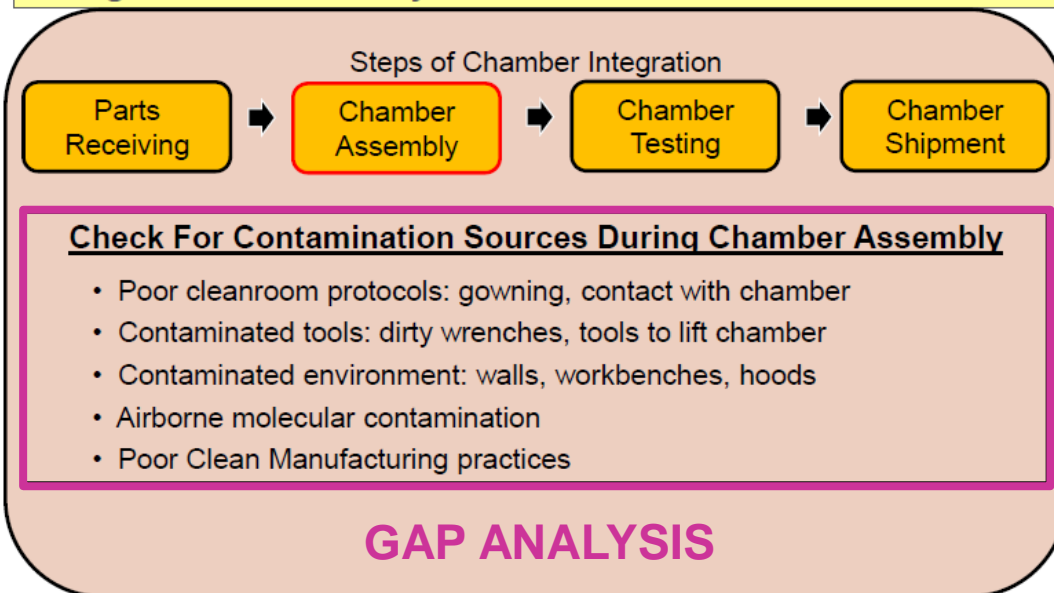
- After PM, critical wipe testing revealed that locations F and J had the highest levels of Sodium and Potassium, while location E had the lowest metals



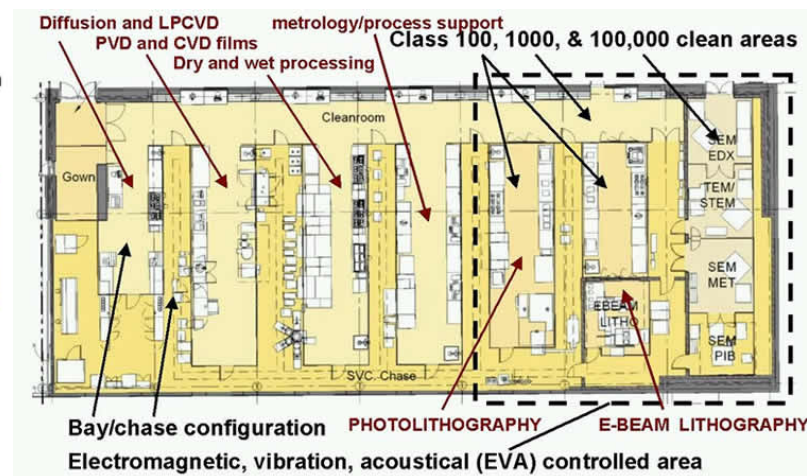
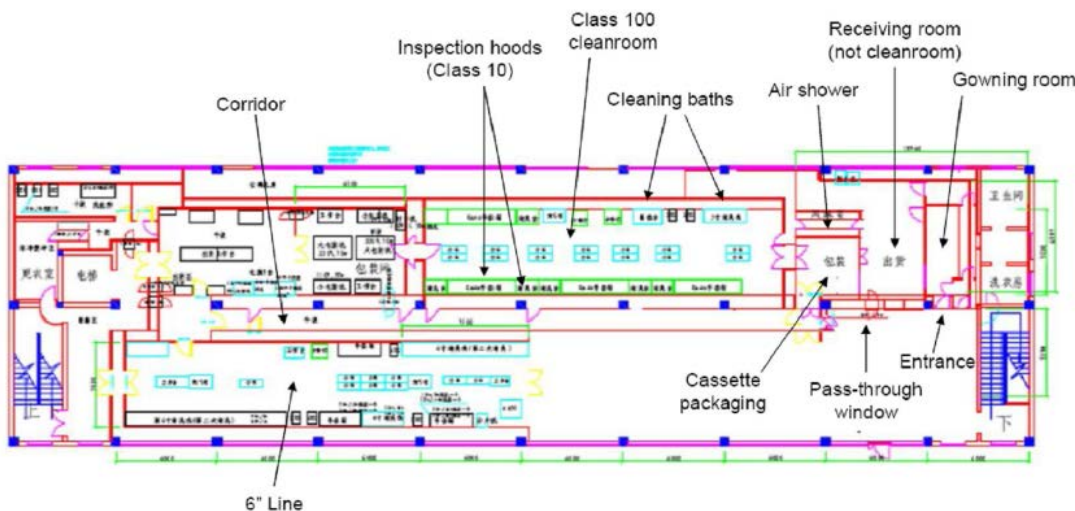
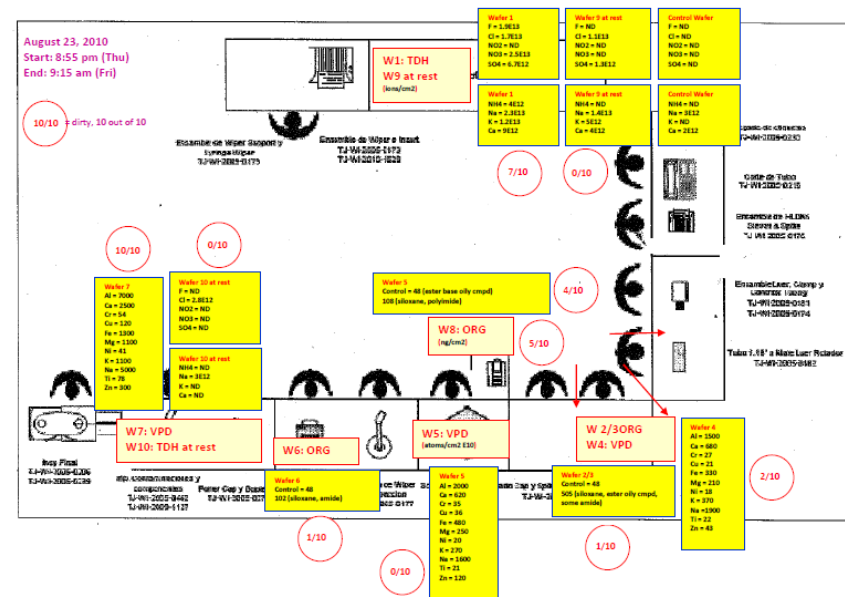
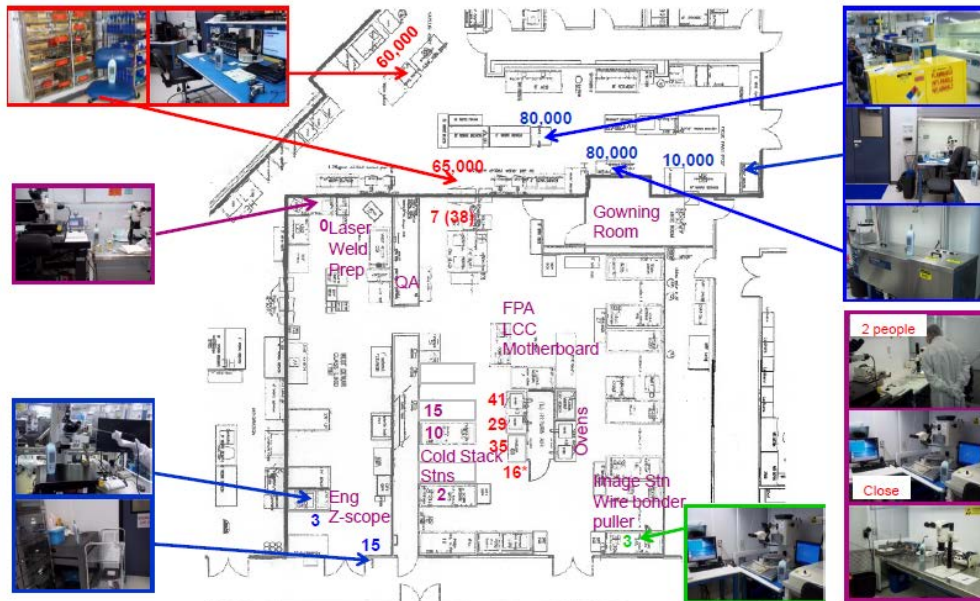
Critical Wipe Test Results of Process Tool Assembly

- Critical wipe testing identified key areas of operations contributing to cross-contamination

Critical Surface Wipe Testing can be used to determine the CAUSE during Chamber Assembly

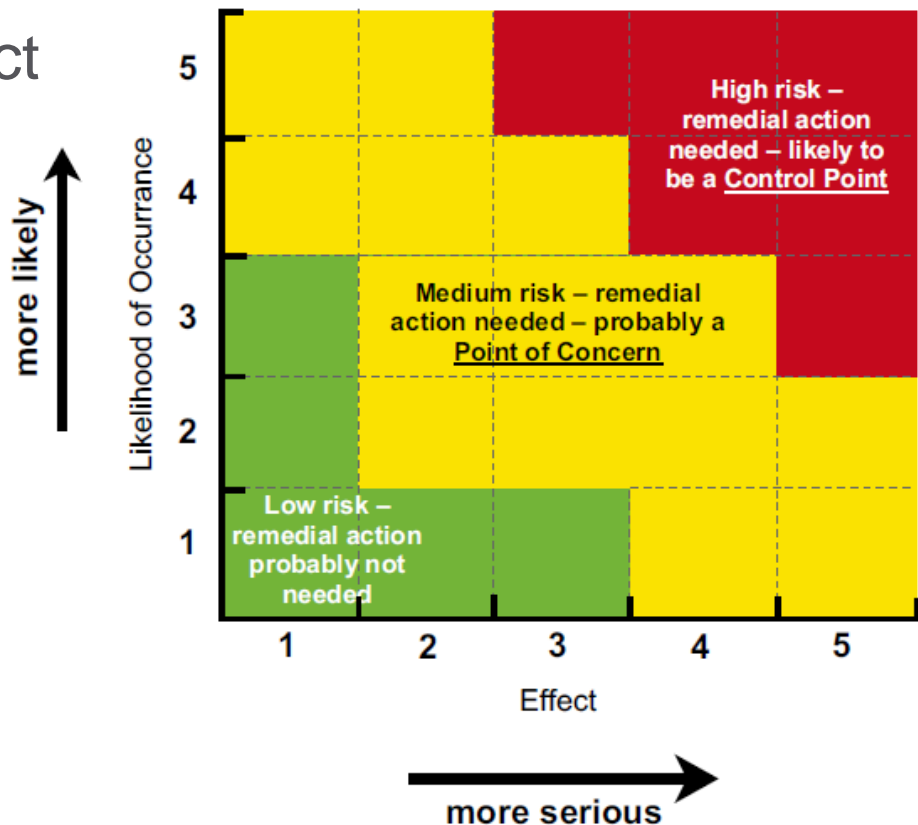


Contamination Mapping of Facility and Operation



Contamination Risk Assessment

- Gap Analysis recommendations and action items concluded from Critical Wipe tests should be reviewed with the intent to calculate their risk posed to the product
- The “**Risk**” is likelihood of the occurrence multiplied by the “**Effect**” of the contamination hazard on the assembly or process step



Summary

- With knowledge of the cleanroom use and how it is maintained, **Critical Wipe Testing is capable of:**
 - Rapid on-site testing for metals on critical surfaces
 - Being performed in a wide range of environments
 - Detect changes in surface metals on a part before and after it undergoes a process, after handling and after cleaning
 - Determine the surface metals on multiple components in wafer processing equipment
 - Quantify metal contamination at various locations in a cleanroom
- Once a historical **Critical Wipe Test data base** has been established, a contamination event (source and cause) will reveal itself