FMS 2023 Automotive Panel – Memory Challenges for AV

Fen Chen, Cruise LLC (GM)

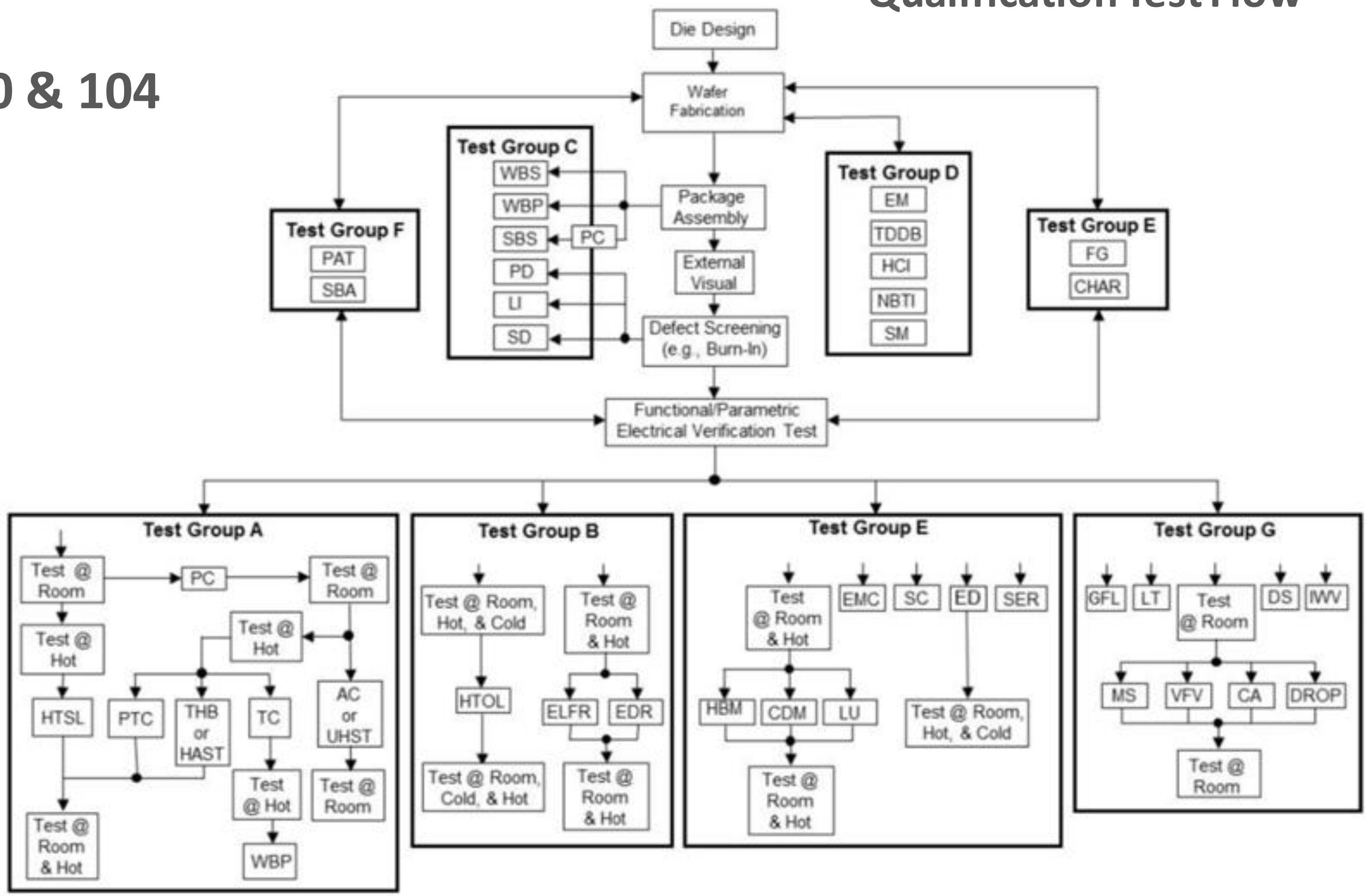
1. **Endurance and Lifespan:** AVs operate for extended periods, accumulating a significant amount of data storage and retrieval.
2. **Data Integrity and Retention:** The reliability of data storage is crucial for autonomous vehicles, especially in safety-critical applications.
3. **Temperature and Environmental Considerations:** Avs are subject to varying temperature extremes and harsh environmental conditions.
4. **Write amplification and Performance:** AVs require frequent write operations, such as logging sensor data, can lead to write amplification. Efficient wear-leveling algorithms and error correction techniques are crucial to mitigate write amplification and maintain optimal performance.
5. **Security and Data Protection:** With autonomous vehicles generating and storing sensitive data, ensuring the security and protection of that data becomes paramount.
6. **Functional Safety Compliance:** Autonomous vehicles are subject to stringent functional safety standards, such as ISO 26262.
7. **Testing and Qualification:** Rigorous testing and qualification processes are necessary to ensure the reliability and adherence to performance specifications of flash memory in autonomous vehicles.

AV Memory Reliability Challenges → Longer POH

Memory Automotive Grade Certification – Passing AEC-Q100 & 104

Key Requirements:
Zero failures from all the tests to demonstrate 99% Rel at 90% CL

AEC-Q100
Qualification Test Flow



Question: Is current AECQ spec adequate to cover memory qualification for AV & EV applications?

Power-on Hour Mission Profile Gap

- Trends: on-time + standby time increase from traditional vehicle → EV → EAV
- Robo-taxi EAV will require 2-3x of life mileages as compared to consumer vehicles.

Service Life = 15 years	131,400 hours /150k miles
Driving - On	10,000 hours
Inhibited - Off	121,400 hours

→

Service Life = 15 years (EV)	131,400 hours /150k miles
Driving - On	8,000 hours
Charging - Standby	30, 000 hours
Inhibited - Standby	67,000 hours
Inhibited - Off	26,400 hours

→

Service Life = 5 years (EAV)	43,800 hours / 400k miles
Driving - On	34,675 hours
Charging - Standby	5,475 hours
Inhibited - Standby	1,825 hours
Inhibited - Off	1,825 hours

Current AECQ Covered POH Target

Note: IC automotive technology: 10-20 years with 15% DF

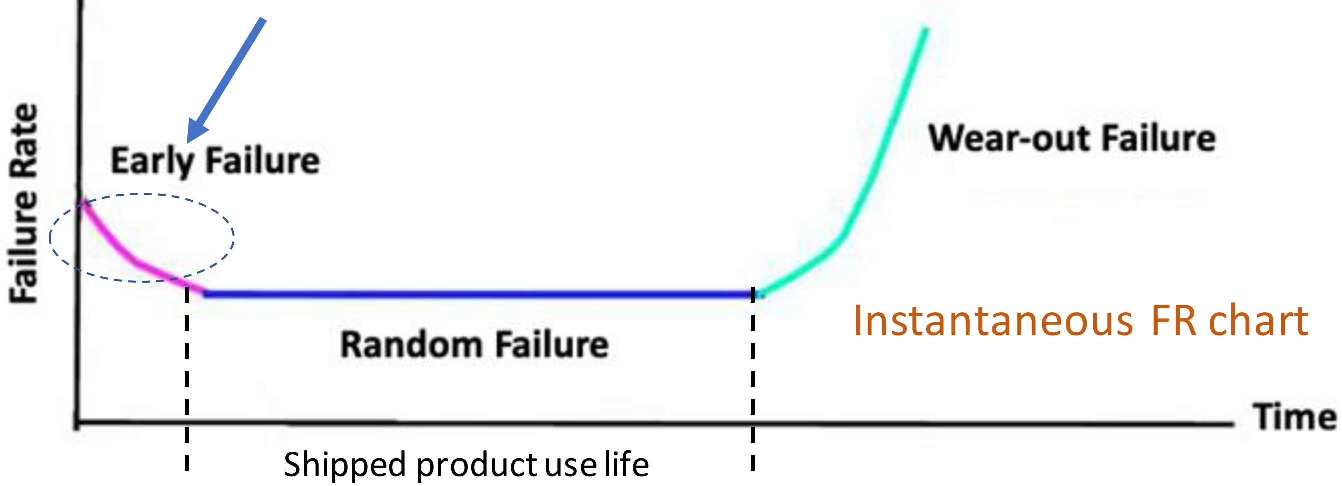
Basic Lifetime Requirement			
	Traditional Vehicle	EV	AV
Lifetime	10-15 years	15 years	5 years
Operational Time	8-10k hours	38.5k hours	40.15k hours
Operational Mileage	150k miles	150k miles	400k miles

* Robo-taxi has long daily operation hours or mileages so reduced vehicle lifetime.
* Robo-taxi AV requires higher reliability to meet operating lifetime & mileages!

A gap exists!

AV Memory Quality Challenges → "Zero DPPM"

For mission critical products, <u>high initial EF/IM failure rate can't be tolerated!</u>

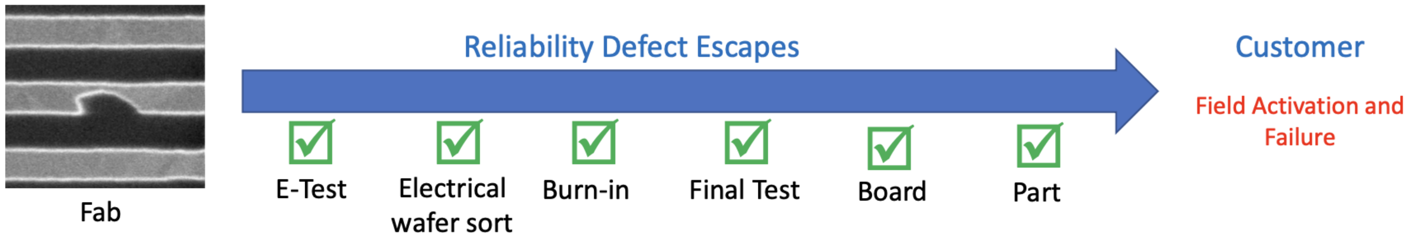


1. Achieving **"Zero Defect"** or virtual 0 DPPM/B
2. Proven reliability enablement from design awareness to process maturity as the "overkill" measures to demonstrate 0 DPPM/B

Source: Gartner

DPPM – Defective Parts Per Million

How to improve to achieve the Zero Defect Goal?



- **Process:** in-line optical defect detection, process variability control, stop excursion – 100% die screen, effective defect inspection, effective metrology
- **Electrical Test:** Go/No-Go decision ambiguity
  - * Latent defects aren't easily detectable at test.
  - * Untestable areas
  - * Coverage versus time-based costs.
- **PAT:** Parametric outlier analysis, but escapes might still happen