

WG Extended Mission Profiles

René Rongen – NXP Semiconductors

AEC RW Hsinchu - October 2026

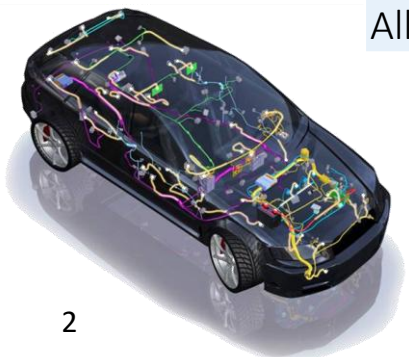


AEC Working Group per October 2026

WG Member	
Name	Company
Carsten Ohlhoff	Aumovio
Matthias Wespel	Aumovio
Friedrich Schröder	Bosch
Ulrich Abelein	Infineon
Mykola Blyzniuk	Melexis
Martin Geiger	Microchip
Imran Ishaq	Microchip
Corinne Bestory	Nexperia
Rene Rongen	NXP
Amy Wu	onsemi
Bassel Atala	STMicroelectronics
Allan Webber	TI

On Copy	
Name	Company
Martina Hommel	Bosch
Gregor Bartsch	Kostal
Tom van Damme	Magna
Arnaud Devos	Melexis
Steven Sibrel	Harman

OEM Contacts	
Name	OEM
Oliver Senftleben	BMW
Karsten Schmidt-Grethe	Volkswagen
Andreas Pfeifer	Volkswagen
Stefan Franz Simon	Audi
Viktor Mueller	Audi
Wolfgang Froehlich	Audi
Heinz Wagensonner	Audi
Raimund Hoell	Audi



AEC WG on Extended Mission Profiles – Charter (1)

In scope:

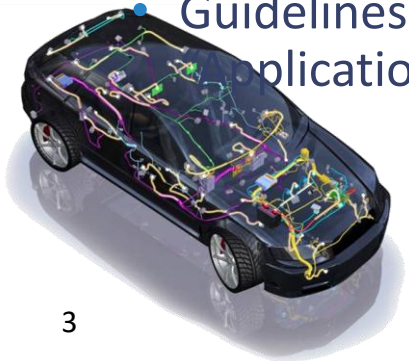
- Classes of Mission Profiles (e.g., via “extension” of the Q100 grade framework) -> Reference Mission Profiles

Not in scope:

- Standardized Extended Mission Profiles

Deliverables:

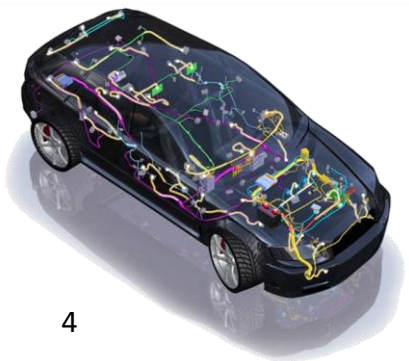
- Classes of Mission Profiles / Reference Mission Profiles
- Qualification Requirements per “Class”
- Guidelines for assessing Extended Mission Profiles (Application of Robustness Validation)
- Guidelines for Tiers 1 how to judge whether a qualified part in “Class xyz” for “Application A” may fit in Application B”



AEC WG on Extended Mission Profiles – Charter (2)

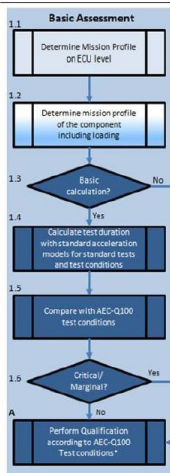
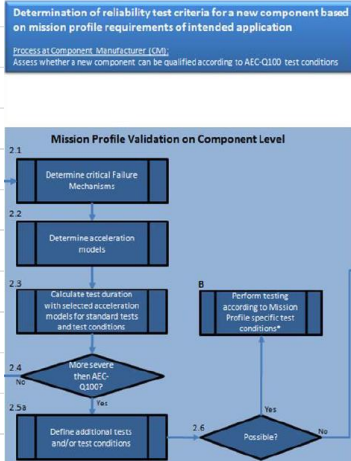
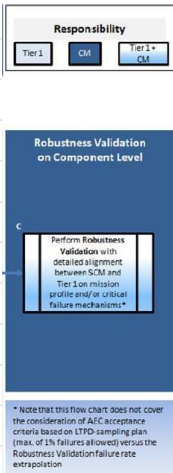
Approach & Schedule:

- Meeting every 3 weeks since kick-off on Feb 5th, 2025
- Report out to AEC, AEC-RW Eu 2025, Oct 8 – 9, 2026
- First Meetings with OEMs for consultation, March 2026
- Report out to AEC, AEC-RW US 2026, Mar 31 - Apr 2, 2026
- Second Meetings with OEMs for consultation, April 2026
- Report out to AEC, AEC-RW Asia 2026, Oct 14 - 15, 2026
- Draft Proposal H2 2026



Framework Proposal 1

- Presented at AEC RW Detroit (Apr 2026)
- Discussed in detail with OEMs resulting some adaptations (First half of 2026)
- Assessment by individual WG members (Aug-Sept 2026)

Class	Basic grade	E-grade	E+ grade
<u>Qualification</u>	HTOL 1000 h at Tamb (Grade) on 3 lots / 77 pcs	- HTOL ≥ 1000 h at $T_j \geq T_{amb,max}$ (Grade) and Parameter Shift Analysis (PSA) on Key Parameters with Extrapolation (until ≥ 2000 h) - Voltage Acceleration allowed on 3 lot / 77 pcs ; 1 lot is used for PSA	- HTOL ≥ 2000 h at $T_j \geq T_{amb,max}$ (Grade) and Parameter Shift Analysis on Key Parameters with Extrapolation (until ≥ 4000 h) - Voltage Acceleration allowed on 3 lot / 77 pcs ; 1 lot is used for PSA
<u>Component Classification</u>	Grade 0 Grade 1 Grade 2 Grade 3	Grade 0E Grade 1E Grade 2E Grade 3E	Grade 0E+ Grade 1E+ Grade 2E+ Grade 3E+
<u>Reliability Specification</u>	n.a.	Design target 55000 h to be used for aging simulation, modeling	Design target 131400 h to be used for aging simulation, modeling MP calculator (Company Specific or AEC Basic Calculator - see below)
<u>Link to Appendix 7 in various O-specs</u>	 1.1 Basic Assessment Determine Mission Profile on ECU level 1.2 Determine mission profile of the component including loading 1.3 Basic calculation? No 1.4 Calculate test duration with standard acceleration models for standard tests and test conditions 1.5 Compare with AEC-Q100 test conditions 1.5a Critical/Marginal? Yes A Perform Qualification according to AEC-Q100 Test conditions*	 Determination of reliability test criteria for a new component based on mission profile requirements of intended application process at Component Manufacture Level Assess whether a new component can be qualified according to AEC-Q100 test conditions 2.1 Determine critical Failure Mechanisms 2.2 Determine acceleration models 2.3 Calculate test duration with selected acceleration models for standard tests and test conditions 2.4 More severe than AEC-Q100? No 2.5a Define additional tests and/or test conditions 2.6 Possible? Yes B Perform testing according to Mission Profile specific test conditions*	 Responsibility Tier 1 CM Tier 1+ CM C Perform Robustness Validation with detailed alignment between SCM and Tier 2 on mission profile and/or critical failure mechanisms* * Note that this flow chart does not cover the consideration of AEC acceptance criteria based on LTPD sampling plan (max. of 1% failures allowed) versus the Robustness Validation failure rate extrapolation

Framework Proposal 1 : Assessment Result

#	Topic/Question	Sum: Agree = 1 Partly Agree = 0 Not agree = -1	# Comments: Comment = 1 No comment = 0	Score: Value Cx / C1	Notes
1	HTOL at $T_j \geq T_{amb,max}$ (Grade) / T_j used to be added to the qual report	4.5	3	0.9	- Next to T_j, additional info is requested, like applied functional mode (with reference to VDE white paper), power dissipation (self heating); note that T_{amb} is defined by the used AEC-Q100 basic grade 0 to 3 - Grand father clause needed for already qualified parts in the past that are EMP capable
2	HTOL $\geq$ 1000 h for E-grade on 1 lot	3	2	0.6	- 1500 h 1 lot if this covers 50% of the MP at least; otherwise longer duration needed - 1 lot is not in line with current Appx 7: change needed - T_j of Grade x may be $\geq T_a$ of grade x+1
3	HTOL $\geq$ 2000 h for E+-grade on 1 lot	-1	2	-0.2	- Large bandwidth: from "agree to "E+ not needed (keep it simple)" - Extending beyond 1000 h should be optional; other data/tests can be complementary - Extended tests should not be considered to cover a MP but only for showing margin



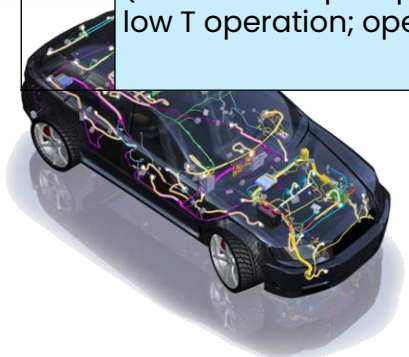
Framework Proposal 1 : Assessment Result (cont'd)

#	Topic/Question	Sum: Agree = 1 Partly Agree = 0 Not agree = -1	# Comments: Comment = 1 No comment = 0	Score: Value Cx / C1	Notes
4	Parameter Shift Analysis on Key Parameters (PSA)	4.5	4	0.9	- Not needed for all parameters - Datasheet should cover aging over life time - Some specific product technology like sensors may need part-to-part PSA
5	PSA $\geq$ 2000 h for E-grade	3	3	0.6	E+ Not needed (keep it simple)
6	PSA $\geq$ 4000 h for E+-grade	-1	4	-0.2	- Large bandwidth: from "agree to "E+ not needed (keep it simple)" - Does not add value unless there is a linear shift e.g., for Chip-Package Interaction or shifts related to wire bond / bump / pillar degradation



Framework Proposal 1 : Assessment Result (cont'd)

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7	E-Grades	4.5	3	0.9	It should be clear that E-Grade is an add on to the normal grade; e.g., E-Grade 1 is the add on to Grade 1
8	E+- Grades	2.5	3	0.5	- Large bandwidth: from "agree to "E+ not needed (keep it simple)" - Supplemented data for already qualified parts (e.g., via white paper
9	Design target 55000 h for E-grade	4.5	4	0.9	- Clarify what is already covered by Q100 today (to justify that 55000 h is a good target for E-Grade) - Prevent confusion with already released technologies/products
10	What details need to be added? (think about split up between high T and low T operation; operation modes	n.a.	5	n.a.	- "Effective high temperature" is needed (e.g., Arrhenius weighted average) - Target at effective low temperature is to be defined (e.g., between 0°C and 20C) for charging & standby - Additional details will make it too complex (e.g., assume max. current) - Derating from other e.g., industrial profiles should be possible
11	Design target 131000 h for E+-grade	2	4	0.4	- Large bandwidth: from "agree to "E+ not needed (keep it simple)"
12	What details need to be added (think about split up between high T and low T operation; operation modes	n.a.	5	n.a.	- Large bandwidth: from "agree to "E+ not needed (keep it simple)" - If introduced: split up hours between high T and low T is sufficient; adding additional details such as operation modes is too complicated - Consider target for technology qualification / level 1 (Group D tests) - Use classical calculators (Hallberg-Peck, Coffin Manson, Arrhenius) - Provide two life limitation situations: high and low T



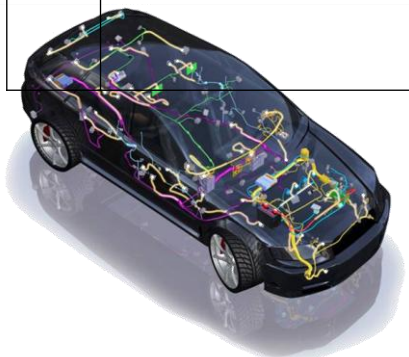
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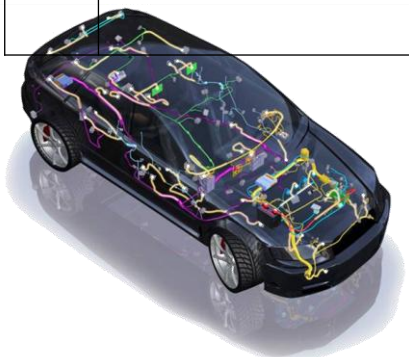
Framework Proposal 1 : Assessment Result (cont'd)

#	Topic/Question	Sum: Agree = 1 Partly Agree = 0 Not agree = -1	# Comments: Comment = 1 No comment = 0	Score: Value Cx / C1	Notes
13	MP calculator concept in general (customer specific with AEC baseline)	5	4	1	- Note that current Table in Appendix 7 of Q100/101/102 is not a calculator but an example - Be aware of confidentiality when it comes to e.g., acceleration/aging models and parameters; agree on a baseline set to be used by all companies - Calculator usage should not be limited to Extended Grade devices
14	AEC Baseline MP Calculator What should it contain?	n.a.	5	n.a.	- (1) voltage acceleration, (2) current acceleration, (3) option for considering duty cycle / frequency (Tj or Ta plus self heating; not Ta solely is not good) - Default AEC parameters or technology (supplier) specific with justification (e.g., for dominating mechanism) - Consider in future to add calculations for other mechanisms (bonding degradation, NVM endurance, data retention)
15	Subdocument for PSA	4.5	4	0.9	- Current ED document is not sufficient - Should include guidelines regarding: parameter selection, drift model / analysis method, extrapolation model (e.g., polynomial), statistical approach, read points, acceptance criteria, mean vs individual drift, example(s) (Example: AEC-Q102 Appendix 5 "Minimum Parametric Test Requirements and Failure Criteria") - Consider vendor declaration in datasheet or white paper - Add guidelines for part-to-part PSA



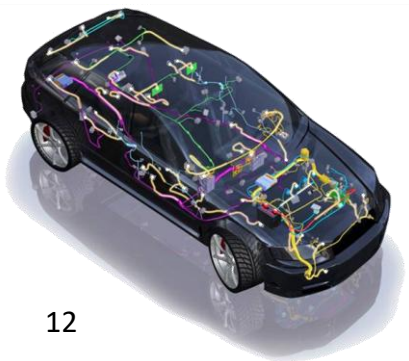
Framework Proposal 1 : Assessment Result (cont'd)

#	Topic/Question	Sum: Agree = 1 Partly Agree = 0 Not agree = -1	# Comments: Comment = 1 No comment = 0	Score: Value Cx / C1	Notes
16	Grade extension for Humidity and/or Thermomechanical and/or High Temperature	1	3	0.2	- If introduced: for each ext grade conditions and pass criteria needed (group A&B) - TC to be considered; especially for devices with high amount of self-heating (GaN)
17	Calculators for Humidity and/or Thermomechanical and High Temperature	1	3	0.2	- TC has the highest prio; fast, short and high number of temp cycle models are needed (100+ kc; wake-up/start) - Use Tj,max for Tmax in passive cycling - HTSL to be considered and include DRET - Humidity may not be needed (binary test)
18	Other comments	n.a.	3	n.a.	- (1) Low temperature portion: qualification requirements are needed, - (2) Voltage acceleration: min Vdd + x%, all voltage domains - Aging simulations: targets needed for aging models in simulation tools (e.g., PPM/PPB for group D tests) - Test Group D to be revisited; connect with EMP Grades and Calculator; consider group D requirements or targets per Failure Mechanism - Links: TDDDB/EM with HTOL data (incl VA); BTI with PSA+Extrapolation; HCI with design aging simulations; SM with HTSL - Pro memory: add calculator for many small temperature swing (power on/off cycles)



Starting Points for Next Proposal

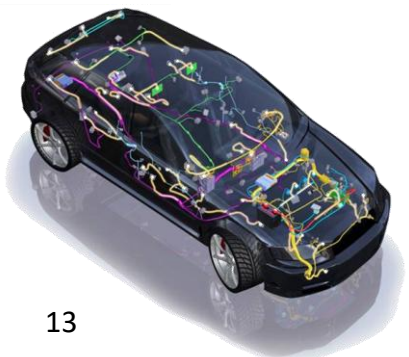
1. Do not require extended HTOL, reporting Tj for HTOL is required
2. Voltage acceleration and parameter shift analysis (with extrapolation) are methods to be used
3. Coverage of most relevant (group-D) mechanisms: design assessment on top of technology assessment
4. Offer a “generic” AEC calculator; but “allow” company specific calculators / model parameters
5. Create document that give guidelines for parameter shift analysis (extrapolation)
6. Challenge: how to standardize anything around aging simulations



E/E+-grade: Reshape Group D + build Generic AEC Calculator, OR use Company specific calculator

TEST GROUP D – DIE DESIGN ASSESSMENT					
STRESS	ABV	#	Reference MP E	Reference MP E+	Method
Electromigration	EM	D1	55k h, $T_{j,eff} = T_{amb-max,grade} - 20^{\circ}C$	121k h, $T_{j,eff} = T_{amb-max,grade} - 20^{\circ}C$	physics-based EM design verification and sign-off; (ext) HTOL
Time Dependent Dielectric Breakdown	TDDDB	D2			physics-based TDDDB design verification and sign-off; (ext) HTOL
Bias Temperature Instability	BTI	D4			aging simulation and sign-off; (ext) HTOL (Volt Acc optional) with PSA
Stress Migration	SM	D5			Design rules validation and sign-off; HTOL or HTSL
Hot Carrier Injection	HCI	D3	10k h, $T_{j,eff} = T_{amb-min,grade} + 20^{\circ}C$	10k h, $T_{j,eff} = T_{amb-min,grade} + 20^{\circ}C$	Aging Simulation and sign-off; (ext) (H)TOL (Volt Acc optional) with PSA

- Disclaimer: devices qualified to traditional AEC grade may also be capable for E and E+ reference MPs.
- Additionally, consider to add a reference profile for traditional AEC grades, e.g., 12000 h at $T_{j,eff} = T_{amb,grade}$



Proposal to Define Reference Profiles (1)

1. Collect successfully ¹ assessed Extended Mission Profiles ² for any product from various companies according to the following format:

MP Origin (OEM/Tier 1)	Basic AEC- Q100 Grade (0, 1, 2, 3)	High Activation Energies ³			Low & Negative Activation Energies	
		POH	T _{j,eff} (0.4eV)	T _{j,eff} (0.7eV)	POH (T _j ≤25°C)	POH (T _j =-40°C)
Tier 1	1	41000 h	39 °C	50 °C	19735 h	0 h
...						
...						

Example:

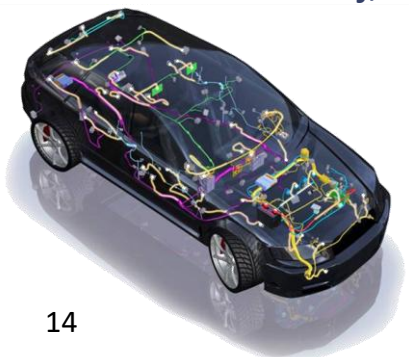
Note 1: Successfully means “product is capable / has enough reliability margin” for the Extended Mission Profile

Note 2: Definition of EMP: beyond AEC-Q100 (applying Flow B and C in Appendix 7)

Note 3: T_{j,eff}: Arrhenius weighted average junction temperature, which is depending on the activation energy

Note that there is no need to exchange:

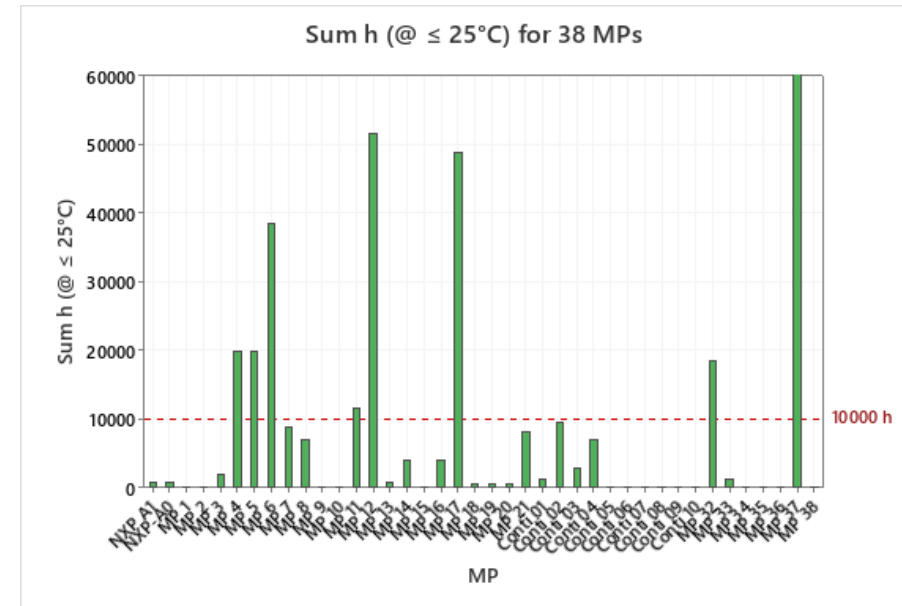
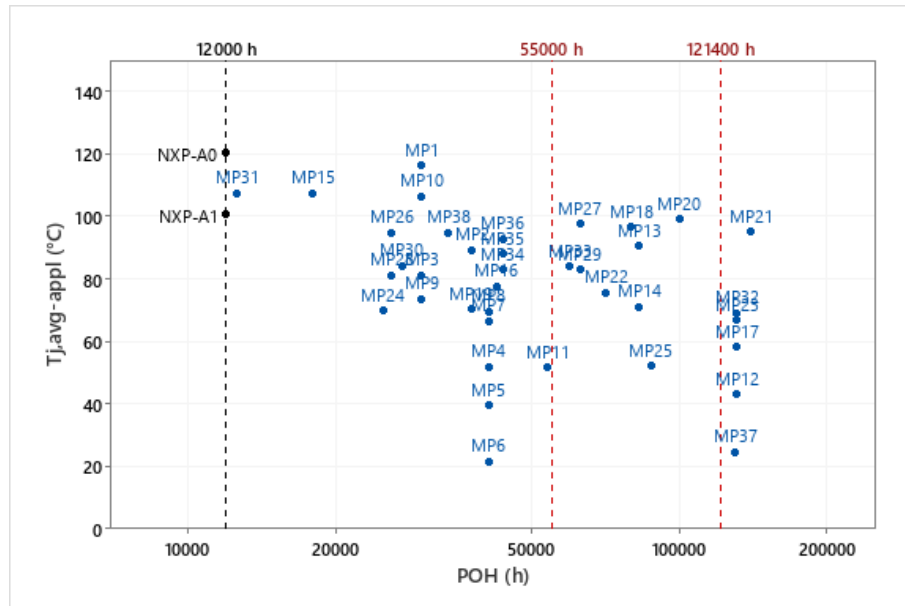
- Details of the assessed Extended Mission Profiles nor their origin
- Details of the assessed products



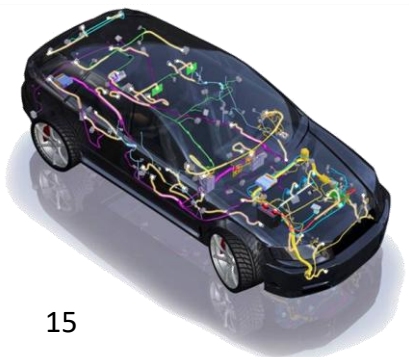
Proposal to Define Reference Profiles (2)

2. Assess the collected data (example for 38 MPs):

Example:
(0.4 eV)

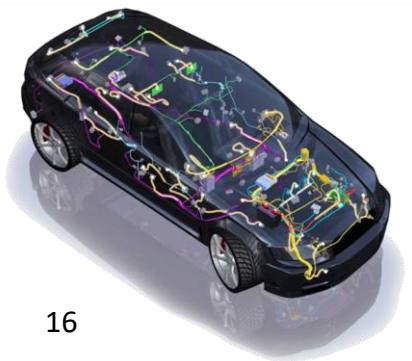


3. Define with whole team “simple” Reference Mission Profiles for E and if needed E+



Sessions with AEC-Q101 and AEC-Q200 team leads

- To be done still: invite WG team leads for a special session
 - AEC-Q101 : Andreas Pinkernelle, Nexperia
 - WBG : Itasham Hussain, ZF
 - AEC-Q200 : Saad Lambaz, Littelfuse



Discussion and Q&A

