



# In-vehicle Battery Durability

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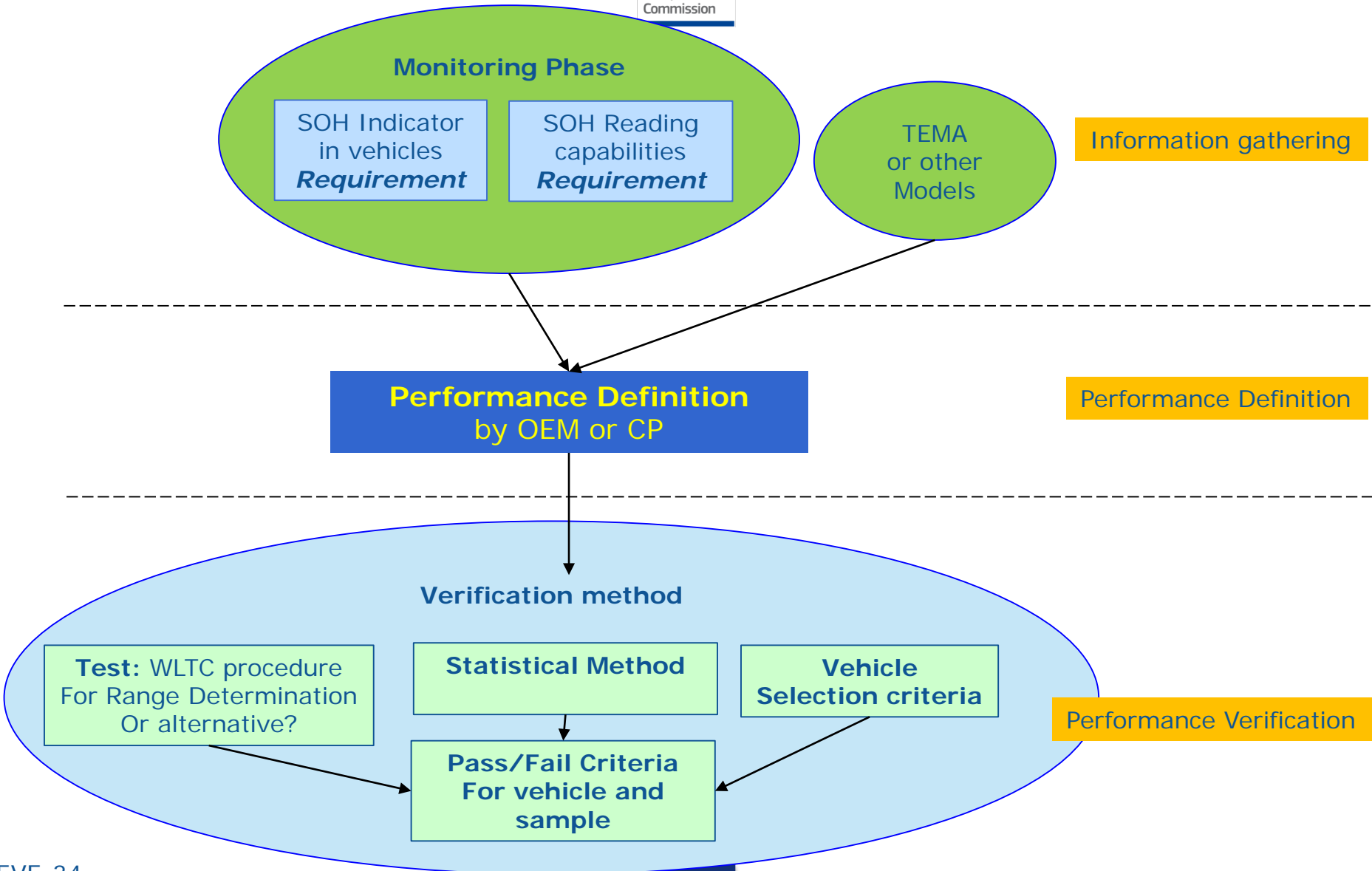
**EVE34 IWG**  
**23/3/2020**

# In-vehicle battery durability

- *Request to develop GTR, Phase 1:*
- *(a) Deliver a first version of a UN GTR on in-vehicle battery durability to AC.3 by November 2021 with;*
  - (i) definition of and requirements for electrified vehicle battery performance criteria
  - (ii) requirements for reading and/or displaying battery health information and usage data from the vehicle; and
  - **(ii) a provisional in-service conformity test which will include generic usage criteria and a statistical method.**

# Verification/In-Service Conformity

- *Should include the possibility to check via independent means the range (not simply reading an ECU signal)*
- *Testing according the WLTP is currently the only option*
- *Rules are obviously needed on sample size, tolerances, etc..*



# Verification Method

- *Designed to verify that the real deterioration remains below the declared deterioration*
- *Need to verify that the declared values are conform with the standard*
- *For a certain period of time*
- *Independ verification is very important*
  - **Not only reading SOH from within the vehicle**
  - **Verification through testing**
  - **WLTP test provides range values**
  - **(other similar tests could be used as well)**

# In-Service Conformity (ISC) in EU

- *Developed in 2017-18, vehicles started to comply in 2019*
- *Designed to confirm durability of emission control systems, mainly through real use verification with RDE test*
- *Allows for testing by independent parties, as long as they are accredited*
  - **Accreditation of labs executing the experiments (RDE/WLTP/...) with ISO 17025**
  - **Accreditation of inspection bodies (could be the same lab) with ISO 17020 for the ISC procedure**

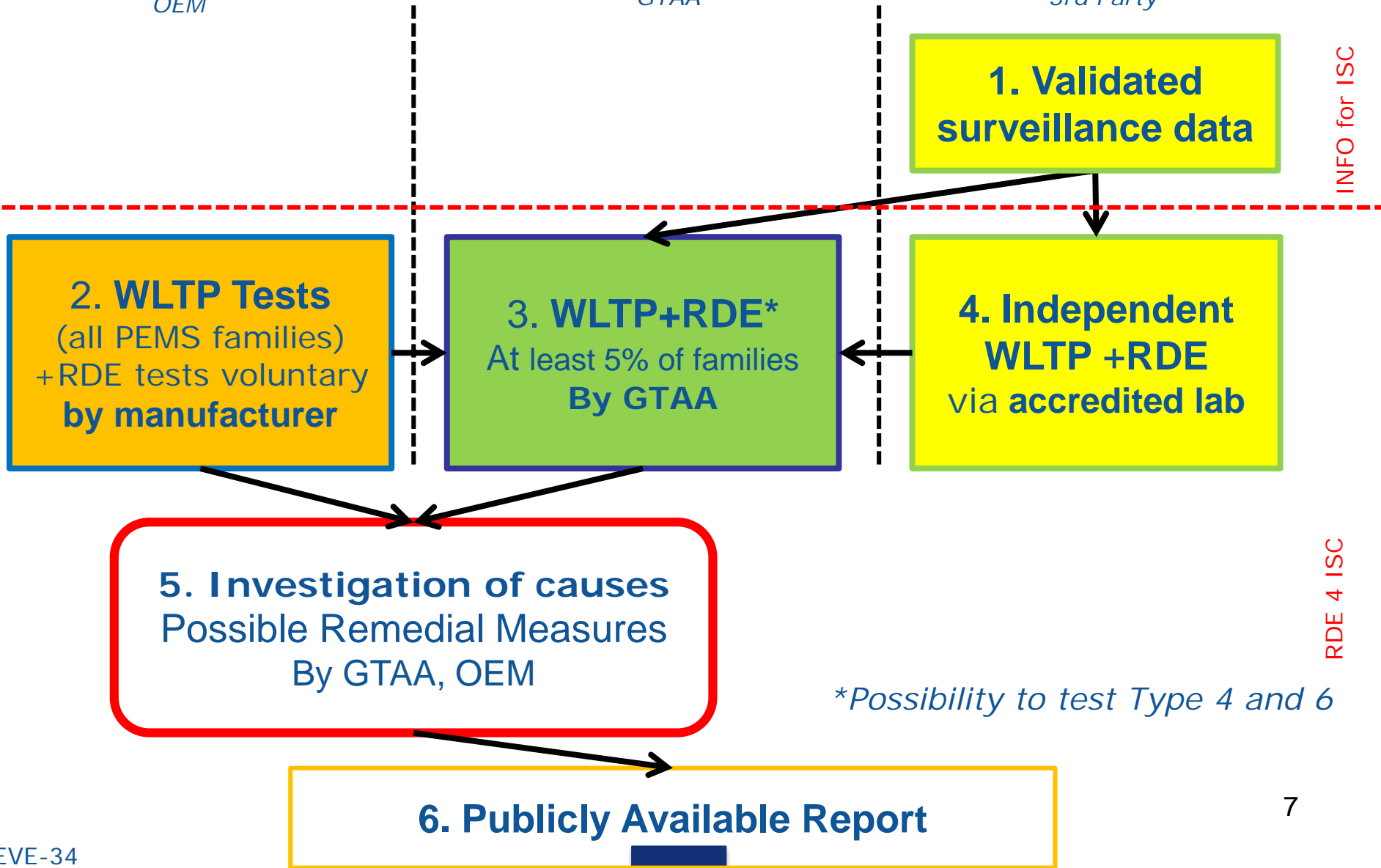
# New ISC procedure



OEM

GTAA

3rd Party



INFO for ISC

RDE 4 ISC

## A. Information Elements for ISC

*Useful info that would allow authorities to select families to be tested:*

- *Annual report on warranty claims, repairs and OBD faults to be provided by manufacturer to the GTAA (EC will have access) and list of faulty vehicles found during ISC selection*
- *Yearly validated report of data collected through remote sensing, SEMS, PEMS, etc.*
- *Risk Analysis used as input to decide which ISC families to check first, but random selection might also be possible*



## B. Testing

- *Families with similarities on their emission characteristics defined*
- *Testing performed every two years throughout lifetime of vehicle*
- *In EU, lifetime was defined as 5 years or 100.000 km for the purposes of emission standards*

## Selection of Vehicles

*Vehicles **between 15,000 km/6 months and 100,000km/5 years***

*Selection of vehicles from 2 MS with different conditions (fuels, ambient conditions, average road speeds and urban/highway split)*

*"shall select a sample of vehicles with sufficient mileage whose use under normal conditions can be reasonably assured"*

# Selection Criteria for vehicles

## *Vehicle examination and interview with owner*

*Only vehicles with good OBD data*

- Regular and appropriate maintenance (with proof)

*No indications of abuse*

*No tampering*

*No unauthorised major repair to engine or vehicle*

*Check exhaust for signs of misfuelling*

*No evident safety problems*

*List of vehicle parameters in Appendix 1 of Annex II of EU WLTP regulation*

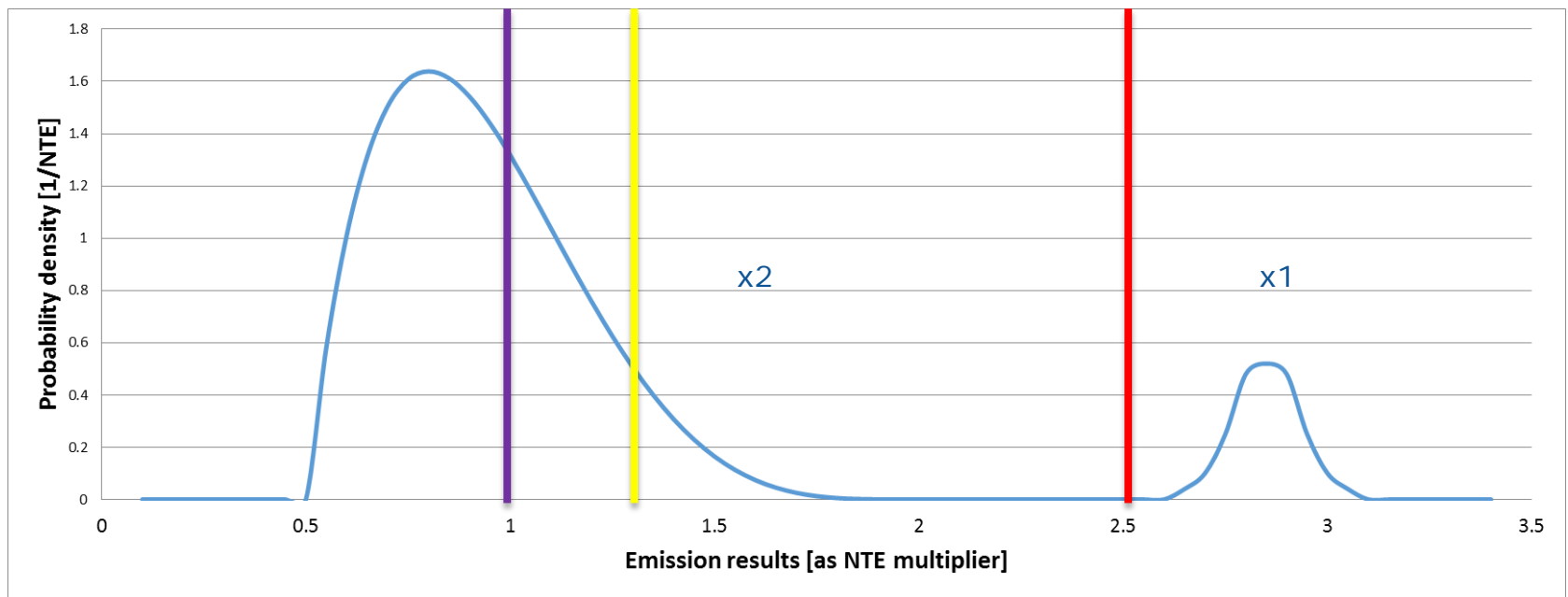
# Sample Statistics

*Statistics are needed in order to balance the risk of the manufacturers and the risk of the customers for a wrong decision*

**ISO COM / ISO COM (custom outlier treatment)**

10									-1
9								-1	-1
8							-1	-1	-1
7						-1	-1	-1	-1
6					-1	-1	-1	-1	-1
5				-1	-1	-1	0	0	1
4			-1	-1	0	0	0	0	1
3		-1	-1	0	0	0	0	1	1
2		0	0	0	0	1	1	1	1
1		0	1	1	1	1	1	1	1
0		1	1	1	1	1	1	1	1
		3	4	5	6	7	8	9	10
FAIL		3	3	4	5	5	6	6	6
PASS		0	1	1	1	2	2	3	5

# Outlier protection



*Outliers, like malfunctioning SCR would get caught by the 2.5 detection point*

*Distribution that shifts so a high % is about the NTE would be caught by the 1.3 detection point*

## 5. Detailed Investigation

- *When sample failed then investigate what caused the issue GTAA+OEM (60 working days)*
- *The details of the investigation shall be decided by GTAA, but will **undergo scrutiny***
- *If yes, then OEM proposes fix, TA validates (45+30 if needed working days)  
OEM apply remedial measures*

GTAA/OEM investigates



**5. Investigation of causes  
Possible Remedial Measures  
By GTAA, OEMS**

## 6. Reporting

*Public report each year with results of ISC by GTAA*

*Direct feedback by GTAA on the outcome of the investigations, including details*

*Peer Review each year*



**6. Publicly Available Report**

# Changes needed for adapting ISC to battery durability

## *A: information Elements*

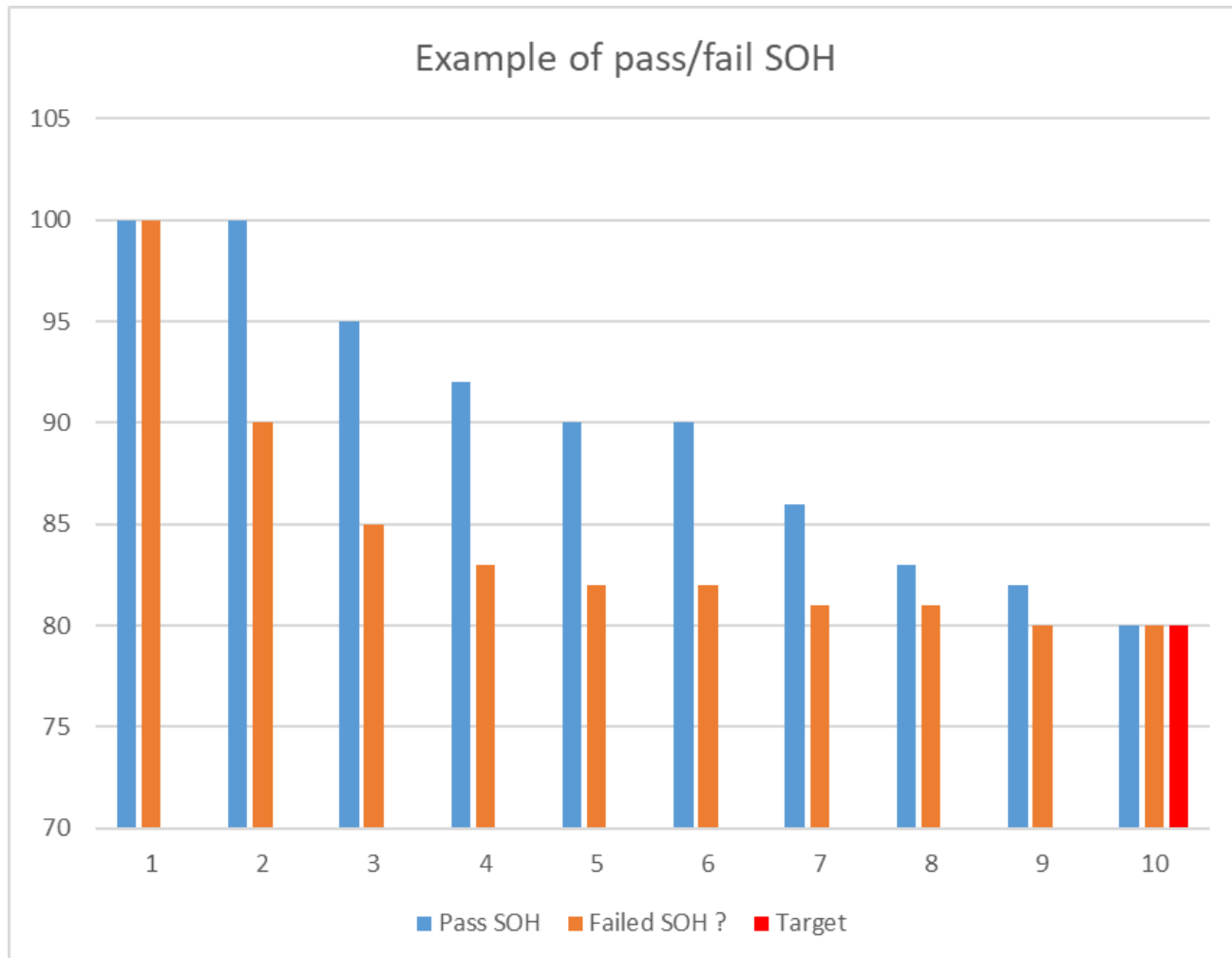
- *Reading of Battery SOH information and Usage Indices from vehicle*
- *Annual report on warranty claims, repairs and OBD faults to be provided by manufacturer to the authorities and list of faulty vehicles found during ISC vehicle selection*



## B. Testing

- *Families with similarities on their battery characteristics/drivetrain need to be defined*
- *Testing performed every X years throughout lifetime of vehicle*
- *Lifetime needs to be defined (km or years, or both?)*
- *But to test against what?*
  - **That the range/SOH is not below the one defined for the end of the lifetime**
  - **Range/SOH is not below a linear degradation between the original and that for the end of the lifetime**

# Pass or Fail Range/SOH: example



# Selection Criteria for vehicles

## *Vehicle examination and interview with owner*

- *Only vehicles with good **normal usage indices** (yet to be developed) as read by OBD*
- *Regular and appropriate maintenance (with proof)*
- *No unauthorised major repair to engine or vehicle*
- *No unauthorised change or repair of battery*
- *No evident safety problems*

# Which statistics?

**ISO COM / ISO COM (custom outlier treatment)**

10									-1
9								-1	-1
8							-1	-1	-1
7						-1	-1	-1	-1
6					-1	-1	-1	-1	-1
5			-1	-1	-1	0	0	0	1
4		-1	-1	0	0	0	0	0	1
3	-1	-1	0	0	0	0	0	1	1
2	0	0	0	0	1	1	1	1	1
1	0	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1	1
	3	4	5	6	7	8	9	10	
FAIL	3	3	4	5	5	6	6	6	6
PASS	0	1	1	1	2	2	3	5	

**ISO ACEA**

10									-1
9								-1	-1
8							-1	-1	-1
7						-1	-1	-1	-1
6					-1	-1	-1	-1	-1
5			-1	-1	0	0	0	0	1
4		-1	0	0	0	0	0	1	1
3	-1	0	0	0	0	0	1	1	1
2	0	0	0	0	1	1	1	1	1
1	0	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1	1
	3	4	5	6	7	8	9	10	
FAIL	3	4	5	6	6	6	6	6	6
PASS	0	1	1	2	2	3	4	5	

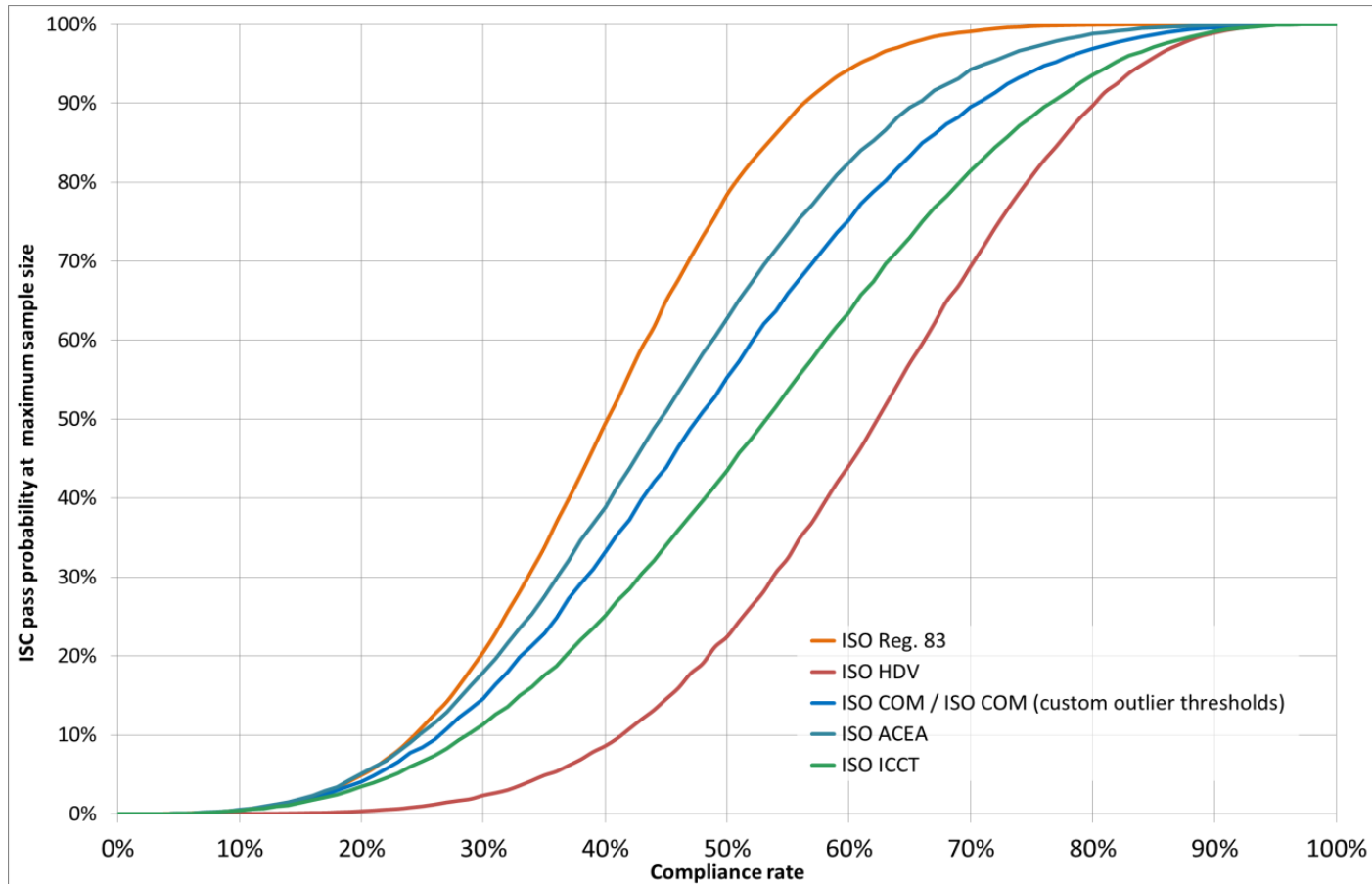
**ISO ICCT**

10									-1
9								-1	-1
8							-1	-1	-1
7						-1	-1	-1	-1
6					-1	-1	-1	-1	-1
5			-1	-1	-1	-1	-1	-1	-1
4		-1	-1	-1	-1	0	0	0	1
3	-1	-1	-1	0	0	1	1	1	1
2	0	0	0	1	1	1	1	1	1
1	0	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1	1
	3	4	5	6	7	8	9	10	
FAIL	3	3	3	4	4	5	5	5	5
PASS	0	1	1	2	2	3	3	4	

**ISO HDV**

10									-1
9								-1	-1
8							-1	-1	-1
7						-1	-1	-1	-1
6					-1	-1	-1	-1	-1
5			-1	-1	-1	-1	-1	-1	-1
4		-1	-1	-1	-1	-1	-1	-1	-1
3	-1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	1	1	1	1
1	0	0	0	1	1	1	1	1	1
0	0	1	1	1	1	1	1	1	1
	3	4	5	6	7	8	9	10	
FAIL	3	4	4	4	4	4	4	4	4
PASS	-1	0	0	1	1	2	2	3	

# Comparison of approaches



## List of issues

- *Evaluation of different statistics*
- *Definition of appropriate vehicles to test*
- *Pass/Fail of a vehicle*
- *Outliers protection needed?*
- *If yes, then based on Normal Usage Indices?*
- *Testing how often?*
- *Independent testing allowed?*
- *Possibility/Requirement for further investigation?*
- *Consequences?*



**Thank you for your attention!**