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ASSESSMENT PROGRAMME

Technical Bulletin

Testing of High Voltage Electric Vehicles

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Preface

DISCLAIMER: Euro NCAP has taken all reasonable care to ensure that the information published in this document is accurate and reflects the technical decisions taken by the organisation. In the unlikely event that this protocol contains a typographical error or any other inaccuracy, Euro NCAP reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

Contents

1. Introduction

TB011 Testing of Electric Vehicles was first released in 2010. Since then, there have been numerous new vehicle propulsion systems coming to the market. For vehicles other than traditional ICE additional preparations and precautions are required to ensure safety before, during and after crash-testing for all persons involved. This bulletin now includes requirements on:

1. Information that OEM needs to provide to the test laboratory.
2. Checks the test laboratory needs to perform on the vehicle pre, during and post test.

2. OEM Pre-test Information

In order to achieve the safe and timely testing of vehicles the following items and information should be provided (at the latest upon vehicle delivery to the lab) by the OEM completing the HV vehicle questionnaire (Annex 1) covering the following:

- The location of the service plug (if applicable).
- Diagram/drawing/photos and guidelines to show the location of HV connection*.
- The minimum State of Charge (SoC) of the Rechargeable Electrical Energy Storage System (REESS) to any state which allows the normal operation of the powertrain.
- Instructions on how to put the vehicle in the correct state to be tested (restraint system deploys as normal as it would on the road, ADL, eCall etc functioning “as normal”).
- Pre & Post test: Instructions on how to move the vehicle in order not to damage the HV system (for Pre) and not to create additional risk (for Post).

**If possible, break-out leads from HV and relevant adaptor to DAU may be fitted by OEM personnel at test lab during the vehicle crash preparation phase (ideally one week in advance from the crash test date).*

From 2023 onwards, if the OEM does not provide the completed questionnaire with the relevant information, the -1pt penalty of the ‘EV and hybrid vehicle compliance with ECE regulations regarding electrical vehicle safety’ assessment (**Rescue, Extrication & Safety Test and Assessment Protocol**) will be applied automatically, irrespective of the post-crash compliance checks.

The HV questionnaire must be supplied to the test laboratory at the same time as the Emergency Response Guide (ERG). These documents must be delivered to the lab at least 2 weeks before the first crash test.

3. HV Vehicle Assessment

Euro NCAP requires laboratories to measure the voltage of the HV battery during the full-scale crash test. UNECE R94, R95, R135 and R137 have requirements which cover protection against electrical shock. Four test options are allowed to verify the protection against electrical shock:

1. Absence of high voltage
2. Low electrical energy
3. Physical protection
4. Isolation resistance

The laboratories are required to record and complete the post-test HV assessment of protection against electrical shock, see Annex 2 for assessment table in accordance with the flow chart process.

3.1 HV Status

Euro NCAP tests can be carried out with a minimum state of charge (SoC) as per the questionnaire in Annex 1.

Pre-test

To indicate the risk of >30v AC/60v DC post-test, an exterior LED indicator light should be mounted to show the status. The OEM is asked to provide guidance for mounting the LED lights.

Post-test

After the crash test, extreme care needs to be taken to ensure that there is no exposure to high voltage before any person touches the vehicle. After all the verifications with an active HV system have been done the HV system must be deactivated following the OEM instructions supplied within the Annex 1 questionnaire.

In the case of non-compliance of protection of electrical shock post-test, all post-test activities will be halted, the laboratory must activate their relevant Emergency Plan and the OEM shall be contacted immediately to instruct on the safe isolation of the HV system.

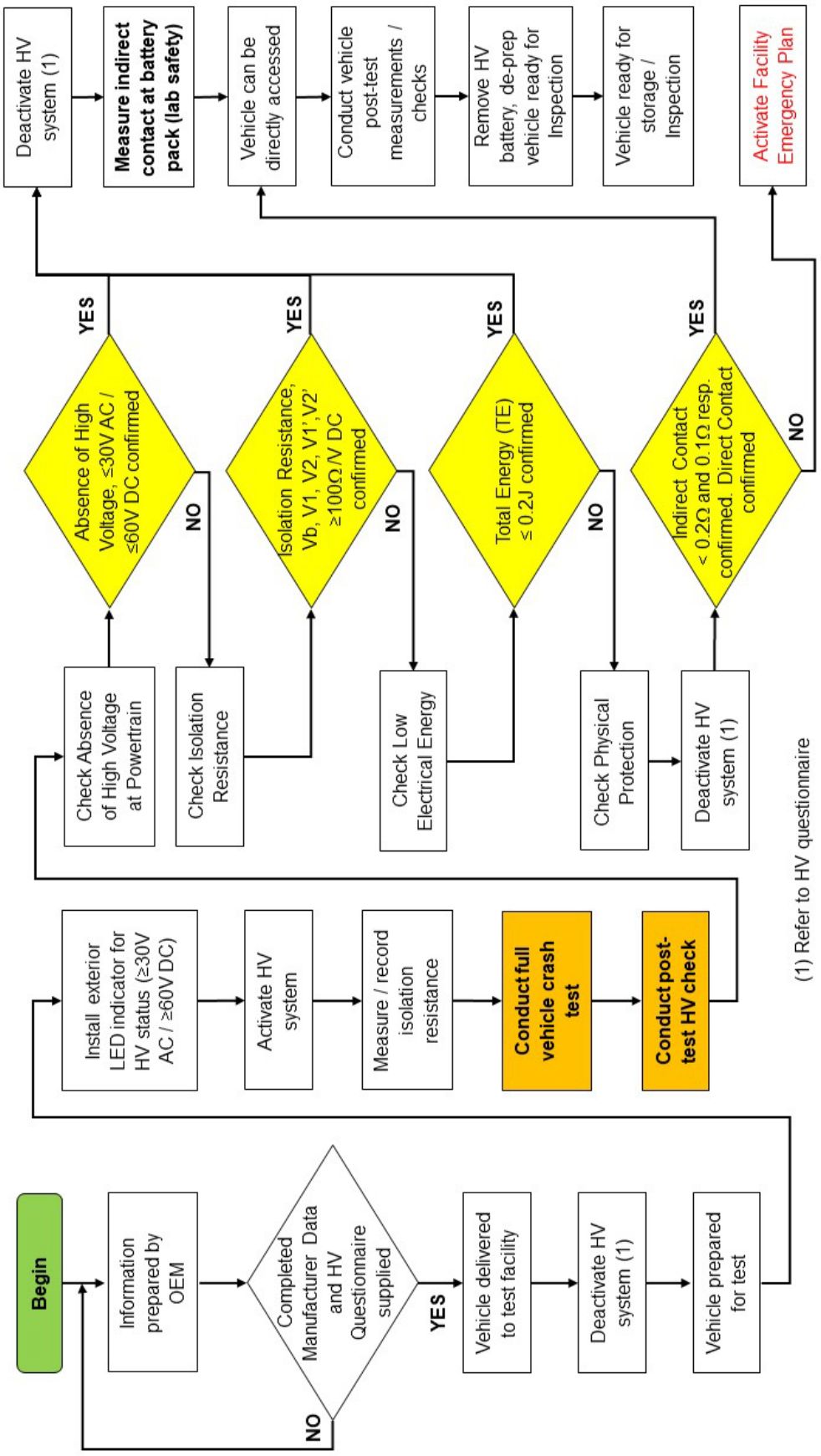
For storage, inspection and viewing the OEM or Laboratory should remove the battery pack post test.

3.2 Thermal Event

Post-crash

The HV battery temperature and battery temperature rise rate should be monitored. The method of monitoring the battery temperature (e.g. thermocouple, CAN data) is at the discretion of the test laboratory. Any and all audio and visual warnings provided by the vehicle of a potential thermal event will be noted. In the case of a thermal event occurring and no warning being provided by the vehicle this will also be noted with Euro NCAP Secretariat being informed.

In order to aid the test laboratories when checking a high voltage vehicle the following process flow chart indicates the preparation and assessment process:


Begin
Information prepared by OEM
Completed Manufacturer Data and HV Questionnaire supplied
NO
YES
Vehicle delivered to test facility
Deactivate HV system (1)
Vehicle prepared for test
Install exterior LED indicator for HV status (≥30V AC / ≥60V DC)
Activate HV system
Measure / record isolation resistance
Conduct full vehicle crash test
Conduct post-test HV check
Check Absence of High Voltage at Powertrain
Absence of High Voltage, ≤30V AC / ≤60V DC confirmed
YES
NO
Check Isolation Resistance
Isolation Resistance, Vb, V1, V2, V1', V2' ≥100Ω/V DC confirmed
YES
NO
Check Low Electrical Energy
Total Energy (TE) ≤ 0.2J confirmed
YES
NO
Check Physical Protection
Deactivate HV system (1)
Indirect Contact < 0.2Ω and 0.1Ω resp. confirmed. Direct Contact confirmed
YES
NO
Deactivate HV system (1)
Measure indirect contact at battery pack (lab safety)
Vehicle can be directly accessed
Conduct vehicle post-test measurements / checks
Remove HV battery, de-prep vehicle ready for Inspection
Vehicle ready for storage / Inspection
Activate Facility Emergency Plan
(1) Refer to HV questionnaire

Annex 1

OEM Vehicle Questionnaire

Information required from OEM regarding their High Voltage vehicle

The following section should be completed by OEM prior to any testing and sent directly to the test laboratory.

Manufacturer Specified Information – General Information	
Information	**Answer by OEM**
Name of the car	
Vehicle type (PHEV, HEV, EV, H2EV/ FCEV, etc)	
1. SD Switch position. Is it mechanical or is it an electric device? If there is no SD switch please provide instructions on a physical way to deactivate the HV system (emergency button).	
2. Technical documents about how to deactivate HV system to work safely. Procedure?	
3. Technical documents about how to remove HV battery to work safely Post test. Procedure?	
4. Vehicle specific tool (lid, pad lock or other), in case there is one, to block the access to the SD switch area once it is unplugged and/or prevent the high voltage system reconnection.	
5. In case of post-test absence of HV not complying, OEM to explain how HV system can be deactivated without contact to, or manipulation of, the vehicle. e.g. if necessary by installation pre-test of external emergency switch to service disconnect.	
6. OEM to provide diagram or pictures of the points where Test Facility must measure the voltage of the powertrain buses after the disconnection relay. If disconnection relay is external to HV battery, diagram to include measurements to that location.	

Manufacturer Specified Information – General Information	
Information	**Answer by OEM**
7. OEM to declare connector type / requirement to the external HV vehicle break-out box. OEM to provide all relevant information.	
8. OEM to explain the powertrain bus type / condition and limit values for isolation resistance measurement (separated or combined AC or DC buses, or confirmation of IPXXB is fulfilled).	
9. OEM to provide document and pictures of safe handling of HV battery, in case of direct contact and / or removal of the HV battery.	
10. Nominal voltage requirement of the HV battery for normal vehicle operation	
11. Minimum state of charge (SoC) of the HV battery to allow electric drive to perform the crash	
12. OEM to provide details of electrolyte (colour, smell etc)	
13. OEM to provide details of how to pre-test operate the vehicle with the HV disconnected, and identify care points to prevent damage and errors to the vehicle ECUs.	
14. OEM to provide details of restrictions to pre-test / post-test movement of the vehicle, without damaging the regenerating system.	
15. OEM to declare risk of regenerating energy during vehicle movement.	
16. OEM to supply and demonstrate values of condenser X and Y.	

Manufacturer Specified Information – General Information	
Information	**Answer by OEM**
Additional item for BEV / PHEV:	
17. OEM to provide battery charger and declare recharge method for BEV and PHEV.	
Additional items for HEV:	
18. OEM to provide information how to attain electric drive.	
19. OEM to explain how the electric drive can be maintained without combustion engine operation. e.g. disabling of combustion engine mode.	
20. OEM to explain how to charge the HV battery without moving or driving the vehicle.	
Additional items for FCEV:	
21. Helium is recommended to be used for test. OEM to provide details of limitations to use helium as substitute to hydrogen.	
22. OEM to provide information of minimum hydrogen tank pressure to allow electric drive.	
23. OEM to provide details of how the Test Facility can install sensors to monitor and record the tank pressure and temperature.	
24. OEM to support with supervision and guidance on the installation of the sensors, within 1 week prior to day of test.	

Definitions of terms used in questionnaire:

- **HV:** "*High Voltage"* is considered at the automotive industry circuits with more than 60 Volts.
- **BEV:** "Battery *Electric Vehicle",* a vehicle driven only by one or more electric motors. The EV also contains a high voltage battery and the battery has external charging.
- **PHEV:** "*Plug-in Hybrid Electric Vehicle"*, it is a vehicle driven by an internal combustion engine and one or several electric motors, at the same time or independently. The vehicle also contains a high voltage battery and the battery has external charging.
- **HEV:** "*Hybrid Electric Vehicle"*, it is a vehicle driven by an internal combustion engine and one or several electric motors, at the same time or

independently. The vehicle also contains a high voltage battery but the battery cannot be charged with external charger.

- **FCEV:** "*Fuel Cell Electric Vehicle*", is an electric vehicle that uses a fuel cell, sometimes in combination with a small battery or supercapacitor, to power its onboard electric motor. Fuel cells in vehicles generate electricity generally using oxygen from the air and compressed hydrogen.
- **SD Switch:** *"Service Disconnect Switch",* mechanical or electric device that is used to disconnect the HV battery avoiding the output of power to the powertrain or additional circuits.

Annex 2

Post-test HV assessment of protection against electrical shock

Post-test HV assessment of protection against electrical shock for each full scale crash test vehicle to be used in combination with the Flow Chart

Test Facility	
Vehicle Make / Model	
Test / Assessment Date	

Post-Test HV Check*			
Absence of High Voltage	**Recorded values graph**		**Status (OK, Not OK, N/A)**
	Vb	**Graph**	
	V1	**Graph**	
	V2	**Graph**	
	Measured values		**Status (OK, Not OK, N/A)**
	Vb		
	V1		
	V2		
	V1'		
	V2'		
	Ri/ Nominal voltage		

***** Relevant checks to be completed as per each lab's internal requirements following the flow chart process.

Post-Test HV Check*			
Isolation Resistance	**Direct measurement with external DC power supply**		**Status (OK, Not OK, N/A)**
	Ri+ / Nominal voltage		
	Ri- / Nominal voltage		
	Voltage measurement + calculations		**Status (OK, Not OK, N/A)**
	V1 > V2		
	V2 > V1		
	Ri+/Nominal voltage		
	Ri-/Nominal voltage		
Low Electrical Energy	**Measured value or calculated value**		**Status (OK, Not OK, N/A)**
	TE		
	TE_1		
	TE_2		
Physical Protection	**Measured value for all exposed conductive parts**		**Status (OK, Not OK, N/A)**
	Indirect		
	Direct		

***** Relevant checks to be completed as per each lab's internal requirements following the flow chart process.