**EVS-GTR Task Force 9 – REESS Safety Warning**

**Purpose**

Task Force 9 set out to address the communication of safety related warnings regarding the Rechargeable Electrical Energy Storage System (REESS) to the vehicle operator (driver). The task force was to identify the safety issues associated with the REESS which may include a battery management system (BMS) malfunction, charging, thermal events, and charge level indicator, which require driver warning, and develop provisions where appropriate for a warning system.

**Background**

 Before the creation of the Task Force 9 (TF9) group, the GTR contained language that addressed the issues of warning indicators for the REESS. The topic of reevaluating the warning indicators requirements had been brought up at previous GTR meetings leading the voting members of the GTR to create an additional Task Force which would address these issues and come up with suitable and acceptable requirements. The Task Force was not only tasked with identifying issues with the REESS that required a warning indicator but was also tasked with the development of requirements that would accurately test that the warning indicator warns for the condition it is designed for as opposed to verifying the warning indicator itself functions.

 Task Force 9 reviewed the language that had been proposed in the GTR and challenged the team to think broader. More specifically, the leaders of TF9 challenged the team to come up with a list of the most significant events related to an REESS they believed required a warning indicator and provide suggestions as to how to test them, essentially, when and how to warn. After various Task Force meetings, the team agreed the most significant events an electric vehicle may experience and should require a warning indicator are a malfunction on the Battery Management System (BMS), later referenced to as BMS malfunction, and a thermal event originating from the REESS compartment.

The team performed a survey to gather the best methods to create uniform BMS malfunction and thermal event tests and discuss its practicability. Unfortunately, the team concluded that a uniform test is unfeasible. Each submitted suggestion provided methods to trigger a warning indicator but the methods were directly tied to the architecture of a specific vehicle design. The team understood that it is not feasible to develop a set general test methods that could be applied to any electric vehicle. This forced the team to find alternatives in which a test method would not be needed, learning from past experiences where similar situations where encountered. Language was drafted that would require vehicle manufacturers to submit, upon request, technical documentation describing the effectiveness of the warning indicators and its process for a given vehicle. During the time of gathering information for the survey, some members proposed to incorporate a low energy warning indicator expressing their concerns that a fully depleted electric vehicle in the middle of the road can and will become a safety concern.

**Justifications**

*BMS Malfunction Indicator*

 The BMS monitors various battery operations, some of which are safety critical. There are multiple fault scenarios that could trigger a BMS to take corrective action. The team questioned whether we would have to test for all possible scenarios for which the BMS will provide safety critical corrective action. Specifically, the team considered if requiring tests for specific scenarios would become a design restrictive regulation. The team agreed that the main objective of the test is to ensure that the BMS is fully functional under normal conditions and should an event occur that renders the BMS not functional, a warning indicator will illuminate. It was emphasized that this test should not try to assess the BMS is functioning appropriately given that task was already delineated to in the ongoing efforts of other task force groups.

*Thermal Event*

 Real world data indicated that a thermal event within a battery pack is a major safety critical event associated with electric powered vehicles that could result in fire and destruction of the vehicle. The question posed to the group was whether there is a specific single measuring parameter that will trigger a warning indicator once a thermal event has initiated or if there should be multiple parameters considered before triggering the warning.

We believed that a warning indicator should come on in the event of a significant thermal event within the battery pack. A warning light should illuminate when the temperature within the battery pack is significantly higher than the maximum operating temperature (even at reduced power). In order to not be design restrictive, it was decided that the parameters to trigger the warning light be decided by the manufacturer. At this time, a test procedure for evaluating the operation of this warning light has not been provided.

*Low Level Warning Indicator*

 The purpose of this indicator is to remind the driver that the REESS remaining energy can only drive a short distance and to charge the BEV as soon as possible. If no mandatory regulations are created for this function, some poorly designed vehicles may lack this indicator entirely, which has the potential to create a dangerous situation for the occupants of a vehicle with no remaining energy as well as surrounding vehicles..

At the indicated low state of charge specified by the vehicle manufacturer, the following performance would be generally expected:

1. It is possible to move the vehicle out of the traffic area using its own propulsion system.
2. A minimum energy reserve is available for the lighting system as required by National and/or International Standards or regulations, when there is no independent energy storage for the auxiliary electrical systems.

As the traffic conditions and layout of charging stations varies from different countries, it is difficult and unnecessary to set a mandatory limit of this “low energy”. Manufacturers could specify the limit value of REESS remaining energy themselves according to the certain road conditions and performance of their product. It is also suggested that the remainder range (including the driving condition) could be introduced to the driver in the owner’s manual.

Currently, all conventional vehicles are equipped with low fuel warning indicators. When there is little fuel left, the warning signal shall be given to the driver to refuel as soon as possible. The manufacturers will define the threshold value on their own.

Although there are no recorded accidents for BEVs running out of energy, it should be noted that in some countries, this indicator is mandatory. It is beneficial to regulate the necessary design for BEV manufacturers at the current technical development level.

Due to the complexity of the vehicle warning signals, only basic requirements can be proposed for regulatory purpose, but the inclusion of such requirements will contribute to eliminate the use of poorly designed vehicles.

**Proposal of Test Requirements**

After much debate and consideration in regards to the limitations of creating generic requirements, the team has reached an agreement on the best course of actions for this Task Force. The team proposes the GTR adopt the following language when requiring warning indicators for electric vehicles:

*BMS malfunction:*

*To ensure that the vehicle shall provide a warning to indicate malfunctions of the Battery Management System (BMS), vehicle manufacturers must make available, at the request of the regulatory entity, the following documentation:*

1. *The parameters necessary to indicate malfunction of the BMS.*
2. *A system diagram outlining the BMS and the warning indicators.*

*Thermal Event:*

*To ensure that the vehicle monitors and appropriately indicates a thermal event in the REESS system through a warning indication, vehicle manufacturers must make available, at the request of the regulatory entity, the following documentation:*

1. *The parameters of the thermal event such as temperature, SOC, voltage and/or electrical current that trigger the warning signals.*
2. *Description of the warning system.*

*Low Energy Content on REESS:*

*If normal driving performance of the vehicle will be negatively affected by low REESS state of charge, occurrence of this condition shall be indicated to the driver. Based on engineering judgment, the manufacturer shall determine the necessary level of REESS energy remaining, when the driver warning is first given.*