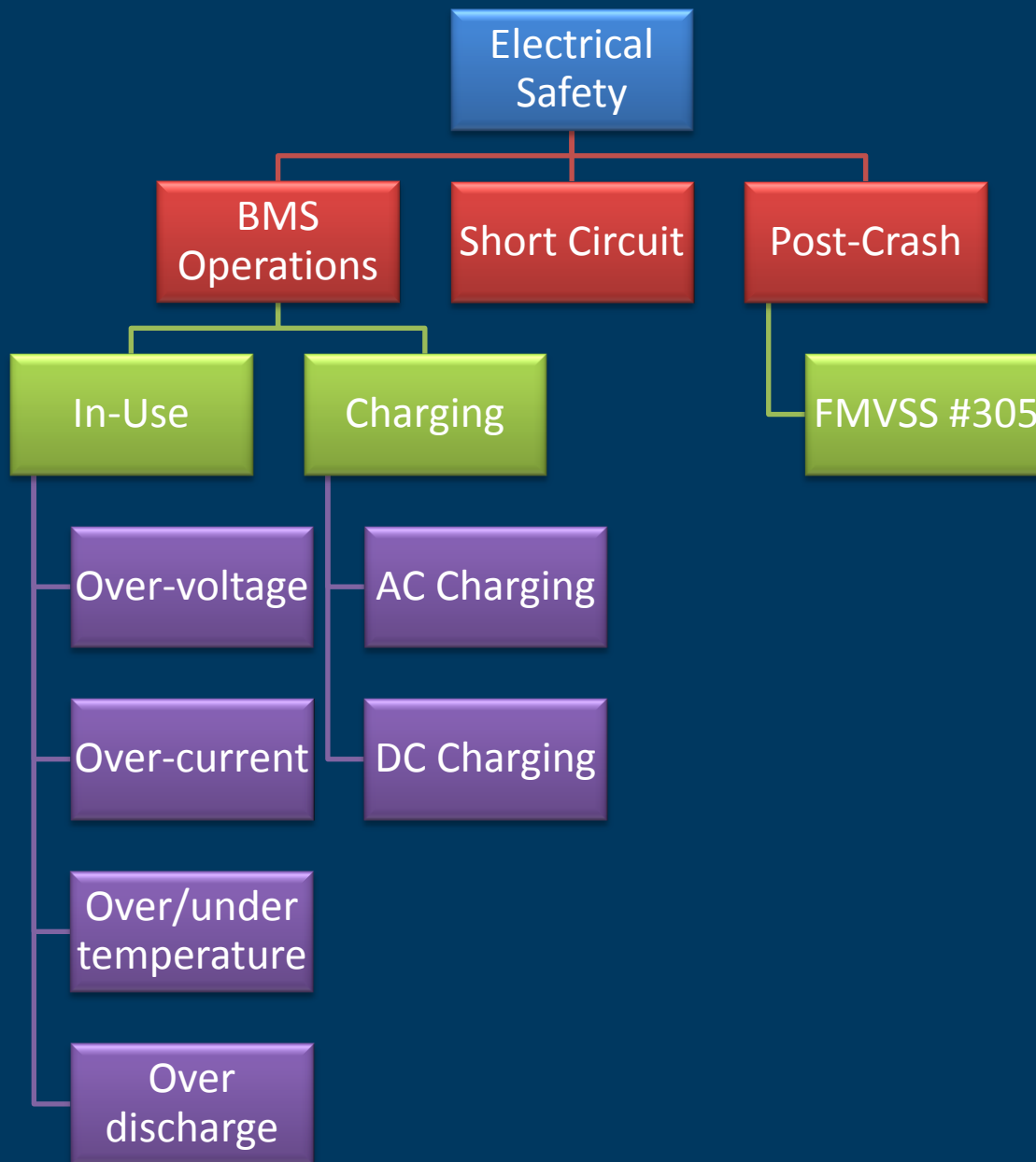
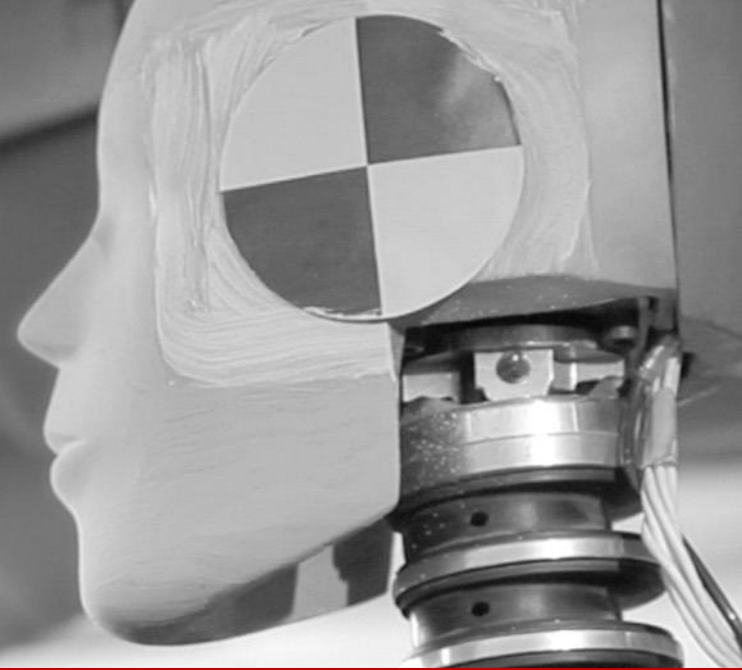


Electrical Safety

William Joel Sánchez



Short Circuit Protection



Objective

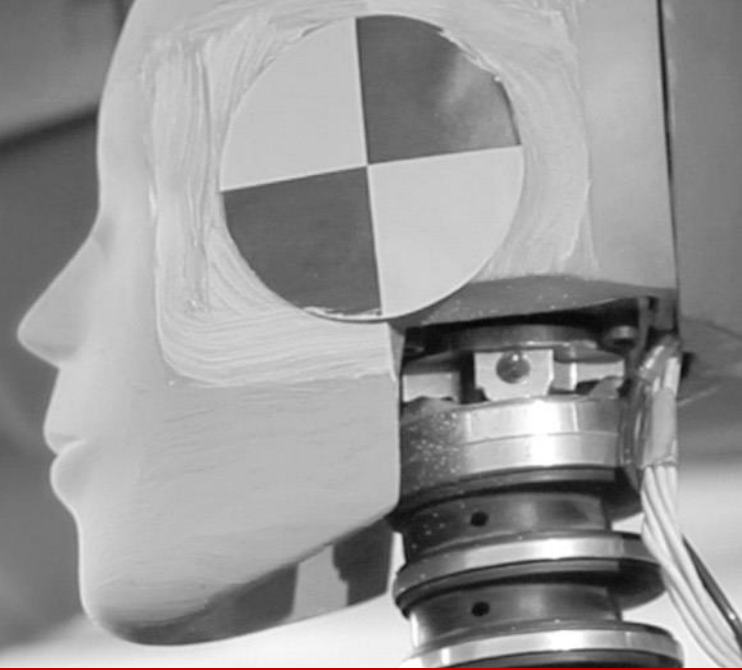
- ***The objective is to assure failsafe REESS response to short circuit exposure and resulting failure modes during all conditions (normal operation, charging, crash, and post-crash)***

Procedure

Broad Impedance Short Circuit Protection

- *NHTSA recognizes the need for failsafe response to all unanticipated short circuit exposure in a REESS. In prior GTR updates, this topic was identified as part of a prior project, however, the results of that project were inadequate in producing the necessary procedure and measurement criteria. Therefore, this topic will be discussed further as one of the ongoing research items.*

BMS Safety
Functionality during
Charging



Objective

- ***The objective is to evaluate the Battery Management System (BMS) response to safety relevant failure modes and conditions during charging.***

Procedure Development

- The test procedure focuses on the failure modes associated with BMS interfaces to the DC charging system for a variety of battery/charging system conditions. The SAE J1772 Combo connector variant was used to develop the procedure.
- Equivalent test procedures will be developed for other BMS interfaces and with hybrid system controller.

ICE 62196-2

AC Type 1

AC Type 2

DC Combo

SAE J1772

AC Charging connector

** DC Combo connector

GB 20234

AC Charging Connector

DC Vehicle Coupler

CHAdeMO

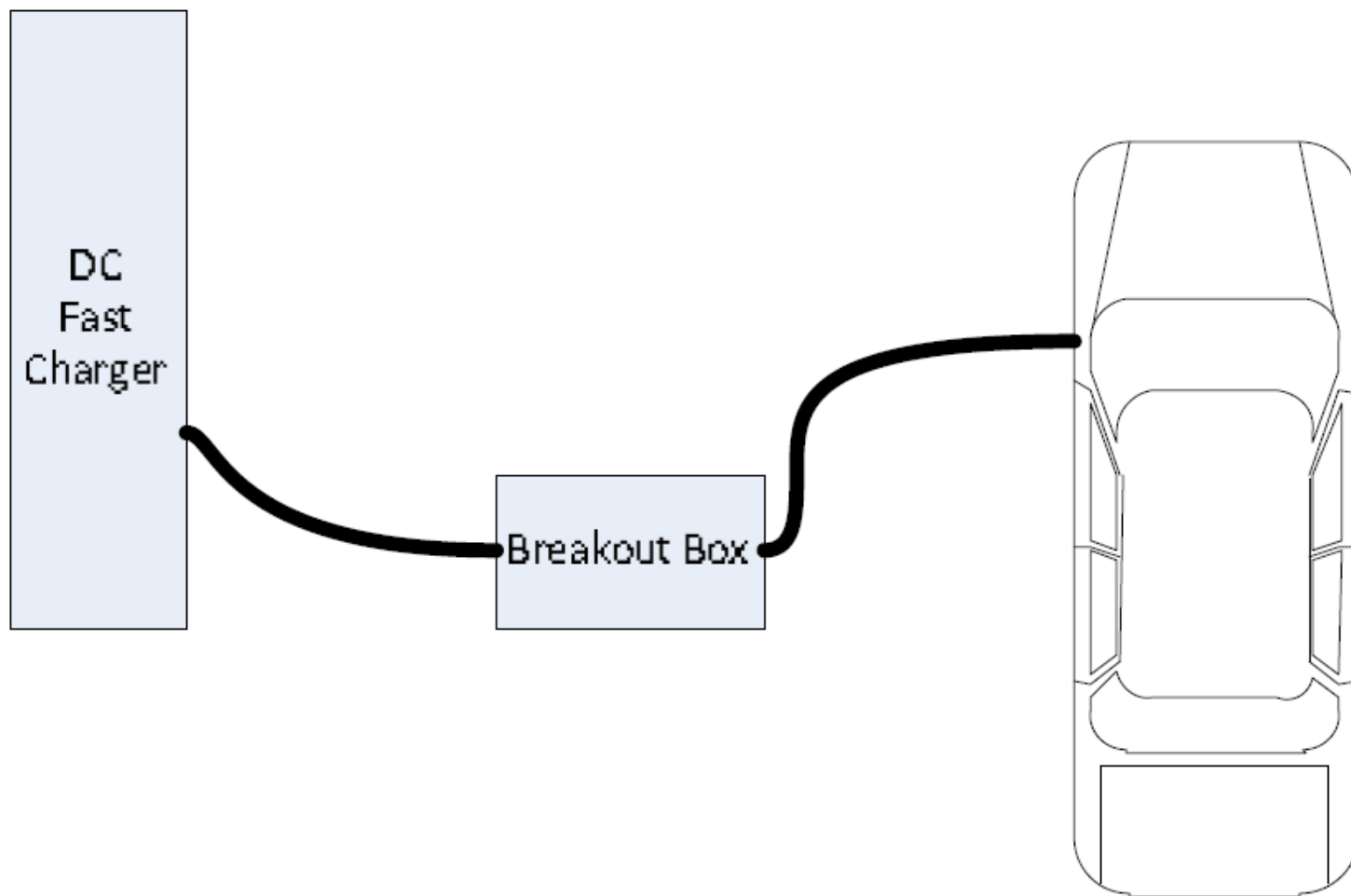
Wireless Charging

Risk areas and Safety needs:

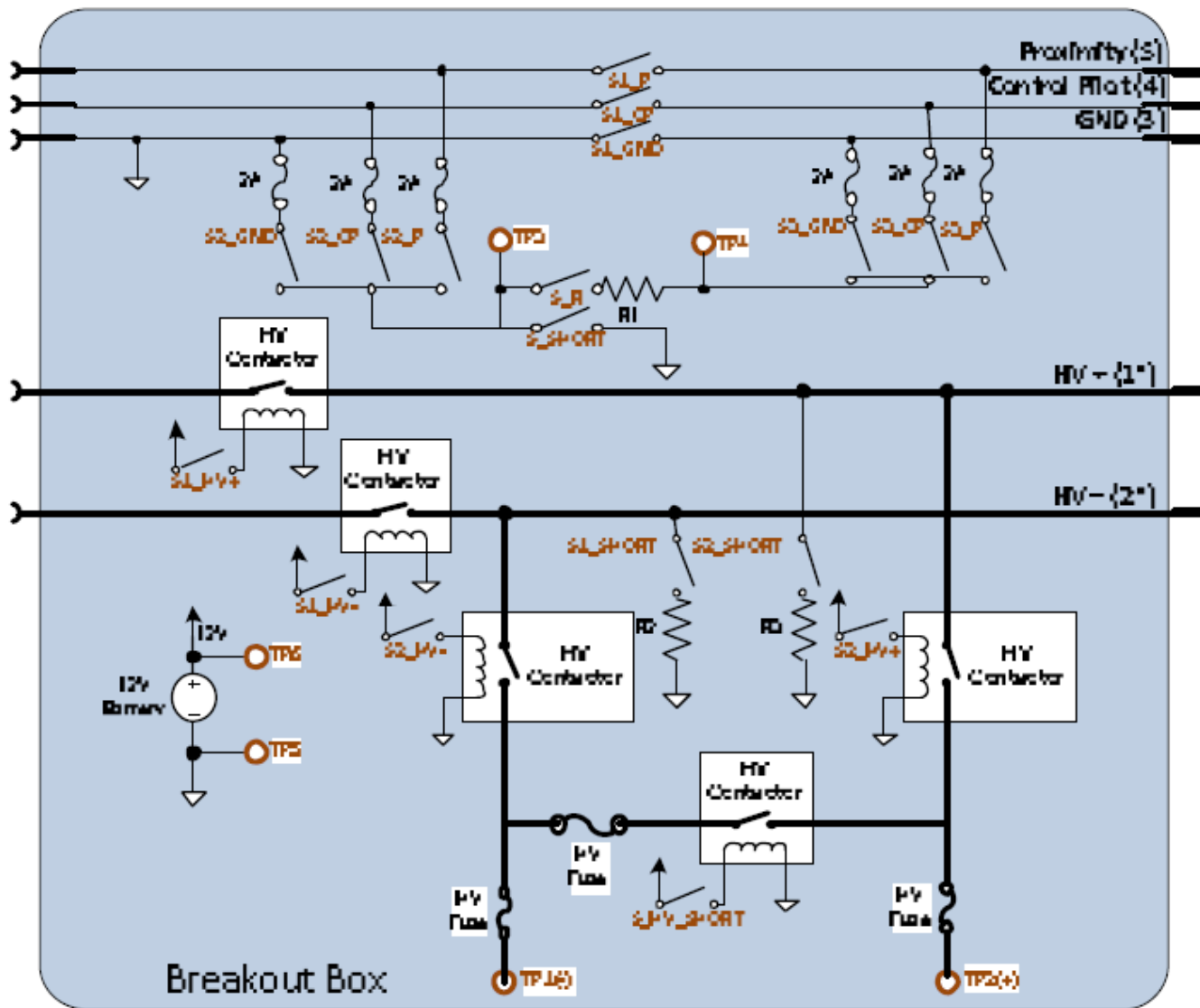
- ***Electrical shock, unintentional system behavior, and thermal event initiations*** are the potential risks areas associated with these tests.
- Twenty four REESS Design Failure Modes and Effects Analysis (DFMEA) were reviewed and analyzed to generate a list of safety risk areas that the BMS might experience during charging. This analysis identified 5 general areas to which safety risks can occur before, and during DC charging.
- These 5 areas include: ***System Grounding, 12V BMS Network Control, High Voltage, Environmental Effects, and Operational Disturbances.***
- Eighteen specific test procedures were developed to test fault conditions in these 5 areas.

Performance

- As many of the fault conditions are in the vehicle to charger interface, a *Breakout Box* was designed to introduce the faults. This device allows the technician to introduce fault conditions between the vehicle charge coupler and the DC charger. Each procedure, in these areas, will require a specific settings of the input controls on the breakout box.
- The pass/fail performance criterion under a simulated fault condition is for the vehicle to transition to a safe system state so as to reduce risk of harm to occupants in and around the vehicle and to the vehicle system.



DC Fast Charge Breakout Box Connection

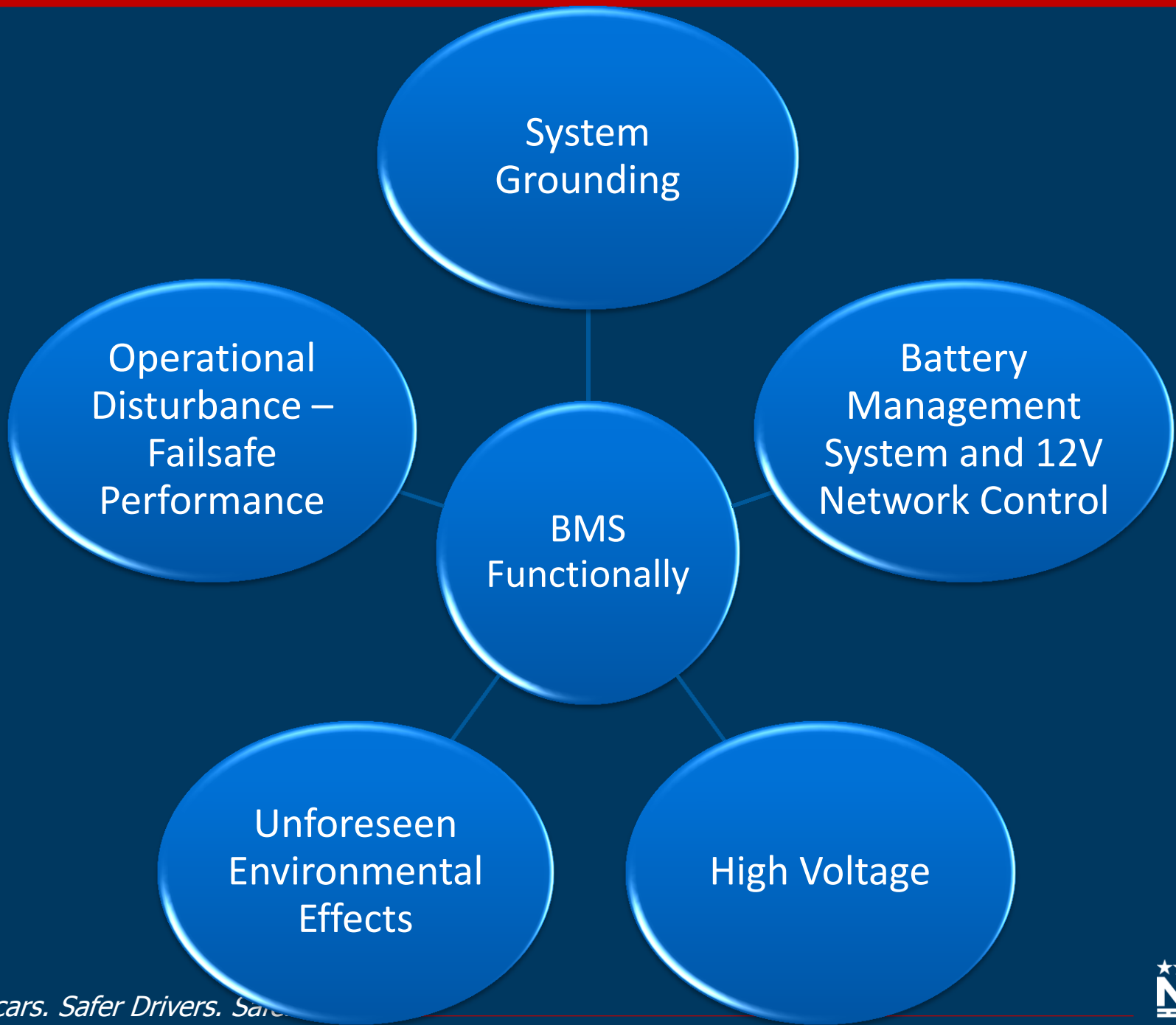


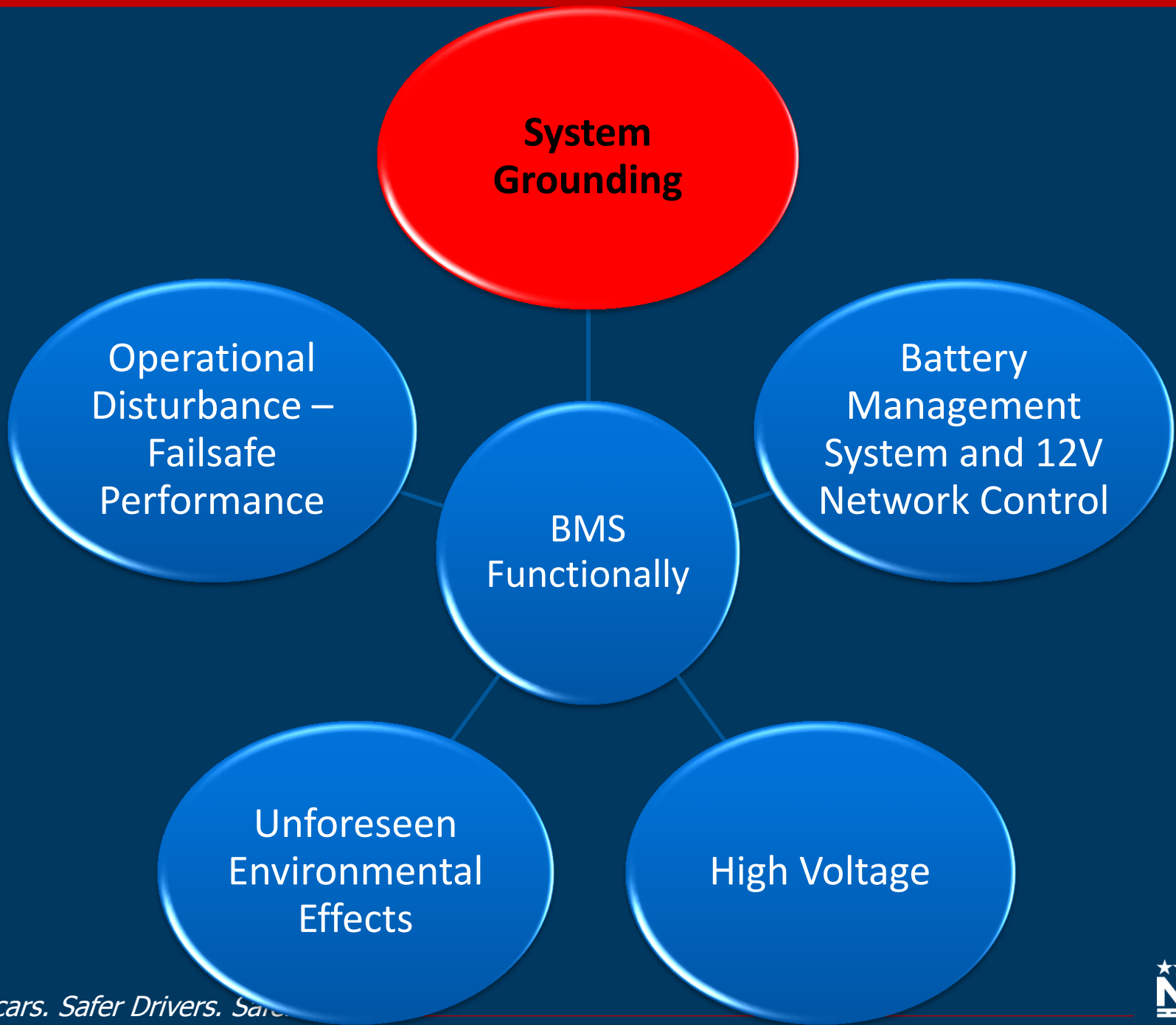
DC Fast Charge Breakout Box Connection

Visual Inspection of Charge Port

- Charge Port Inspection: The purpose of this inspection is to detect any incompatibility or unintended issues between the charge plug and the vehicle receptacle.

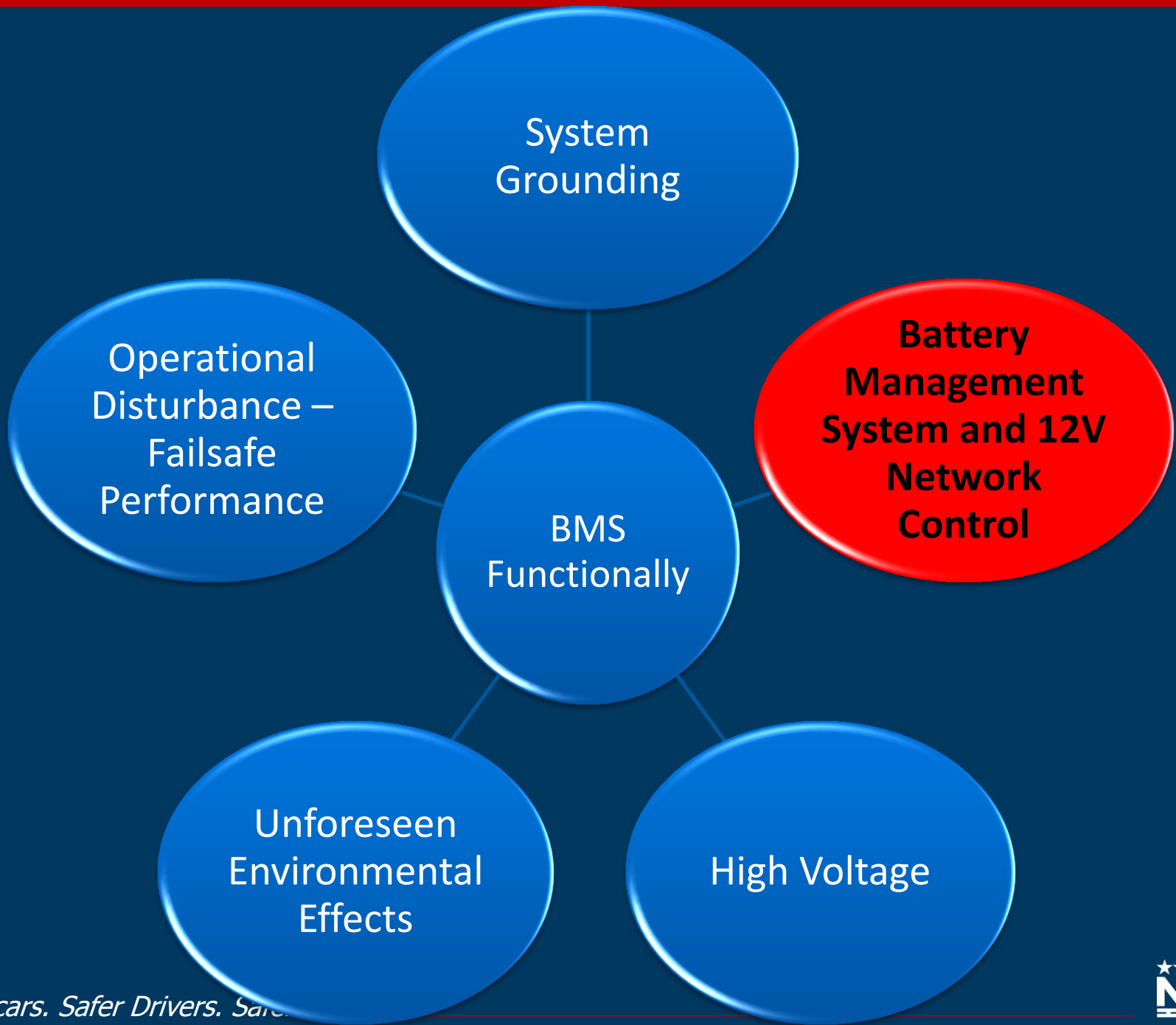
Though this inspection is presently described as a separate procedure in the “Draft” document provided to GTR at meeting #6 (Seoul), it will be moved to section 5 of the procedure as a “preliminary test set-up”. This will allow safe and accurate procedure completion.





System Grounding

- Ground Fault: This procedure determines the response of the BMS to a loss of or a fault on the ground connection between the vehicle charge port and the charger.
- Chassis Ground Offset : This procedure determines the response of the vehicle and charger system to an offset on the ground connection between the vehicle charge port and the charger.



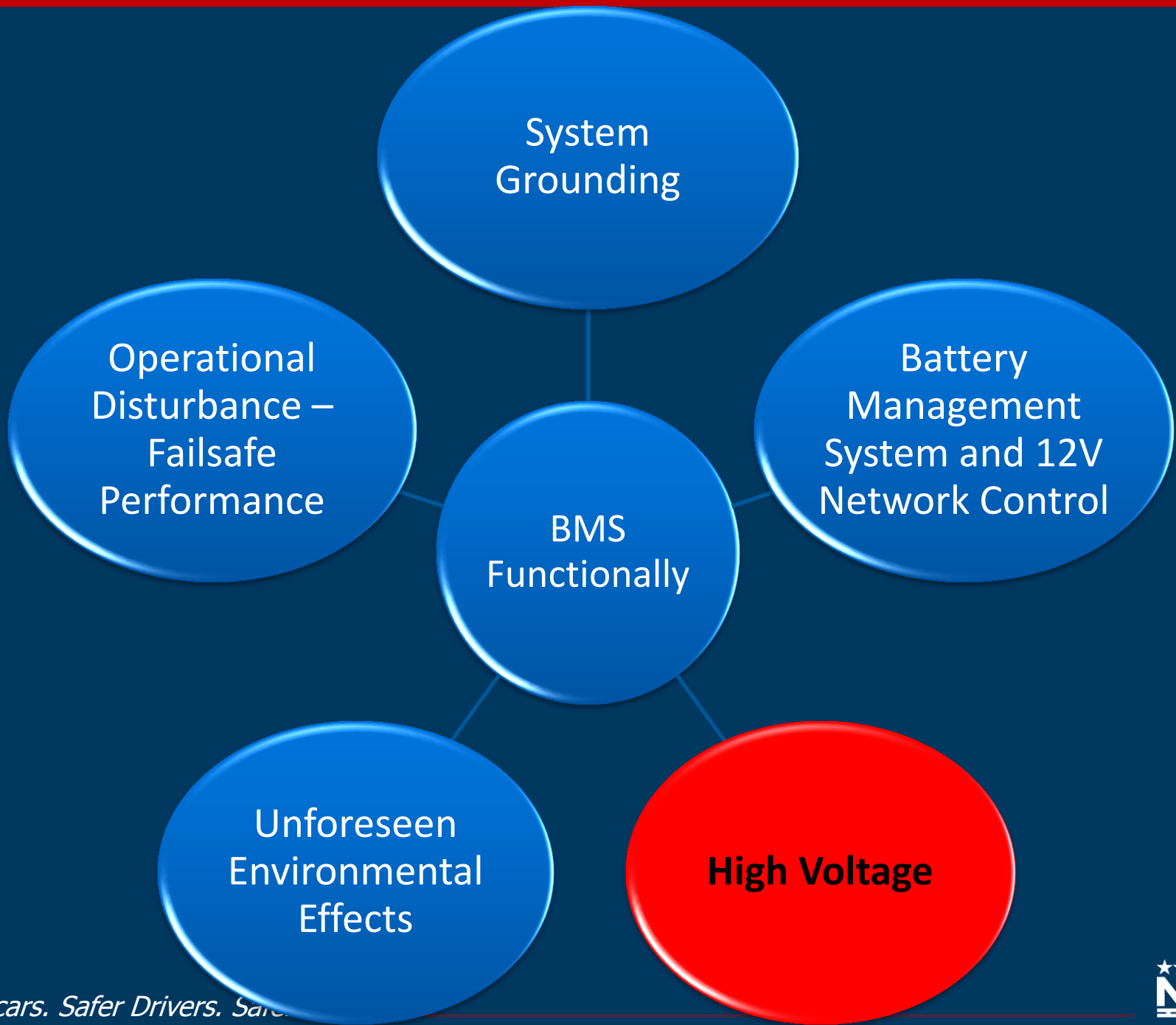
Battery Management System (BMS) and 12V Network Control

- 12V System Over-voltage : This procedure determines the response of the vehicle and charger system to an overvoltage of the 12V system on the vehicle.
- 12V System Under-voltage : This procedure determines the response of the vehicle and charger system to under voltage of the 12V system on the vehicle.
- 12V System Disturbance : This procedure determines the response of the vehicle and charger system to switching load disturbance of the 12V network during DC fast charging.
- BMS Internal Fault Detection : This procedure determines if a BMS is able to detect safety relevant internal BMS faults.

Battery Management System (BMS) and 12V Network Control

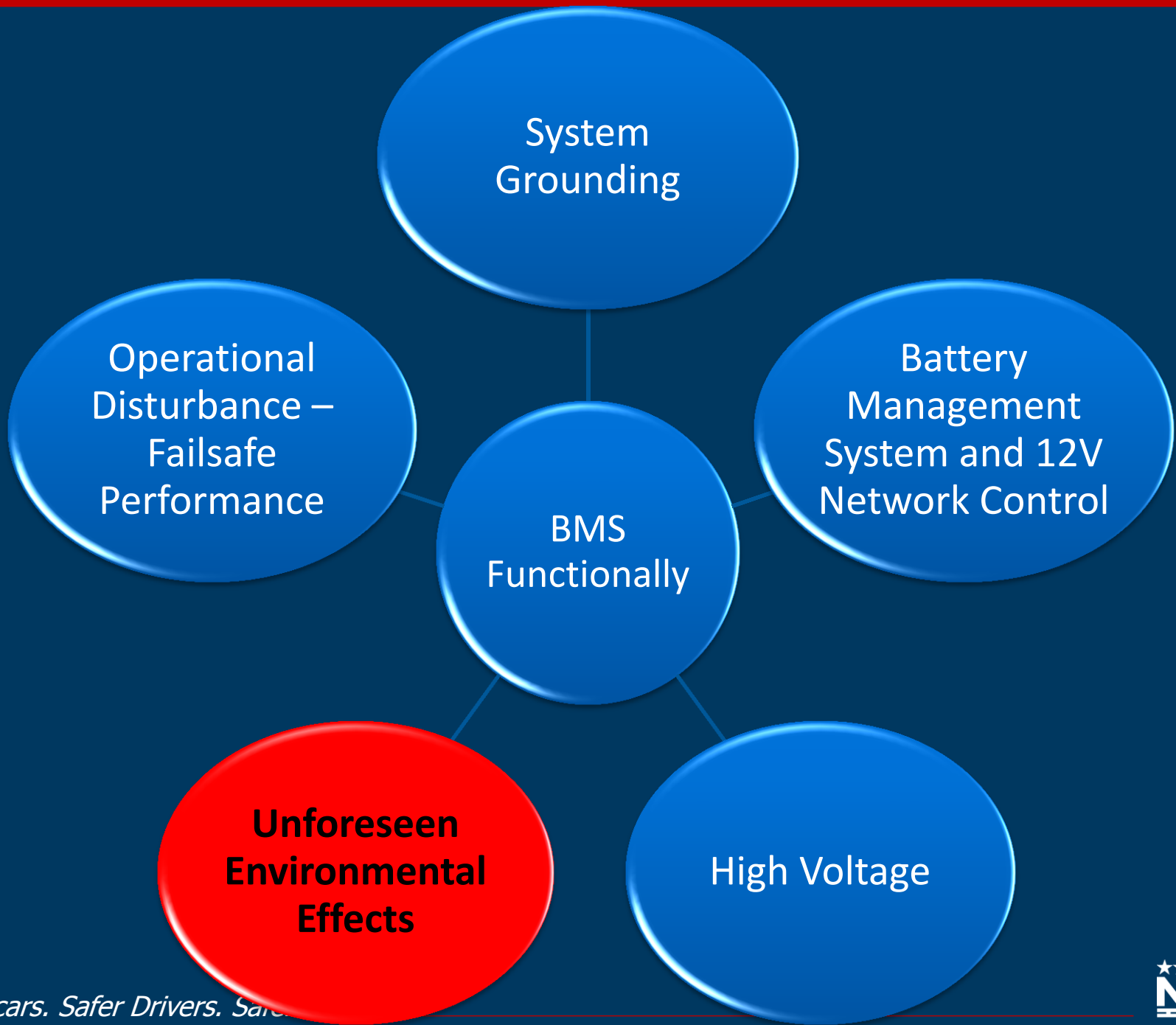
- EMI/EMC: This procedure is to determine if electromagnetic disturbances can affect the DC charging system

As sufficient procedures and acceptance criteria have been described in separate documents (i.e., ISO 11451 1-4) and can be referenced, a separate procedure was not developed for this area.



High Voltage

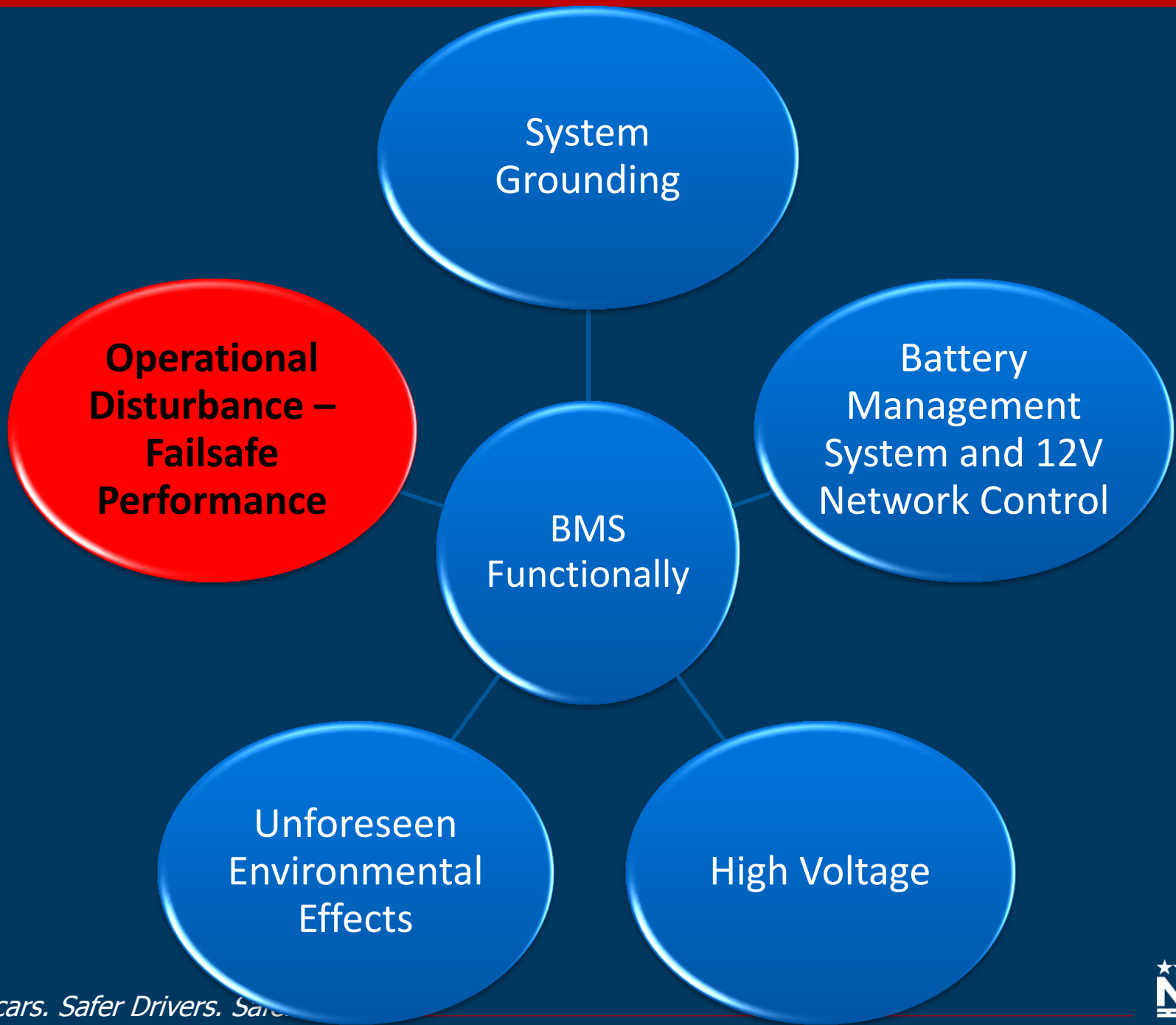
- DC Bus Short: This procedure determines the response of the BMS and vehicle to a DC bus short in the vehicle charge coupler.
- DC Bus Held High: This procedure determines the response of the vehicle and DC charging system to a vehicle DC bus being held high during disconnect, which means that a potential high voltage is still present at the two charge connector pins.



Unforeseen Environmental Effects

- Vehicle Movement : This procedure determines the response of the vehicle and charger system to vehicle attempted movement during DC fast charging and if the drive away interlocks of the vehicle system are effective during a DC fast charge.
- Vehicle Crash or Bump: This procedure determines the response of the BMS to a slow speed (low energy) collision during a DC fast charge.
- Cooling/Heating System: The purpose of this procedure is to determine the reaction of degraded or failed thermal management system in the vehicle/charger system.

This procedure can only be described in general terms as design specific processes which would be necessary for each OEM vehicle configuration



Operational Disturbance – Failsafe Performance

- Charge Operation Disturbance : This procedure determines the response of the vehicle/charger system to a series of unexpected inputs during a DC fast charge.
- Charge Connector Control Signal Disturbance: This procedure determines the response of the vehicle/charge system to control signal disturbances between the vehicle and the fast charger.
- Charge Connector Field Ground Connection Disturbance : This procedure determines the response of the vehicle/charger system to a disturbance between the vehicle field ground and the charger field ground connection.
- Charge Connector HV Connection Disturbance: This procedure determines the response of the vehicle/charger system to disturbances in the HV connection between the vehicle and the DC fast charger.
- Overcharge: This procedure determines the response of the vehicle/charger system to a simulated overcharge condition.

Conclusion

- The process of charging an Electric Vehicle exposes hazards and risks that are unique to this technology and differ from an ICE vehicle; these risks must be mitigated through proper designs and verified through performance testing. The U.S. proposes this procedure as a template for all charging configurations and conditions (DC and AC).
- The current GTR draft proposes the external short circuit test, overcharge protection test, over-discharge protection test, and over temperature protection test, which are relatable, but do not address the BMS functionality during charging.

Safer cars. Safer Drivers. Safer roads.

Questions?

