Krav – shell eco marathon

# Article 31 – HORN

1. Each vehicle must be equipped with an electric horn mounted towards the front of the vehicle in such a manner that is effectively audible to other vehicles and track marshals. With the vehicle in normal running condition, it must emit a sound greater that 85 dBa when measured 4 meters horizontally from the vehicle.
2. The horn must have a high tone(pitch) or greater than 420 Hz

# Article 37 – Emergency shutdown system

d) for battery electric vehicle the emergency shutdown mechanism must provide a physical isolation of the propulsion battery from the vehicle electrical system. If relays are used, the relays must be a normally open contact type. The use of a power controller or other logic system to drive an isolation device is not permitted.

G2) all other propulsion energy types – latching red push button

h) In addition to the above devices, all vehicles must be equipped with a “dead man’s safety switch” or sometimes referred to as “operator presence control”. The purpose for this device is to ensure that in case the driver becomes incapacitated the vehicle’s propulsion power is automatically disengaged(i.e. returns to an idle condition). This device may consist of a spring loaded hand operated accelerator or foot pedal lever. An electrical dead man switch is used the dricer must directly(for example by thumb or index finger) engage the switch at all times while driving.

1) This device is a separate switch from the required “emergency shut-down” mechanisms identified in section ©

# Article 57 – Vehicle electrical system

1. For safety reasons, the maximum voltage on board of any vehicle at any point must not exceed 48 Volts nominal and 60 volts max ( this includes on-board batteries, external batteries, Super capacitors, fuell cell stack, etc…)
2. For all vehicles only one on-board battery is allowed. For battery electric vehicles this is known as the propulsion battery.
3. If Lithium-based batteries are used, Battery Management Systems (BMS) tailored to this chemistry must be installed to control and protect the battery against risk of fire. The BMS must provide cell balancing and overvoltage protection during off-track charging. For E-mobility vehicles, the additional requirement of cell level over-discharge, over-current and over-temperature must be provided as part of the on-vehicle system. The BMS must AUTOMATICALLY isolate the battery, without operator intervention, if a limit or out of range condition is reached on any of the above parameters. For Lithium-based accessory batteries, the BMS cell balancing and overvoltage protection may be contained as part of the off-board charger. The maximum capacity of any Lithium-based battery used in any propulsion energy class vehicle is 1,000 Wh. For batteries not rated in Wh, the Wh rating is calculated by multiplying the amp-hour rating of the battery by its nominal voltage. Protection for Lithium-based battery charging, whether in or out of the vehicle must be provided, see Article 24(i).
4. Any Lithium based battery must be equipped with a metal tray under the battery suitable to prevent the battery, in the event of a fire or battery event, from burning through the vehicle body and dropping to the ground.

e) All batteries and Super Capacitors must be short circuit protected. Protection may be in the form of a fuse, fusible link, or a current interrupting device (circuit breaker). Automatic reclosing current interrupting devices are not allowed. Short circuit protection devices must be located on the positive conductor and as close as possible to the battery or Super Capacitor itself. The rating of the short circuit protection device must be such that the battery or Super Capacitor will be able to supply enough short circuit current at all times to open the device. For vehicles with a starter motor, the starter motor cable is NOT required to be protected.

f) For safety reasons, both the positive and negative circuits of the propulsion battery or Super Capacitors must be electrically isolated from the vehicle frame.

g) All vehicle electrical circuits must be protected against electrical overload. Overload protection may be in the form of fixed current limits within electric controllers or by the insertion of individual circuit fuses. For Internal Combustion vehicles, overload protection is required for the motor controller, ignition system, and other accessory load electrical circuits.

h) The accessory battery (see i) must maintain a negative ground.

i) The accessory battery provides for all allowed electrical needs such as safety devices (horn, windscreen wipers, lights, hydrogen sensors, hydrogen relays and hydrogen shutdown valve), ignition, fuel injection control, starter motor, and ventilation/cooling fan for the driver. For Internal Combustion vehicles only the accessory battery may also be used for engine management systems.

The capacity of the accessory battery must be sufficient to power all the accessory loads with a sufficient safety margin. An accessory battery load analysis will be reviewed during technical inspection to validate sufficient battery capacity. The accessory battery is not allowed to power compressors, blowers, engine cooling systems or motors.

j) The Organisers reserve the right to request Teams to install one joulemeter, intended to measure the quantity of energy provided by the accessory battery. If this amount of energy exceeds the power typically required to operate the starter motor, horn and safety devices the competitor will be disqualified.

k) Both propulsion and accessory batteries must be installed outside of the driver’s compartment behind a bulk head.

l) The following devices may be powered by batteries other than the propulsion or accessory battery provided they use built-in or small capacity batteries: radio communication system, GPS system, data loggers excluding engine management units, driver ventilators.

m) All electrical/electronic enclosures built and populated by the teams must be made of transparent material or at least have a transparent cover to allow the technical inspectors to view the contents.

# Article 58 – Technical documentation

1. Competitors need to provide technical documentation in 2 stages:
   1. Prior to the event during the online process. This documentation serves only to verify that the teams have an understanding of the rules. Online approval in no way constitutes a pre-approval for the technical inspection phase
   2. At the event. This should be a precise description of the vehicle. During technical inspection, the documentation will be compared against the vehicle. Deviations between the technical documentation and the vehicle will be required to be reconciled prior to passing technical inspection.

Technical documentation- prior to event

1. Competitors must provide through the online submittal process documentation on the vehicle energy supply and propulsion system. It is not necessary to submit detailed component specifications or electrical schematics as part of the online submittal process
2. Energy supply block diagram

The online submitted energy supply block diagram and associated text description must contain information describing the energy flow and component function for the vehicle energy systems. For BE(electrical): Motor, battery/BMS, fuse, wiring, e-stop switches, motor controller, vehicle cut-off mechanism.

1. Propulsion system block diagram.

The online submitted propulsion system block diagram and associated text description must contain information describing the propulsion mechanism for each energy category below: BE(electrical): Motor to road

Technical Documentation – at the event( to be reviewed during Technical inspection)

1. Competitors must have available for inspection with the vehicle printed documentation describing selective technical aspects of the vehicle. The printed documentation must be bound and divided into the following sections. The specific required sections for each energy category are defined below.

BE(electrical): Energy supply diagram(electrical Schematic), Propulsion system diagram, Battery/BMS, Motor/motor controller.

1. The minimal contents of each of the above required sections are defined below:

Energy Supply Diagram: include updated diagrams and associated descriptive text as defined in Article 58 (b) above.

Electrical Schematic: provide a vehicle level schematic showing all vehicle wiring and associated components and connections. The schematic should include component values such as voltage levels and fuse ratings. Schematics of components such as the engine management system or fuel cell controller are not required in this section.

Battery/BMS: (For Lithium-based batteries only) Provide battery/BMS manufacturer component specifications at the lowest level of purchased components. At minimum, the battery documentation should include cell chemistry, cell electrical characteristics, cell series or parallel configurations, battery voltage, and current ratings. The BMS data MUST include:

1. Cell over-voltage and under-voltage protection limits

2. Battery over-current limit (not required for accessory battery)

3. Operation of cell balancing (how and when)

4. Battery over-temperature limit (not required for accessory battery)   
5. How the BMS will protect the battery when an over-voltage, under-voltage, over-current or over-temperature condition is reached, i.e. how will the BMS protect or isolate the battery, in the case of Battery Electric Vehicles, when these limits are reached?

Motor/Motor Controller: Provide motor/motor controller manufacturers component specifications at the lowest level of purchased components. For Battery Electric Vehicles, include design documentation on the purpose built motor controller. The documentation may contain control flow diagrams, motor controller and sub-component schematics and PC board layouts if PC boards were used. Also include software documentation if software was written as part of the motor controller development.

Super Capacitors: Provide super capacitor manufacturers component specifications at the lowest level of purchased components. At a minimum, include super cap system rated voltage and max current.

# Article 67 – BATTERY ELECTRIC VEHICLES

1. The drive train in the ‘Battery Electric’ category is restricted to a **maximum of one electric storage device**, and up to two electric motors, with associated control units. The electric motors may be purchased, purchased-and-modified, or purpose-built. The motor controller MUST be purpose-built for the Shell Eco-marathon. Modifications to purchased motor controllers or the use of purchased motor controller evaluation kits are not acceptable. Motor controllers built from sub-components such as single-board computers, power stages, etc. are encouraged. If a motor controller is built incorporating one or more single printed circuit boards (PCBs), the text “SEM” needs to be included in the mask of the PCB etching.
2. Only Lithium-based batteries are permitted as electric storage devices.
3. The vehicle must be equipped with a Battery Management System (BMS) to control and protect the battery against risk of fire as defined in Article 57:.
   1. Any BMS for propulsion batteriesmust provide an AUTOMATIC isolation of this battery in the event of any measured parameters getting out of their designed range.
4. The Lithium-based battery and any accessory circuits are subject to the maximum voltage defined in a). (ARTICLE 57).
5. Participants are required to present electrical schematics at Technical Inspection.
6. All batteries must be placed outside the Driver’s compartment behind the bulkhead and securely mounted. Bunge cords or other elastic materials are not permitted for securing the battery.
7. All vehicles must be equipped with one joulemeter located between the battery and the motor controller(s) to measure the vehicle propulsion energy consumption.
8. The Organisers will provide the joulemeter for the duration of the event.
9. The joulemeter must be positioned so that the display can be easily read and reset from the outside of the vehicle without the removal of any vehicle body components. It is acceptable to access the joulemeter from outside the vehicle though a hinged door.
10. The joulemeter must be inaccessible to the Driver in his or her normal driving position.

k) All electrical circuits must be protected as defined in Article 57:g.