Definitions:

* EV 5.1.1 Cell – a battery cell or super-capacitor.
* EV 5.1.2 Cell Energy – the maximum cell voltage times the nominal capacity of the used cell.
* EV 5.1.3 TS Accumulator – all cells that store the electrical energy to be used by the TS as a whole.
* EV 5.1.4 Accumulator Container – the container itself, which contains the TS accumulator.
* EV 5.1.5 Accumulator Segments – sub-divisions of the TS accumulator.

Cells:

* EV 5.2.1-2 Prohibited Cells: molten salt, thermal batteries and fuel cells.
* EV 5.3.1 All cells which store the TS energy must be enclosed in (an) accumulator container(s).
* EV 5.3.5 spare cells must be presented at technical inspection.
* EV 5.5.10 Tabs of pouch cells must not carry mechanical loads.
* EV 5.8.3 Cell temperature must be measured at the negative terminal of the respective cell. the sensor used must be in direct contact with the **negative terminal** or **less than 10 mm along the high current path away from the terminal in direct contact with the respective busbar**. It is acceptable to monitor multiple cells with one sensor if this requirement is met for all cells sensed by the sensor.
* EV 5.8.4 Maximum cell temperature: 60 ◦C, or the limit stated in the cell data sheet, whichever is lower.
* EV 5.8.5 An independent cell temperature monitoring device may be provided by the officials during accumulator inspection and must be installed. The device must be placed on the **warmest negative cell terminal** of the accumulator container and in direct contact with the terminal or **less then 30 mm away from it on the busbar**.

TS accumulators:

* EV 5.3.3 If **spare** TS accumulators are used, they must be of the same size, weight and type as those that are replaced.
* EV 5.3.5 Spare accumulators must be presented at technical inspection.
* EV 5.5.12 The AIRs and the main fuse must be separated with an electrically insulated and fire retardant material from the rest of the TS accumulator. Air is not considered to be a suitable insulation material in this case.
* EV 5.5.16 Any TS accumulators that may vent an explosive gas must have a ventilation system to prevent the vented gas from reaching an explosive concentration.
* EV 5.7.1 A circuit that ensures that the intermediate circuit is pre-charged to at least 95 % of the actual TS accumulator voltage before closing the second AIR must be implemented. Therefore the intermediate circuit voltage must be measured.
* EV 5.7.2 The pre-charge circuit must use a mechanical, normally open type relay. All pre-charge current must pass through this relay.

AIR:

* EV 5.6.1 At least two AIRs must be fitted inside each TS accumulator container.
* EV 5.6.2 The AIRs must open both poles of the TS accumulator. If the AIRs are open, no TS voltage may be present outside of the accumulator container and the vehicle side of the AIRs must be galvanically isolated from the accumulator side.
* EV 5.6.3 The AIRs must be mechanical relays of a “normally open” type. Solid-state relays are prohibited.
* EV 5.6.4 The fuse protecting the accumulator TS circuit must have a rating lower than the maximum switch off current of the AIRs.

AMS:

* EV 5.8.1 Each TS accumulator must be monitored by an AMS whenever the LVS is active or the accumulator is connected to a charger.
* EV 5.8.2 The AMS must continuously measure   
  • all cell voltages   
  • the TS current   
  • the temperature of thermally critical cells   
  • for lithium based cells: the temperature of at least 30 % of the cells equally distributed within the accumulator containers.
* EV 5.8.6 The AMS must switch off the TS via the shutdown circuit, if critical voltage, temperature or current values according to the cell manufacturer’s datasheet or these rules persistently occurs for more than:   
  • 500 ms for voltage and current values   
  • 1 s for temperature values   
  The **accuracy**, **noise** and **sample rate** of the measurement must be taken into account.
* EV 5.8.7 AMS cell **voltage measurement** **inputs**, **temperature measurement inputs** and **supply voltage** of decentralized AMS slaves may be rated below the maximum TS voltage if the team has proven by calculations in the Electrical System Form (ESF) that the input voltage rating is reasonably chosen.
* EV 5.8.8 If the AMS opens the shutdown circuit, red indicator light in the cockpit that is easily visible from inside and outside the cockpit even in bright sunlight and clearly marked with the lettering “AMS” must light up. It must stay illuminated until the error state has been manually reset. Signals controlling this indicator are SCS.
* EV 5.8.10 It must be possible to individually disconnect the **current sensor**, a **temperature sensor** and a **cell voltage measurement** wire during technical inspection, if any wire used.
* EV 5.8.11 The AMS must be able to read and display all measured values by connecting a laptop to the AMS.

TS accumulator container:

* EV 5.3.4 Spare cells must be stored in an electrically insulated container made of fire retardant material. The container must be labeled.
* EV 5.3.6 It must be possible to open the TS accumulator container for technical inspection.
* EV 5.3.7 Each TS accumulator container must be removable from the vehicle while still remaining rules compliant without the need to install extra components. A dummy connector or similar may be used to restore the system’s isolation.
* EV 5.3.8 The vehicle number, the university name and the ESO phone number(s) must be displayed and written in **Roman Sans-Serif** characters of at least **20 mm high** on the lid of each TS accumulator container. The characters must be clearly visible and placed on a high contrast background.
* EV 5.4.1 If the TS accumulator container is made from an electrically conductive material, the insulation barrier must be adequately protected against conductive penetrations.
* EV 5.4.2 Every TS accumulator container must contain at least one fuse and at least two AIRs.
* EV 5.4.3 LVS must not be included in the TS accumulator container except where inherently required. Except: **AIRs**, **TS DC/DC converters**, Accumulator Management System (**AMS**), Insulation Monitoring Device (**IMD**), and parts of the **TSAL** and **cooling fans**.
* EV 5.4.7 Every wire used in an TS accumulator container, regardless of whether it is part of the LVS or TS, must be rated to the maximum TS voltage.
* EV 5.4.8 Each TS accumulator container must have a **prominent indicator** (a voltmeter or a red LED visible even in bright sunlight) that will illuminate whenever a voltage greater than 60 VDC or half the maximum TS voltage, whichever is lower, is present at the vehicle side of the AIRs.
* EV 5.4.9 The indicator must be clearly visible while disconnecting the TS accumulator container from the vehicles. The indicator must be clearly marked with “**Voltage Indicator**”.
* EV 5.4.10 The indicator must be hard wired electronics without software control and directly supplied by the TS and always working, even if the accumulator is disconnected from the LVS or removed from the vehicle.
* EV 5.5.1 All TS accumulator containers must lie within and be attached to the primary structure or any additional structures fixed to the primary structure which meet the minimum specification for side impact structures, no higher than the top of the side impact structure.
* EV 5.5.2 The TS accumulator containers must be protected from side or rear impact collisions by structure equivalent to that defined in T 3.2. The container must not be part of this structure.
* EV 5.5.3 TS accumulator container materials must be fire retardant.
* EV 5.5.4 TS accumulator containers must be constructed of **steel** or **aluminum**. With the following requirements:   
  • The bottom of the accumulator container must be at least 1.25 mm thick if made from steel or 3.2 mm if made from aluminium.   
  • The internal and external vertical walls, covers and lids must be at least 0.9 mm thick if made from steel or 2.3 mm if made from aluminium.   
  Alternative materials are allowed with proof of equivalency per T 3.3 or for composite materials per EV 5.5.5. This must be documented in the SES. When alternative materials are used, test samples must be presented at technical inspection.
* EV 5.5.5 Composite TS accumulator containers must have the following requirements:   
  • Data obtained from the laminate perimeter shear strength test and three point bending test, should be used to prove adequate strength is provided.   
  • Each attachment point requires steel backing plates with a minimum thickness of 2 mm. Alternate materials may be used for backing plates if equivalency is approved.   
  • The calculations and physical test results must be included in the SES.
* EV 5.5.6 The floor and walls of the TS accumulator container must be joined by welds, bonding and/or fasteners.
* EV 5.5.7 The TS accumulator container must consist of electrically insulating internal vertical walls with a minimum of 75 % of the height of the external vertical walls, that divide the accumulator container into section of a maximum of 12 kg .
* EV 5.5.9 The mounting of the TS accumulator container to the chassis and the mounting of each cell to the container must be designed to withstand the following accelerations:   
  • 40 g in the longitudinal direction (forward/aft)   
  • 40 g in the lateral direction (left/right)   
  • 20 g in the vertical direction (up/down)   
  Calculations and/or tests must be documented in the SES.
* EV 5.5.13 Any brackets used to mount the TS accumulator container must be made of steel 1.6 mm thick or aluminium 4 mm thick and must have gussets to carry bending loads. Each attachment point including **brackets**, **backing plates** and **inserts**, must be able to withstand 20 kN in any direction.
* EV 5.5.14 Holes, both internal and external, in the TS accumulator container are only allowed for the **wiring-harness**, **ventilation**, **cooling** or **fasteners**. The TS accumulator container must still be compliant with all other rules, especially the ones concerning its structural requirements.
* EV 5.5.15 A sticker according to “ISO 7010-W012” (triangle with black lightning bolt on yellow background) with triangle side length of at least 100 mm and the text “Always Energized” must be applied on every TS accumulator container. The sticker must also contain the text “High Voltage” if the voltage is more than 60 VDC or 25 VAC.
* EV 5.5.17 Every TS accumulator container which is completely sealed must also have a **pressure relief valve** to prevent high-pressure in the container.
* EV 5.5.18 The design of the TS accumulator container and its contents must be documented in the SES including **materials used**, **drawings**, **images**, **fastener locations**, **segment weight**, **cell** and **segment position**.

TS accumulator segment:

* EV 5.3.2 For each TS accumulator segment:   
  maximum static voltage- 120 VDC,   
  maximum energy - 6 MJ,   
  maximum mass- 12 kg.
* EV 5.4.4 Maintenance plugs must allow electrical separation of all TS accumulator segments. The separation must affect **both poles of all segments** (including first and last segment).
* EV 5.4.5 Maintenance plugs must:  
  • **not require tools** to separate the TS accumulator segments.   
  • be non-conductive on surfaces that do not provide any electrical connection.   
  • be physically impossible to electrically connect them in any way other than the design intent configuration.   
  • have a visible sign whether the connection is open or closed. Electrically controlled switches must not be used.
* EV 5.4.6 Each TS accumulator segment must be electrically insulated by the use of suitable rigid and fire retardant material between the segments and on top of the segment. (to prevent arc flashes caused by inter segment contact or by parts/tools accidentally falling into the TS accumulator container during maintenance).
* EV 5.5.8 The accumulator segments must be separated by a rigid, electrically insulating and fire retardant barrier.