

# FORMULA SAE®

## New for 2022 Pre-Competition Accumulator Video

**Although the Submission of this Video is optional, see the *Reason to Submit a Video* section below for incentives!**

### Purpose

The main reason for an accumulator video submission is to shorten the on-site accumulator inspection process while identifying major rules violations approximately a week prior to the start of the competition so that corrections can be made at your shop instead of in your trailer.

Accumulators are very compact, normally with multiple layers of components. Submission of a video will allow the judges to see critical accumulator features without asking your team to disassembly it at the inspection. If your team takes pictures and/or video footage as you assemble your accumulator, creating the video should not be that time consuming.

It is anticipated that teams with more refined accumulators will be preferentially given the Accumulator Inspection first/early. Historically these teams take the least amount of time to complete the accumulator inspection. For a thorough accumulator Video submission, it is our hope that they will be complete with the rest of their accumulator inspection in approximately 30 minutes. This will allow an even flow of EVs into Mechanical and Active Electric Inspections.

### Deadlines and Submission Details

- The video submission can be submitted between May 1<sup>st</sup> until May 31<sup>st</sup>
- A timed PowerPoint presentation (i.e., judges just hit play) will be considered a video. This format would allow teams to use photographs and videos with the ability to add titles and labels. The 10-minute time limit will still apply.
- Teams may submit a video format.
- Submission on FSAEOnline should be the timed PowerPoint file OR a Word document which contain an accessible link to where you have stored the video. For example, host your video privately on YouTube, put a link to that video in a Word document, then submit the Word document.
- Accumulator Inspection sheets will be posted on **June 6th**. (Located in your document submission area)
- Accumulator Inspection order will be posted on **June 8th**.

### Reason to Submit a Video

- Any item on the accumulator checklist that is evident in the video will be pre-checked (i.e., it won't be checked at accumulator inspection)
- If everything is NOT totally evident in the video, the item is question will be noted on your Accumulator Inspection sheet (inspection of noted item instead of everything for that line item)
- All videos will be reviewed, and accumulator tech sheets and acceptable items will be checked off.
- If a video is submitted, the team's accumulator tech sheet will be available to the teams approximately a week before competition. The team will know which items/criteria are already approved and which items/criteria will need to be demonstrated at accumulator inspection.
- ***Accumulator Tech Number order will be determined by the completeness of the accumulator tech sheet.*** THESE INSPECTION ORDER NUMBERS are only valid for Accumulator Inspection

## Video Best Practices

- Read the rules, they evolve/change from year to year
- Download the Accumulator Inspection Sheet
- Take pictures and/or video segments as you assemble your accumulator
- Make your video so that the order of the presentation follows the Accumulator Inspection Sheet from top to bottom
- Submit and have your ESF accepted. The first portion of the Accumulator Tech sheet (items) is marked as complete with an accepted ESF.

## Sample Accumulator Tech Sheet

- The next two pages show the anticipated accumulator checklist. **NOTE:** all accumulator rules are still enforced even though they may not appear on the Tech sheet.
- Section highlighted in **Yellow** will be marked complete if your ESF is accepted
- Items highlighted in **Green** can be marked complete from a team's submitted accumulator video.

ACCUMULATOR INSPECTION			
UNIVERSITY:		INSPECTOR(s):	
	ESF Accepted	<input type="checkbox"/> YES <input type="checkbox"/> NO	
DESIGN			
TSMP	TSMP body protection resistor value.	_____ [kΩ]	
TS Fusing	All wiring protected by overcurrent protection with current rating <= ampacity of wire.	Visible check of documentation	
	All overcurrent protection in TS must have DC voltage rating >= max TS voltage	Visible check of documentation	
	Precharge and discharge circuits must not be fused.	Visible check of documentation	
Accumulator	Maintenance plugs must separate the internal cell stacks. Cell stacks must have a voltage less than 120VDC and a maximum energy of 6MJ. The separation has to affect both poles of the stack.	Per Stack: Max Voltage: _____ [V]  Max Energy: _____ [MJ]	
	AMS must monitor the temperature of at least 20% of the cells	Visible check	
	Temperature sensor must be in direct contact with negative terminal or <10mm away on the bus bar	Visible check	
Shutdown/Safety Circuits	Shutdown buttons directly carry current of AIRs and precharge relay	Visible check of documentation	
	IMD, BMS, and BSPD have independent relays or transistors to open the shutdown circuit.	Visible check of documentation	
	An interlock line opens the AIRs whenever the HVD is removed.	Visible check	
APPS	Must have at least two sensors not sharing supply or signal lines.	Visible check	
	The transfer functions of the two sensors must not cross.	Visible check	
ACCUMULATOR			
HV warning stickers	Accumulator housing must be labeled with "High Voltage" and	Visible check	
Separation on self-developed PCBs	GLV and TS circuits have at least the spacing specified in EV.7.5.7.	Visible check	
HV Path	Bolted connections in the high current path must have a positive locking mechanism. <b>Lock washers, nyloc's and thread locking compound are NOT allowed.</b>	Visible check	
	Soldering is not allowed in the high current path.	Visible check	
Internals	The poles of the accumulator stack(s) and cells must be insulated against the inner wall of the accumulator container if the container is made of electrically conductive material.	Visible check	
	Every accumulator container must contain at least one fuse in the high current path.	Visible check	
	No always energized TS wires leaving accumulator container (All TS wires leaving accumulator disconnected by an AIR).	Visible check	
	Branch circuits are fused within 600mm of source.	Visible check	
	Fuse and AIRs must be separated from the rest of the enclosure by an electrically insulating fireproof material.	Visible check	
Maintenance Plugs	Maintenance plugs can be removed without tools.	Visible check	
	Surfaces of the maintenance plugs must be non-conductive except as required to make the electrical connection.	Visible check	
	Maintenance plugs cannot be incorrectly installed.	Visible check	
Internals - Cell stacks	Each stack has to be electrically insulated by the use of suitable materials towards other stacks in the container and on top of the stack. <b>Air is not a suitable insulation material in this case.</b>	Visible check	

	The contained cell stacks must be separated by an insulating and fire resistant (according to UL94-V0, FAR25 or equivalent) barrier.	Visible check	
Indicator Light	Each container must have an indicator showing that voltages greater than 60V DC are present outside of the container. <b>Indicator must function with accumulator removed from vehicle.</b>	Visible check	
Accumulator Container Connectors	All Tractive System connectors outside of an enclosure must include an interlock.	Visible check	
Spare accumulator(s)	Must have the same size, weight and type	Visible check	
Chargers	Charger connector must incorporate an interlock such that the connectors only become live if is correctly connected.	Visible check	
	HV charging leads must be orange.	Visible check	
Energy Meter	Energy Meter Installed (if located in accumulator) Energy Meter provided (if not in accumulator)	Visible check	
<b>!!TEST AT HIGH VOLTAGE!!</b>			
<b>Pack removed on charging cart</b>			
Accumulator Indicator	Accumulator Indicator indicates if voltage above 60VDC is present outside of the container.	Visible check	
Charging	Emergency stop button on charger stops charging	TS voltage must decrease below 60VDC in 5 sec	
	IMD must open shutdown circuit in 30 seconds when isolation fault is present. 1. Activate Tractive System 2. Connent IMD test box between TSMP and GLVS Ground. 3. IMD must trip in 30 seconds and TS voltage must decrease below 60VDC is 5 sec.	Perform Test	
	When charging, the AMS must be live and must be able to turn off the charger in the event that a fault is detected.	Set vehicle to charge. Team must demonstrate AMS is active.	

## New Technical Inspection Order

PRESENT THE VEHICLE FOR INSPECTION IN THE FOLLOWING ORDER:

1. SAFETY GEAR CHECK (Bring all items, plus rain tires)
2. ACCUMULATOR INSPECTION
3. MECHANICAL TECHNICAL INSPECTION (Can be started with accumulator removed)
4. ELECTRIC VEHICLE ACTIVE INSPECTION
5. TILT TEST
6. RAIN TEST
7. BRAKING PERFORMANCE INSPECTION

## Common Mistakes from Last Year's Inspections

- Brake Pedal Plausibility (spelling?) – Teams are no longer allowed to simulate a power discharge from the accumulator while the brake pedal is depressed using software. The rules require a wire to be installed in the accumulator that is ‘wrapped’ around your current sensor so that an external power supply can simulate a power discharge while the brake pedal is depressed. A good implementation would have the wire wrap around the current sensor 5 to 8 times (this will multiply the supplied current) and have the wires routed to an accumulator bulkhead connector. This plausibility test will be conducted during the active test portion when the accumulator will be installed in your car in the ready to drive mode active (i.e., the accumulator will be sealed – hence the bulkhead connector out of the accumulator).
- High Voltage test points – read the rules! Chassis ground must have a black test point, both POSITIVE and MINUS high voltage test points must be red. Also, all test points must be labeled.
- Power Meter should not be supported by unsupported wire. This is a terrible engineering practice and will not be allowed this year. STANDOFFS!
- Clearing define/mark your high voltage and low voltage regions on mixed circuit boards. Demonstrate the required separation distance for your accumulator design voltage. The best practice is to design a high voltage and low voltage label onto the board with corresponding lines indicating their ‘borders’.
- Ground Fault Isolation systems not functioning during battery charger portion of accumulator inspection. Try this before you leave your shop.