

Formula Student Netherlands				
2023 Inspection Sheet				
Accumulator Inspection				
Car Number				
University				
ESF state				
REQUIRED RESOURCES				
No.	Checkpoint	Checkbox	Comment	
	- All accumulator containers to be used during the event			
	- Accumulator Container Hand Cart			
	- Charger			
	- Tools needed for (dis-)assembly of Accumulator Container			
	- Laptop and cables to display data of the AMS			
	- Print-out of Rule Request (if applicable)			
	- An ESO must attend			
	- Pictures of accumulator internals, if necessary			
	- Datasheets for used wiring, insulation materials, tractive system components and container material with needed values highlighted NOT ON A CELL PHONE			
	- Samples of all wire types used inside the accumulator container			
	- Samples of all used accumulator container material			
	- Power Supply for AIL test			
SAFETY BRIEFING				
No.	Checkpoint		Checkbox	Comment
	- No jewellery, no rings			
	- No cell phone			
	- No watch / no necklace			
	- No sources of distraction			
	- Do not wear synthetic clothes			
	- Wear safety glasses			
	- Wear safety gloves (if necessary)			
BASIC SET OF HV-PROOF TOOLS				
No.	Checkpoint	Checkbox	Comment	
	1 Insulated cable shear	<input type="checkbox"/>		
	2 Insulated screw drivers	<input type="checkbox"/>		
	3 Insulated spanners, if applicable	<input type="checkbox"/>		
	4 Multimeter with protected probe tips	<input type="checkbox"/>		
	5 Two 4mm banana plug test leads (1000V CAT III)	<input type="checkbox"/>		
SAFETY EQUIPMENT				
No.	Checkpoint	Checkbox	Comment	
	6 Face shield	<input type="checkbox"/>		
	7 Safety glasses (minimum three)	<input type="checkbox"/>		
	8 HV Insulating gloves (minimum two pairs)	<input type="checkbox"/>		
	9 HV insulating blankets (two) (min 1m ²) with label or serial number and datasheet	<input type="checkbox"/>		
SELF DEVELOPED PCBs				
No.	Checkpoint	Checkbox	Comment	
	▶ Ask for fully assembled spare PCB of self developed PCBs inside accumulator container			
	10 Sufficient spacing regarding system voltage and implementation	<input type="checkbox"/>		
	11 Sufficient insulation and temperature rating of coating if used, datasheet available	<input type="checkbox"/>		
	12 Coating process according to datasheet	<input type="checkbox"/>		
CHARGER ASSEMBLY				
No.	Checkpoint	Checkbox	Comment	
	13 Completely closed (no open TS connections), test with probe (100mm length, 6mm diameter)	<input type="checkbox"/>		
	14 Interlock integrated	<input type="checkbox"/>		
	15 TSMP integrated	<input type="checkbox"/>		
	16 Emergency shutdown button integrated ≥24mm diameter	<input type="checkbox"/>		
	17 TS wiring is orange, marked with gauge, temperature rating >85°C and voltage rating	<input type="checkbox"/>		
	18 Conductive parts of charging equipment and accumulator are connected to protective earth (PE) while charging	<input type="checkbox"/>		
	19 Conductive parts are able to continuously carry current of 10% of main fuse	<input type="checkbox"/>		
	20 Casing made of at least 0.5 mm thick electrically conductive material or electrically insulated material	<input type="checkbox"/>		
	21 Test conductivity to PE at 1A measurement	<input type="checkbox"/>		
DIS-CHARGE CIRCUIT AND BODY PROTECTION RESISTORS				
No.	Checkpoint	Checkbox	Comment	
	▶ Switch off Charger. Measure resistance between TS+ and TS- measuring points			
	22 Resistance is 30 kΩ + discharge resistor	<input type="checkbox"/>		
	23 Body protection resistor power and voltage rating is sufficient	<input type="checkbox"/>		
INSULATION MEASUREMENT TEST				
No.	Checkpoint	Checkbox	Comment	
	▶ Check low resistance connection between LVMP and PE/casing			
	▶ Choose test voltage to 500V			

	▶ Connect insulation tester to charger TS+ and LV ground		
	▶ Connect charger (do not activate charger) to accumulator, keep AIRs opened		
	▶ Measure resistance: Riso+ = MΩ		
24	Resistance is much higher than (min. 500Ω/V*Umax)	<input type="checkbox"/>	
	▶ Connect insulation tester to TS- and GLV ground		
	▶ Measure resistance: Riso+ = MΩ		
25	Resistance is much higher than (min. 500Ω/V*Umax)	<input type="checkbox"/>	
26	Resistances are nearly equal.	<input type="checkbox"/>	
HOUSING			
No.	Checkpoint	Checkbox	Comment
27	Vehicle number, university name and ESO phone number(s) written on a high contrast background	<input type="checkbox"/>	
28	Roman Sans-Serif characters of at least 20mm high are used	<input type="checkbox"/>	
29	Warning stickers with side length of 100mm and text "Always Energized" and "High Voltage" (if TS >60 V) installed. (triangle with black lightning bolt on yellow background)	<input type="checkbox"/>	
30	Check if all parts and the cover/lid of the housing are rigidly fastened	<input type="checkbox"/>	
	▶ Open container housing, remove maintenance plugs		
	▶ Check if no voltage is present		
ACCUMULATOR CONTAINER MATERIALS AND CELL STACK			
No.	Checkpoint	Checkbox	Comment
	▶ Remove a random stack from the accumulator		
	▶ Compare SES/ESF documentation with the stack on the table		
31	Stack and SES/ESF documentation are the same	<input type="checkbox"/>	
32	Stacks are robust and rigidly fastened to the container	<input type="checkbox"/>	
33	Stacks are insulated and separated by barrier according to UL94-V0, FAR25 or equivalent	<input type="checkbox"/>	
34	Maintenance plugs are located at both poles of each stack (including first and last stack)	<input type="checkbox"/>	
35	Maintenance plugs removable without tools	<input type="checkbox"/>	
36	Maintenance plugs have positive locking mechanism	<input type="checkbox"/>	
37	Maintenance plugs must not be able to unintentionally create circuits or short circuits	<input type="checkbox"/>	
38	Stacks separated by maintenance plugs <120VDC and <6MJ	<input type="checkbox"/>	
39	Cell tabs must not be mechanically loaded	<input type="checkbox"/>	
40	No cells are damaged or can be damaged by the segment structures	<input type="checkbox"/>	
41	Cells securely fastened towards all 3 directions	<input type="checkbox"/>	
42	All parts carrying cells and loads are made of UL94-V0 or equivalent certified materials	<input type="checkbox"/>	
43	Every temperature sensor placed on negative terminal of monitored cell or in <10mm distance on busbar	<input type="checkbox"/>	
44	Galvanic Separation included inside the Accumulator Management System	<input type="checkbox"/>	
45	Internal vertical walls have to be rigidly fastened to the container	<input type="checkbox"/>	
46	Internal vertical walls have a minimum height of 75% of the external walls	<input type="checkbox"/>	
47	Internal vertical walls divide the accumulator in sections of maximum 12 kg	<input type="checkbox"/>	
	▶ Present all Accumulator container materials		
	▶ Compare samples with Accumulator container		
48	Samples and Accumulator container are of equal quality	<input type="checkbox"/>	
ASSEMBLY			
No.	Checkpoint	Checkbox	Comment
49	All components and parts of the TSAC need to be properly fixed	<input type="checkbox"/>	
50	All used fasteners must be secured by the use of positive locking except they are non-conductive and non-structural	<input type="checkbox"/>	
51	TS potentials are insulated against inner wall of accumulator container if container made from conductive material	<input type="checkbox"/>	
52	No soldering in high current path	<input type="checkbox"/>	
53	Every container contains at least one appropriately sized and rated fuse	<input type="checkbox"/>	
	▶ Check datasheet of fuse, main wires and cells and compare to ESF		
54	Every container contains at least two appropriately sized and rated isolation relays	<input type="checkbox"/>	
55	Pre-charge relay is of mechanical type with appropriate voltage rating	<input type="checkbox"/>	
56	Isolation relays and fuses are separated from all other components by a barrier according UL94-V0, FAR25 or equivalent	<input type="checkbox"/>	
57	Holes in container only for wiring harness, ventilation, cooling or fasteners if mechanical properties are not influenced	<input type="checkbox"/>	
58	External openings not pointing towards hand cart operator	<input type="checkbox"/>	
59	Check opening in TS enclosures, try to reach TS potentials with insulated test probe (100mm length, 6mm diameter)	<input type="checkbox"/>	
60	If fully closed, an equalizing valve must be implemented	<input type="checkbox"/>	
61	Spare accumulators of same size, weight and type	<input type="checkbox"/>	
WIRING			
No.	Checkpoint	Checkbox	Comment
62	All TS wires have proper overcurrent protection	<input type="checkbox"/>	
63	No other wires than TS wires are orange	<input type="checkbox"/>	
64	Securely anchored to withstand at least 200N, if outside of enclosure	<input type="checkbox"/>	
65	Located out of the way of possible snagging or damage	<input type="checkbox"/>	
66	TS and LV wires separated (not valid for Interlock)	<input type="checkbox"/>	
67	Every wire used in the Accumulator container (TS and LV) is rated for maximum TS voltage	<input type="checkbox"/>	
68	TS wires are marked with gauge, temperature rating >85°C and voltage rating	<input type="checkbox"/>	
69	Positive locking mechanism or if no positive locking possible, automotive certified components	<input type="checkbox"/>	
	▶ Check if insulated tools needed for the assembly of certified components are available		
70	Insulation is not only insulating tape or rubber-like paint	<input type="checkbox"/>	
INDICATOR LIGHT OR VOLTMETER			
No.	Checkpoint	Checkbox	Comment
71	Red Indicator light or voltmeter installed	<input type="checkbox"/>	
72	Marked with "Voltage Indicator"	<input type="checkbox"/>	

	73	Visible while disconnecting the battery connector	<input type="checkbox"/>	
	74	Hard wired electronics, supplied by TS	<input type="checkbox"/>	
		Connect power supply with 60VDC to accumulator TS connector with proper plugs, ▶ no measuring probes	<input type="checkbox"/>	
	75	Indicator light on or voltmeter showing present TS voltage	<input type="checkbox"/>	
	76	Visible in bright sunlight	<input type="checkbox"/>	
ACCUMULATOR MANAGEMENT SYSTEM				
No.		Checkpoint	Checkbox	Comment
	77	AMS is located in the TSAC	<input type="checkbox"/>	
	78	A minimum of 30% of cells are monitored with temperature sensors	<input type="checkbox"/>	
		▶ Disconnect any AMS internal connector	<input type="checkbox"/>	
	79	The AMS must open the shutdown circuit within 1s	<input type="checkbox"/>	
		▶ Disconnect AMS current sensor	<input type="checkbox"/>	
	80	The AMS must open the shutdown circuit within 0.5s	<input type="checkbox"/>	
		▶ Ask the team to connect their laptop to the AMS	<input type="checkbox"/>	
		▶ Connect charger to battery/batteries, start charging process	<input type="checkbox"/>	
	81	Cell voltages can be displayed	<input type="checkbox"/>	
	82	Cell temperatures can be displayed	<input type="checkbox"/>	
	83	Temperature and voltage limit according to ESF	<input type="checkbox"/>	
	84	Plausible accumulator current can be displayed	<input type="checkbox"/>	
		▶ Disconnect one SINGLE voltage sense wire, if any wires used	<input type="checkbox"/>	
	85	The AMS must open the shutdown circuit within 0.5 s	<input type="checkbox"/>	
		▶ Disconnect one SINGLE temperature sense wire, if any wires used	<input type="checkbox"/>	
	86	The AMS must open the shutdown circuit within 1 s	<input type="checkbox"/>	
CHARGER SHUTDOWN CIRCUIT				
No.		Checkpoint	Checkbox	Comment
	87	IMD is integrated into the charging system	<input type="checkbox"/>	
		▶ Connect charger to battery/batteries, start charging process	<input type="checkbox"/>	
	88	Voltage indicator shows that HV is present	<input type="checkbox"/>	
		▶ Press shutdown button	<input type="checkbox"/>	
	89	AIRs open	<input type="checkbox"/>	
	90	Battery indicator shows voltage <60V	<input type="checkbox"/>	
		▶ Start charging, unplug TSAC connector	<input type="checkbox"/>	
	91	AIRs open	<input type="checkbox"/>	
	92	Charger disabled, no voltage at charger connector, measure on TSMP	<input type="checkbox"/>	
INSULATION MONITORING DEVICE				
No.		Checkpoint	Checkbox	Comment
	93	IMD connected to vehicle side of the AIRs	<input type="checkbox"/>	
		▶ Determine Rtest = (max TS voltage * 250 Ω/V) - BPR	<input type="checkbox"/>	
		▶ Activate charger output, connect RTest between TS+ and LV GND	<input type="checkbox"/>	
	94	Shutdown circuits opens within 30 s	<input type="checkbox"/>	
	95	TS voltage decreases below 60VDC within 5 s after shutdown circuit opens	<input type="checkbox"/>	
	96	Reactivation of charger output is not possible	<input type="checkbox"/>	
		▶ Push the reset button, if any	<input type="checkbox"/>	
	97	Reactivation of charger output is not possible	<input type="checkbox"/>	
		▶ Remove RTest. Wait 40 s until IMD resets status output	<input type="checkbox"/>	
	98	Reactivation of charger output is not possible	<input type="checkbox"/>	
		▶ Activate TS, connect RTest between TS- and LV GND	<input type="checkbox"/>	
	99	Shutdown circuits opens within 30 s	<input type="checkbox"/>	
	100	One IMD GND line is connected to the TSAC and the other to the charger housing with a direct wire	<input type="checkbox"/>	
		- IMD indicator light . . .	<input type="checkbox"/>	
	101	. . . is available during charging	<input type="checkbox"/>	
	102	. . . is red and visible in bright sunlight	<input type="checkbox"/>	
HAND CART				
No.		Checkpoint	Checkbox	Comment
	103	Hand cart has four wheels	<input type="checkbox"/>	
	104	Hand cart has maximal dimensions of 1200mm x 800mm	<input type="checkbox"/>	
	105	Hand cart has always on type brake system	<input type="checkbox"/>	
	106	The accumulator must be mechanically fixed to the handcart while on the handcart	<input type="checkbox"/>	
	107	The accumulator must be protected from vibrations and shocks	<input type="checkbox"/>	
	108	Firewall (same width as hand cart, from lowest point to 30 cm above TSAC/handle) must protect operator	<input type="checkbox"/>	
	109	Label according to EV5.3.8 (checked points 27-28) still visible while on handcart	<input type="checkbox"/>	
SEALING OF COMPONENTS				
No.		Checkpoint	Checkbox	Comment
	110	Seal accumulator container(s)	<input type="checkbox"/>	
	111	Seal charger	<input type="checkbox"/>	
	112	Additional part:	<input type="checkbox"/>	
	113	Additional part:	<input type="checkbox"/>	
OTHER COMMENTS				