

**CHANGELOG**

Version	Comments	Date	Responsible person
0.0	Helmet equipment added	14.07.2024	
0.1	Accumulator inspection – Tasks order is changed	17.08.2024	

**INFORMATIONS**

UNIVERSITY: \_\_\_\_\_  
 VEHICLE NUMBER: \_\_\_\_\_  
 SES PASSED:  YES /  NO  
 IAD PASSED:  YES /  NO  
 ESF PASSED:  YES /  NO  
 TS VOLTAGE: \_\_\_\_\_  
 BODY PROTECTION R: \_\_\_\_\_

Parts of the inspection:  
 1. Pre-Inspection  
 2. Accumulator Inspection  
 3. Low Voltage Inspection  
 4. Mechanical Inspection  
 5. Weighting  
 6. High Voltage Inspection  
 7. Tilt Test  
 8. Rain Test  
 9. Brake Test

**NOTES:**  
 - This form must always stay with the vehicle!  
 - Technical inspection approval is invalid if inspection sheet is lost.  
 - If there is a conflict between this form and the rules, the rules prevail.

**Used Symbols:**

- Information
- ▶ Action
- △ Check in responsibility of the team
- Check

**PART I: COMMENTS FROM DOCUMENT REVIEW**

**ACCUMULATOR**

**ELECTRICAL**

**MECHANICAL**

**PART II: PRE-INSPECTION**

TIS STATUS UPDATE

▶ Set online TIS status to *In Progress*

TIRES

- 1  **DRY TIRES** – Make: \_\_\_\_\_
- 2  **DRY TIRES** – Size: \_\_\_\_\_
- 3  **DRY TIRES** – Compound: \_\_\_\_\_
- 4  **RAIN TIRES** – Make: \_\_\_\_\_
- 5  **RAIN TIRES** – Size: \_\_\_\_\_
- 6  **RAIN TIRES** – Compound: \_\_\_\_\_
- 7  **RAIN TIRES** – 2,4 mm min. tread depth molded by tire manufacturer

DRIVER GEAR & SAFETY

- 8  **FIRE EXTINGUISHERS** – Two (2) hand-held, 0,9 kg (2 lb.) minimum, dry chemical (10BC, 1A10BC, 34B, 5A 34B, 20BE or 1A 10BE), with pressure/charge gauge, Aqueous Film Forming Foam (AFFF) are prohibited, 1 WITH VEHICLE securely installed on push-bar, 1 in paddock. (Must see BOTH at inspection).
- 9  **UNDERWEAR** – Nomex or equivalent, fire resistant underwear (no cotton, no polyester, no bare skin). No holes.
- 10  **SOCKS** – Nomex or equivalent, fire resistant socks (no cotton, no polyester, no bare skin). No holes.
- 11  **GLOVES** – Fire resistant material. Leather allowed only over fire resistant material. No holes.
- 12  **ARM RESTRAINTS** – SFI Standard 3.3 or equivalent
- 13  **EQUIPMENT** – Nothing should be mounted on helmet that is not certified part with/for the helmet - if headset is connected with jack to tx/rx on the car, driver egress has to be done with system connected
- 14  **HELMETS** – Snell K2010, K2015, K2020, M2010, M2015, M2020, SA2010, SAH2010, SA2015, SA2020, EA2016 or newer.SFI 31.1/2010, 31.1/2015, 31.1/2020, 41.1/2010, 41.1/2015, 41.1/2020 or newer FIA 8860-2010, FIA 8860-2018, FIA 8859-2015 (with SA 2015), FIA 8858-2010 (with SA(H) 2010) or newer. Closed Face, no Open Face, must have integrated shield (no dirtbike helmets). No camera mounts.
- 15  **DRIVER SUITS** – Single piece SFI 3.2A/5 (or higher), SFI 3.4/5 (or higher), FIA 8856-2000/2018 (or higher), and LABELED AS SUCH. No holes.
- 16  **HAIR COVER** – Fire resistant (Nomex or equiv.) balaclava of full helmet skirt **REQUIRED FOR ALL DRIVERS**. No holes.
- 17  **SHOES** – SFI 3.3 or FIA 8856-2000/2018
- 18  **SEWING OR STITCHING** – Teams must show compliance to T13.3 if driver's clothing is embroidered. Fire resistant material must be used, examples: Carbon X, Indura, Nomex Polybenzimidazole (PBI) and Proban.

TIS STATUS UPDATE

▶ Set online TIS status to *In Passed or Failed*

**NON-COMPLIANCE / COMMENTS**

**APPROVAL**

Inspector Names	Date, Time	Signatures when passed
1. _____ / _____	_____	_____

**PART III: EGRESS TEST**

**DRIVER POSITION**

- 19 ARM RESTRAINTS** – Must be installed so the driver can release them and exit unassisted regardless of vehicle's position.
- 20 HEAD RESTRAINT** – Near vertical. Max. 25 mm from helmet. Helmet contact point 50 mm min. from any edge.
- 21 MAIN HOOP & FRONT HOOP HEIGHTS** – Helmet of driver to be 50 mm below line between top of front and main roll hoop AND between top of main hoop to rear attachment point of main hoop bracing.
- 22 LAP BELT MOUNTING** – Must pass over pelvic area between 45 - 65 deg. to horizontal for upright driver, 60-80 deg. for reclined. The lap belts must not be routed over the sides of the seat.
- 23 SHOULDER HARNESS MOUNTING** – Angle from shoulder between 10 deg. up and 20 deg. down to horizontal.
- 24 EQUIPMENT** – if headset is connected with jack to tx/rx on the car, driver egress has to be done with system connected

**DRIVER EGRESS TEST**

- All drivers must be able to exit the vehicle in less than 5s
- Driver must be seated in ready to race condition

**EGRESS PROCEDURE**

- ▶ Both hands on the steering wheel. (in all possible steering positions)
- ▶ Pressing cockpit-mounted shutdown button
- The egress time will stop when the driver has both feet on the ground

**DRIVER APPROVAL & RUN DOCUMENTATION**

Driver Name	Wristband ID	Inspector signature when passed	Acc	Skid Pad	AutoX	Endurance
1. _____	_____	_____	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>
2. _____	_____	_____	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>
3. _____	_____	_____	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>
4. _____	_____	_____	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>
5. _____	_____	_____	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>
6. _____	_____	_____	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>

## PART IV: ACCUMULATOR INSPECTION

The time limit for this part of the inspection is 105 minutes. Continuation of the inspection is possible after requeuing. During technical inspection all work carried out on the vehicle must be approved by a technical inspector.

### TIS STATUS UPDATE

- ▶ Set online TIS status to *In Progress*

### COMMENTS

- ▶ Check comments from first page

### REQUIRED RESSOURCES

- <sup>25</sup>  An ESO must attend.
- All accumulator containers to be used during the event.
  - Accumulator Container Hand Cart.
  - Charger.
  - Tools needed for (dis-)assembly of Accumulator Container.
  - PDF or print-out of rule questions, if necessary.
  - Pictures of accumulator internals, if necessary.
  - Datasheets for used wiring, insulation materials, and TS components. (printed or properly sorted on one laptop, not on a cell phone)
  - Samples of all wire types used inside the accumulator container.
  - Samples of all used accumulator container material.
  - Fully assembled spare boards of all inaccessible TS boards inside the accumulator
  - Laptop and cables to display data of the AMS
  - Printed or digital version of ESF.

### SAFETY BRIEFING

- no jewellery, no rings
- no cell phone
- no batch / no necklace
- no sources of distraction
- do not wear synthetic clothes
- wear safety glasses
- wear safety gloves
- use only insulated tools

### BASIC SET OF HV-PROOF TOOLS

- <sup>26</sup>  Insulated cable shear.
- <sup>27</sup>  Insulated screw driver.
- <sup>28</sup>  Insulated spanners (n/a if no screwed connections in TS).
- <sup>29</sup>  Multimeter with protected probe tips.
- <sup>30</sup>  two 4mm banana plug test leads (1000V CAT III).

### SAFETY EQUIPMENT

- <sup>31</sup>  Face shield.
- <sup>32</sup>  Safety glasses (minimum three).
- <sup>33</sup>  HV insulating gloves (minimum two pairs).
- <sup>34</sup>  HV insulating blankets (two) (min 1 m2) with label or serial number and datasheet.

### SELF DEVELOPED PCBs

- ▶ Ask for fully assembled spare PCB of self developed PCBs inside accumulator container.
- <sup>35</sup>  Sufficient spacing regarding system voltage and implementation.
- <sup>36</sup>  Sufficient insulation and temperature rating of coating if used, datasheet available.
- <sup>37</sup>  Coating process according to datasheet.

### HAND CART

- <sup>38</sup>  Hand cart present with four wheels. Max. dimensions 1200 mm x 800 mm.
- <sup>39</sup>  Hand cart has always on type brake system.
- <sup>40</sup>  The accumulator must be mechanically fixed to the handcart while on the handcart.
- <sup>41</sup>  The accumulator must be protected from vibrations and shocks.
- <sup>42</sup>  Firewall (same width as hand cart, from lowest point to 30 cm above TSAC/handle) must protect operator.
- <sup>43</sup>  Label according to EV5.3.8 still visible while on handcart.

### INDICATOR LIGHT OR VOLTMETER

- <sup>44</sup>  Red indicator light or voltmeter installed
- <sup>45</sup>  Marked with "Voltage Indicator"
- <sup>46</sup>  Visible while opening the battery connector.
- <sup>47</sup>  Hard wired electronics, supplied by TS
- ▶ Connect power supply with 60 VDC<sup>1</sup> to accumulator TS connector. Use proper plugs, no measuring probes.
  - <sup>48</sup>  Indicator light on or voltmeter showing present TS voltage.
  - <sup>49</sup>  Visible in bright sunlight

<sup>1</sup> 60V or half the nominal tractive system voltage, whichever is lower

**CHARGER ASSEMBLY**

- 50  Completely closed. Check opening in HV/TS enclosures, try to reach HV/TS potentials with insulated test probe (100 mm length, 6 mm diameter).
- 51  Interlock integrated.
- 52  TSMP integrated.
- 53  Emergency shutdown button integrated.
- 54  Emergency shutdown button  $\geq 24$  mm diameter.
- 55  TS wiring is orange, marked with gauge, temperature rating  $>85^{\circ}\text{C}$  and voltage rating.
- 56  Conductive parts of charging equipment and accumulator are connected to protective earth (PE) while charging. Mind new grounding rules, see EV 3.1.
- 57  Switches, plugs and indicators must be labeled.

**CHARGER SHUTDOWN CIRCUIT**

- 58  IMD is integrated into the charging system
  - ▶ Connect charger to battery/batteries, start charging process
- 59  Voltage indicator shows that HV is present
  - ▶ Press shutdown button
- 60  AIRs open
- 61  Voltage indicator shows voltage  $<60$  V
  - ▶ Start charging, unplug TS accumulator connector
- 62  AIRs open.
- 63  Charger disabled, no voltage at charger connector

**DIS-CHARGE CIRCUIT AND BODY PROTECTION RESISTORS**

- ▶ Switch off Charger. Measure resistance between TS+ and TS- measuring points
- 64  Resistance is  $\text{--- k}\Omega^2$  + discharge resistor.
- 65  Body protection resistor power rating is  $> \text{--- W}^3$ .

**INSULATION MONITORING DEVICE**

- 66  One IMD ground line is connected to the accumulator container and one ground line is connected to the charger casing by a separate wired connection
  - ▶ Rtest =  $\text{--- k}\Omega^4$
  - ▶ Activate charger output, connect RT est between TS+ and LV GND.
- 67  Shutdown circuits opens within 30 s.
- 68  TS voltage decreases below 60 VDC within 5 s after shutdown circuit opens
- 69  Reactivation of charger output is not possible.
  - ▶ Push the reset button, if any.
- 70  Reactivation of charger output is not possible.
  - ▶ Remove Rtest. Wait 40 s until IMD resets status output.
- 71  Reactivation of charger output is not possible.
  - ▶ Activate TS, connect Rtest between TS- and LV GND.
- 72  Shutdown circuits opens within 30 s

**INSULATION MEASUREMENT TEST**

- ▶ Check low resistance connection between LV ground MP and PE/casing
- ▶ Choose test voltage to  $\text{--- V}^5$
- ▶ Connect insulation tester to charger TS+ and LV ground.
- ▶ Connect charger (do not activate charger) to accumulator, keep AIRs opened.
- ▶ Measure resistance: Riso+ =  $\text{--- k}\Omega$
- 73  Resistance is much higher than  $\text{--- k}\Omega^6$ .
  - ▶ Connect insulation tester to TS- and LV ground.
  - ▶ Measure resistance: Riso- =  $\text{--- k}\Omega$
- 74  Resistance is much higher than  $\text{--- k}\Omega^4$ .
- 75  Resistances are nearly equal.
- ▶ **Open container housing, remove maintenance plugs.**
- ▶ Check if no voltage is present.

**ACCUMULATOR CONTAINER**

- ▶ Team must show approved SES for accumulator container.
- ▶ Team must show SES test samples for accumulator container if alternative materials are used.
- 76  Accumulator container manufactured according to SES.
- 77  Internal vertical walls have to be rigidly fastened to the container. Minimum 75% of the height of the external walls. Divide the accumulator in sections of max. 12 kg.
- 78  Cells securely fastened towards all 3 directions.
- 79  All parts carrying cells and loads: UL94-V0 certified materials
- 80  External openings not pointing towards driver or hand cart operator.
- 81  Vehicle number, university name and ESO phone number(s) written on a high contrast background.
- 82  Roman Sans-Serif characters of at least 20 mm high are used.
- 83  Warning stickers with side length of  $\geq 100$  mm and text "Always Energized" and "High Voltage" (if TS  $>60$  V) installed. (triangle with black lightning bolt on yellow background)
- 84  Check if all parts and the cover/lid of the housing are rigidly fastened

<sup>2</sup> 2x Body Protection Resistor (BPR)  
<sup>3</sup> Sufficient to short circuit TS+ and TS-  
<sup>4</sup> Rtest = (max. TS voltage \* 250 Ohm/V) - BPR

<sup>5</sup> Umax  $\leq$  250VDC -> UTest = 250VDC;  
 Umax  $>$  250VDC -> UTest = 500VDC  
<sup>6</sup> Minimal Resistance = 500  $\Omega$ /V \* Umax + BPR

**ASSEMBLY** 

- 85  All components and parts of the accumulator container need to be properly fixed.
- 86  All used fasteners must be secured by the use of positive locking except they are non-conductive and non-structural.
- 87  TS potentials are insulated against inner wall of accumulator container if container made from conductive material.
- 88  Tabs of pouch cells must not carry mechanical loads.
- 89  No cells are damaged or can be damaged by the segment structures.
- 90  No soldering in high current path
- 91  Every container contains at least one appropriately sized and rated fuse.
  - ▶ Check datasheet of fuse, main wire and cells and compare to ESF.
- 92  Every container contains at least two appropriately sized and rated isolation relays (current and voltage).
- 93  Isolation relays and fuses are separated from cells by barrier according UL94-V0 or equivalent.
- 94  Pre-charge relay is of mechanical type with appropriate voltage rating.
  - ▶ Check datasheet of pre-charge relay and compare to ESF
- 95  Maintenance plugs are located at both poles of each stack (including first and last stack).
- 96  Maintenance plugs removable without tools.
- 97  Maintenance plugs have positive locking mechanism.
- 98  Maintenance plugs must not be able to unintentionally create circuits or short circuits.
- 99  Stacks separated by Maintenance plugs  $\leq 120$  VDC.
- 100  Stacks separated by Maintenance plugs  $\leq 6$  MJ.
- 101  Stacks are insulated and separated by a fire resistant barrier according to UL94-V0 for min. used thickness or equivalent.
- 102  Holes in container only for wiring harness, ventilation, cooling or fasteners, if mechanical properties are not influenced.
  - ▶ Check opening in TS enclosures, try to reach TS potentials with insulated test probe (100 mm length, 6 mm diameter).
- 103  If fully closed, equalizing valve implemented.
- 104  Spare accumulators of same size, weight and type.

**WIRING** 

- 105  All TS wires have proper overcurrent protection.
- 106  No other wires than TS wires are orange.
- 107  Securely anchored to withstand at least 200 N, if outside of enclosure.
- 108  Located out of the way of possible snagging or damage.
- 109  TS and LV wires separated (not valid for Interlock).
- 110  Every wire used in the Accumulator container (TS and LV) is rated for  $\geq$  \_\_\_ V<sup>7</sup>.
- 111  Possible to clearly assign and prove gauge, temperature and voltage rating of TS wires.
- 112  Positive locking mechanism or if no positive locking possible, automotive certified components.
  - ▶ Check if insulated tools needed for the assembly of certified components are available
- 113  Insulation is not only insulating tape or rubber-like paint.

**ACCUMULATOR MANAGEMENT SYSTEM** 

- 114  A minimum of 30 % of cells are monitored with temperature sensors.
  - ▶ Connect charger to battery/batteries, start charging process.
- 115  Every temperature sensor placed on negative terminal of monitored cell or in <10mm distance on busbar.
  - ▶ Disconnect AMS current sensor connector
- 116  The AMS must open the shutdown circuit within 0.5 s.
  - ▶ Disconnect one SINGLE voltage sense wire, if any wires used.
- 117  The AMS must open the shutdown circuit within 1 s.
  - ▶ Disconnect any other AMS internal connector
  - ▶ The AMS must open the shutdown circuit within 0.5 s.
  - ▶ Disconnect one SINGLE temperature sense wire, if any wires used.
- 118  Cell voltages can be displayed.
- 119  Cell temperatures can be displayed.
- 120  Plausible accumulator current can be displayed.
- 121  The AMS must open the shutdown circuit within 0.5 s.
- 122  The AMS must open the shutdown circuit within 1 s.

**SEALING OF COMPONENTS**

- ▶ After all tests have been passed successfully seal the inspected TS housings:
- 123  Accumulator container(s) including spares
- 124  Charger
- 125  Additional Part:
- 126  Additional Part:

**TIS STATUS UPDATE**

- ▶ Set online TIS status to *Passed* or *Failed*

**NON-COMPLIANCE / COMMENTS**

**APPROVAL**

Inspector Names	Date, Time	Signatures when passed
1. _____ / _____	_____	_____

<sup>7</sup> Max. TS voltage

## PART V: LOW VOLTAGE ELECTRICAL INSPECTION

The time limit for this part of the inspection is 60 minutes. Continuation of the inspection is possible after requeuing.  
The Tractive System Accumulator Container(s) shall be outside of the car during this inspection.  
During technical inspection all work carried out on the vehicle must be approved by a technical inspector.

### TIS STATUS UPDATE

- ▶ Set online TIS status to *In Progress*

### COMMENTS

- ▶ Check comments from first page

### REQUIRED RESSOURCES

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>127 <input type="checkbox"/> An ESO must attend</p> <ul style="list-style-type: none"> <li>• LV battery or cell datasheet</li> <li>• For self-developed LV battery packs: an opened battery pack, laptop, and cables to display data of the AMS</li> <li>• Datasheets for used wiring, insulation materials, and TS components. (printed or properly sorted on one laptop, not on a cell phone)</li> <li>• At least all non-passed parts of the ESF. (printed or properly sorted on one laptop, not on a cell phone)</li> </ul> | <ul style="list-style-type: none"> <li>• Samples of all wire types used for the tractive system</li> <li>• Fully assembled spare boards of all inaccessible TS boards outside the accumulator</li> <li>• The connector to safely supply the TS using shrouded receptacles when the TS accumulator is unconnected</li> <li>• Photographs of all inaccessible TS connections</li> <li>• HVD is disconnected</li> <li>• HVD dummy if used</li> </ul> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### LV BATTERY

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>128 <input type="checkbox"/> Voltage <math>\leq 60</math> VDC</p> <p>129 <input type="checkbox"/> Rigid and sturdy casing</p> <p>130 <input type="checkbox"/> Only for wet-cell batteries: IPX7 rated and acid resistant casing if inside cockpit</p> <p>131 <input type="checkbox"/> Behind Firewall</p> <p>132 <input type="checkbox"/> Short circuit protection (e.g. fused)</p> <p>133 <input type="checkbox"/> Grounded to the chassis</p> <p>134 <input type="checkbox"/> Proper insulation of internal electrical connections</p> <p>135 <input type="checkbox"/> Proper mounting of cells</p> <p>136 <input type="checkbox"/> Complete battery pack inside rollover protection envelope</p> | <ul style="list-style-type: none"> <li>• Following checks only for Li-Ion batteries other than LiFePO4:</li> </ul> <p>137 <input type="checkbox"/> UL94-V0 for min. used thickness or equivalent casing</p> <p>138 <input type="checkbox"/> Overcurrent protection that trips below max. discharge current</p> <p>139 <input type="checkbox"/> Overtemperature protection of at least 30 % of the cells (max. 60°C or datasheet, whichever is lower)</p> <p>140 <input type="checkbox"/> Voltage protection of all cells</p> <p>141 <input type="checkbox"/> Signal failures electrically disconnect the LV battery (SCS)</p> <p>▶ Ask the team to connect their laptop to the AMS</p> <p>142 <input type="checkbox"/> Cell voltages can be displayed</p> <p>143 <input type="checkbox"/> Cell temperatures can be displayed</p> |
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### SELF DEVELOPED PCBs

- |                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                   |
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| <p>▶ Ask for fully assembled spare PCB of self-developed PCBs</p> <p>144 <input type="checkbox"/> Sufficient spacing regarding system voltage and implementation</p> <p>145 <input type="checkbox"/> Sufficient insulation and temperature rating of coating if used, datasheet available</p> | <p>146 <input type="checkbox"/> Coating process according to datasheet</p> <p>147 <input type="checkbox"/> <math>\Delta</math> The 1 min AC RMS isolation voltage is <math>\geq 3 \times</math> max. TS voltage</p> <p>148 <input type="checkbox"/> BSPD PCB(s) is standalone with only minimum interface</p> <p>149 <input type="checkbox"/> BSPD PCB(s) are directly supplied from the LVMS</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### MASTER SWITCHES

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>150 <input type="checkbox"/> TSMS &amp; LVMS installed easily accessible on the right side of the vehicle and located next to each other</p> <p>151 <input type="checkbox"/> <math>\Delta</math> All master switches are located above 80% of shoulder height of Percy</p> <p>152 <input type="checkbox"/> Rigidly mounted and no need to be removed during maintenance</p> <p>153 <input type="checkbox"/> Rotary type with removable handle</p> <p>154 <input type="checkbox"/> <math>\Delta</math> Handle length <math>\geq 50</math> mm</p> <p>155 <input type="checkbox"/> "ON" position in horizontal</p> <p>156 <input type="checkbox"/> "ON" and "OFF" positions marked</p> <p>157 <input type="checkbox"/> TSMS with locking mechanism for "OFF" position</p> | <p>158 <input type="checkbox"/> LVMS marked with "LV" and a symbol showing a red spark in a white-edged blue triangle</p> <p>159 <input type="checkbox"/> LVMS mounted on a red circular area on high contrast background</p> <p>160 <input type="checkbox"/> <math>\Delta</math> Circular area diameter <math>\geq 50</math> mm</p> <p>161 <input type="checkbox"/> TSMS marked with "TS" and triangle with black lightning bolt on yellow background</p> <p>162 <input type="checkbox"/> TSMS mounted on an orange circular area on high contrast background</p> <p>163 <input type="checkbox"/> <math>\Delta</math> Circular area diameter <math>\geq 50</math> mm</p> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### MEASURING POINTS

- |                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>164 <input type="checkbox"/> Two TS measuring points on exclusive orange background</p> <p>165 <input type="checkbox"/> A black LV ground measuring point installed</p> <p>166 <input type="checkbox"/> Next to the master switches</p> <p>167 <input type="checkbox"/> 4 mm shrouded banana jacks</p> | <p>168 <input type="checkbox"/> Non conductive cover</p> <p>169 <input type="checkbox"/> Cover removable without tools</p> <p>170 <input type="checkbox"/> Correctly marked ("TS+", "TS-", "GND")</p> <p>171 <input type="checkbox"/> Are not located on a removable bodywork</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**TS SHUTDOWN DEVICES**

- 172  Two shutdown buttons installed next to the main hoop, right and left on the vehicle at approx. height of the driver's head. Push-Pull or Push-Rotate-Pull functionality
- 173  Marked with red sparked sticker
- 174  Diameter >39 mm
- 175  One cockpit shutdown button installed. Push-Pull or Push-Rotate-Pull functionality
- 176  Marked with red sparked sticker
- 177  Easy actuation by the driver
- 178  Diameter  $\geq 24$  mm
- 179  Inertia switch rigidly mounted to the chassis and can be demounted for functionality test
- ▶ Check interlocks on . . .
- 180  TS accumulator container(s)
- 181  Inverters
- 182  HVD
- 183  Power distribution boxes
- 184  Data Logger box
  - Outboard wheel motors . . .
- 185  . . . have a dedicated interlock wire routed along the TS wiring, must act before the TS wiring or its clamping fails
- 186  . . . have a dedicated interlock wire routed along a suspension member, must act if the suspension fails
- 187  . . . interlock(s) can be opened for demonstration

**TS VOLTAGE**

- ▶ Measure voltage at TS measuring points
- 188  Equal or less than 60 VDC

**TS WIRING**

- 189  All TS wiring and components have to be in the envelope and behind the impact structures
- 190  TS connectors outside of enclosures cannot be physically connected other than the design intent configuration
- 191  TS wires of outboard wheel motors must not be able to reach the cockpit opening in case of a wire break. The wiring outside of the impact structure is the shortest possible distance.
- 192  All TS wires and connectors have proper overcurrent protection
- 193  TS wiring channels are orange
- 194  No other wires than TS wires are orange
- 195  TS wiring outside electrical enclosures in separate nonconductive conduit or orange shielded cable
- 196  Securely anchored to withstand at least 200 N, if outside of enclosure
- 197  Located out of the way of possible snagging or damage
- 198  Shielded against rotating/moving parts
- 199  No wire lower than the chassis
- 200  TS and LV wires separated (n/a for interlock)
- 201  Possible to clearly assign and prove gauge, temperature, and voltage rating of TS wires
- 202  Suitable temperature rating for used position
- 203  Positive locking mechanism on every screwed connection. (Photographs for all inaccessible TS connections)
- 204  TSMPs: positive locking mechanism on every connection. (Photographs for all inaccessible TS connections)
- 205  Insulation is not insulating tape or rubber-like paint

**DATA LOGGER**

- 206  Data logger is fully enclosed in a housing
- 207  Data logger is rigidly mounted
- 208  All energy from accumulator flows through the data logger

**TRACTIVE SYSTEM PROTECTIONS**

- ▶ Check openings in TS enclosures, try to reach TS potentials with insulated test probe (100 mm length, 6 mm diameter)
- 209  Not possible to reach any TS potentials
- 210  TS components and containers protected from moisture

**HV WARNING STICKERS**

- ▶ Check for warning stickers on TS containing enclosures. (triangle with a black lightning bolt on yellow background)
- 211  Inverter(s)
- 212  Motor(s)
- 213  Power Distribution box(es)
- 214  Energy meter box
- 215  Other TS containing enclosures

**HIGH VOLTAGE DISCONNECT**

- 216  Clearly marked with "HVD"
- 217  Distance to ground greater than 350 mm
- 218  Inside roll-over protected envelope
- 219  Easily visible while standing behind the vehicle
- 220  No remote actuation (e.g. through wires)
- 221  Integrated interlock
  - ▶ Ask the team to connect the HVD
  - ▶ Stand next to the vehicle, remove HVD
- 222  Removed within 10 s without tools
- 223  TS protection still given (insulated test probe). If a dummy connector is used, it must be stored at the push bar

**TRACTIVE SYSTEM ACTIVE LIGHT**

- 224  Max. 75 mm below the highest point of the main hoop and within the roll-over protected envelope (including mounting)
- 225  Full illuminated surface visible by a person standing 3 m away from TSAL (1.6 m eye height)
- 226   $\leq 10^\circ$  blocked by main hoop



**☐ FIREWALLS**

- Separates any point of the driver (less than 100 mm above the bottom of the helmet of the tallest driver) from any TS component (including TS wiring) . . .
- 227  . . . behind the driver's back
- 228  . . . at the sides of the driver
- 229  . . . at the front of the vehicle
- 230  First layer, facing TS must be made of Aluminum with a thickness of at least 0.5 mm
- 231  Second layer, facing driver must be made of electrically insulated material (no CFRP)
- 232  Material meets UL94-V0 for min. used thickness or equivalent
- 233  TSAC cooling duct openings do not point towards the driver, although if behind a firewall

**☐ ACCELERATOR PEDAL POSITION SENSOR (APPS)**

- 234  Returns to the original position if not actuated
- 235  At least two sensors with different transfer functions, each having a positive slope sense with either different gradients and/or offsets to the other(s) are installed. (For digital sensors, a checksum is necessary)
- 236  Sensors do not share supply or signal lines
- 237  Sensors are protected from being mechanically overstressed (positive stop of the pedal)
- 238  Minimum two springs installed to return pedal
- 239  Each spring still returns pedal with the second one disconnected (springs in the torque encoders not counted)

**☐ BRAKE LIGHT**

- 240  Only one brake light in red color
- 241  Located on vehicle centerline, height between wheel centerline and drivers shoulder
- 242  Round, triangle, or rectangular on black background
- 243  15 cm<sup>2</sup> minimum illuminated area OR LED strips with a total length greater than 150 mm with elements <20 mm apart

**☐ DIS-CHARGE CIRCUIT AND BODY PROTECTION RESISTORS**

- ▶ Switch off LV. Measure resistance between TS+ and TS- measuring points
- 244  Resistance is \_\_\_\_ kΩ<sup>8</sup> + discharge resistor
- 245  Body protection resistor power rating is > \_\_\_\_ W<sup>9</sup>
- 246  Dis-charge power rating is sufficient for continuous dis-charge

**☐ TIS STATUS UPDATE**

- ▶ Set online TIS status to *Passed* or *Failed*

**NON-COMPLIANCE / COMMENTS**

**APPROVAL**

Inspector Names	Date, Time	Signatures when passed
1. _____ / _____	_____	_____

<sup>8</sup> 2x Body Protection Resistor (BPR)

<sup>9</sup> Sufficient to short circuit TS+ and TS-

**PART VI: HIGH VOLTAGE ELECTRICAL INSPECTION**

The time limit for this part of the inspection is 60 minutes. Continuation of the inspection is possible after requeuing.  
The Tractive System Accumulator Container(s) shall be inside the car during this inspection.  
During technical inspection all work carried out on the vehicle must be approved by a technical inspector.

**TIS STATUS UPDATE**

- ▶ Set online TIS status to *In Progress*

**COMMENTS**

- ▶ Check comments from first page

**REQUIRED RESSOURCES**

- <sup>247</sup>  An ESO must attend
  - Datasheets for used wiring, insulation materials, and TS components. (printed or properly sorted on one laptop, not on a cell phone)
  - At least all non-passed parts of the ESF. (printed or properly sorted on one laptop, not on a cell phone)
- Samples of all wire types used for the tractive system
- Fully assembled spare boards of all inaccessible TS boards outside the accumulator
- The connector to safely close the SDC while the HVD is removed
- Photographs of all inaccessible TS connections

**INSULATION MEASUREMENT TEST**

- ▶ Choose test voltage to 500V<sup>10</sup>
- ▶ Connect insulation tester to TS+ and LVMP
- ▶ Measure resistance: Riso+ = \_\_\_\_\_ kΩ
- <sup>248</sup>  Resistance is much higher than \_\_\_\_\_ kΩ<sup>11</sup>
- ▶ Connect insulation tester to TS- and LVMP
- ▶ Measure resistance: Riso- = \_\_\_\_\_ kΩ
- <sup>249</sup>  Resistance is much higher than \_\_\_\_\_ kΩ<sup>11</sup>
- <sup>250</sup>  Resistances are nearly equal

**COCKPIT INDICATORS**

- TS off indicator light . . .
- <sup>251</sup>  . . . is inside the cockpit and marked with "TS off"
- <sup>252</sup>  . . . is green and visible in bright sunlight
- <sup>253</sup>  . . . is visible for the driver

**GROUNDING CHECKS**

- EV 3.1 has been fully revised. Each TS enclosure must either contain a ≥0.5 mm properly grounded conductive layer or all materials must be electrically isolating for each own. Conductive seat, driver harness, and firewall mountings, as well as TS firewalls and conductive parts protruding through TS enclosures, must be properly grounded. A conductive part having ≤300 mΩ measured at 1 A and being able to continuously carry ≥10 % of the TS main fuse to LVS ground is properly grounded. Other conductive parts within 100 mm of any TS component must be ≤100 Ω to LVS ground.
- It is possible to join two TS enclosures one following EV 3.1.1 point 1 and the other one following EV 3.1.1 point 2 if each individual TS enclosure is fully closed.
  - ▶ Check for each TS enclosure . . .
- <sup>254</sup>  . . . all materials used to build a TS enclosure separately have a resistance ≥2 MΩ @ 500 V ⇒ fully isolated TS enclose, no grounded layer needed
- <sup>255</sup>  . . . expect e.g. screws, (shielded) connectors, backing plates isolating materials used ⇒fully isolated TS enclose, no grounded layer needed but protruding elements must be properly grounded
- <sup>256</sup>  . . . at least one material has <2 MΩ ⇒ ≥0.5 mm thick solid grounded layer made of aluminium or better required and properly grounded
- <sup>257</sup>  . . . a ≥0.9 mm thick steal layer might be used for TSAC as the grounded layer
  - ▶ Measure resistance of conductive parts to LVS ground next to TSMPs (max. 300 mΩ @ 1 A) . . .
- <sup>258</sup>  . . . main hoop
- <sup>259</sup>  . . . seat mounting points
- <sup>260</sup>  . . . driver harness mounting points
- <sup>261</sup>  . . . firewall mounting points, also if not protruding through the firewall
- <sup>262</sup>  . . . TS firewall
- <sup>263</sup>  . . . TS accumulator container
- <sup>264</sup>  . . . TS enclosures if applicable
- <sup>265</sup>  . . . TS enclosure protruding parts if applicable
- <sup>266</sup>  . . . parts protruding through TS enclosures
- <sup>267</sup>  Each grounding is able to carry ≥10 % of TS main fuse
  - ▶ Measure resistance of conductive parts to LVS ground (max. 100 Ω) . . .
- <sup>268</sup>  . . . carbon fiber part within 10 cm around TS part
- <sup>269</sup>  . . . suspension front left or right if applicable
- <sup>270</sup>  . . . suspension rear left or right if applicable

<sup>10</sup> Umax ≤ 250VDC -> UTest = 250VDC;  
Umax > 250VDC -> UTest = 500VDC

<sup>11</sup> Minimal Resistance = 500 Ω/V \* Umax + BPR

**!!! TEST AT HIGH VOLTAGE !!!**

**☐ TRACTIVE SYSTEM POWER-UP**

- ▶ All driven wheels are off the ground, driven wheels removed
- ▶ Connect multimeter between TS+ and TS-
- ▶ Switch on TSMS with LVMS deactivated
- 271  Voltage at TS measurement points less or equal 60 VDC
- ▶ Switch on LVMS with TSMS deactivated
- 272  IMD and AMS and TS Cockpit indicator light illuminate for 1 s to 3 s for visible check
- 273  Voltage at TS measurement points less or equal 60 VDC
- ▶ Switch on TSMS and all shutdown buttons
- ▶ Reset any IMD or AMS errors
- 274  TS still deactivated
- ▶ Activate TS, measure TS voltage during TS power-up. Use the team's multimeter and test leads. Set multimeter into manual range
- 275  System is precharged before second AIR closes
- ▶ Switch off TSMS
- 276  TS voltage decreases below 60 VDC within 5 s
- ▶ Try to power-up TS with switched off TSMS
- 277  TS still deactivated
- ▶ Switch on TSMS
- 278  TS still deactivated

**☐ TRACTIVE SYSTEM SHUTDOWN**

- ▶ Connect multimeter between TS+ and TS-
- ▶ For each of the following switches, deactivation leads to TS shutdown, the voltage decreases below 60 VDC within 5 s
- 279  LVMS
- 280  Shutdown button left
- 281  Shutdown button right
- 282  Cockpit shutdown button
- 283  Inertia switch
- 284  Break-over-travel-switch
- ▶ Show schematic of TS with all interlocks (ESF)
- 285  Interlocks

**☐ TRACTIVE SYSTEM ACTIVE LIGHT**

- ▶ Activate LVS
- 286  TSAL and Cockpit Indicator (CI) is green only
- ▶ Activate TS
- 287  TSAL flashes red with freq 2 Hz - 5 Hz, and CI is off
- 288  TSAL is clearly visible (horizontal position, entire illuminated surface)
- ▶ Deactivate TS, disconnect TSAC state detection circuitry connector if applicable<sup>12</sup>, activate LVS and TS
- 289  TSAL flashes red and CI is off
- ▶ Deactivate TS, reconnect TSAC state detection, connect power supply >60 VDC<sup>13</sup> to TS<sup>14</sup>, activate LVS
- 290  TSAL is both green and red flashing simultaneously and CI is on
- ▶ Disconnect power supply, remove HVD, override HVD interlock (!! cover TS potentials !!), activate LVS and TS
- 291  TSAL and CI is off

**☐ INSULATION MONITORING DEVICE**

- 292  One IMD ground line is connected to the accumulator container<sup>15</sup> and one ground line is connected to the main hoop by a separate wired connection
- ▶ Rtest = \_\_\_\_ kΩ<sup>16</sup>
- ▶ Activate TS, connect Rtest between TS+ and LV GND
- 293  Shutdown circuits opens within 30 s
- 294  IMD indicator light illuminates
- 295  TS voltage decreases below 60 VDC within 5 s after shutdown circuit opens
- ▶ Try to activate the TS by the required additional action (EV5.11.2)
- 296  Reactivation of TS is not possible
- IMD indicator light . . .
- 297  . . . is inside the cockpit and marked with "IMD"
- 298  . . . is red and visible in bright sunlight, even from outside
- 299  . . . is visible for the driver
- ▶ Push the reset button which is not accessible to the driver, if any and/or restart LVMS
- 300  Reactivation of TS is not possible
- ▶ Remove Rtest. Wait for 40 s until IMD resets status output
- 301  Reactivation of TS is not possible
- ▶ Push all reset buttons in the cockpit, if any
- 302  Reactivation of TS is not possible
- ▶ Push the IMD reset button which is not accessible to the driver, if any
- 303  Reactivation of TS is possible
- ▶ Push and hold the reset button which is not accessible to the driver, if any. Connect Rtest between TS- and LV GND
- 304  Shutdown circuits opens within 30 s
- 305  IMD indicator light illuminates

**☐ ACCUMULATOR MANAGEMENT SYSTEM**

- ▶ Disconnect TS accumulator
- 306  AMS indicator light is illuminated.
- AMS indicator light . . .
- 307  . . . is inside the cockpit and marked with "AMS"
- 308  . . . is illuminated red and visible in bright sunlight, even from outside
- 309  . . . is visible for the driver
- ▶ Ask the team to connect their laptop to the AMS
- 310  AMS data can be displayed

<sup>12</sup> Skip test if disconnecting the connector also opens the interlock and/or stops LVS supply

<sup>13</sup> 25 VAC equal 42.5VDC when signal is sinusoidal

<sup>14</sup> Do not use measuring points. The team needs to provide a method of connection that uses the same receptacles as used for TSMP

<sup>15</sup> Or IMD's enclosure

<sup>16</sup> Rtest = (max. TS voltage \* 250 Ω/V) - BPR

**READY TO DRIVE ACTIVATION SEQUENCE**

- ▶ Activate TS, press torque pedal
- 311  No turning of motors
- ▶ Let the team set the vehicle to ready-to-drive mode
- 312  Pressing brake pedal WHILE activating is necessary
- ▶ Repeat the activation sequence, but push the brake pedal only once before finally pushing the activation button
- 313  No ready-to-drive mode possible
- ▶ Disconnect the brake sensor
- 314  No ready-to-drive mode possible
- 315  Ready to drive sound duration is 1 s to 3 s continuously
- 316  Ready to drive sound is min 80 dBA (2 m around the vehicle)
- 317  Ready to drive sound is easily recognizable and no animal sound or song part

**APPS AND BSPD**

- ▶ Set vehicle to ready to drive state
- ▶ Disconnect  $\geq 50\%$  of APPS
- 318  Motors do not turn
- ▶ Disconnect all APPS
- 319  Motors do not turn
- ▶ Team simulates 5 kW power (complete BSPD circuitry must be used), press brake representing hard braking ( $>0.5$  s)
- 320  TS shuts down
- ▶ Reactivate TS. Disconnect the current sensor, press brake representing hard braking ( $>0.5$  s)
- 321  TS shuts down
- 322  Reactivation of TS is only possible after 10 s without implausibility

**SEALING OF COMPONENTS**

- ▶ After all tests have been passed successfully seal the inspected TS housings:
- 323  Motor Controller housing
- 324  Energy Meter housing
- 325  IMD housing
- 326  TSAL circuitry housing
- 327  BSPD casing /BSPD calibration
- 328  Additional Part:
- 329  Additional Part:

**DATA LOGGER**

- 330  Check data logger functionality and connectivity

**TIS STATUS UPDATE**

- ▶ Set online TIS status to *Passed* or *Failed*

**NON-COMPLIANCE / COMMENTS**

**APPROVAL**

Inspector Names	Date, Time	Signatures when passed
1. _____ / _____	_____	_____

**PART VII: MECHANICAL INSPECTION**

The time limit for this part of the inspection is 75 minutes. Continuation of the inspection is possible after requeuing. During technical inspection all work carried out on the vehicle must be approved by a technical inspector.

**TIS STATUS UPDATE**

- ▶ Set online TIS status to *In Progress*

**COMMENTS**

- ▶ Check comments from first page

**VEHICLE WITH TALLEST DRIVER READY TO RACE**

- 331  **PUSH BAR (red color)** – With vehicle, securely attached to vehicle, detachable, push & pull function for 2 people. University must be written on. Two pair of HV gloves in protecting case and Multimeter must be installed. The inspection sheet must always stay with push bar.
- 332  **CAMERAS** – Must be secured by two points, see T13.5. No cameras mounted to helmet.
- 333  **VISIBILITY** – Minimum of 100 deg. field either side. Head rotation allowed or mirrors. If mirrors, must be firmly installed and adjusted.
- 334  **VEHICLE CONTROLS** – All controls, including shifter, must be inside cockpit. No arms or elbows outside the SIS plane.
- 335  **DRIVER FLUID PROTECTION** – A firewall (rigidly mounted cover plate for cooling systems using plain water (except wheel motors and their cooling hoses)) must extend sufficiently far upwards and/or rearwards such that any point, less than 100mm above the bottom of the helmet of the tallest driver, is not in direct line of sight with any of the following parts: cooling system and low voltage battery.
- 336  **ROLL BAR PADDING** – Roll bar or bracing that could be hit by driver's helmet must be covered with 12mm thick, SFI spec 45.1 or FIA 8857-2001 padding.
- 337  **OTHER SIDE TUBES** – Design prevents driver's neck hitting bracing or other side tubes
- 338  **HEAD RESTRAINT** – Near vertical. Must take 890N load. 40mm thick, SFI 45.2 standard. Max. 25mm from helmet. Helmet contact point 50mm min. from any edge. May be changed for different drivers. Minimum 150x150mm.
- 339  **DRIVER RESTRAINT HARNESS** – SFI 16.1, SFI 16.5, SFI 16.6, FIA 8853/98 or FIA 8853/2016. 6- or 7-point system – Two-piece lap belt (min. width 50mm), two shoulder straps (min. width 75mm) and two leg or anti-submarine straps (min. width 50mm). (7-point system must have three anti-submarine straps). Must be securely attached to prim. structure (25.4 x 2.4mm or equal.)
- 340  **LAP BELT MOUNTING** – Pivoting mounting with eye bolts or shoulder bolts attached securely to Primary Structure. Min. tab thickness 1.6mm. Attachment brackets to the monocoque must be steel, see T5.3.2.
- 341  **SHOULDER HARNESS MOUNTING** – Mounting points 180 - 230mm apart (measured center to center). Angle from shoulder between 10 deg. up and 20 deg. down to horizontal. Attach to Primary Structure - 25.4 x 2.4mm or 25.0 x 2.5mm steel tube min. NOT to put bending loads into Main Hoop Bracing without extra bracing. Additional braces if not straight to main hoop. Cannot pass through a firewall. Attachment brackets to the monocoque must be steel.
- 342  **SUSPENSION** – Fully operational with dampers front and rear; 50mm minimum wheel travel (minimum jounce of 25mm) with driver in vehicle.

**VEHICLE WITHOUT DRIVER**

- 343  **TECH STICKER SPACE** - 70 mm x 150 mm on centerline of front of vehicle in front of the cockpit opening
- 344  **SCHOOL NAME & OTHER DECALS** - School Name, or recognized initials - min. 50mm tall (all letters). on both sides in Roman letters. Must be clearly visible.
- 345  **VEHICLE NUMBERS** - On front & both sides of vehicle, minimum 150mm tall, 20mm stroke & spacing, 25mm min. between number and background edge, Black on White, White on Black only, specified background shapes. Must be clearly visible, font: Roman Sans-Serif characters.
- 346  **BODYWORK EDGES** - edges that could contact a pedestrian must have a minimum radius of 1.0mm (safety requirement)
- 347  **BODY & STYLING** - Open wheeled, open cockpit, formula style body. Vertical keepout zones 75mm in front and behind tires (no aero exceptions), tires unobstructed from sides.
- 348  **BODYWORK** - Min. 38mm radius on nose. No large openings in bodywork into driver compartment in front of or alongside driver, (except cockpit opening).
- 349  **AERODYNAMIC DEVICES** - Securely mounted. The deflection may not exceed 10mm when a force of 200N is applied over a surface of 225 cm<sup>2</sup> and not more than 25mm when a point force of 50N is applied.
- 350  **AERODYNAMICS** - ALL aerodynamic devices maximum 250mm rearward of rear tires, maximum 700mm forward of front tires. Devices lower than 500mm from the ground rearward of the front axle must be no wider than vertical plane from the outside of the front and rear tires. Devices higher than 500mm behind the front axle must not be wider than the inside of the rear tires.
- 351  **AERO VERTICAL HEIGHT** - Devices forward of a vertical plane through the rearmost portion of the front face of the driver head restraint support, excluding any padding, set to its most rearward position, must be lower than 500mm from the ground. Rear device max 1.2 m above ground (incl. end plates); Front device max 250mm above ground outside of the inside plane of the front tires inside this plane max 500mm.
- 352  **EDGES/RADII** - Edges that could contact a pedestrian must have a minimum radius of: horizontal leading edges min 5mm; vertical forward facing edges min 3mm. All other edges must have a minimum radius of 1.0mm
- 353  **SEAT** - Insulated against heat conduction, convection and radiation. Lowest point no lower than top of of the upper surface of the lowest SIS member OR must have longitudinal, 25.4 x 1.65mm steel tube underneath.

- 354 ○ **COCKPIT OPENING** - Fig. 11 (left) template passes down from above cockpit to below the upper side impact member. Steering wheel, seat & padding can be removed. No removing of firewall.
- 355 ○ **COCKPIT INTERNAL CROSS SECTION** - Fig. 11 (right) template passes from the cockpit opening to 100mm rear of rearmost pedal contact area (in most forward position). Steering wheel and paddings can be removed (without tools).
- 356 △ **STEERING WHEEL** - Continuous perimeter, near round (no concave sections) with driver operable quick disconnect. 250mm max from front hoop.
- 357 ○ **ROTATING PARTS** - Finger guards are required to cover any parts (e.g. fans) that spin while the vehicle is stationary. No holes >12mm dia.

**□ REMOVE BODY PANELS**

- 358 ○ **JACKS** - Up to two devices that lift up all driven wheels min. 100 mm above the ground. In lifted position it is safe to enter and exit the vehicle and the devices must not extend out of the footprint of the four tires. University name must be written on. Vehicle pickup points must be indicated by orange triangles.
- 359 ○ **DRIVER'S LEG PROTECTION** - Covers inside of cockpit over any sharp edges or moving suspension / steering components.
- 360 ○ **DRIVER'S FOOT PROTECTION** - Feet must be rearward of the Front Bulkhead. The Front Bulkhead, together with the AIP, must cover the driver's feet in front view. No part of shoes or legs above or outside the Primary Structure (25x1.2 or equivalent) in side or front views when touching the pedals.
- 361 ○ **PERCY** - Helmet of 95th percentile male (PERCY) to be 50mm below the lines between top of front and main roll hoops and between top of main hoop to rear attachment point of main hoop bracing. Center of bottom circle placed minimum 915mm from pedals.
- 362 ○ **BRAKES** - Dual hydraulic system & reservoirs, operating on all four wheels, (one brake on limited slip differential is OK). System must be protected by structure or shields from drivetrain failure or minor collisions. No plastic brake lines. No brake-by-wire. No parts below chassis in side view. Brake pedal capable of 2000N, no failures if official exerts max force (seated normally in vehicle).
- 363 △ **BRAKE OVER TRAVEL SWITCH** - In the event of a failure in one or both of the brake circuits the brake pedal over travel will result in the shutdown circuit being opened.
- 364 ○ **TUBING & MATERIALS** - Team must show an APPROVED SES. No Magnesium tubes in primary structure.
- 365 ○ **MONOCOQUE** - Must see laminate test specimen. Steel backing plates (≥2 mm thick) with perimeter near circular or oval used at attachment points (must be fully supported).
- 366 ○ **BOLTED JOINTS** in primary structure - Distance hole centerline to the nearest free edge > 1.5 x hole diameter. According to SES if two panels are bolted together
- 367 ○ **HARNES ATTACHMENTS** for shoulder harness, lap belt and anti-submarine belt according to SES calculation, simulation and/or physical test.
- 368 ○ **MAIN HOOP** - MUST BE STEEL. Check dimension as shown in approved SES. Must be made of one piece and extend to lowest frame member. Above Major Structure, must be within 10 deg. of vertical plane. Smooth bends without wrinkles.
- 369 ○ **MAIN HOOP BRACING** - MUST BE STEEL. One straight brace on each side. Dimension as shown in the approved SES. Attached within 160mm from the top. Min. 30 deg. included angle with hoop. If main hoop is not vertical, bracing must not be on same side of the vertical plane as the main hoop. No bends. No rod-ends. Proper design for removable braces (capping etc.) on BOTH ENDS. Must take load back to bottom of main hoop and node of upper side impact tube through proper triangulated structure. (25.4 x 1.2mm or equivalent)
- 370 ○ **FRONT HOOP** - Must be closed section metal tube. Can be multi-piece with gussets or additional attachments to the monocoque. Must extend down to lowest frame member. No lower than top of steering wheel. Max. 20 deg. to vertical. Check dimension as shown in approved SES.
- 371 ○ **FRONT HOOP BRACING** - Two straight forward facing braces, 25.4 x 1.65mm or 25.0 x 1.75mm or 25.4 x 1.6mm wall steel or equivalent, attached within 50mm of top. Extra rearward bracing required if Front Hoop leans backwards more than 10 deg.
- 372 ○ **SIDE IMPACT PROTECTION** - Min. of 2 tubes + diagonal must connect the main and front hoops in straight line. Upper tube between 240 - 320mm above lowest inside chassis point between FH and MH. Dimension as shown in approved SES.
- 373 ○ **FRONT IMPACT PROTECTION** - Team must show an APPROVED IAD and test piece, which both must reflect status on the car. IMPACT ATTENUATOR forward of bulkhead, 200 mm long x 200 mm wide x 100 mm high, these minimum volume dimensions cannot not be more than 350 mm above ground (can be measured with driver seated). IA must be securely fastened directly to AIP capable of taking transverse & vertical loads (no tape, etc.). Non-crushable objects forward of bulkhead must have been evaluated in IAD. No wing supports through the IA. Standard IA: Requires diagonal or X-brace if FBH dimensions larger than 400 mm width and/or 350 mm height.
- 374 ○ **ANTI INTRUSION PLATE** - A 1.5 mm solid steel or 4.0 mm solid aluminium sheet. Standard: attachment must be welded (full perimeter, size: min. to centerlines) or min. 8 screws M8 Grade 8.8 (critical fasteners T10) (size: min. outside dimensions). Non-standard: Must follow T3.16.6. CFRP plate is accepted if SES/IAD approved.
- 375 ○ **FRONT BULKHEAD SUPPORT** - Support back to front roll hoop; 3 tubes per side, all 25mm x 1.5mm wall steel tube or equiv. 1 bottom; 1 top within 50mm of top of bulkhead, and connecting within 100mm above and 50mm below upper SIS tube; 1 or more node-to-node diagonal to completely triangulate connections to upper and lower SIS tubes.
- 376 ○ **INSPECTION HOLES** - 4.5mm inspection holes required in non-critical areas of front & main hoops. Inspectors may ask for holes in other tube(s).
- 377 ○ **WHEELS** - 203.2mm (8") min. diam. No Aluminium or hollow wheel bolts. Single retaining nut must incorporate a device to retain the nut. Aluminum wheel nuts must be hard anodized.
- 378 ○ **FIREWALL** - Fire resistant material; must separate driver compartment from cooling, oil system & LV battery. Passthroughs OK with grommets. Multiple panels OK if gaps sealed. No gaps at sides or bottom. Must be rigidly mounted to the chassis. Material must meet UL94-V0, FAR25 or equivalent. On tractive side min. 0.5mm aluminum plate grounded, on the driver side a rigid insulating layer (no CFRP) UL94-V0 or equivalent should be installed that can withstand a 250N 4mm screwdriver penetrating test.

**VEHICLE LIFTED AND WHEELS REMOVED**

- 379  **SUSPENSION PICK-UP POINTS** - Inspected thoroughly for integrity.
- 380  **FASTENERS** - Steering, braking, harness and suspension systems must use SAE Grade 5 or Metric Grade M8.8 or higher specs (AN/MS) with visible positive locking mechanisms, no Loctite or lock washers. Minimum of 2 exposed threads with locking nuts. Rod ends in single shear are captured by a washer larger than the ball diameter. Adjustable tie-rod ends must have jam nuts to prevent loosening. No Nylon lock nuts for Brake calipers or Brake discs. No button head cap, pan head or round head screws in critical locations, e.g cage structure or harness mount. Primary structure e/D > 1.5.
- 381  **STEERING** - All steerable wheels must have positive stops placed on the rack to prevent linkage lock up or tires from contacting any part of the vehicle. 7 degrees max. free play at the steering wheel. NO STEER-BY-WIRE on front wheels. Rear wheel steering, max. 6 deg. and mechanical stops installed. Bonded joints in accordance with T3.2.8.
- 382  **FLOOR CLOSEOUT PANEL** - Required from foot area to firewall; solid, non-brittle material; multiple panels are OK if gaps less than 3mm.
- 383  **GAS CYLINDERS LOCATION** - Axis not pointed at driver, within the rollover protection envelope (FIGURE 3), insulated from any heat source, must be shielded from the driver. The shields must be steel or aluminum with a minimum thickness of 1 mm.
- 384  **GAS CYLINDERS** - Proprietary manufacture & labeled, Nonflammable gas, regulator on tank, securely mounted, appropriate lines & fittings. Positively retained, i.e. no tie-wraps. Maximum of 10bar allowed, except cylinders/tanks with directly mounted pressure regulator (-> 10bar).
- 385  **SCATTERSHIELDS INCL. MOUNTING** - Required for clutches, chains, belts, etc. No holes. 6mm diam. Grade 8.8 minimum. End parallel to lowest part of the sprocket/pulley in front and rear.
- 386  **SCATTERSHIELD MATERIALS** - For chains, 2mm min. thick solid STEEL, 3 x chain width. For belts, 3mm min. thick Al 6061-T6, 3 x belt width. Finger guards: cover all drivetrain parts that spin while vehicle is stationary. No holes >12mm dia.
- 387  **LV BATTERY** – Attached securely to frame or chassis.
- 388  **HIGH PRESS HYDRAULICS** - Pumps and lines must have 1mm steel or aluminium shields protecting driver and workers.
- 389  **COOLANT** - 100% water. NO ADDITIVES WHATSOEVER.
- 390  **CATCH TANKS** - Any coolant overflow or lube system vents must have separate catch tanks. 0.9 l minimum each, 100 deg. C material, behind firewall, below shoulder level. 3mm min. dia. vent away from driver down to the bottom level of frame. Cooling systems using plain water, unless sealed, require 100 ml catch tanks.
- 391  **FLUID LEAKS** - Oil, grease, coolant, Brake fluid -> none permitted
- 392  **BELLYPANS** - In total minimum of two venting holes of at least 25mm diameter in the lowest part of the structure to prevent accumulation of liquids. One in each enclosed chassis structure. Additional holes are required when multiple local lowest parts exist in the structure.
- 393  **ACCUMULATOR CONTAINER POSITION** - All accumulator containers must lie within the primary structure of the frame lower than the top of the SIS. All accumulator containers must be protected from side or rear impact collisions. If an accumulator container or parts of it are mounted outside of the primary structure (EV.3.5.1, EV 3.5.3) an additional impact structure according to T3.2 must be build to protect the accumulator.
- 394  **ACCUMULATOR CONTAINER ATTACHMENT** – Accumulator container must be attached to the primary structure with fasteners min. Grade 8.8. Fasteners have to follow T10. Mounting as designed in SES. Brackets 1.6 mm steel or 4 mm aluminium with gussets to withstand bending loads. Monocoque needs 2 mm steel backing plates with perimeter near circular or oval. Equivalent attachment may be according to SES.
- 395  **POSITION OF TRACTIVE SYSTEM PARTS** - All parts belonging to the tractive system must be located within the rollover protection envelope, excluding outboard motors.
- 396  **PROTECTION OF TRACTIVE SYSTEM PARTS** - If tractive system parts are mounted in a position where damage could occur from a rear or side impact (below 350 mm from the ground), they have to be protected by a fully triangulated structure with tubes of a minimum outer diameter of 25.4 mm and a minimum wall thickness of 1.25 mm or equivalent.
- 397  **MOTOR CASING** - Min. 2 mm Aluminium 6061-T6. May be split into two equal sections. If motor casing is rotating around the stator or is perforated an additional 1 mm Aluminium 6061-T6 scatter shield around the motor should be installed.

**TIS STATUS UPDATE**

► Set online TIS status to *Passed* or *Failed*

**NON-COMPLIANCE / COMMENTS**

**APPROVAL**

Inspector Names	Date, Time	Signatures when passed
1. _____ / _____	_____	_____

**PART VIII: TILT TEST**

TIS STATUS UPDATE

▶ Set online TIS status to *In Progress*

COMMENTS

▶ Check comments from first page

TILT TEST

<sup>398</sup>  **FLUID LEAKAGE** - No fluid spill permitted when vehicle is tilted to 60 degrees in the direction most likely to create spillage.

<sup>399</sup>  **VEHICLE STABILITY** - All wheels in contact with tilt table when tilted to 60 degrees to the horizontal.

<sup>400</sup>  **GROUND CLEARANCE** - At least 30 mm min. with driver.

TIS STATUS UPDATE

▶ Set online TIS status to *Passed* or *Failed*

NON-COMPLIANCE / COMMENTS

**APPROVAL**

Inspector Names	Date, Time	Signatures when passed
1. _____ / _____	_____	_____



**PART IX: RAIN TEST**

TIS STATUS UPDATE

- ▶ Set online TIS status to *In Progress*

COMMENTS

- ▶ Check comments from first page

PREPARATION

- ▶ Activate the LV system before the team jacks up the vehicle.
- <sup>401</sup>  TSAL is continuously green and visible.
- <sup>402</sup>  Cockpit indicator is continuously green and visible.
  - ▶ Apply seal sticker to all additional sealing material, that can be removed (e.g. tape, as not mentioned in IN1.5.1).
  - ▶ Jack up the vehicle, remove the driven wheels. There is no driver in the car.
  - ▶ Activate the TS and measure the TS voltage at TSMP+ and TSMP- with a multimeter. (use banana test plug for measurement)
- <sup>403</sup>  Tractive system voltage is present at TSMPs
- <sup>404</sup>  TSAL is flashing in red and visible in bright sunlight.

RAIN TEST

- ▶ **RAIN PROOF** – No driver is allowed to sit in the vehicle during the test. Water like rain will be sprayed at the vehicle for 120sec. Another 120sec. of waiting without water spray.
- <sup>405</sup>  The Insulation Monitoring Device does not react and not shut down the tractive system.
- <sup>406</sup>  TSAL is still flashing in red and visible in bright sunlight.
  - ▶ Connect  $R_{Test}$  between any TSMP and LVS GND.
- <sup>407</sup>  Shutdown circuit opens within 30s.
- <sup>408</sup>  TSAL is continuously green.
  - ▶ Activate the TS.
- <sup>409</sup>  TSAL is flashing in red.
  - ▶ Press any of the shutdown buttons (on the main hoop or in the cockpit) or turn off any of the master switches (LVMS, TSMS)
- <sup>410</sup>  Shutdown circuit opens.
- <sup>411</sup>  TSAL is continuously green.

TIS STATUS UPDATE

- ▶ Set online TIS status to *Passed* or *Failed*

**NON-COMPLIANCE / COMMENTS**

**APPROVAL**

Inspector Names	Date, Time	Signatures when passed
1. _____ / _____	_____	_____

**PART X: BRAKE TEST**

TIS STATUS UPDATE

▶ Set online TIS status to *In Progress*

COMMENTS

▶ Check comments from first page

BRAKE TEST

- 412  **R2D sound level** – is between 80 and 90 dB(A) in radius of 2m.
- 413  **BRAKING PERFORMANCE** - Must lock all four wheels (roughly at the same time) and stop the vehicle in a straight line at the end of an acceleration run specified by the officials without electrical braking from motors. The tractive system has to be shut down by the driver before braking. The Tractive System Active Light has to be Green during breaking or shortly after the vehicle stopped (may take up to 5 sec. after shut down).
- 414  **BRAKE LIGHT** - has to be clearly visible even in bright sunlight
- 415  **TSAL** - has to be clearly visible even in bright sunlight
- 416  **BRAKE FLUID LEAKAGE** – check fluid leakage on brake lines (If fluid leakage occurs, inform scrutineering leaders who may take mech. Inspection sticker from the team)

TIS STATUS UPDATE

▶ Set online TIS status to *Passed or Failed*

**NON-COMPLIANCE / COMMENTS**

**APPROVAL**

Inspector Names	Date, Time	Signatures when passed
1. _____ / _____	_____	_____