

TEAM:	FSS Racing Team
UNIVERSITY:	University of Spain
CAR NUMBER:	10
<hr/>	
SES PASSED:	✓
IAD PASSED:	✓
ESF PASSED:	X
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Present the vehicle for inspection in the following order:

1. Accumulator Inspection *
2. Electrical Inspection *
3. Pre-Inspection / Egress
Mechanical Inspection *
4. Tilt Test *
5. Rain Test *
6. Brake Test *

* The vehicle is marked with a sticker if this part has been passed successfully

Used Symbols:

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

Notes:

- The order of points 1, 2 and 3 will be given by the Organization
- To enter the Mechanical Inspection bay the vehicle must show the Accumulator sticker or come without the accumulator
- To enter the Tilt Test vehicle must show Accumulator, Electrical and Mechanical stickers and Pre-Inspection successfully passed
- **This form must always stay with the vehicle!**
- If there is a conflict between this form and the rules, the rules prevail

PART I – ACCUMULATOR INSPECTION

The time limit for this part of the inspection is **100 minutes**. Continuation of the inspection is only possible on free slots. During technical inspection all work carried out on the vehicle must be approved by a technical inspector.

STATUS UPDATE

- ▶ Set online status to **Present**
- ▶ Write down Scrutineer(s) name(s), sign when passed

REQUIRED RESOURCES

- | | |
|---|--|
| <ul style="list-style-type: none"> 1 <input type="radio"/> An ESO must attend <ul style="list-style-type: none"> • 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 | <ul style="list-style-type: none"> • Datasheets for used wiring, insulation materials, tractive system components and container material with needed values highlighted • 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 |
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SAFETY BRIEFING

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| <ul style="list-style-type: none"> • no jewelry, no rings • no cell phone • no batch / necklace • no sources of distraction | <ul style="list-style-type: none"> • do not wear synthetic clothes • wear safety glasses • wear safety gloves |
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BASIC SET OF HV PROOF TOOLS

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| <ul style="list-style-type: none"> 2 <input type="radio"/> Insulated cable shear 3 <input type="radio"/> Insulated screwdriver 4 <input type="radio"/> Insulated spanners (only if screwed connections in TS) | <ul style="list-style-type: none"> 5 <input type="radio"/> Multimeter with protected probe tips rated for 1000V CAT III or better 6 <input type="radio"/> Two 4 mm banana plug test leads rated for 1000V CAT III or better |
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SAFETY EQUIPMENT

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| <ul style="list-style-type: none"> 7 <input type="radio"/> Face shield 8 <input type="radio"/> Safety glasses (minimum three) 9 <input type="radio"/> HV insulating gloves (minimum two pairs) | <ul style="list-style-type: none"> 10 <input type="radio"/> HV insulating blankets with label or serial number and datasheet (two, 1m² min.) |
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SELF-DEVELOPED PCB

- | | |
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| <ul style="list-style-type: none"> ▶ Ask for fully assembled spare PCB of self-developed PCBs inside accumulator container 11 <input type="radio"/> Sufficient spacing regarding system voltage and implementation | <ul style="list-style-type: none"> 12 <input type="radio"/> Sufficient insulation and temperature rating of coating if used, datasheet available 13 <input type="radio"/> Coating process according to datasheet 14 <input type="radio"/> The working voltage of the isolation barrier, if specified in the datasheet, is higher than the maximum TS voltage |
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CHARGER ASSEMBLY

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| <ul style="list-style-type: none"> 15 <input type="radio"/> Completely closed. Check openings in HV / TS enclosures, try to reach HV / TS potentials with insulated test probes (Ø 6 mm, 100 mm length) 16 <input type="radio"/> Interlock integrated 17 <input type="radio"/> TSMP integrated 18 <input type="radio"/> Emergency shutdown button integrated | <ul style="list-style-type: none"> 19 <input type="radio"/> Emergency shutdown button ≥ Ø 24 mm 20 <input type="radio"/> TS wiring is orange, marked with gauge, temperature rating > 85 °C and voltage rating 21 <input type="radio"/> Conductive parts of charging equipment and accumulator are connected to protective earth (PE) while charging [see EV 3.1, new grounding rules] |
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DIS-CHARGE CIRCUIT AND BODY PROTECTION RESISTORS

- ▶ Switch off Charger
- ▶ Measure resistance between TS+ and TS- measuring points
- 22 ○ Body protection resistor power rating is > 6 W, sufficient to short circuit TS+ and TS-
- 23 ○ Resistance is 30 kΩ (2 x BPR) + discharge resistor

INSULATION MEASUREMENT TEST

- ▶ Check low resistance connection between LV ground MP and PE / casing
- ▶ Choose test voltage:

$U_{MAX} \leq 250 V_{DC}$	$U_{MAX} > 250 V_{DC}$
$U_{TEST} \leq 250 V_{DC}$	$U_{TEST} > 250 V_{DC}$
- ▶ Connect insulation tester to TS+ and LV ground
- ▶ Connect the charger (do not activate charger) to the accumulator, keep AIR(s) opened
- ▶ Measure resistance: $R_{iso+} = \quad k\Omega$
- 24 ○ Resistance is much higher than 315 kΩ (Minimal Resistance = $500 \Omega / V \cdot U_{MAX} + BPR$)
- ▶ Connect insulation tester to TS- and LV ground
- ▶ Measure resistance: $R_{iso-} = \quad k\Omega$
- 25 ○ Resistance is much higher than 315 kΩ (Minimal Resistance = $500 \Omega / V \cdot U_{MAX} + BPR$)
- 26 ○ Resistances are nearly equal

ASSEMBLY

- 27 ○ All components and parts of the accumulator container need to be properly fixed
- 28 ○ Holes in containers only for wiring harness, ventilation, cooling, or fasteners, if mechanical properties are not influence
 - ▶ Open container housing, remove maintenance plugs
 - ▶ Check if no voltage is present (multimeter and / or dashboard)
- 29 ○ All used fasteners must be secured using positive locking except if they are non-conductive and non-structural
- 30 ○ TS potentials are insulated against the inner wall of the accumulator container if the container is made from conductive material
- 31 ○ Tabs of pouch cells must not carry mechanical loads
- 32 ○ No cells are damaged or can be damaged by the segment structures.
- 33 ○ No soldering in high current path [see EV 4.5.16 for exceptions]
- 34 ○ Every container contains at least one appropriately sized and rated fuse
 - ▶ Check the datasheet of fuse, main wire and cells and compare to ESF
- 35 ○ Every container contains at least two appropriately sized and rated isolation relays
- 36 ○ Isolation relays and fuses are separated from cells by a barrier according to UL94-V0, FAR25 or equivalent
- 37 ○ Pre-charge relay is of mechanical type with appropriate voltage rating
 - ▶ Check datasheet of pre-charge relay and compare to ESF
- 38 ○ Maintenance plugs are located at both poles of each stack (including first and last stack)
- 39 ○ Maintenance plugs removable without tools
- 40 ○ Maintenance plugs have a positive locking mechanism
- 41 ○ Maintenance plugs must not be able to unintentionally create circuits or short circuits
- 42 ○ Stacks separated by maintenance plugs < 120 V_{DC}
- 43 ○ Stacks separated by maintenance plugs < 6 MJ
- 44 ○ Stacks are insulated and separated by a fire-resistant barrier according to UL94-V0, FAR25 or equivalent
 - ▶ Check opening in TS enclosures, try to reach ITS potential with insulated test probe (Ø 6 mm, 100 mm length)
- 45 ○ If fully closed, an equalizing valve is implemented
- 46 ○ Spare accumulators of the same size, weight and type

WIRING

- 47 ○ All TS wires have proper overcurrent protection
- 48 ○ No other wires than TS wires are orange
- 49 ○ Securely anchored to withstand at least 200 N, if outside of enclosure
- 50 ○ Located out of the way of possible snagging or damage
- 51 ○ TS and LVS wires separated (not valid for Interlock)
- 52 ○ Every wire used in the Accumulator Container (TS and LV) is rated for $\geq 600 V$
- 53 ○ Possible to clearly assign and prove gauge, temperature, and voltage rating of TS wires
- 54 ○ 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

- 55 ○ Insulation is not only insulating tape or rubber-like paint

INDICATOR LIGHT OR VOLTMETER

- 56 ○ Red indicator light or voltmeter installed
- 57 ○ Marked with "Voltage Indicator"
- 58 ○ Visible while opening the battery connector
- 59 ○ Hard wired electronics, supplied by TS

- ▶ Connect the power supply with 60 V_{DC} (or half the nominal tractive system voltage whichever is low) to the accumulator HV connector
- 60 ○ Indicator light on or voltmeter showing present TS voltage
- 61 ○ Visible in bright sunlight

ACCUMULATOR MANAGEMENT SYSTEM

- 62 ○ A minimum of 30 % of cells are monitored with temperature sensors
- 63 ○ Every temperature sensor placed on negative terminal of monitored cell or in < 10 mm distance on busbar
 - ▶ Ask the team to connect their laptop to the AMS
 - ▶ Connect AMS to laptop, if possible, check SDC, do not place maintenance plugs and just visualize SDC. If not possible, connect maintenance plugs and start the charging process or balancing
- 64 ○ Cell voltages and temperatures can be displayed
 - ▶ Disconnect AMS current sensor connector
- 65 ○ The AMS must open the shutdown circuit within 0.5 s

- ▶ Disconnect any other AMS internal connector
- 66 ○ The AMS must open the shutdown circuit within 1 s
 - ▶ Connect charger to battery / batteries and start charging process
- 67 ○ Plausible accumulator current can be displayed
 - ▶ Disconnect one SINGLE voltage sense wire, if any wires are used
- 68 ○ The AMS must open the shutdown circuit within 0.5 s
 - ▶ Disconnect one SINGLE temperature sense wire, if any wires used
- 69 ○ The AMS must open the shutdown circuit within 1 s

CHARGER SHUTDOWN CIRCUIT

- 70 ○ IMD is integrated into the charging system
 - ▶ Connect charger to battery / batteries, start charging process
- 71 ○ Voltage indicator shows that HV is present
 - ▶ Press the shutdown button
- 72 ○ AIR(s) open

- 73 ○ Voltage indicator shows voltage < 60 V
 - ▶ Start charging and unplug TS accumulator connector
- 74 ○ AIR(s) open
- 75 ○ Charger disabled, no voltage at the charger connector

INSULATION MONITORING DEVICE

- 76 ○ 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 (see installation)
 - $R_{TEST} = 120 \text{ k}\Omega$
 - $R_{TEST} = (\text{max. TS voltage} \cdot 250 \Omega / V) - BPR$
 - ▶ Activate charger output and connect R_{TEST} between TS+ and GLVS GND
- 77 ○ Shutdown circuits open within 30 s
- 78 ○ TS voltage decreases below 60 V_{DC} within 5 s after shutdown circuit opens

- 79 ○ Reactivation of charger output is not possible
 - ▶ Push the reset button if there is any
- 80 ○ Reactivation of charger output is not possible
 - ▶ Remove R_{TEST} and wait 40 s until IMD resets status output
- 81 ○ Reactivation of charger output is not possible
 - ▶ Activate TS and connect R_{TEST} between TS- and LV GND
- 82 ○ Shutdown circuits open within 30 s

ACCUMULATOR CONTAINER

- ▶ Team must show approved SES for Accumulator Container

- ▶ Team must show SES test samples for Accumulator Container if alternative materials are used
- 83 ○ Accumulator Container manufactured according to SES

- 84 Internal vertical walls must be rigidly fastened to the container, dividing the accumulator in sections of 12 kg max. Minimum 75 % of the external wall's height
- 85 Cells securely fastened towards all 3 directions
- 86 All parts carrying cells and loads: UL94-V0 certified materials
- 87 External openings not pointing towards the driver or hand cart operator
- 88 Vehicle number, university name and ESO phone number(s) written on a high contrast background
- 89 **Roman Sans-Serif characters of at least 20 mm high are used**
- 90 Warning stickers with side length ≥ 100 mm and text "Always Energized" and "High Voltage" if TS > 60 V (Triangle with black lightning bolt on yellow background)
- 91 Check if all parts and the cover / lid of the housing are rigidly fastened

HANDCART

- 92 Handcart present with four wheels. Maximum dimensions 1200 x 800 mm
- 93 Handcart has always on type brake system
- 94 The Accumulator must be mechanically fixed to the handcart while on the Handcart
- 95 The Accumulator must be protected from vibrations and shocks
- 96 The hand cart must provide a firewall to protect the person while moving the hand cart
- 97 The firewall must have the same width as the hand cart, start at the lowest point of the hand cart excluding the wheels, and be at least 30 cm higher than the hand cart handle and the TSAC
- 98 The firewall must be made from a rigid, fire-retardant material [see T 1.2.1], and be transparent from 1.3 m above the ground
- 99 The hand cart itself must be labeled on its firewall below the hand cart handle [see EV 5.3.8]

SEALING OF COMPONENTS

- ▶ After all tests have been passed successfully seal the inspected TS housings:
- 100 Accumulator container(s) including spares
- 101 Charger
- 102 Non-used connectors (e.g.: to program the software of the charger)
- 103 Additional Part:

NON-COMPLIANCE / COMMENTS

STATUS UPDATE

- ▶ Set online status to **Pass** or **Fail**

APPROVAL

Scrutineer/s name/s

Date, Time

Signature/s when PASSED

PART II – ELECTRICAL INSPECTION

The time limit for this part of the inspection is **120 minutes**. Continuation of the inspection is only possible on free slots. During technical inspection all work carried out on the vehicle must be approved by a technical inspector.

STATUS UPDATE

- ▶ Set online status to **Present**
- ▶ Write down Scrutineer(s) name(s), sign when passed

REQUIRED RESOURCES

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| <p>104 ○ An ESO must attend</p> <ul style="list-style-type: none"> ● LV battery or cell datasheet ● For self-developed LV battery packs: an opened battery pack laptop and cables to display data of the AMS ● 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) | <ul style="list-style-type: none"> ● 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 ● The connector to safely supply the TS using shrouded receptacles when the TS accumulator is unconnected ● Photographs of all inaccessible TS connections |
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LOW VOLTAGE BATTERY

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| <p>105 ○ Voltage $\leq 60 V_{DC}$</p> <p>106 ○ Rigid and sturdy casing</p> <p>107 ○ Only for wet-cell batteries: IPX7 rated and acid resistant casing if inside the cockpit</p> <p>108 ○ Behind Firewall</p> <p>109 ○ Short circuit protection (e.g.: fused)</p> <p>110 ○ Proper insulation of internal electrical connections</p> <p>111 ○ Grounded to the chassis</p> <p>112 ○ Proper mounting of cells</p> <p>113 ○ Complete battery pack inside rollover protection envelope</p> <ul style="list-style-type: none"> ▶ All following checks only needed for Li-Ion batteries (other than LiFePO4) <p>114 ○ UL94-V0 casing used thickness, FAR25 or equivalent casing</p> <p>115 ○ Overcurrent protection that trips below max. discharge current</p> | <p>116 ○ Overtemperature protection of at least 30 % of the cells (max. 60 °C or datasheet, whichever is lower)</p> <p>117 ○ Voltage protection of all cells</p> <ul style="list-style-type: none"> ▶ Ask the team to connect their laptop to the AMS (and don't disconnect until the section finishes) <p>118 ○ Cell voltages can be displayed</p> <p>119 ○ Cell temperatures can be displayed</p> <ul style="list-style-type: none"> ▶ Let the team explain how signal failures electrically disconnect the LV battery (SCS) <p>120 ○ Implementation is expected to work, and it is good practice engineering implementation</p> <ul style="list-style-type: none"> ▶ Disconnect one SINGLE voltage sense wire, if any wires are used <p>121 ○ The LV battery is electrically disconnected, and cell voltage data is not refreshed</p> <ul style="list-style-type: none"> ▶ Disconnect one SINGLE temperature sense wire, if any wires are used <p>122 ○ The LV battery is electrically disconnected, and cell temperature data is not refreshed</p> |
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SELF-DEVELOPED PCB(S)

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| <ul style="list-style-type: none"> ▶ Ask for fully assembled spare PCB of self-developed PCBs outside accumulator container <p>123 ○ Sufficient spacing regarding system voltage and implementation</p> <p>124 ○ The working voltage of the isolation barrier, if specified in the datasheet, is higher than the maximum TS voltage</p> | <p>125 ○ Sufficient insulation and temperature rating of coating if used, datasheet available</p> <p>126 ○ Coating process according to datasheet</p> <p>127 ○ BSPD PCB(s) is standalone with only minimum interface</p> <p>128 ○ BSPD PCB(s) are directly supplied from the LVMS</p> <p>129 ○ Ends of a BSPD current transducer's auxiliary winding must be insulated</p> |
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DC-DC CONVERTER (NO LV BATTERY)

- 130 Show DC-DC connected to TSAC diagram / schematics
- 131 Container contains at least one appropriately sized and rated fuse
- 132 Verify insulation is proper, not only insulated tape or rubber-like paint

MASTER SWITCHES

- 133 TSMS and LVMS installed on the right side of the vehicle and located next to each other
- 134 All master switches are located above 80 % of shoulder height of Percy
- 135 Not mounted on removable bodywork. Rigidly mounted and no need to be removed during maintenance
- 136 Rotary type with removable handle (handle length ≥ 50 mm)
- 137 "ON" position in horizontal
- 138 "ON" and "OFF" positions marked
- 139 TSMS with locking mechanism for "OFF" position
- 140 LVMS marked with "LV" and a symbol showing a red spark in a white edged blue triangle
- 141 LVMS mounted on a red circular area on a high contrast background
- 142 Circular area $> \varnothing 50$ mm
- 143 TSMS marked with "TS" and triangle with black lightning bolt on yellow background
- 144 TSMS mounted on an orange circular area
- 145 Circular area $> \varnothing 50$ mm

TRACTIVE SYSTEM MEASURING POINTS

- 146 Next to the master switches
- 147 Correctly marked ("TS+", "TS-", "GND")
- 148 Two TS measuring points on an exclusive orange background
- 149 A black LV ground measuring point installed
- ▶ The TSMPs must be directly connected to the intermediate circuit capacitors. Disconnect the HVD and the TS accumulator
- 150 Measured voltage is lower than 60V (expected some voltage of DC Link from controller when LVS is activated) (**Note:** In the case where the DC Link does not present voltage, compare implementation in vehicle to ESF, use photographs if it is inaccessible)
- Used banana jacks must be...
- 151 ...4 mm shrouded
- 152 ...rated for 1000V CAT III or better
- The TSMPs must be protected by a cover that...
- 153 ...it is non-conductive
- 154 ...can be opened without tools
- 155 ...must always be mechanically linked to the vehicle

TRACTIVE SYSTEM SHUTDOWN DEVICES

- 156 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. Must be red.
- 157 Marked with a red sparked sticker
- 158 $\varnothing > 39$ mm
- 159 One cockpit shutdown button installed. Push-Pull or Push-Rotate-Pull functionality. Must be red
- 160 Marked with red sparked sticker
- 161 Easy actuation by the driver
- 162 $\varnothing > 24$ mm
- 163 Inertia switch upright and rigidly mounted to the chassis according to manufacturer specifications and can be demounted for functionality test
- ▶ Check interlocks on...
- 164 ...TS accumulator container(s)
- 165 ...Inverters
- 166 ...HVD
- 167 ...Power distribution boxes
- 168 ...Data Logger box
- ▶ Outboard wheel motors interlocks...
- 169 ...must act before a TS wiring and / or suspension failure
- 170 ...have a dedicated interlock wire routed along the TS wiring, must act before the TS wiring or its clamping fails
- 171 ...have a dedicated interlock wire routed along a suspension member, must act if the suspension fails
- 172 ...interlock(s) can be opened for demonstration

TRACTIVE SYSTEM VOLTAGE

- ▶ Measure voltage at TS measuring points
- 173 Equal or less than 60 V_{DC}

TRACTIVE SYSTEM WIRING

- ▶ Remember that the following points must be checked for ALL TS wiring (TSAC to Controller, Controller to Motors, TSAC to HV Distribution Boxes, TSMP wiring, etc)
- 174 All TS wiring and components must be in the envelope and behind the impact structures
- 175 TS cannot be activated if TS connectors outside of enclosures are connected other than the design intent configuration
- 176 TS wires of outboard wheel motors must not be able to reach the cockpit opening in case of a wire break
- 177 The wiring outside of the impact structure is the shortest possible distance
- 178 All TS wires and connectors (pin terminals) have proper overcurrent protection
- 179 TS wiring channels are orange
- 180 No other wires than HV wires are orange
- 181 TS wiring outside electrical enclosures in separate nonconductive enclosure or orange shielded cable
- 182 Securely anchored to withstand at least 200 N, if outside of enclosure
- 183 Located out of the way of possible snagging or damage
- 184 Shielded against rotating / moving parts
- 185 No wire lower than the chassis
- 186 TS and LV wires separated (N/A for interlock)
- 187 Clear to verify with gauge, temperature rating and voltage rating of TS wires
- 188 Suitable temperature rating for used position
- 189 Positive locking mechanism on every screwed connection (photographs for all inaccessible TS connections)
- 190 TSMP(s): positive locking mechanism on every screwed connection. (Photographs for all inaccessible TS connections)
- 191 Insulation is not insulating tape or rubber-like paint

HIGH VOLTAGE WARNING STICKERS

- ▶ Check for warning stickers on TS containing enclosures:
- 192 Accumulator(s) re-check
- 193 Inverter(s)
- 194 Motor(s)
- 195 Power distribution box(es)
- 196 Energy meter box
- 197 Other TS containing enclosures

TRACTIVE SYSTEM PROTECTIONS

- ▶ Check opening in TS enclosures, try to reach TS potentials with insulated test probe (\varnothing 6 mm, 100 mm length)
- 198 Not possible to reach any HV potentials
- 199 TS components and containers protected from moisture

HIGH VOLTAGE DISCONNECT (HVD)

- 200 Clearly marked with "HVD"
- 201 Distance from ground > 350 mm
- 202 Inside roll-over protected envelope
- 203 Easily visible while standing behind the vehicle
- 204 No remote actuation (e.g.: through wires)
- 205 Integrated interlock
- ▶ Stand next to the vehicle, remove HVD
- 206 Removed by any ESO within 10 s in Ready-to-Race condition
- 207 TS protection is still given (insulated test probe). If a dummy connector is used, it must be stored at the push-bar

TRACTIVE SYSTEM ACTIVE LIGHT (TSAL)

- 208 Check the "TSAL green" sign for working on the car
- 209 Mounted max. 75 mm below the highest point of the main hoop and within the roll-over protected envelope
- 210 Visible by a person standing 3 m horizontal radius from TSAL (1.6 m vertical from ground level). Visible except angles less than 10° on each side blocked by MH
- Cockpit indicator light...
- 211 ...is inside the cockpit and marked with "TS off"
- 212 ...is green and visible in bright sunlight
- 213 ...is visible for the driver

DATA LOGGER

- | | |
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| <p>214 <input type="radio"/> The data logger must be in an easily accessible location so that it is possible to insert, remove, or replace it within 15 min in Ready-to-Race condition</p> <p>215 <input type="radio"/> The data logger must not be placed within the TSAC</p> <p>216 <input type="radio"/> The data logger is enclosed in a housing</p> <p>217 <input type="radio"/> The data logger housing is rigidly mounted</p> <p>218 <input type="radio"/> Only the two pre applied 3M Dual Lock strips on the bottom side of the data logger are used</p> | <p>219 <input type="radio"/> The data logger must be directly supplied from the LVMS [see T 1.3.1]</p> <p>220 <input type="radio"/> All current supplying the TS must run through the data logger. The data logger must be inserted in the negative TS supply between the most negative AIR(s) and the inverters</p> <p>221 <input type="radio"/> The TS voltage sense connection of the data logger must be directly connected [see T 1.3.1], to the most positive AIR(s) on the vehicle side</p> |
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FIREWALLS

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| <ul style="list-style-type: none"> • 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)... <p>222 <input type="radio"/> ...behind the driver's back</p> <p>223 <input type="radio"/> ...at the sides of the driver</p> <p>224 <input type="radio"/> ...at the front of the vehicle</p> <p>225 <input type="radio"/> First layer, facing TS, must be made of Aluminum with a thickness of at least 0.5 mm</p> | <p>226 <input type="radio"/> Second layer, facing the driver, must be made of electrically insulated material (no CFRP)</p> <p>227 <input type="radio"/> Material meets UL94-V0 for min. used thickness or equivalent</p> <p>228 <input type="radio"/> TSAC cooling duct openings do not point towards the driver, although if behind a firewall</p> |
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ACCELERATOR PEDAL POSITION SENSOR (APPS)

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| <p>229 <input type="radio"/> Returns to original position if not actuated</p> <p>230 <input type="radio"/> 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)</p> <p>231 <input type="radio"/> Sensors do not share supply or signal lines</p> | <p>232 <input type="radio"/> Sensors are protected from being mechanically overstressed (positive stop of pedal)</p> <p>233 <input type="radio"/> Minimum two springs installed to return pedal</p> <p>234 <input type="radio"/> Each spring still returns pedal with the second one disconnected (springs in the torque encoders not counted)</p> |
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BRAKE LIGHT

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| <p>235 <input type="radio"/> Only one brake light in red color</p> <p>236 <input type="radio"/> Located on the vehicle centerline</p> <p>237 <input type="radio"/> Height between wheel centerline and driver's shoulder</p> | <p>238 <input type="radio"/> Rectangular, triangular or near round shape on black background</p> <p>239 <input type="radio"/> 15 cm² minimum illuminated area or LED strips with a total length > 150 mm with elements closer than 20 mm apart</p> |
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ACCUMULATOR MANAGEMENT SYSTEM (AMS)

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| <ul style="list-style-type: none"> ▶ Turn ON LVMS • AMS indicator light is... <p>240 <input type="radio"/> ...inside the cockpit and marked with AMS</p> <p>241 <input type="radio"/> ...illuminated red and visible in bright sunlight, even from outside</p> <p>242 <input type="radio"/> ...visible for the driver</p> | <ul style="list-style-type: none"> ▶ Ask the team to connect the laptop to the AMS <p>243 <input type="radio"/> AMS data can be displayed</p> <ul style="list-style-type: none"> ▶ Without disconnecting the laptop, disconnect TS accumulator <p>244 <input type="radio"/> AMS indicator light is illuminated red</p> <p>245 <input type="radio"/> AMS data is not refreshed</p> |
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DISCHARGE CIRCUIT AND BODY PROTECTION RESISTORS (BPR)

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| <ul style="list-style-type: none"> ▶ Switch off LV ▶ Measure resistance between TS+ and TS- measuring points <p>246 <input type="radio"/> Resistance is 30 kΩ (2 x BPR) + discharge resistor</p> | <p>247 <input type="radio"/> Body protection resistor power rating is > 6 W sufficient to short circuit HV+ and HV-</p> <p>248 <input type="radio"/> Discharge power rating is sufficient for continuous discharge</p> |
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GROUNDING CHECKS

- EV 3.1 has been fully revised
- 249 ○ Each TS enclosure must either contain a ≥ 0.5 mm properly grounded conductive layer or all materials must be electrically isolating for each own
- 250 ○ Conductive seat, driver harness, and firewall mountings, as well as TS firewalls and conductive parts protruding through TS enclosures, must be properly grounded
- 251 ○ A conductive part having ≤ 300 m Ω measured at 1 A and being able to continuously carry ≥ 10 % of the TS main fuse to LVS ground is properly grounded
- 252 ○ 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...
- 253 ○ ...all materials used to build a TS enclosure separately have a resistance ≥ 2 M Ω @ 500 V \Rightarrow fully isolated TS enclose, no grounded layer needed
- 254 ○ ...except e.g. screws, (shielded) connectors, backing plates insulating materials used \Rightarrow fully isolated TS enclose, no grounded layer needed but protruding elements must be properly grounded
- 255 ○ ...at least one material has < 2 M Ω \Rightarrow ≥ 0.5 mm thick solid grounded layer made of aluminum or better required and properly grounded
- 256 ○ ...a ≥ 0.9 mm thick steel layer might be used for TSAC as the grounded layer
 - ▶ Measure resistance of conductive parts to LVS ground next to TSMPs (max. 300 m Ω @ 1 A)...
- 257 ○ ...main hoop
- 258 ○ ...seat mounting points
- 259 ○ ...driver harness mounting points
- 260 ○ ...firewall mounting points, also if not protruding through the firewall
- 261 ○ ...TS firewall
- 262 ○ ...TS accumulator container
- 263 ○ ...TS enclosures if applicable
- 264 ○ ...TS enclosure protruding parts if applicable
- 265 ○ Each grounding is able to carry ≥ 10 % of TS main fuse
 - ▶ Measure resistance of conductive parts to LVS ground (max. 100 Ω @ 0 A)
- 266 ○ ...carbon fiber part within 10 cm around TS part
- 267 ○ ...suspension front left or right if applicable
- 268 ○ ...suspension rear left or right if applicable

INSULATION MEASUREMENT TEST

- ▶ Choose test voltage to 500 V

$U_{MAX} \leq 250$ V _{DC}	$U_{MAX} > 250$ V _{DC}
$U_{TEST} \leq 250$ V _{DC}	$U_{TEST} > 250$ V _{DC}
- ▶ Connect insulation tester to TS+ and GLVMP
- ▶ Measure resistance: $R_{iso+} =$ k Ω
- 269 ○ Resistance is much higher than 315 k Ω
- Minimal Resistance = $500 \Omega / V \cdot U_{MAX} + BPR$
- ▶ Connect insulation tester to TS- and GLVMP
- ▶ Measure resistance: $R_{iso+} =$ k Ω
- 270 ○ Resistance is much higher than 315 k Ω
- 271 ○ Resistances are nearly equal

⚠ 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
- 272 ○ Voltage at TS measurement points less or equal 60 V_{DC}
 - ▶ Switch on LVMS with TSMS deactivated
- 273 ○ IMD and AMS indicator light illuminate for 1 to 3 s for visible check
- 274 ○ Voltage at TS measurement points less or equal 60 V_{DC}
 - ▶ Switch on TSMS and all shutdown buttons
- ▶ Reset any IMD or AMS errors
- 275 ○ TS still deactivated
 - ▶ Activate TS, measure TS voltage during TS power-up
- 276 ○ System is pre charged before second AIR closes
 - ▶ Switch off TSMS
- 277 ○ TS voltage decreases below 60 V_{DC} within 5 s
 - ▶ Try to power-up TS with switched off TSMS
- 278 ○ TS still deactivated
 - ▶ Switch on TSMS
- 279 ○ TS still deactivated

TRACTIVE SYSTEM SHUTDOWN

- ▶ Connect multimeter between TS+ and TS-
- ▶ For every of the following switches, deactivation leads to TS shutdown, voltage decreases below 60 V_{DC} within 5 s
- 280 ○ LVMS
- 281 ○ Shutdown button left
- 282 ○ Shutdown button right
- 283 ○ Cockpit shutdown button
- 284 ○ Inertia switch
- 285 ○ Break-Over-Travel-Switch
 - ▶ Show schematic of TS with all interlocks (ESF)
- 286 ○ Interlocks

TRACTIVE SYSTEM ACTIVE LIGHT (TSAL)

- ▶ Activate LV system
- 287 ○ TSAL and Cockpit Indicator (CI) is green only
 - ▶ Activate TS
- 288 ○ TSAL flashes red with frequency 2 Hz - 5 Hz, and CI is off
- 289 ○ TSAL is clearly visible (horizontal position, entire illuminated surface)
 - ▶ Disconnect TSAL state detection circuitry (disconnect data connection to accumulator container)
 - ▶ Activate LVS and TS
- 290 ○ TSAL and CI are off or red
- ▶ Deactivate TS and connect power supply > 60 V_{DC} to TS. Do not use measuring points. The team needs to provide a method of connection which uses the same receptacles as used for TSMP
- ▶ Activate LVS
- 291 ○ TSAL is both green and red flashing simultaneously and CI is on
 - ▶ Disconnect power supply and remove HVD
 - ▶ Override HVD interlock (! Cover TS potentials !!)
 - ▶ Activate TS
- 292 ○ TSAL and CI off

INSULATION MONITORING DEVICE (IMD)

- 293 ○ One IMD ground line is connected to the accumulator container and one ground line is connected to the main hoop by a separate wired connection
 - $R_{TEST} = (\text{max. TS voltage} \cdot 250 \Omega / V) - BPR$
 - ▶ $R_{TEST} = 135 \text{ k}\Omega$
 - IMD indicator light...
- 294 ○ ...is inside the cockpit and marked with IMD
- 295 ○ ...is red and visible in bright sunlight
- 296 ○ ...is visible for the driver
 - ▶ Activate TS
 - ▶ Connect R_{TEST} between TS+ and GLVS GND
- 297 ○ Shutdown circuits open within 30 s
- 298 ○ IMD indicator light illuminates
- 299 ○ TS voltage decreases below 60 V_{DC} within 5s after shutdown circuit opens
 - ▶ Try to activate the TS
- 300 ○ Reactivation of TS is not possible
 - ▶ Push the reset button, which is not accessible to the driver, if any
- 301 ○ Reactivation of TS is not possible
 - ▶ Remove R_{TEST} and wait 40 s until IMD resets status output
- 302 ○ Reactivation of TS is not possible
 - ▶ Push all reset buttons in the cockpit if any
- 303 ○ Reactivation of TS is not possible
 - ▶ Push the IMD reset button, which is not accessible to the driver, if any
- 304 ○ Reactivation of TS is possible
 - ▶ Push and hold the reset button, which is not accessible to the driver, if any
 - ▶ Connect R_{TEST} between TS- and LV GND
- 305 ○ Shutdown circuits open within 30 s
- 306 ○ IMD indicator light illuminates

READY-TO-DRIVE ACTIVATION SEQUENCE

- ▶ Activate TS and press torque pedal
- 1 ○ No turning of motors
 - Let the team set the vehicle to Ready-to-Drive mode
- 2 ○ Pressing the brake pedal WHILE activating is necessary
 - ▶ Repeat the activation sequence but push the brake pedal only once before finally pushing the activation button
- 3 ○ No Ready-to-Drive mode possible

- ▶ Disconnect the brake sensor
- 4 No Ready-to-Drive mode possible

- Ready-to-Drive sound...
- 5 ...duration is 1 to 3 s
- 6 ...is minimum 80 dB (2 m around the vehicle)
- 7 ...is easily recognizable (no animal sound or song part)

APPS AND BSPD

- ▶ Set the vehicle to Ready-to-Drive state
- ▶ Disconnect $\geq 50\%$ of APPS
- 307 Motors do not turn
- ▶ Disconnect all APPS
- 308 Motors do not turn
- ▶ Team simulates ≥ 5 kW power (complete BSPD circuitry must be used)
- ▶ Press brake representing hard braking (> 0.5 s)
- 309 TS shuts down
- ▶ Reactivate TS and disconnect the current sensor
- ▶ Press brake representing hard braking (> 0.5 s)
- 310 TS shuts down
- 311 Reactivation of TS is only possible after 10 s without implausibility

REGENERATIVE BRAKING

- ▶ Ask the team to mount wheels
- ▶ Set the vehicle to Ready-to-Drive state
- ▶ Press the brake slightly without activating the hydraulic brake system
- 312 The driven wheels do not turn in the opposite direction
- 313 Turning a driven wheel by hand is possible

SEALING OF COMPONENTS

- ▶ After all tests have been passed successfully seal the inspected TS housings:
- 314 Motor Controller housing
- 315 Energy Meter / Data Logger housing
- 316 IMD housing
- 317 TSAL circuit housing
- 318 BSPD casing / BSPD calibration
- 319 Additional Part:
- 320 Additional Part:

DATA LOGGER

- 321 Check data logger functionality and connectivity

NON-COMPLIANCE / COMMENTS

STATUS UPDATE

- ▶ Set online status to **Pass** or **Fail**

APPROVAL

Scrutineer/s name/s

Date, Time

Signature/s when PASSED

PART III – PRE-INSPECTION

The time limit for this part of the inspection is **20 minutes**. Continuation of the inspection is only possible on free slots. During technical inspection all work carried out on the vehicle must be approved by a technical inspector.

STATUS UPDATE

► Set online status to **Present**

► Write down Scrutineer(s) name(s), sign when passed

DRIVER GEAR & SAFETY

- | | |
|---|---|
| <p>322 ○ FACE SHIELDS – Made of impact resistant material</p> <p>323 ○ UNDERWEAR – Nomex or equivalent, fire-resistant under-wear (no cotton, polyester, or bare skin). No holes</p> <p>324 ○ SOCKS – Nomex or equivalent, fire-resistant socks (no cotton, polyester, or bare skin). No holes</p> <p>325 ○ GLOVES – Fire resistant material. Leather allowed only over fire-resistant material. No holes</p> <p>326 ○ ARM RESTRAINTS – SFI Standard 3.3 or equivalent</p> <p>327 ○ HELMETS – Snell K2010, K2015, K2020, M2010, M2015, M2020, SA2010, SAH2010, SA2015, SA2020; EA2016. (or newer), SFI 31.1/2010, 2015, 2020; SFI 41.1/2010, 2015, 2020 (or newer); FIA 8860-2010, 2018, 8859-2010 (with SAH2010 or newer), 8859-2015 (with SA2015). Closed-face, no open-face, must have integrated shields (no dirt-bike helmets). No camera mounts</p> | <p>328 ○ DRIVER SUITS – Single piece SFI 3-2A/5 (or higher), SFI 3.4/5 (or higher), FIA 8856-2000/2018 (or higher) rating and labeled as such. No holes</p> <p>329 ○ HAIR COVER – Fire resistant (Nomex or equiv.) balaclava of full helmet skirt REQUIRED FOR ALL DRIVERS. No holes</p> <p>330 ○ SHOES – SFI 3.3 or FIA 8856-2000/2018</p> <p>331 ○ FIRE EXTINGUISHERS – Two (2) hand-held, 0.9kg (2lb) min., dry chemical (10BC, 1A10BC, 34B, 5A 34B, 20BE or 1A 10BE), with pressure / charge gauge, Aqueous Film Forming Foam (AFFF) fire extinguishers are prohibited, 1 WITH CAR securely installed on push-bar, 1 in paddock (must see both at Tech.). On-board fire system possible</p> <p>332 ○ SEWING OR STITCHING – Teams must show compliance to T 13.3 if driver's clothing is embroidered. Fire-resistant material must be used (e.g., Carbon X, Indura, Nomex, Polybenzimidazole (PBI) and Proban)</p> |
|---|---|

TIRES

- | | |
|---|---|
| <p>333 ○ DRY TIRES – Make:</p> <p>334 ○ DRY TIRES – Size:</p> <p>335 ○ DRY TIRES – Compound:</p> | <p>336 ○ RAIN TIRES – Make:</p> <p>337 ○ RAIN TIRES – Size:</p> <p>338 ○ RAIN TIRES – Compound:</p> <p>339 ○ RAIN TIRES – 2.4 mm min. tread depth molded by tire manufacturer</p> |
|---|---|

EGRESS PROCEDURE

- All drivers must be able to exit the vehicle in less than 5 s
- Driver must be seated in Ready-to-Race condition
- Wings must remain fixed in position
- ▶ Both hands on the steering wheel (in all possible steering positions)
- ▶ Press cockpit shutdown button
- ▶ The time will stop when the driver has both feet on the ground

Driver 1 (Tallest): _____

Signature: _____

Driver 2: _____

Signature: _____

Driver 3: _____

Signature: _____

Driver 4: _____

Signature: _____

Driver 5: _____

Signature: _____

Driver 6: _____

Signature: _____

NON-COMPLIANCE / COMMENTS

STATUS UPDATE

- ▶ Set online status to **Pass** or **Fail**

APPROVAL

Scrutineer/s name/s

Date, Time

Signature/s when PASSED

PART IV – MECHANICAL INSPECTION

The time limit for this part of the inspection is **90 minutes**. Continuation of the inspection is only possible on free slots. During technical inspection all work carried out on the vehicle must be approved by a technical inspector.

STATUS UPDATE

- ▶ Set online status to **Present**
- ▶ Write down Scrutineer(s) name(s), sign when passed

CAR WITH TALLEST DRIVER READY-TO-RACE

- 340 ○ **PUSH BAR (RED COLOR)** – With car, securely attached to car, detachable, push & pull function for 2 people standing erect. The push bar must be attached to the rear of the vehicle for moving it. Fire extinguisher must be installed
- 341 ○ **GROUND CLEARANCE** – At least 30 mm in any condition
- 342 ○ **CAMERAS** – Must be secured by two points [see T 11.11] and inside the surface envelope. No cameras mounted on the helmet
- 343 ○ **VISIBILITY** – 100 ° min. field either side. Head rotation allowed or mirrors. If mirrors, must be firmly installed and adjusted
- 344 ○ **VEHICLE CONTROLS** – All controls, including shifter, must be inside the cockpit. No arms or elbows outside the side impact system to actuate
- 345 ○ **OTHER SIDE TUBES** – Design prevents driver's neck hitting bracing or other side tubes
- 346 ○ **WHEELBASE** - At least 1525 mm
- **DRIVER FLUID PROTECTION** – A firewall must extend sufficiently far upwards and / or rearwards such that any point, less than 100 mm above the bottom of the helmet of the tallest driver, is not in direct line of sight with any of the following parts:
 - 347 ○ ...cooling system
 - 348 ○ ...low voltage battery
 - 349 ○ **MAIN HOOP & FRONT HOOP HEIGHTS** – Helmet of tallest 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
 - 350 ○ **ROLL BAR PADDING** – Roll bar or bracing that could be hit by driver's helmet must be covered with 12 mm thickness, SFI 45.1 or FIA 8857-2001 padding. Pipe insulation and foam not acceptable
 - 351 ○ **SUSPENSION** – Fully operational with dampers front and rear; 50 mm min. wheel travel (min. 25 mm jounce) with driver in vehicle

DRIVER RESTRAINT SYSTEM

- 352 ○ **ARM RESTRAINTS** – Must be installed so the driver can release them and exit unassisted regardless of vehicle's position
 - **HEAD RESTRAINT...**
- 353 ○ ...near vertical, SFI 45.2 standard and must take 890 N load (may be changed for different drivers)
- 354 ○ ...150 x 150 mm min. and 40 mm thickness, 25 mm max. from helmet with contact point 50 mm min. from any edge
 - **DRIVER RESTRAINT HARNESS...**
- 355 ○ ...SFI 16.1, 16.5, 16.6, FIA 8853/2016. 6- or 7- point system and be labeled
- 356 ○ ...two-piece lap belt (width 500 mm min.)
- 357 ○ ...two shoulder straps (width 75 mm min, 50 mm OK with HANS)
- 358 ○ ...two leg or anti-submarine straps (width 50 mm min.) (7- point system must have three anti-submarine straps)
- 359 ○ ...all lap belts must have Quick Adjusters
- 360 ○ ...must be securely attached to Primary Structure (25.4 x 2.4 mm or equivalent)
 - ▶ Define if driver is in upright or reclined driving position [see T 5.1.3 & T 5.1.4]
 - **LAP BELT MOUNTING...**
- 361 ○ ...reclined: 60 ÷ 80°, upright: 45 ÷ 65 ° (to be measured in the pelvic area diagonally in the leg)
- 362 ○ ...pivoting mounting with eye bolts or shoulder bolts securely attached to Primary Structure. Tab thickness 1.6 mm min.
 - **SHOULDER HARNESS MOUNTING...**
- 363 ○ ...mounting points 180 ÷ 230 mm apart with an angle from shoulder between 10 ÷ 20° down to horizontal
- 364 ○ ...attached to Primary Structure (25.4 x 2.4 mm or 25 x 2.5 mm steel tube min.)
- 365 ○ ...not to put bending loads into MHB without extra bracing and additional braces if not straight to the MH
- 366 ○ ...cannot pass through a firewall

CAR WITHOUT DRIVER

- **SEAT...**
- 367 ○ ...insulated against heat conduction, convection and radiation [see T 4.6.2]
- 368 ○ ...lowest point no lower than bottom of side rails or must have longitudinal 25.4 x 1.65 mm steel tube underneath
- 369 ○ **SCHOOL NAME & OTHER DECALS** – School Name, or recognized initials - 5 cm tall min. on both sides in Roman letters. Must be clearly visible
- 370 ○ **CAR NUMBERS** – On front & both sides of vehicle, 15 cm min. tall, 20 mm stroke & spacing, 25 mm min. between number and background edge. Black on White or White on Black only, specified background shapes. Must be clearly visible
- 371 ○ **TECH STICKER SPACE** – 7.5 x 15 cm on centerline of front of car in front of the cockpit opening
 - **BRAKES...**
 - 372 ○ ...dual hydraulic system & reservoirs, operating on all four wheels, (one brake on limited slip is OK)
 - 373 ○ ...system must be protected by structure or shields from drivetrain failure or minor collisions
 - 374 ○ ...no plastic brake lines
- 375 ○ ...no brake-by-wire
- 376 ○ ...no parts below chassis / tub in side view
- 377 ○ ...brake pedal capable of 2000 N, no failures if official exerts maximum force (seated normally in vehicle)
- 378 ○ **BRAKE OVER-TRAVEL SWITCH (BOTS)** – Must constantly open the shutdown circuit if one brake circuit fails for the brake balance bar in all possible positions. Not resettable by driver
- 379 ○ **COCKPIT OPENING** – Template passes down from above cockpit center line to top SIS tube or to 320 mm above lowest inside chassis point between FH and MH [see T 4.1.1 fig. 12 left]. Steering wheel column, seat & padding can be removed. No removing of firewall
- 380 ○ **COCKPIT INTERNAL CROSS SECTION** – Template passes forward from cockpit to 100 mm rear of rearmost pedal contact area in most forward position [see T 4.1.1 fig. 12 right]. Steering wheel and padding removable with no tools & driver-in can be removed
- 381 ○ **ROTATING PARTS** – Finger guards are required to cover any parts (e.g., fans) that spin while the vehicle is stationary. No holes > Ø 12 mm

BODYWORK & AERODYNAMIC DEVICES

- 382 ○ **EDGES** – Bodywork and aerodynamic edges that could contact a pedestrian must have a radius of 1 mm min. (3 mm min. when forward facing edges) (safety requirement)
- 383 ○ **BODY & STYLING** – Open wheeled, open cockpit, formula style body. Vertical keep out zones 75 mm in front and behind tires (no aero exceptions), tires unobstructed from sides [see T 2.1.3 fig. 4]
- 384 ○ **BODYWORK** – No external concave radii in any side view in front of the cockpit. 38 mm min. radius on nose [see T 2.3.4]. No large openings in bodywork into the driver compartment in front of or alongside the driver (except cockpit opening)
 - **WINGS...**
 - 385 ○ ...securely mounted and not extending further than the rear portion of the head restraint in the rearmost position
 - 386 ○ ...deflection may not exceed 10 mm when a force of 200 N is applied over a surface of 225 cm²
 - 387 ○ ...deflection may not exceed 25 mm with a point force of 50 N is applied
 - 388 ○ ...permanent deflection < 5 mm
- **HEIGHT DEVICES** [see T 8.2.1]...
- 389 ○ ...forward of a vertical plane through the rearmost portion of the front face of the driver's head restraint support, excluding any padding, and set to its most rearward position, must be lower than 500 mm from the ground
- 390 ○ ...rearward of mentioned plane before must be lower than 1.2 m from the ground (including end plates)
- 391 ○ ...in front of the front axle and extending further outboard than the most inboard point of the front tire / wheel must be lower than 250 mm from the ground
- **WIDTH DEVICES** [see T 8.2.2]...
- 392 ○ ...lower than 500 mm from the ground and further rearward than the front axle, must be not wider than the outside plane of the wheels / tires
- 393 ○ ...higher than 500 mm from the ground, must not be wider than the inside plane of the rear wheel / tire [see T 8.2 fig. 16]
- **LENGTH DEVICES** [see T 8.2.3]...
- 394 ○ ...250 mm max. rearward of rear tires
- 395 ○ ...700 mm max. forward of front tires

REMOVE BODY PANELS

- 396 ○ **JACKS** – Up to two devices that lift up all driven wheels 100 mm min. above the ground. In a 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.
- 397 ○ **WHEELS** – Ø 203.2 mm min. (8"). No Aluminum or hollow wheel bolts. Single retaining nut must incorporate a device to retain the nut. Aluminum wheel nuts must be hard anodized

- 398 ○ **PERCY** – Helmet of 95th percentile male to be 50 mm below the lines between top of MH & FH and between top of MH to rear attachment point of MHB [see T4.3.1 fig. 13 and fig. 14]. Center of the bottom circle placed 915 mm min. from pedals
- 399 ○ **DRIVER'S FOOT PROTECTION** – Feet must be rearward of the FBH and no part of shoes or legs above or outside the Primary Structure (25 x 1.2 mm or equivalent) in lateral or front views when touching pedals
- 400 ○ **DRIVER'S LEG PROTECTION** – Covers inside cockpit over sharp and moving suspension & steering components
- **FIREWALL** – Fire resistant material (must meet UL94-V0, FAR25 or equivalent). Passthroughs OK with grommets. Multiple panels OK if gaps sealed. No gaps at sides or bottom. Must be rigidly mounted to the chassis and separate...
- 401 ○ ...driver compartment from cooling, oil system & LV battery

SES, IAD & REQUIRED TESTS

- ▶ Team must show an APPROVED SES and all relevant test specimen(s), labeled (non-removable) with structure acronym & date and width, skin & core thickness according to SES
 - ▶ Team must show an APPROVED IAD and test piece same as IA on vehicle (if applicable)
- 402 ○ **SES TUBING & MATERIALS** – No Magnesium tubes in Primary Structure
- 403 ○ **BOLTED JOINTS** – In Primary Structure, distance of hole centerline to the nearest free edge > 1.5 x Ø hole ($e / D > 1.5$) [see T 10.1.4]
- 404 ○ **MONOCOQUE** – Must see laminate test specimen. Steel backing plates more than 2 mm thick are used at attachment points. According to SES if two panels are bolted together
- 405 ○ **INSPECTION HOLES** – Ø 4.5 mm required in non-critical areas of MH and FH. Inspectors may ask for holes in other tube(s)
- **MAIN HOOP (MH)...**
- 406 ○ ...must be made of one piece and extend to the lowest frame member. Above Major Structure, within 10 ° of vertical plane (dimension as shown in approved SES)
- 407 ○ ...must be steel, smooth bends without wrinkles
- **MAIN HOOP BRACING (MHB)...**
- 408 ○ ...attached within 160 mm from the top, 30 ° min. included angle with MH (if MH is not vertical, bracing must not be on the same side of the vertical plane) (dimension as shown in approved SES)
- 409 ○ ...must be steel, one brace each side, no bends, no rod-ends. Proper design for removable braces (capping etc.) on both ends
- 410 ○ ...must take load back to bottom of MH and node of upper SIS tube thru proper triangulated structure (25.4 x 1.2 mm or equivalent)
- **FRONT HOOP (FH)...**
- 411 ○ ...20 ° max. vertical, no lower than the top of the steering wheel and longitudinal distance 250 mm max. (dimension as shown in approved SES)
- 412 ○ ...must be a closed section metal tube. Can be multi-piece with gussets or extra attachments to the monocoque. Must extend down to the lowest frame member
- 413 ○ **FRONT HOOP BRACING (FHB)** - Two straight forward-facing braces, 25.4 x 1.65 mm, 25 x 1.75 mm or 25.4 x 1.6 mm wall steel or equivalent, attached within 50 mm of top. Extra rearward bracing is required if FH leans backwards > 10 °
- **SIDE IMPACT PROTECTION (SIS)...**
- 414 ○ ...minimum of two tubes + diagonal must connect the MH and FH in a straight line (dimension as shown in approved SES)
- 415 ○ ...upper tube must be between 240 ÷ 320 mm above the lowest inside chassis point between FH and MH
- 416 ○ ...lower tube can be the lower frame member
- 417 ○ **FRONT IMPACT PROTECTION** – No non-crushable objects forward of the bulkhead
- **IMPACT ATTENUATOR (IA)...**
- 418 ○ ...forward of bulkhead with no wing support through the IA and must be securely fastened directly to AIP capable of taking transverse or vertical loads (no tape, etc.)
- 419 ○ ...min. volume dimensions of 200 mm long x 200 mm wide x 100 mm high and cannot be more than 350 mm above ground (measured with driver seated)
- 420 ○ ...standard IA requires diagonal or X-brace if FBH dimensions larger than 400 mm width and / or 350 mm height
- 421 ○ **ANTI INTRUSION PLATE (AIP)** – A 1.5 mm solid steel metal or 4 mm solid aluminum metal sheet (same size as outside dimensions) must be welded or minimum 8 screws M8 8.8. A CFRP plate is accepted if SES / IAD is approved
- 422 ○ **FRONT BULKHEAD SUPPORT (FBHS)** – Support back to front roll hoop; 3 tubes per side, all 25 x 1.5 mm wall steel tube or equivalent. 1 bottom; 1 top within 50 mm of top of bulkhead and connecting within 100 mm above and 50 mm below upper SIS tube; 1 or more node-to-node diagonal to completely triangulate connections to upper and lower SIS tubes

CAR LIFTED AND WHEELS REMOVED

- 423 ○ **SUSPENSION PICK-UP POINTS** – Inspected thoroughly for integrity
- **FASTENERS** – Must use SAE grade 5, M8.8 or higher specs (AN / MS) with visible positive locking mechanisms [see T10.2.2], no Loctite or lock washers. Min. 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 button head cap, pan head or round head screws in critical locations (e.g., cage structure or harness mount). It must be complied with in the Primary Structure and...
- 424 ○ ...driver's harness
- 425 ○ ...steering
- 426 ○ ...braking (no nylon lock nuts for caliper or discs)
- 427 ○ ...suspension
- **STEERING...**
- 428 ○ ...all steerable wheels must have positive stops to prevent linkage lock up or tires from contacting any part of the car
- 429 ○ ...7 ° max. free play at the steering wheel, mechanical joints to steering rack [see T 3.2.8 for bonded joints]
- 430 ○ ...no Steer-by-Wire on front wheels. For rear wheel steering, 6 ° max. and mechanical stops installed
- 431 ○ ...mechanically attached to Primary Structure and stationary parts within rollover protection envelope
- 432 ○ **STEERING WHEEL** – Continuous perimeter, near round (no concave sections) with driver operable quick disconnect. 25 cm max. from the FH and no higher than the FH top-most surface
- 433 ○ **FLOOR CLOSEOUT PANEL** – Required from foot area to Firewall. Solid, non-brittle material. Multiple panels are OK if gaps < 3 mm
- 434 ○ **GAS CYLINDERS** – Proprietary manufacture & labeled, Non-flammable gas, regulator on tank, securely mounted, axis not pointed at driver, to rear of MH within the frame envelope, or in structural side pod, but not in cockpit, insulated from exhaust, appropriate lines & fittings. Positively retained (e.g., no tie-wraps)
- 435 ○ **GAS CYLINDER'S LOCATION** – Axis not pointed at driver, within the rollover protection envelope, insulated from any heat source, must be shielded from the driver. The shields must be steel or aluminum with a 1 mm min. of thickness
- **SCATTERSHIELDS GENERAL** – No holes. Ø 6 mm grade 8.8 min. End parallel to lowest part of the sprocket / pulley in front and rear. Required for...
- 436 ○ ...clutches, chains, belts, etc.
- **SCATTERSHIELD MATERIAL...**
- 437 ○ ...chains: 2 mm min. thickness solid steel, 3 x chain width, belts: 3 mm min. thickness Al 6061-T6, 3 x belt width
- 438 ○ ...finger guards: cover all drivetrain parts that spin while the car is at rest and no holes > Ø 12 mm
- 439 ○ **LV BATTERY** – Rigid and sturdy casing and attached securely to frame or chassis. Battery behind Firewall; wet cells in IPX7 rated and acid resistant casing if inside cockpit. Must be contained within the rollover protection envelope [see T 1.1.16]. Grounded to chassis; hot terminal insulated; protected for short circuits (fused). No circuits > 60 V_{DC}
- 440 ○ **STUDENT BUILD LV BATTERY** – Proper insulation of internal connections; proper mounting of cells
- 441 ○ **LI-ION LV BATTERY** – Only applicable if other than LiFePO4. Has a fire-retardant casing according to UL94-V0. Battery pack includes: an overcurrent protection that trips below maximum discharge current; overtemperature protection of 30 % of the cells; voltage protection of all cells. It must be possible to display all cell voltages and measured temperatures on a team laptop
- 442 ○ **HIGH PRESS HYDRAULICS** – Pumps and lines must have 1 mm thickness steel or aluminum shields to protect drivers and workers
- 443 ○ **COOLANT** – Only 100 % water. No additives whatsoever
- 444 ○ **CATCH TANKS** – Any coolant overflow, crankcase breather or lube system vents must have separate catch tanks. 0.9 L min. each, 100 °C material, behind the firewall, below shoulder level. Ø 3 mm min. vent away from the driver down to the bottom level of the frame. Transmission or differential, unless sealed, requires 100 ml catch bottle
- 445 ○ **FLUID LEAKS** – None permitted (e.g., oil, grease, coolant, fuel, brake fluid)
- 446 ○ **BELLYPANS** – Must be vented to prevent accumulation of volatile fluids. Must have at least two holes (Ø 25 mm min.). These holes must be positioned in the lowest part of the structure

ACCUMULATOR CONTAINER(S)

- 447 Must lie within the Primary Structure of the frame lower than the top of the SIS
- 450 Must be attached to Primary Structure with fasteners grade 8.8 min. (must follow T 10)
- 448 Must be protected from side or rear impact collisions
- 451 Mounting as described in SES. Brackets of 1.6 mm steel or 4 mm aluminum with gussets to withstand bending loads. Monocoque needs 2 mm steel backing plates or equivalent (as described in SES)
- 449 If an accumulator container (or parts of it) are mounted outside the Primary Structure [see EV 5.5.1, EV 5.5.2] an additional impact structure must be built to protect the accumulator [see T 3.2.1]

PROTECTION OF TRACTIVE SYSTEM PARTS

- 452 In side view no parts of the tractive system can project below the lower surface of the frame or monocoque
- triangulated structure with tubes of Ø 25.4 x 1.25 mm min. or equivalent
- 453 All parts belonging to the tractive system, including cables and wirings, must be contained within the rollover protection envelope [see T 1.1.16].
- 455 Motor casing made of 2 mm min. Aluminum 6061-T6 (may be split into two equal sections, each 1 mm thickness)
- 454 If tractive system parts are mounted in a position where damage could occur from a rear or side impact (< 350 mm from the ground) they must be protected by a fully
- 456 If motor casing is rotating around the stator or is perforated, an additional scattershield of 1 mm min. Aluminum 6061-T6 around the motor should be installed

NON-COMPLIANCE / COMMENTS

STATUS UPDATE

- ▶ Set online status to **Pass** or **Fail**

APPROVAL

Scrutineer/s name/s

Date, Time

Signature/s when PASSED

PART V – TILT TEST

STATUS UPDATE

- ▶ Set online status to **Present**
- ▶ Write down Scrutineer(s) name(s), sign when passed

FLUID LEVELS

457 **FLUID LEVELS** – All vehicle fluids are at their maximum fill level

TEST

- ▶ Weight the vehicle
- 458 **FLUID LEAKAGE** – No fluid leaks
- ▶ Lift the tilt table to an angle of 60 ° in the direction most likely to create spillage
- 459 **VEHICLE STABILITY** – All wheels in contact with the tilt table surface

NON-COMPLIANCE / COMMENTS

STATUS UPDATE

- ▶ Set online status to **Pass** or **Fail**

APPROVAL

Scrutineer/s name/s	Date, Time	Signature/s when PASSED

PART VI – RAIN TEST

The vehicle must be in Ready-to-Race condition (not in Ready-to-Drive mode [see EV 4.11]). All components and constructions used to protect the vehicle from water during the rain test must be used during the entire competition. The test will be conducted without a driver.

STATUS UPDATE

- ▶ Set online status to **Present**
- ▶ Write down Scrutineer(s) name(s), sign when passed

TEST

- ▶ The vehicle is lifted off the ground and all four wheels must be removed. Tractive system must be active (TSAL ON)
- ▶ Another 120 s of waiting without water spray
- 460 Tractive system voltage is present at TSMP(s)
- 461 The Insulation Monitoring Device is not triggered during or after the water spray has stopped
- ▶ Water will be sprayed at the vehicle from any possible direction for 120 s
- ▶ Connect R_{TEST} between any TSMP and LVS GND
- 462 Shutdown circuit opens within 30 s

NON-COMPLIANCE / COMMENTS

STATUS UPDATE

- ▶ Set online status to **Pass** or **Fail**

APPROVAL

Scrutineer/s name/s	Date, Time	Signature/s when PASSED

PART VII – BRAKE TEST

The time limit for this part of the inspection is **3 attempts**. Continuation of the inspection is only possible on free slots. During technical inspection all work carried out on the vehicle must be approved by a technical inspector.

STATUS UPDATE

- ▶ Set online status to **Present**
- ▶ Write down Scrutineer(s) name(s), sign when passed

TEST

- ▶ The tractive system must be shut down by the driver before braking
- **BRAKING PERFORMANCE...**
- 463 ...must lock-up all four wheels on dry asphalt at any speed
- 464 ...stop the vehicle in a straight line without electrical braking from motors
- 465 ...the TSAL must be green during breaking or shortly after the vehicle stopped (may take up to 5 s after shutdown)
- 466 **BRAKE LIGHT** – Must be clearly visible even in bright sunlight
- 467 **BOTS** – It has not been activated after the brake test

NON-COMPLIANCE / COMMENTS

STATUS UPDATE

- ▶ Set online status to **Pass** or **Fail**

APPROVAL

Scrutineer/s name/s	Date, Time	Signature/s when PASSED

PART VIII – DYNAMIC EVENTS INSPECTION

This is a guideline of points to be checked during dynamic events. Random inspections could be done arbitrarily and at the technical inspector discretion, even if they are not specified in this section.

PRE-INSPECTION

REQUIRED	ACC.	SKIDPAD	AUTO-X	ENDUR.
ROLL BAR PADDING – Securely attached and in direction of driver’s helmet				
WINGS – Securely attached and properly marked				
FIREWALL – Securely attached and properly sealed				
SUSPENSION – Securely attached and check possible loose joints				
TYRES – Check clearances inside the rim, white marking tyre-rim and possible displacement				
IMD – Connect IMD tester and check insulation				

OPTIONAL	ACC.	SKIDPAD	AUTO-X	ENDUR.
FLUID LEAKS – Oil, grease, coolant, fuel, brake fluid -> none permitted				
GROUND CLEARANCE – At least 30 mm min. in any condition				
BODYWORK EDGES – Edges that could contact a pedestrian must have a minimum radius of 1 mm				
BODY & STYLING – Vertical keep out zones 75mm in front and behind tires (no aero exceptions), tires unobstructed from sides				
AERODYNAMICS – Securely attached				
BOTS – If failure in one or both brake circuits the brake pedal over travel will open the shutdown circuit				

POST-INSPECTION

REQUIRED	ACC.	SKIDPAD	AUTO-X	ENDUR.
GROUND CLEARANCE – At least 30 mm min. in any condition				
FLUID LEAKS – Oil, grease, coolant, fuel, Brake fluid -> none permitted				
BOTS – If failure in one or both brake circuits the brake pedal over travel will open the shutdown circuit				
AERODYNAMICS – Check height, width or length randomly				

OPTIONAL	ACC.	SKIDPAD	AUTO-X	ENDUR.
WINGS – Securely mounted				
FIREWALL – Securely attached and properly sealed				