

University:	Amet University	Present the vehicle for inspection in the following order
Vehicle number:	422	
ESF Passed:	-	
TS Voltage:	600 V	

1. Pre-Inspection
2. Egress Test
3. Done simultaneously
 - 3.1 Accumulator Inspection
 - 3.2 Mechanical Inspection
4. Electrical Inspection (TS OFF)
5. High Voltage Inspection (TS ON)
6. Tilt Test
7. Rain Test
8. Brake Test

INFORMATION

USED SYMBOLS

- Information
- ▲ Action
- △ Check is the responsibility of the team
- Check

NOTES

- This sheet must always stay with the push bar. (Can be temporarily split for Accumulator inspection)
- Technical inspection approval voids if the inspection sheet is lost.
- If there is a conflict between this sheet and the rules, the rules prevail.

PART I: PRE-INSPECTION

APPROVAL

Inspector Names	Date and Time	Signatures when passed
_____	_____	_____
_____	_____	_____

○ TIRES

- | | |
|--|---|
| 1 ○ DRY TIRES - Make | 4 ○ WET TIRES - Make |
| 2 ○ _____
DRY TIRES - Size | 5 ○ _____
WET TIRES - Size |
| 3 ○ _____
DRY TIRES - Compound | 6 ○ _____
WET TIRES - Compound |
| | 7 ○ _____
WET TIRES - 2.4 mm min. tread depth molded by tire manufacturer |

○ DRIVER GEAR AND SAFETY

- Fire-resistant clothing must not be older than 10 years, recognizable since no FIA hologram label present.
- 8 ○ **FACE SHIELDS** - Made of impact resistant material.
- 9 ○ **UNDERWEAR** - Must be made from acceptable fire-resistant material as listed in T 13.3.13 and must cover the driver's body completely from neck down to ankles and wrists.
- 10 ○ **SOCKS** - Nomex or equivalent, fire-resistant socks (no cotton, no polyester, no bare skin).
- 11 ○ **GLOVES** - Fire resistant material. No holes. Leather is allowed only over fire-resistant material.
- 12 ○ **ARM RESTRAINTS** - SFI Standard 3.3 or equivalent.
- 13 ○ **HELMETS** - Snell K2015, K2020, M2015, M2020, SA2020, EA2016 or newer, SFI 31.1/2015, 31.1/2020, 41.1/2015, 41.1/2020 or newer, FIA 8860-2010, FIA 8860-2018, FIA 8859-2015 or newer. Closed Face, no Open Face, must have integrated shield (no dirt bike helmets). No camera mounts.

- 14 **FRONTAL HEAD RESTRAINT** - If FHR/HANS is used, it must be certified to one of the following standards and be labelled as such - FIA 8858-2010, FIA 8860-2004, SFI 38.1.
- 15 **DRIVER SUITS** - SFI 3.2A/5 (or higher), SFI 3.4/5 (or higher), FIA Standard 8856-2000 or FIA Standard 8856-2018.
- 16 **HAIR COVER** - Fire resistant (Nomex or equiv.) balaclava of full helmet skirt **REQUIRED FOR ALL DRIVERS.**
- 17 **SHOES** - SFI 3.3 or FIA 8856-2000/2018.

NON-COMPLIANCE/COMMENTS

PART II: EGRESS TEST

APPROVAL

Inspector Names	Date and Time	Signatures when passed

DRIVER POSITION

- | | |
|---|--|
| <p>18 <input type="radio"/> ARM RESTRAINTS - Must be installed, so the driver can release them and exit unassisted regardless of the vehicle's position.</p> <p>19 <input type="radio"/> HEAD RESTRAINT - Near vertical. Max. 25 mm from helmet. Helmet contact point 50 mm min. from any edge.</p> <p>20 <input type="radio"/> MAIN HOOP AND FRONT HOOP HEIGHTS - Helmet of driver to be 50 mm below the line between the top of the front and main roll hoop</p> | <p>AND between the top of the main hoop to rear attachment point of main hoop bracing.</p> <p>21 <input type="radio"/> LAP BELT MOUNTING - Must pass over pelvic area between 45° and 65° to horizontal for upright driver, 60° to 80° for reclined. The lap belts must not be routed over the sides of the seat.</p> <p>22 <input type="radio"/> SHOULDER HARNESS MOUNTING - Angle from shoulder between 10° up and 20° down to horizontal.</p> |
|---|--|

DRIVER EGRESS TEST

- | | |
|--|---|
| <p><input checked="" type="radio"/> All drivers must be able to exit the vehicle in less than 5 s.</p> | <p><input checked="" type="radio"/> Driver must be seated in ready-to-race condition.</p> |
|--|---|

EGRESS PROCEDURE

- | | |
|--|---|
| <p>▲ Both hands on the steering wheel - in all possible steering positions.</p> <p>▲ Pressing cockpit-mounted shutdown button.</p> | <p>▲ The egress time will stop when the driver has both feet on the ground.</p> |
|--|---|

DRIVER APPROVAL AND RUN DOCUMENTATION

Driver Name	Driver ID	Approved by	Acc	SkidPad	AutoX	Endurance
			○ ○	○ ○	○ ○	○ ○
			○ ○	○ ○	○ ○	○ ○
			○ ○	○ ○	○ ○	○ ○
			○ ○	○ ○	○ ○	○ ○
			○ ○	○ ○	○ ○	○ ○
			○ ○	○ ○	○ ○	○ ○

NON-COMPLIANCE/COMMENTS

PART III: ACCUMULATOR INSPECTION

APPROVAL

Inspector Names	Date and Time	Signatures when passed
_____	_____	_____
_____	_____	_____

INSPECTION RULES

- The time limit for each attempt at this technical inspection is 120 min. 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.
- The time limit for repair works is 15 min cumulative per one inspection attempt.

TIS STATUS UPDATE/TIMER

- ▲ Set online TIS to Present
- ▲ Attach/place the timer
- ▲ Start the timer

REQUIRED RESOURCES

- 23 An ESO must attend.
 - All accumulator containers to be used during the event.
 - Accumulator Container Hand Cart.
 - Charger.
 - Tools needed for (dis)assembly of the Accumulator Container.
 - PDF or printout 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.

SAFETY BRIEFING

- All accumulator containers to be used during the event.
- No jewelry, no rings.
- No cell phone.
- No badge / no necklace.
- No other sources of distraction.
- Wear safety glasses.
- Wear safety gloves.

BASIC SET OF HV-PROOF TOOLS

- 24 Insulated cable shears.
- 25 Insulated screwdriver.
- 26 Insulated spanners (n/a if no screwed connections in TS).
- 27 Multimeter with protected probe tips.
- 28 Two 4 mm banana plug test leads (1000V CAT III).

SAFETY EQUIPMENT

- 29 Face shield.
- 30 Safety glasses (minimum three).
- 31 HV insulating gloves (minimum two pairs).
- 32 HV insulating blankets (two) (min 1 m²) with label or serial number and datasheet.

SELF DEVELOPED PCBS

- ▲ Ask for fully assembled PCB spares of self-developed PCBs inside the TSAC and the charger.
- 33 Sufficient TS to LVS spacing and resistance regarding system voltage and implementation.
- 34 The 1 min AC RMS isolation voltage (TS to LVS) is $\geq 1800 V_{DC}$ ¹.
- 35 The working voltage of the isolation barrier (TS to LVS), if specified in the datasheet, is higher than the U_{TSmax} .
- 36 Sufficient insulation and temperature rating of coating if used, datasheet available.
- 37 Coating process according to datasheet.

CHARGER ASSEMBLY

- 38 Completely closed. Check openings in HV/TS enclosures, try to reach HV/TS potentials with an insulated test probe (100 mm length, 6 mm diameter).
- 39 Interlock integrated.
- 40 TSMP integrated.
- 41 Emergency shutdown button integrated.
- 42 Emergency shutdown button ≥ 24 mm diameter.
- 43 TS wiring is orange, ask team to prove temperature rating 85 °C and voltage rating.
- 44 Conductive parts of charging equipment and accumulator are connected to protective earth (PE) while charging.

DISCHARGE CIRCUIT AND BODY PROTECTION RESISTORS

- ▲ Switch off Charger. Measure resistance between TS+ and TS measuring points.
- 45 Resistance is $30 k\Omega^2 + R_{discharge}$. If not measurable, ask for an explanation and alternative measurement procedure.
- 46 Body protection resistor power rating is sufficient.³
- 47 Discharge power rating is sufficient for continuous discharge.

INSULATION MEASUREMENT TEST

- ▲ Check low resistance connection between LVS ground MP and PE/casing.
- ▲ Choose test voltage according to IN 4.1.1.⁴
- ▲ Connect insulation tester to charger TS+ and LVS GND measuring point.
- ▲ Connect charger (do not activate charger) to accumulator, keep AIRs opened.
- ▲ Measure resistance: $R_{iso+} =$ k Ω
- 48 Resistance is much higher than 315 k Ω ⁵.
- ▲ Connect insulation tester to charger TS- and LVS ground.
- ▲ Measure resistance: $R_{iso-} =$ k Ω
- 49 Resistance is much higher than 315 k Ω ⁵.
- 50 Resistances are nearly equal.

ASSEMBLY

- ▲ Open container housing, remove maintenance plugs.
- ▲ Check if no voltage is present.
- 51 All components and parts of the accumulator container are properly fixed.
- 52 TS potentials are insulated against the inner wall of the accumulator container if the container is made from conductive materials.
- 53 All used fasteners must be secured by the use of positive locking except they are non-conductive and non-structural.
- 54 Tabs of pouch cells do not carry mechanical loads. Pouch cells carry mechanical loads only on large surface areas.

¹ $3 \times U_{TSmax}$

² Body Protection Resistor (BPR). It is one of following:

$$U_{TSmax} \leq 200 V_{dc} : BPR = 5 k\Omega$$

$$200 V_{dc} \leq U_{TSmax} \leq 400 V_{dc} : BPR = 10 k\Omega$$

$$400 V_{dc} \leq U_{TSmax} \leq 600 V_{dc} : BPR = 15 k\Omega$$

³Sufficient to short circuit TS+ and TS-

⁴

$$U_{TSmax} \leq 250 V_{DC} : U_{Test} = 250 V_{DC}$$

$$U_{TSmax} > 250 V_{DC} : U_{Test} = 500 V_{DC}$$

⁵ Minimal Resistance = $500 \Omega/V \times U_{TSmax} + R_{BPR}$

- 55 ○ No soldering in the high current path.
- 56 ○ Every container contains at least one appropriately sized and rated fuse.
 - ▲ Check the datasheet of fuse, main wire and cells and compare them to ESF.
- 57 ○ Every container contains at least two appropriately sized and rated isolation relays (current and voltage).
- 58 ○ Isolation relays and fuses are separated from cells by a barrier according to UL94-V0 or equivalent.
 - ▲ Check the datasheet of the pre-charge relay and compare it to ESF.
- 59 ○ Pre-charge relay is of mechanical type with appropriate voltage rating.
- 60 ○ Maintenance plugs are located at both poles of each stack (including the first and last stack). Removable from both poles.
- 61 ○ Maintenance plugs are removable without tools.
- 62 ○ Maintenance plugs have a positive locking mechanism.
- 63 ○ Maintenance plugs must not be able to unintentionally create circuits or short circuits.
- 64 ○ Stacks separated by Maintenance plugs $\leq 120 V_{DC}$.
- 65 ○ Stacks separated by Maintenance plugs 6 MJ.
- 66 ○ Stacks are insulated and separated by a fire-resistant barrier according to UL94-V0 for min. used thickness or equivalent.
- 67 ○ Holes in the container only for the wiring harness, ventilation, cooling or fasteners, mechanical properties are not influenced.
- 68 ○ External openings for cooling or mounted connected cooling ducts are not pointing towards the driver, or if the accumulator is out of the car, towards the operator of the accumulator hand cart.
- 69 ○ Check openings in TS enclosures, try to reach TS potentials with an insulated test probe (100 mm length, 6 mm diameter).
- 70 ○ If fully closed, an equalizing valve is implemented.
- 71 ○ Spare accumulators of the same size, weight, and type.

○ **WIRING**

- 72 ○ All TS wires have proper overcurrent protection.
- 73 ○ No other wires than TS wires are orange.
- 74 ○ Securely anchored to withstand at least 200 N, if outside of enclosure.
- 75 ○ Located out of the way of possible snagging or damage.
- 76 ○ TS and LVS wires separated (n/a for Interlock).
- 77 ○ Every wire used in the Accumulator container (TS and LVS) is rated for U_{TSmax} .
- 78 ○ Ask team to prove that TS wires fulfill temperature rating $> 85^\circ C$ and voltage rating.
- 79 ○ Positive locking mechanism or automotive certified components if no positive locking is possible.
- 80 ○ Connectors outside TS enclosures are physically impossible to electrically connect in other than the design intended configuration.
 - ▲ Check if insulated tools needed for the assembly of certified components are available.
- 81 ○ Insulation is not only insulating tape or rubber-like paint.

○ **INDICATOR LIGHT OR VOLTMETER**

- 82 ○ Indicator light or voltmeter installed.
- 83 ○ Marked with "Voltage Indicator".
- 84 ○ Visible while opening the battery connector.
- 85 ○ Hard-wired electronics, supplied by TS.
 - ▲ Connect power supply with $60 V_{DC}^6$ to accumulator TS connector.
- 86 ○ Indicator light on or voltmeter showing present TS voltage.
- 87 ○ Red (in case of indicator light) and visible in bright sunlight.

○ **ACCUMULATOR MANAGEMENT SYSTEM**

- 88 ○ A minimum of 30% of cells equally distributed within TSAC(s) are monitored with temperature sensors.
 - ▲ Do the following procedure for all TSACs, if applicable.
- 89 ○ Every temperature sensor is placed on the negative terminal of the monitored cell or in ≤ 10 mm distance on the busbar.
 - ▲ Disconnect AMS current sensor connector.
- 90 ○ If multiple TSACs are used, each one has its own, full AMS and includes exclusive SDC.
 - ▲ Disconnect one SINGLE voltage sense wire, if any wires are used.
- 91 ○ AMS must open the shutdown circuit within 0.5 s.
- 92 ○ AMS must open the shutdown circuit within 0.5 s.

⁶60 V or half the nominal tractive system voltage, whichever is lower

- ▲ Ask the team to connect their laptop to the AMS.
- 93 ○ Cell voltages can be displayed.
- 94 ○ Cell temperatures can be displayed.
- ▲ Disconnect AMS internal connector used for cell

- temperature measurement.
- 95 ○ Respective failed cell temperature measurement is displayed.
- 96 ○ Plausible accumulator current can be displayed.

○ CHARGER SHUTDOWN CIRCUIT

- 97 ○ IMD is integrated into the charging system 5s.
- ▲ Connect the charger to the battery/batteries, and start the charging process.
- 98 ○ Voltage indicator shows that HV is present.
- ▲ Press the shutdown button.

- 99 ○ AIRs open.
- 100 ○ Voltage indicator shows voltage < 60 V.
- ▲ Start charging, unplug TS accumulator connector.
- 101 ○ AIRs open.
- 102 ○ Charger disabled, no voltage at charger connector.

○ INSULATION MONITORING DEVICE

- 103 ○ 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.
- ▲ $R_{Test} = 135 \text{ k}\Omega^7$
- ▲ Activate charger output, connect R_{Test} between TS+ and LVS GND.
- 104 ○ Shutdown circuits opens within 30 s.
- 105 ○ TS voltage decreases below 60 V_{DC} within 5 s after shutdown circuit opens.
- 106 ○ Reactivation of charger output is not possible.

- ▲ Push the reset button, if any.
- 107 ○ Reactivation of charger output is not possible.
- ▲ Remove R_{Test} . Wait 40 s until IMD resets status output.
- 108 ○ Reactivation of charger output is not possible.
- ▲ Ask the team to perform power cycle to unlatch all faults.
- ▲ Activate TS, connect R_{Test} between TS- and LVS GND.
- 109 ○ Shutdown circuits opens within 30 s.

○ ACCUMULATOR CONTAINER

- ▲ Invite mechanical scrutineer for assistance with point 110.
- ▲ Team must show approved SES for the accumulator container.
- ▲ Team must show SES test samples for the accumulator container if alternative materials are used.
- 110 ○ Accumulator container manufactured according to SES.
- 111 ○ Internal vertical walls have to be rigidly fastened to the container. Minimum 75 % of the height of the external walls. Divide the accumulator into sections of max. 12 kg.

- 112 ○ Barriers do not divide any accumulator segment.
- 113 ○ Cells securely fastened towards all 3 directions.
- 114 ○ Vehicle number, university name and ESO phone number(s) written on a high contrast background.
- 115 △ Roman Sans-Serif characters of at least 20 mm high are used.
- 116 ○ Warning stickers with a side length of ≥ 100 mm and text "Always Energized" and "High Voltage" (if TS > 60 V) installed. (Triangle with black lightning bolt on yellow background).
- 117 ○ Check if all parts and the cover/lid of the housing are rigidly fastened.

○ HAND CART

- 118 ○ Hand cart present with four wheels. Max. dimensions 1200 × 800 mm.
- 119 ○ Hand cart has an always-on type brake system.
- 120 ○ Hand cart provides a firewall with the same width as the hand cart to protect the person while moving it, starting at the lowest point of the hand cart (excluding wheels) and is > 30 cm higher than the handle and the TSAC.
- 121 ○ The firewall must be made from a rigid, fire retardant material (UL94-V0 or equivalent) and be

- transparent from 1.3 m above the ground.
- 122 ○ The accumulator must be mechanically fixed to the hand cart while on the hand cart.
- 123 ○ The accumulator must be protected from vibrations and shocks.
- 124 ○ The accumulator must not protrude the hand cart.
- 125 ○ The hand cart itself must have a label according to EV5.3.8 on its firewall below the hand cart handle (The vehicle number, the university name, and the ESO phone number(s) must be displayed

⁷ $R_{Test} = (U_{TSmax} \times 250 \Omega/V) - R_{BPR}$

and written in Roman Sans-Serif characters of at least 20 mm high, clearly visible and placed on a high-contrast background).

SEALING OF COMPONENTS

- ▲ After all tests have been passed successfully seal the inspected TS housings:
- 126 Accumulator container(s) including spares.
- 127 Charger.
- 128 Additional Part:
- 129 Additional Part:

TIS STATUS UPDATE/TIMER

- ▲ Set online TIS to Passed or Failed
- ▲ Stop the timer
- ▲ Collect the timer

NON-COMPLIANCE/COMMENTS

PART IV: ELECTRICAL INSPECTION (TS OFF)

APPROVAL

Inspector Names	Date and Time	Signatures when passed

INSPECTION RULES

- The time limit for each attempt at this technical inspection is 120 min. 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.
- The time limit for repair works is 15 min cumulative per one inspection attempt.

○ TIS STATUS UPDATE/TIMER

- ▲ Set online TIS to Present
- ▲ Attach/place the timer
- ▲ Start the timer

○ REQUIRED RESOURCES

- | | |
|--|---|
| <p>130 ○ An ESO must attend.</p> <ul style="list-style-type: none"> ● TSAC mounted into the vehicle. ● LV battery or cell datasheet. ● For self-developed LV battery packs: an opened LV battery pack, laptop, and cables to display data of the LV battery AMS. ● Datasheets for used wiring, insulation materials, and TS components. Printed or properly sorted | <ul style="list-style-type: none"> 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. ● Photographs of all inaccessible TS connections. ● "TSAL green" sign. |
|--|---|

○ LV BATTERY

- | | |
|---|---|
| <p>131 ○ Voltage $\leq 60 V_{DC}$.</p> <p>132 ○ Rigid and sturdy casing.</p> <p>133 ○ Only for wet-cell batteries: IPX7 rated and acid resistant casing if inside the cockpit.</p> <p>134 ○ Behind Firewall.</p> <p>135 ○ Short circuit protection (e.g., fused).</p> <p>136 ○ Proper insulation of internal electrical connections.</p> <p>137 ○ Proper mounting of cells.</p> <p>138 ○ Complete battery pack inside rollover protection envelope.</p> <p>139 ○ Has overpressure relief, gas vent behind a firewall (only applies to fully enclosed battery case).</p> <ul style="list-style-type: none"> ▲ Following checks only for Li-Ion batteries other than LiFePO4: | <p>140 ○ UL94-V0 for min. used thickness or equivalent casing.</p> <p>141 ○ Overcurrent protection that trips below max. discharge current.</p> <p>142 ○ Overtemperature protection of at least 30% of the cells (max. 60°C or datasheet, whichever is lower).</p> <p>143 ○ Voltage protection of all cells.</p> <p>144 ○ Signal failures electrically disconnect the LV battery (SCS) (check the schematics of LV battery AMS).</p> <ul style="list-style-type: none"> ▲ Ask the team to connect their laptop to the AMS. <p>145 ○ Cell voltages can be displayed.</p> <p>146 ○ Cell temperatures can be displayed.</p> |
|---|---|

○ SELF DEVELOPED PCBs

- ▲ Ask for fully assembled PCB spares of self-developed boards where both TS and LVS parts are present (outside the TSAC) - i.e. discharge, TSMP, motor controller. . .
- 147 ○ Sufficient TS to LVS spacing and resistance regarding system voltage and implementation.
- 148 ○ The 1 min AC RMS isolation voltage (TS to LVS) is $\geq 1800 V_{DC}^8$.

⁸ $3 \times U_{TSmax}$

- 149 ○ The working voltage of the isolation barrier (TS to LVS), if specified in the datasheet, is higher than the U_{TSmax} .
- 150 ○ Sufficient insulation and temperature rating of coating if used, datasheet available.
- 151 ○ Coating process done properly and according to the datasheet.
- ▲ Ask for fully assembled PCB spare(s) and schematic of BSPD board(s).
- 152 ○ BSPD PCB(s) is standalone with only minimum interface.
- 153 △ BSPD PCB(s) are directly supplied from the LVMS.

○ **MASTER SWITCHES**

- 154 ○ TSMS, ASMS and LVMS installed easily accessible on the right side of the vehicle and located next to each other.
- 155 △ All master switches are located above 80% of shoulder height of Percy.
- 156 ○ Rigidly mounted and no need to be removed during maintenance.
- 157 ○ Rotary type with removable handle.
- 158 △ Handle length ≥ 50 mm.
- 159 ○ "ON" position in horizontal.
- 160 ○ "ON" and "OFF" positions marked.
- 161 ○ TSMS with a locking mechanism for "OFF" position.
- 162 ○ LVMS marked with "LV" and a symbol showing a red spark in a white-edged blue triangle.
- 163 ○ LVMS mounted on a red circular area on a high contrast background.
- 164 △ Circular area diameter ≥ 50 mm.
- 165 ○ TSMS marked with "TS" and triangle with a black lightning bolt on a yellow background.
- 166 ○ TSMS mounted on an orange circular area on a high contrast background.
- 167 △ Circular area diameter ≥ 50 mm.
- 168 ○ ASMS marked with "AS".
- 169 ○ ASMS mounted on a blue circular area on a high contrast background.
- 170 △ Circular area diameter ≥ 50 mm.

○ **MEASURING POINTS**

- 171 ○ Two TS measuring points on exclusive orange background.
- 172 ○ A black LV ground measuring point installed.
- 173 ○ Next to the master switches.
- 174 ○ 4 mm shrouded banana jacks.
- 175 ○ Non-conductive cover.
- 176 ○ Cover removable without tools.
- 177 ○ Correctly marked ("TS+", "TS-", "GND").

○ **TS SHUTDOWN DEVICES**

- 178 ○ 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.
- 179 ○ Marked with red sparked sticker.
- 180 △ Diameter > 39 mm.
- 181 ○ One cockpit shutdown button installed. Push-Pull or Push Rotate-Pull functionality.
- 182 ○ Marked with red sparked sticker.
- 183 ○ Easy actuation by the driver.
- 184 △ Diameter ≥ 24 mm.
- 185 ○ Inertia switch rigidly mounted to the chassis with correct orientation (according to datasheet) and can be unmounted for functionality test.
- Check interlocks on ...
- 186 ○ TS accumulator container(s).
- 187 ○ Inverters.
- 188 ○ HVD.
- 189 ○ Power distribution boxes.
- 190 ○ Data Logger box.
- If outboard wheel motors are used:
- 191 ○ Outboard wheel motors - interlocks must act before a TS wiring failure.
- 192 ○ Suspension member - interlock must act in case of suspension failure.

○ **TS VOLTAGE**

- ▲ Measure voltage at TS measuring points.
- 193 ○ Equal or less than $60V_{DC}$.

DISCHARGE CIRCUIT AND BODY PROTECTION RESISTORS

- ▲ Switch off LVMS. Measure resistance between TS+ and TS- measuring points.
- 194 Resistance is $30\text{ k}\Omega^9 + R_{\text{discharge}}$. If not measurable, ask for an explanation and alternative measurement procedure.
- 195 Body protection resistor power rating is sufficient.¹⁰
- 196 Discharge power rating is sufficient for continuous discharge.

TS WIRING

- 197 All TS wiring and components have to be in the envelope and behind the impact structures.
- 198 TS wires of outboard wheel motors must not be able to reach the cockpit opening in case of a wire break. Any wiring outside the impact structure is the shortest possible distance.
- 199 All TS wires and connectors have proper overcurrent protection.
- 200 TS wiring channels are orange.
- 201 No other wires than TS wires are orange.
- 202 TS wiring outside electrical enclosures in a separate non-conductive enclosure or orange shielded cable.
- 203 Securely anchored to withstand at least 200 N, if outside of enclosure.
- 204 Located out of the way of possible snagging or damage.
- 205 Shielded against rotating/moving parts.
- 206 No wire lower than the chassis.
- 207 TS and LVS wires separated (n/a for Interlock).
- 208 Ask team to prove that TS wires fulfill temperature rating $> 85\text{ }^\circ\text{C}$ and voltage rating.
- 209 Suitable temperature rating for the used position.
- 210 Positive locking mechanism on every screwed connection, photographs for all inaccessible TS connections.
- 211 Positive locking mechanism on every TSMP connection, photographs for all inaccessible connections.
- 212 Insulation is not only insulating tape or rubber-like paint.

HV WARNING STICKERS

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

TRACTIVE SYSTEM PROTECTIONS

- ▲ Check opening in TS enclosures, try to reach TS potentials with insulated test probe (100 mm length, 6 mm diameter).
- 218 Not possible to reach any TS potentials.
- 219 TS components and containers protected from moisture.

HIGH VOLTAGE DISCONNECT

- 220 Clearly marked with "HVD".
- 221 Distance to ground greater than 350 mm.
- 222 Inside roll-over protected envelope.
- 223 No remote actuation (e.g., through wires).
- 224 Integrated interlock.
- ▲ Ask ESO to remove HVD and document the process (video).
- 225 Removed within 10s without tools.
- 226 TS protection still given (insulated test probe). If a dummy connector is used, it must be stored at the push bar.

⁹2 × Body Protection Resistor (BPR). It is one of following:

$$U_{TSmax} \leq 200\text{ V}_{dc} : BPR = 5\text{ k}\Omega$$

$$200\text{ V}_{dc} \leq U_{TSmax} \leq 400\text{ V}_{dc} : BPR = 10\text{ k}\Omega$$

$$400\text{ V}_{dc} \leq U_{TSmax} \leq 600\text{ V}_{dc} : BPR = 15\text{ k}\Omega$$

¹⁰Sufficient to short circuit TS+ and TS-

TRACTIVE SYSTEM ACTIVE LIGHT

- 227 Mounted below the highest point of the main roll hoop (no lower than 75 mm) and within the roll-over protected envelope (including mounting). ● Cockpit indicator light. . .
228 . . . is inside the cockpit and marked with "TS off",
229 . . . is visible for the driver.

DATA LOGGER

- 230 Data logger is fully enclosed in a housing. 232 All TS current flowing from/to accumulator flows through the data logger.
231 Data logger is properly mounted.

ACCUMULATOR MANAGEMENT SYSTEM

- ▲ Disconnect AMS signal(s) from the TS accumulator. 234 . . . is illuminated red and visible in bright sunlight, even from outside,
● AMS indicator light. . . 235 . . . is visible for the driver.
233 . . . is inside the cockpit and marked with "AMS",

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). . . 239 First layer, facing TS must be made of Aluminum with a thickness of at least 0.5 mm.
236 . . . behind the driver's back, 240 Second layer, facing driver must be made of electrically insulated material (no CFRP).
237 . . . at the sides of the driver, 241 Material meets UL94-V0 for min. used thickness or equivalent.
238 . . . at the front of the vehicle.

ACCELERATOR PEDAL POSITION SENSOR (APPS)

- 242 Returns to the original position if not actuated. 245 Sensors are protected from being mechanically overstressed (positive stop of the pedal).
243 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. 246 Minimum two springs installed to return pedal.
244 Sensors do not share supply or signal lines. 247 Each spring still returns the pedal with the second one disconnected (springs in the torque encoders not counted).

AUTONOMOUS SYSTEM STATUS INDICATORS (ASSI)

- 248 Both side ASSIs are mounted behind the driver's compartment, min 160 mm below the top of the main hoop and 600 mm above ground. point 160 cm above the ground within 3 m radius from main hoop.
249 The rear ASSI is mounted on vehicle centerline, min. 160 mm below the top of the main hoop and 100 mm above the brake light. 251 Round, triangle, or rectangular on dark background.
250 At least one ASSI visible from any angle from a 252 15 cm² minimum illuminated area, or LED strip with a total length greater than 150 mm with elements < 20 mm apart

BRAKE LIGHT

- 253 Only one brake light. ground.
254 Located on vehicle centerline, height between wheel center line and driver's shoulder. 256 15 cm² minimum illuminated area, or LED strips with a total length greater than 150 mm with elements < 20 mm apart.
255 Round, triangle, or rectangular on black back-

○ INSULATION MEASUREMENT TEST

- ▲ Choose test voltage according to IN 4.1.1.¹¹
- ▲ Connect insulation tester to TS+ and LVS GND measuring point.
- ▲ Measure resistance: $R_{iso+} = \quad \quad \quad k\Omega$
- 257 ○ Resistance is much higher than $315 k\Omega$ ¹².
- ▲ Connect insulation tester to TS- and LVS ground.
- ▲ Measure resistance: $R_{iso-} = \quad \quad \quad k\Omega$
- 258 ○ Resistance is much higher than $315 k\Omega$ ¹².
- 259 ○ Resistances are nearly equal.

GROUNDING CHECKS

- EV 3.1 has been fully revised. Each TS enclosure must either contain a $\geq 0.5 mm$ 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 $\leq 300 m\Omega$ measured at 1 A and being able to continuously carry $\geq 10\%$ of the TS main fuse to LVS ground is properly grounded. Other conductive parts within 100 mm of any TS component must be $\leq 100 \Omega$ 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.
- Each $\leq 300 m\Omega$ grounding is able to carry $\geq 10\%$ of TS main fuse - measure if needed/in doubts.
- N/A: Not applicable - not conductive or not closer to TS components than 100 mm.
- ▲ Measure resistance between LVS GND measuring point and...
- ▲ Check for each TS enclosure...
- 260 ○ ... all materials used to build a TS enclosure separately have a resistance $\geq 2 M\Omega @ 500 V \rightarrow$ fully isolated TS enclosure, no grounded layer needed.
- 261 ○ ... except e.g. screws, (shielded) connectors, backing plates isolating materials used \rightarrow fully isolated TS enclosure, no grounded layer needed but protruding elements must be properly grounded.
- 262 ○ ... at least one material has $< 2 M\Omega \rightarrow \geq 0.5 mm$ thick solid grounded layer made of aluminium or better required and properly grounded.
- 263 ○ ... $\geq 0.9 mm$ thick steel layer might be used for TSAC as the grounded layer.

¹¹

$U_{TSmax} \leq 250 V_{DC} : U_{Test} = 250 V_{DC}$
 $U_{TSmax} > 250 V_{DC} : U_{Test} = 500 V_{DC}$

¹² Minimal Resistance = $500 \Omega/V \times U_{TSmax} + R_{BPR}$

Part	N/A	< 300 mΩ@1 A	< 100 Ω
Main Roll Hoop		<input type="checkbox"/>	
Driver harness mounting points		<input type="checkbox"/>	
Seat and seat mounting points (N/A if not conductive)	<input type="checkbox"/>	<input type="checkbox"/>	
Firewall(s) mounting points and aluminium layer		<input type="checkbox"/>	
Accumulator container and/or protruding parts (fasteners, connectors)	<input type="checkbox"/>	<input type="checkbox"/>	
TS enclosures and/or protruding parts (fasteners, connectors)	<input type="checkbox"/>	<input type="checkbox"/>	
TS connectors (shells) (N/A if not conductive)	<input type="checkbox"/>	<input type="checkbox"/>	
TS motor(s) startionary part (N/A if fully enclosed/unreachable)	<input type="checkbox"/>	<input type="checkbox"/>	
Suspension Front left (N/A e.g. if RWD)	<input type="checkbox"/>		<input type="checkbox"/>
Suspension Front right (N/A e.g. if RWD)	<input type="checkbox"/>		<input type="checkbox"/>
Suspension Rear left (N/A e.g. if FWD)	<input type="checkbox"/>		<input type="checkbox"/>
Suspension Rear right (N/A e.g. if FWD)	<input type="checkbox"/>		<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

TIS STATUS UPDATE/TIMER

- ▲ Set online TIS to Passed or Failed
- ▲ Stop the timer
- ▲ Collect the timer

NON-COMPLIANCE/COMMENTS

PART V: MECHANICAL INSPECTION

APPROVAL

Inspector Names	Date and Time	Signatures when passed
_____	_____	_____
_____	_____	_____

INSPECTION RULES

- The time limit for each attempt at this technical inspection is 75 min. 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.
- Only tools needed for the (dis)assembly of parts for mechanical inspection.

○ TIS STATUS UPDATE/TIMER

- ▲ Set online TIS to Present
- ▲ Attach/place the timer
- ▲ Start the timer

○ VEHICLE WITH TALLEST DRIVER READY TO RACE

- | | |
|---|--|
| <p>264 ○ 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) fire extinguishers are prohibited, 1 WITH VEHICLE securely installed on push bar, 1 in paddock. (Must see BOTH at Tech.). On-board fire system possible.</p> <p>265 ○ PUSH BAR (red color) - With vehicle, securely attached to the vehicle, detachable, push and pull function for 2 people. University name on it.</p> <p>266 △ CAMERAS - Must be secured by two points on different sides of the camera body, see T 11.11. No cameras mounted to helmet.</p> <p>267 ○ AUTONOMOUS SYSTEM SENSORS - Sensors may not come into contact with the driver's helmet when normally seated.</p> <p>268 ○ VISIBILITY - Minimum of 100° field either side. Head rotation allowed or mirrors. If mirrors, must be firmly installed and adjusted.</p> <p>269 △ VEHICLE CONTROLS - All controls, including the shifter, must be inside the cockpit. No arms or elbows outside the SIS plane.</p> <p>270 ○ DRIVER FLUID PROTECTION - A firewall (rigidly mounted cover plate for cooling systems using plain water) 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 a straight line of sight with any of the following parts: fuel supply system, hydraulic fluid (except brake system and dampers), flammable liquids and low voltage battery.</p> <p>271 ○ ROLL BAR PADDING - Roll bar or bracing that could be hit by the driver's helmet must be covered with 12 mm thick, SFI spec 45.1 or FIA 8857-2001</p> | <p>padding.</p> <p>272 △ OTHER SIDE TUBES - Design prevents driver's neck hitting bracing or other side tubes</p> <p>273 ○ HEAD RESTRAINT - Near vertical. Must take 890 N load. 40 mm thick, SFI 45.2 standard or FIA technical list n°17 type B. Max. 25 mm from helmet. Helmet contact point 50 mm min. from any edge. May be changed for different drivers. Minimum 150x150 mm.</p> <p>274 ○ DRIVER RESTRAINT HARNESS - SFI 16.1, SFI 16.5, SFI 16.6, or FIA 8853/2016. 6- or 7-point system – Two-piece lap belt (min. width 50 mm), two shoulder straps (min. width 75 mm) and two leg or anti-submarine straps (min. width 50 mm). (7-point system must have three anti-submarine straps). Must be securely attached to prim. structure (25.4 × 2.4 mm or equal.)</p> <p>275 ○ LAP BELT MOUNTING - Pivoting mounting with eye bolts or shoulder bolts attached securely to Primary Structure. Min. tab thickness 1.6 mm. Attachment brackets to the monocoque must be steel, see T 5.3.2.</p> <p>276 ○ SHOULDER HARNESS MOUNTING - Mounting points 180 mm to 230 mm apart (measured center to center). Angle from shoulder between 10° up and 20° down to horizontal. Attach to Primary Structure - 25.4 × 2.4 mm or 25.0 × 2.5 mm steel tube min. NOT to put bending loads into the Main Hoop Bracing without extra bracing. Additional braces if not straight to the main hoop. Cannot pass through a firewall. Attachment brackets to the monocoque must be steel.</p> <p>277 ○ SUSPENSION - Fully operational with dampers front and rear; 50 mm minimum wheel travel (minimum jounce of 25 mm) with driver in vehicle.</p> |
|---|--|

○ VEHICLE WITHOUT DRIVER

- 278 △ **TECH STICKER SPACE** - 45 × 175 mm on the centerline of front of the vehicle in front of the cockpit opening
- 279 △ **SCHOOL NAME AND OTHER DECALS** - School Name, or recognized initials - min. 50 mm tall (all letters). on both sides in Roman letters. Must be clearly visible.
- 280 △ **VEHICLE NUMBERS** - On front and both sides of vehicle, minimum 150 mm tall, 20 mm stroke and spacing, 25 mm min. between number and background edge, Black on White, White on Black only, and specified background shapes. Must be clearly visible, font: Roman Sans-Serif characters.
- 281 △ **BODYWORK/AERODYNAMIC DEVICES EDGES** - Edges that could contact with any standing pedestrian without reaching to the vehicle must have a minimum radius of 3.0 mm for all forward-facing edges and 1.0 mm for all other edges (safety requirement).
- 282 △ **BODY AND 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.
- 283 ○ **BODYWORK** - Min. 38 mm radius on nose. No large openings in bodywork into the driver compartment in front of or alongside the driver, (except cockpit opening). Any gaps between bodywork and other parts must be reduced to a minimum. No external concave radii of curvatures in front of the cockpit opening and T 8.2 (in side view).
- 284 ○ **AERODYNAMIC DEVICES** - Securely mounted. The deflection may not exceed 10 mm when a force of 200 N is applied over a surface of 225 cm² and not more than 25 mm when a point force of 50 N is applied.
- 285 △ **AERODYNAMICS** - ALL aerodynamic devices maximum 250 mm rearward of rear tires, maximum 700 mm forward of front tires. Devices lower than 500 mm 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 500 mm behind the front axle must not be wider than the inside of the rear tires.
- 286 △ **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 500 mm from the ground. Rear device max 1.2 m above ground (incl. end plates); Front device max 250 mm above ground outside of the inside plane of the front tires inside this plane max 500 mm.
- 287 △ **SEAT** - Insulated against heat conduction, convection and radiation. The lowest point no lower than the top of the upper surface of the lowest SIS member OR must have a longitudinal, 25.4 × 1.65 mm steel tube underneath.
- 288 ○ **COCKPIT OPENING** - Fig. 12 (left) template passes down from above the cockpit to below the upper side impact member. The steering wheel, seat and padding can be removed. No removing of firewall.
- 289 ○ **COCKPIT INTERNAL CROSS SECTION** - Fig. 11 (right) template passes from the cockpit opening to 100 mm rear of the rearmost pedal contact area (in most forward position). The steering wheel and paddings can be removed (without tools).
- 290 △ **STEERING WHEEL** - Continuous perimeter, near round (no concave sections) with driver-operable quick disconnect. 250 mm max from the front hoop.
- 291 △ **ROTATING PARTS** - Finger guards are required to cover any parts (e.g. fans) that spin while the vehicle is stationary. No holes > 12 mm dia.

○ REMOVE BODY PANELS

- 292 ○ **DRIVER'S LEG PROTECTION** - Covers inside of cockpit over any sharp edges or moving suspension / steering components.
- 293 ○ **DRIVER'S FOOT PROTECTION** - Feet must be rearward of the Front Bulkhead and no part of shoes or legs above or outside the Major Structure (25x1.2 or equivalent) in side or front views when touching the pedals.
- 294 ○ **PERCY** - Helmet of 95th percentile male (PERCY) to be 50 mm below the lines between the top of the front and main roll hoops and between the top of the main hoop to rear attachment point of main hoop bracing. Center of bottom circle placed minimum 915 mm from pedals.
- 295 ○ **BRAKES** - Dual hydraulic system and 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. Any part of the brake system must be within the surface envelope. Brake pedal capable of 2000 N, no failures if official exerts max force (seated normally in the vehicle).
- 296 △ **BRAKE OVER TRAVEL SWITCH** - In the

event of a failure in one or both brake circuits the brake pedal over travel will result in the shutdown circuit being opened.

- 297 Δ **LOW VOLTAGE MASTER SWITCH** - Must be located on the right side of the vehicle, in proximity to the main hoop, at the 95th percentile male driver's shoulder height, in the middle of a completely red circular area of ≥ 50 mm diameter. Marked with LV and international symbol. Level horizontal when in ON position.
- 298 \circ **TUBING AND MATERIALS** - Team must show an APPROVED SES. No Magnesium tubes in the primary structure.
- 299 \circ **MONOCOQUE** - Must see laminate test specimen. All samples must be marked with the following non-removable (e.g.: permanent marker or engraving, but no sticker) information: laminated structure acronym and date of testing. Steel backing plates (≥ 2 mm thick) used at attachment points (must be fully supported).
- 300 \circ **BOLTED JOINTS** - In primary structure - distance hole centerline to the nearest free edge $> 1.5 \times$ hole diameter.
- 301 \circ **MAIN HOOP** - MUST BE STEEL. Check dimensions as shown in the approved SES. Must be made of one piece and extend to the lowest frame member. Above Major Structure, must be within 10° of vertical plane. Smooth bends without wrinkles.
- 302 \circ **MAIN HOOP BRACING** - MUST BE STEEL. One straight brace on each side. Dimension as shown in the approved SES. Attached within 160 mm from the top. Min. 30° Included angle with hoop. If the main hoop is not vertical, bracing must not be on the 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 the load back to the bottom of the main hoop and node of the upper side impact tube through proper triangulated structure. (25.4×1.2 mm or equivalent)
- 303 \circ **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 the top of the steering wheel. Max. 20° to vertical. Check dimensions as shown in the approved SES. Requires 6 attachment points – 2 on each side connecting to front bulkhead support structures and two connecting to front hoop bracing.
- 304 \circ **FRONT HOOP BRACING** - Two straight forward-facing braces, 25.4×1.65 or 25.0×1.75 mm or 25.4×1.6 mm wall steel or equivalent, attached within 50 mm of top and must have a minimum distance of 100 mm between each other at the front hoop. Extra rearward bracing is required if the Front Hoop leans backwards more than 10° .
- 305 \circ **SIDE IMPACT PROTECTION** - Min. of 2 tubes + diagonal must connect the main and front hoops in a straight line. The upper tube between 240 - 320 mm above the lowest inside chassis point between FH and MH. Dimension as shown in approved SES.
- 306 \circ **FRONT IMPACT PROTECTION** - No non-crushable objects forward of bulkhead. IMPACT ATTENUATOR forward of the bulkhead, 200 mm long \times 200 mm wide \times 100 mm high. No portion of the required $100 \times 200 \times 200$ mm volume of the IA can be positioned more than 350 mm above the ground. No wing supports through the IA. IA must be securely fastened directly to AIP capable of taking transverse and vertical loads (no tape, etc.) Test piece presented and same as IA on vehicle. Standard IA: Requires diagonal brace if bulkhead >25.4 mm from IA on any side, adhesive used to mount standard IA to AIP must have a shear strength of at least 24 MPa.
- 307 \circ **ANTI INTRUSION PLATE** - A 1.5 mm solid steel or 4.0 mm solid aluminum sheet. Must be welded (size: min. to centerlines) or min. 8 screws M8 Grade 8.8 critical fasteners T10 (size: min. outside dimensions). CFRP plate is accepted if SES is approved. Attachment(s) using adhesive must be able to carry a load of 60kN in any direction.
- 308 \circ **FRONT BULKHEAD SUPPORT** - Support back to front roll hoop; 3 tubes per side, all 25×1.5 mm wall steel tube or equiv. 1 bottom; 1 top within 50 mm of top of bulk-head 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.
- 309 \circ **INSPECTION HOLES** - 4.5 mm inspection holes required in non-critical areas of front and main hoops. Inspectors may ask for holes in other tube(s).
- 310 \circ **JACKS** - One or two devices that must be available to safely lift and hold all driven wheels min. 100 mm above the ground. In lifted position the jack (s) must be locked/secured and function without the support of a person or additional weights. It must be safe for the driver to enter and exit the vehicle. The device must not extend out of the vehicle's projected surface area. Device pick-up points must be indicated by orange triangles on both sides. University name on it.
- 311 \circ **WHEELS** - 203.2 mm (8") min. diam. No Aluminum or hollow wheel bolts. Single retaining nut must incorporate a device to retain the nut. Aluminum wheel nuts must be hard anodized.

312 ○ **FIREWALL** - Fire resistant material; must separate driver compartment from cooling, oil system and LV battery. Passthroughs are OK with grommets. Multiple panels are OK if gaps are

sealed. No gaps at the sides or bottom. Must be rigidly mounted to the chassis. Material must meet UL94-V0, FAR 25.853(a)(1)(i) or equivalent (THICKNESS NEEDED IN DATA SHEET).

○ **VEHICLE LIFTED AND WHEELS REMOVED**

313 ○ **SUSPENSION PICK-UP POINTS** - Inspected thoroughly for integrity.

314 ○ **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 $e/D > 1.5$. Alternative fasteners allowed for steering and suspension if equivalency can be shown.

315 ○ **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° max. free play at the steering wheel. NO STEER-BY-WIRE on front wheels. Rear wheel steering, max. 6° and mechanical stops installed. No bonded joints in the steering column.

316 △ **FLOOR CLOSEOUT PANEL** - Required from foot area to firewall; solid, non-brittle material; multiple panels are OK if gaps less than 3 mm.

317 ○ **GAS CYLINDERS** - Proprietary manufacture and labeled, Nonflammable gas, regulator on tank, securely mounted, axis not pointed at driver, within the rollover protection envelope, or in structural side pod, insulated from the exhaust, appropriate lines and fittings. Positively retained, i.e., no tie-wraps. Gas cylinders/tanks and their pressure regulators must be shielded from the driver. The shields must be steel or aluminum with a minimum thickness of 1 mm.

318 ○ **SCATTERSHIELDS INCL. MOUNTING** - Required for clutches, chains, belts, etc. No holes. 6 mm diam. Grade 8.8 minimum. End parallel to the lowest part of the sprocket/pulley in front and rear.

319 △ **SCATTERSHIELD MATERIALS** - For chains, 2 mm min. thick solid STEEL, 3 × chain width. For belts, 3 mm min. thick Al 6061-T6, 3 × belt width. Finger guards: cover all drivetrain parts that spin while the vehicle is stationary. No holes > 12 mm dia.

320 ○ **LV BATTERY** - Rigid and sturdy casing and attached securely to frame or chassis. Battery behind a 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}. Completely closed LV battery cases must have an overpressure relief. Venting gases must be separated from the driver by a firewall.

321 ○ **STUDENT BUILD LV BATTERY** - Proper Insulation of internal connections; proper mounting of cells.

322 ○ **LI-ION LV BATTERY** - 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 percent of the cells; voltage protection of all cells; it must be possible to display all cell voltages and measured temperatures on a team laptop.

323 ○ **HIGH PRESS HYDRAULICS** - Pumps and lines must have 1 mm steel or aluminum shields protecting driver and workers.

324 ○ Including all autonomous system high pressure hydraulics like the ASB.

325 △ **COOLANT** - 100 percent water. NO ADDITIVES WHATSOEVER.

326 ○ **CATCH TANKS** - Any coolant overflow or combustion engine lubrication system vents must have separate catch tanks. 0.9L or 10 percent of the fluid being contained minimum volume each, whichever is greater. 100 °C material, behind firewall, below shoulder level. 3 mm min. dia. vent away from the driver down to the bottom level of the frame. Trans or diff., cooling systems using plain water, unless sealed, require 100 mL catch tanks.

327 △ **FLUID LEAKS** - Oil, grease, coolant, Brake fluid → none permitted

328 ○ **BELLYPANS** - In a total minimum of two venting holes of at least 25 mm 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.

SENSORS FOR AUTONOMOUS SYSTEM

- 329 **CHECK SENSORS** - Check if all Sensors are fulfilling the legal requirements (mainly radar and laser). The teams must provide the according certifications.
- 330 **SENSOR POSITION** - Sensors must be positioned within the surface defined by the top of the main hoop and the outside edge of the four tires, with a maximum distance of 500 mm above the ground and not further forward than 700 mm forward of the front of the front tires. They must not exceed the width of the front axle.
- 331 **SENSOR MOUNTING** - Sensors must be securely and rigidly mounted to the vehicle's structure.
- 332 **SENSOR MARKING** - Mark all sensors.

ACTUATORS FOR AUTONOMOUS SYSTEM

- 333 **DECOUPLING** - Check if the team uses a decoupling mechanism for the brake/steering actuators.
 - ▲ If yes, check next items:
- 334 **PART REMOVAL** - Parts like including bolts, clips, etc. must not be removed for disconnection i.e. they must never lose the physical contact to the disconnection mechanism.
- 335 **MANUAL OPERATION** - The disconnection mechanism must not block manual operation of steering/ braking in any position.
- 336 **LOCKING** - The disconnection mechanism must be securely locked in both positions.

TIS STATUS UPDATE/TIMER

- ▲ Set online TIS to Passed or Failed
- ▲ Stop the timer
- ▲ Collect the timer

NON-COMPLIANCE/COMMENTS

PART VI: HIGH VOLTAGE INSPECTION (TS ON)

APPROVAL

Inspector Names	Date and Time	Signatures when passed
_____	_____	_____
_____	_____	_____

INSPECTION RULES

- The time limit for each attempt at this technical inspection is 120 min. 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.
- The time limit for repair works is 15 min cumulative per one inspection attempt.

TIS STATUS UPDATE/TIMER

- ▲ Set online TIS to Present
- ▲ Attach/place the timer
- ▲ Start the timer

SAFETY BRIEFING

- No badge / no necklace.
- No cell phone nor radio - do your calls outside.
- No other sources of distraction.
- One team member at SDC button when TS ON.
- Wear safety gloves when touching TS components.

TRACTIVE SYSTEM POWER-UP

- ▲ Recommend the team to lower the maximum motor speed for the upcoming inspection.
- ▲ All driven wheels are off the ground, driven wheels are removed.
- ▲ Connect multimeter between TS+ and TS- measuring points.
- ▲ Switch on TSMS with LVMS deactivated.
- 337 Voltage at TS measurement points less or equal $60 V_{DC}$.
- ▲ Switch on LVMS with TSMS deactivated.
- 338 IMD and AMS cockpit indicator lights illuminate for 1 s to 3 s for visible check.
- 339 IMD and AMS cockpit indicator lights are clearly visible in very bright sunlight.
- 340 Voltage at TS measurement points less or equal $60 V_{DC}$.
- ▲ Switch on TSMS and all shutdown buttons.
- ▲ Reset any IMD or AMS errors.
- 341 TS still deactivated.
- ▲ Activate TS, measure TS voltage during TS power-up.
- 342 System is pre-charged before the second AIR closes.
- ▲ Switch off TSMS.
- 343 TS voltage decreases below $60 V_{DC}$ within 5 s.
- ▲ Try to power up TS with switched off TSMS.
- 344 TS still deactivated.
- ▲ Switch on TSMS.
- 345 TS still deactivated.

TRACTIVE SYSTEM SHUTDOWN

- ▲ Connect multimeter between TS+ and TS- measuring point.
- ▲ For each of the following switches, deactivation leads to TS shutdown, voltage decreases below $60 V_{DC}$ within 5 s.
- 346 LVMS.
- 347 Shutdown button left.
- 348 Shutdown button right.
- 349 Cockpit shutdown button.
- 350 Inertia switch.
- 351 Break-over-travel-switch.
- ▲ Show schematic of TS with all interlocks (ESF).
- 352 Interlocks.

○ TRACTIVE SYSTEM ACTIVE LIGHT

- ▲ Activate LVS.
- 353 ○ TSAL and "TS Off" Cockpit Indicator (CI) is green only, visible in bright sunlight.
- ▲ Activate TS.
- 354 ○ TSAL flashes red with a frequency of 2 Hz to 5 Hz, and CI is off.
- 355 ○ Entire illuminated surface of the TSAL is visible in bright sunlight.
- 356 ○ TSAL has a fully illuminated surface visible by a person standing 3 m away from TSAL (1.6 m eye height) - use a dedicated tool.
- 357 ○ Less than 10° is blocked by the main hoop.
- ▲ Deactivate TS, disconnect TSAC state detection circuitry connector if applicable¹³, activate LVS and TS.
- 358 ○ TSAL flashes red and CI is off.
- ▲ Deactivate TS, reconnect TSAC state detection, connect power supply $> 60 V_{DC}$ to TS¹⁴, activate LVS.
- 359 ○ TSAL is green and simultaneously is flashing red, CI is on.
- ▲ Disconnect power supply, remove HVD, override HVD interlock (!! cover TS potentials !!), activate LVS and TS.
- 360 ○ TSAL and CI is completely off (no red nor green light).
- ▲ Deactivate TS, reconnect HVD, activate LVS. Ask the team to demonstrate the safe state of TSAL by disconnecting any signal influencing the green light.
- 361 ○ TSAL and CI is completely off (no red nor green light).

○ INSULATION MONITORING DEVICE

- 362 ○ 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.
- ▲ $R_{Test} = 135 \text{ k}\Omega$ ¹⁵
- IMD indicator light...
- 363 ○ ... is inside the cockpit and marked with "IMD",
- 364 ○ ... is red and visible in bright sunlight, even from outside (check during power-on self-test),
- 365 ○ ... is visible for the driver.
- ▲ Activate TS, connect R_{Test} between TS+ and LVS GND.
- 366 ○ Shutdown circuits opens within 30 s.
- 367 ○ IMD indicator light illuminates.
- 368 ○ TS voltage decreases below $60 V_{DC}$ within 5 s after shutdown circuit opens.
- 369 ○ Reactivation of TS is not possible.
- ▲ Push the reset button which is not accessible to the driver, if any and/or restart LVMS.
- 370 ○ Reactivation of TS is not possible.
- ▲ Remove R_{Test} . Wait 40 s until IMD resets the status output.
- 371 ○ Reactivation of TS is not possible.
- ▲ Push all reset buttons in the cockpit if any.
- 372 ○ Reactivation of TS is not possible.
- ▲ Push the IMD reset button, which is not accessible to the driver, if any.
- 373 ○ 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 LVS GND measuring points.
- 374 ○ Shutdown circuits opens within 30 s.
- 375 ○ IMD indicator light illuminates.

○ MOTOR(S) SPINNING SAFETY RULES

- Clean up unnecessary equipment from car surroundings.
- All team members in inspection slot are aware of upcoming actions.
- Don't stand in spinning parts scatter areas (even the SDC button responsible team member if possible).

¹³Skip test if disconnecting the connector also opens the interlock or stops LVS supply

¹⁴Do not use measuring points

¹⁵ $R_{Test} = (U_{TSmax} \times 250 \Omega/V) - R_{BPR}$

READY-TO-DRIVE ACTIVATION SEQUENCE

- ▲ Activate TS, press the torque pedal.
- 376 Motors are not spinning.
 - ▲ Let the team set the vehicle to ready-to-drive mode.
- 377 Pressing brake pedal WHILE activating is necessary.
- 378 Brake light in red color.
- 379 Verify that motors respond to the torque pedal and spin.
 - ▲ Repeat the activation sequence, but push the brake pedal only once before finally pushing the activation button.
- 380 No ready-to-drive mode possible.
 - ▲ Disconnect the brake sensor.
- 381 No ready-to-drive mode possible.
 - ▲ Set vehicle to ready-to-drive state.
- 382 Ready-to-drive sound duration is 1 s to 3 s continuously.
- 383 Ready-to-drive sound is min 80 dBA (2 m around the vehicle).
- 384 Ready-to-drive sound is easily recognizable and no animal sound or song part.

APPS AND BSPD

- ▲ Set vehicle to ready-to-drive state.
- 385 Verify that motors respond to the torque pedal and spin.
 - ▲ Disconnect $\geq 50\%$ of APPS.
 - ▲ Move the accelerator pedal over the entire pedal travel range.
- 386 Motors do not spin.
 - ▲ Disconnect all APPS.
 - ▲ Move the accelerator pedal over the entire pedal travel range.
- 387 Motors do not spin.
 - ▲ Team simulates 5 kW power (complete BSPD circuitry must be used), press brake representing hard braking (> 0.5 s).
- 388 TS shuts down.
 - ▲ Reactivate TS. Disconnect the current sensor, and press the brake representing hard braking (> 0.5 s).
- 389 TS shuts down.
- 390 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:
- 391 Motor Controller housing,
- 392 Energy Meter housing
- 393 IMD housing,
- 394 TSAL circuitry housing,
- 395 BSPD casing /BSPD calibration.
- 396 Additional Part:
- 397 Additional Part:

DATA LOGGER

- ▲ Check data logger functionality and connectivity.

TIS STATUS UPDATE/TIMER

- ▲ Set online TIS to Passed or Failed
- ▲ Stop the timer
- ▲ Collect the timer

NON-COMPLIANCE/COMMENTS

PART VII: DRIVERLESS INSPECTION

APPROVAL

Inspector Names	Date and Time	Signatures when passed
_____	_____	_____
_____	_____	_____

TIS STATUS UPDATE/TIMER

- ▲ Set online TIS to Present
- ▲ Atach/place the timer
- ▲ Start the timer

REMOTE EMERGENCY SYSTEM BYPASS

- ▲ Check, if RES bypass is implemented correctly (as per ASF-Form "Actuator Power Supply").
- 398 RES bypass is implemented as described in the ASF.
- 399 Correct safety relay is used.

AUTONOMOUS SYSTEM BRAKE

- ▲ Compare implementation in vehicle to ASF (Forms: "EBS Concept Overview" OR "EBS Mechanical System").
- 400 Autonomous System Brake is identical to the system described in the ASF.
- 401 All parts of the Autonomous System Brake are properly mounted, no leaks.
- 402 No push-in fittings are used.
- 403 No more than two release points are used.
- 404 All release points are in proximity to each other and are either mounted in proximity to the ASMS or on the top side of the vehicle between front bulkhead and front hoop close to the vehicles center line.
- 405 The release points are operable by maximum two simple push/pull and/or turning actions, the order and direction of these actions are shown next to the deactivation points.
- 406 The release points are marked with "brake release".

AUTONOMOUS SYSTEM TEST

- ▲ Switch on the LVMS and select the inspection mission (AMI).
- 407 Misson must be selected without use of an external device.
- 408 The ASSIs remains off.
- ▲ Switch on the ASMS and the TSMS.
- 409 Activating the TS using the cockpit activation button is not possible
- ▲ Activate the TS via the external activation button.
- 410 The ASSIs light up in yellow continuously after a self check ("AS Ready").
- ▲ Press RES "Go" button within 5s after "AS Ready".
- 411 "AS Driving" (ASSIs flashing yellow) has not been entered
- 412 Vehicle is still not in R2D.
- 413 Check functionality and visibility of AMI.
- 414 All 3 ASSIs are clearly visible in very bright sunlight. At least one ASSI is visible from any angle of the vehicle.
- 415 Brakes are closed at least on one axle.
- ▲ Press the RES "Go" button.
- !! CAUTION WHEELS AND STEERING SYSTEM ARE MOVING !!**
- 416 The ASSIs start flashing yellow ("AS Driving").
- 417 Drivetrain is slowly spinning and steering system is moving.
- ▲ Wait for the transition from "AS Driving" to "AS Finished".
- 418 The ASSIs light up in blue continuously within 25s to 30s and brakes are engaged ("AS Finished"). ASSIs must not start flashing.
- 419 ASSIs are clearly visible in very bright sunlight.
- 420 TS is deactivated.
- ▲ Turn off the ASMS and release the Brakes via the deactivation points.
- 421 Brakes are disengaged, manual steering is possible, ASSI is off.
- ▲ Re-enter "AS Ready" state.
- ▲ Press one shutdown button.
- 422 ASSIs start flashing blue ("AS Emergency").
- 423 Brakes are closed.

- 424 ○ Intermittent sound for 8 s to 10 s (1 Hz to 5 Hz, 50 % duty cycle).
 - ▲ For following tests, system is able to detect a failure and enters "AS Emergency" when in "AS Ready" or "AS Driving" state.
- 425 △ Sound level is min 80 dBA (2 m around the vehicle).
 - ▲ Test all operating errors (e. g. manual valves).
- 426 ○ TS is deactivated.
 - ▲ Choose randomly 1 to 3: Test ASB failure modes (e.g. disconnect sensors/energy supply/pneumatics/hydraulics. . .).
 - 431 ○ System has detected a failure.
 - ▲ Re-enter "AS Driving" state with inspection mission selected.
 - ▲ Wait till "AS Finished".
 - ▲ Open SDC by pressing RES emergency button.
- ▲ Turn off ASMS and release brakes (manual actions may be required).
- ▲ Every following test, re-enter "AS Driving" state with inspection mission selected.
- ▲ For each of the following tests, deactivation leads to TS shutdown and transition to "AS Emergency".
- 427 ○ Press RES.
- 428 ○ Switch off ASMS.
- 432 ○ Vehicle transitioned to "AS Emergency".

○ **TIS STATUS UPDATE/TIMER**

- ▲ Set online TIS to Passed or Failed
- ▲ Stop the timer
- ▲ Collect the timer

NON-COMPLIANCE/COMMENTS

PART VIII: TILT TEST

APPROVAL

Inspector Names	Date and Time	Signatures when passed
_____	_____	_____
_____	_____	_____

TILT TEST

- 433 **FLUID LEAKAGE** - No fluid spill permitted when the vehicle is tilted to 60° in the direction most likely to create spillage. Tanks must be filled to the scribe line with non-moveable fuel level line 12-25 mm below the top of the sight tube.
- 434 **VEHICLE STABILITY** - All wheels in contact with tilt table when tilted to 60° to the horizontal.
- 435 **GROUND CLEARANCE** - At least 30 mm with driver. If an active suspension is installed, the static ground clearance is measured in the lowest adjustable position

NON-COMPLIANCE/COMMENTS

PART IX: RAIN TEST

APPROVAL

Inspector Names	Date and Time	Signatures when passed
_____	_____	_____
_____	_____	_____

RAIN TEST

- ▲ The vehicle is lifted off the ground.
- ▲ Turn on Tractive System - TSAL is flashing red.
- 436 Tractive system voltage is present at TSMPs.
- ▲ No driver is allowed to sit in the vehicle during the test. Rain-like water will be sprayed at the vehicle for 120 s. Then wait another 120 s without spraying.
- 437 The Insulation Monitoring Device does not react and does not shut down the tractive system.
- ▲ Connect R_{Test} between any TSMP and LVS ground.
- 438 Shutdown circuit opens within 30 s.

NON-COMPLIANCE/COMMENTS

PART X: BRAKE TEST

APPROVAL

Inspector Names	Date and Time	Signatures when passed
_____	_____	_____
_____	_____	_____

BRAKE TEST

- 439 **BRAKING PERFORMANCE** - Must lock all four wheels and stop the vehicle in a straight line at the end of an acceleration run specified by the officials without stalling the engine.
- 440 **BRAKE LIGHT** - Must be clearly visible even in bright sunlight.

NON-COMPLIANCE/COMMENTS

PART XI: EMERGENCY BRAKE SYSTEM TEST

APPROVAL

Inspector Names

Date and Time

Signatures when passed

EMERGENCY BRAKE SYSTEM TEST

- ▲ Switch on LVMS and select mission "EBS test".
- 441 AMI shows the correct mission.
- ▲ Switch on ASMS.
- ▲ Activate TS.
- 442 ASSI is yellow continuous.
- 443 TSAL is red flashing.
- ▲ Press RES "Go" button.
- 444 ASSI is yellow flashing and vehicle accelerates.
- ▲ Press RES "stop button" when vehicle is at brake point.
- 445 Vehicle has to stop within 10 m and has to stay stable.
- 446 Speed at brake point has to be around 40 km/h.
- 447 ASSI is blue flashing, intermittent sound is clearly noticeable for 8 s to 10 s.
- 448 TSAL is green continuous.

NON-COMPLIANCE/COMMENTS