

# FORMULA STUDENT INSPECTION SHEET

DRIVERLESS – copy for Formula Student Germany



UNIVERSITY:	Metropolis TU
VEHICLE NUMBER:	6206
INSPECTION ORDER:	X01
SES PASSED:	✓
IADR PASSED:	✓
ASF PASSED:	-
ENGINE:	F4L 912
BORE/STROKE:	100 mm/120 mm
FUEL TYPE:	Diesel
ETC:	✓
ABS:	<input type="checkbox"/> YES <input type="checkbox"/> NO

Present the vehicle for inspection in the following order:

- Pre-Inspection
1. Mechanical Inspection\* Mon 04:00-05:15
  - Driver Egress Mon 09:30-10:00
  2. Tilt Test\*
  3. ETC Inspection
  4. Noise Test\*
  - Driverless Inspection\*
  5. Brake Test\*
  6. Emergency Brake System Test\*

\* the vehicle is marked with a sticker if this part has been passed successfully.

## Used Symbols:

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

## NOTES:

- This form must stay with the vehicle at all times!
- Technical inspection approval voids if inspection sheet is lost.
- If there is a conflict between this form and the rules, the rules prevail.

## PART I: COMMENTS FROM DOCUMENT REVIEW

### DRIVERLESS

- Driverless Ok

### MECHANICAL

- Mech Ok
- SES to be checked

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## PART II: PRE-INSPECTION

### TIS STATUS UPDATE

▶ Set online TIS status to *Present*

### TIRES

- |   |   |
|---|---|
| 1 <input type="radio"/> <b>DRY TIRES</b> - Make:<br>_____     | 4 <input type="radio"/> <b>RAIN TIRES</b> - Make:<br>_____                                      |
| 2 <input type="radio"/> <b>DRY TIRES</b> - Size:<br>_____     | 5 <input type="radio"/> <b>RAIN TIRES</b> - Size:<br>_____                                      |
| 3 <input type="radio"/> <b>DRY TIRES</b> - Compound:<br>_____ | 6 <input type="radio"/> <b>RAIN TIRES</b> - Compound:<br>_____                                  |
|   | 7 <input type="radio"/> <b>RAIN TIRES</b> - 2,4 mm min. tread depth molded by tire manufacturer |

### DRIVER GEAR & SAFETY

- |  |   |
|--|---|
| 8 <input type="radio"/> <b>UNDERWEAR</b> - Nomex or equivalent, fire resistant underwear (no cotton, no polyester, no bare skin). No holes.  | 41.1/2015, 41.1/2020 or newer FIA 8860-2010, FIA 8860-2018, FIA 8859-2015 (with SA 2015), FIA 8858-2010 (with SA(H) 2010) or newer. Closed Face, no Open Face, must have integrated shield (no dirtbike helmets). No camera mounts. |
| 9 <input type="radio"/> <b>SOCKS</b> - Nomex or equivalent, fire resistant socks (no cotton, no polyester, no bare skin). No holes.  |   |
| 10 <input type="radio"/> <b>GLOVES</b> - Fire resistant material. Leather allowed only over fire resistant material. No holes.   | 13 <input type="radio"/> <b>DRIVER SUITS</b> - Single piece SFI 3.2A/5 (or higher), SFI 3.4/5 (or higher), FIA 8856-2000/2018 (or higher), and LABELED AS SUCH. No holes.   |
| 11 <input type="radio"/> <b>ARM RESTRAINTS</b> - SFI Standard 3.3 or equivalent.   | 14 <input type="radio"/> <b>HAIR COVER</b> - Fire resistant (Nomex or equiv.) balaclava of full helmet skirt <b>REQUIRED FOR ALL DRIVERS</b> . No holes.  |
| 12 <input type="radio"/> <b>HELMETS</b> - Snell K2010, K2015, K2020, M2010, M2015, M2020, SA2010, SAH2010, SA2015, SA2020, EA2016 or newer.SFI 31.1/2010, 31.1/2015, 31.1/2020, 41.1/2010, | 15 <input type="radio"/> <b>SHOES</b> - SFI 3.3 or FIA 8856-2000/2018   |

### TIS STATUS UPDATE

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

### NON-COMPLIANCE / COMMENTS

### APPROVAL

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

## PART III: EGRESS TEST

### DRIVER POSITION

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

### DRIVER EGRESS TEST

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

### EGRESS PROCEDURE

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

### DRIVER APPROVAL & RUN DOCUMENTATION

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

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## PART IV: MECHANICAL INSPECTION

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

### TIS STATUS UPDATE

- ▶ Set online TIS status to *Present*

### COMMENTS

- ▶ Check comments from first page

### VEHICLE WITH TALLEST DRIVER READY TO RACE

- 21 ○ **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.).
- 22 ○ **PUSH BAR (red color)** - With vehicle, securely attached to vehicle, detachable, push & pull function for 2 people. University must be written on.
- 23 △ **CAMERAS** - Must be secured by two points, see T13.5. No cameras mounted to helmet.
- 24 ○ **AUTONOMOUS SYSTEM SENSORS** - Sensors may not come into contact with the driver's helmet when normally seated.
- 25 ○ **VISIBILITY** - Minimum of 100 deg. field either side. Head rotation allowed or mirrors. If mirrors, must be firmly installed and adjusted
- 26 △ **VEHICLE CONTROLS** - All controls, including shifter, must be inside cockpit. No arms or elbows outside the SIS plane.
- 27 ○ **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 100mm above the bottom of the helmet of the tallest driver, is not in direct line of sight with any of the following parts: fuel system, engine oil system, cooling system and low voltage battery.
- 28 ○ **ROLL BAR PADDING** - Roll bar or bracing that could be hit by driver's helmet must be covered with 12mm thick, SFI spec 45.1 or FIA 8857-2001 padding.
- 29 △ **OTHER SIDE TUBES** - Design prevents driver's neck hitting bracing or other side tubes
- 30 ○ **HEAD RESTRAINT**- Near vertical. Must take 890N load. 40mm thick, SFI 45.2 standard. Max. 25mm from helmet. Helmet contact point 50mm min. from any edge. May be changed for different drivers. Minimum 150x150mm.
- 31 ○ **DRIVER RESTRAINT HARNESS** - SFI 16.1, SFI 16.5, SFI 16.6, FIA 8853/98 or FIA 8853/2016. 6- or 7-point system – Two-piece lap belt (min. width 50mm), two shoulder straps (min. width 75mm) and two leg or anti-submarine straps (min. width 50mm). (7-point system must have three anti-submarine straps). Must be securely attached to prim. structure (25.4 x 2.4mm or equal.)
- 32 ○ **LAP BELT MOUNTING** - Pivoting mounting with eye bolts or shoulder bolts attached securely to Primary Structure. Min. tab thickness 1.6mm. Attachment brackets to the monocoque must be steel, see T5.3.2.
- 33 ○ **SHOULDER HARNESS MOUNTING** - Mounting points 180 - 230mm apart (measured center to center). Angle from shoulder between 10 deg. up and 20 deg. down to horizontal. Attach to Primary Structure - 25.4 x 2.4mm or 25.0 x 2.5mm steel tube min. NOT to put bending loads into Main Hoop Bracing without extra bracing. Additional braces if not straight to main hoop. Cannot pass through a firewall. Attachment brackets to the monocoque must be steel.
- 34 ○ **SUSPENSION** - Fully operational with dampers front and rear; 50mm minimum wheel travel (minimum jounce of 25mm) with driver in vehicle.

### VEHICLE WITHOUT DRIVER

- 35 △ **TECH STICKER SPACE** - 45 mm x 175 mm on centerline of front of vehicle in front of the cockpit opening
- 36 △ **SCHOOL NAME & OTHER DECALS** - School Name, or recognized initials - min. 50mm tall (all letters). on both sides in Roman letters. Must be clearly visible.
- 37 △ **VEHICLE NUMBERS** - On front & both sides of vehicle, minimum 150mm tall, 20mm stroke & spacing, 25mm min. between number and background edge, Black on White, White on Black only, specified background shapes. Must be clearly visible, font: Roman Sans-Serif characters.
- 38 △ **BODYWORK EDGES** - edges that could contact a pedestrian must have a minimum radius of 1.0mm (safety requirement)
- 39 △ **BODY & STYLING** - Open wheeled, open cockpit, formula style body. Vertical keepout zones 75mm in front and behind tires (no aero exceptions), tires unobstructed from sides.
- 40 ○ **BODYWORK** - Min. 38mm radius on nose. No large openings in bodywork into driver compartment in front of or alongside driver, (except cockpit opening).
- 41 ○ **AERODYNAMIC DEVICES** - Securely mounted. The deflection may not exceed 10mm when a force of 200N is applied over a surface of 225 cm<sup>2</sup> and not more than 25mm when a point force of 50N is applied.
- 42 △ **AERODYNAMICS** - ALL aerodynamic devices maximum 250mm rearward of rear tires, maximum 700mm forward of front tires. Devices lower than 500mm from the ground rearward of the front axle must be no wider than vertical plane from the outside of the front and rear tires. Devices higher than 500mm behind the front axle must not be wider than the inside of the rear tires.
- 43 △ **AERO VERTICAL HEIGHT** - Devices forward of a vertical plane through the rearmost portion of the front face of the driver head restraint support, excluding any padding, set to its most rearward position, must be lower than 500mm from the ground. Rear device max 1.2 m above ground (incl. end plates); Front device max 250mm above ground outside of the inside plane of the front tires inside this plane max 500mm.
- 44 ○ **EDGES/RADII** - Edges that could contact a pedestrian must have a minimum radius of: horizontal leading edges min 5mm; vertical forward facing edges min 3mm. All other edges must have a minimum radius of 1.0mm
- 45 ○ **AIR INTAKE SYSTEM ROLL OVER PROTECTION** - All parts of air intake system (including throttle body or carb, air intake ducting, air cleaner & air box) must be within a surface defined by the top of the main hoop and the outside top edge of the tires.
- 46 ○ **AIR INTAKE SYSTEM** - Must be supported if cantilevered (isolated to frame, rigid to engine). Any portion < 350mm above ground must have Side Impact protection to rule CV 1.3.2. Intercooler after throttle body.
- 47 △ **SEAT** - Insulated against heat conduction, convection and radiation. Lowest point no lower than top of of the upper surface of the lowest SIS member OR must have longitudinal, 25.4 x

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1.65mm steel tube underneath.

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

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- 52 ○ **FUEL SYSTEM ROLL OVER PROTECTION** - All parts of the fuel storage, supply and fuel control system systems (including fuel rail, throttle body or carburettor), must lie within the surface envelope.
- 53 ○ **FUEL FILLER NECK** - Min. 35mm dia., within 30° of vertical. Fuel resistant, transparent sight tube or transparent filler neck (material must be rated for at least 120°C). min 125mm vert. height visible to fueller with vehicle fully assembled, with non-moveable fuel level line 12-25mm below top of sight tube. Sight tube must NOT run below top of tank. Must prevent

fuel spillage contacting driver, exhaust or ignition. Fueled w/o manipulating vehicle in any way. Cap secure and capable of withstanding pressurization (ie: threads or latch.)

- 54 ○ **FUEL FILLER NECK LOCATION** - Must be located within the rollover protection envelope, except the whole filler neck is 350mm above the ground.
- 55 △ **REFUELING** - Must be able to be accomplished without the removal of any body parts of the vehicle.
- 56 ○ **FUEL VENTS** - Must exit outside of the bodywork, and have a check valve to prevent leakage if vehicle inverted.

## □ REMOVE BODY PANELS

- 57 ○ **DRIVER'S LEG PROTECTION** - Covers inside of cockpit over any sharp edges or moving suspension / steering components.
- 58 ○ **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.
- 59 ○ **PERCY** - Helmet of 95th percentile male (PERCY) to be 50mm below the lines between top of front and main roll hoops and between top of main hoop to rear attachment point of main hoop bracing. Center of bottom circle placed minimum 865mm from pedals.
- 60 ○ **BRAKES** - Dual hydraulic system & reservoirs, operating on all four wheels, (one brake on limited slip differential is OK). System must be protected by structure or shields from drivetrain failure or minor collisions. No plastic brake lines. No brake-by-wire. No parts below chassis in side view. Brake pedal capable of 2000N, no failures if official exerts max force (seated normally in vehicle).
- 61 △ **BRAKE OVER TRAVEL SWITCH** - In the event of a failure in one or both of the brake circuits the brake pedal over travel will result in the shutdown circuit being opened.
- 62 △ **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  $\geq 50$  mm diameter. Marked with LV and international symbol. Level horizontal when in ON position.
- 63 △ **AUTONOMOUS SYSTEM MASTER SWITCH** - Must be located in proximity to the low voltage master switch, at the 95th percentile male driver's shoulder height, in the middle of a completely blue circular area of  $\geq 50$  mm diameter. Marked with "AS". Level horizontal when in ON position. "ON" and "OFF" positions must be marked. ASMS must have locking mechanism for "OFF" position.
- 64 ○ **TUBING & MATERIALS** - Team must show an APPROVED SES. No Magnesium tubes in primary structure.
- 65 ○ **MONOCOQUE** - Must see laminate test specimen. Steel backing plates ( $\geq 2$  mm thick) used at attachment points (must be fully supported).
- 66 ○ **BOLTED JOINTS** in primary structure - Distance hole centerline to the nearest free edge  $> 1.5 \times$  hole diameter.
- 67 ○ **MAIN HOOP** - MUST BE STEEL. Check dimension as shown in approved SES. Must be made of one piece and extend to lowest frame member. Above Major Structure, must be within 10 deg. of vertical plane. Smooth bends without wrinkles.
- 68 ○ **MAIN HOOP BRACING** - MUST BE STEEL. One straight brace on each side. Dimension as shown in the approved SES. Attached within 160mm from the top. Min. 30 deg. included angle with hoop. If main hoop is not vertical, bracing must not be on same side of the vertical plane as the main hoop. No bends. No rod-ends. Proper design for removable braces (capping etc.) on BOTH ENDS. Must take load

back to bottom of main hoop and node of upper side impact tube through proper triangulated structure. (25.4 x 1.2mm or equivalent)

- 69 ○ **FRONT HOOP** - Must be closed section metal tube. Can be multi-piece with gussets or additional attachments to the monocoque. Must extend down to lowest frame member. No lower than top of steering wheel. Max. 20 deg. to vertical. Check dimension as shown in approved SES.
- 70 ○ **FRONT HOOP BRACING** - Two straight forward facing braces, 25.4 x 1.65mm or 25.0 x 1.75mm or 25.4 x 1.6mm wall steel or equivalent, attached within 50mm of top. Extra rearward bracing required if Front Hoop leans backwards more than 10 deg.
- 71 ○ **SIDE IMPACT PROTECTION** - Min. of 2 tubes + diagonal must connect the main and front hoops in straight line. Upper tube between 240 - 320mm above lowest inside chassis point between FH and MH. Dimension as shown in approved SES.
- 72 ○ **FRONT IMPACT PROTECTION** - No non-crushable objects forward of bulkhead. IMPACT ATTENUATOR forward of bulkhead, 200mm long x 200mm wide x 100mm high. No wing supports through the IA. IA must be securely fastened directly to AIP capable of taking transverse & 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.
- 73 ○ **ANTI INTRUSION PLATE** - A 1.5mm solid steel or 4.0mm solid aluminium 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 approved.
- 74 ○ **FRONT BULKHEAD SUPPORT** - Support back to front roll hoop; 3 tubes per side, all 25mm x 1.5mm wall steel tube or equiv. 1 bottom; 1 top within 50mm of top of bulkhead, and connecting within 100mm above and 50mm below upper SIS tube; 1 or more node-to-node diagonal to completely triangulate connections to upper and lower SIS tubes.
- 75 ○ **INSPECTION HOLES** - 4.5mm inspection holes required in non-critical areas of front & main hoops. Inspectors may ask for holes in other tube(s).
- 76 ○ **QUICK JACK (red color)** - One device must be available to lift up all driven wheels min. 100mm above the ground. Lifting the car must be possible by one person. In lifted position the quick jack must be locked/secured and function without the support of a person or additional weights. University name must be written on.
- 77 ○ **WHEELS** - 203.2mm (8") min. diam. No Aluminium or hollow wheel bolts. Single retaining nut must incorporate a device to retain the nut. Aluminum wheel nuts must be hard anodized.
- 78 ○ **FIREWALL** - Fire resistant material; must separate driver compartment from cooling, oil system & LV battery. Pass-throughs OK with grommets. Multiple panels OK if gaps sealed. No gaps at sides or bottom. Must be rigidly mounted to the chassis. Material must meet UL94-V0, FAR25 or equivalent.

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## VEHICLE LIFTED AND WHEELS REMOVED

- 79 ○ **SUSPENSION PICK-UP POINTS** - Inspected thoroughly for integrity.
- 80 ○ **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  $e/D > 1.5$ .
- 81 ○ **STEERING** - All steerable wheels must have positive stops placed on the rack to prevent linkage lock up or tires from contacting any part of the vehicle. 7 degrees max. free play at the steering wheel. NO STEER-BY-WIRE on front wheels. Rear wheel steering, max. 6 deg. and mechanical stops installed. No bonded joints in steering column.
- 82 ○ The steering system has to be fully operational by a driver when ASMS is in "OFF"-Position.
- 83 △ **FLOOR CLOSEOUT PANEL** - Required from foot area to firewall; solid, non-brittle material; multiple panels are OK if gaps less than 3mm.
- 84 ○ **ENGINE** - Four cycle piston engine. No hybrids. Waste heat recovery allowed.
- 85 ○ **ON-BOARD STARTER** - Required.
- 86 ○ **COMPRESSORS** - Turbo or super chargers allowed if not OEM to engine; must be between restrictor and throttle. Carburetors are not allowed, if compressors are used. Compressor recirculation valves are ok if located downstream of restrictor.
- 87 ○ **INTAKE MANIFOLD** - Securely attached to block or head with mech. Fasteners (positive locking!). OEM type rubber bushings not sufficient.
- 88 ○ **RESTRICTOR** - Must be circular; max. diam. 20mm for gasoline fuelled vehicles and 19mm for E85 fuelled vehicles. Cannot be movable. Placed before compressor.
- 89 ○ **THROTTLE** - Must have minimum of 2 springs (1 spring when ETC installed) at the TB, each capable of closing the throttle independently. TPS not acceptable as a return spring. Cable must have smooth operation with no binding or sticking; min. 50mm from any exhaust component.
- 90 ○ **THROTTLE PEDAL** - Must have positive stop to prevent over-stressing cable
- 91 ○ **ENGINE LUBRICATION SYSTEM** - Lowest point of the engine lubrication system not be lower than the lowest frame part. Otherwise protection structure mounted to chassis necessary.
- 92 ○ **GAS CYLINDERS 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 minimum thickness of 1 mm.
- 93 ○ **GAS CYLINDERS** - Proprietary manufacture & labeled, Non-flammable gas, regulator on tank, securely mounted, appropriate lines & fittings. Positively retained, i.e. no tie-wraps. Maximum of 10bar allowed, except cylinders/tanks with directly mounted pressure regulator (-> 10bar).
- 94 ○ **SCATTERSHIELDS INCL. MOUNTING** - Required for clutches, chains, belts, etc. No holes. 6mm diam. Grade 8.8 minimum. End parallel to lowest part of the sprocket/pulley in front and rear.
- 95 △ **SCATTERSHIELD MATERIALS** - For chains, 2mm min. thick solid STEEL, 3 x chain width. For belts, 3mm min. thick Al 6061-T6, 3 x belt width. Finger guards: cover all drivetrain parts that spin while vehicle is stationary. No holes >12mm dia.
- 96 ○ **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 T1.1.14. Grounded to chassis; hot terminal insulated; protected for short circuits (fused). No circuits >60 VDC.
- 97 ○ **STUDENT BUILD LV BATTERY** Proper Insulation of internal connections; proper mounting of cells
- 98 ○ **LI-ION LV BATTERY** (only applicable if other than LiFePO<sub>4</sub>)- Has a fire retardant casing according to UL94-V0. Battery pack includes: an overcurrent protection that trips below maximum discharge current; overtemperature protection of  $\geq 30\%$  of the cells; voltage protection of all cells; it must be possible to display all cell voltages and measured temperatures on a team laptop.
- 99 ○ **HIGH PRESS HYDRAULICS** - Pumps and lines must have 1mm steel or aluminium shields protecting driver and workers.
- 100 ○ Including all autonomous system high pressure hydraulics like the ASB.
- 101 △ **COOLANT** - 100% water. NO ADDITIVES WHATSOEVER.
- 102 ○ **CATCH TANKS** - Any coolant overflow or lube system vents must have separate catch tanks. 0.9 l minimum each, 100 deg. C material, behind firewall, below shoulder level. 3mm min. dia. vent away from driver down to the bottom level of frame. Trans or diff., cooling systems using plain water, unless sealed, require 100 ml catch tanks.
- 103 △ **FLUID LEAKS** - Oil, grease, coolant, fuel, Brake fluid -> none permitted
- 104 ○ **FUEL SYSTEM** - All parts of the fuel system which can come in contact with the fuel must be rated for permanent contact with fuel. All fuel lines must be fitted in such a way that any leakage cannot result in the accumulation of fuel in the cockpit.
- 105 ○ **FUEL RAIL** - Securely attached to block (no nylon nuts), head or int. manifold with brackets & mech. Fasteners (grade min. 8.8). Plastic, carbon fibre or rapid prototyping flammable materials are prohibited.
- 106 ○ **FUEL TANKS** - Must lie within major structure of the chassis with full side impact protection & firewall between fuel supply & driver, min. 50mm away from exhaust components. Rigid tanks cannot carry structural load & must be flexibly mounted and must not touch anything else than its mounting.
- 107 ○ **FUEL LINES** - No plastic lines between fuel tank & engine. Fuel injection systems must use metal braided hose with threaded fittings or reinforced rubber hose (beaded hose fittings must be used). Must be securely attached and protected from possible rotating equipment or collision failure. No plastic connectors in fuel line. High pressure injection systems see CV 2.5.2
- 108 ○ **BELLYPANS** - In total minimum of two venting holes of at least 25mm diameter in the lowest part of the structure to prevent accumulation of liquids. One in each enclosed chassis structure. Additional holes are required when multiple local lowest parts exist in the structure.
- 109 ○ **BRAKE LIGHT** - Only one RED brake light, clearly visible from the rear; on vehicle centerline; height between wheel centerline & driver's shoulders. Round, triangle, or rectangular on black background. 15 cm<sup>2</sup> minimum illuminated area. LED strips OK if elements closer than 20 mm apart and total length > 150 mm.
- 110 ○ **AUTONOMOUS SYSTEM STATUS INDICATORS** - 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.
- 111 ○ The rear ASSI is mounted on vehicle centerline, near vertical, min 160 mm below the top of the main hoop and 100 mm above the brake light.
- 112 ○ Round, triangle, or rectangular on black background
- 113 △ 15 cm<sup>2</sup> minimum illuminated area OR LED strips with a total length greater than 150 mm with elements <20 mm apart

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## SENSORS FOR AUTONOMOUS SYSTEM

- 114  **CHECK SENSORS** - Check if all Sensors are fulfilling the legal requirements (mainly radar and laser). The teams must provide the according certifications.
- 115  **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 500mm
- 116  **SENSOR MOUNTING** - Sensors must be securely and rigidly mounted to the vehicle's structure.
- ▶ **SENSOR MARKING** - Mark all sensors.

above the ground and not further forward than 700mm forward of the front of the front tires. They must not exceed the width of the front axle.

## ACTUATORS FOR AUTONOMOUS SYSTEM

- 117  **DECOUPLING** - Check if the team uses a decoupling mechanism for the brake/steering actuators.
- 118  **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
- 119  **MANUAL OPERATION** - the disconnection mechanism must not block manual operation of steering/ braking in any position.
- 120  **LOCKING** - the disconnection mechanism must be securely locked in both positions.

## TIS STATUS UPDATE

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

## NON-COMPLIANCE / COMMENTS

## APPROVAL

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



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## PART V: TILT TEST

### TIS STATUS UPDATE

▶ Set online TIS status to *Present*

### COMMENTS

▶ Check comments from first page

### TILT TEST

- 121  **FLUID LEAKAGE** - No fluid spill permitted when vehicle is tilted to 60 degrees in the direction most likely to create spillage. Tanks must be filled to scribe line with non-moveable fuel level line 12-25 mm below top of sight tube.
- 122  **VEHICLE STABILITY** - All wheels in contact with tilt table when tilted to 60 degrees to the horizontal.
- 123  **FUEL TYPE:** Diesel
- 124  **GROUND CLEARANCE** - At least 30 mm min. with driver.

### TIS STATUS UPDATE

▶ Set online TIS status to *Passed or Failed*

### NON-COMPLIANCE / COMMENTS

## APPROVAL

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

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## PART VI: ETC INSPECTION

### TIS STATUS UPDATE

- ▶ Set online TIS status to *Present*

### COMMENTS

- ▶ Check comments from first page

### ACCELERATOR PEDAL POSITION SENSOR (APPS)

- 125  Accelerator Pedal returns to original position if not actuated. ▶ Disassemble one spring.
- 126  At least two sensors with different transfer function are installed. (For digital sensors, a checksum is necessary) 130  Each spring still returns pedal with the second one disconnected (springs in the APPSs not counted.)
- 127  Sensors do not share supply or signal lines. ▶ Open throttle and disconnect APPS(s).
- 128  Sensors are protected from being mechanically overstressed (positive stop of pedal). 131  Power to ETC system shuts down after 100 ms and throttle goes to idle position if less than two APPS are connected.
- 129  Minimum two springs installed to return pedal.

### THROTTLE AND THROTTLE POSITION SENSOR (TPS)

- 132  Two sources of energy to return the throttle to idle position. One must be a return spring (springs in the TPSs not counted.). 134  At least two Throttle Position Sensors (TPS) installed
- ▶ Disconnect electronic throttle connector while throttle is open. ▶ Open throttle and disconnect TPS(s).
- 133  Throttle must return to idle position in one second. 135  Power to ETC system shuts down after 100 ms and throttle goes to idle position if less than two TPS are connected.

### PLAUSIBILITY CHECKS

- ▶ Activate fuel pump (verify, that it is running), open throttle, insert a blocking device, command throttle to fully close.
- 136  After 1 s, power to ignition, injection and fuel pump shuts down and throttle goes to idle position. This action must remain active until the TPS signals indicate the throttle returned to idle position for at least one second.

### NON-COMPLIANCE / COMMENTS

### APPROVAL

Inspector Names \_\_\_\_\_ Date, Time \_\_\_\_\_ Signatures when passed \_\_\_\_\_  
1. \_\_\_\_\_ / \_\_\_\_\_

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## PART VII: NOISE TEST

### TIS STATUS UPDATE

- ▶ Set online TIS status to *Present*

### COMMENTS

- ▶ Check comments from first page

### NOISE TEST

- ▶ **TEST RPM** - Test at 7500 rpm<sup>1</sup>.

- 137  **ENGINE START BUTTON** - The vehicle must be equipped with an additional engine start button next to the primary master switch.
- 138  Engine cannot be started with the additional start button in manual mode.
- 139  **GEARBOX IN NEUTRAL INDICATOR LIGHT** - There must be a green light next to the engine start button, that indicates that the gearbox is in neutral.
- 140  **NOISE LEVEL 1** - 110 dB(C) (fast weighting) maximum during a static test, gearbox in neutral, UP TO a specified rpm (see Rule CV 3.2). Microphone level with the exhaust outlet(s), 0.5 m from the outlet(s), at 45 degrees to the outlet. If multiple outlets, all to be checked. If movable tuning or throttling device, see IN 10.1.6.
- 141  **NOISE LEVEL 2** - 103 dB(C) (fast weighting) maximum during a static test, gearbox in neutral at idle. Microphone level with the exhaust outlet(s), 0.5 m from the outlet(s), at 45 degrees to the outlet. If multiple outlets, all to be checked. Movable tuning or throttling device must be in "worst condition"
- 142  **REMOTE EMERGENCY SYSTEM** - The remote emergency system must be rigidly mounted and must trigger the shutdown circuit which is defined as a series connection of at least the cockpit-mounted shutdown button, the brake over travel switch and the inertia switch.
- 143  **LOW VOLTAGE MASTER SWITCH** - Access from outside of vehicle, rotary type, no relay, must kill ALL electrical systems. Must cause engine to stop when actuated. (Perform at around 5000 rpm).
- 144  **SHUTDOWN BUTTONS 1** - Push-pull or push-rotate. Unobstructed by steering wheel, easily reached by belted-in driver. Must kill ignition & fuel pump(s). Marked with international symbol. Must cause engine to stop when actuated (Perform at around 5000 rpm).
- 145  **SHUTDOWN BUTTONS 2** - Push-pull or push-rotate. One button must be located on each side of the vehicle behind the driver's compartment at approximately the level of the driver's head. Must be easy reachable from outside the vehicle. Must kill ignition & fuel pump(s). Marked with international symbol. Must cause engine to stop when actuated (Perform at around 5000 rpm).
- 146  **INERTIA SWITCH** - Rigidly attached to the vehicle, demountable for functionality check. Must open the shutdown circuit and kill ignition & fuel pump(s) when accelerated between 6g and 11g (T10.5). Must cause engine to stop when actuated (Perform at around 5000 rpm).
- 147  **BRAKE PEDAL OVER-TRAVEL SWITCH** - Must constantly open the shutdown circuit if one brake circuit fails for brake balance bar in all possible positions. No re-start if released or actuated a second time. Push pull or flip type Must NOT rely on programming to work. Not resettable by driver (Perform at around 5000 rpm).
- 148  **INTAKE SYSTEM LEAKAGE/BYPASS** - There is no air leakage or bypass of the intake system permitted. When the intake is closed completely, the engine should almost immediately stall
- 149  **EXHAUST OUTLET** - Outlet no more than 45 cm behind rear axle centreline or more than 60 cm above the ground.
- 150  **EXHAUST SHIELDING** - components outside the body forward of main hoop must be shielded from people approaching the vehicle. No fibrous/cloth wraps around exhaust tubes.

### BRAKE SYSTEM PLAUSIBILITY DEVICE (BSPD)

- 151  **△** Must directly supplied from the LVMS & no additional functionality implemented on all required Printed Circuit Boards (PCBs) & the interfaces must be reduced to the minimum necessary signals.
  - ▶ Disconnect brake system encoder from BSPD while throttle is open.
- 152  Power to ignition & fuel pump(s) must shut down.
  - ▶ Disconnect throttle position sensor from BSPD and press brake pedal while throttle is open.
- 153  Power to ignition & fuel pump(s) must shut down.
  - ▶ Team simulates a throttle of >25%, press brake representing hard braking (>500 ms).
- 154  Must open the shutdown circuit and kill ignition & fuel pump(s).
- 155  Reactivation by the driver is not possible. May reset itself if the opening condition is no longer present for more than 10 s.
  - ▶ Power cycle vehicle (reset BSPD).

### TIS STATUS UPDATE (NOISE)

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

### REMOTE EMERGENCY SYSTEM BYPASS

- 156  RES bypass is implemented as described in the ASF.
  - ▶ Let the teams explain their implementation.
- 157  Correct Safety relays is used.

### AUTONOMOUS SYSTEM BRAKE

- 158  Autonomous System Brake is identical to the system described in the ASF.
- 159  All parts of the Autonomous System Brake are properly mounted, no leaks.
- 160  No push-in fittings are used.
- 161  No more than two release points are used.
- 162  All release points are in proximity to each other and either be

<sup>1</sup> Calculated for the specific engine

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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.

163  The release points are operable by maximum two simple

push/pull and/or turning actions, the order and direction of these actions must be shown next to the deactivation points.

164  Manual release points are marked with "brake release".

## AUTONOMOUS SYSTEM TEST

▶ Switch on the LVMS and select the inspection mission (AMI).

165  The ASSIs remains off.

▶ Check for neutral gear and switch on the ASMS.

166  Starting the engine using the cockpit start button is not possible.

▶ Start the engine via the external start button.

167  The ASSIs light up in yellow continuously after a self check ("AS Ready").

▶ Press RES "Go" button within 5 s after "AS Ready".

168  "AS Driving" (ASSIs flashing yellow ) has not been entered.

169  Vehicle is still in neutral gear.

170  Check functionality and visibility of AMI.

171  All 3 ASSIs are clearly visible in very bright sunlight. At least one ASSI is visible from any angle of the vehicle.

172  Brakes are closed.

▶ Press the RES "Go" button.

**!! CAUTION WHEELS AND STEERING SYSTEM ARE MOVING !!**

173  The ASSIs start flashing yellow ("AS Driving").

174  Drivetrain is slowly spinning and steering system is moving.

▶ Wait for the transition from "AS Driving" to "AS Finished".

175  The ASSIs light up in blue continuously within 25 s to 30 s and brakes are engaged ("AS Finishes"). ASSIs must not start flashing.

176  ASSIs are clearly visible in very bright sunlight.

177  Engine stopped.

▶ Turn off the ASMS and release the Brakes via the deactivation points.

178  Brakes are disengaged, manual steering is possible, ASSI is off.

▶ Try to start the engine again and enter "AS Ready" state.

179  Engine stays stopped and system does not enter state "AS Ready".

▶ Powercycle LV system or press the reset button and re-enter "AS Ready" state.

▶ Press one shutdown button while autonomous state is "AS Ready".

180  ASSIs start flashing blue ("AS Emergency").

181  Brakes are closed.

182  Intermittent sound for 8 s to 10 s (1 Hz to 5 Hz, 50 % duty cycle).

183  ASB error indicator inside the cockpit is off.

184  Engine stopped.

▶ Turn of ASMS and reset the ASB (manual actions may be required).

▶ Reset the ASB and re-enter "AS Driving" state with inspection mission selected, before each of the following tests.

▶ 1. Press RES 2. Press any shutdown button 3. Switch off the ASMS

185  Engine stopped.

186  Transition to "AS Emergency", ASSI is blue flashing, brakes are closed and intermittent sound for 8 to 10 s.

187  ASB error indicator is off.

▶ Test all operating errors (e. g. manual valves) and some (choose randomly 1 to 3) ASB failure modes (e.g. disconnect sensors/energy supply/pneumatics/hydraulics...).

188  System has detected a failure.

189  ASB indicator light illuminates.

190  When ASS is "AS Ready" or "AS Driving" state, the system has to enter "AS Emergency".

191  When ASS is "AS OFF" state no transition to "AS Ready" is possible when switching on ASMS and activating the TS (without LVMS power cycle).

## TIS STATUS UPDATE (DRIVERLESS)

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

## NON-COMPLIANCE / COMMENTS

## APPROVAL

Inspector Names

Date, Time

Signatures when passed

1. \_\_\_\_\_ / \_\_\_\_\_

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## PART VIII: BRAKE TEST

### TIS STATUS UPDATE

- ▶ Set online TIS status to *Present*

### COMMENTS

- ▶ Check comments from first page

### BRAKE TEST

- 192  **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.
- 193  **BRAKE LIGHT** - has to be clearly visible even in bright sunlight.

### TIS STATUS UPDATE

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

### NON-COMPLIANCE / COMMENTS

## APPROVAL

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

## PART IX: EMERGENCY BRAKE SYSTEM TEST

### TIS STATUS UPDATE

- ▶ Set online TIS status to *Present*

### COMMENTS

- ▶ Check comments from first page

### EMERGENCY BRAKE SYSTEM TEST

- ▶ Use the RES dongle.
- ▶ Apply EBS adapter device to team's RES sender, if available.
- ▶ Switch on LVMS and select mission "EBS test".
- 194  AMI shows the correct mission.
  - ▶ Switch on ASMS.
  - ▶ Check for neutral gear and press engine start button
- 195  ASSI is yellow continuous.
  - ▶ Press RES "Go" button.
- 196  ASSI is yellow flashing and vehicle accelerates.
  - ▶ EBS gets automatically triggered by the EBS adapter device at the brake point. If the EBS adapter device is not available press RES "stop button" when vehicle is at brake point.
- 197  Vehicle has to stop within 10m and has to stay stable.
- 198  Speed at brake point has to be around 40 km/h.
- 199  ASSI is blue flashing, intermittent sound is clearly noticeable for 8 - 10 s.
- 200  Engine stopped.

### TIS STATUS UPDATE

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

### NON-COMPLIANCE / COMMENTS

## APPROVAL

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