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:	☐ YES	☐ NO

Used Symbols:

- ● Information
- ▶ Action
- △ Check in responsibility of the team
- ◯ Check
- ⊙ Check optional, if Mechanical Inspection at FSA, FSCH, FSN, FSPT is passed

NOTES:

- This form must stay with the push bar 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.

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.

PART I: COMMENTS FROM DOCUMENT REVIEW

DRIVERLESS

- Driverless Ok

MECHANICAL

- Mech Ok
- SES to be checked

PART II: PRE-INSPECTION

☐ TIS STATUS UPDATE

► Set online TIS status to *Present*

► Write down inspector names legibly, sign only when passed

☐ TIRES

1 ◯ **DRY TIRES** - Make: _____

2 ◯ **DRY TIRES** - Size: _____

3 ◯ **DRY TIRES** - Compound: _____

4 ◯ **RAIN TIRES** - Make: _____

5 ◯ **RAIN TIRES** - Size: _____

6 ◯ **RAIN TIRES** - Compound: _____

7 ◯ **RAIN TIRES** - 2,4 mm min. tread depth molded by tire manufacturer

☐ DRIVER GEAR & SAFETY

8 ◯ **FIRE EXTINGUISHERS** - Two (2) hand-held, 0.9 kg (2 lb.) minimum, dry chemical (10BC, 1A10BC, 34B, 5A 34B, 20BE or 1A 10BE), with pressure/charge gauge, Aqueous Film Forming Foam (AFFF) fire extinguishers are prohibited, 1 WITH VEHICLE securely installed on push-bar, 1 in paddock. (Must see BOTH at inspection.).

9 ◯ **UNDERWEAR** - Nomex or equivalent, fire resistant underwear (no cotton, no polyester, no bare skin). No holes.

10 ◯ **SOCKS** - Nomex or equivalent, fire resistant socks (no cotton, no polyester, no bare skin). No holes.

11 ◯ **GLOVES** - Fire resistant material. Leather allowed only over fire resistant material. FIA hologram present. No holes.

12 ◯ **ARM RESTRAINTS** - SFI Standard 3.3 or equivalent.

13 ◯ **HELMETS** - Snell K2015, K2020, M2015, M2020, SA2020, EA2016 or newer. 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 dirtbike helmets). No camera mounts.

14 ◯ **FHR/HANS** - If used, must be certified to one of these standards: FIA 8858-2010, FIA 8860-2004, SFI 38.1.

15 ◯ **DRIVER SUITS** - Single piece SFI 3.2A/5 (or higher), SFI 3.4/5 (or higher), FIA 8856-2000/2018 (or higher), and LABELED AS SUCH. FIA hologram present. No holes.

16 ◯ **HAIR COVER** - Fire resistant (Nomex or equiv.) balaclava of full helmet skirt REQUIRED FOR ALL DRIVERS. No holes.

17 ◯ **SHOES** - SFI 3.3 or FIA 8856-2000/2018

18 ◯ **SEWING OR STITCHING** - Teams must show compliance to T13.3 if driver's clothing is embroidered. Fire resistant material must be used, examples: Nomex, Aramid, Belcotex and Indura.

☐ 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

19 ◯ **ARM RESTRAINTS**- Must be installed so the driver can release them and exit unassisted regardless of vehicle's position.

20 ◯ **HEAD RESTRAINT**- Near vertical. Max. 25 mm from helmet. Helmet contact point 50 mm min. from any edge.

21 ◯ **MAIN HOOP & FRONT HOOP HEIGHTS** - Helmet of driver to be 50 mm below line between top of front and main roll hoop AND between top of main hoop to rear attachment point of main hoop bracing.

22 ◯ **LAP BELT MOUNTING** - Must pass over pelvic area between 45 - 65 deg. to horizontal for upright driver, 60-80 deg. for reclined. The lap belts must not be routed over the sides of the seat.

23 ◯ **SHOULDER HARNESS MOUNTING** - Angle from shoulder between 10 deg. up and 20 deg. down to horizontal.

☐ 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's Name	Wristband ID	Signature Inspector - when passed	Acc	Skid Pad	AutoX	Endurance
1.				☐☐	☐☐	☐☐	☐
2.				☐☐	☐☐	☐☐	☐
3.				☐☐	☐☐	☐☐	☐
4.				☐☐	☐☐	☐☐	☐

Checked by officials only after a dynamic run!

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 (M-INSPECTION)

- ► Set online TIS status (M-Inspection) to *Present*
- ► Write down inspector names legibly, sign only when passed

☐ COMMENTS

- ► Check comments from first page

☐ VEHICLE WITH TALLEST DRIVER READY TO RACE

24 ○ **PUSH BAR (red color)** - Securely attached to vehicle, detachable, push & pull function for 2 people. University must be written on. The inspection sheet must always stay with the push bar.

25 △ **CAMERAS** - Must be secured by two points, see T13.5. No cameras mounted to helmet.

26 ○ **AUTONOMOUS SYSTEM SENSORS** - Sensors may not come into contact with the driver's helmet when normally seated.

27 ○ **VISIBILITY** - Minimum of 100 deg. field either side. Head rotation allowed or mirrors. If mirrors, must be firmly installed and adjusted.

28 △ **VEHICLE CONTROLS** - All controls, including shifter, must be inside cockpit. No arms or elbows outside the SIS plane.

29 ○ **DRIVER FLUID PROTECTION** - A firewall (or heat resistant cover plate for cooling systems using plain water (except wheel motors and their cooling hoses)) must be rigidly mounted and extend sufficiently far upwards and/or rearwards such that any point, less than 100 mm above the bottom of the helmet of the tallest driver, is not in direct line of sight with any of the following parts: fuel system, engine oil system, cooling system and low voltage battery.

30 ○ **ROLL BAR PADDING** - Roll bar or bracing that could be hit by driver's helmet must be covered with 12 mm thick, SFI spec 45.1 or FIA 8857-2001 padding.

31 △ **OTHER SIDE TUBES** - Design prevents driver's neck hitting bracing or other side tubes.

32 ○ **HEAD RESTRAINT**- Near vertical. Must take 890 N load. 40 mm thick, SFI 45.2 standard. Max. 25 mm from helmet. Helmet contact point 50 mm min. from any edge. May be changed for different drivers. Minimum 150x150 mm.

33 ○ **DRIVER RESTRAINT HARNESS** - SFI 16.1, SFI 16.5, SFI 16.6, 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 x 2.4 mm or equal.).

34 ○ **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 T5.3.2.

35 ○ **SHOULDER HARNESS MOUNTING** - Mounting points 180 - 230 mm apart (measured center to center). Attach to primary structure - 25.4 x 2.4 mm or 25.0 x 2.5 mm 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.

36 △ **SUSPENSION** - Fully operational with dampers front and rear; 50 mm minimum wheel travel (minimum jounce of 25 mm) with driver in vehicle.

☐ VEHICLE WITHOUT DRIVER

37 △ **TECH STICKER SPACE** - 45 mm x 175 mm on centerline of front of vehicle in front of the cockpit opening

38 △ **SCHOOL NAME & OTHER DECALS** - School name, or recognized initials - min. 50 mm tall (all letters). on both sides in roman letters. Must be clearly visible.

39 △ **VEHICLE NUMBERS** - On front & both sides of vehicle, minimum 150 mm tall, 20 mm stroke & spacing, 25 mm 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.

40 △ **BODYWORK EDGES** - edges that could contact a pedestrian must have a minimum radius of 1.0 mm (safety requirement).

41 △ **BODY & STYLING** - Open wheeled, open cockpit, formula style body. Vertical keepout zones 75 mm in front and behind tires (no aero exceptions), tires unobstructed from sides.

42 ○ **BODYWORK** - Min. 38 mm radius on nose. No large openings in bodywork into driver compartment in front of or alongside driver, (except cockpit opening). In any side view in front of the cockpit opening no external concave radii (exception T8.2).

43 ○ **AERODYNAMIC DEVICES** - Securely mounted. The deflection may not exceed 10 mm when a force of 200 N is applied over a surface of 225 cm^2 and not more than 25 mm when a point force of 50 N is applied.

44 △ **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.

45 △ **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.

46 ○ **EDGES/RADII** - Edges that could contact a pedestrian must have a minimum radius of: forward facing edges min 3 mm; all other edges min. 1 mm.

47 ○ **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.

48 ○ **AIR INTAKE SYSTEM** - Must be supported if cantilevered (isolated to frame, rigid to engine). Any portion < 350 mm above ground must have impact protection to rule CV 1.3.2. Intercooler after throttle body.

49 △ **SEAT** - Insulated against heat conduction, convection and radiation. Lowest point no lower than top of of the upper surface of the lowest SIS member OR must have longitudinal, 25.4 x 1.65 mm steel tube underneath.

50 ⊙ **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.

51 ○ **COCKPIT INTERNAL CROSS SECTION** - Fig. 11 (right) template passes from the cockpit opening to 100 mm rear of rearmost pedal contact area (in most forward position). Steering wheel and paddings can be removed (without tools).

52 △ **STEERING WHEEL** - Continuous perimeter, near round (no concave sections) with driver operable quick disconnect. 250 mm max from front hoop.

53 ○ **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.

54 ○ **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.

55 ○ **FUEL FILLER NECK** - Min. 35 mm dia., within 30° of vertical. Fuel resistant, transparent sight tube or transparent filler neck (material must be rated for at least 120°C). min 125 mm vert. height visible to fueler with vehicle fully assembled, with non-moveable fuel level line 12-25 mm 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.)

56 ○ **FUEL FILLER NECK LOCATION** - Must be located within the rollover protection envelope, except the whole filler neck is 350 mm above the ground.

57 △ **REFUELING** - Must be able to be accomplished without the removal of any body parts of the vehicle.

58 ○ **FUEL VENTS** - Must exit outside of the bodywork, and have a check valve to prevent leakage if vehicle inverted.

☐ REMOVE BODY PANELS

59 ○ **JACKS** - Up to two devices that lift up all driven wheels min. 100 mm above the ground. In lifted position it is safe to enter and exit the vehicle and the devices must not extend out of the vehicles projected surface area. University name must be written on. Vehicle pickup points must be indicated by orange triangles.

60 ○ **DRIVER'S LEG PROTECTION** - Covers inside of cockpit over any sharp edges or moving suspension / steering components.

61 ⊙ **DRIVER'S FOOT PROTECTION** - Feet must be rearward of the front bulkhead. The front bulkhead, together with the AIP, must cover the driver's feet in front view. No part of shoes or legs above or outside the primary structure (25x1.2 or equivalent) in side or front views when touching the pedals.

62 ⊙ **PERCY** - Helmet of 95th percentile male (PERCY) including 50 mm clearance must be 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 865 mm from pedals.

63 ○ **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 2000 N, no failures if official exerts max force (seated normally in vehicle).

64 △ **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.

65 ○ **WHEELS** - 203.2 mm (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.

66 ○ **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.

67 △ **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.

68 △ **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 ≥ 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.

☐ SES, IAD & REQUIRED TESTS PRESENTED

69 ○ **SES TUBING & MATERIALS** - Team must show an APPROVED SES. No magnesium tubes in primary structure.

70 ⊙ **SES TEST SPECIMEN** - Team must show all relevant test specimen. Labled (non-removable) with structure acronym and date. Speciment width, skin & core thickness according to SES.

71 ⊙ **INSPECTION HOLES** - 4.5 mm inspection holes required in non-critical areas of front & main hoops. Must be accessible with standard calliper. Inspectors may ask for holes in other tubes and/or structures.

72 ⊙ **SES DIMENSIONS & THICKNESSES** - All chassis dimensions according to SES: tube diameter and wall thickness; laminate skin thickness, core thickness, panel height.

73 ○ **HOLES & CUTOUTS** - All holes/cutouts in primary structure < 60 mm² or deducted from panel height.

74 ⊙ **LAMINATE ORIENTATION** - Tested structures must be correctly oriented or quasi-isotropic (T3.5.4, especially MHBS).

75 ⊙ **BOLTED JOINTS/ATTACHMENTS** in primary structure - Distance hole centerline to the nearest free edge > 1.5 x hole diameter. Steel backing plates (≥2 mm thick) with perimeter near circular or oval used at attachment points (must be fully supported). According to SES (T3.16.6) if two panels are bolted together.

76 ⊙ **HARNESS ATTACHMENTS** for shoulder harness, lap belt and anti-submarine belt according to SES calculation, simulation and/or physical test. Test/calculation conducted according to realistic belt angle.

77 ⊙ **MAIN HOOP** - 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, not oval after bending.

78 ⊙ **MAIN HOOP BRACING** - Same material as main hoop (both (non) magnetic). One straight brace on each side. Attached within 160 mm from the top. Min. 30 deg. included angle with main hoop. No bends. No rod-ends. Proper design for removable braces (capping etc.) on both ends.

79 ⊙ **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.

80 ⊙ **FRONT HOOP BRACING** - Two straight forward facing braces, attached within 50 mm of top. Extra rearward bracing required if front hoop leans backwards more than 10 deg.

81 ⊙ **FRONT BULKHEAD SUPPORT** - Upper tube connecting within 50 mm of top of bulkhead, and connecting within 100 mm above and 50 mm below upper SIS tube.

82 ⊙ **SIDE IMPACT PROTECTION** - Upper tube between 240 - 320 mm above lowest inside chassis point between FH and MH.

83 ◯ **SUSPENSION PICK-UP POINTS** - Inspected thoroughly for integrity. No crushed core, no skin detacted from core.

84 ⊙ **FRONT IMPACT PROTECTION** - Team must show an APPROVED IAD and test piece (if applicable), which both must reflect status on the car. IMPACT ATTENUATOR forward of bulkhead. IA must be securely fastened directly to AIP capable of taking transverse & vertical loads (no tape, etc.). Non-crushable objects forward of bulkhead must have been evaluated in IAD. No wing supports through the IA.

85 ⊙ **IAD DIMENSIONS** - IA min. 200 mm long x 200 mm wide x 100 mm high. AIP solid sheet metal, min. 1.5 mm steel or 4.0 mm aluminium; alternative design accepted, if SES/IAD approved. Standard IA: Requires diagonal or X-brace if FBH dimensions larger than 400 mm width and/or 350 mm height.

86 △ **IA POSITION** - The minimum volume dimensions cannot not be more than 350 mm above ground (measured with driver seated).

87 ⊙ **AIP ATTACHMENT** - Standard: must be welded (full perimeter, size: min. to centerlines) or min. 8 screws M8 grade 8.8 (critical fasteners T10) (size: min. outside dimensions). Non-standard: Must follow T3.16.6.

☐ VEHICLE LIFTED AND WHEELS REMOVED

88 ◯ **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 adhesive or lock washers. Minimum of 2 exposed threads with lock 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. Snap or retaining rings must not bear any load in non-OEM application (e.g. not for brake disc floaters).

89 ⊙ **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. Stationary parts within rollover protection envelope. 7 degrees max. free play at the steering wheel. NO STEER-BY-WIRE on front wheels. Rear wheel steering, max. 6 deg. and mechanical stops installed. Bonded joints in accordance with T3.2.8.

90 ◯ The steering system has to be fully operational by a driver when ASMS is in “OFF”-Position.

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

92 ◯ **ENGINE** - Four cycle piston engine. No hybrids. Waste heat recovery allowed.

93 ◯ **ON-BOARD STARTER** - Required.

94 ◯ **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.

95 ◯ **INTAKE MANIFOLD** - Securely attached to block or head with mech. Fasteners (positive locking!). OEM type rubber bushings not sufficient.

96 ◯ **RESTRICTOR** - Must be circular; max. diam. 20 mm for gasoline fuelled vehicles and 19 mm for E85 fuelled vehicles. Cannot be movable. Placed before compressor.

97 ◯ **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. 50 mm from any exhaust component.

98 ◯ **THROTTLE PEDAL** - Must have positive stop to prevent overstressing cable.

99 ◯ **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.

100 ◯ **GAS CYLINDERS LOCATION** - Axis not pointed at driver, within the rollover protection envelope (see FIGURE 2), 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.

101 ◯ **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 10 bar allowed, except cylinders/tanks with directly mounted pressure regulator (-> 10 bar).

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

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

104 ◯ **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.

105 ◯ ⚡ **STUDENT BUILD LV BATTERY** Proper Insulation of internal connections; proper mounting of cells

106 ◯ ⚡ **LI-ION LV BATTERY** (only applicable if other than $LiFePO_4$)- 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.

107 ◯ **HIGH PRESS HYDRAULICS** - Pumps and lines must have 1 mm steel or aluminium shields protecting driver and workers.

108 ◯ Including all autonomous system high pressure hydraulics like the ASB.

109 △ **COOLANT** - 100% water. NO ADDITIVES WHATSOEVER.

110 ◯ **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. 3 mm min. dia. vent away from driver down to the bottom level of frame. Cooling systems using plain water, unless sealed, require 100 ml catch tanks.

111 △ **FLUID LEAKS** - Oil, grease, coolant,fuel, Brake fluid -> none permitted

112 ◯ **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.

113 ◯ **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.

114 ◯ **FUEL TANKS** - Must lie within major structure of the chassis with full side impact protection & firewall between fuel supply & driver, min. 50 mm away from exhaust components. Rigid tanks cannot carry structural load & must be flexibly mounted and must not touch anything else than its mounting.

115 ◯ **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

116 ⊙ **BELLYPANS** - In 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.

117 ◯ **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 cm2 minimum illuminated area. LED strips OK if elements closer than 20 mm apart and total length > 150 mm.

118 ◯ **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.

119 ◯ 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.

120 ◯ Round, triangle, or rectangular on black background

121 △ $15\,cm^2$ minimum illuminated area *OR* LED strips with a total length greater than 150 mm with elements <20 mm apart

☐ TIS STATUS UPDATE (M-INSPECTION)

► Set online TIS status (M-Inspection) to *Passed* or *Failed*

☐ SENSORS FOR AUTONOMOUS SYSTEM

122 ◯ **CHECK SENSORS** - Check if all Sensors are fulfilling the legal requirements (mainly radar and laser, e.g. Class 1 Laser Product acc. to **IEC 60825-1**). The teams must provide the according certifications.

123 ◯ **SENSOR POSITION** - Sensors must be positioned within the surface envelope or the envelope for aerodynamic devices.

124 ◯ **SENSOR MOUNTING** - Sensors must be securely and rigidly mounted to the vehicle's structure.

► **SENSOR MARKING** - Mark all sensors.

☐ ACTUATORS FOR AUTONOMOUS SYSTEM

125 ◯ **DECOUPLING** - Check if the team uses a decoupling mechanism for the brake/steering actuators.

126 ◯ **PART REMOVAL** - parts like including bolts, clips, etc. must not be removed for disconnection i.e. they must never loose the physical contact to the disconnection mechanism

127 ◯ **MANUAL OPERATION** - the disconnection mechanism must not block manual operation of steering/ braking in any position.

128 ◯ **LOCKING** - the disconnection mechanism must be securely locked in both positions.

☐ AUTONOMOUS SYSTEM BRAKE (ASB)

129 ◯ **MOUNTING** - All parts are properly mounted. No lateral forces acting on the pistons of pneumatic/hydraulic actuators.

130 ◯ **LEAKS** - No leaks in pneumatic/hydraulic circuit

131 ◯ **PUSH-IN FITTINGS** - None used

132 ◯ **OVERPRESSURE PROTECTION** - Must have overpressure protection in function critical pneumatic circuits, if parts of the circuit exceed 10 bar.

☐ TIS STATUS UPDATE (D-INSPECTION)

► If **ALL** **driverless checks** **from eletrical inspection** (page 11) are passed as well: Set online TIS status (D-Inspection) to *Passed* or *Failed*

NON-COMPLIANCE / COMMENTS

APPROVAL

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

PART V: TILT TEST

☐ TIS STATUS UPDATE

► Set online TIS status to *Present*

► Write down inspector names legibly, sign only when passed

☐ COMMENTS

► Check comments from first page

☐ TILT TEST

133 ◯ **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.

134 ◯ **VEHICLE STABILITY** - All wheels in contact with tilt table when tilted to 60 degrees to the horizontal.

135 ◯ **FUEL TYPE:** Diesel

136 △ **GROUND CLEARANCE** - At least 30 mm min. with driver. Active suspension in lowest position.

☐ TIS STATUS UPDATE

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

NON-COMPLIANCE / COMMENTS

APPROVAL

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

PART VI: ETC INSPECTION

☐ TIS STATUS UPDATE

► Set online TIS status to *Present*

► Write down inspector names legibly, sign only when passed

☐ COMMENTS

► Check comments from first page

☐ ACCELERATOR PEDAL POSITION SENSOR (APPS)

137 ◯ Accelerator Pedal returns to original position if not actuated.

138 ◯ At least two sensors with different transfer function are installed. (For digital sensors, a checksum is necessary)

139 ◯ Sensors do not share supply or signal lines.

140 ◯ Sensors are protected from beeing mechanically overstressed (positive stop of pedal).

141 ◯ Minimum two springs installed to return pedal.

► Disassemble one spring.

142 ◯ Each spring still returns pedal with the second one disconnected (springs in the APPSs not counted.)

► Open throttle and disconnect APPS(s).

143 ◯ Power to ETC system shuts down after 100 ms and throttle goes to idle position if less than two APPS are connected.

☐ THROTTLE AND THROTTLE POSITION SENSOR (TPS)

144 ◯ Two sources of energy to return the throttle to idle position. One must be a return spring (springs in the TPSs not counted.).

► Disconnect electronic throttle connector while throttle is open.

145 ◯ Throttle must return to idle position in one second.

146 ◯ At least two Throttle Position Sensors (TPS) installed

► Open throttle and disconnect TPS(s).

147 ◯ 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.

148 ◯ 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.	_____/_____	_____	_____

PART VII: NOISE TEST

☐ TIS STATUS UPDATE (NOISE)

► Set online TIS status (Noise) to *Present*

☐ COMMENTS

► Check comments (Mechanical) from first page

☐ NOISE TEST

► **TEST RPM** - Test at 7500 rpm[1].

149 ◯ **ENGINE START BUTTON** - The vehicle must be equipped with an additional engine start button next to the primary master switch.

150 ◯ Engine cannot be started with the additional start button in manual mode.

151 ◯ **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.

152 ◯ **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.

153 ◯ **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"

154 ◯ **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.

155 ◯ **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).

156 ◯ **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).

157 ◯ **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).

158 ◯ **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).

159 ◯ **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).

160 ◯ **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

161 ◯ **EXHAUST OUTLET** - Outlet no more than 45 cm behind rear axle centreline or more than 60 cm above the ground.

162 ◯ **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)

163 △ 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.

164 ◯ Power to ignition & fuel pump(s) must shut down.

► Disconnect throttle position sensor from BSPD and press brake pedal while throttle is open.

165 ◯ Power to ignition & fuel pump(s) must shut down.

► Team simulates a throttle of >25%, press brake representing hard braking (>500 ms).

166 ◯ Must open the shutdown circuit and kill ignition & fuel pump(s).

167 ◯ 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 (Noise) to *Passed* or *Failed*

[1] Calculated for the specific engine

FORMULA STUDENT INSPECTION SHEET

DRIVERLESS – copy for Formula Student Germany

☐ TIS STATUS UPDATE (D-INSPECTION)

► Set online TIS status (D-Inspection) to *Present*

☐ COMMENTS

► Check comments (Driverless) from first page

☐ REMOTE EMERGENCY SYSTEM BYPASS

► Check, if RES bypass is implemented correctly (as per ASF-Form "Actuator Power Supply")

168 ◯ RES bypass is implemented as described in the ASF

169 ◯ Correct safety relay is used

☐ AUTONOMOUS SYSTEM BRAKE

► Compare implementation in vehicle to ASF (Forms: "EBS Concept Overview" OR "EBS Machnical System")

170 ◯ Autonomous System Brake is identical to the system described in the ASF

171 ◯ No more than two release points are used

172 ◯ 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

173 ◯ 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

174 ◯ The release points are marked with "brake release"

☐ AUTONOMOUS SYSTEM TEST

► Switch on the LVMS and select the inspection mission

► Disable Race E-Key frequency of RES (Set race mode switch next to master switches to position opposite to "R")

175 ◯ The ASSIs remains off

► Check for neutral gear and switch on the ASMS

176 ◯ Starting the engine using the cockpit start button is not possible

► Start the engine via the external start button

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

► Press RES "Go" button within 5 s after "AS Ready"

178 ◯ "AS Driving" (ASSIs flashing yellow) has not been entered

179 ◯ Vehicle is still in neutral gear

180 △ Autonomous Mission Indicator (AMI) is easily readable and shows the correct mission

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

182 ◯ Brakes are closed at least on one axle

► Press the RES "Go" button.
!! CAUTION WHEELS AND STEERING SYSTEM ARE MOVING !!

183 ◯ The ASSIs start flashing yellow ("AS Driving")

184 ◯ Drivetrain is slowly spinning and steering system is moving

► Wait for the transition from "AS Driving" to “AS Finished”

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

186 ◯ ASSIs are clearly visible in very bright sunlight

187 ◯ Engine stopped

► Turn off the ASMS and release the Brakes via the deactivation points

188 ◯ Brakes are disengaged, manual steering is possible, ASSI is off

► Re-enter "AS Ready" state

► Press one shutdown button

189 ◯ ASSIs start flashing blue ("AS Emergency")

190 ◯ Brakes are closed

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

192 △ Sound level is min 80 dBA (2 m around the vehicle)

193 ◯ Engine stopped

► Turn off ASMS and release brakes (manual actions may be required)

► Re-enter "AS Driving" state with inspection mission selected, before each of the following tests

► 1. Press RES 2. Switch off the ASMS

194 ◯ Engine stopped

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

► 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. . .)

196 ◯ System has detected a failure

197 ◯ When ASSI is "AS Ready" or "AS Driving" state, the system enters "AS Emergency"

► Enable Race E-Key frequency (Set race mode switch to position "R")

► Try to enter "AS Ready" state

198 ◯ Starting the engine is not possible, "AS Ready" state is not entered

☐ TIS STATUS UPDATE (D-INSPECTION)

► If **ALL driverless checks from mechanical inspection** (page 7) are passed as well: Set online TIS status (D-Inspection) to *Passed* or *Failed*

NON-COMPLIANCE / COMMENTS

APPROVAL

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

PART VIII: BRAKE TEST

☐ TIS STATUS UPDATE

- ▶ Set online TIS status to *Present*
- ▶ Write down inspector names legibly, sign only when passed

☐ COMMENTS

- ▶ Check comments from first page

☐ BRAKE TEST

199 ○ **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.

200 ○ **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*
- ▶ Write down legibly inspector name

☐ 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".

201 △ AMI shows the correct mission.

- ▶ Switch on ASMS.
- ▶ Check for neutral gear and press engine start button

202 ○ ASSI is yellow continuous.

- ▶ Press RES "Go" button.

203 ○ 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.

204 ○ Vehicle has to stop within 10m and has to stay stable.

205 ○ Speed at brake point has to be around 40 km/h.

206 ○ ASSI is blue flashing, intermittent sound is clearly noticeable for 8 - 10 s.

207 ○ 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.	_____/_____	_____	_____