A TECHNICAL INSPECTOR’S GUIDE TO THE 2012 FSAE RULES

PART 6
ENGINE COMPARTMENT FUEL SYSTEM & ELECTRICAL
B.8.1 - Engines

B.8.1 Engine Limitation

• B.8.1.1 The engine(s) used to power the car must be a piston engine(s) using a four-stroke primary heat cycle with a displacement not exceeding 610 cc per cycle.

• Hybrid powertrains, such as those using electric motors running off stored energy, are prohibited.

Note: All waste/rejected heat from the primary heat cycle may be used. The method of conversion is not limited to the four-stroke cycle.
All parts of the engine air and fuel control systems (including the throttle or carburetor, and the complete air intake system, including the air cleaner and any air boxes) must lie within the surface defined by the top of the roll bar and the outside edge of the four tires (see figure 13).
B.8.4.1 & B.9.5.1 Air Intake & Fuel System Rollover Protection - cont’d

Not Correct Envelope

Correct Envelope

All parts of the fuel storage and supply system, and all parts of the engine air and fuel control systems (including the throttle or carburetor, and the complete air intake system, including the air cleaner and any air boxes) must lie within the surface defined by the top of the roll bar and the outside edge of the four tires (see figure 13).
B.8.4.1 & B.9.5.1 Air Intake & Fuel System Rollover Protection - cont’d

All parts of the fuel storage and supply system, and all parts of the engine air and fuel control systems (including the throttle or carburetor, and the complete air intake system, including the air cleaner and any air boxes) must lie within the surface defined by the top of the roll bar and the outside edge of the four tires (see figure 13).
B.8.4.2 Air Intake System Protection - Not OK

B.8.4.2
Any portion of the air intake system that is less than 350 mm (13.8 inches) above the ground must be protected by the same rules in Side Impact Structure.
B.8.4.2 Air Intake Side Protection - cont’d

OK

Not OK
B.8.5.4 Throttle Return Springs-TPS

• The throttle actuation system must use at least two (2) return springs located at the throttle body, so that the failure of any component of the throttle system will not prevent the throttle returning to the closed position.

• Note: Throttle Position Sensors (TPS) are NOT acceptable as return springs.
B.8.4 - Intake Systems

B.8.4.3 Intake Manifold

• The intake manifold must be securely attached to the engine block or cylinder head with brackets and mechanical fasteners.

• This precludes the use of hose clamps, plastic ties, or safety wires. The use of rubber bushings or hose is acceptable for creating and sealing air passages, but is not considered a structural attachment.

B.8.4.4 Intake Systems

• Intake systems with significant mass or cantilever from the cylinder head must be supported to prevent stress to the intake system.

• Supports to the engine must be rigid.

• Supports to the frame or chassis must incorporate some isolation to allow for engine movement and chassis flex.
B.8.9.3 Intake Manifold Attachment

Intake Manifold – The intake manifold must be securely attached to the engine block or cylinder head with **brackets and mechanical fasteners**. This precludes the use of hose clamps, plastic ties, or safety wires. **The use of rubber bushings or hose is acceptable for creating and sealing air passages, but is not considered a structural attachment.**
B.8.9.2 Fuel Rail Attachment

**Fuel Rail** – The fuel rail must be securely attached to the engine cylinder block, cylinder head, or intake manifold with brackets and mechanical fasteners. This precludes the use of hose clamps, plastic ties, or safety wire.
B. 10.1.2 Exhaust System

- B.10.1.2 The exhaust outlet(s) must not extend more than 45 cm (17.7 inches) behind the centerline of the rear axle, and shall be no more than 60 cm (23.6 inches) above the ground.

Note: The previous requirement that “The car must be equipped with a muffler in the exhaust system to reduce the noise to an acceptable level” has been deleted. The maximum noise level test being deemed sufficient.
Exhaust Shielding Alongside Driver- OK

B.10.1.3 Exhaust Outlet

Any exhaust components (headers, mufflers, etc.) that protrude from the side of the body in front of the main roll hoop must be shielded to prevent contact by persons approaching the car or a driver exiting the car.
B.8.13 - Drivetrain Shields & Guards

• B.8.13.1 Exposed high-speed final drivetrain equipment such as Continuously Variable Transmissions (CVTs), sprockets, gears, pulleys, torque converters, clutches, belt drives and clutch drives, must be fitted with scatter shields in case of failure.

• The final drivetrain shield must cover the chain or belt from the drive sprocket to the driven sprocket/chain wheel/belt or pulley.

• The final drivetrain shield must end parallel to the lowest point of the chain wheel/belt/pulley. (See figure). Body panels or other existing covers are not acceptable unless constructed from approved materials per B. 8.13.3 or B.8.13.4.

Comment: Scatter shields are intended to contain drivetrain parts which might separate from the car.
B.8.13 - Drivetrain Shields & Guards - Cont’d

- B.8.13.2 Perforated material may not be used for the construction of scatter shields.
- B.8.13.3 Chain Drive - Scatter shields for chains must be made of at least 2.66 mm (0.105 inch) steel (no alternatives are allowed), and have a minimum width equal to three (3) times the width of the chain.
  - The guard must be centered on the center line of the chain and remain aligned with the chain under all conditions.
- B.8.13.4 Non-metallic Belt Drive - Scatter shields for belts must be made from at least 3.0 mm (0.120 inch) Aluminum Alloy 6061-T6, and have a minimum width that is equal to 1.7 times the width of the belt.
  - The guard must be centered on the center line of the belt and remain aligned with the belt under all conditions.
- B.8.13.5 Attachment Fasteners - All fasteners attaching scatter shields and guards must be a minimum 6mm grade M8, or stronger (1/4 inch SAE grade 5).
- B.8.13.6 Finger Guards – Finger guards are required to cover any drivetrain parts that spin while the car is stationary with the engine running. Finger guards may be made of lighter material, sufficient to resist finger forces. Mesh or perforated material may be used but must prevent the passage of a 12 mm (1/2 inch) diameter object through the guard.

Comment: Finger guards are intended to prevent finger intrusion into rotating equipment while the vehicle is at rest.
B.8.11 System Sealing

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• B.8.11.1 The engine and transmission must be sealed to prevent leakage.

• B.8.11.2 Separate catch cans must be employed to retain fluids from any vents for the coolant system or the crankcase or engine lubrication system. Each catch-cant must have a minimum volume of ten (10) percent of the fluid being contained or 0.9 liter (one U.S. quart) whichever is greater.

• B.8.11.3 Catch cans must be capable of containing boiling water without deformation, and be located rearwards of the firewall below driver’s shoulder level, and be positively retained, i.e. no tie-wraps or tape.

• B.8.11.4 Any catch can on the cooling system must vent through a hose with a minimum internal diameter of 3 mm (1/8 inch) down to the bottom levels of the Frame.

• B.8.11.5 Any crankcase or engine lubrication vent lines routed to the intake system must be connected upstream of the intake system restrictor.

• B.8.11.6 Crankcase breathers that pass through the oil catch tank(s) to exhaust systems, or vacuum devices that connect directly to the exhaust system, are prohibited.
B.8.10 Coolant

B.8.10 Coolant Fluid Limitations

- Water-cooled engines must only use plain water. Glycol-based antifreeze, water wetter, water pump lubricants of any kind, or any other additives is strictly prohibited.

(At the competition.)
B.13.1 Compressed Gas Cylinders

B.13.1 Compressed Gas Cylinders and Lines

• Any system on the vehicle that uses a compressed gas as an actuating medium must comply with the following requirements:

  a. Working Gas-The working gas must be nonflammable, e.g. air, nitrogen, carbon dioxide.

  b. Cylinder Certification- The gas cylinder/tank must be of proprietary manufacture, designed and built for the pressure being used, certified by an accredited testing laboratory in the country of its origin, and labeled or stamped appropriately.

  c. Pressure Regulation -The pressure regulator must be mounted directly onto the gas cylinder/tank.

  h. Insulation- The gas cylinder/tank must be insulated from any heat sources, e.g. the exhaust system.

  i. Lines and Fittings- The gas lines and fittings must be appropriate for the maximum possible operating pressure of the system.
d. Protection – The gas cylinder/tank and lines must be protected from rollover, collision from any direction, or from damage resulting from the failure of rotating equipment.

e. Cylinder Location - The gas cylinder/tank and the pressure regulator must be located either rearward of the Main Roll Hoop and within the envelope defined by the Main Roll Hoop and the Frame (see B.3.2), or in a structural side-pod that meets the requirements of B.3.24 or B.3.31. It must not be located in the cockpit.

f. Cylinder Mounting - The gas cylinder/tank must be securely mounted to the Frame, engine or transmission.

g. Cylinder Axis - The axis of the gas cylinder/tank must not point at the driver.
B.13 - High Pressure Pumps

B.13.2 High Pressure Hydraulic Pumps and Lines

- The driver and anyone standing outside the car must be shielded from any hydraulic pumps and lines with line pressures of 300 psi (2100 kPa) or higher. The shields must be steel or aluminum with a minimum thickness of 1 mm (0.039 inch).

Note: Brake lines are not classified as “hydraulic pump lines” and as such brake lines are excluded from B13.2
B.9.4 Fuel Tanks

9.4 Fuel Tanks

9.4.1 The fuel tank is defined as that part of the fuel containment device that is in contact with the fuel. It may be made of a rigid material or a flexible material.

9.4.2 Fuel tanks made of a rigid material cannot be used to carry structural loads, e.g. from roll hoops, suspension, engine or gearbox mounts, and must be securely attached to the vehicle structure with mountings that allow some flexibility such that chassis flex cannot unintentionally load the fuel tank.

9.4.3 Any fuel tank that is made from a flexible material, for example a bladder fuel cell or a bag tank, must be enclosed within a rigid fuel tank container which is securely attached to the vehicle structure. Fuel tank containers (containing a bladder fuel cell or bag tank) may be load carrying.

9.4.4 Any size fuel tank may be used.

9.4.5 The fuel system must have a provision for emptying the fuel tank if required.
B.9.5. Fuel Tank Location

9.5 Fuel System Location Requirements

9.5.1 All parts of the fuel storage and supply system must lie within the surface defined by the top of the roll bar and the outside edge of the four tires. (See Figure 13).

9.5.2 All fuel tanks must be shielded from side or rear impact collisions. Any fuel tank which is located outside the Side Impact Structure required by 3.24, 3.25, or 3.26 must be shielded by structure built to 3.24, 3.26, or 3.26.

9.5.3 A firewall must be incorporated to separate the fuel tank from the driver, per Rule 4.5.
B.9.5.1 Fuel System Rollover Protection

All parts of the fuel storage and supply system must lie within the surface defined by the top of the roll bar and the outside edge of the four tires (see figure 13).
B.8.9 - Fuel Injection Systems

B.8.9.1 Low Pressure Injection (LPI)

- Low pressure fuel injection systems are those functioning at a pressure below 10 Bar (145 psi). Most Port Fuel Injected (PFI) fuel systems are low pressure.

- **(A) Fuel Lines** – On low pressure fuel injected systems, any flexible fuel lines must be either (i) metal braided hose with either crimped-on or reusable, threaded fittings, or (ii) reinforced rubber hose with some form of abrasion resistant protection with fuel line clamps per B.8.8.2.

  **Note:** Hose clamps over metal braided hose will not be accepted.

- **(B) Fuel Rail** – The fuel rail must be securely attached to the engine cylinder block, cylinder head, or intake manifold with mechanical fasteners. This precludes the use of hose clamps, plastic ties, or safety wire.

- **(C) Intake Manifold** – On engines with port fuel injection, the intake manifold must be securely attached to the engine block or cylinder head.
B.8.9.1 Fuel Lines for LPI Systems

**Fuel Lines** – On low pressure fuel injected systems, any flexible fuel lines must be either

(i) Metal braided hose with either crimped-on or reusable, threaded fittings, or  
(ii) Reinforced rubber hose with some form of abrasion resistant protection with fuel line clamps per B.8.8.2.

**Note:** Hose clamps over metal braided hose will not be accepted.
If rubber fuel line or hose is used, the components over which the hose is clamped must have annular bulb or barbed fittings to retain the hose.

Also, clamps specifically designed for fuel lines must be used. These clamps have three (3) important features,

(i) a full 360 deg. wrap,
(ii) a nut and bolt system for tightening, and
(iii) rolled edges to prevent the clamp cutting into the hose. Worm-gear type hose clamps are not approved for use on any fuel line.
B.8.9.2 High Pressure Injection (HPI) / Direct Injection (DI)

- High pressure fuel systems are those functioning at 10 Bar (145 psi) pressure or above. Direct injection fuel systems are those where the injection occurs directly into the combustion system.

- DI systems often utilize a low pressure electric fuel pump and high pressure mechanical "boost" pump driven off the engine.

- The high pressure lines are those between the boost pump and injectors, and the low pressure lines lead from the electric supply pump up to the boost pump.
(A) High Pressure Fuel Lines – All high pressure fuel lines, normally those downstream of the high pressure pump on Direct Injection systems, must be stainless steel rigid line or Aeroquip FC807 smooth bore PTFE hose with stainless steel reinforcement and visible Nomex tracer yarn. Equivalent products may be used with prior Rules Committee approval. Use of elastomeric seals is prohibited.

Lines must be rigidly connected every 100mm by mechanical fasteners to structural engine components such as cylinder heads or block.

(B) Low Pressure Fuel Lines – Low pressure lines, normally those upstream of the high pressure pump, that are flexible must be either (i) metal braided hose with either crimped-on or reusable, threaded fittings, or (ii) reinforced rubber hose with some form of abrasion resistant protection with fuel line clamps per B8.8.2.

Note: Hose clamps over metal braided hose will not be accepted.
B.8.9.2 - HPI/DI Systems - cont’d

• **(C) Fuel Rail** – The fuel rail must be securely attached to the engine cylinder head with mechanical fasteners. This precludes the use of hose clamps, plastic ties, or safety wire. The fastening method must be sufficient to hold the fuel rail in place with the maximum regulated pressure acting on the injector internals and neglecting any assistance from in-cylinder pressure acting on the injector tip.

• **(D) High Pressure Fuel Pump** – The fuel pump must be rigidly mounted to structural engine components such as the cylinder head or engine block.

• **(E) Pressure Regulator** – A fuel pressure regulator must be fitted between the high and low pressure sides of the fuel system in parallel with the DI boost pump. The external regulator must be used even if the DI boost pump comes equipped with an internal regulator.

• **(F) Required Test** – Prior to the tilt test specified in B.9.9, engines fitted with mechanically actuated fuel pumps must be run to fill and pressure the system downstream of the high pressure pump.
B.9.6 Fuel Tank Filler Neck & Sight Tube

All fuel tanks must have a filler neck:
(a) at least 38 mm (1.5 inches) diameter,
(b) at least 125 mm (4.9 inches) vertical height and
(c) angled at no more than 45 degrees from the vertical.

The 125 mm of vertical height must be above the top level of the fuel tank, and must be accompanied by a clear, fuel resistant sight tube for reading the fuel level (Figure 7).

The sight tube must have at least 75 mm (3 inches) of vertical height and a minimum inside diameter of 6 mm (0.25 inches). The sight tube must not run below the top surface of the fuel tank.

A clear filler tube may be used, subject to approval by the Rules Committee or technical inspectors at the event.
B.9.6 Fuel Tank Filler Neck & Sight Tube - OK
B.9.6 Fuel Tank Filler Neck & Sight Tube - cont’d
B.9.6 Fuel Tank Filler Neck & Sight Tube - cont’d

Not OK

Not OK
B.9.1 Fuel

B.9.1 Fuel

• The basic fuel available at competitions in the Formula SAE Series is unleaded gasoline with an octane rating of 93 \((R+M)/2\) (approximately 98 RON). However, the basic fuel may be changed at the discretion of the organizing body. Other fuels may be available at the discretion of the organizing body.

• Note 2: The fuels provided at Formula SAE Michigan are expected to be 93 and 100 octane \((R+M)/2\) gasoline and E-85. The fuels provided at Formula SAE Lincoln are expected to be ????
Article B.11.4 Batteries

B.11.4.3 The hot *(ungrounded)* terminal must be insulated.

B.11.4.5 Battery packs based on *Lithium Chemistry other than LiFePo*:
   a. must be commercially manufactured items
   b. must have over voltage, under voltage, short circuit and over temperature cell protection

B.11.4.6 All batteries using chemistries other than lead acid must be presented at technical inspection with markings identifying it for comparison to a datasheet or other documentation proving the pack and supporting electronics meet all rules requirements