

# **2010 RFL Extensible Technical Regulations**

## **for:**

### **SCRC Kilobots events**

1. General
  - 1.1. All participants build and operate robots at their own risk. Combat robotics is inherently dangerous. There is no amount of regulation that can encompass all the dangers involved. Please take care to not hurt yourself or others when building, testing and competing.
  - 1.2. This rule set is designed to for adjustment by each event depending on its safety concerns. Any parts of these rules [bracketed in red] are parts that may be changed or omitted from event to event. Text that is stricken (~~stricken~~) represents rules that are not applicable to this event.
  - 1.3. If you have a robot or weapon design that does not fit within the categories set forth in these rules or is in some way ambiguous or borderline, please contact this event. Safe innovation is always encouraged, but surprising the event staff with your brilliant exploitation of a loophole may cause your robot to be disqualified before it ever competes.
  - 1.4. Compliance with all event rules is mandatory. It is expected that competitors stay within the rules and procedures of their own accord and do not require constant policing.
  - 1.5. Each event has safety inspections. It is at their sole discretion that your robot is allowed to compete. As a builder you are obligated to disclose all operating principles and potential dangers to the inspection staff.
  - 1.6. Cardinal Safety Rules: Failure to comply with any of the following rules could result in expulsion or worse, injury and death.
    - 1.6.1. Radios may not be turned on at or near events for any purpose without obtaining the appropriate frequency clip or explicit permission from the event.
    - 1.6.2. Proper activation and deactivation of robots is critical. Robots must only be activated in the arena, testing areas, or with expressed consent of the event and it's safety officials.
    - 1.6.3. All robots must be able to be FULLY deactivated, which includes power to drive and weaponry, **in under 60 seconds by a manual disconnect.**
    - 1.6.4. All robots not in an arena or official testing area must be raised or blocked up in a manner so that their wheels or legs cannot cause movement if the robot were turned on. Runaway bots are VERY dangerous.
    - 1.6.5. Locking devices: Moving weapons that can cause damage or injury must have a **clearly visible** locking device in place **at all times** when not in the arena. Locking devices must be painted in neon orange or another high-visibility color. Locking devices must be clearly capable to stopping, arresting or otherwise preventing harmful motion of the weapon.
    - 1.6.6. Weapon locking pins **must be in place** when weapon power is applied during a robot's power-on procedure. This includes **all** powered weapons regardless of the power source or weight class.

## Robot Fighting League 2010 Rules 14 November 2009

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1.6.7. It is expected that all builders will follow basic safety practices during work on the robot at your pit station. Please be alert and aware of your pit neighbors and people passing by.

2. Weight Classes. This event offers the listed weight classes in section 2.1. [ **There is a 100% weight bonus for non-wheeled bots.**] (Non-wheeled robots in the 340 class may receive a 35% bonus. There is a weight bonus for shufflers or other forms of locomotion which are predicated on rolling - see 3.1.2 for a definition of a non-wheeled robot.)

2.1.

Rolling	Non-Wheeled	Shuffling or Cam-driven
1 pound	2 pound	1.5 pound
1 kilogram	2 kilogram	1.5 kilogram
3 pound	6 pound	4.5 pound
6 pound	6 pound (0%)	6 pound (0%)

- 2.2. **1-kg Sportsman Class**<sup>1</sup>. A 1-kg robot may be entered in the "Sportsman" class if it complies with the additional rules in this section. Any 1-kg robot may be entered in the "standard" 1-kg class.

2.2.1. **Intent.** The intent of the Sportsman Class is to encourage novel designs and driving ability. The focus of this class is **fun and creativity**, not the annihilation of your opponent. Robots must comply with both the letter and spirit of these rules to qualify for this class.

2.2.2. **Active Weapon Required.** Sportsman class robots must have an active weapon. This is defined as a weapon or device intended for use in attacking the opponent, independent of the robot drive train. These include but are not limited to lifters, hammers, clamps, flame weapons and spinning weapons (within the limitations specified in 2.2.3)

2.2.3. **Limitations on Spinning Weapons.** Spinning weapons [are allowed] at this event. [Enter any additional restrictions or explanatory text regarding limitations here.] If allowed, weapons that can rotate continuously are permitted if and only if the edge/tip velocity does not exceed **500 surface feet per minute (SFM)**. Weapon SFM will be determined by tachometer prior to the start of the event using this formula:

$$SFM = RPM * \pi D$$

Flywheels and other spinning parts internal to the robot are allowed without limit, but may not act directly as weapons. For example, a flywheel-powered hammer or axe would be legal if the weapon arm did not move more than 360 degrees.

2.2.4. **No Wedges.** A "**wedge**" is any part of a robot that in any position is capable of elevating a flat sided box with ¼" of ground clearance more than ½" off the floor simply by sliding the wedge under the box when the robot in question is in any "normal" driving positions e.g. with its wheels on the floor.

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<sup>1</sup> The "Sportsman Class" was introduced by the Northeast Robot Club (NERC) in 2006. The RFL rules are based on the original NERC rules and incorporated with the permission of NERC. ([www.nerc.us](http://www.nerc.us)).

## Robot Fighting League 2010 Rules 14 November 2009

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2.2.4.1. Large plates extending from the robot that are flat or nearly flat to the floor are not allowed.

2.2.4.2. Other **static** devices which have the purpose of removing the opponent's wheels from the arena floor are not allowed.

**2.2.5. Lifting, Flipping and Grabbing Weapons.** An articulated "spatula", parallel to the floor is allowed, provided that:

- It complies with the "no wedge" rule (2.2.4) and
- It is no more than ¼ the width of the robot (as measured across the wheels at their widest point) and
- It extends no more than 2" from the front edge of the robot.

2.2.6. **Excessively Destructive Weapons.** Weapons deemed too destructive by virtue of their mass, MOI or other characteristics may be further limited or disallowed at the discretion of the event. Please contact the event organizer concerning your design to avoid problems.

2.2.7. **Standard RFL Rules Apply.** Unless otherwise stated, all other standard RFL rules will apply. This includes walkers and their weight bonuses. However, a walker that uses the weight bonus for a spinning (or other) weapon that is too destructive will be disqualified.

### 3. Mobility

3.1. All robots must have **easily visible and controlled mobility** in order to compete. Methods of mobility include:

3.1.1. Rolling (wheels, tracks or the whole robot)

3.1.2. Non-wheeled: non-wheeled robots have **no** rolling elements in contact with the floor and **no** continuous rolling or cam operated motion in contact with the floor, either directly or via a linkage. Motion is "continuous" if continuous operation of the drive motor(s) produces continuous motion of the robot. Linear-actuated legs and novel non-wheeled drive systems may qualify for this bonus. **[Contact this event with questions on weight bonuses to see if your robot may qualify.]**

3.1.3. Shuffling (rotational cam operated legs)

3.1.4. Ground effect air cushions (hovercrafts)

3.1.5. Jumping and hopping **[is allowed]**

3.1.6. Flying (airfoil using, helium balloons, ornithopters, etc.)**[is not allowed]**

3.1.7. **[Additional notes on mobility.]**

### 4. Robot control requirements:

4.1. Tele-operated robots must be radio controlled, or use an approved custom system as described in 4.4.3. Radio controlled robots must use approved ground frequencies **[27/49/50/53/75/900/2400 for the United States ]**.

4.2. Tethered control is not allowed.

4.3. Pre 1991 non-narrow band radio systems are not allowed.

4.4. Radio system restrictions for this event with corresponding weight and or weapon restrictions:

4.4.1. Radio systems that stop all motion in the robot (drive and weapons), when the transmitter loses power or signal, are required for all robots with active weapons or any robot over 12lbs. This may be inherent in the robots electrical

## Robot Fighting League 2010 Rules

## Robot Fighting League 2010 Rules 14 November 2009

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- system or be part of programmed fail-safes in the radio. Robots 1 lb and less [ do not require] drive fail-safes.
- 4.4.2. All robot radio systems must have a way to change frequencies or coded channels to prevent radio conflicts. Having at least **two** frequencies or coded channels available is **required**. Lack of extra frequencies may result in a forfeit. Digital spread-spectrum radios that use frequency hopping or automatic channel selection qualify under this rule.
  - 4.4.3. If you are using a home built control system, or a control system not covered here, you must first clear it with this event.
  - 4.4.4. Toy radio systems **[are]** allowed at this event for robots up to 12 lbs with no active weapons.
  - 4.4.5. RC systems on the AM band **[are]** allowed at this event for robots up to 12 lbs with no active weapons.
  - 4.4.6. All robots that are either: a.) 30 lbs or above or b.) 12 lbs or above with an active weapon **MUST** use a radio systems on the FM band with **[PCM, IPD]** coding, a digitally coded 900 MHz or 2.4GHz system (for example IFI, Spektrum, etc), or an approved custom control system.
  - 4.5. This event does not require a separate power switch for the radio, but it is encouraged.
  - 4.6. This event **[has not]** reserved frequencies/channels for testing and safety. **[Frequency/Channel List:]**
5. Autonomous/Semi-Autonomous Robots: Any robot that moves, seeks a target, or activates weapons without human control is considered autonomous. If your robot is autonomous **[you are required to]** contact this event before registration. **[no extra notes]**
    - 5.1. Autonomous robots must have a clearly visible light for each autonomous subsystem that indicates whether or not it is in autonomous mode, e.g. if your robot has two autonomous weapons it should have two "autonomous mode" lights (this is separate from any power or radio indicator lights used).
    - 5.2. Robots in the 12 pound or under classes are exempt from the remaining rules below, but safe operation, arming, and disarming must be demonstrated in safety inspections.
    - 5.3. The autonomous functionality of a robot must have the capability of being remotely armed and disarmed. (This does not include internal sensors, drive gyros, or closed loop motor controls.)
      - 5.3.1. While disarmed, all autonomous functions must be disabled.
      - 5.3.2. When activated the robot must have no autonomous functions enabled, and all autonomous functions must failsafe to off if there is loss of power or radio signal.
      - 5.3.3. In case of damage to components that remotely disarm the robot, the robots autonomous functions are required to automatically disarm **within one minute of the match length time** after being armed.
  6. Batteries and Power
    - 6.1. The only permitted batteries are ones that cannot spill or spray any of their contents when damaged or inverted. This means that standard automotive and motorcycle wet cell batteries are prohibited. Examples of batteries that are

## Robot Fighting League 2010 Rules 14 November 2009

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permitted: gel cells, Hawkers, NiCads, NiMh, dry cells, AGM, LIon, LiPoly, etc. [If your design uses a new type of battery, or one you are not sure about please contact this event]

- 6.2. All onboard voltages above **48 Volts** require prior approval from this event. (It is understood that a charged battery's initial voltage state is above their nominal rated value)
  - 6.3. All electrical power to weapons and drive systems (systems that could cause potential human bodily injury) must have a manual disconnect that can be activated within **15 seconds** without endangering the person turning it off. (E.g. No body parts in the way of weapons or pinch points.) Shut down must include a **manually** operated mechanical method of disconnecting the main battery power, such as a switch (Hella, Wyachi, etc) or removable link. Relays may be used to control power, but there must also be a mechanical disconnect. Please note that complete shut down time is specified in section 1.6.
  - 6.4. All efforts must be made to protect battery terminals from a direct short and causing a battery fire.
  - 6.5. If your robot uses a grounded chassis you must have a switch capable of disconnecting this ground. ICE robots are excepted from this rule if there is no practical way to isolate their grounding components. It is [required] to contact this event for this exception.
  - 6.6. All Robots must have a light easily visible from the outside of the robot that shows its main power is activated.
7. Pneumatics
    - 7.1. Example diagrams of typical pneumatic systems in robots over 30lbs:
      - 7.1.1. CO2 based systems  
<http://www.botleague.com/pdf/GeneralPneumaticsCO2.pdf>
      - 7.1.2. High Pressure Air (HPA) based systems  
<http://www.botleague.com/pdf/GeneralPneumaticsHPA.pdf>
    - 7.2. Pneumatic systems on board the robot must only employ non-flammable, nonreactive gases (CO2, Nitrogen and air are most common). It is not permissible to use fiber wound pressure vessels with liquefied gasses like CO2 due to extreme temperature cycling.
    - 7.3. You must have a safe and secure method of refilling your pneumatic system. [The RFL recommends the use of standard paintball fill fittings available at many retail outlets and online. For specs see Part#12MPS from Foster, <http://www.couplers.com>.]
    - 7.4. **Exemptions**
      - 7.4.1. Robots **12 lbs and under** and systems with gas storage of **2 fl oz** or less are exempt from the remaining rules in this section **provided that** the maximum actuation pressure is **250 PSI or less** and all components are used within the specifications provided by the manufacturer or supplier. If the specifications aren't available or reliable, then it will be up to the EO to decide if the component is being used in a sufficiently safe manner.
      - 7.4.2. Pneumatic systems with pressures below 100 PSI, small volumes (12-16g CO2 cartridges), single firing applications, or pneumatics used for internal actuation (as opposed to external weaponry) **may** also be exempted from the

## Robot Fighting League 2010 Rules 14 November 2009

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remaining pneumatic rules. You are [required] to contact this event if you would like an exception.

- 7.5. All pneumatic components on board a robot must be securely mounted. Particular attention must be made to pressure vessel mounting and armor to ensure that if ruptured it will not escape the robot. (The terms 'pressure vessel, bottle, and source tank' are used interchangeably)
  - 7.6. All pneumatic components within the robot must be rated or certified for AT LEAST the maximum pressure in that part of the system. You may be required to show rating or certification documentation on ANY component in your system.
  - 7.7. All pressure vessels must be rated for at least 120% of the pressure they are used at and have a current hydro test date. (This is to give them a margin of safety if damaged during a fight.) If large actuators, lines, or other components are used at pressures **above 250psi** these will also need to be over-rated and are [required] to be pre-approved for this event.
  - 7.8. All primary pressure vessels must have an over pressure device (burst/rupture disk or over pressure 'pop off') set to no more than 130% of that pressure vessels rating. (Most commercially available bottles come with the correct burst assemblies, use of these is encouraged)
  - 7.9. If regulators or compressors are used anywhere in the pneumatic system there must be an (additional) over pressure device downstream of the regulator or compressor set for no more than 130% of the lowest rated component in that part of the pneumatic system.
  - 7.10. All pneumatic systems must have a manual main shut off valve to isolate the rest of the system from the source tank. This valve must be easily accessed for robot de activation and refilling.
  - 7.11. All pneumatic systems must have a manual bleed valve downstream of the main shut off valve to depressurize the system. This bleed valve must be easily accessed for deactivation. This valve must be left OPEN whenever the robot is not in the arena to ensure the system cannot operate accidentally.
    - 7.11.1. It is **required** to be able to easily bleed all pressure in the robot before exiting the arena. (You may be required to bleed the entire system if it is believed that you have any damaged components.)
  - 7.12. All regulated pneumatic systems must have an appropriate gauge scaled for maximum resolution of the pressure on the low-pressure side of the system. HPA (air, nitrogen, or inert gas) systems must have gauges on both the high AND low-pressure sides of regulators. A gauge or other clear visual indication that the system is charged is strongly recommended for all pneumatic systems. Whether specifically required or not.
  - 7.13. If back check valves are used anywhere in the system you must ensure that any part of the system they isolate can be bled and has an over pressure device.
  - 7.14. Any pneumatic system that does not use a regulator, or employs heaters or pressure boosters, or pressures above 2500psi [must be pre qualified by this event.]
8. Hydraulics
- 8.1. Robots in the 12 lb class or lighter are exempt from the remaining rules in this section, but good engineering and best practices must be used in all hydraulic systems. **However the pressure for 12 pound or less robots is limited to**

**Robot Fighting League 2010 Rules**  
**14 November 2009**

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**250psi and there must be an easy way to determine this pressure. [Contact this event with questions.]**

- 8.2. All hydraulic components onboard a robot must be securely mounted. Particular attention must be made to pump and accumulator mounting and armor to ensure that if ruptured direct fluid streams will not escape the robot.
  - 8.3. All hydraulic components within the robot must be rated or certified for AT LEAST the maximum pressure in that part of the system. You may be required to show rating or certification documentation on ANY component in your system.
  - 8.4. Any accumulators or large reservoir must be rated for at least 120% of the pressure they are used at. (This is to give them a margin of safety if damaged during a fight)
  - 8.5. All hydraulic systems must have an over pressure by pass device set to no more than 130% of the lowest component rating. It must be rated to bypass the full volume of the hydraulic pump.
  - 8.6. All hydraulic systems must have a(n) accessible manual by pass valve(s) to easily render the system harmless.
  - 8.7. All hydraulic systems must have appropriate gauges scaled for maximum resolution of the pressures in that part of the system.
  - 8.8. All hydraulic systems must use non-flammable, non-corrosive fluid and must be designed not to leak when inverted.
  - 8.9. Any hydraulic system using pressure boosters, or pressures above 5000psi (without accumulator) or pressures above 2000psi (with accumulator) **[must be pre qualified by this event.]**
  - 8.10. Please note that some simple low pressure and volume hydraulic systems, like simple braking, may not need to adhere to all the rules above. You are **[required]** to contact this event if you would like an exception.
9. Internal Combustion Engines (ICE) and liquid fuels. **[are allowed]**
- 9.1. Fuel and Fuel Lines
    - 9.1.1. All commercially available grades of automobile or RC hobby fuel are allowed. Alcohol, Nitro-methane, jet fuel and other specialty grades of fuel **[require prior approval.]**
    - 9.1.2. Fuel lines and tanks must be made of high quality materials and all ends must be clamped securely.
    - 9.1.3. All fuel tanks and lines must be well protected and armored from all sides including moving parts and heat sources inside the robot.
  - 9.2. Fuel tank volume, on any robot, shall not be greater than the amount required to operate the engine for more than **1 minute longer than the match time** at combat power plus a reasonable pre-match warm-up period. Total fuel volume, including fuel for both ICE and flame weapons (if allowed) may not exceed **20 oz** unless prior approval is granted from this event.
  - 9.3. The output of any engines connected to weapons or drive systems must be coupled through a clutch which will decouple the motor when it is at idle. (This does not include motors used for generators and hydraulic pumps.)
  - 9.4. Any engine connected to a weapon **must** be capable of being started while the weapon locking pin is in place (see 1.6.6).
  - 9.5. All engines must turn off or return to idle at loss of **radio signal** and turn off at loss of radio **receiver power**.

**Robot Fighting League 2010 Rules**

## Robot Fighting League 2010 Rules 14 November 2009

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- 9.6. All engines must have a method of remotely shutting off.
  - 9.7. Any robot with liquid fuel and oil must be designed not to leak when inverted. (Minor oil leakage may be tolerated, however if it affects the other robot or becomes a large cleanup issue you may be called and the leaking robot will forfeit.)
  - 9.8. Use of engines other than standard piston engines (i.e. turbines etc.) [**require prior approval**] at this event.
10. Rotational weapons or full body spinning robots [**are allowed**]:
- 10.1. Spinning weapons that can contact the outer arena walls during normal operation must be pre-approved by the event. (Contact with an inner arena curb, or containment wall is allowed and does not require prior permission.)
  - 10.2. Spinning weapons must come to a full stop within **60 seconds** of the power being removed using a self-contained braking system.
11. Springs and flywheels
- 11.1. Springs used in robots in the 12 lbs class or smaller are excepted from the rules in this section. However safe operation and good engineering are always required.
  - 11.2. Any large springs used for drive or weapon power must have a way of loading and actuating the spring remotely under the robots power.
    - 11.2.1. Under no circumstances must a large spring be loaded when the robot is out of the arena or testing area.
    - 11.2.2. Small springs like those used within switches or other small internal operations are excepted from this rule.
  - 11.3. Any flywheel or similar kinetic energy storing device must not be spinning or storing energy in any way unless inside the arena or testing area.
    - 11.3.1. There must be a way of generating and dissipating the energy from the device remotely under the robots power.
  - 11.4. All springs, flywheels, and similar kinetic energy storing devices must fail to a safe position on loss of radio contact or power.}
12. Forbidden Weapons and Materials. The following weapons and materials are absolutely forbidden from use:
- 12.1. Weapons designed to cause invisible damage to the other robot. This includes but is not limited to:
    - 12.1.1. Electrical weapons
    - 12.1.2. RF jamming equipment, etc.
    - 12.1.3. RF noise generated by an IC engine. (Please use shielding around sparking components)
    - 12.1.4. EMF fields from permanent or electro-magnets that affect another robot's electronics.
    - 12.1.5. Entangling Weapons or defenses: these are weapons or defenses that can reasonably be expected to stop drive train and/or weapon motion by being wrapped around rotating parts. This includes nets, tapes, strings, and other entangling materials or devices.
    - 12.1.6. Weapons or defenses that that can reasonably be expected to stop combat completely of both (or more) robots.
  - 12.2. Weapons that require significant cleanup, or in some way damages the arena to require repair for further matches. This includes but is not limited to:

## Robot Fighting League 2010 Rules

**Robot Fighting League 2010 Rules**  
**14 November 2009**

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- 12.2.1. Liquid weapons. Additionally a bot may not have liquid that can spill out when the robot is superficially damaged.
  - 12.2.2. Foams and liquefied gasses
  - 12.2.3. Powders, sand, ball bearings and other dry chaff weapons
  - 12.3. Un-tethered Projectiles (see tethered projectile description in Special Weapons section 13.5)
  - 12.4. Heat and fire are forbidden as weapons. This includes, but is not limited to the following:
    - 12.4.1. Heat or fire weapons not specifically allowed in the Special Weapons section (13.2)
    - 12.4.2. Flammable liquids or gases
    - 12.4.3. Explosives or flammable solids such as:
      - 12.4.3.1. DOT Class C devices
      - 12.4.3.2. Gunpowder / Cartridge Primers
      - 12.4.3.3. Military Explosives, etc.
  - 12.5. Light and smoke based weapons that impair the viewing of robots by an Entrant, Judge, Official or Viewer. (You are allowed to physically engulf your opponent with your robot however.) This includes, but is not limited to the following:
    - 12.5.1. Smoke weapons not specifically allowed in the Special Weapons section (13.3)
    - 12.5.2. Lights such as external lasers above 'class I' and bright strobe lights which may blind the opponent.
  - 12.6. Hazardous or dangerous materials are forbidden from use anywhere on a robot where they may contact humans, or by way of the robot being damaged (within reason) contact humans. **[Contact this event if you have a question.]**
13. Special weapon descriptions allowed at this event:
- 13.1. Tethered Projectiles **[are]** allowed at this event.
    - 13.1.1. **[If allowed tethered projectiles must have a tether or restraining device that stops the projectile and is no longer than 8 feet.]**
  - 13.2. Heat and Fire **[are not]** allowed at this event. The subsequent rules in this section apply when heat and fire are allowed. Flame weapon rules are subject to change to comply with local fire regulations and fire officials.
    - 13.2.1. **Fuel must exit the robot and be ignited as a gas. It cannot leave the robot in a liquid or gelled form or use oxidizers.**
    - 13.2.2. **Fuel types allowed are propane and butane, the maximum quantity allowed is 4 fl oz in robots up to 30 lbs, 8 fl oz for robots 60 lbs and above.**
    - 13.2.3. **The fuel tank must be as far from the outer armor of the robot as practicable and be protected from heat sources within the robot.**
    - 13.2.4. **The ignition system must have a remotely operated shut-off that allows the operator to disable it using the radio control system.**
  - 13.3. Smoke Effects **[are not]** allowed at this event.
    - 13.3.1. **Small smoke effects may be used, please contact the event if you plan on using it.**

**Robot Fighting League 2010 Rules**  
**14 November 2009**

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\* If you plan on using the RFL rule set for your event you are welcome to. Our only requirement is that it not be changed other than in the extensible areas, and that it be referred to as the RFL Tech Regs.