



## TCRL TECHNICAL REGULATIONS

Revision Date: June 2013

### 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. Robots must be free of words, logos or graphics that are offensive in any way.
- 1.2. 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 the Event Organizer. 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.
- 1.3. 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.
- 1.4. Each event has safety inspectors. 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.
- 1.5. Cardinal Safety Rules: Failure to comply with any of the following rules could result in expulsion or worse, injury or death.
  - 1.5.1. Radios may not be turned on, at or near events for any purpose without obtaining permission from the event personnel.
  - 1.5.2. Proper activation and de-activation of robots is critical. Robots must only be activated in the arena, testing areas, or with the expressed consent of the event personnel or its safety officials.
  - 1.5.3. All robots must be able to be FULLY de-activated, which includes poser to the drive and the weaponry, within 60 seconds by a manual disconnect (Removable link or Main Power Switch). The operator must be able to perform the de-activation without handling the robot.
  - 1.5.4. All robots must be able to be fully activated within 30 seconds.
  - 1.5.5. 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 accidentally activated. Runaway bots are VERY dangerous. (We strongly suggest a custom designed block that ensures the robot will not be inadvertently dislodged from the block.)
  - 1.5.6. Locking devices: Moving weapons that can cause damage or injury must have a clearly visible locking pin in place at all times when not in the arena or testing area. Locking pins must be painted in a high visibility color (e.g. Neon Orange). Locking pins must be clearly capable of stopping, arresting or otherwise preventing harmful motion of the weapon.
  - 1.5.7. Weapon locking pins must be in place when weapon switch is turned on during a robot's power-on procedure (the weapon switch will be on, but no power will be applied to the weapon). The locking pin will be removed just prior to closing the arena door. This includes all powered weapons regardless of the power source.



1.5.8. It is expected that all builders will follow basic safety practices during work on the robot at their pit station. Please be alert and aware of your pit neighbors and people passing by. Continued failure to follow safety directions could result in an individual's or the entire team's disqualification from the event. This includes and is not limited to wearing SAFETY GLASSES at ALL times while in the pit area.

Safety offenses will be handled as follows:

- 1) The first safety offense from any member of the team will result in a warning.
- 2) The second offense from any member of that same team will result in that individual or individuals being removed from the pit area permanently and not allowed to compete with the team.
- 3) A third offense from the same team will result in the entire team being disqualified from the event.

## 2. Weight Classes & Size

- 2.1. This event offers 15 pound robots. (There is no 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.)
- 2.2. Wheeled weight = 15 pounds
- 2.3. Non-wheeled weight = 20 pounds
- 2.4. Your robot must be no wider than 3 feet and no taller than 3 feet. This is to ensure that your robot fits in the arena door.
- 2.5. Multi-bots are allowed as long as the combined weight is 15 pounds or less. If both bots are exactly the same weight, the team will need to decide which robot is the “primary” robot. If one of the bots weighs more than the other, the heavier bot is automatically the “primary” robot. The primary bot must be clearly marked. The “primary” bot is identified for the purpose of a countdown or knockout. As long as the “primary” bot is functioning, the match continues. If the “primary” bot is knocked out or it is counted out, the match is over. The other bot cannot operate without the “primary” bot.

## 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.
  - 3.1.3. Shuffling (rotational cam operated legs).
  - 3.1.4. Ground effect air cushions (hovercrafts).
  - 3.1.5. \*In the case of a Multi-bot, only the “primary” bot must have easily visible and controlled mobility in order to compete.



#### 4. Robot Control Requirements

- 4.1. Tele-operated robots must be radio controlled. Radio controlled robots must use approved spread spectrum transmitters and receivers.
- 4.2. Radio systems restrictions for this event with corresponding weight and or weapon restrictions:
  - 4.2.1. Radio systems that stop all motion in the robot (drive and weapons), when the receiver loses power or signal, are required for all robots. This may be inherent in the robots electrical system or be part of programmed fail-safes in the receiver.
  - 4.2.2. No home built control system will be allowed.

#### 5. Autonomous/Semi-Autonomous Robots

- 5.1. Autonomous/Semi-Autonomous robots are defined as any robot that moves, seeks a target, or activates weapons without human control. If your robot is autonomous, please contact Event Organizer.
- 5.2. 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, then it should have two "autonomous mode" lights (this is separate from any power or radio indicator lights used.)
- 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 a 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 permitted include, but are not limited to: gel cells, Hawkers, NiCad, NiMh, dry cells, AGM, LiIon, and LifePo4 (NO LiPoly batteries will be allowed). [If your design uses a new type of battery, or one that you are not sure is acceptable, please contact the Event Organizer.]
- 6.2. All nominal onboard maximum voltages are limited to: 24 Volts for 15# class robots for this league. (It is understood that a charged batteries initial voltage state is above their nominal rated value).
- 6.3. All electrical power to the 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, Whyachi, Fingertech, 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 1.5.



- 6.4. All efforts must be made to protect battery terminals from a direct short and causing a battery fire.
- 6.5. All robots must have a separate light per switch that is easily visible from the outside of the robot that shows its main power is activated.
- 6.6. Batteries must be visible for inspection and must have marking from the manufacturer that clearly identified the type of battery. If such markings are not possible, be prepared to show another form of proof that your battery is allowed, (i.e. vendor receipt, data sheet, etc.).

## 7. Pneumatics

- 7.1. Pneumatic systems on board the robot must employ non-flammable, non-reactive gasses. Only LPA (low pressure air [150 PSI max]) or single use CO2 cartridges are permissible. LPA systems may use certified refillable tanks; CO2 systems may NOT use refillable tanks. (The terms 'pressure vessel, bottle, and source tank' are used interchangeably).
- 7.2. All components must be used within the specifications provided by the manufacturer or supplier.
- 7.3. 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.
- 7.4. All pneumatic components within the robot must be rated to certified for AT LEAST the maximum pressure in that part of the system. You are required to have rating or certification documentation on all components in the pneumatic system. This includes the following:
  - Onboard air compressors
  - Air Tanks/Air Storage Devices
  - All Valves (Solenoid, Purge, Shut-Off, Pressure Relief, Check & Shraeder)
  - Pressure Switch
  - Manifolds
  - Tubing/Hose
- 7.5. All pressure vessels must be rated for at least 120% of the pressure at which they are used. (This is to give them a margin of safety if damaged during a fight).
- 7.6. If regulators are used anywhere in the pneumatic system there must be an (additional) over pressure safety valve downstream of the regulator set for no more than 100% of the lowest rated component in that part of the pneumatic system and there must be a gauge easily visible from outside the robot not on the bottom.
- 7.7. 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 deactivation and refilling. It must also be out of any danger areas. It must be clearly marked.
- 7.8. 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.
  - 7.8.1. You MUST be able to be able to easily bleed all pressure in the robot before exiting the arena. (You may be required to bleed the entire system, including the source tank, if it is believed that you have any damaged components).
- 7.9. 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 safety valve.



- 7.10. All pneumatic systems must have an appropriate gauge on the low side of the regulator to show maximum resolution of the pressure in that part of the system. The gauge should be easily readable from outside the bot, not on the bottom.
- 7.11. Source Specifications for Pneumatic Systems:
- 7.11.1. Source Specifications for CO2 Based System: The max pressure that may be stored on board when using CO2 is relative to ambient temperature. The pressure at the liquid to vapor phase of CO2 at 70 degrees F ambient temperature is 853 PSI. No form of tank heater is allowed, including mounting of tank near components that heat up during use. The max total volume of pressurized gas stored on board is 8 cubic ft at standard temperature (70 degrees F) and pressure (14.7 PSI or 1 atmosphere).
- 7.11.1.1. No refillable tanks may be used for CO2.
- 7.11.1.2. Source system must be hard plumbed down to 150 PSI (no flexible tubing).
- 7.11.1.3. Minimum requirement for component stream: Single use CO2 → Puncture Valve → Burst disc → Regulator → Pop-off Valve → Gauge → 150 PSI (max)
- 7.11.1.4. Burst disc must be rated at 1.8k (1800 PSI standard CO2 Safety Burst Disc or less).
- 7.11.1.5. Over pressure safety valve must be rated at 175 PSI or less.
- 7.11.1.6. Gauge must show maximum resolution for 150 PSI max and must be readable from outside the robot.
- 7.11.2. Source Specifications for LPA Based Systems: The max pressure that may be stored on board when using LPA is 150 PSI.
- 7.11.2.1. Minimum requirement component stream for On-Board Compressor System: On Board LPA Compressor → Pressure Switch → Over pressure safety valve → pressure gauge → 150 PSI (max)
- 7.11.2.2. Pressure switch must be set at 150 PSA (max).
- 7.11.2.3. Over pressure safety valve must be rated at 175 PSI or less.
- 7.11.2.4. Gauge must show maximum resolution for 150 PSI max and must be readable from outside the robot.
- 7.11.2.5. Minimum requirement component stream for refillable LPA System: Fill Valve → LPA Tank → Pop-off Valve → Gauge
- 7.11.2.6. Over pressure safety valve must be rated at 175 PSI or less
- 7.11.2.7. Gauge must show maximum resolution for 150 PSI max and must be readable from outside the robot.
- 7.11.2.8. You must have a safe and secure method of refilling your pneumatic system.

## 8. Hydraulics

- 8.1. Robots in the 15# class are NOT allowed to use hydraulics.

## 9. Internal Combustion Engines (ICE) and liquid fuels.

- 9.1. Robots in the 15# class are NOT allowed to use ICE or liquid fuels.



## 10. Rotational weapons or full body spinning robots.

- 10.1. Spinning weapons cannot contact the outer arena walls during normal operation. (Contact with an inner arena curb, or containment wall is allowed).
- 10.2. Spinning weapons must come to a full stop within 30 seconds of the power being removed.

## 11. Springs and Flywheels

- 11.1. Springs used in robots will use the remaining rules in this section. Safe operation, good engineering and best practices must be used in all systems.
- 11.2. Any 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. Springs used for active weapons must not be loaded when the robot is out of the arena or testing area.
  - 11.2.2. Springs used within switches or other internal operations are exempt 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. EMF fields from permanent or electro-magnets that affect another robot's electronics.
  - 12.1.4. Weapons or defenses that stop combat completely. This includes nets, tapes, strings, or other entanglement devices.
- 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:
  - 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 non-powder guns or weapons.
- 12.3. Un-tethered Projectiles (see tethered projectile description in Special Weapons section 13.1)
- 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.
  - 12.4.2. Flammable liquids or gasses.
  - 12.4.3. Explosives or flammable solids, such as:
    - DOT Class C devices
    - Gunpowder / Cartridge Primers
    - Military Explosives, etc.



- 12.5. Light & smoke based weapons that impair the viewing of robots by an Entrant, Judge, Official or Viewer. This includes but is not limited to the following:
- 12.5.1. Smoke weapons not specifically allowed in the Special Weapons section.
  - 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.

**13. Special Weapon description allowed:**

- 13.1. Tethered projectiles are allowed, but must be no longer than 3 feet and may not entangle the opponent.