



COMBAT ROBOT BUILD RULES & GUIDELINES

(UPDATED 2nd August 2024)



Adapted and Modified Based On Build Rules
Fighting Robot Association (F.R.A), United Kingdom

1. General

1.1. Participation

All participants build and operate Robots at their own risk. Combat Robotics is inherently dangerous. There are no amounts of regulations that can encompass all the dangers involved. Please take care to not hurt yourself or others when building, testing and competing.

1.2. Weapon Design

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 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. Event Rules

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. Safety Inspections

Each event has safety inspections [Tech checks]. It is at the inspector's 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 cardinal safety rules set out below by the Fighting Robot Association may result in expulsion from events or worse, injury and death.

1.6. Transmitters

Transmitters must not be turned on at, or near events for any purpose without obtaining the appropriate frequency clip or explicit permission from the event organizer.

1.7. Activation

Proper activation and deactivation of robots is critical. Robots should only be activated in the arena, testing areas, or with expressed consent of the event and its safety officials. All activation and deactivation of Robots must be completed from outside the arena barrier. You must never enter the arena with live robots without the express permission and supervision of the event organizer.

1.8. Weapon Restraints

All Robots not in an arena or official testing area should have secure safety covers over any sharp edges and restraints on any active weapons or pinch hazards.

1.9. Carrying Cradles

All robots not in an arena or official testing area should be raised on their carrying cradles in a manner so that their motive power cannot cause movement if the robot were turned on, or cannot roll or fall off a pit table. Runaway robots are VERY dangerous.

1.10. Restrictions

In some situations the safety inspection team may deem it necessary to place restrictions on your robots operation for safety purposes. It is entirely your responsibility that these restrictions are adhered to at all times.

1.11. Power Tools

The operation of power tools such as grinders or hand drills is not permitted in the pits area. Battery powered tools such as drills are permitted. It is expected that builders will follow all basic safety practices such as gloves and goggles when operating any machinery. Whether in the pits or dedicated workshop area, please take care.

1.12. Body Parts

Any fragile and loose parts such as rope, plastic wrapper, glass and etc. are strictly prohibited to be used as part of the robots.

2. Weight Classes / Sizes

2.1. Weight Classification

Middleweight: 45.0 kg (**MAXIMUM**)

All machines including their power sources, cables and other parts of each machine shall be weighed prior to the competition. The total allowable weight of the machine and above accessories for each team to be used throughout the contest **MUST NOT EXCEEDED** 45.0 kg. The total weight of 45.0 kg doesn't include spare batteries with the same shape, same weight, voltage and wireless remote controller.

2.2. Legged Robots

Legged Robots [Walkers] can weigh up to twice the specified weight in all classes. A walker must employ moveable legs to support its weight. Each leg must have at least 2 axis of motion. Robots with rolling or sliding mechanisms will not be classified as walkers.

2.3. Consumables

Maximum weight includes all consumables.

2.4. Safety Equipment

Maximum weight does not include safety bars, straps, guards or similar equipment used to immobilize moving arms or weapons and that are removed during competition.

2.5. Interchangeable Panels

If interchangeable panels and/or weapons are used, the weight is measured with the heaviest set-up in place.

2.6. Sizes

The robot's dimensions must not exceed the following measurements:

The size of the robot **CANNOT EXCEED MORE THAN** (800 mm L x 800 mm W x 500 mm H) throughout the entire competition. Robot should fit into a (800 mm L x

800 mm W x 500 mm H) box during the inspection session and no portion of the machine should penetrate this imaginary cube during a match.

3. Mobility

3.1. Methods

All Robots must have (easily visible mobility) in order to compete. Methods of mobility include:

3.1.1. Rolling

Rolling on wheels or the whole robot rolling.

3.1.2. Walking

Walking such as linear actuator operated legs.

3.1.3. Shuffling

Shuffling mechanisms such as rotational cam operated legs.

3.1.4. Ground Effect

Ground effect air cushions such as a hovercraft

3.1.5. Jumping

Jumping and hopping (although the height may be limited by each event due to arena safety constraints)

3.1.6. Flying

Flying (helium balloons, ornithopters, etc.)(Currently flying robots are not allowed unless prior approval by the event has been granted.)

3.2. Restrictions

Robots are not permitted to use exposed rotating aerofoil, rocket or jet propulsion methods.

4. Radio control requirements

4.1. Frequencies

4.1.1. Regulation

Radio systems used at events MUST comply with restrictions put in place by local regulatory bodies and applicable laws.

4.1.2. Interference

Radio systems MUST NOT cause interference to other frequency users.

4.1.3. Digital Spread Spectrum

Digital Spread Spectrum 2.4GHz is recommended for combat robotics in all weight classes.

4.1.4. Allowed Frequencies

For use in robots, the following frequencies are allowed:

40MHz FM Digital	2.4GHz DSS	459MHz Digital
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Please note that events may have additional restrictions on allowable frequencies.

4.2. Operation

All device(s) MUST operate to the tech checker's satisfaction before the robot will be allowed to compete.

4.3. Crystals

Where used, spare crystal pairs must be available for each Radio Control set involved in running the robot.

4.4. Changeable Frequencies

Frequencies must be easily changeable e.g. where crystals are used they must be accessible, particularly on the receiver, so that a change of frequency can easily take place.

4.5. Output Power

Transmitter output power must not exceed that specified by the local regulatory body or any applicable laws.

4.6. Home Built

If you are using a home built control system you must first clear it with the event organizer and declare it during "Tech Check"

4.7. Power Switch

The event may require a separate power switch for the receiver radio power.

4.8. Reserved Frequencies

The event may have reserved frequencies for testing, safety and arena effects that you may not use.

4.9. Telemetry

Radio telemetry is permitted on 433MHz and 2.4GHz. Please check with the event organizer if you are using radio telemetry.

5. Autonomous/ Semi-Autonomous Robots

Robots that do not require human input for one or more of their functions.

If you are bringing an autonomous robot or a robot with significant autonomous functions please contact your event organizer in advance.

5.1. *Remote Operation*

Any autonomous function of a robot, including drive and weapons, must have the capability of being remotely armed and disarmed.

5.2. *Disarming*

While disarmed, the robot is not allowed to function in an autonomous fashion.

5.3. *Light*

In addition to the required main power light, robots with autonomous functions must have an additional clearly visible light, which indicates whether or not it is in autonomous mode.

5.4. *Deactivation*

When deactivated the robot should have no autonomous functions enabled, and all autonomous functions should failsafe to off if there is loss of power or radio signal.

5.5. *Timeout*

In case of damage to components that remotely disarm the robot, the robot will automatically deactivate 4 minutes after being activated.

6. **Electrical Power**

6.1. *Deactivation*

All Middleweight Robots must incorporate a way of removing all power to weapons and drive systems (systems that could cause potential human bodily injury) that can be activated easily without endangering the person turning it off.

6.1.1. *Removable Link*

The main power cut-off MUST be a removable link, which must NOT be in place unless the robot is in the arena or under the supervision of a technician. A key or switch is not allowed. If there is more than one link they must be positioned adjacent to each other.

6.1.2. *Accessibility*

The link must be positioned in a visible part of the robot's bodywork, fitted away from any operating weaponry or drive, and this position must be clearly marked.

6.1.3. *Covers*

The link may be fitted under a cover, but the cover must be able to be opened without the use of tools.

6.1.4. *Kill Switch*

If the robot uses an internal combustion engine(s), the "Power" cut-off must take the form of a clearly labeled "Kill" switch. See Section 7 for further details on engines.

6.1.5. *Inverted Link*

Robots in the heavyweight and super heavyweight class that are capable of being driven inverted, having a removable link fitted that is only accessible when the

robot is the right way up, must have a duplicate link fitted in the opposing panel, so as to allow the robot to be disarmed when inverted.

6.2. *Cabling*

Cabling must be of sufficient grade and suitably insulated for maximum operational current.

6.3. *Exposed Components*

Current must not be carried through exposed components.

6.4. *Power Light*

All Middleweights robots must have at least one surface mounted non-filament power light that is illuminated when power is supplied to the robot (i.e. when the link is in). The power light can be any colour but must be non-flashing and be in contrast with its surroundings.

6.5. *Activation*

The robot must be able to be activated and de-activated by way of the removable link from outside an arena. (e.g. in a “bullpen” over a low wall).

6.6. *Voltages*

Mean working voltage should not exceed 36V DC ($\pm 10\%$). It is understood that a charged battery’s initial voltage state is above their nominal rated value.

7. Batteries

7.1. *Fitting*

Batteries must be secured properly inside the robot.

7.2. *Terminals*

Battery terminals must be protected to prevent short circuits.

7.3. *Permitted Types*

The only permitted batteries are ones that cannot spill or spray any of their contents when damaged or inverted. Standard car and motorcycle wet cell batteries are prohibited.

7.4. *Approved Battery Chemistry*

Type	Allow / Not Allow
NiCd (Nickel-cadmium)	Allow
NiMH (Nickel-metal Hydride)	Allow
Pb (Sealed Lead Acid)	Allow
LiFePo4 (Lithium Iron Phosphate)	Allow
LiPo (Lithium Polymer)	Allow

7.5. *Parallel Cells*

Battery cells may be connected in parallel to increase capacity and discharge current. Caution must be taken with NiCd and NiMH as these cells may only be connected in parallel during discharge.

7.6. *Charging*

Improper charging may result in fire and/ or explosion.

7.6.1. *Design*

Only chargers specifically designed for the battery chemistry may be used.

7.6.2. *Rate of Charge*

The rate of charge must not exceed the manufacturer's specification.

7.7. *Pb (SLA), NiCd, NiMH and LiFePo4*

The following battery types can be used without any specific precautions although care must be taken when any battery particularly during charging:

- Pb (Sealed Lead Acid, SLA), non-spillable gel type. (e.g. Yuasa, Hawker)
- NiCd and NiMH
- LiFePo4 (Lithium Iron Phosphate)

7.8. *Internal Combustion Engines*

Please take note that internal combustion engines are not allowed to be used in this competition.

8. Pneumatics

8.1. *Allowed Gasses*

Pneumatic systems must use Carbon Dioxide [CO₂] or Air.

8.2. *Maximum Pressure*

The maximum pressure at any point within a pneumatics system must not exceed **1000psi (68bar)**.

8.3. *Cylinders*

The compressed gas shall be stored in a commercially manufactured gas cylinder of appropriate design, specification and certification. Except where the maximum storage pressure is less than 50psi (3.4bar). Some events may have further restrictions on bottle sizes/ weights used, please contact the event organizer for clarification.

8.4. *Burst Disc*

The gas cylinder must incorporate a burst disc rated below the maximum test pressure of the bottle. Except where the manufacturer or manufacturer's agent fills the gas cylinder and applies an integrity seal or wrapping, or the storage pressure is less than 50psi (3.4bar). Event organizers may wish to check integrity seals prior to their use.

8.5. Isolation Valve

Gas cylinders charged to pressures of greater than 50psi must incorporate an isolation valve that can be operated from outside of the robot.

8.6. Remote Isolation Valve

Gas cylinders that do not incorporate a valve (for example: the gas is released as soon as the cylinder is screwed into its mating pneumatic connection) such as found on disposable welding bottles and “fizzy drinks” machines must have an additional remote isolation valve accessible from outside of the robot.

8.6.1. Position

Any remote isolation valve shall be positioned so as to minimize the pipe length between it and the cylinder. This pipe length must fully vent before the cylinder is fully unscrewed from the pneumatic connection.

8.7. Rating

All pneumatic components used with pressures greater than 50psi (3.4bar) must be rated/ tested to at least the maximum pressure available in that part of the system. You may be required to provide documentation/ certification to support this.

8.7.1. Custom Components

Custom made components, or parts operating above the suppliers maximum working pressure, must be independently tested and certified at 120% of the maximum system pressure available at that point.

8.7.2. Hydraulic Components

Components originally designed for hydraulics use will be de-rated by 50% for pneumatics use.

8.8. Pressure Relief Device

A certified pressure relief device must be installed in each part of the pneumatics system where a different operating pressure is used (operating pressures separated by a pressure regulating device).

8.8.1. Rating

Pressure relief devices must have a rating of 1000psi (68bar) or 110% of the pneumatic component with the lowest “maximum working pressure” rating protected by that particular pressure relief device, whichever is the lower.

8.8.2. Low Pressure Systems

Pneumatic systems employing pressures less than 50psi or systems employing air compressors that have a maximum output pressure lower than the pneumatic component with the lowest “maximum working pressure” do not require a pressure relief device.

The pressure relief device(s) dictate the maximum pressure available in that part of the pneumatics system. The pressure relief device(s) must have a flow rate capacity that exceeds the maximum flow rate that can be expected under “over pressure” conditions. Any attempt to falsify the pressure settings of pressure

relief device(s) will be considered as gross misconduct by the FRA and may result in expulsion.

8.8.3. Full Pressure Systems

Non-regulated pneumatic systems or pneumatic systems where the regulator is not directly attached to the gas cylinder require that a 1000psi pressure relief device is fitted.

8.8.4. Regulated Systems

Regulated pneumatic systems that operate at less than 235psi (16bar) and where the regulator is directly attached to the gas cylinder do not require a 1000psi pressure relief device before the regulator. The regulator must be rated to 120% of the gas bottle burst disc pressure. A pressure relief device is required downstream of the regulator rated at 110% of the component with the lowest “maximum working pressure” rating.

8.9. Pressure Relief Devices

Pressure relief devices should be readily accessible and must be removable for testing purposes.

8.10. Mounting

All pneumatic components must be securely mounted and adequately protected within the body shell. Any component storing gas (i.e. gas cylinders, buffer tanks etc.) must be secured in such a way as it cannot escape the robot even if suffering a rupture.

8.11. Gauges

Pneumatic pressure gauges and pressure test points are not a requirement but may be requested by some event organizers.

8.12. Dump Valve

All pneumatic systems must incorporate a pressure dump valve accessible from outside of the robot. This dump valve shall quickly and reliably exhaust all gas downstream of the gas cylinder isolation (or remote isolation) valve including systems with a maximum operating pressure of less than 50psi (3.4bar).

8.12.1. Normally Open

The dump valve shall be left open at all times when the robot is not in the arena or testing areas. Particular attention should be made that where non-return valves are used, no part of the system is left pressurized.

8.13. Removable Cylinders

Gas cylinders must be readily removable for inspection and refilling.

8.14. Heaters and Boosters

Pneumatic systems using heaters or pressure boosters are not permitted.

8.15. Pressure Equipment Directive

Pneumatic components manufactured from 1 June 2002 shall carry a CE mark.

Pneumatic components “custom made” since 30 May 2002 shall carry a label indicating their non-conformity with the “Pressure Equipment Directive” and their non-availability for sale. Components manufactured prior to 30 May 2002 are not necessarily required to carry a CE mark.

9. Hydraulics

9.1. Pressure

Hydraulic system pressure (In the actuator or cylinder) must be limited to 10,000psi by way of a maximum pressure relief valve.

9.2. Test Point

A hydraulic test point is a mandatory fitment to allow verification of a robots maximum system pressure. A team will need its own test gauge and hose.

9.3. Storage Tanks

Hydraulic fluid storage tanks must be of a suitable material and adequately guarded against rupture.

9.4. Standards

Hydraulic fluid lines and fittings must be to British Standard (BS) and/ or to European DIN specifications.

9.5. Ratings

Hydraulic fluid lines and fittings must be capable of withstanding the maximum working pressures used within the robot.

9.6. Protection

Hydraulic fluid lines must be routed to minimize the chances of being cut or damaged.

9.7. Accumulators

Hydraulic accumulators (pressurized oil storage devices) are banned in whatever form they may take.

9.8. Bleeding (Advisory only)

Care needs to be taken when building a hydraulic system that consideration is given to bleeding the system of air. Trapped air in the hydraulic system will degrade the performance of the system and may make a robot run foul.

9.9. Power Sources

For power sources (other than electric motors) please consult the organizer for advice as to suitability.

10. Rotational weapons or full body spinning robots

Full body spinning robots with an eccentric mass or “twackbots”, are excepted from this section unless they spin over 500 revolutions per minute.

10.1. Stopping Time

The spinning element of any rotational weapon must spin down to a full stop in under 60 seconds.

10.2. Limits

Rotational weapons exceeding any TWO of the three limits below must be submitted for review and be preapproved by the event organizer.

10.2.1. Weight

The spinning element is more than 20% of the robots total weight. (This includes any directly coupled motor components rotating on the same axis).

10.2.2. Speed

The spinning element spins above 500 RPM.

10.2.3. Size

The spinning element is greater than 24 inches in diameter.

11. Springs and flywheels

11.1. Springs

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. Deactivation

Under no circumstances should a large spring be loaded when the robot is out of the arena or testing area. These devices must be made safe before removing the robot from the arena or testing area.

11.3. Small springs

Small springs like those used within switches or other small internal operations are excluded from this rule. In addition springs used in robots less than 5 kilos may be excepted from this rule. Please contact the organizer for clarification.

11.4. Flywheels

Flywheels or similar kinetic energy storing devices must not be spinning or storing energy in any way, unless inside the arena or testing area. These devices must be made safe before removing the robot from the arena or testing area.

11.5. Remote Deactivation

There must be a way of generating and dissipating the energy from the device remotely under the robots power to allow safe activation and deactivation of the robot.

11.6. Failsafe

All springs, flywheels, and similar kinetic energy storing devices should fail to a safe position on loss of radio contact or power.

12. Weapon Restrictions

The following weapons and materials are forbidden from use: Note: Some of the listed items may be allowed for effects but not as weapons. If you have an application of these items which you feel should be allowed, please contact the organizer.

12.1. Invisible Damage

Weapons designed to cause invisible damage to the other robot. This includes but is not limited to:

12.1.1. Electricity

Electricity as a weapon such as Tesla coils, Van-der-Graaf generators, stun guns, or cattle prods.

12.1.2. Radio Frequency

Radio Frequency jamming equipment or similar devices.

12.1.3. Electromagnetic Fields

Electromagnetic fields from permanent or electromagnets, which affect another robot's electronics.

12.2. Rotating Weapons

The speed of any rotating weapons - e.g. circular saws, carbon or steel cutting discs - must not exceed the manufacturer's specification. The manufacturer's specification must be available for inspection.

12.3. Hardened Blades

Commercially manufactured, hardened steel blades that may shatter are not allowed.

12.4. Blade Length

Commercial blades - e.g. bayonets - must not exceed 20cm in length.

12.5. Untethered Projectiles

Projectiles must have a tether capable of stopping the projectile at full speed and be no longer than 1 meter.

12.6. Heat and Fire

Heat and fire are forbidden as weapons, (however some events may allow limited fire effects). This includes, but is not limited to the following:

12.6.1. Generated

Heat specifically generated to damage an opponent

12.6.2. Flammables

Flammable liquids or gases

12.6.3. Explosives

Explosives or flammable solids such as DOT Class C devices, Gunpowder, Cartridge Primers or Military Explosives, etc.

12.7. Smoke and Light

Smoke and light based weapons, which 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:

12.7.1. Smoke or Dust

Large quantities of smoke or dust. Limited smoke effects may be allowed by some events.

12.7.2. Lights

Lights such as external lasers above Class 2 (1mw) output and bright strobe lights, which may blind the opponent.

12.8. Hazardous Materials

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. Note: If you have a question please contact the organizer.

12.9. Tethers

All high-speed weaponry, such as axes and flippers, must carry a suitable tether to ensure all moving parts cannot break free from the chassis during operation. There is no weight penalty for this tether. If unsure please contact the organizer.

12.10. Weapon Restraints

All weapons must incorporate a secure restraint that locks the weapon in a safe position. The restraint may incorporate locking pins, straps and bars but must be secured in such a way that it cannot be removed inadvertently. The design should ensure that the weapon cannot be fired during the activation process.