



## Build Rules

International Build Rules and Guidelines  
Effective from January 1<sup>st</sup> 2008

Last Updated: 13 October 2007



## Build Rules 2008

### 1. General

- 1.1. 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. 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 organiser. 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 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. Failure to comply with any of the cardinal safety rules set out below by the F.R.A., may result in expulsion from events or worse, injury and death.
  - 1.5.1. Transmitters [TX] must not be turned on at, or near events for any purpose without obtaining the appropriate frequency clip or explicit permission from the event organisers.
  - 1.5.2. 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.
  - 1.5.3. All activation and de-activation of Robots must be completed from outside the arena barrier. You must never enter the arena with live Robots without the express permission/supervision of the event organisers.
  - 1.5.4. 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.
  - 1.5.5. 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.
  - 1.5.6. 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.
  - 1.5.7. 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.



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### 2. Weight Classes

#### 2.1. Weight Classification

- Antweight: 0 to 150 grams
- Featherweight: 1kg to 13.6kgs [2.2lbs to 30lbs]
- Lightweight: 12kgs to 27.5kgs [26lbs to 60lbs]
- Middleweight: 27.5kgs to 55kgs [60lbs to 120lbs]
- Heavyweight: 55kgs to 100kgs [120lbs to 220lbs]
- Super heavyweight: 100kgs to 145kgs [220lbs to 320lbs]

Note: Please contact the event organiser before commencing build/ arriving at an event with a Super heavyweight.

#### 2.2.

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

#### 2.3.

For heavyweights, total weight is measured without consumables. e.g. fuel up to the 500ml maximum, and gases up to a total of 2kg for heavyweights.

Further gas bottles and gas are permitted to be installed, but are to be included in the overall maximum weight of the particular weight class.

Maximum weight does not include safety bars, straps, guards or similar equipment used to immobilise moving arms/weapons.

Please note that batteries are not considered as consumables

Total weight also does not include such safety devices as the "safety tether" required while running in some arena types.

#### 2.4.

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



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### 3. Mobility

#### 3.1.

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

##### 3.1.1.

Rolling (wheels or the whole robot)

##### 3.1.2.

Walking (linear actuated legs)

##### 3.1.3.

Shuffling (rotational cam operated legs)

##### 3.1.4.

Ground effect air cushions (hovercrafts)

##### 3.1.5.

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

##### 3.1.6.

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

#### 3.2

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



## 4. Radio control requirements

### 4.1.

#### 4.1.1.

Radio systems used at events MUST comply with restrictions put in place by local regulatory bodies and applicable laws. For the UK this is OFCOM. Where a special licence is required for operation of radio equipment the event organiser must be informed and the license must be available for viewing at the event.

#### 4.1.2.

Radio systems MUST NOT cause interference to other frequency users.

#### 4.1.3.

Digital Spread Spectrum 2.4GHz is recommended for combat robotics in all weight classes. Roboteers are encouraged to switch to the newer technology as and when they can.

#### 4.1.4.

For use in robots, the following frequencies are allowed:

	AW	FW	LW	MW	HW	SHW
IR	✓	X	X	X	X	X
27MHz AM	✓	✓	X	X	X	X
40MHz AM	✓	✓	X	X	X	X
40MHz FM	✓	✓	✓	✓	✓	X
40MHz FM Digital	✓	✓	✓	✓	✓	✓
2.4GHz Digital	✓	✓	✓	✓	✓	✓
459MHz Digital	✓	✓	✓	✓	✓	✓

Please note that events may have additional restrictions on allowable frequencies.

### Symbols:

✓ = Allowed Frequency

X = Disallowed frequency

AW = Antweight

FW = Featherweight

LW = Lightweight

MW = Middleweight

HW = Heavyweight

SHW = Super heavyweight

IR = Infra-Red remote control systems – For use with Antweights Only

27MHz AM = AM PPM radio systems e.g. Futaba Skysports 2

40MHz AM = AM PPM radio systems e.g. Futaba 2ER Attack

40MHz FM = FM PPM radio systems e.g. Futaba Skysports 4

40MHz FM Digital = FM PCM radio systems e.g. Futaba Fieldforce 6

2.4GHz Digital = Digital Spread Spectrum radio systems e.g. Spektrum DX6

459MHz Digital = Radio systems using 459MHz Modules

### 4.2.

#### 4.2.1.

All systems that are deemed to be 'dangerous' (normally the drive and weapons) must have a 'failsafe' device. This MUST bring the systems to a pre-set 'off' or 'zero' position if the transmitter signal experiences interference or is lost. These devices should also failsafe when the receiver battery is low or if power is completely lost.

#### 4.2.2.

The failsafe(s) may take the form of plug-in commercial devices; electronic circuitry incorporated into some receivers e.g. PCM type; or other devices e.g. electronic speed controllers such as the Vantec. It could also consist of digital switches, which return to preset off position on loss of power. Care should be taken in the selection of devices to ensure they meet the requirements specified above.

#### 4.2.3.

Some receiver failsafes such as Futaba PCM do not store the preset positions and will take a few seconds from first turning on to receive these settings from the transmitter. This type of failsafe MUST be set correctly to ensure the safe operation of the robot.



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- 4.2.4.  
Care should be taken to ensure that the failsafe(s) are set correctly.  
Particular attention should be taken with programmable failsafe(s) that may be overlooked when transferring receivers between robots or when altering the trim (zero position) on sticks that may affect the 'off' or 'zero' position. With newer receivers e.g. Spektrum BR6000 it may be necessary to 'bind' your receiver to program the preset failsafe positions.
- 4.2.5.  
It is not advised you use servo/ pot/ micro-switch interfaces, as these will remain in their last position with loss of power.
- 4.3. *Advisory only*  
In addition to the main power light (See. Batteries and Power no. 6.8.) showing that the main power is activated. It should also indicate if the robot is in "failsafe", "off" or "zero" position.
- 4.4. *Advisory only*  
Robots should incorporate a "remote kill" that should bring the robot's failsafe device(s) to the pre-set 'off' or 'zero' position via a switch on the transmitter. This is to allow for de-activation of robots from outside a fully enclosed arena and prevent accidental operation of controls.
- 4.5.  
All device(s) MUST operate to the tech checker's satisfaction before the robot will be allowed to compete.
- 4.6.  
Where used, spare crystal pairs must be available for each Radio Control set involved in running the robot.
- 4.7.  
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.
- 4.8.  
Transmitter output power must not exceed that specified by the local regulatory body or any applicable laws.
- 4.9.  
If you are using a home built control system you must first clear it with the event organiser and declare it during 'Tech Check'.
- 4.10.  
The event may require a separate power switch for the receiver radio power.
- 4.11.  
The event may have reserved frequencies for testing, safety and arena effects that you may not use.
- 4.12.  
Radio telemetry is permitted on 433MHz and 2.4GHz. Please check with the event organiser if you are using radio telemetry.



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### 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 organiser in advance.

5.1.

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

5.2.

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

5.3.

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.

When activated 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.

In case of damage to components that remotely disarm the robot, the Robot will automatically disarm 4 min 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 car and motorcycle wet cell batteries are prohibited. Examples of batteries that are permitted: gel cells and impregnated glass mat, e.g. Yuassa, Hawkers, NiCads, NiMh, dry cells, AGM, Llon, etc. If your design uses a new type of battery, or one you are not sure about please contact the event organisers.

##### 6.1.1.

Lithium rechargeable batteries will be permitted subject to the following restrictions.

##### 6.1.1.1.

The event organiser must be informed prior to the event and approve their use.

##### 6.1.1.2.

Until further notice, Lithium rechargeable batteries may only be used in robots in the Featherweight class and below.

##### 6.1.1.3.

Only chargers specifically designed for use with Lithium rechargeable batteries may be used.

##### 6.1.1.4.

The robot must be fitted with both an under voltage cut-out set at or higher than the battery manufacturers recommendation that will prevent the batteries from becoming damaged due to over discharge.

##### 6.1.1.5.

Batteries must be removed from the robot, inspected and placed into a sealable steel or other suitable heat proof container prior to, and during the charging process. (It is the responsibility of the roboteer to provide this container, which shall be inspected as part of the normal 'tech check'.)

##### 6.1.1.6.

**Batteries must not be left unattended at any time during the charging process.** Leaving batteries unattended while charging will be considered a serious breach of pit safety and may result in you and your robot being removed from the event.

##### 6.1.1.7.

Batteries showing any evidence of damage or 'swelling' must immediately be placed in the heat proof container, covered in salt, the container sealed and removed to a safe area outdoors.

##### 6.1.1.8.

A suitable quantity of salt, sufficient to completely cover the batteries in the event of damage or fire must be available. If not provided by the event organiser, it will be the responsibility of the roboteer to provide this.

#### 6.2.

Mean working voltage should not exceed 36V DC or 36V RMS AC except where prior approval from the event organisers has been confirmed. It is understood that a charged battery's initial voltage state is above their nominal rated value.



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- 6.3. All Featherweight, Lightweight, Middleweight, Heavyweight and Super heavyweight 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.
- 6.3.1. 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.
- 6.3.2. 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.
- 6.3.3. The link may be fitted under a cover, but the cover must be able to be opened without the use of tools.
- 6.3.4. If the robot uses an internal combustion [IC] Engine(s), the "Power" cut-off must take the form of a clearly labelled "Kill" switch. See Section 7 for further details on engines.
- 6.4. All Featherweight, Lightweight, Middleweight, Heavyweight and Super heavyweight Robots must be fitted with on-off switches that operate both radio receiver and drive/weapon circuits - in practice totally removing all power from the Robot. If there is more than one switch, these must be positioned adjacent to one another.
- 6.5. All efforts should be made to protect battery terminals from a direct short and causing a battery fire.
- 6.6. Cabling must be of sufficient grade and suitably insulated for maximum operational current.
- 6.7. Current must not be carried through exposed components.
- 6.8. All Featherweights, Lightweights, Middleweights, Heavyweights and Super Heavy Weights, 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 it's surroundings.
- 6.9. The robot must be able to be activated/de-activated by way of the removable link from outside an arena. (e.g. in a "bullpen" over a low wall)



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### 7. Internal Combustion Engines [IC]

Note: Please check that your event allows IC engines.

7.1.

Fuel capacity is limited to 17floz (500ml).

7.2

Separate fuel tanks must be made of an acceptable type of plastic (e.g. nylon).

7.2.1.

If the tank is integral to the engine assembly and is metal, the cap must be plastic or a plastic "pop off" seal fitted.

7.2.2.

The tank must be adequately protected from puncture.

7.3.

All fuel lines must be of the correct type and held with the correct type of fittings. They must be routed to minimise the chances of being cut.

7.4.

A return spring must be fitted to the throttle of all IC engines to return the throttle to "idle" or "off" in the case of servo breakage or failure. This is in conjunction to any failsafes.

7.5.

The output of any engines connected to weapons or drive systems must be coupled through a clutch which will de-couple the motor when it is at idle. This does not include motors used for generators and hydraulic pumps.

7.6.

All engines must have a method of remotely shutting off.

7.7.

Any robot with liquid fuel and oil should be designed not to leak when inverted. Minor leakage may be tolerated, however if it affects other robots or becomes a large cleanup issue you will be banned.

7.8.

Use of IC engines other than standard piston type (e.g. turbines etc.) must be pre-approved by the event organisers.



### 8. Pneumatics

- 8.1. Pneumatic systems must use Carbon Dioxide [CO<sub>2</sub>] or Air.
- 8.2. The maximum pressure at any point within a pneumatics system must not exceed 1000psi (68bar).
- 8.3. 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 organiser for clarification.
- 8.4. 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 organisers may wish to check integrity seals prior to their use.
- 8.5. 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. Gas cylinders that do not incorporate a valve (for example: the gas is released as soon as the cylinder is screwed into it's 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 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. 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 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 Components originally designed for hydraulics use will be de-rated by 50% for pneumatics use.
- 8.8. 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 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 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.



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- 8.8.3  
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 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 down stream of the regulator rated at 110% of the component with the lowest 'maximum working pressure' rating.
- 8.9.  
Pressure relief devices should be readily accessible and must be removable for testing purposes.
- 8.10.  
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.  
Pneumatic pressure gauges and pressure test points are not a FRA requirement but may be a requirement of the event organiser.
- 8.12.  
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  
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.  
Gas cylinders must be readily removable for inspection / refilling. You should ensure that your gas cylinder connection is compatible with the event organiser's filling stations, or that you have suitable adapters available.
- 8.14.  
Pneumatic systems using heaters or pressure boosters are not permitted.
- 8.15.  
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.



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### 9. Hydraulic

- 9.1. Hydraulic system pressure (In the actuator/cylinder) must be limited to 4000psi/ 272bar by way of a maximum pressure relief valve.
- 9.2. 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. Hydraulic fluid storage tanks must be of a suitable material and adequately guarded against rupture.
- 9.4. Hydraulic fluid lines and fittings must be to British Standard (BS) and/ or to European DIN specifications.
- 9.5. Hydraulic fluid lines and fittings must be capable of withstanding the maximum working pressures used within the robot.
- 9.6. Hydraulic fluid lines must be routed to minimise the chances of being cut or damaged.
- 9.7. Hydraulic accumulators (pressurised oil storage devices) are banned in whatever form they may take.
- 9.8. *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 of rule 9.7

For power sources (other than electric motors/ petrol engines) please consult FRA Hydraulic technical for advice as to suitability.



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### 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 revolution per minute [RPM].

#### 10.1.

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

#### 10.2.

Rotational weapons exceeding any TWO of the three limits below must be submitted for review and be pre approved by the event organiser

##### 10.2.1.

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.

The spinning element spins above 500 RPM

##### 10.2.3.

The spinning element is greater than 24 inches in diameter.



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### 11. Springs and flywheels

#### 11.1.

Any large springs used for drive or weapon power must have a way of loading and actuating the spring remotely under the robots power.

##### 11.1.1.

Under no circumstances should a large spring be loaded when the robot is out of the arena or testing area.

##### 11.1.2.

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

#### 11.2.

Any flywheel or similar kinetic energy storing device should not be spinning or storing energy in any way unless inside the arena or testing area.

##### 11.2.1.

There must be a way of generating and dissipating the energy from the device remotely under the robots power.

#### 11.3.

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



### 12. Forbidden Weapons and Materials

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, consult the event organiser ahead of time.

#### 12.1.

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

##### 12.1.1.

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

##### 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 electromagnets, which affect another robots electronics.

#### 12.2.

Weapons or defences, which tend to stop combat completely, of both (or more) robots. This includes, but is not limited to the following:

##### 12.2.1.

Entanglement devices. Such as nets, fishing line, cables, string, glues or tapes, which require the match to be stopped and the robots separated. (If this occurs the 'entangler' forfeits the match)

#### 12.3.

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.

#### 12.4.

Rotating hardened steel blades that may shatter are not allowed.

#### 12.5.

Commercial blades - e.g. bayonets - must not exceed 20cm/8inches in length.

#### 12.6.

Untethered Projectiles. Projectiles must have a tether capable of stopping the projectile at full speed and be no longer than 2.5m (approx 8 feet).

#### 12.7.

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

##### 12.7.1.

Heat specifically generated to damage an opponent

##### 12.7.2.

Flammable liquids or gases

##### 12.7.3.

Explosives or flammable solids such as:

###### 12.7.3.1.

DOT Class C devices

###### 12.7.3.2.

Gunpowder/ Cartridge Primers

###### 12.7.3.3.

Military Explosives, etc.



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### 12.8.

Light and smoke 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:

#### 12.6.1.

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

#### 12.6.2.

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

### 12.9.

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 your event organizer.



## Build Rules 2008

The most up to date revision of this document can always be found at:  
<http://www.fightingrobots.co.uk/>

If you wish to contact the FRA via post please address to:

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