



BattleBots[®] Inc.

Technical Regulations

Version 1.0

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All Technical Regulations subject to change at any time.

BattleBots[®] has no affiliation with any other robotic sports organization.

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1.0 Introduction

1.1 Defining Documents and Information

Multiple documents and sources of information define the requirements for participating in the sport of BattleBots. All BattleBots participants must be familiar with the contents of these documents and sources.

1.1.1 BattleBots Technical Regulations

The BattleBots Technical Regulations ("Tech Regs") define the requirements specific to BattleBot design and construction.

1.1.2 BattleBots Builder's Guide

A supplement to the Tech Regs is the BattleBots Builder's Guide, which contains suggestions and recommendations for building and testing BattleBots.

1.1.3 BattleBot Tournament Rules and Procedures

The BattleBots Tournament Rules and Procedures (TR&P) document defines the rules and procedures for a safe, fair and efficient BattleBots Tournament.

1.1.4 Other Documents

There may be other BattleBots documents that provide additional information. These additional documents will be posted on the BattleBots website and/or e-mailed to competition entrants.

1.1.5 BattleBots Website

The BattleBots website contains general information on BattleBots and also makes available copies of this and other documents.

1.1.6 E-Mail Communications

BattleBots Inc. may issue e-mail messages to current and former entrants to provide event and/or competition-specific information on a timely basis. Be sure to check your e-mail regularly if you have entered a BattleBots competition.

1.1.7 Responsibility

It is the sole responsibility of every BattleBot designer, builder and/or entrant to verify that they are referencing the last-updated version of any BattleBots document available on the BattleBots website.

1.2 Safety/Warning Notice

Building and operating BattleBots can be dangerous. Do not build or operate a BattleBot unless you are qualified to do so, or are supervised by a qualified adult. BattleBots owners are solely responsible for their BattleBot whether or not it complies with the rules of BattleBots, Inc. or has been inspected for safety or otherwise by BattleBots, Inc. The BattleBots owners' responsibility includes all matters of safety, condition, design, conformity to law, operation, merchantability and fitness for use and for any particular purpose.

1.3 General Definitions

1.3.1 BattleBots Inc.

"BattleBots Inc." refers, collectively, to the incorporated entity, all its officers, employees and authorized agents.

1.3.2 BattleBots Executive Officers

"BattleBots Executive Officers" have jurisdiction on all BattleBots matters, as follows:

- a. **BattleBots CEO** – Has overriding authority on all BattleBots matters.
- b. **BattleBots President** – Has overriding authority on all BattleBots matters, unless specifically overridden by the BattleBots CEO.
- c. **Authorized Proxy** – The BattleBots CEO or President may authorize certain persons to have specific Executive Officer rights for a specific time period. Any such authorization must be specified in writing from the BattleBots CEO or President.

1.4 Rules Interpretation

Interpretation of all BattleBots rules, procedures and regulations are governed as follows:

1.4.1 Applicability

These Technical Regulations supercede all previous rules and regulations regarding BattleBots design and construction.

1.4.2 Overlapping Requirements

If two or more requirements in this or any other BattleBots document appear to overlap, then the effective requirement will be the combination of all of the overlapping requirements.

1.4.3 Conflicting Requirements

If two or more requirements in this or any other BattleBots document appear to conflict, then the effective requirement will be the most restrictive of the conflicting requirements.

1.4.4 Additional Restrictions

At the discretion of BattleBots Executive Officers, additional regulations and restrictions may be applied to all BattleBots, or to all BattleBots in a specific Weight Class.

1.4.5 Final Authority

BattleBots Executive Officers, have the final authority over the interpretation of the rules, procedures and regulations in this and all other BattleBots documents.

1.4.6 Change Publication

Any changes or special interpretations of these Technical Regulations will be published on the official BattleBots website.

1.4.7 Waivers and Advance Acceptance

If a BattleBot will employ certain specific design features, a Waiver Form or an Advance Acceptance Form must be submitted. These regulations specify those cases where a waiver or advance acceptance is required. Forms are posted on the BattleBots website.

Any Waiver Form or Advance Acceptance Form must be received by BattleBots Inc. by the date specified in any BattleBot entry document, or at least thirty (30) days in advance of the beginning of any competition at which the BattleBot is entered, whichever is sooner. Completed forms must be submitted to BattleBots Inc. at the address specified in "1.5 Contacting BattleBots".

Waivers and acceptance forms are decided on a case-by-case basis and acceptance is not automatically granted. Moreover, acceptance does not in any way imply or guarantee approval of the BattleBot at any BattleBots Safety/Technical Inspection.

1.5 Contacting BattleBots

For all questions, comments, requests and clarifications regarding the rules, regulations and procedures in this or any other BattleBots documents, contact BattleBots Inc. at the following:

Address: BattleBots Inc.
701 De Long Avenue - Unit K
Novato, CA 94945

Phone: (415) 898-7522

Fax: (415) 898-7525

E-mail: rules@battlebots.com

Website: <http://www.battlebots.com/>

2.0 General Requirements

2.1 BattleBot Weight Classes

BattleBots are classified into four Weight Classes as follows:

- Lightweight
- Middleweight
- Heavyweight
- Super Heavyweight

BattleBots outside the defined Weight Classes may make special exhibition arrangements with BattleBots Inc.

2.2 Weight Class Limits

Non-walking BattleBots Weight Classes are defined by minimum and maximum weights, as follows:

Weight Class Designation	Measured Weight	
	More Than	Maximum
Lightweight	25.0 lbs.	60.0 lbs.
Middleweight	60.0 lbs.	120.0 lbs.
Heavyweight	120.0 lbs.	220.0 lbs.
Super Heavyweight	220.0 lbs.	340.0 lbs.

If a BattleBot's measured weight reads exactly on a specified limit, it will be classified into the lower Weight Class. As an example, a BattleBot whose weight reads exactly 60.0 pounds will be classified as a Lightweight, since it weighs a "Maximum" of 60.0 pounds, and is not "More Than" 60.0 pounds.

If a BattleBot qualifies as a Walker (a "StompBot"), it is allowed an additional weight advantage. Refer to "3.2 Walking BattleBots (StompBots)".

2.2.1 Lower Weight Limits

If a BattleBot is under the lower weight limit for the Weight Class in which it entered, ballast must be added to the BattleBot to bring its weight up to the minimum specified.

2.2.2 Modular Designs

If a BattleBot is of a modular design, allowing components to be exchanged, then:

- a. The weight of the heaviest configuration will determine the Weight Class designation of the BattleBot.
- b. The weight of the lightest configuration must not be less than that allowed for the Weight Class as determined by **2.2.2.a** above.

2.3 Weight Limit Regulations

2.3.1 Weight Limit Enforcement

BattleBot weight limits, as defined in "2.2 Weight Class Limits", will be strictly and uniformly enforced.

Refer to the latest version of the BattleBots Tournament Rules and Procedures document for information on the exact weighing procedures.

2.3.2 Items Included in Weight

A BattleBot is weighed in its battle-ready configuration. Safety covers and safety restraints will be removed. However, the following items must be on-board:

- a. Any fluids, as allowed in this document.
- b. Any gasses, as allowed in this document.
- c. Any cosmetic features such as dolls, artificial plants, etc.
- d. Any accessory systems such as Internet feeds, telemetry systems, etc.
- e. Any cameras and audio equipment, except as specifically excluded in **2.3.3**.

2.3.3 Excluded Weight

Some items are excluded when determining the weight of the BattleBot. They are:

- a. BattleBots-approved, media-supplied remote camera and/or audio systems.
- b. Official BattleBots win pogs for previous battles fought and won by the BattleBot.

The items described must be removable in case of any weight check dispute.

2.4 Dimensional Limits

The size of a BattleBot primarily affects its access to the BattleBox arena and the allocation of pit space. The following conditions apply:

2.4.1 Maximum Size

In order to allow efficient entry to and exit from the BattleBox, a BattleBot must meet the following size-limit requirements:

- a. In its pre-battle configuration, the BattleBot must be able to be moved up the entrance ramp of the BattleBox and through the 8-foot by 8-foot entry door.
- b. With all of its moveable parts fully open, extended, inflated and/or unfolded, the BattleBot must be able to be moved through the 8-foot by 8-foot BattleBox exit door and down the exit ramp.
- c. Moving the BattleBot into or out of the BattleBox must not require any assembly and/or disassembly of the BattleBot.
- d. In its pre-battle configuration, any BattleBot or MultiBot cluster must fit entirely inside the 8-foot by 8-foot red or blue BattleBox starting square.

2.4.2 Large-Size BattleBots

If a BattleBot has a length greater than 5 feet or a width greater than 4 feet, the BattleBot may require special consideration when assigning the pit area. If the BattleBot will be larger than 5' x 4', notify BattleBots Inc. as specified in "1.5 Contacting BattleBots".

2.5 Construction Materials

There are restrictions on the types of materials that may be used to construct a BattleBot.

2.5.1 Allowed Construction Materials

The types of materials that can be used to construct BattleBots are far too varied and numerous to be enumerated in these Technical Regulations.

Generally, most type of metals, plastics, elastomers, and composites may be used unless they are specifically restricted or prohibited, as specified in **2.5.2** or **2.5.3** or the material used poses a safety risk due to toxicity or other safety-related reasons.

2.5.2 Restricted-Use Construction Materials

The following materials are allowed, but only with certain restrictions:

- a. Any Lead (Pb) metal must not be exposed on the exterior of the BattleBot in any position where it can be readily damaged by another BattleBot or by any arena hazards.
- b. Rigid plastic foams (e.g., PVC, Polystyrene, Polyurethane) must not be exposed on the exterior of the BattleBot in any position where they can be damaged by another BattleBot or by any arena hazards.

2.5.3 Construction Materials Not Allowed

For toxicity or other reasons, the following materials are specifically not allowed and cannot be used on a BattleBot.

- a. Beryllium metal.
- b. Boron fibers.
- c. Depleted Uranium.
- d. Radioactive materials.
- e. Asbestos.
- f. Loose (unbonded or unwoven) fibers of Carbon or Fiberglass.
- g. Unsintered metal powder of any type.
- h. Metal shavings or "wool".
- i. Decayable organic substances.
- j. Reactive metals (e.g. Lithium, Sodium).
- k. Non-fibrous silicon-based glass.

Note: Beryllium-Copper alloys, wood and leather may be used.

2.5.4 Materials Questions

If there are questions on BattleBot construction materials, check with BattleBots Inc. as specified in "1.5 Contacting BattleBots", before beginning construction.

2.6 Non-Construction Substances

There are specific restrictions on non-construction-material substances that can be carried aboard a BattleBot.

2.6.1 Lubricants

Certain lubricants can be carried aboard a BattleBot if they are used for internal lubrication purposes only. They are:

- a. Non-toxic greases for bushings, bearings and gearboxes.
- b. Oil for Fuel-Powered Engines.
- c. Oil for chains and gearboxes.
- d. Graphite powder for bearing lubrication.

2.6.2 Gasses

Only those gasses as are specified in "8.2.1 Allowed Gasses" may be carried on-board a BattleBot.

2.6.3 Cooling Liquids

A maximum total of two (2) quarts of water, or a mixture of antifreeze and water, may be used for the cooling of Fuel-Powered Engines or Electric Motors.

2.6.4 Hydraulic Fluid

Only hydraulic fluid as specified in "9.2.2 Hydraulic Fluid Type" may be carried on-board a BattleBot.

2.6.5 Flammable Liquids

Only fuels as specified in "7.3.2 Allowed Fuels" may be carried on-board a BattleBot.

2.6.6 Battery Electrolytes

Dilute acids and alkalis can be used only in electrical batteries, subject to the restrictions on the types of batteries as defined in "6.4 Allowed Battery Types".

2.6.7 Other Substances

Substances other than those specified in this section **2.6** may be allowed to be carried on-board a BattleBot. This will require the submission of an Advance Acceptance Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

2.7 Power Systems**2.7.1 Number of Power Systems**

There is no limit on number of power systems that can be used on a BattleBot, providing that each system complies with all other BattleBots rules and regulations.

2.7.2 Types of Power Systems

The types of power systems that can be used in a BattleBot are:

- a. Electric motors, as defined in "6.9 Electric Motors".
- b. Fuel-Powered engines, as specified in "7.0 Fuel-Powered Engines".
- c. Pneumatics, as defined in "8.0 Pneumatic Systems".
- d. Hydraulics, as defined in "9.0 Hydraulic Systems".
- e. Mechanical, as defined in "10.0 Mechanical Energy Storage Systems".

2.7.3 Other Power Systems

Power Systems other than those specified in this section **2.7** may be accepted for use on a BattleBot. This will require the submission of an Advance Acceptance Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

2.8 Safety Covers

Safety Covers are intended to protect people around a BattleBot from injuring themselves on a part of the BattleBot. Safety Covers are considered to be part of the overall BattleBot design.

2.8.1 Where Required

Safety Covers must be used on all external sharp points and all external cutting edges on the exterior of a BattleBot.

2.8.2 Sharp Point Protection

Covers over sharp points must be designed such that a person can press the palm of their hand against the covered point with a force of at least five (5) pounds, and not receive any injury.

2.8.3 Cutting Edge Protection

Covers over cutting edges must be designed such that a person can rub the palm of their hand over the covered edge while pressing down with a force of at least two (2) pounds, and not receive any injury.

2.8.4 Attachment Method

All Safety Covers must be attached with the following considerations:

- a. Covers must be designed and installed such that they will not be pulled or pushed off by a force of up to one (1) pound applied in any direction at any point on the cover.
- b. Covers can be retained using friction, a bungee, a securing lock or any other method that does not deteriorate with repeated use.

Note: Covers cannot be retained using an adhesive or any type of adhesive tape.

2.8.5 Removal and Installation

Covers must be designed such that their removal and installation can be accomplished within the time limits, and also comply with the safety requirements specified in "5.0 BattleBot Activation and Deactivation".

2.9 Safety Restraints

Safety Restraints are removable attachments to the BattleBot intended to protect people from injuring themselves as the result of movement of an exterior part or section of a BattleBot. Safety Restraints are considered to be part of the overall BattleBot design.

2.9.1 Where Required

Safety restraints are required to protect against the following types of hazards:

- a. Pinch Hazards, where a body part (such as a finger) can be squeezed between two BattleBot external parts which can freely move relative to each other.
- b. Motion Hazards, whereby the driven movement of a weapon or other BattleBot part can strike a person with injurious force. This specifically includes any spinning weapon on a BattleBot.

2.9.2 Pinch Hazard Protection

A pinch hazard restraint must consist of either:

- a. A cover or guard that prevents placing any body part in the area of the pinch hazard.
- b. A pin, block, chain or similar restraint, which prevents relative movement of the pinching parts.

2.9.3 Motion Hazard Protection

A motion hazard protection device must consist of either:

- a. A pin, block, chain or other similar restraint that will prevent significant movement of a hazardous part, even if that part is being driven by its actuation system.
- b. A method of physically disconnecting the actuator from the hazardous part.

2.9.4 Restraint Retention

All restraints must be designed and installed such that they satisfy the following requirements.

- a. A force of up to one (1) pound applied in any direction to any point on the restraint will not cause the restraint to move significantly or to come off.
- b. Moving the BattleBot in any position, including upside down, will not cause a restraint to lose its effectiveness.
- c. Restraints are retained using a method that does not deteriorate with repeated use.

Note: Restraints cannot be retained using an adhesive or any type of adhesive tape.

2.9.5 Removal and Installation

Restraints must be designed such that their removal and installation can be accomplished within the time limits, and also comply with the safety requirements specified in "5.0 BattleBot Activation and Deactivation".

2.10 External Control Accessories

With certain restrictions, a BattleBot team may employ external accessories located outside the BattleBox as part of its combat control, location or targeting system.

2.10.1 Equipment Restrictions

External control accessories must, at a minimum, meet all the following requirements:

- a. The equipment can be set-up easily within two (2) minutes prior to a match.
- b. The equipment can be removed easily within two (2) minutes after a match.
- c. The equipment does not interfere with another contestant, the CrewBots, the TV Crew or the visibility of the Referees or Judges.
- d. The equipment does not significantly interfere with the live audience's visibility.
- e. The equipment complies with all the requirements of "4.0 Radio Control" and "2.12 Lights and Sound".

2.10.2 BattleBots Acceptance

External Control Accessories that comply with the restrictions of "2.10.1 Equipment Restrictions" may be allowed, but also require the submission of an Advance Acceptance Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

2.11 Autonomous BattleBots and Components

Autonomous BattleBots or autonomous components on a BattleBot are allowed, provided that the following conditions are met:

2.11.1 Radio-Control Override

The BattleBot's radio control system can be used to override and stop any and all BattleBot and weapon system autonomous motion.

2.11.2 Fail-Safe

In the case of radio-control transmitter failure, all BattleBot and weapon system motion, autonomous or controlled, will cease within one (1) second after the failure.

2.12 Lights and Sound

The uses of lasers, lights and/or sound sources on a BattleBot are restricted for safety and practicality.

2.12.1 Deactivation

If the BattleBot contains any type of artificial light or sound source, there must be a method of easily and safely deactivating the light(s) and/or sound(s).

2.12.2 Class I Lasers

Class I lasers can be used on a BattleBot without restriction.

2.12.3 Non-Class I Lasers

Lasers brighter than Class I can cause eye damage. Thus:

- a. Lasers mounted on a BattleBot are limited to Class II, with an output of less than 1 mW, regardless of the frequency value of the light.
- b. Class II lasers must be securely mounted and pointed such that their beams strike the ground no more than four feet (4') away from an edge of the BattleBot, when the BattleBot is resting on the ground in battle-ready configuration.

Note: Some handheld laser pointers are Class IIIa, and therefore cannot be mounted on BattleBots.

2.12.4 Lights

No bright lights may be installed on a BattleBot. Low-brightness lighting may be used, provided that it is not distracting to other contestants, the Referees or the Judges.

2.12.5 Ultra-Violet Lighting

Ultra-violet lights ("Black Lights") primarily emitting at wavelengths shorter than 400 nm cannot be installed on a BattleBot or used as any part of a BattleBot's combat system.

2.12.6 Strobes

Low-brightness strobe lights may be used, provided that they are not distracting to other contestants, the Referees or the Judges.

2.12.7 Sound

A BattleBot cannot employ any extremely loud and/or low frequency sound source.

The sound level emitted from an operating BattleBot cannot exceed one-hundred-ten decibels (110 dB) as measured at ten feet (10') from the BattleBot in any direction.

2.12.8 Questions

If there are any questions regarding the use of lights or sound on a BattleBot, contact BattleBots Inc. as specified in "1.5 Contacting BattleBots".

3.0 Special BattleBots Configurations

3.1 MultiBots

3.1.1 MultiBot Definition

A MultiBot is defined as BattleBot composed of two or more individual detached segments that compete together as a single BattleBot.

3.1.2 Number of Segments

A MultiBot, by definition, must have at least two (2) segments. There is no specific limit on the maximum number of segments as long as all segments comply with the requirements of "4.0 Radio Control" and "5.3 Activation/Deactivation Requirements".

3.1.3 Weight Class

The Weight Class designation of a MultiBot is determined by weighing all of the individual segments together.

3.1.4 Segment Weights

There are no specific restrictions on the relative weights of the MultiBot segments.

However, the judging of a match involving a MultiBot may depend upon the relative weights of the individual segments. Refer to the latest version of the BattleBots Tournament Rules and Procedures document for the MultiBot judging criteria.

3.1.5 Size Requirements

The combined segments of a MultiBot must be able start a match completely within either the red or the blue BattleBox starting square. Each starting square is 8 feet on a side.

3.1.6 Autonomous MultiBot Segments

If a MultiBot segment is autonomous, it must conform to the requirements of "2.11 Autonomous BattleBots and Components".

Note that it is not required that each MultiBot segment be independently controlled.

3.1.7 Rules Applicability

All applicable rules and restrictions for BattleBots design and construction apply to each individual MultiBot segment separately and to all the MultiBot segments collectively.

3.2 Walking BattleBots (StompBots)

A BattleBot which uses certain methods of locomotion may qualify as a "StompBot" and be allowed an additional weight advantage. Non-wheeled BattleBots that do not qualify as StompBots may be entered, but are not given any weight advantage.

3.2.1 StompBot Definition

A BattleBot may be considered a StompBot if it satisfies all the following criteria:

- The drive mechanism for the BattleBot locomotion is powered solely by linear hydraulic or pneumatic actuators or by certain actuators driven by rotary electric motors. Any electric actuator must operate such that the reversal of motion requires reversal of the rotary electric motor.
- All BattleBot parts that touch the ground for locomotion or support must move forward and backward in a reciprocating motion relative to the center-of-gravity of the BattleBot.
- All BattleBot parts that touch the ground for locomotion must be actuated such that they can potentially be moved vertically (up-and-down) without any horizontal (forward-and-backward) movement. Likewise, horizontal movement must be potentially possible without vertical movement.
- No part of the BattleBot weight is supported on the ground by any type of rolling mechanism.

Note: Linear electric motors cannot be used as part of the locomotion method of a StompBot.

3.2.2 Specific Exclusions

If the locomotion drive system of a BattleBot contains any crankshafts, rotary camshafts, or non-reversing rotary electric actuators, it will not qualify as a StompBot.

3.2.3 BattleBots Acceptance

Even if a BattleBot appears to satisfy the requirements of **3.2.1** and **3.2.2**, the proposed design must in addition be accepted by BattleBots Inc. to qualify as a StompBot. Request for acceptance requires the submission of an Advance Acceptance Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

3.2.4 StompBot Weights

Any BattleBot accepted as a StompBot is allowed to be exactly 20% heavier than a non-StompBot in the same Weight Class, as follows:

StompBot Weight Class	Measured Weight	
	More Than	Maximum
Lightweight	30.0 lbs.	72.0 lbs.
Middleweight	72.0 lbs.	144.0 lbs.
Heavyweight	144.0 lbs.	264.0 lbs.
Super Heavyweight	264.0 lbs.	408.0 lbs.

StompBot weight limits are subject to all the constraints of "2.2 Weight Class Limits" and "2.3 Weight Limit Regulations".

3.3 Hopping/Jumping BattleBot

A hopping or jumping BattleBot is allowed with the following restrictions:

3.3.1 Maximum Jump Height

The maximum height that a BattleBot can reach on a jump can not exceed six (6) feet, as measured from the ground to the lowest point of the BattleBot at the peak of the jump.

3.3.2 Maximum Jump Length

The maximum length that a BattleBot can jump is ten (10) feet, measured from the leading edge portion of the BattleBot both before and after the jump.

3.3.3 BattleBox Damage

The landing of a hopping/jumping BattleBot must not materially damage the BattleBox floor or walls, such that repairs would be required for the next scheduled match to proceed.

3.4 Ground-Effect Machines

Ground-effect machines are supported by a cushion of air entrapped beneath a plenum. Such machines can be entered in BattleBots, if they meet the following requirements:

3.4.1 Lift Method

Any lift from the ground is provided by an air cushion, and not directly by an external moving aerodynamic device (e.g., a rotor). Partial support by wheels or other rolling devices is allowed.

3.4.2 Maximum Lift Height

The maximum height from the ground to the primary bottom of the BattleBot, with the lift fan(s) operating at maximum speed, must not exceed ten percent (10%) of either the length or width of the air cushion plenum.

3.5 Powered Flight

A BattleBot may not be moved using powered flight. Moveable or fixed aerodynamic devices may be used for cooling and control, but are not allowed to provide lift in the absence of ground effects.

3.6 Special Configurations

BattleBot configurations other than those listed in this section **3.0** may be acceptable, but require the submission of an Advance Acceptance Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

4.0 Radio Control

4.1 BattleBot Control

All BattleBot movement and weapons operation must be controlled and predictable.

4.1.1 Radio Control

All primary control and fail-safe communications to a BattleBot must be via a radio link. Using light wave (e.g., infrared), sound or tethered control is not allowed.

Note: Tethered controlled is allowed in some cases for BattleBot testing outside of the BattleBox. Refer to the latest version of the BattleBots Tournament Rules and Procedures document for information regarding tethered BattleBot testing.

4.1.2 Movement Speed Control

Binary (on/off) movement speed control is not recommended, but is allowed.

It is strongly recommended that all BattleBot movement along the ground utilize proportional speed control.

4.1.3 Weapons Control

BattleBot weapons control type may be proportional, discrete, or binary.

4.2 Commercial R/C Equipment

For BattleBot control, commercially-available Radio Control (R/C) equipment can be used with the following restrictions:

4.2.1 Allowed Frequencies

The following commercial-equipment R/C frequencies (channels) may be used:

- a. 27 MHz band (channels 1 thru 6).
- b. 75 MHz band (channels 61 thru 90).
- c. 50 MHz (channels RC00 thru RC09). FCC Amateur license is required.
- d. 53 MHz. Not recommended. FCC Amateur license is required.
- e. 900 MHz. Utilizing Wireless technology and protocols.

Note: Custom radio equipment may use frequencies other than those specified above. Refer to "4.3 Custom Radio Equipment".

4.2.2 Prohibited Frequencies

Effective for ALL BattleBots after December 31, 2001, R/C equipment in the 72 MHz band (channels 11 thru 60) cannot be used in any way on a BattleBot.

A BattleBot that competed in any previous BattleBots' competition using 72 MHz R/C equipment may continue to use the same equipment through December 31, 2001.

4.2.3 Synthesized Frequencies

Synthesized-frequency R/C equipment is allowed provided that it complies with the requirements of **4.2.1** and **4.4.2** above.

4.2.4 900 MHz Robot Controllers

BattleBots Inc. recommends the use of 900 MHz radio controllers by IFI Robotics (IFI), or IFI-compatible robot controllers from other manufacturers. Only IFI controllers, or IFI-compatible controllers may be used in the 902-905 MHz and 925-928 MHz frequency bands.

4.2.5 Multiple-Frequency

To minimize the problem of frequency conflicts, non-ISM and non-frequency-synthesized R/C equipment must be designed to allow the changing of frequency crystals.

Such BattleBots entries must have two (2) or more sets of frequency crystals that allow operation on at least two different frequencies.

4.2.6 Control Methods

Commercial "hobby" R/C transmitters use either Amplitude Modulated (AM) or Frequency Modulated (FM) transmission. Different types of control methods are allowed/disallowed as follows:

- a. Amplitude Modulated (AM) R/C equipment cannot be used on any BattleBot in any Weight Class.
- b. FM Pulse-Position Modulation (FM/PPM) and Intelligent Pulse Decoding (FM/IPD) R/C equipment may be used for BattleBots in the Lightweight class only.
- c. All Middleweight, Heavyweight and Super Heavyweight BattleBots using commercial R/C equipment must use Pulse-Code Modulation (FM/PCM).

4.2.7 Fail-Safe

Any BattleBot remote-control system must have a robust fail-safe feature that complies with the specifications of "6.8.5 Radio-Controlled Fail-Safe".

4.3 Custom Radio Equipment

Custom radio control transmission or telemetry equipment is allowed but is not generally recommended. If custom equipment is used, it will have to demonstrate that, at a minimum, it meets the following requirements.

4.3.1 Frequencies

Custom equipment must comply with the following frequency restrictions:

- a. Equipment that uses the 27, 50, 52 or 75 MHz frequency band cannot require more frequency channels than specified in "4.4.3 Number of Frequencies".
- b. The equipment cannot use any frequency band disallowed by FCC rules.
- c. If the equipment's frequency band is restricted to FCC licensed users, all BattleBot operator(s) must have the appropriate license(s).
- d. Equipment that uses the 900 MHz ISM band is restricted to the frequency range of 905.00 MHz to 925.00 MHz.

4.3.2 Interference

Custom equipment must comply with the following:

- a. It cannot cause interference with any event communications and broadcast equipment.
- b. It is not susceptible to interference from any event communications and broadcast equipment.
- c. It does not interfere with the IFI or other commercial 900 MHz robot controllers.

4.3.3 Fail-Safe

Any custom BattleBot remote-control system must have a robust fail-safe feature that complies with the specifications of "6.8.5 Radio-Controlled Fail-Safe".

4.4 Controlling a BattleBot

4.4.1 Number of Operators

A BattleBot may be controlled by multiple operators. The number of operators is limited to the number of members allowed on the Pit Crew for that BattleBot.

Refer to the latest version of the BattleBots' [Tournament Rules and Procedures](#) document for information regarding Pit Crew members.

4.4.2 Controlling Devices

There is no specific limit on the number of manual controlling devices as long as all radio transmission uses no more than the number of frequencies defined in **4.4.3**, as is applicable.

4.4.3 Number of Frequencies

There are restrictions on the number of frequencies that may be used by commercial "hobby" R/C equipment.

- a. A single BattleBot using R/C equipment may be controlled using a maximum of two (2) different R/C frequencies.
- b. A MultiBot cluster using R/C equipment may be controlled using a maximum of three (3) different R/C frequencies.

Note: Using any transmitter in "trainer mode" (with an attached control box) is allowed.

4.4.4 Other Control Methods

BattleBot radio control methods other than those specified in this section **4.4** may be acceptable. This will require the submission of an Advance Acceptance Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

5.0 BattleBot Activation and Deactivation

5.1 BattleBot Safety

The design of a BattleBot must be such that at any time when the BattleBot is not in combat or being tested, it must be completely safe and non-hazardous to all personnel and objects in the vicinity of the BattleBot.

Moreover, the process of activating or deactivating a BattleBot must be accomplished in a reasonably short time with minimal risk to the person(s) performing the Activation or Deactivation, or to anyone else in the vicinity of the BattleBot.

5.2 BattleBot States

Except when it is being converted from one state to another, a BattleBot must always be in one of two states: Deactivated or Activated.

5.2.1 Deactivated State

A BattleBot in its Deactivated State must, at a minimum, meet the following requirements:

- a. All Radio Control transmitters and receivers are off.
- b. All sharp points and edges are covered with the required Safety Covers.
- c. All pinch or weapons-motion hazards are constrained with Safety Restraints.
- d. All primary-power electrical Master Switches are switched off.
- e. All pneumatic system Shut-Off Valves are closed and all Purge Valves are open.
- f. All hydraulic system Bypass/Bleed Valves are open.
- g. All Fuel-Powered Engines are not running.
- h. All spring-loaded devices are released, as defined in "10.3.2 Deactivated Spring".

5.2.2 Activated State

A BattleBot in its Activated State is defined as being in battle-ready condition, as it would be just prior to the start of a match.

5.3 Activation/Deactivation Requirements

Notwithstanding any other restrictions and regulations in this or other BattleBots documents, a BattleBot will be required to demonstrate the following:

5.3.1 Activation

With the BattleBot on the ground in a completely Deactivated State, the following Activation steps must be performed in less than sixty (60) seconds.

- a. All radio control transmitters and receivers are turned on.
- b. All primary-power electrical Master Switches are switched on.
- c. All pneumatic system Purge Valves are closed and Shut-Off Valves opened.
- d. All hydraulic system Bypass/Bleed Valves are closed.
- e. All Fuel-Powered Engines are started and running at Idle Speed, as defined in "7.2.2 ICE Idle Speed".
- f. Safety Covers are removed.
- g. Safety Restraints are removed.

5.3.2 Critical Deactivation

Starting with the battle-ready, Activated BattleBot on the ground in any stable position (including upside-down), the following Critical Deactivation steps must be performed in less than thirty (30) seconds:

- a. All primary-power electrical Master Switches are turned off.
- b. All pneumatic system Shut-Off Valves are closed and Purge Valves are opened.
- c. All hydraulic system Bypass/Bleed Valves are opened.
- d. All Fuel-Powered Engines are stopped.
- e. All radio control transmitters are turned off.

5.3.3 Final Deactivation and Safing

With all of the Critical Deactivation steps completed, the following safing steps must be performed in less than thirty (30) seconds

- a. Safety Restraints are re-installed.
- b. Safety Covers are re-installed.

5.3.4 Activation/Deactivation Sequence

The efficacy of each step in both the "5.3.1 Activation" and "5.3.2 Critical Deactivation" processes must be the same, regardless of the order in which the steps are performed. That is: No Activation step can depend upon another Activation step being done first; No Deactivation step can depend upon another Deactivation step being done first.

5.3.5 Activation/Deactivation Conditions

The following are conditions for Activation and Deactivation

- a. During the Activation and Deactivation processes there must be absolutely no powered movement of the BattleBot or any of its weapons systems as a result of the Activation or Deactivation.
- b. Activation and Deactivation can be performed with either one (1) or two (2) people.
- c. A maximum of two (2) special tools or devices can be used for the Activation and Deactivation of the BattleBot. There must be at least one spare set of such tool(s).
- d. The complete Activation and Deactivation sequences must be performed without any person placing a body part in the path of any weapon system or other part of the BattleBot that can be moved under power.

5.3.6 MultiBot Requirements

For the purposes of Activation and Deactivation, all MultiBots are considered to be a single BattleBot and must collectively meet the Activation and Deactivation time limits and other conditions defined in this "5.3 Activation/Deactivation Requirements".

5.4 Spinning Parts

5.4.1 Spinning Part Fail-Safe

If the BattleBot has any spinning parts, it must be demonstrated that with any part running at maximum speed, shutting off the remote-control transmitter will cause that spinning part to lose all drive power as specified in "6.8.5 Radio-Controlled Fail-Safe".

5.4.2 Spin-Down Time

When power is removed from a spinning part on a BattleBot, the design and construction of the BattleBot must be such that the part will spin down to a full stop within sixty (60) seconds after drive power is removed.

Note: The spin down time limit will be strictly enforced both in Safety/Tech Inspection and during competition.

6.0 Electrical Power

6.1 BattleBot Electrical Systems

A typical BattleBot has two general types of electrical systems: primary-power and secondary-power.

6.1.1 Primary-Power Systems

Primary-power electrical systems are used to move the robot and directly or indirectly actuate any weapons systems. The characteristics of the primary-power systems are that they require large batteries and have high power-consumption rates.

6.1.2 Secondary-Power Systems

All BattleBots have some kind of low-voltage Secondary-Power System to operate their radio control receivers. This system may either use a separate battery or it can convert voltage from the Primary-Power System.

Although the power requirements are low, the consequences of Secondary-Power System failure are lost communication and attendant BattleBot failure.

6.2 Standard Voltage Limitations

There are standard voltage limitations for electrical systems in BattleBots, depending upon whether the voltage is provided by a Direct Current (DC) or Alternating Current (AC) power source.

6.2.1 DC Voltage

The nominal DC voltage in a BattleBot can be up to 48 Volts. The maximum allowed measured DC voltage, with all electrical systems activated, measured from any point of highest potential to the point of lowest potential, is **56.0 volts**.

6.2.2 AC Voltages

The minimum/maximum AC voltages in a BattleBot with all electrical systems activated are -80/+80 volts. That is, an AC voltage-meter must read no more than **56.5 volts rms**.

6.2.3 Transients

During BattleBot operation, switching transients may cause the voltage values to temporarily exceed the specified limits. This is allowed provided that the transients are the result of normal system operation and are not specifically generated to increase the average voltage level.

6.2.4 Charging Unit

The maximum output voltage of any external battery charging unit on a BattleBot cannot exceed **60.0** volts, when the charger is on and being used to charge batteries.

6.2.5 Voltage Step-Up Devices

A BattleBot cannot use any voltage-conversion devices to generate higher voltages than those specified in this section **6.2**.

6.3 High DC Voltages

Any DC Voltage above the limits specified in "6.2.1 DC Voltage" is considered to be a "High DC Voltage". High DC Voltages may be accepted in a BattleBot provided that the BattleBot fully complies with certain specific additional requirements.

6.3.1 Not Allowed in Lightweight

BattleBots in the Lightweight class are not allowed to use DC voltages higher than that specified in "6.2 Standard Voltage Limitations".

6.3.2 High DC Voltage

Effective for ALL BattleBots after December 31, 2001, the nominal High DC Voltage in a BattleBot can be up to 96 Volts. The maximum allowed measured High DC Voltage, with all electrical systems activated, measured from any point of highest potential to the point of lowest potential, is **112.0 volts**.

A BattleBot that competed in any previous BattleBots' competition using a High DC Voltage up to 144 volts (maximum 168 volts differential) may continue to use the same voltage through December 31, 2001.

6.3.3 Transient High Voltages

It is understood that control of brushless DC motors requires the generation of switched DC voltages. However, the peak generated voltage values, with the exception of high-frequency switching transients, must not exceed the maximum allowed voltage potential as defined in "6.3.2 High DC Voltage".

6.3.4 Battery Packs

All batteries used in a High DC Voltage system must be arranged into electrically separate insulated packs, with the following characteristics:

- a. The voltage for any pack cannot exceed a nominal 48 volts (**56.0 volts** maximum).
- b. Each pack must be designed so that it is possible to inspect the batteries to confirm that they conform to the requirements of "6.4 Allowed Battery Types"
- c. All electrical connections from the pack must employ high-current "push-and-lock" or circular-plug plastic connectors.

6.3.5 Recharging

- a. The maximum output voltage of any High DC Voltage external battery charging unit for a BattleBot cannot exceed **60.0** volts, when the charger is on and being used to charge batteries.
- b. Each High DC Voltage battery pack must be recharged individually; connecting battery packs in series for recharging is not allowed.

6.3.6 Wiring

All High DC Voltage wiring must conform to the following:

- a. The wiring must be completely contained within the BattleBot behind protective panels. In no case can the wiring be on, or outside, any exterior portion of the BattleBot.
- b. The wiring must be protected against chafing and cutting even in the presence of high vibration and impact levels.
- c. The wiring must also conform to the requirements specified in "6.7 Electrical Circuits".

6.3.7 DC-Isolated Chassis

No part of any High DC Voltage system can have a DC electrical connection to the BattleBots chassis.

6.3.8 No Liquids

Any BattleBot using High DC Voltages cannot also have any liquid substances on board (e.g., water, fuel, hydraulic fluid), other than electrolyte used in batteries.

6.3.9 BattleBots Acceptance

Proposed use of the High DC Voltage limits as specified in this section **6.3** also requires the advance submission of the specific High DC Voltage Waiver Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

6.4 Allowed Battery Types

Only certain type of batteries can be used in BattleBots, as follows:

6.4.1 Sealed Lead Acid

Lead-Acid batteries can be used on BattleBots, provided they are of a sealed type, and have the following characteristics:

- a. They can be used in any position, including upside-down.
- b. They are described in their data sheet as using an "Absorbed" or "Stabilized" electrolyte.
- c. They may be described as "Leak Proof".
- d. There is no provision for checking or adding battery fluid.

6.4.2 Nickel-Cadmium

Commercially available Ni-Cad batteries can be used on BattleBots.

6.4.3 Nickel-Metal Hydride

Commercially available Ni-MH batteries can be used on BattleBots.

6.4.4 Lithium-Ion

Commercially available Li-Ion batteries are allowed to be used on BattleBots. Lithium metal batteries are specifically not allowed.

6.4.5 Questions on Battery Models

To confirm if a specific battery model is allowed to be used in a BattleBot, contact BattleBots Inc. as specified in "1.5 Contacting BattleBots".

6.5 Battery Mounting

For both safety and reliability, all batteries in a BattleBot must be properly mounted and protected.

6.5.1 Battery Hold-Down

Any batteries must be constrained in such a way that they can withstand a force equal to five (5) times the weight of the battery in any direction, including upward (in case the BattleBot is flipped upside-down) without breaking free.

6.5.2 Hold-Down Materials

Any hold-downs for primary-power Ni-Cad, Ni-MH or Li-Ion batteries must use electrically insulated metal straps or clamps, or other materials capable of withstanding moderately high heat. Plastic tie-wraps cannot be used to retain these types of batteries.

Small secondary-power battery packs used for the radio-control receiver may be constrained with tie-wraps.

6.5.3 Battery Heating

Because of battery heating during operation, all primary-power Ni-Cad, Ni-MH and Li-Ion batteries must be insulated from any pneumatic system component as defined in "8.10.3 Pneumatic Component Insulation".

6.5.4 Battery Protection

To prevent inadvertent battery short-circuiting, batteries must be installed as follows:

- a. Battery packs composed of individual battery cells must be properly assembled and insulated such that no single cell can be accidentally shorted out.
- b. All exposed battery terminals must be individually covered with electrical insulation. Insulation must be applied such that it cannot be easily penetrated or knocked off.
- c. Batteries must be located such that they are reasonably protected within the body of the BattleBot.

6.6 Power-Storage Capacitors

The use of power-storage capacitors to store power in the primary-power electrical system is allowed. However all electrolytic-type capacitors must be located such that they are reasonably protected and securely mounted within the body of the BattleBot.

6.7 Electrical Circuits

Primary and secondary electrical circuits in a BattleBot are expected to conform to accepted electrical engineering practices. Some specific requirements are:

6.7.1 Wiring Type

All wiring must be multi-stranded and insulated using primarily the factory-applied insulation and/or heat-shrink tubing.

Small sections of wire may be insulated with quality electrical tape. Using any other type of tape (e.g., duct tape, masking tape) for insulation is not allowed.

6.7.2 Insulation

All exposed terminals and bare wire-ends in primary-power electrical circuits must be covered with electrical insulation. This insulation must be attached such that it cannot be easily penetrated or knocked off.

Secondary-power electrical circuits should be similarly insulated.

6.7.3 Wire Securing

All electrical wiring must be attached to or supported by the BattleBot structure using tie-wraps and/or cable clamps.

6.8 Electrical Power Deactivation

All BattleBots with primary-power electrical systems must have a method of completely deactivating such systems.

6.8.1 Master Switch

Any primary-power electrical system must have a master-switch cut-off that meets all of the following requirements:

- a. The switch must be completely mechanical and operate directly to make or break the circuit, without any electronic components.
- b. The switch must be of an enclosed type, so that any electrical arcing will occur on the interior of the switch.
- c. The switch must directly shut off power from the primary-power batteries. It cannot indirectly shut off power using a relay or contactor.
- d. The switch must be located as near to the batteries as possible, consistent with the access requirements described in "5.3 Activation/Deactivation Requirements".
- e. If a primary-power battery is connected to a conductive BattleBot chassis, the switch must be located such that power is cut between the battery and the chassis.

Note: A removable link may be used in lieu of an actual Master Switch, if it complies with all of the requirements of a Master Switch.

6.8.2 Number of Switches

Multiple master switches can be used, consistent with all other requirements in this document.

6.8.3 Activation/Deactivation Time

The time to turn on and turn off all Master Switches must be such that the BattleBot meets all of the requirements as defined in "5.3 Activation/Deactivation Requirements".

6.8.4 Access Requirements

All master switches must be located in such a position that they can be switched on or off without placing any body part in the path of any weapon system or other powered moveable part of the BattleBot.

Using a special tool to access a Master Switch is acceptable, provided that a single tool can be used to both turn on and turn off all Master Switches.

6.8.5 Radio-Controlled Fail-Safe

All BattleBots must have a radio failsafe that electronically or mechanically shuts off all motion-system and weapons power within one (1) second after the transmitter is switched off, or otherwise stops transmitting.

Note: This Fail-Safe is required in addition to the other Master Switch requirements specified in this document.

6.8.6 Secondary Power Deactivation

If the secondary-power system has an on-off switch, it must be located in such a position that it can be switched without placing any body part in the path of any weapon system or other powered moveable part of the BattleBot.

6.8.7 Bypass Switches

A BattleBot must not contain an alternate switch or any other method that bypasses or otherwise compromises the effect of any Master Switch.

6.9 Electric Motors

Electric motors are the primary method for powering the wheels, legs and/or weapons of most BattleBots. Compared to Pneumatic Systems and Internal Combustion Engines, they are relatively safer, and thus there are fewer restrictions on their use.

6.9.1 Electric Motor Types

Electric motors used on BattleBots can be of any type, including DC or AC, brushed or brushless, permanent magnet, series or parallel wound.

For brush-type motors, using noise suppression capacitors is strongly recommended. Refer to the [BattleBots Builder's Guide](#) for more information.

6.9.2 Size/Power

There are no specific restrictions on the physical size or the output power of any electric motors that can be used on a BattleBot.

6.9.3 Motor Cooling

During BattleBots competition, electric motors can become very hot. The restrictions on cooling electric motors are as follows:

- a. Internal and/or external air cooling is allowed (and recommended).
- b. Cooling using an attached heat-sink is allowed. However, the heat sink must not be, or have a direct connection to, any pneumatic or hydraulic component.
- c. Liquid cooling of electric motors is allowed, using either a radiator or a liquid-filled jacket. Reference the coolant volume limits specified in "2.6.3 Cooling Liquids".
- d. Vapor cooling of a motor using stored CO₂ is allowed provided that the CO₂ system complies with all the requirements of "8.0 Pneumatic Systems".

6.9.4 Mounting Position

Any motor and its associated heat sink(s) must be insulated from any pneumatic system component as defined in "8.10.3 Pneumatic Component Insulation".

6.10 Generators and Alternators

Generators and Alternators can be used on a BattleBot, provided that their voltage output complies with the limitations defined in "6.2 Standard Voltage Limitations".

6.11 Electromagnets

Externally-mounted electromagnets can be used on a BattleBot, provided that:

- a. Any electromagnet is powered only by a DC voltage, which may be switched on and off, or reversed in polarity.
- b. If any electromagnet is repeatedly switched on and off, the maximum switching frequency must be less than **10.0 Hz** (10 times per second).
- c. The control electronics for any electromagnet must not interfere with any BattleBot radio control signals or with any event communications equipment.

7.0 Fuel-Powered Engines

7.1 Internal Combustion Engine

The only type of fuel-powered engine that can be installed on a BattleBot is an Internal Combustion Engine (ICE). Any engine that burns fuel outside of an enclosed combustion chamber cannot be used in BattleBots.

7.1.1 ICE Definition

An Internal Combustion Engine is defined as an engine that continuously burns small quantities of fuel in one or more combustion chambers in order to produce continuous rotary motion on an output shaft.

7.1.2 Number of ICE's

BattleBots may use one or more ICE's, provided that each engine complies with "7.2 ICE Engine Requirements".

7.2 ICE Engine Requirements

7.2.1 Engine cooling

ICE's may use air or water/antifreeze for cooling. For liquid cooling, reference the coolant volume limits specified in "2.6.3 Cooling Liquids".

7.2.2 ICE Idle Speed

The Idle Speed of any ICE must be less than one-fourth (1/4) the maximum operating speed.

7.2.3 Supercharging and Turbocharging

- a. Belt or gear-driven superchargers can be used on a BattleBot ICE.
- b. Turbochargers can be used on a BattleBot provided that the hot section of the turbocharger housing is insulated as specified in "7.2.4 Engine Exhaust Restrictions" and is not exposed on the exterior of the BattleBot.

7.2.4 Engine Exhaust Restrictions

Exhaust from the engine is subject to several restrictions:

- a. Engine exhaust must not be directed toward any fuel or oil supply tank, or toward any pneumatic or hydraulic component on the BattleBot.
- b. Any engine exhaust system component must be insulated from any pneumatic system component as defined in "8.10.3 Pneumatic Component Insulation".
- c. The engine exhaust must not be directed toward any hydraulic or pneumatic component.

- d. Any engine exhaust system component must be located at least two inches (2") away from any fuel tank on the BattleBot, or be at least one inch (1") away with a metal heat shield securely mounted midway between the fuel tank and the exhaust system.
- e. If an ICE does not have a muffler, then the exhaust of the engine must not be vented to the interior of the BattleBot.

Note: Mufflers are strongly recommended, but not specifically required.

7.2.5 Turbo-Shaft Engines

Turbo-shaft engines cannot be used in BattleBots as their exhaust heat can damage the BattleBox.

7.2.6 Turbo-Jets and Pulse-Jets

Turbo-Jets and Pulse-Jets cannot be used in BattleBots.

7.2.7 Combustion-Enhancing Gasses

Using combustion-enhancing gasses is specifically prohibited. The only types of gasses that may be stored on a BattleBot are those specified in "8.2.1 Allowed Gasses".

7.2.8 Other ICE Types

ICE types and configurations other than those specified in this section **7.2** may be allowed, but will require the submission of an Advance Acceptance Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

7.3 Liquid Fuel Restrictions

7.3.1 Purpose of Liquid Fuels

Liquid fuels may be carried aboard a BattleBot solely for the purpose of powering ICE's. There are additional restrictions on the types and quantity of fuel, as defined below in **7.3.2** and **7.3.3**.

7.3.2 Allowed Fuels

The only fuels that can be used on a BattleBot are:

- a. Unleaded Gasoline, as generally available from commercial distributors.
- b. Diesel fuel, as generally available from commercial distributors.
- c. A blend of Unleaded Gasoline, Methanol (optional) and lubricating oil. To minimize the hazard of invisible burning, the blend cannot contain more than 40% Methanol by volume.
- d. Glow-plug 2-stroke fuel blends, as generally available at hobby supply outlets. Such blends must not contain more than 10% Nitromethane or 40% Methanol by volume.

7.3.3 Fuel Quantity Limits

The quantity of fuel that may be carried on a BattleBot is based on the Weight Class designation only. The fuel limits are the total for each BattleBot, not for each engine.

Weight Class Designation	Fuel Limit
Lightweight	6.0 fl. oz.
Middleweight	8.0 fl. oz.
Heavyweight	12.0 fl. oz.
Super Heavyweight	16.0 fl. oz.

The above limits include any lubricating oil blended into the fuel.

7.4 Fuel System

Due to fire hazards, the storage of liquid fuels on a BattleBot is subject to many safety constraints.

7.4.1 Number of Fuel Tanks

There must be no more than one fuel tank for each engine on a BattleBot. One fuel tank feeding two or more engines is permissible, provided the tank and its installation meet all of the requirements specified in this section 7.4.

7.4.2 Fuel Tank Size

The fuel tanks on a BattleBot must be designed or modified such that, when all tanks are filled to their maximum capacity, they do not contain any more fuel than is allowed for the designated weight-class of the BattleBot.

7.4.3 Fuel Tank Safety

Fuel tanks must meet all of the following standards:

- a. Fuel tanks must be made of metal, fiber composite, or molded impact-resistant plastic.
- b. Fuel tanks must be located such that they are reasonably protected within the body of the BattleBot.
- c. Fuel tanks must be mounted such that they can withstand a force in any direction equal to ten (10) times the weight of the fuel stored, without damage to the tank or its mounting.
- d. Fuel tanks must be mounted away from any heat-producing components of the BattleBot. Tanks must specifically comply with the specifications of "7.2.4 Engine Exhaust Restrictions".

Note: Shock mounting of fuel tanks is recommended.

7.4.4 Fuel Lines

Fuel lines from the tank to the engine(s) must meet all of the following standards:

- a. The fuel line material must be compatible with the type of fuel being used.
- b. The fuel line must contain and/or be completely covered with a cut-resistant metallic sheath.
- c. The ends of all fuel lines, including at valves and manifolds, must be secured with a screw-on pressure fitting, a screw-type hose clamp, at least two wraps of stainless-steel safety wire, or a properly-sized spring-type hose clamp.
- d. Any valves or manifolds on the fuel line between the fuel tank and the engine must be attached to or supported by the BattleBot structure.
- e. All fuel lines must be constrained to prevent vibration or impact loading from breaking the fuel line or from tearing the fuel line loose from its fittings.
- f. All fuel lines must be routed away from any heat-producing components of the BattleBot.

7.4.5 Pressurized Fuel Tanks

Pressurized fuel tanks are not allowed. All fuel tanks must be vented to atmospheric pressure.

7.4.6 Fuel Vent Systems

All fuel vent systems must be designed such that they will not continuously leak fuel if the BattleBot is inverted.

7.4.7 Fuel Filling Access

Gaining access to, and adding fuel to any fuel tank must not require placing any body part in the path of any weapon system or other powered moveable part of the BattleBot.

7.4.8 Excess Fuel Drainage

The location of the fuel tank and the design of the BattleBot must be such that any fuel spillage during the refueling process will result in the excess fuel draining immediately to the ground below the BattleBot. There must be no puddling of any quantity of excess fuel inside the BattleBot.

7.5 Lubrication Oil

Engine lubricating oil can create a fouling hazard if it spills on the BattleBox floor. The following requirements are intended primarily to minimize accidental spillage of oil.

7.5.1 Oil Sumps

If an ICE contains an integral oil sump, the venting system must be designed such that oil will not continuously spill out if BattleBot is inverted.

7.5.2 External Oil Tanks

External oil tanks are allowed solely for the purpose of providing lubricating oil to 2-stroke engines that utilize integral oil injection systems.

Any external oil tanks must meet all the following requirements.

- a. They must not be pressurized.
- b. They must be made of metal, fiber composite, or impact-resistant plastic.
- c. They must be reasonably protected within the body of the BattleBot.
- d. They must be securely mounted to the structure of the BattleBot. Shock mounting is recommended.
- e. They must be designed such that oil will not continuously spill out if the BattleBot is inverted.

7.5.3 External Tank Oil Lines

Oil lines from any external tank to any ICE must meet all of the standards for fuel lines described in "7.4.4 Fuel Lines".

7.6 Automatic Shutdown

Due to the nature of ICE operation, there are specific safety requirements regarding their installation, as follows:

7.6.1 Fail-Safe Cutoff

Any ICE installed in a BattleBot must be configured such that if the signal from the radio-control transmitter is lost, the engine will shut off (cease producing power) or return to Idle Speed within one (1) second of signal loss.

7.6.2 ICE Mechanical Disconnect

Any ICE installed in a BattleBot must utilize a centrifugal clutch or other mechanical mechanism such that, while the engine is running at Idle Speed, there is no movement of any BattleBot component driven by that engine.

7.7 ICE Starting

There are specific requirements for starting an Internal Combustion Engine.

7.7.1 Start-Up Time

Any ICE must be able to demonstrate that, with the engine cylinder head temperature at or below 100° Fahrenheit, it can be reliably started in thirty (30) seconds or less.

7.7.2 Built-In Electric Starters

Built-in electric starters may be used on ICE's.

7.7.3 Portable Starters

External electric starters can be used for starting ICE's, providing that the starting apparatus is sufficiently portable that a single individual can easily transport it.

7.7.4 Access to Starting

Gaining access to, and starting any ICE must not require placing any body part in the path of any weapon system or other powered moveable part of the BattleBot.

8.0 Pneumatic Systems

8.1 Pneumatics Overview

Pneumatic systems involve the storage, use and control of high-pressure gasses to power actuators.

8.1.1 Cautions

Pneumatic systems can be very dangerous if not designed and constructed properly. Moreover, damage caused by BattleBots competitions can render any pneumatic system unsafe.

8.1.2 Designer/Builder Responsibility

This section contains many requirements intended to assist in the design of a safe and durable pneumatic system. However, it is ultimately the responsibility of all BattleBot designers and builders to ensure the safety of their pneumatic system design. If the designer and/or builder is not knowledgeable about all aspects of pneumatic systems, he or she should not attempt to use them in a BattleBot.

For additional suggestions, refer to the [BattleBots Builder's Guide](#).

8.2 Compressed Gas Restrictions

There are restrictions on the type and use of gasses in BattleBots pneumatic systems.

8.2.1 Allowed Gasses

The following gasses are the only ones that can be stored or used in a BattleBot:

- a. Nitrogen (N_2), in compressed gaseous form only.
- b. Air (21% O_2 , 78% N_2) in compressed gaseous form only. Oxygen-enriched air is prohibited.
- c. Carbon Dioxide (CO_2) may be stored in liquid or gaseous form, provided that the pneumatic system is designed to safely use liquid CO_2 .

8.2.2 Maximum Pressure

2,500 psi is the maximum pneumatic pressure that may be stored or used anywhere aboard a BattleBot at any time.

8.2.3 Maximum Actuation Pressure

Effective for ALL BattleBots after December 31, 2001, the maximum pneumatic pressure downstream of the Regulator that may be used for actuation anywhere aboard a BattleBot at any time is limited to **1000 psi**.

8.2.4 Volume/Weight Limits

Depending upon the type of gas used, the following are restrictions on the total amount of gasses that may be stored on a single BattleBot or on a MultiBot cluster. The maximum amount is different for each Weight Class, as shown.

In the following table:

- "Maximum Air/N₂ Volume" refers to the total volume of Air or Nitrogen that may be stored, in standard cubic feet at standard temperature and pressure.
- "CO₂ Weight Limit" refers to the total weight of Carbon Dioxide that may be stored.

Weight Class Designation	Maximum Air/N ₂ Volume	CO ₂ Weight Limit
Lightweight	11 cu. ft.	20 oz.
Middleweight	22 cu. ft.	3 lb.
Heavyweight	44 cu. ft.	6 lb.
Super Heavyweight	72 cu. ft.	8 lb.

8.2.5 Maximum Storage per Tank

No single storage tank in a BattleBot may store more than one-half (1/2) the maximum allowed volume/weight as specified in the table of "8.2.4 Volume/Weight Limits".

8.2.6 Using Both Air/N₂ and CO₂

If a BattleBot uses both Air/N₂ and CO₂, the quantities of each will be limited to half the amount allowed for the specified Weight Class designation.

8.2.7 Powered Pneumatic Pump

A powered pneumatic pump (compressor) may be used to provide or augment on-board pneumatic pressure. This is allowed provided that:

- There is a pressure-relief valve for each compressor, rated for a flow rate of at least 120% of the compressor output.
- Each compressor is rated for a pressure output equal to or greater than the compressor's pressure-relief valve.

8.3 Pressure Tank Requirements

All pneumatic pressure tanks, whether used as primary storage, or as an expansion tank, must meet the following requirements:

8.3.1 Air/N₂ Tanks

Storage tanks containing Air or N₂ must be rated for at least the maximum pressure allowed for the gas type, as defined in **8.2.2**. The maximum rating must be stamped on each tank such that it is clearly readable.

8.3.2 CO₂ Tanks

Tanks containing CO₂ must be either aluminum or chrome-moly steel and rated for at least the maximum pressure allowed for the gas type, as defined in **8.2.2**. The maximum rating must be stamped on each tank such that it is clearly readable.

Fiber-wound CO₂ tanks are not allowed.

8.3.3 Hydro-Test Date

Each tank rated at higher than 1000 psi must have a current hydro-test date (per DOT standards) indicated on the tank. For new tanks, or for tanks with finite lifetimes, the date of manufacture must be clearly indicated on the tank.

If no date is stamped on the tank, official written documentation will have to be provided of the date of manufacture and/or hydro-testing.

8.3.4 Pressure Relief

Each pressure tank must be equipped with a burst disc or ASME certified pressure relief device appropriate for the maximum pressure rating of the tank.

The pressure relief exit must be positioned in such a way that it will relieve pressure away from the direction of any persons refilling the tank.

8.3.5 Pressure Tank Damage

Any pressure tank must not have any observable damage which in any way compromises its structural integrity. Such tanks cannot ever be used to store pressurized gas aboard a BattleBot.

8.3.6 Custom Pressure Tanks

All pneumatic pressure tanks must be commercially manufactured, distributed and sold. Custom-made or modified pressure tanks are prohibited.

8.4 Pressure Regulators

8.4.1 Requirements

Pneumatic pressure regulators are not specifically required except in the Lightweight class. However, BattleBots Inc. strongly recommends that all BattleBots use regulators. Any BattleBot using a regulator must conform to the applicable requirements specified below in this section **8.4**.

Effective for ALL BattleBots after December 31, 2001, pneumatic pressure regulators are specifically required for all BattleBots. Any regulator with a maximum output pressure greater than **250 psi** must have an adjustment which allows the regulated pressure to be adjusted down to **250 psi**.

8.4.2 Lightweight Pressure Limit

Lightweight class BattleBots with pneumatic systems are required to have pressure regulators set to a maximum output pressure of **200 psi**.

8.4.3 Regulator Lock-Down

If any adjustable regulator does not normally operate at its maximum setting, then the regulator must have a locking method that prevents the regulated pressure from increasing due to vibration or shock.

8.4.4 Regulator Location

All expansion tanks, actuators and active components of the pneumatic system must be downstream of the regulator.

8.4.5 Regulator Mounting

A pressure regulator may be directly attached to a primary pressure storage tank, or it may be attached to the BattleBot chassis. In either case, the regulator must be positively secured to the BattleBot structure such that it can withstand a pulling force of ten (10) pounds in any direction without any observable deformation.

8.4.6 Connection to Regulator

If a regulator is not mounted directly on a pressure storage tank, any connecting hoses and associated manifolds must be rated for the maximum pressure allowed as defined in "8.2.2 Maximum Pressure". These connecting components must conform to the requirements defined in "8.9 Pneumatic Components".

8.5 High-Pressure Pneumatics

Any BattleBot pneumatic system that is either unregulated or has a regulator that operates above **250 psi** pressure is considered to be using "High-Pressure Pneumatics". High-Pressure Pneumatics may be accepted in a BattleBot provided that the BattleBot fully complies with certain specific additional requirements.

8.5.1 Not Allowed in Lightweight

BattleBots in the Lightweight class cannot qualify for High-Pressure Pneumatics and must use regulators set no higher than specified in "8.4.2 Lightweight Pressure Limit".

8.5.2 Maximum Pressures

The maximum pressures allowed in a High-Pressure Pneumatic system cannot at any time exceed the pressures specified in "8.2.2 Maximum Pressure" and "8.2.3 Maximum Actuation Pressure".

8.5.3 Accumulator Tanks

All High-Pressure Pneumatic accumulator or expansion tanks must be protected using the same standards as defined in "8.10.4 Pressure Tank Protection".

8.5.4 Actuator Protection

All High-Pressure Pneumatic actuators must be protected using the same standards as defined in "8.10.4 Pressure Tank Protection".

8.5.5 BattleBots Acceptance

Proposed use of the High-Pressure Pneumatic limits as specified in this section **8.5** also requires the advance submission of the specific High-Pressure Pneumatic Waiver Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

8.6 Shut-Off Valves

Any pneumatic system on a BattleBot must have a method to isolate the high-pressure gasses stored in each of the pressure storage tanks. The requirements are as follows:

8.6.1 Regulator Shut-Off Valve

If a regulator is directly attached to the pressure storage tank and contains an integral but specific shut-off valve, that is an acceptable shut-off valve implementation.

However, adjusting the regulator to shut off pressure is not allowed.

8.6.2 Dedicated Shut-Off Valve

If a regulator shut-off valve is not used, a separate dedicated shut-off valve must be used. The shut-off valve must comply with the following:

- a. The shut-off valve must be manually operated. Electrically operated shut-off valves are not allowed.
- b. A separate dedicated shut-off valve is required for each pressure storage tank, mounted on the tank, or between the tank and the regulator.
- c. Each valve must be rated for the maximum pressure used in its associated pressure storage tank.
- d. Each separate shut-off valve must be mounted on, or as close as is practical to its respective pressure storage tank.
- e. If the shut-off valve is not mounted directly to the pressure storage tank, it must be connected only by a single continuous pipe or hose from the pressure storage tank fitting to the shut-off valve fitting; no other components are allowed between the pressure tank and the shut-off valve.

8.6.3 Shut-Off Valve Access

Access to all shut-off valves must be such that the BattleBot must comply with the access, total time and safety conditions for pre-match Activation, and post-match Deactivation, as described in "5.0 BattleBot Activation and Deactivation".

8.7 Purge Valves

Any BattleBot pneumatic system must have a method to relieve all gas pressure in the system downstream of the Shut-Off valve(s). The minimum requirements are as follows:

8.7.1 Regulator Combination Valve

If a regulator is directly attached to the pressure storage tank and contains an integral combination shut-off/purge valve, that is acceptable, provided the shut-off action is fully complete before the purge action begins.

8.7.2 Dedicated Purge Valve

Any dedicated purge valve must be manually operated. This valve must be rated for the maximum outlet pressure of the regulator.

Electrically operated purge valves are not allowed.

8.7.3 Purge Valve Location

Purge valves may be located anywhere in the pneumatic system, provided that their combined activation relieves all pressure in the pneumatic system downstream of the shut-off valve even if any electrically-controlled actuator valve is stuck in any position.

8.7.4 Purge Valve Access

Access to all purge valves must be such that the BattleBot can comply with the access, total time and safety conditions for pre-match BattleBot Activation, and post-match BattleBot Deactivation, as described in "5.0 BattleBot Activation and Deactivation".

8.8 Pressure Relief Valves

Any pneumatic system must have ASME pressure reliefs installed downstream of the pressure regulator or Shut-Off Valve, as required, to limit pressure on the downstream side.

8.8.1 Relief Valve Setting

Relief valves must be set to start relieving pressure at no more than one-hundred-twenty percent (120%) of the pressure rating of the lowest rated component in that part of the pneumatic system.

8.9 Pneumatic Components

8.9.1 Standard Components

Using standard rated pneumatic components is strongly recommended. Some custom components are allowed with restrictions.

8.9.2 Component Ratings

All primary pneumatic components on the BattleBot, including tanks, regulators, valves, and actuators must be clearly marked as rated for the pressures being used in the pneumatic system.

If any pneumatic component is not visibly marked for inspection, the BattleBot entrant must supply the necessary data sheets to prove that it is properly rated for the pressures being used.

8.9.3 Component Damage

If a pneumatic component is damaged in any way that compromises its structural integrity, then that component must not be used in a pressurized BattleBot pneumatic system.

8.9.4 Custom Components

Due to the high risk, custom made or modified pneumatic components are not encouraged. If any custom-made or custom-modified component is used in the BattleBot's pneumatic system, the entrant will be required to:

- a. Supply data sheets and/or computations to prove that the component is properly designed.
- b. Demonstrate at any Safety/Tech inspection that the component performs reliably and safely.

As specified in "8.3.6 Custom Pressure Tanks", custom-made or modified pressure tanks are prohibited.

8.9.5 Custom Component Acceptance

Request for custom pneumatic component acceptance requires the submission of an Advance Acceptance Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

8.9.6 Heaters

No active heating system utilizing on-board power can be used for pressure tanks, expansion tanks or anywhere else in a pneumatic system on board a BattleBot.

For tanks containing liquid CO₂ only, an externally-powered heater may be used during the filling of a primary pressure storage tank.

Fans are allowed to blow ambient air across pneumatic components.

8.9.7 Pressure Boosters

A pressure booster (intensifier) is a component designed to raise the system operating pressure. Using pressure boosters anywhere in a pneumatic system is not allowed.

8.10 Component Installation and Mounting

There are minimum requirements for the installation and mounting of pneumatic components. These are intended to mitigate the effects of the high inertial forces and weapons damage that can occur during BattleBot combat.

8.10.1 Pressure Bottle Securing

Each primary pressure storage tank must be, at a minimum, constrained as follows:

- a. A load of thirty (30) pounds applied at any point on the pressure tank will not cause any damage to, or more than one-eighth inch (1/8") movement of, any tank securing restraint.
- b. The tank is constrained at multiple points, such that a load on any part of the tank will be taken primarily by the hold-down, not the tank structure.
- c. The tank is not constrained primarily at the outlet "neck".
- d. Vibration or impact inertial shock will not cause release of the securing method.
- e. Tie-wraps or other non-reusable pressure tank hold-downs are not allowed.

8.10.2 Pneumatic Component Mounting

In addition to the mounting of the pressure tanks, other pneumatic components must be mounted in such a way as to minimize the hazard created when part of the pneumatic system is damaged. Some specific requirements are:

- a. Other than hoses and piping, any pneumatic system component, such as a valve, gauge or manifold, must be positively secured to the BattleBot structure such that it can withstand a force of ten (10) pounds in any direction without damage to the component or its securing method.

- b. Any flexible connecting hose longer than six (6) inches must be constrained to prevent vibration or impact loading from applying a bending force to any fittings.
- c. Where necessary, a hose or pipe must be curved or looped to prevent strain on the hose or pipe and its fittings due to expansion and contraction during operation.

8.10.3 Pneumatic Component Insulation

All pneumatic components must be insulated against sources of heat. These sources include electric motors, fuel-powered engines and certain types of batteries.

- a. For electric motors and non-Lead-Acid batteries, a free-air space of at least one-eighth inch (1/8") between any part of the component and any part of the pneumatic system.
- b. For any fuel-powered engine exhaust pipe or muffler, at least one-half inch (1/2") of free air space, with a metal heat shield securely mounted midway between the exhaust pipe and the pneumatic component.

8.10.4 Pressure Tank Protection

Any pneumatic pressure storage tank must not be directly exposed at any point on the outside of the BattleBot.

The tank must be protected on all sides with removable armor consisting of one or more of the following:

- a. At least 1/4-inch thick polycarbonate plastic.
- b. At least 3/16-inch thick glass, carbon or aramid fiber composite.
- c. At least 1/8-inch thick Aluminum or steel.
- d. At least 1/16-inch thick Titanium.

The armor must not be wrapped tightly around the tank, but must be generally spaced a minimum of one-quarter inch (1/4") from the tank on all sides.

8.10.5 Pneumatic Component Protection

All pneumatic components should be mounted well inside the interior of the BattleBot, and protected such that impacts and weapon blows will not damage the components.

8.11 Pressure Test Points

A BattleBot pneumatic system must have a method of quickly and easily checking all system pressures at any point in the pneumatic system.

8.11.1 Tank Pressure

Each individual pressure storage tank must have a pressure gauge or test point prior to the shut-off valve, which allows reading the gas pressure in that tank.

8.11.2 System Pressure

Any pneumatic system must have at least one pressure gauge or test point downstream of any regulator, which allows reading the regulated system pressure.

If there is no regulator, there must be at least one pressure gauge or test point downstream of the Shut-Off Valve.

8.11.3 Pressure Gauge Specifications

Each pressure gauge must indicate a minimum of one hundred twenty-five percent (125%) and a maximum of three hundred percent (300%) of the maximum rated pressure that the gauge is measuring.

8.11.4 Test Point Fittings

If a gauge is not mounted to the BattleBot test point, a Stauff or other equivalent fitting is allowed in lieu of a gauge. If a Stauff-compatible fitting is not used, it is the responsibility of the individual BattleBot team to provide the appropriate gauges compatible with the test fittings of their BattleBot. The gauges must comply with the requirements specified in **8.11.3** for the gauge range values.

8.11.5 Pressure Test Accessibility

Design and placement of the gauges and/or test points must allow quick and safe reading of the pressure values. Specifically:

- a. Accessibility of the gauges and/or test points must be such that it requires no more than one (1) minute to read all test point pressures on a battle-ready BattleBot.
- b. Gaining access to and reading of the test-point pressures must not require placing any body part in the path of any weapon system or other powered moveable part of the BattleBot.

8.12 Air/N₂ Filling Apparatus

To allow safe and convenient filling of high-pressure Air or N₂, the following requirements must be met:

8.12.1 Filling Pressure

The Air/N₂ filling apparatus must be designed and constructed such that during filling, the maximum allowed air pressure in any on-board storage tank does not exceed the limit defined in "8.2.2 Maximum Pressure".

8.12.2 Approved Components.

Only standard, commercially produced pneumatic components can be used on the filling apparatus. All components must be rated for the pressures used.

8.12.3 Filling Access

Access to the BattleBot for filling Air/N₂ must not require the BattleBot to be held or supported in any unstable position.

8.12.4 Connect/Disconnect

The filling apparatus must be able to be connected and disconnected in a safe and controlled manner to a filling port on the BattleBot, or to an individual pressure tank.

9.0 Hydraulic Systems**9.1 Hydraulics Overview**

Hydraulic systems involve the pressurization and control of a liquid to power linear and rotary actuators.

9.1.1 Cautions

Hydraulic systems involve very-high-pressure liquid and can be dangerous if not designed and constructed properly. Moreover, damage caused by BattleBots competitions can render any hydraulic system unsafe.

9.1.2 Designer/Builder Responsibility

This section contains many requirements intended to assist in the design of a safe and durable hydraulic system. However, it is ultimately the responsibility of all BattleBot designers and builders to ensure the safety of their hydraulic system design. If the

designer and/or builder is not knowledgeable about all aspects of hydraulic systems, he or she should not attempt to use them in a BattleBot.

For suggestions and recommendations, refer to the [BattleBots Builder's Guide](#).

9.2 Hydraulic System Requirements

Hydraulic systems used in BattleBots are subject to the following requirements:

9.2.1 Maximum Hydraulic Pressure

5000 psi is the maximum hydraulic pressure that may be used in a BattleBot.

If an accumulator or other hydraulic pressure storage tank is used anywhere in the system, the maximum pressure in that tank cannot exceed **2500 psi**.

9.2.2 Hydraulic Fluid Type

Any hydraulic fluid used in a BattleBot must be non-flammable, non-corrosive, have moderate-to-low toxicity, and be rated for the maximum pressure used in the hydraulic system. The maximum temperature rating of the fluid must be at least 200° Fahrenheit.

9.2.3 Hydraulic Pressure Source

All hydraulic pressure in a BattleBot must be generated on-board by one or more hydraulic pumps driven by an Electric Motor or a Fuel-Powered Engine.

9.2.4 Pressure Regulation

All hydraulic pumps must have a pressure-relief valve that limits the output pressure of the pump to the appropriate limit specified in **9.2.1**, and which bypasses any excess hydraulic fluid at low pressure to a storage reservoir. The relief valve must be able to pass a flow rate of at least 120% of the hydraulic pump's output capacity.

9.2.5 Hydraulic Fluid Storage

Hydraulic fluid must be stored in a hydraulic reservoir that is not pressurized to more than **35 psi**.

There is no specific limit on the amount of hydraulic fluid that may be stored in a storage reservoir on a BattleBot. To minimize arena fouling, the fluid quantity should be kept to the minimum value necessary for proper functioning of the hydraulic system.

9.2.6 Storage Reservoir Venting

Any vent system for the hydraulic storage reservoir must be designed such that the tank will not continuously leak hydraulic fluid if the BattleBot is inverted.

9.3 Hydraulic System Components

Each component in a BattleBot hydraulic system is subject to the following restrictions:

9.3.1 Standard Components

Using standard rated hydraulic components is strongly encouraged. Certain custom components are allowed with restrictions.

9.3.2 Component Ratings

All hydraulic components used on the BattleBot, including pumps, accumulators, valves, manifolds, hoses, couplings and actuators must be clearly marked as rated for the pressures being used in the hydraulic system.

If any hydraulic component is not clearly marked and visible for inspection, the BattleBot entrant will need to supply the necessary data sheets to prove that it is properly rated for the pressures being used.

9.3.3 Component Damage

If any pressurized hydraulic component is damaged in any way that compromises its structural integrity, then that component must not be pressurized in a BattleBot hydraulic system.

9.3.4 Accumulators and Pressure Boosters

Any hydraulic accumulators and pressure boosters must be commercially manufactured and distributed. Custom-made or modified accumulators or pressure boosters are specifically prohibited.

9.3.5 Other Custom Components

Due to the risk involved, custom hydraulic components are not generally recommended. If any custom-made or custom-modified component is used in the BattleBot's hydraulic system, the entrant will be required to:

- a. Supply data sheets and/or computations to prove that the component is properly designed.
- b. Demonstrate at any Safety/Tech inspection that the component performs reliably and safely.

9.3.6 Component Acceptance

Request for custom hydraulic component acceptance requires the submission of an Advance Acceptance Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

9.4 Component Installation and Mounting

There are minimum requirements for the installation and mounting of hydraulic components. These requirements are intended to mitigate the effects of the high inertial forces and weapons damage that can occur during BattleBot combat.

9.4.1 Component Mounting

All hydraulic components must be mounted in such a way as to minimize the hazard created when part of the hydraulic system is damaged. Some specific requirements are:

- a. Any hydraulic pump must be positively secured to the BattleBot structure or to the drive motor such that it can withstand a force of twenty (20) pounds in any direction without damage to the motor or the pump mount.
- b. Other than pumps and hoses and piping, any hydraulic component, such as a valve, gauge or manifold, must be positively secured to the BattleBot structure such that it can withstand a force of ten (10) pounds in any direction without significant movement.
- c. Any flexible hydraulic hose longer than twenty (20) times its diameter must be attached to or supported by the BattleBot structure to prevent vibration or impact loading from applying a bending force to the hose fittings.
- d. Where necessary, a hydraulic hose and piping must be curved or looped to prevent strain on the hose, piping or fittings due to expansion and contraction during operation.

9.4.2 Hydraulic Component Protection

All hydraulic components should be mounted well inside the interior of the BattleBot, and protected such that impacts and weapon blows will not damage the components.

9.5 Hydraulic Accumulator Requirements

Any hydraulic accumulators used on a BattleBot must meet the following requirements:

9.5.1 Disallowed in Lightweight

Hydraulic accumulators cannot be used in Lightweight class BattleBots.

9.5.2 Pressure Rating

Any accumulator must be rated for at least the maximum pressure allowed for hydraulic systems with accumulators, as defined in "9.2.1 Maximum Hydraulic Pressure". The maximum rating must be stamped on the accumulator such that it is clearly readable.

9.5.3 Accumulator Volume Limits

If an accumulator or other volume-building device is used in a BattleBot hydraulic system, the maximum pressure-storage capacity is limited for each Weight Class, as shown in the table below. In the table, "Maximum Accumulator Volume" refers to the total actual volume of all hydraulic pressure-accumulation systems on the BattleBot.

BattleBots Class Designation	Maximum Accumulator Volume
Lightweight	N/A
Middleweight	80 cu. in.
Heavyweight	140 cu. in.
Super Heavyweight	220 cu. in.

9.5.4 Pressure Relief

Any accumulator must be equipped with a dedicated pressure relief device set to the accumulator limit specified in "9.2.1 Maximum Hydraulic Pressure", or the maximum pressure rating of the accumulator, whichever is less.

9.5.5 Accumulator Securing

Any mounting systems for hydraulic accumulators must use sound engineering practices and meet the following minimum criteria:

- a. A load of twenty (20) pounds applied at any point on the accumulator will not cause significant movement of the accumulator mounting system.
- b. The accumulator is constrained at multiple points, such that a load on any part of the accumulator will be taken primarily by the mounting, not the accumulator.
- c. The accumulator is not mounted primarily at the connection "neck".
- d. Tie-wraps cannot be used for accumulator mounting.

9.5.6 BattleBots Acceptance

Use of any hydraulic accumulator requires the advance submission of the specific Hydraulic System Waiver Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

9.6 Hydraulic Pressure Boosters

A hydraulic pressure booster (intensifier) is a component designed to raise the operating pressure of the system.

9.6.1 Disallowed in Lightweight

Pressure boosters cannot be used in BattleBots that fall within the Lightweight class designation.

9.6.2 Limitations on Use

Using a pressure booster anywhere in a hydraulic system may be allowed provided that it does not raise the system pressures above the limits specified in "9.2.1 Maximum Hydraulic Pressure".

9.6.3 Pressure Relief

Any pressure-booster must be equipped with a dedicated pressure relief device set to either the maximum limit specified in "9.2.1 Maximum Hydraulic Pressure", or the maximum pressure rating of the pressure booster, whichever is less.

9.6.4 BattleBots Acceptance

Use of any hydraulic pressure booster requires the advance submission of the specific Hydraulic System Waiver Form to BattleBots Inc. as defined in "1.4.7 Waivers and Advance Acceptance".

9.7 Bypass/Purge Valves

Any BattleBot hydraulic system must use one or more bypass/purge valves to relieve all pressure in the hydraulic system. The minimum requirements are as follows:

9.7.1 Bypass/Purge Valve Type

Any bypass/purge valve must be manually operated. The valves must be rated for the maximum allowed pressure of the hydraulic system.

Electrically operated bypass/purge valves are not allowed.

9.7.2 Bypass/Purge Valve Locations

Bypass/purge valves may be located anywhere in the hydraulic system, provided that their combined activation relieves all pressure in the hydraulic system even if any electrically-controlled actuator valve is stuck closed.

9.7.3 Accumulator Bypass/Purge Valve

If the hydraulic system uses any accumulators, then each accumulator must have a dedicated bypass/purge valve.

9.7.4 Valve Access

Access to all bypass/purge valves must be such that the BattleBot can comply with the access, total time and safety conditions for pre-match Activation, and post-match Deactivation, as described in "5.0 BattleBot Activation and Deactivation".

9.7.5 Fluid Storage

All hydraulic fluid released by any bypass valve must be directed to the low-pressure storage reservoir on-board the BattleBot. There must be a fixed, no-leak connection from any bypass valve to the reservoir.

9.8 Pressure Test Points

BattleBot hydraulic systems must have a method of quickly and easily checking all hydraulic system pressures.

9.8.1 System Pressure

Any hydraulic system must have at least one pressure gauge or test point that allows reading the operating hydraulic system pressure.

9.8.2 Accumulator Test Point

If the hydraulic system uses any accumulators, then each accumulator must have a separate dedicated test point.

9.8.3 Pressure Booster Test Point

If the hydraulic system uses any pressure boosters, then each pressure booster must have a separate dedicated test point.

9.8.4 Pressure Gauge Specifications

Each pressure gauge must indicate a minimum of one hundred twenty-five percent (125%) and a maximum of two hundred percent (200%) of the maximum rated pressure that the gauge is measuring.

9.8.5 Test Point Fittings

If a gauge is not mounted to the BattleBot test point, a Stauff or other equivalent fitting is allowed in lieu of a gauge. If a Stauff-compatible fitting is not used, it is the responsibility of the individual BattleBot team to provide the appropriate gauges compatible with the test fittings of their BattleBot. The gauges must comply with the requirements specified in **9.8.4** for the gauge range values.

9.8.6 Pressure Test Accessibility

Design and placement of the gauges and/or test points must allow quick and safe reading of the pressure values. Specifically:

- a. Accessibility of the gauges and/or test points must be such that it requires no more than one (1) minute to read any test point pressures on a battle-ready BattleBot.
- b. Gaining access to and reading of the test-point pressures must not require placing any body part in the path of any weapon system or other powered moveable part of the BattleBot.

10.0 Mechanical Energy Storage Systems

10.1 Mechanical Storage Methods

There are two fundamental methods of storing energy mechanically: Potential energy and kinetic energy.

10.1.1 Potential Energy

Potential energy is stored using the deformation of an elastic medium. Pneumatics stores energy in a compressible gas. A spring stores energy by distorting a solid material.

10.1.2 Kinetic Energy

Kinetic energy is stored in the movement of a mass. The usual method of kinetic energy storage is a flywheel.

10.2 Pneumatics

Regulations for pneumatic systems are described in "8.0 Pneumatic Systems".

10.3 Large Springs

Large Springs are capable of storing a great deal of energy, which can be released very quickly. Thus, there are specific requirements on the use of Large Springs in BattleBots.

10.3.1 Large Spring Definition

A Large Spring is defined as any spring, or grouped combination of springs, that requires, at any point of its extension or compression, more than twenty (20) pounds of force to extend or compress the spring.

A Large Spring can use any type of spring mechanism, including coiled, torsion bar, beam, hairpin or coned-disk.

10.3.2 Deactivated Spring

Any Large Spring used on a BattleBot must be installed such that, in its Deactivated (unarmed) position, it is not exerting a force of more than ten (10) pounds on any component of the BattleBot.

10.3.3 Mounting

The mounting of any Large Spring must be such that at maximum strain, there is no observable deformation of the connections retaining the ends of the spring.

10.3.4 Arming Mechanism

Any BattleBot part powered by Large Spring must not be manually armed. All arming must be done via a remote-control method using a power source on-board the BattleBot.

10.3.5 Release Mechanism

Any Large Spring remote-controlled release mechanism must require a specific command from the remote transmitter to release an armed BattleBot part powered by a Large Spring.

10.3.6 Release Fail-Safe

Any Large Spring remote-controlled release mechanism must be designed such that, upon loss of transmitter signal, any armed BattleBot part powered by a Large Spring will not be released.

10.3.7 Safety Release

A safety mechanical release mechanism must be provided for releasing the spring force of any Large Spring with the following conditions:

- a. A single person must be able to activate a mechanism that releases the spring force.
- b. It must require no more than ten (10) seconds to release the spring force.
- c. Releasing the spring force must not require placing any body part in the path of any weapon system or other powered moveable part of the BattleBot.
- d. A special tool can be used to release the spring force. If a special tool is used, an additional spare tool must be made.

10.4 Flywheels

The amount of energy that can be stored by a flywheel is primarily constrained by the strength of the material used in its construction. However, flywheels can also take a considerable amount of time to absorb that energy ("spin up").

10.4.1 Flywheel Definition

A Flywheel refers to any heavy spinning disk used in or on a BattleBot. This includes the spinning exterior of a "Spinner" BattleBot. Small, thin saw blades and small rotary cutters are not considered to be Flywheels.

10.4.2 Flywheel Power

A Flywheel on a BattleBot cannot be used as a primary power source. That is, the Flywheel must be spun-up using another power source (batteries, fuel, HPA) stored on the BattleBot.

10.4.3 Flywheel Use Restrictions

A Flywheel may be used in the following ways:

- a. Directly as an impact or cutting weapon.
- b. Indirectly to drive an impact or cutting weapon.
- c. To gyroscopically stabilize or control the BattleBot.
- d. As an energy-storage device to drive a generator or pump.

Note: A Flywheel may not, either deliberately or inadvertently, be used as a fragmentation weapon, whereby the explosion of a Flywheel is used to damage an opponent.

10.4.4 Spin-Up

Notwithstanding any additional requirements in the BattleBots Tournament Rules and Procedures document, BattleBots Inc. will not allow a Flywheel to be spun up except in the BattleBox or in a designated Test Area.

10.4.5 Flywheel Safety

Any Flywheel design must comply with all the safety and spin-down requirements defined in "5.4 Spinning Parts".

10.4.6 Flywheel Design Requirements

To minimize the risk of using a Flywheel in a BattleBot, there are some specific design requirements:

- a. The Flywheel must be mounted securely to the BattleBot such that a force equal to twice the weight of the Flywheel, applied in any direction on the Flywheel, will not cause visible deformation of the Flywheel securing method.
- b. The Flywheel must be balanced to minimize vibration such that at maximum operating Flywheel speed, the BattleBot motion along the ground is fully controllable in all directions.

Note: BattleBots Inc. reserves the right to exclude any BattleBot Flywheel design that in its determination poses a safety risk to BattleBots participants or spectators.

10.4.7 Flywheel Deactivation

All Flywheels must have safety restraints, as defined in "2.9 Safety Restraints".

11.0 BattleBot Weapons

11.1 Weapon Design

11.1.1 Weapon Safety

Except when the BattleBot is in combat or is being tested, a BattleBot weapon system must be completely safe and non-hazardous to all personnel and objects in the vicinity of the BattleBot.

11.1.2 Weapon Activation and Deactivation

All weapons Activation and Deactivation must comply with all of the requirements of "5.3 Activation/Deactivation Requirements".

11.1.3 Damage to BattleBox

All BattleBots weapon systems must be designed such that, during normal operation, they will not materially damage the BattleBox floor, such that repairs would be required for the next scheduled match to proceed.

11.2 Entanglement Devices

A BattleBot cannot use any device specifically designed to entangle a competitor BattleBot.

11.2.1 Entanglement Device Definition

An Entanglement Device is a substance or material that, by itself, is not sufficient to cause any damage directly, but it serves only to foul one or more mechanisms of another BattleBot.

11.2.2 Entanglement Device Types

Entanglement devices include, but are not limited to the following:

- a. Any type of net.
- b. Fishing Line, string, rope, etc.
- c. Non-metal chain or cable.
- d. Ball Bearings or marbles.
- e. Adhesive-coated tape.
- f. "Liquid String" toy products.
- g. Metal filings or "wool"

11.2.3 Metal Chains and Cables

The classification of metal cables and chains as an Entanglement Device depends on the length and how they are used.

- a. A metal chain or cable will not be considered an Entanglement Device if it is less than one foot (1') in length.
- b. A chain or cable exceeding the length defined in **11.2.3a** may be considered an Entanglement Device, depending upon the extended length, the mounting location and the deployment method.

11.2.4 Grappling Hooks

A grappling hook weapon by itself is not considered an Entanglement Device.

A cable or chain holding a grappling hook may be considered an Entanglement Device if it is non-metal, or if it exceeds the length specified for metal chains and cables.

11.3 Projectiles

Projectiles can be used as a weapon on a BattleBot, with some restrictions:

11.3.1 Tether Required

Any projectile must be connected by a non-elastic tether to the structure of the BattleBot.

11.3.2 Tether Strength

The tether must be of sufficient strength such that it can by itself restrain the fired projectile without sustaining any damage, even after multiple firings.

11.3.3 Tether Length

The length of the tether as measured from the attachment point on the BattleBot to the tip of the projectile must be less than 8 feet.

11.4 Forbidden Weapons

In addition to any other restrictions in this document, the following weapons may not be used:

11.4.1 Electricity

Electricity or electric fields may not be used directly as weapon. This includes, but is not limited to:

- a. Stun guns and cattle prods.
- b. Radio jamming equipment.
- c. Electro-Magnetic Pulse output.

11.4.2 Liquids

No type of liquid may be used as, or in, a weapon. This includes, but is not limited to:

- a. Water or other liquids.
- b. Liquefied gasses.

- c. Chemicals or corrosives.
- d. Foaming liquids.
- e. Glues or adhesives.

11.4.3 Explosives

No type of explosive or rapidly burning substance may be used as or in a weapon. This includes, but is not limited to:

- a. DOT Class C devices.
- b. Gunpowder or cartridge primers.
- c. Military explosives.
- d. Sodium Azide.

11.4.4 Flammable Liquids and Gasses

No type of flammable liquid or gas may be used as, or directly in a weapon. This includes, but is not limited to:

- a. Gasoline, Alcohol, Ether, etc.
- b. Propane, Butane, Acetylene, etc.

11.4.5 Visual Obstruction

No weapon can be used to impair the vision of an opponent BattleBot's operator. This includes, but is not limited to:

- a. Heavy smoke, intentionally created.
- b. Lights or lasers directed at the operator.

11.4.6 Heat/Cold

No weapon can use heat or cold specifically generated to damage an opponent. This includes, but is not limited to:

- a. Flame Throwers
- b. Plasma Torches
- c. Liquefied Gasses

11.4.7 Non-Combustible Gas

A BattleBot cannot deliberately use a non-combustible gas to disable an opponent's fuel-burning engine.

11.4.8 Explosive Flywheel

Using a fragmenting flywheel as a weapon is considered to be using projectiles without restraining tethers, and is thus not allowed.

11.4.9 Mutually-Destructive Weapon

A Mutually-Destructive Weapon is designed with the intent that attacking an opponent will also disable the attacking BattleBot.

A BattleBot cannot deliberately use a battery, fuel tank, pneumatic tank, hydraulic accumulator or any similar component as a Mutually-Destructive Weapon.

11.5 Multiple Weapons

Multiple weapons are allowed. Each weapon is subject to all the constraints defined in this and other BattleBots documents.

11.6 Smothering or Covering

A BattleBot can use a weapon designed to partly or completely cover (smother) an opponent.

11.7 Laser or Light Homing

A BattleBot team can use a laser or other (non-coherent) light source to "paint" a target BattleBot, provided that the light source complies with the following:

11.7.1 Hand-Held Lasers

Hand-held targeting lasers are limited to Class IIIa or below, regardless of the frequency value of the light.

11.7.2 Non-Coherent Lights

Non-coherent targeting light sources must not be so bright that their reflection from a polished-metal BattleBot will distract or blind the opponent, the Referees or the Judges.

Ultra-violet light sources cannot be used in BattleBots as specified in "2.12.5 Ultra-Violet Lighting".

11.8 Airbags/Balloons

A BattleBot may use airbags or balloons as a weapon, providing that:

- a. The inflation of any airbag is accomplished using a pneumatic system that complies with the standards defined in "8.0 Pneumatic Systems".
- b. The maximum volume of any airbag is 33.5 cu. ft. (a 4-foot sphere).
- c. A deflated airbag/balloon is not used as an entanglement device.

Note: Automotive airbag inflators are specifically prohibited since they use Sodium Azide.

12.0 BattleBot Appearance

12.1 External Appearance

The exterior appearance and design of a BattleBot must project the image of BattleBots as an aggressive yet "clean" sporting activity. Therefore, the appearance of a BattleBot must conform to some requirements.

12.1.1 Suitable for TV

The BattleBot exterior surfaces cannot contain any words, pictures or graphics that cannot be broadcast on national network or cable television.

12.1.2 Suitable for Children

The BattleBot exterior surfaces cannot contain any words, pictures or graphics that are not suitable for viewing by young children.

12.1.3 Non-Offensive

The BattleBot design and exterior surfaces must not embody any words, pictures or graphics that impugn religious organizations, racial groups or nationalities, or are publicly indecent or offensive.

12.2 Advertising and Graphics

Advertising can be displayed on a BattleBot with the following restrictions:

12.2.1 Good Taste

All advertising on a BattleBot must be in good taste.

12.2.2 Safety Devices

Any stickers or appliqués must not interfere with the use or operation of any safety devices used on the BattleBot.

12.2.3 Advertising Conflicts

Any advertising must not conflict with BattleBots Inc., its affiliates, its sponsors, or its affiliates' sponsors in any way.

12.3 BattleBots Rights

BattleBots Inc., at its sole discretion, reserves the right to require removal or modification of any sponsor logos, signage or other materials or designs that it determines are offensive or in conflict with the regulations of **12.1** and **12.2**.

12.4 Appearance Questions

If there are questions on the external appearance of a BattleBot, request a clarification from BattleBots Inc. as specified in "1.5 Contacting BattleBots".