Professional Class

College Class

Building Rules

2009 Season

BattleBots Inc.
1024 Nimitz Ave
Building 140 - Mare Island
Vallejo, CA 94592

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1.0 DECLARATIONS

1.1 SAFETY/WARNING NOTICE

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

1.2 BATTLEBOTS ENTRY CLASSES

There are three Entry Classes of combat robots that may compete in BattleBots Tournaments: The Professional Class, the College Class and the High-School Class. Robots in each Class compete with other robots in the same Class, but not against other Classes.

1.2.1 COLLEGE CLASS

College Class Teams are composed of students and instructors from bona fide Colleges, Universities or other Post-Secondary schools.

1.2.2 PROFESSIONAL CLASS

Professional Class ("Pro Class") Teams have no general affiliation restrictions and may include members of High School and College Class Teams.

1.2.3 PRO/COLLEGE RULES APPLICABILITY

The College Class and the Pro Class robots have different weight limits. However, all other rules in this document apply equally to both Classes.

There are some restrictions on Team membership in both the College Class and the Pro Class.

1.2.4 HIGH-SCHOOL CLASS

High-School Class Teams are composed primarily of students from High Schools, Middle Schools, or legally-established youth organizations. The Building Rules for the High-School Class are different from these Pro/College Rules and are published in a separate document.

Note: For additional information and clarification of the BattleBots Entry Classes and Teams, refer to the BattleBots Tournament Rules document.

1.2.5 INNOVATIVE ROBOTS

BattleBots Inc. wants to encourage unusual and creative robot designs. College and Professional Teams can apply to enter a robot that uses innovative and novel design features, even if that robot does not meet all the requirements in these Rules.

The robot may be entered for display and/or demonstration purposes. If it is within the weight limit for its Class, it may be allowed to compete in robot combat, subject to the approval of the BattleBots Executive Officers.

To inquire whether a proposed robot could qualify as an Innovative Robot, contact BattleBots Inc, as specified in "1.7 CONTACTING BATTLEBOTS".

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1.3 GENERAL DEFINITIONS

1.3.1 BATTLEBOTS INC.

"BattleBots Inc." ("BattleBots") 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.

1.3.3 BATTLEBOTS OFFICIALS

"BattleBots Officials" are authorized employees or agents of BattleBots Inc., who have jurisdiction in certain, possibly overlapping, BattleBots activities.

1.3.4 BATTLEBOTS-COMPLIANT COMBAT ROBOT

A "BattleBots-Compliant Combat Robot" ("BattleBots Robot") is a combat robot whose design, construction and decoration comply with all the rules and restrictions contained in this and other relevant BattleBots documents.

1.3.5 ENTRANT

An "Entrant" is a Team that has registered for entry into a BattleBots contest.

1.3.6 CONTESTANT

A "Contestant" is an Entrant whose entry into a BattleBots contest has been accepted by BattleBots Inc., and whose combat robot has passed the Safety/Tech inspection, and is thus allowed to compete in the contest.

1.3.7 BATTLEBOX

The "BattleBox" is the arena in which BattleBots combat takes place.

1.4 DOCUMENTS AND INFORMATION SOURCES

Multiple documents and information sources define the requirements for participation in a BattleBots Tournament. All Entrants must be familiar with the contents of these documents and sources.

1.4.1 PRIMARY DOCUMENTS

These Pro/College Class BattleBots Building Rules ("Building Rules") define the requirements specific to the design and construction of a Pro/College BattleBots Robot.

The BattleBots Tournament Rules define the operational rules for a safe, fair and efficient BattleBots Tournament.

There may be other BattleBots documents that provide additional information.

1.4.2 BATTLEBOTS INTERNET INFORMATION

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

BattleBots Inc. may send e-mail messages to current and former Entrants to provide event and/or competition-specific information on a timely basis.

1.4.3 ENTRANT RESPONSIBILITY

It is the sole responsibility of every potential Entrant to verify that they are referencing the last-updated version of any BattleBots document available on the BattleBots website. It is also each Entrant's responsibility to check their e-mail regularly.

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1.5 BATTLEBOTS INC. EXCLUSION PRIVILEGES

Authorized BattleBots Officials may exclude from competition any combat robot that, due to its design, construction or usage, they judge to be a hazard to safe competition, even if that Robot has met all of the requirements in these Building Rules or any other BattleBots document.

BattleBots Executive Officers may at any time exclude from entry or disqualify from competition any robot for any reason.

1.6 RULES INTERPRETATION

1.6.1 APPLICABILITY

These Pro/College Building Rules supersede all previously-published rules and regulations regarding Pro/College Class BattleBots Robot design and construction requirements.

1.6.2 OVERLAPPING/CONFLICTING REQUIREMENTS

A reasonable effort is made to ensure that the requirements in all BattleBots documents are self-consistent. However, in case of an inconsistency:

a. If any requirements appear to overlap, then the effective requirement will be the combination of all of the overlapping requirements.

b. If any requirements appear to conflict, then the effective requirement will be the most restrictive of the conflicting requirements.

1.6.3 ADDITIONAL REQUIREMENTS

At the discretion of BattleBots Executive Officers, additional rules and requirements may be applied to all potential or qualified BattleBots Robots, or to all such robots in a specific Entry Class.

1.6.4 FINAL AUTHORITY

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

1.6.5 CHANGE PUBLICATION

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

1.6.6 RULES CLARIFICATION

If a proposed combat robot's configuration or component design is not adequately addressed by the rules set forth in this document, it is the builder's responsibility to contact BattleBots Inc. for clarification in advance of constructing the robot.

The sole responsibility of BattleBots Inc. will be to notify the requestor if the proposed design does not comply with these Building Rules. BattleBots Officials cannot and will not provide any guarantees that a robot will be accepted to compete in a BattleBots Tournament.

No "waivers", release forms or other documents will be issued to allow a robot to compete if that robot does not meet the Rules, as interpreted by BattleBots Officials, defined herein.

1.7 CONTACTING BATTLEBOTS INC.

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

Address: BattleBots Inc.
1024 Nimitz Ave.
Bldg. 140 – Mare Island
Vallejo, CA 94592

E-mail: rules@battlebots.com

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

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2.0 GENERAL REQUIREMENTS

2.1 WEIGHT LIMITS

Professional Class and College Class BattleBots Robots have different maximum weight requirements.

Note: Refer to the BattleBots Tournament Rules for information on the exact weighing procedures.

2.1.1 NON-WALKER WEIGHTS

Non-walking Entry Classes are defined by the robot's measured weight, as follows:

a. College-Class Maximum Weight: **120.0 pounds**
b. Professional-Class Maximum Weight: **220.0 pounds**

2.1.2 STOMPBOT WEIGHTS

A robot that uses walking locomotion may qualify as a "StompBot", and be allowed the following weights:

a. College-Class StompBot Maximum Weight: **160.0 pounds**
b. Professional-Class StompBot Maximum Weight: **300.0 pounds**

For a robot to qualify as a StompBot, it has to meet the requirements defined in **Appendix C** of this document.

*Note: If there are questions on whether a robot would qualify as a StompBot, check with BattleBots Inc. as specified in "*1.7 CONTACTING BATTLEBOTS*" before beginning construction.*

2.1.3 ITEMS INCLUDED/EXCLUDED IN WEIGHT

The robot's weight is defined in its battle-ready configuration, with all fluids, gasses and accessory items on board. Safety covers and safety restraints can be removed.

BattleBots-approved, media-supplied remote camera and/or audio systems are excluded from the allowed weight. However, those items need to be removable in case of any weight check dispute.

2.1.4 MODULAR DESIGN WEIGHT

If a robot is of a modular design, allowing interchangeable components, the robot will be weighed in its heaviest configuration.

Note: There are restrictions on exchanging parts between different BattleBots Robots. Refer to the BattleBots Tournament Rules document.

2.2 SIZE AND MOBILITY

2.2.1 SIZE LIMIT REQUIREMENTS

BattleBots Robot size limit requirements are:

a. In its pre-battle configuration, the robot can be moved on its transport cart up the entrance ramp of the BattleBox and through the **8 foot** wide by **8 foot** tall entry door.
b. With all of its moveable parts fully open and/or extended, the robot can be moved through the **8 foot** wide by **8 foot** tall BattleBox exit door and down the exit ramp.
c. BattleBox entry or exit does not require any robot assembly or disassembly.
d. In pre-battle configuration, the robot fits inside an **8 x 8 foot** square area.

*Note: If a robot is longer than 5 feet or wider than 4 feet, notify BattleBots Inc. as specified in "*1.7 CONTACTING BATTLEBOTS*", as the robot may require a special pit location.*

2.2.2 SPEED/MOBILITY REQUIREMENTS

A BattleBots Robot has to be able to move at a speed of at least **two feet-per-second** in an approximately straight line.

A BattleBots Robot has have a turning/rotating radius such that it can make 360° turns in either direction (left or right) while all parts of the robot remain within a **12 foot** circle.

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2.3 CONSTRUCTION MATERIALS

To minimize BattleBox fouling and risk to BattleBots personnel, there are limitations on the materials used to construct a BattleBots Robot.

2.3.1 GENERAL RESTRICTIONS

In general, hazardous or dangerous materials are forbidden from use anywhere on the robot where they may contact humans, even if the robot has been seriously damaged.

Note: If there is a question on robot construction materials, check with BattleBots Inc. as specified in "1.7 CONTACTING BATTLEBOTS" before beginning construction.

2.3.2 RESTRICTED-USE CONSTRUCTION MATERIALS

Certain materials can only be used as follows:

a. Lead (Pb) metal cannot be exposed on the exterior of the robot.
b. Rigid plastic foams (e.g., PVC, Polystyrene, Polyurethane) cannot be exposed on the exterior of the robot.
c. Exposed permanent magnets have to be attached to the robot using adhesive (e.g., epoxy, silicone) or some mechanical means (e.g., screws).
d. Expanding liquid foam cannot be used anywhere in the robot where it encapsulates or otherwise obscures any wiring, plumbing or other non-structural part of the robot.
e. Toxic or reactive metals (e.g., Cadmium, Mercury, Lithium) can only be used within on-board batteries, subject to the restrictions defined in "5.2.1 ALLOWED BATTERY TYPES".

2.3.3 CONSTRUCTION MATERIALS NOT ALLOWED

The following types of materials cannot be used in a BattleBots Robot:

a. Radioactive materials.
b. Toxic or hazardous fibers (e.g., asbestos, loose fiberglass).
c. Brittle, easily-breakable glass or ceramics (e.g., plate glass).

2.4 SAFETY COVERS AND RESTRAINTS

Safety Covers and Restraints are required to protect people from injuring themselves due to contact with the robot's exterior.

All covers, restraints and protection devices:

a. Have to be attached using a positive securing method such as a wire loop, bungee cord, locking pin or other mechanical retention system.
b. Cannot be attached using friction, an adhesive, adhesive tape or any other method that can deteriorate with repeated use.

2.4.1 SAFETY COVERS

Safety Covers are pads or blocks mounted on all external sharp points, corners and edges on the exterior of the robot, installed such that they will prevent injury to someone bumping or striking those parts.

2.4.2 PINCH HAZARD RESTRAINT

Pinch Hazards are where a body part (such as a finger) can be squeezed between external robot parts that can freely move relative to one another. A pinch hazard restraint can be either:

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

2.4.3 MOTION HAZARD PROTECTION

Motion Hazards are where the driven movement of a weapon or other robot part can strike a person with injurious force. Motion hazard protection can be either:

a. A pin, block, chain or other similar restraint that will prevent significant movement of a hazardous part.
b. A method of physically disconnecting the actuator from the hazardous part, such that any exterior parts cannot move in a hazardous fashion.

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2.4.4 INSTALLATION AND REMOVAL

Installation and removal of any restraint cannot require placing any body part in the path of any moveable part of the robot, as required in "4.2.3 ACTIVATION/DEACTIVATION CONDITIONS".

2.5 LIGHTS AND SOUND

2.5.1 LASER LIGHTS

No external laser lights can be mounted on a BattleBots Robot. Lasers may be used internal to the robot for operational purposes.

2.5.2 NON-LASER LIGHTING

Non-laser lighting installed on a BattleBots Robot is limited as follows:

a. Any lighting cannot be distracting to other Contestants or to BattleBots Officials.
b. Ultra-violet lights ("Black Lights") cannot be used on or in any part of the robot.

2.5.3 SOUND

The sound level emitted from a BattleBots Robot cannot exceed **120 dB(A)** as measured in an open area, **10 feet** from the robot in any direction.

2.6 FLAME AND SMOKE EFFECTS

Flames and smoke intended for "effects" or showmanship may be allowed subject to the restrictions defined below.

2.6.1 FLAME EFFECTS

A BattleBots Robot can contain a mechanism to generate external flames, subject to the following requirements:

a. The only two fuel types allowed are **propane** and **butane**.
b. The maximum allowed quantity of fuel is **8 fluid ounces**.
c. The flame effect can be started and stopped at will using the remote control. Fuel shut-off must be immediate.
d. Fuel exiting the robot must be ignited as a gas, not as a liquid or gel.
e. The fuel tank must be as far from the outer shell of the robot as practical, and be protected or insulated from any interior heat sources.

Note: This flame effect allowance is subject to change or deletion to comply with local fire regulations. Refer to the BattleBots Tournament Rules for additional information.

2.6.2 SMOKE EFFECTS

A BattleBots Robot can contain a mechanism to generate smoke effects subject to the following requirements:

a. The smoke effect can be started and stopped at will using the remote control.
b. The smoke is non-toxic.
c. The smoke does not significantly obscure the robot or its opponent.

*Note: If there are questions on whether a robot's flame and/or smoke effects will be allowed, check with BattleBots Inc. as specified in "*1.7 CONTACTING BATTLEBOTS*".*

2.7 SPECIAL CONFIGURATIONS

2.7.1 MULTIBOTS

A MultiBot is defined as a robot composed of **two or more** individual controllable segments that compete together as a single robot. MultiBots are allowed subject to the following:

a. All applicable rules for BattleBots Robot design, construction and fail-safe apply to each individual MultiBot segment.
b. All limits, such as weight, size, fuel capacity, pneumatic storage, etc, apply to the combination of all MultiBot segments.
c. For a MultiBot to get the additional StompBot weight allowance, as defined in "2.1.2 STOMPBOT WEIGHTS", all of the MultiBot segments have to qualify as StompBots.

Note: The judging of a tournament Match involving a MultiBot may depend upon the relative weights of the segments. Refer to the BattleBots Tournament Rules.

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2.7.2 AUTONOMOUS ROBOTS AND SUB-SYSTEMS

An autonomous function is one that moves the robot, seeks a target or operates a weapon independently of any remote control input. Control feedback devices such as steering gyros and motor speed servos are not considered to be autonomous components.

*Note: If there are questions whether a robot or sub-system qualifies as autonomous, check with BattleBots Inc. as specified in "*1.7 CONTACTING BATTLEBOTS*".*

Autonomous BattleBots Robots and autonomous sub-systems are allowed, provided that:

a. When the robot is Activated, all autonomous functions are initially disabled, and require a specific remote command to become enabled.
b. The robot's remote control can be used to override and stop any and all robot and sub-system autonomous motion.
c. All autonomous systems must failsafe to OFF if there is loss of power or radio signal. They must also comply with the other requirements of "3.1.3 FAIL-SAFE OPERATION".
d. The robot has a clearly visible external light to indicate when any autonomous system is enabled.
e. Any autonomous system will automatically disable itself within **4 minutes** after the last time it received a remote enable command.

2.7.3 HOPPING/JUMPING

A hopping or jumping BattleBots Robot is allowed provided that:

a. The maximum jump height is <u>less than</u> **6 feet**.
b. The landing of a hopping/jumping robot does not materially damage the BattleBox floor or walls, where repairs would be required for the next scheduled Match to proceed.

2.7.4 GROUND-EFFECT MACHINES

Ground-effect (Hovercraft) BattleBots Robots are allowed, provided that any lift 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 ground-contact devices is allowed.

2.7.5 JET OR ROCKET POWER

A BattleBots Robot cannot use jet or rocket power for movement or any other purpose. One or more propellers (ducted or unducted) may be used to provide movement and/or lift for a ground-effect machine.

2.7.6 POWERED FLIGHT

A BattleBots Robot cannot move using powered flight. Moveable or fixed aerodynamic devices may be used for cooling and control, but cannot provide substantial lift in the absence of ground effects.

2.8 EXTERNAL DESIGN AND DECORATION

The exterior design and appearance of a BattleBots Robot is expected to conform to general standards of public decency, and to also consider the commercial sponsors of BattleBots Inc.

2.8.1 EXTERIOR APPEARANCE

The robot’s design and exterior surfaces cannot embody any form, words, pictures or graphics that impugn religious organizations, nationalities or racial groups, or are publicly indecent or offensive.

BattleBots Inc., at its sole discretion, reserves the right to require removal or modification of any external markings, materials or designs that it determines are offensive or inappropriate.

2.8.2 SPONSORSHIP SPACE ALLOCATION

BattleBots Inc. may make arrangements with certain advertisers and sponsors ("Sponsors").

A BattleBots Robot is required to allocate space on the visible exterior of the robot for <u>a minimum of</u> **two** separate **5 inch** by **8 inch** “TV Panels” to be used by BattleBots Sponsors for the display of Sponsor logos. At BattleBots' discretion, <u>additional</u> panels may be required, using up to a maximum of **25%** of the external visible area of the robot's chassis. The locations of the panels are to be, where possible, on diametrically opposite sides of the Robot.

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The size, number and placement of the TV Panels may be modified by mutual agreement between BattleBots Inc. and the Team, taking into account the nature and structure of the robot.

Note: Refer to the BattleBots Tournament Rules and all BattleBots Tournament entry documents for additional information on BattleBots sponsorship requirements and restrictions.

2.8.3 ADVERTISING

All Builder-applied advertising on the exterior of a BattleBots Robot must be in good taste and cannot conflict with BattleBots Inc., its affiliates, its Sponsors, or its affiliates' Sponsors in any way.

BattleBots Inc., at its sole discretion, reserves the right to require removal or modification of any logos, signage or designs that conflict with any Sponsors of a BattleBots Tournament.

*Note: If there are questions on a robot's advertising and sponsorship, check with BattleBots Inc. as specified in "*1.7 CONTACTING BATTLEBOTS*".*

2.8.4 EXTERIOR ROBOT NAME

The robot's official name has to be clearly marked on the exterior of the robot in letters at least **1/2 inch high**. The name has to be visible and readable when the robot is in its normal pre-battle configuration with all safety covers and restraints installed.

2.8.5 WARNING MARKERS

BattleBots Robots using certain components or systems are required to have special color-coded markers permanently attached and clearly visible on both the top and bottom of the robot. Each marker has a minimum size of **2 by 2 inches** and may be larger. Depending upon the robot's configuration, it may require more than one marker type as follows:

a. A robot with a pneumatic system requires **Red Markers**.

b. A robot using High Voltage Electronics requires **Blue Markers**.

c. A robot using Lithium-Polymer batteries requires **Yellow Markers**.

BattleBots Inc. will supply the appropriate markers at the Tournament, but adequate space must be provided on the robot's exterior for their application.

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3.0 REMOTE CONTROL

3.1 REMOTE OPERATION

3.1.1 OPERATOR

An "Operator" is defined as a person who remotely controls the robot during combat.

Control of a BattleBots Robot cannot require more than **two** Operators.

Note: Refer to the BattleBots Tournament Rules document for additional information and restrictions regarding Operators.

3.1.2 CONTROL METHODS

Primary control and communication between a BattleBots Robot and its Operator(s) has to be via a wireless link. Tethered control is specifically not allowed.

There are no specific restrictions on the mechanics of the controller itself, provided that it can be easily transported to the BattleBox, does not interfere with other Contestants or BattleBots Officials, and can be operated by no more than the number of Operators specified in "3.1.1 OPERATOR".

3.1.3 FAIL-SAFE OPERATION

All BattleBots Robots require a robust fail-safe system that electronically or mechanically shuts off all motion-system and weapons power within **two seconds** after either:

a. The remote-control transmitter is switched off, or otherwise stops transmitting.
b. The remote-control receiver electrical power is lost.

3.1.4 INTERFERENCE

A BattleBots Robot's remote control equipment cannot:

a. Cause interference with any event communications and broadcast equipment.
b. Be susceptible to interference from any event communications and broadcast equipment.
c. Interfere with the operation of any commercially-available remote controllers.

Note: Refer also to the BattleBots Tournament Rules document for additional rules related to Interference.

3.2 LEGACY RADIO CONTROL EQUIPMENT

Old-style, commercial R/C equipment in the 27 MHz to 75 MHz band can be used to control a BattleBots Robot, subject to the restrictions below:

3.2.1 EQUIPMENT REQUIREMENTS

a. The equipment must use FM Pulse-Code Modulation (**FM/PCM**) with a built-in or programmable fail-safe.
b. Only ground R/C frequencies (27, 40, 50, 53 and 75 MHz bands) may be used.
c. FM/PPM, FM/IPD and any AM equipment is specifically not allowed.
d. R/C equipment operating in the 72 MHz band is specifically not allowed.

3.2.2 NUMBER OF FREQUENCIES

A single robot or MultiBot cluster using Legacy R/C Equipment can use a maximum of **three** different R/C frequencies for control.

3.2.3 CHANGING FREQUENCIES

If the R/C equipment uses crystals (rather than frequency synthesis), then:

a. The R/C equipment and robot design have to allow for the simple and rapid changing of frequency crystals.
b. The Competitor must have **two or more** sets of crystals that allow operation on different frequencies.

3.2.4 RULE CHANGE DATE

Effective **July 1, 2009**, Legacy Radio Control Equipment will no longer be allowed to be used at any BattleBots Tournament.

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3.3 2.4 GHZ DSS CONTROLLERS

Commercially-available 2.4 GHz digital spread-spectrum radio controllers are allowed provided that they have a fail-safe that complies with the requirements of "3.1.3 FAIL-SAFE OPERATION".

BattleBots Inc. recommends using the Spektrum DX6 or DX7 controller with the BR6000 receiver. The DX6 or DX7 transmitter can be used only with the BR6000 receiver.

3.4 IFI ROBOTICS CONTROLLERS

BattleBots Inc. allows the use of 900 MHz robot controller systems by IFI Robotics (IFI).

3.5 CUSTOM REMOTE CONTROL EQUIPMENT

Custom-made remote-control equipment may be allowed if it meets certain requirements.

3.5.1 RADIO EQUIPMENT REQUIREMENTS

Custom radio control equipment is subject to the following:

a. Equipment that uses the 27, 40, 50, 52 or 75 MHz frequency bands cannot use more frequency channels than specified in "3.2.2 NUMBER OF FREQUENCIES".
b. The equipment cannot use any frequency band disallowed by FCC rules.
c. The transmitter cannot exceed the maximum power allowed by FCC rules.
d. If the equipment's frequency band is restricted to FCC licensed users, the Operator(s) are required to have the appropriate license(s).
e. The equipment cannot cause Interference, as defined in "3.1.4 INTERFERENCE".

3.5.2 NON-RADIO REMOTE CONTROLLERS

Wireless remote controllers that use light waves for control are permitted provided that the communication method:

a. Uses light in the non-visible infrared region.
b. Does not interfere with or otherwise cause problems with video recording equipment.
c. Demonstrates that control is not affected by any ambient lighting conditions.

Remote controllers using sound waves are specifically not allowed.

3.5.3 BATTLEBOTS AUTHORITY

Notwithstanding any other requirements, BattleBots Inc. has the sole discretion and final authority to determine if specific Custom Remote Control Equipment will be allowed to be used on a robot.

*Note: If there is a question on a custom R/C system, check in advance with BattleBots Inc. as specified in "*1.7 CONTACTING BATTLEBOTS*".*

3.6 TELEMETRY

Telemetry from a BattleBots Robot is allowed, provided that the telemetry does not cause Interference, as defined in "3.1.4 INTERFERENCE".

3.7 EXTERNAL CONTROL EQUIPMENT

A BattleBots Robot may employ external equipment located outside the BattleBox as part of its combat control, location or targeting system.

External control equipment, at a minimum, has to:

a. Be set-up easily within **two minutes** prior to a Match.
b. Be removed easily within **two minutes** after a Match.
c. Not interfere with another Contestant or with any BattleBots personnel.
d. Not significantly interfere with the live audience's visibility.
e. Not cause Interference, as defined in "3.1.4 INTERFERENCE".

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4.0 ACTIVATION AND DEACTIVATION

4.1 STATES DEFINITIONS

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

4.1.1 DEACTIVATED STATE

A BattleBots Robot in its Deactivated State meets the following minimum requirements:

a. Remote control transmitters are off.
b. Electrical primary-power Master Switches are OFF.
c. The pneumatic system is depressurized downstream of any pressure tank shut-off.
d. All hydraulic system components are depressurized.
e. No internal or external parts are moving.
f. Tension on spring-loaded devices is released.
g. Safety Covers and Restraints are installed.

A BattleBots Robot must be designed and built so that at any time when it is not in combat or being tested, it is completely safe and non-hazardous to all personnel and objects near the robot.

4.1.2 ACTIVATED STATE

A BattleBots Robot in its Activated State is defined as being in battle-ready condition, as it would be at the start of a competition Match.

4.2 ACTIVATION/DEACTIVATION REQUIREMENTS

Activation and Deactivation are the processes of changing the robot between the Activated and Deactivated states.

4.2.1 ACTIVATION TIME

With the robot on the ground in a completely Deactivated state, the Activation of a BattleBots Robot cannot require more than **60 seconds**.

4.2.2 DEACTIVATION TIME

Starting with the battle-ready, Activated robot on the ground in any stable position (including upside-down), the Deactivation of a BattleBots Robot cannot require more than **60 seconds**.

The Deactivation time limits include any time that may be required to right an upside-down robot in order to gain access to switches or valves.

4.2.3 ACTIVATION/DEACTIVATION CONDITIONS

To minimize risk to personnel, the Activation and Deactivation sequences cannot require:

a. More than **one person** to perform each sequence.
b. A person to place any body part in the path of any weapon system or any other powered part of the robot that can cause injury.
c. A person to place any body part inside the external frame or shell of the robot.
d. A person or the robot to balance or be balanced in any unstable position.
e. The installation or removal of any panels, covers or fasteners from the robot, other than the Safety Covers and Restraints.

4.2.4 ACTIVATION/DEACTIVATION TOOLS

Special tools may be used for Activation and Deactivation subject to the following:

a. A maximum of **two** tools or devices can be used for the Activation and Deactivation.
b. Any tool is required to have an identical backup spare.

4.2.5 MULTIBOT REQUIREMENTS

For the purposes of Activation and Deactivation, the combined MultiBot segments are considered to be a single BattleBots Robot and have to collectively meet all Activation and Deactivation conditions.

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5.0 ELECTRICAL POWER

5.1 VOLTAGE LIMITATIONS

These voltage limitations are intended to minimize the risk of shock to builders and others that may handle the robot.

5.1.1 STANDARD VOLTAGE LIMITS

The maximum nominal voltage aboard a BattleBots Robot is **36 DC Volts** or **36 AC RMS Volts**. It is understood that fully-charged batteries will have voltages approximately 10% higher than the specified nominal value

Switching transients above the nominal voltages are allowed provided that the transients are the result of normal operation and not generated to increase the average voltage level.

5.1.2 HIGH DC VOLTAGE

DC Voltages higher than above the limits may be accepted in a BattleBots Robot provided that the robot fully complies with certain specific additional requirements specified in **Appendix D**.

5.1.3 IGNITION SYSTEM VOLTAGE

Fuel-powered engine ignition systems and flame-effect igniters use high-voltage sparks. This is allowed provided that the ignition system is generating the high voltage only to provide the ignition spark.

5.2 ELECTRICAL POWER SOURCES

BattleBots Robot electrical power sources have to, at a minimum, comply with requirements below.

5.2.1 ALLOWED BATTERY TYPES

Only commercially available batteries of the following types can be used:

a. Dry-cell batteries (e.g., Zinc-Carbon, Alkaline)
b. Leakproof Lead-Acid. Refer to **Appendix A**.
c. Nickel-Cadmium (Ni-Cad) and Nickel-Metal Hydride (Ni-MH).
d. Lithium-Ion (Li-Ion) batteries. Refer to **Appendix B** for Li-Ion examples.
e. Lithium-Polymer (LiPo) batteries. These are subject to the installation and special handling procedures defined in **Appendix B**.

5.2.2 BATTERY MOUNTING

All batteries have to be securely mounted and located so that they are enclosed within the structural frame of the robot and reasonably armored against impacts.

5.2.3 CAPACITORS

All electrolytic-type capacitors have to be securely mounted and located so that they are enclosed within the structural frame of the robot.

5.2.4 GENERATORS AND ALTERNATORS

Generators and Alternators can be used on a BattleBots Robot, provided that their voltage output complies with the requirements of "5.1 VOLTAGE LIMITATIONS".

5.3 ELECTRICAL SYSTEM REQUIREMENTS

The electrical system has to be designed and constructed to minimize the possibility of a short circuit or electrical arcing.

5.3.1 BATTERY POWER MASTER SWITCH

A BattleBots Robot's electrical system is required to have a Master Switch or a combination of Master Switches that:

a. Directly shut off power from all on-board batteries, and not indirectly shut off power using a relay or contactor.

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b. Be completely mechanical and operate directly to make or break the circuit, without any electronic components.
c. Be a two-position switch that is stable in both the ON and OFF positions. Momentary-operation and push-on/push-off Master Switches are not allowed.
d. Be an enclosed type, so that any electrical arcing will occur on the interior of the switch.

A removable link may be used in lieu of a Master Switch if the link complies with all of the above requirements.

If a battery is connected to a conductive robot chassis, a Master Switch is required to cut power between the battery and the chassis.

5.3.2 ELECTRICAL WIRING

Electrical wiring must be installed such that:

a. Multi-stranded wiring is used for connecting the batteries to the input of any Master Switch.
b. Exposed terminals and bare wire-ends from the batteries to the Master Switch(es) are covered with electrical insulation.
c. All wires are insulated using the factory-applied insulation and/or heat-shrink tubing and/or quality electrical tape.

Non-electrical type tapes (e.g., duct tape, masking tape) cannot be used for insulation.

5.3.3 POWER INDICATOR LIGHT

A BattleBots Robot has to have an easily visible external light, or combination of lights, that is/are automatically lighted whenever any Master Switch is turned on.

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6.0 FUEL-POWERED ENGINES

6.1 COMBUSTION ENGINE

Internal and external-combustion engines can be used aboard a BattleBots Robot, subject to the requirements specified below.

6.1.1 ALLOWED ENGINE TYPES

A Combustion Engine can be any of the following types:

a. Internal Combustion Engine (ICE) with a rotating output shaft.
b. Turbo-Shaft.
c. External Combustion Engine (e.g., Steam, Sterling).
d. Internal combustion linear ram.

Note: Turbo-Jet and Pulse-Jet engines are not allowed, as specified in "2.7.5 JET OR ROCKET POWER".

*Note: Before constructing or designing-in an External Combustion Engine, contact BattleBots Inc. as specified in "*1.7 CONTACTING BATTLEBOTS*".*

6.1.2 FUEL TYPES

Only commercially-available fuels can be used to power a Combustion Engine; custom blends cannot be used. Allowed types are:

a. All grades of Unleaded Gasoline.
b. All types of Diesel Fuel.
c. Kerosene.
d. Glow-plug 2-stroke fuel blends, as is sold at hobby supply outlets. The blend cannot contain more than **40% Methanol** or **10% Nitromethane** by volume.

Oil is allowed to be mixed into the fuel for use in 2-stroke engines.

6.1.3 FUEL QUANTITY LIMITS

The amount of fuel allowed aboard a BattleBots Robot is based on the Entry Class, as follows:

a. College Class: **8 fluid oz.**
b. Professional Class: **12 fluid oz.**

These limits include any lubricating oil blended into the fuel.

6.1.4 REMOTE STARTING

Any continuous-operation combustion engine on a BattleBots Robot is required to have an on-board self-starting mechanism. This mechanism has to be activated using a specific command from the remote-control radio.

6.1.5 COMBUSTION-ENHANCING GASSES

Use of combustion-enhancing gasses (e.g., NOx, ether) is specifically prohibited.

6.1.6 ENGINE EXHAUST

The engine exhaust system must be installed such that:

a. Any engine exhaust system pipe or muffler is isolated or insulated from any fuel tank or fuel line on the robot.
b. The exhaust is not directed toward any fuel or oil supply tank, any fuel or oil line, or any pneumatic or hydraulic component on the robot.
c. The exhaust is not vented to the interior of a fully enclosed robot.
d. Any external muffler or exhaust pipe has a protective heat shield.

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6.2 FUEL SYSTEM

Liquid fuels pose serious fire and BattleBox fouling risks. Thus, the storage and use of fuels on board a BattleBots Robot are subject to several safety requirements.

6.2.1 FUEL TANK SIZE

Fuel tanks have to be built or modified so that they cannot contain more than **16 fluid ounces** of fuel.

6.2.2 PRESSURIZED FUEL TANKS

Pressurized fuel tanks are not allowed. All fuel tanks have to be either vented to atmospheric pressure, or else be an unpressurized bladder type.

6.2.3 FUEL TANK REQUIREMENTS

Fuel tanks have to be designed and installed such that:

a. A tank cannot continuously leak fuel if the robot is inverted.
b. The tanks are securely mounted and located so that they are reasonably protected within the structural frame of the robot.
c. Rigid fuel tanks are made of metal, fiber composite, or impact-resistant plastic.
d. Bladder-type fuel tanks are enclosed in a conformal rigid container made of metal, fiber composite, or molded impact-resistant plastic.
e. The fuel filler cap is a screw-on or otherwise positively retained. Press-in (cork-like) fuel caps are not allowed.
f. Tanks are isolated or insulated from any heat-producing components.
g. Gaining access to and adding fuel to any tank does not require placing any body part in the path of any battery-powered moveable part of the robot.
h. Any spillage during tank refueling does not result in the puddling of fuel inside the robot.

6.2.4 FUEL LINE INSTALLATION

Fuel lines have to be installed such that:

a. A fuel line is not exposed on the exterior of the robot. Fuel lines are either located in the interior of the robot, or are shielded by metallic protective armor that completely covers the fuel line.
b. The ends of all fuel lines, including at valves and manifolds, are retained with either a secure clamp or a screw-on fitting.
c. Any valves or manifolds on the fuel line between the fuel tank and the engine are attached to or supported by the robot's structure.
d. Fuel lines are constrained to prevent vibration or impact loading from breaking the fuel line or from tearing a fuel line loose from its fittings.
e. Fuel lines are isolated or insulated from any heat-producing components.

6.2.5 FUEL PUMPS

Mechanical fuel pumps driven by the engine are allowed provided that pump operation stops when the engine stops.

Electrical fuel pumps must:

a. Have a remote-controlled shut-off that immediately stops the operation of the fuel pump.
b. Shut-off immediately if the remote-control radio signal or receiver power is lost.

Any external fuel line from the fuel pump to the engine has to:

a. Be rated for at least the maximum output pressure of the fuel pump.
b. Be a single continuous hose from the pump to the engine.
c. Meet the other requirements for fuel lines as defined in "6.2.4 FUEL LINE INSTALLATION".

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6.3 LUBRICATION OIL

6.3.1 OIL SUMP/TANK VENTING

If an engine contains an integral oil sump or external tank, the sump/tank venting system cannot allow oil to continuously spill out if the robot is inverted.

6.3.2 ENGINE OIL TANKS

External engine oil tanks are allowed provided that:

a. Any oil tank complies with the same requirements as for fuel tanks, as defined in "6.2.3 FUEL TANK REQUIREMENTS".
b. The oil line from any oil tank to any engine meets the same requirements as fuel lines as defined in "6.2.4 FUEL LINE INSTALLATION".

6.4 ENGINE FAIL-SAFE

6.4.1 RADIO FAIL-SAFE

Upon loss of the remote-control signal, any continuously-rotating Combustion Engine used in a BattleBots Robot has to either shut off (cease producing power) or return to idle speed within **5 seconds** of signal loss.

The fail-safe has to be designed such that the engine will shut off upon loss of electrical power to the remote-control receiver.

6.4.2 AUTOMATIC MECHANICAL DISCONNECT

Any continuously-rotating Combustion Engine in a BattleBots Robot requires a centrifugal clutch or other mechanical disconnect. The mechanism has to be designed so that, while the engine is running at idle speed, there is no hazardous movement of the robot itself, or of any external weapon component driven by that engine.

If a disconnect system is directly remote controlled, it has to automatically revert to a disconnected configuration if the remote control signal or electrical power to the receiver is lost.

6.4.3 REMOTE SHUT-OFF

A Combustion Engine in a BattleBots Robot must be able to be completely shut off using the remote control. This shut-off must also prevent the engine from being started and operating.

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7.0 PNEUMATIC SYSTEMS

7.1 PNEUMATICS SAFETY

7.1.1 DESIGNER/BUILDER RESPONSIBILITY

Pneumatic systems can be dangerous if not designed, constructed and tested properly. A designer and/or builder who is not knowledgeable about all aspects of pneumatic systems must not attempt to use them in a robot.

7.1.2 COMPONENT DAMAGE

If any pneumatic component is damaged in any way that compromises its structural integrity, then that component cannot be used in a BattleBots Robot's pressurized pneumatic system.

7.2 COMPRESSED GAS SPECIFICATIONS

There are specific limits on how compressed gas can be used in a BattleBots Robot's pneumatic system.

7.2.1 ALLOWED GAS TYPES

The only types of gasses that can be stored or used in a BattleBots Robot's pneumatic system are:

a. Nitrogen (N_2), in compressed gaseous form only.
b. High-Pressure-Air (HPA). Also called "compressed air".
c. Carbon Dioxide (CO_2) in liquid or gaseous form, provided that the pneumatic system is designed to safely use liquid CO_2 .

7.2.2 MAXIMUM STORAGE PRESSURE

The maximum pneumatic storage pressure on a BattleBots Robot is as follows:

a. **2,500 psi** for N2 or HPA.
b. **1,500 psi** for CO_2 .
c. **150 psi** for any gas, if fuel for a Combustion Engine is also stored on the robot.

7.2.3 MAXIMUM ACTUATION PRESSURE

1000 psi is the maximum pneumatic pressure that may be used for actuation anywhere aboard a BattleBots Robot.

7.2.4 VOLUME/WEIGHT LIMITS

There are no specific limits on the quantity of gas that can be stored on a BattleBots Robot. However the weight of the stored gas/liquid is counted as part of the allowed maximum robot weight.

Note: A cubic foot of air or Nitrogen weighs approximately 1.25 ounces.

7.2.5 POWERED PNEUMATIC PUMP

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

a. There is a pressure-relief valve for each compressor, rated for a flow rate of **at least 120%** the output volume and set to **no more than 130%** of the peak output pressure.
b. Any compressor is designed for a pressure output equal to or greater than the compressor's pressure-relief valve.

7.3 PRESSURE TANKS

Pressure Tanks refer to all pneumatic tanks or vessels used for gas storage, and any downstream expansion or buffer tanks.

7.3.1 STORAGE TANK RATINGS

Pressure storage tanks are required to be commercially-available, DOT-approved and currently rated for **at least 120%** the maximum pressure stored in that tank.

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The date of manufacture or current hydro-test date should be indicated on the tank. If the rating or date is not clearly readable on a tank, certified documentation of the tank rating will be required.

Custom-made or modified pressure storage tanks are specifically not allowed.

7.3.2 BUFFER TANK RATINGS

Buffer tanks used downstream of the regulator have to be rated for **at least 150%** of the maximum actuation pressure that will be used aboard the robot.

The tank rating has to be either stamped on each tank, or official written documentation of the tank rating will have to be provided.

7.3.3 CO_2 TANKS

Due to temperature-change effects, tanks storing CO_2 are required to be all-metal. Fiber-wound CO_2 tanks are specifically not allowed.

7.3.4 PRESSURE RELIEF

Each pressure tank is required to be equipped with a burst disc or ASME certified pressure relief device set to **no more than 130%** of the tank's pressure rating. This pressure relief must be upstream of any high-pressure shut-off valve.

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

All pressure relief devices have to be readily accessible and also removable for testing purposes.

7.3.5 TANK MOUNTING

Any pressure tank cannot be directly exposed at any point on the outside or underside of a BattleBots Robot, regardless of the position of weapons or any other moving parts of the robot.

Pressure tanks are not required to be removable.

Each pressure tank has to be secured to the robot's structure such that:

a. The tank is constrained at multiple points, so that a combat load on any part of the tank will be taken primarily by the hold-down, not the tank structure.
b. Vibration or impact inertial shock will not cause release of the securing method.
c. The securing method, combined with any additional armor, will insure that a ruptured tank will not separate from the robot.

Tie-wraps, adhesive tape or other non-reusable tank hold-downs are specifically not allowed.

7.3.6 TANK PRE-HEATERS

Electrical tank pre-heaters are allowed to warm CO_2 storage tanks prior to a contest, provided that:

a. The heater jacket is commercially-purchased and not custom-made or modified.
b. The heater jacket is thermostatically controlled by the tank pressure.
c. Electrical power to the heater jacket is controlled by a sealed on-off switch.
d. The CO_2 tank contains a pressure relief valve with a maximum setting of **1500 psi**, regardless of the tank rating.

Note: The use of pre-heaters is also regulated by the rules defined in the BattleBots Tournament Rules document.

7.4 TANK SHUT-OFF VALVES

Each storage tank on a BattleBots Robot is required to have a mechanical shut-off valve to isolate the high-pressure gas stored in that tank. Shut-offs are not required for expansion or buffer tanks.

The shut-off valve must be easily accessed for robot Deactivation and tank refilling.

7.4.1 REGULATOR SHUT-OFF VALVE

A regulator directly attached to a storage tank with an integral shut-off valve is an acceptable shut-off valve implementation.

Adjusting the regulator to shut off pressure is specifically not allowed.

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7.4.2 TANK-MOUNTED SHUT-OFF VALVE

If a tank-mounted regulator shut-off valve is not used, a separate dedicated mechanical shut-off valve can be used if it is mounted directly to the tank upstream of a regulator or any other pneumatic component.

Unscrewing or rotating a tank to shut off pressure is specifically not allowed.

7.4.3 REMOTE SHUT-OFF VALVE

A shut-off valve can be separate from the tank if:

a. The valve is mounted as close as is practical to its respective storage tank.
b. The valve is connected only by a single continuous pipe or hose from the tank fitting to the shut-off valve fitting.
c. Impacts and other combat loads will not stress the hose or its fittings.

7.5 PNEUMATIC COMPONENTS

Pneumatic Components are defined as all pressurized parts of a pneumatic system other than the pressure tanks.

7.5.1 COMPONENT RATINGS

Each pneumatic component on a BattleBots Robot is required to be marked as being rated for at least the maximum pressure that the component will be subjected to during operation. Certain components may require higher ratings.

Components originally designed for hydraulics must have a rating of at least **twice (200%)** the maximum pressure that component will be subjected to.

If any rating is not clearly marked on a component, certified documentation of the rating will be required.

7.5.2 REGULATOR ADJUSTMENT LOCK

If a regulator is adjustable and its maximum setting exceeds the limit specified in "7.2.3 MAXIMUM ACTUATION PRESSURE", then the regulator adjustment requires a position locking method that prevents the regulated pressure from increasing due to vibration or shock.

The locking method has to be mechanical and cannot use any kind of adhesive tape or other non-reusable method.

7.5.3 PRESSURE RELIEF VALVES

If a regulator or compressor is used anywhere in the pneumatic system, pressure relief valve is required to be installed downstream of the regulator or compressor, as necessary, to limit pressure in that part of the pneumatic system.

Any pressure reliefs have to start relieving pressure at **no more than 120%** of the pressure rating of the lowest-rated component in that part of the pneumatic system.

7.5.4 PNEUMATIC SYSTEM DESIGN

The pneumatic system has to be designed and built so that:

a. All pneumatic components other than flexible hoses are secured to the robot's structure.
b. Connecting hoses are constrained or routed to prevent pressurization, vibration or impact loads from applying a bending force to any hose fittings.
c. Pneumatic components, other than actuators, are not used as a structural part of, or subject to any significant loads from, the robot's chassis.

7.5.5 ACTUATOR MOUNTING AND INSTALLATION

Pneumatic actuators have to be mounted and installed such that:

a. All actuation loads are taken by specifically-designed load points, and not by any pneumatic fittings on the actuator.
b. Any actuator and its attachment points are able to withstand repeated maximum pressure operation without any significant structural degradation.

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c. If the piston of a cylindrical actuator strikes the rod-cap during its operation, there is a containment method that will retain or capture any parts that would come loose if the rod-cap separates from the actuator.

7.5.6 HYDRAULIC COMPONENT USE

Hydraulic components used in a pneumatics system must have a hydraulic rating of **at least twice (200%)** the actuation pressure that they will be subjected to during pneumatics operation.

7.5.7 CUSTOM COMPONENTS

Custom-made or custom-modified pneumatic components may be used in the robot's pneumatic system. The Entrant is required to supply data sheets and/or computations and/or certified hydro-testing results to prove that the custom component is properly designed and built to have a burst pressure that is **300%** of the maximum pressure that the component will be subjected to during operation.

Custom-made pressure storage tanks are specifically not allowed, as specified in "7.3.1 STORAGE TANK RATINGS".

7.6 PURGE VALVES

Any pneumatic system is required to have a purge (bleed) valves to vent pressure.

7.6.1 PURGE VALVE OPERATION

A purge valve has to be manually operated. Electrically operated purge valves are not allowed.

The purge valve is required to operate so that it remains open and venting in the purge position. Spring-closure purge valves are not allowed, even if an external mechanism holds the valve open.

Any purge valve must be easily accessed for Deactivation.

7.6.2 PURGE VALVE LOCATION

Purge valves have to be located in the pneumatic system such that their combined activation relieves <u>all</u> pressure in all sections of the pneumatic system downstream of the shut-off valve(s).

Any purge valve has to be installed so that the vented gas is directed away from the person operating the valve.

7.6.3 MAXIMUM VENTING TIME

The combined operation of all purge valves must allow the fully-charged pneumatic system to be <u>completely</u> discharged (including storage tanks) within **60 seconds**.

7.7 PRESSURE GAUGES

Pressure gauges are required to allow for quick and accurate checking of all system pressures.

7.7.1 TANK PRESSURE

Every pressure storage tank is required to have a calibrated pressure gauge which allows reading the unregulated gas pressure in that tank.

A single gauge may be used to indicate the pressure in more than one tank, provided that each tank has a separate shut-off valve.

Turning on a tank shut-off valve to read a tank pressure is acceptable, provided that there is an additional shut-off valve that prevents downstream pressurization of the pneumatic system.

7.7.2 REGULATED PRESSURE

If the pneumatic system contains a regulator, there has to be at least one calibrated pressure gauge that allows reading of the system pressure downstream of each regulator.

7.7.3 PRESSURE GAUGE RESOLUTION

The maximum reading on each pressure gauge has to be between **120%** and **200%** of the maximum pressure that the gauge is measuring.

7.7.4 TEST POINT FITTINGS

A rated pneumatic test-point fitting is allowed in lieu of any required gauge. The Entrant is required to supply an appropriate connector and gauge compatible with each test fitting.

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7.7.5 PRESSURE TEST ACCESSIBILITY

Gaining access to and reading of any gauge/test-point pressure cannot require:

a. More than **60 seconds**.
b. Placing any body part in the path of any weapon system or powered part of the robot.
c. The use of external mirrors or other special tools. Use of a flashlight is acceptable.

Each gauge face must be oriented toward the viewing position, so that there is minimum parallax distortion of the reading.

7.8 PRESSURE TANK FILLING

7.8.1 FILLING ACCESS

If the robot does not use removable tanks, access for filling cannot require the robot to be held or supported in any unstable position.

7.8.2 CONNECT/DISCONNECT

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

7.8.3 STANDARD FILLING CONNECTION

BattleBots Robot pneumatic systems should be designed to be filled using a Foster (www.couplers.com) FST-series 12MPS straight-through 1/8" male thread Stainless Steel quick disconnect plug fitting. The exact equivalent fitting from other manufacturers (Parker, Hansen, etc.) is also acceptable.

Note: The 12MPS or equivalent Stainless Steel fitting is commonly available from paintball suppliers. The fitting is usually described as a "quick disconnect". Only the plug (male) part is needed.

A shut-off valve is required be installed on the robot's filling line, so that the line is not under tank pressure when coupling or uncoupling the quick disconnect fitting.

7.8.4 FILLING ADAPTER

If the robot is not equipped with the connector defined in “7.8.3 STANDARD FILLING CONNECTION”, then the Entrant must provide an adapter that connects the robot’s fitting to the standard connector fitting.

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8.0 HYDRAULIC SYSTEMS

8.1 HYDRAULICS SAFETY

8.1.1 DESIGNER/BUILDER RESPONSIBILITY

Hydraulic systems can be dangerous if not designed, constructed and tested properly. A designer and/or builder who is not knowledgeable about all aspects of hydraulics must not attempt to use them in a robot.

8.1.2 COMPONENT DAMAGE

If any pressurized hydraulic component is damaged in any way that compromises its structural integrity, then that component cannot be pressurized in a BattleBots Robot's hydraulic system.

8.2 HYDRAULIC SYSTEM REQUIREMENTS

8.2.1 MAXIMUM HYDRAULIC PRESSURES

3000 psi is the maximum allowed hydraulic pressure used anywhere on board a BattleBots Robot.

2500 psi is the maximum pressure that can be used in a BattleBots Robot's accumulator or other pressure storage tank in a hydraulic system.

8.2.2 HYDRAULIC POWER SOURCES

The hydraulic system may use either electric motors or Combustion Engines to power hydraulic pumps.

8.2.3 PRESSURE RELIEF VALVE

Any hydraulic pump is required to have a pressure-relief valve that limits the output pressure of the pump to the appropriate limit specified in "8.2.1 MAXIMUM HYDRAULIC PRESSURE", and which bypasses any excess hydraulic fluid at low pressure to a storage reservoir.

The relief valve requires a flow rate of **at least 120%** of the pump's output flow capacity.

Simple low-pressure/low-volume hydraulic systems (such as hydraulic brakes) are exempt from these pressure relief requirements.

8.2.4 HYDRAULIC FLUID

Any hydraulic fluid used in a BattleBots Robot is required to be non-flammable, non-corrosive, have moderate-to-low toxicity, and be rated for the maximum pressure used in the hydraulic system.

8.2.5 HYDRAULIC PRESSURE BOOSTERS

Hydraulic pressure boosters (intensifiers) can be used on a BattleBots Robot provided that:

a. The pressure booster does not raise the system pressures above the limits specified in "8.2.1 MAXIMUM HYDRAULIC PRESSURE".
b. The pressure-booster is equipped with a dedicated pressure relief device set to **no more than 130%** of the maximum pressure rating of the pressure-booster.

8.2.6 BYPASS VALVES

Any BattleBots Robot hydraulic system is required to have bypass valves to relieve all pressure in the hydraulic system to the hydraulic reservoir. The minimum requirements are:

a. Each bypass valve is manually operated and rated for the maximum allowed pressure of the hydraulic system.
b. The activation of all bypass/purge valves relieves all pressures in the hydraulic system.
c. All hydraulic fluid released by any bypass valve is directed to a low-pressure storage reservoir on-board the robot.
d. There is a fixed, no-leak connection from any bypass valve to any reservoir.

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8.3 HYDRAULIC SYSTEM COMPONENTS

Hydraulic Components are all those parts in the robot that contain or control hydraulic fluid.

8.3.1 RATED STANDARD COMPONENTS

Only rated standard hydraulic components can be used on a BattleBots Robot. Thus:

a. Each hydraulic component used on the robot should be clearly marked as rated for at least the pressure it will be subjected to.
b. If any hydraulic component is not clearly marked and visible for inspection, documentation will be required to prove that the component is properly rated.

8.3.2 COMPONENT MOUNTING

Hydraulic components have to be mounted such that:

a. Any hydraulic pump is positively secured either to the robot structure or to the drive motor.
b. Other than pumps, hoses and piping, any hydraulic component, such as a valve, gauge or manifold, is positively secured to the robot's structure.
c. Where necessary, hydraulic hoses are constrained or routed to prevent pressure, vibration or impact loading from applying a significant bending force to any fittings.
d. Pumps and accumulators are mounted and armored to ensure that, if ruptured, direct fluid streams will not escape the robot.

8.3.3 HYDRAULIC FLUID RESERVOIRS

Any hydraulic fluid reservoir aboard a BattleBots Robot has to:

a. Be constructed of a suitable material compatible with the hydraulic fluid.
b. Be enclosed and reasonably protected by the structural frame of the robot.
c. Use a vent system that will not continuously leak fluid if the robot is inverted.

8.3.4 CUSTOM COMPONENTS

If any custom-made or custom-modified hydraulic component is used in the robot's hydraulic system, the Entrant is required to supply data sheets and/or computations and/or certified hydro-testing results to prove that the component is properly designed and built to withstand **120%** of the maximum pressure to which the component will be subjected.

8.4 HYDRAULIC ACCUMULATORS

Hydraulic accumulators can be used on a BattleBots Robot, subject to restrictions.

8.4.1 ACCUMULATOR PRESSURE RATING

The accumulator must be rated for at least **120%** of the maximum pressure it will store.

The maximum rating should be clearly indicated on the accumulator, or else documentation will be required to show the pressure rating.

8.4.2 ACCUMULATOR PRESSURE RELIEF

Any accumulator has to be equipped with a dedicated pressure relief device set to no more than **130%** of the accumulator limit specified in "8.2.1 MAXIMUM HYDRAULIC PRESSURE", or the maximum pressure rating of the accumulator, whichever is less.

8.4.3 ACCUMULATOR MOUNTING

Any accumulator has to be mounted to the robot's structure and constrained at multiple points, so that a combat load on any part of the accumulator will be taken primarily by the securing components, not by the accumulator or its fittings.

8.5 PRESSURE TEST POINTS

Hydraulic systems require a method of quickly and easily checking all hydraulic system pressures.

8.5.1 TEST POINT LOCATIONS

Hydraulic system test points have to be located as follows:

a. The system is required to have at least one calibrated pressure gauge or else a test point that allows reading the operating hydraulic system pressure.

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b. If the system uses any accumulators, then each accumulator is required to have a separate dedicated test point.
c. If the system uses any pressure boosters, then each pressure booster is required to have a separate dedicated test point at its output.

8.5.2 PRESSURE GAUGE RESOLUTION

The maximum reading on each pressure gauge is required to be between **120%** and **200%** of the maximum pressure that the gauge is measuring.

8.5.3 TEST POINT FITTINGS

A Stauff SMK-20 or other equivalent fitting is allowed in lieu of any required gauge.

If any test fittings are used, the Entrant is required to supply an appropriate connector and gauge compatible with each test fitting.

8.5.4 PRESSURE TEST ACCESSIBILITY

Gaining access to and reading of any gauge/test-point pressure cannot require:

a. More than **60 seconds.**
b. Placing any body part in the path of any powered moveable part of the robot.
c. The use of external mirrors or other special tools. Using a flashlight is acceptable.

Any permanently-mounted gauge face must be oriented toward the viewing position, so that there is minimum parallax distortion of the reading.

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9.0 WEAPONS

9.1 ACTIVE WEAPON REQUIREMENT

All BattleBots Robots are required to have at least one actively-powered weapon system clearly designed to work by either taking control of the opposing robot (e.g., lifting, grabbing), or by damaging through direct physical contact (e.g., hammers, flippers, spinners, drums).

9.1.1 BATTLEBOTS ROBOT SYSTEMS

A BattleBots Robot contains two basic types of systems:

1) **Mobility System**: Used to move the robot around the BattleBox.
2) **Weapon System**: Designed to damage, restrain or otherwise incapacitate an opponent.

9.1.2 ACTIVE WEAPON DEFINITION

A BattleBots Robot must contain at least one Weapon System that meets all the following requirements:

a. POWERED ACTUATION

Each Weapon System must be actively powered either by an independent actuator, or by linkage to a Mobility System power source.

b. SEPARATE CONTROL

On the remote controller, all Weapon Systems must be activated or controlled by levers or switches that operate separately from the Mobility System controls.

c. INDEPENDENT OPERATION

The robot must be able to demonstrate that it can actuate its Weapon System(s) while simultaneously moving around the BattleBox in a controlled manner in multiple directions.

d. EFFECTIVENESS

A Weapon System can demonstrate that it has sufficient power and/or energy to lift, damage, restrain or otherwise incapacitate a robot of similar weight.

Note: The BattleBots Tournament Rules contain additional information on the determination of weapon effectiveness and other Active Weapon issues.

A flame-effect system does not qualify as an Active Weapon.

9.1.3 MULTIBOT WEAPONS

Not all segments of a MultiBot are required to have an Active Weapon. However, those segments with Active Weapons have to comprise at least **75%** of the MultiBot's combined weight.

9.2 WEAPON DESIGN

9.2.1 WEAPON SAFETY

When a BattleBots Robot has been Deactivated, any Weapon System is required to be non-hazardous to all personnel and objects in the vicinity of the robot.

9.2.2 DAMAGE TO BATTLEBOX

All Weapon Systems have to be designed and built so that during normal operation they will not damage the BattleBox floor or walls, where repairs would be required before the next scheduled Match can begin.

9.2.3 MODULAR WEAPONS

A Modular Weapon is defined as a weapon that can be added and removed from the robot in a short period of time.

A BattleBots Robot may be approved for using multiple Modular Weapons, providing that:

a. Each robot/weapon combination complies with of all applicable BattleBots Rules.
b. The combined time for adding and removing each Modular Weapon is less than **30 minutes**.
c. Each Modular Weapon is an Active Weapon as defined in "9.1.2 ACTIVE WEAPON DEFINITION".

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9.3 WEAPON TYPES NOT ALLOWED

For reasons of safety and practicality, certain weapon types cannot be used on a BattleBots Robot.

9.3.1 ELECTRICAL/ELECTROMAGNETIC WEAPONS

Electricity and electromagnetic fields cannot be used directly as a weapon. This includes, but is not limited to:

a. Tesla coils, stun guns, or cattle prods.
b. EMF generating or RF jamming equipment.

Radio interference caused by poorly-isolated ICE ignition systems or noisy electric motor brushes will be considered to be electromagnetic weapons if they can be shown to interfere with the radio control system of an opponent robot.

9.3.2 BATTLEBOX FOULING WEAPONS

Weapons that require significant cleanup, or in some way damage the BattleBox cannot be used. This includes but is not limited to:

a. Water, corrosive chemicals, glues and liquid foams.
b. Powders, sand, ball bearings and other dry chaff.
c. Deliberately released lubricants such as oil, grease, graphite and silicone.

9.3.3 OBSCURATION WEAPONS

Devices that impair the viewing of any robot by either the opponent, or by any BattleBots Official, are not allowed. This includes, but is not limited to:

a. Large quantities of smoke, dust or mist.
b. Bright strobe, arc or incandescent lights
c. External laser lights, regardless of power.

Small quantities of smoke may be deliberately created, with restrictions as defined in “2.6 FLAME AND SMOKE EFFECTS”.

9.3.4 EXPLOSIVE/FLAMMABLE WEAPONS

Heat and fire cannot be used directly as weapons. This includes, but is not limited to:

a. Explosives or rapidly burning substances such as primer cord, cartridge primers, gunpowder or military explosives.
b. Rapidly decomposing substances such as Sodium Azide.
c. Flammable liquids such as gasoline, alcohol and MEK.
d. Flammable gasses such as propane, butane and acetylene.
e. High-temperature devices such as flame throwers or plasma torches

Certain flammable liquids as defined in "6.1.2 FUEL TYPES" may be used to power Combustion Engines, which may in turn be used to drive weapons.

Flames not intended as a weapon may be used, provided that the robot complies with all the restrictions defined in “2.6.1 FLAME EFFECTS”.

9.3.5 MECHANISM FOULING WEAPONS

A Mechanism Fouling Weapon is one that is not sufficient to directly cause damage, but serves only to foul a mechanism of the opponent robot. Such weapons are not allowed on a BattleBots Robot. They include, but are not limited to:

a. Non-combustible gas used to disable an opponent's fuel-burning engine.
b. Fine/powdered substances deliberately dropped from or launched by the robot, such as chopped fibers or metal filings.
c. Any non-controllable part deliberately dropped, thrown or detached from the robot, such as bolts, magnets or uncontrolled vehicles.
d. Long lightweight fibers such as fishing line, string or Kevlar® strands, regardless of whether or not they remain attached to the robot.
e. Sticky substances such as adhesive-coated tape and "Liquid String" toy products.
f. Blankets, tarps, nets, or other flexible coverings.
g. Liquefied gasses.

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9.3.6 MUTUALLY-DESTRUCTIVE WEAPONS

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

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

A BattleBots Robot cannot use a flywheel or other component deliberately designed to fragment as a weapon.

9.4 RESTRICTED WEAPON TYPES

Certain types of weapons are allowed with restrictions.

9.4.1 PROJECTILE WEAPONS

Projectiles can be used as a weapon, provided that:

a. They are restrained by a tether.
b. The fully-extended tether is less than **8 feet** in length.
c. The tether can restrain the fired projectile, even after multiple full-power firings.

9.4.2 COVERING WEAPONS

A BattleBots Robot can use a weapon intended to partly or completely cover an opponent. However, the weapon has to be a rigid or semi-rigid shell or cage that can be controlled to release the opponent at will.

9.4.3 AIRBAGS/BALLOONS

A BattleBots Robot may use airbags or balloons as a weapon, provided that:

a. Airbag inflation uses a pneumatic system that complies with all the requirements defined in "7.0 PNEUMATIC SYSTEMS".
b. A deflated airbag/balloon is not used as a Mechanism Fouling Weapon.

Automotive airbag inflators are specifically prohibited.

9.4.4 ELECTROMAGNETS

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

a. Any electromagnet is powered only by a DC voltage, which may be switched on and off, or reversed in polarity.
b. The control electronics for any electromagnet does not interfere with any robot radio control signals or with any Tournament communications equipment.

9.5 KINETIC ENERGY WEAPONS

9.5.1 KE WEAPON DEFINITION

A Kinetic Energy Weapon ("KE Weapon") is any heavy spinning part, or collection of parts, used on or within the robot, where the inertia of the part(s) stores a substantial amount of energy.

If the weight of a rotating part (or connected combination of parts) is <u>less than</u> **5%** of the weight of the combat-ready BattleBots Robot, then that part (or combination) will not be considered a KE Weapon. In order to qualify for this exclusion, the rotating part(s) must be readily removable from the robot.

9.5.2 KE WEAPON POWER

A KE Weapon has to be spun-up using a power source (batteries, fuel, pressurized gas) located on the robot. It cannot be spun up prior to the start of any combat competition.

9.5.3 MAXIMUM KE WEAPON SPEED

Any KE Weapon on a BattleBots Robot has to be designed and built such that the fastest moving part(s) of the weapon do not exceed **400 feet-per-second**.

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9.5.4 KE WEAPON INSTALLATION

Any KE Weapon has to be sufficiently strong, well balanced and securely mounted to the robot's chassis structure, such that at maximum spinning speed, the weapon will not break apart, separate from the robot, or significantly affect robot controllability.

9.5.5 BATTLEBOTS AUTHORITY

BattleBots Officials reserve the right to exclude any robot whose KE Weapon installation or structural design, in their determination, poses a safety or operational risk to BattleBots participants, crew or spectators.

9.6 SPINNING PARTS

9.6.1 SPINNING PART FAIL-SAFE

If the robot has any spinning parts, it will have to be demonstrated that with any part spinning at maximum speed, shutting off the remote-control transmitter will cause that spinning part to lose all drive power, as defined in "3.1.3 FAIL-SAFE".

9.6.2 SPIN-DOWN TIME

When drive power is removed from any spinning part on an undamaged BattleBots Robot, the part is required to spin down to a full stop within **60 seconds** after power is removed, using a self-contained braking system.

Spin-down time is measured by first bringing the spinning part up to its maximum speed. The radio-control transmitter is then shut off and timing begins from the moment the transmitter is shut off. Timing ends when the spinning part has completely stopped.

9.7 STRONG SPRING WEAPONS

9.7.1 STRONG SPRING DEFINITION

A Strong Spring is defined as any spring, or grouped combination of springs, that requires, at any point of its movement, **more than 20 pounds** of force to extend or compress the spring.

9.7.2 DEACTIVATED SPRING

In its Deactivated position, any Strong Spring cannot exert a force of **more than 5 pounds** on any component of the robot.

9.7.3 REMOTE ARMING MECHANISM

Any BattleBots Robot part powered by Strong Spring cannot be manually armed. All arming is required to be done via a remote-control method using a power source on-board the robot.

9.7.4 REMOTE RELEASE MECHANISM

Any Strong Spring remote-controlled release mechanism has to require a specific command from the transmitter to release an armed robot part powered by a Strong Spring.

The remote-controlled release mechanism has to operate so that any armed robot part powered by a Strong Spring will <u>not</u> be released upon loss of transmitter signal.

9.7.5 SAFETY RELEASE

A back-up mechanical release mechanism is required for releasing the spring force of any Strong Spring, with the following conditions:

a. A single person can activate the release mechanism.
b. Release cannot require **more than 60 seconds**.
c. Using the release cannot require placing any body part in the path of any weapon system or other powered part of the robot.

A special tool can be used to release the spring force. If used, an identical spare tool is required.

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Appendix A: LEAD-ACID BATTERIES

A.1 SEALED LEAD-ACID TYPES

The only types of Lead-Acid batteries that can be used on a BattleBots Robot are "Sealed Lead-Acid" (SLA) batteries that are both "non-spillable" and "**Leak-Proof**".

A "non-spillable" battery only means that it can be used in any position without leaking battery acid. A non-spillable battery is not necessarily leak-proof.

Note: Some SLA batteries are described as "Lead-Calcium". These are acceptable if they also meet the leak-proof requirements specified below.

A.2 LEAK-PROOF REQUIREMENTS

A leak-proof SLA is designed such that the battery case can be cracked or punctured without leaking acid. Leak-proof SLAs meet one or more of the following requirements:

a. They are described in their specifications, or on the battery case, as using **AGM** (Absorbed Glass Mat) construction, and/or as using an "absorbed" electrolyte, and/or as using "electrolyte retaining separators".
b. They are described in their specifications as being a "Gel-Cell" type and/or as using a "Gelled" or "Stabilized" electrolyte.
c. They are specifically described as "Leak-Proof" in the manufacturer's or distributor's documentation.

A battery described only as “Spill-Proof” or “Non-Spillable” does not qualify for use in a BattleBots Robot.

A.3 BATTERY DOCUMENTATION

If a Lead-Acid battery is not factory-marked as being Leak-Proof on its exterior, printed documentation will be required to show that the battery uses AGM or Gel-Cell construction.

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Appendix B: LITHIUM-POLYMER BATTERIES

B.1 LITHIUM-POLYMER BATTERIES

Lithium-Polymer (LiPo) batteries, when damaged, overcharged or over-discharged, can be dangerous. As a result, there are several rules governing the installation and use of LiPo batteries in a BattleBots Robot.

The LiPo rules do not currently apply to the various types of Lithium-Ion batteries (Lithium-Cobalt, Lithium-Iron, Lithium-Manganese, Lithium-Nickel, etc.). However, the LiPo rules are good guidelines for Lithium-Ion type batteries also.

B.2 BATTERY CONTAINER

All LiPo batteries installed on a BattleBots Robot must be encased in a vented aluminum, steel or titanium container designed to prevent movement of the batteries as a result of combat impact loadings.

The LiPo battery container(s) must be mounted as far as reasonably possible from the outer shell or frame of the robot.

B.3 PRESSURE TANKS

If a BattleBots Robot uses LiPo batteries and contains a pneumatic storage tank or hydraulic accumulator, then:

a. The storage tank or accumulator must be of all-metal construction.
b. The storage tank or accumulator must be separated **at least 2 inches** away from any LiPo battery container, with a solid metal barrier between the tank and the LiPo container.

B.4 FLAMMABLE SUBSTANCES

If LiPo batteries are used in a BattleBots Robot, no flammable substance can be carried aboard the robot. This includes fuel used for Combustion Engines (ref. “6.1.2 FUEL TYPES”) or flame-effects (ref. “2.6.1 FLAME EFFECTS”).

B.5 BATTERY CHARGING

The LiPo battery mounting has to allow for removal from the robot for charging.

Note: It is not required that LiPo batteries be removed for charging. However, the BattleBots Tournament Rules document contains additional restrictions, procedures and rules regarding the charging, discharging and handling of LiPo batteries.

LiPo chargers must be commercially-available, be specifically designed for LiPo batteries, and have built-in overcharge protection.

B.6 OVER-DISCHARGE PROTECTION

The LiPo batteries have to be fitted with an undervoltage cut-out, set at a voltage that will prevent the batteries from becoming damaged due to over-discharge.

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Appendix C: STOMPBOTS

C.1 STOMPBOT DEFINITION

A "StompBot" is a true walking BattleBots Robot that moves using articulated legs.

C.2 STOMPBOT WEIGHTS

A BattleBots Robot that qualifies as a StompBot will be allowed an additional weight advantage over a non-walking BattleBots Robot, as defined in “2.1.2 STOMPBOT WEIGHTS”.

C.3 STOMPBOT REQUIREMENTS

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

a. There are no rolling elements in contact with the ground.

b. The drive mechanism for robot locomotion is powered solely by linear electric, hydraulic or pneumatic actuators or else powered by linear actuators driven by rotary electric motors. Any rotary-driven electric actuator must operate such that reversal of linear motion requires reversal of the rotary electric motor.

c. During movement along the ground, all robot parts that touch the ground for locomotion or support have to move forward and backward in a reciprocating motion relative to the center-of-gravity of the robot.

d. All robot parts that touch the ground for locomotion have to be actuated such that they can potentially be moved vertically (up-and-down) without any horizontal (forward-and-backward) movement.

e. During movement along the ground, no part of the robot’s weight can be supported on the ground by any type of rolling or skidding mechanism.

C.4 SPECIFIC EXCLUSIONS

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

*Note: Certain novel methods of locomotion not covered by the above rules may qualify as non-walking. Check with BattleBots Inc. as specified in "*1.7 CONTACTING BATTLEBOTS*".*

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Appendix D: HIGH DC VOLTAGE

D.1 DEFINITION

Any BattleBots Robot electrical system that operates using a DC voltage above that defined in paragraph "5.1.1 STANDARD VOLTAGE LIMITS" is considered to be using a "High DC Voltage".

Design and construction of a safe High DC Voltage system requires specific engineering expertise. Do not attempt to build such a system unless you are qualified to do so.

A High DC Voltage may be accepted in a BattleBots Robot provided that the robot fully complies with certain specific requirements in addition to those specified in "5.0 ELECTRICAL POWER".

D.2 BATTERY PACKS

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

a. The voltage for any pack cannot exceed **54.0 volts** when the battery pack is fully charged.
b. Each pack is mounted so that it is possible to inspect the batteries to confirm that they conform to the requirements of "5.2.1 ALLOWED BATTERY TYPES".
c. All electrical connections from the pack employ high-current "push-and-lock" connectors, circular-plug plastic connectors or other fully insulated connection method.

D.3 RECHARGING

Battery packs have to be recharged individually.

a. The maximum output voltage of any High DC Voltage external battery charging unit for a BattleBots Robot **cannot exceed 70.0** volts, when the charger is 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.

D.4 HIGH VOLTAGE WIRING

All High DC Voltage wiring in a BattleBots Robot is required to conform to the following:

a. Wiring is multi-stranded and insulated using the factory-applied insulation and/or heat-shrink tubing and/or quality electrical tape.
b. Wire insulation is rated for **at least twice** the maximum voltage in that wire. Wire gauge is appropriate for the maximum current through the wire.
c. Exposed terminals and bare wire ends are covered with electrical insulation, attached so that it cannot come loose or be easily penetrated.
d. The wiring is completely contained within the robot behind protective panels. The wiring cannot be on or outside any exterior part of the robot.
e. The wiring is attached to or supported by the robot's structure so that impact or vibration should not cause damage to the wiring or terminals.
f. The High DC Voltage system cannot have a DC electrical connection to the robot's chassis.

D.5 NO LIQUIDS

Any BattleBots Robot using a High DC Voltage cannot also have any liquid substances on board, other than electrolytes used in batteries and electrolytic capacitors.

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