Mini Class

Technical Regulations

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Reg changes from 2007.0 and 2006.0 in blue text

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All Technical Regulations subject to change at any time.

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1.0 Introduction

1.1 BotsIQ

BotsIQ is an educational program that promotes math, science, engineering expertise, competitive sportsmanship and creativity among teams of Middle school, High school and College students. These skills are promoted through the design and creation of competitive robots.

1.1.1 The BotsIQ "Mini" Class

The design requirements for a "Mini" Class BotsIQ robot are a subset of the regs for the original "Large" Class BotsIQ robot, with a lower weight and additional restrictions on design features.

Middle/High School and College students can enter BotsIQ robots in both the Mini Class and the Large Class.

When designing a Mini Class BotsIQ robot, it is important to reference the requirements in this document. A separate version of the Tech Regs defines the rules for a Large Class BotsIQ robot.

1.2 Safety/Warning Notice

Building and operating competition robots can be dangerous. A Team must not build or operate a BotsIQ robot unless it is qualified to do so, and has the supervision of a qualified adult. Each BotsIQ Team is solely responsible for its robot whether or not it complies with the rules of BotsIQ, Inc. or has been inspected for safety or otherwise by BotsIQ, Inc. Each BotsIQ Team's responsibility includes all matters of safety, condition, design, conformity to law, operation, merchantability and fitness for use and for any particular purpose.

1.3 BotsIQ Teams

BotsIQ is structured as a Team activity. On a Team, multiple students collaborate under the guidance of one or more adult supervisors, advisors and mentors.

A minimum number of Team members will be required to attend the BotsIQ competition. Refer to the BotsIQ Tournament Rules and Procedures document for additional information on Teams and requirements.

1.3.1 QYO Teams

A Qualified Youth Organization ("QYO") is a Middle school, High school, vocational school or a legally established youth organization. A QYO is the entity that enters student Teams into a BotsIQ competition.

A QYO Team is composed of the following:

a. At least **three** students, who are between the ages of **11 years** and **18 years** old, inclusive, who are members of the same QYO.

b. At least **one**, but not more than **two** Supervising Adults who are at least **21 years** old. Each Supervising Adult is responsible for the Team and must be affiliated with the Team's QYO.

c. Optionally, two additional non-student Technical Advisors at least **18 years** old, who need not be affiliated with the Team's QYO.

Other adult Mentors may advise and assist the Team, but they cannot be Team members.

There is no stated limit to the number of Teams that may be entered by a QYO. However, any Team can only be affiliated with a single QYO.

1.3.2 PSEI Teams

College and University Teams are collectively known as Post-Secondary Educational Institution (PSEI) Teams. PSEI Teams compete against one another, and not against QYO Teams.

A PSEI Team is composed of the following:

a. At least **three** college or other post-secondary school students. These student members must all attend the same PSEI.
b. At least **one**, but not more than **two** Adult Supervisors who are at least **21 years** old and are instructors at the same PSEI as the student Team members.
c. Optionally, two additional Technical Advisors at least **18 years** old, who need not be affiliated with the PSEI.

Other adult Mentors may advise and assist the Team, but they cannot be Team members.

There is no stated limit to the number of Teams that may be entered by a PSEI. However, any Team can only be affiliated with a single PSEI.

1.3.3 Entries Per Team

A QYO Team may enter a robot in each of the Large, Mini and TableTop classes. That is, a QYO Team can enter up to three robots, as long as they are in different classes.

A PSEI Team may enter a robot in either or both of the Large or Mini classes. That is, a single PSEI Team can enter two robots, as long as they are in different classes.

1.3.4 Team Member Restrictions

Different Teams are generally not allowed to share members.

a. No student may be a member of more than **one** Team.
b. No Supervising Adult may be a member of more than **one** Team.
c. A Technical Advisor may be a member of up to **two** different Teams.

1.3.5 Team Member Participation

One goal of BotsIQ is to encourage hands-on participation of the student Team members, with a minimum of adult intervention. Thus:

a. Each of the student members must have actively participated in the design, assembly, testing, promotion and/or support of the Team's robot(s).
b. The Adult Supervisor(s), Technical Advisors and Mentors are expected to serve in supervisory and advisory capacities only, and should not physically participate in the assembly, testing, promotion and/or support of the Team's robot(s).
c. Where necessary or prudent for reasons of safety or experience, Adult Supervisors, Technical Advisors, or other entities (e.g., machine shops) may fabricate components for the Team's robot(s). However, students should participate in parts fabrication whenever possible.

1.4 General Definitions

1.4.1 BotsIQ Inc.

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

1.4.2 BotsIQ Executive Officers

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

a. **BotsIQ President** – Has final overriding authority on all BotsIQ matters.
b. **BotsIQ CEO** – Has overriding authority on all BotsIQ matters, unless specifically overridden by the BotsIQ President.
c. **BotsIQ COO** – Has overriding authority on all BotsIQ matters, unless specifically overridden by the BotsIQ CEO or President.
d. **Authorized Proxy** – The BotsIQ President or CEO may authorize certain persons to have specific Executive Officer rights for a specific time period.

1.4.3 BotsIQ Officials

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

1.5 Rules Interpretation

1.5.1 Overlapping/Conflicting Requirements

A reasonable effort is made to ensure that the requirements in all BotsIQ 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.

1.5.2 Final Authority

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

At the discretion of BotsIQ Executive Officers, additional regulations and requirements may be applied to any and all BotsIQ robots at any time.

1.5.3 Change Publication

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

1.5.4 BotsIQ Inc. Privileges

Authorized BotsIQ Officials may exclude from competition any 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 Tech Regs.

1.6 Documents and Information Sources

Multiple documents and information sources define the requirements for participation in BotsIQ. All Teams have to be familiar with the contents of these documents and sources.

1.6.1 Primary Documents

These BotsIQ Technical Regulations ("Tech Regs") define the requirements specific to the design and construction of a Mini Class BotsIQ robot.

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

There may be other BotsIQ documents that provide additional information.

1.6.2 BotsIQ Internet Information

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

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

1.6.3 Team Responsibility

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

1.7 Contacting BotsIQ

For questions, comments, requests and clarifications regarding the rules, regulations and procedures in this or other BotsIQ documents, contact BotsIQ at the following:

BotsIQ Inc

7865 SW 21 Terrace
Miami, FL 33155

Phone: 305.264.1488

Fax: 305.267.2208

Questions: info@BotsIQ.org

Website: http://www.BotsIQ.org/

2.0 General Requirements

2.1 Mini Class Weight Limits

Weight limits are fundamental to BotsIQ robot specification and are thus closely controlled. Mini Class BotsIQ robots weighing less than the minimum or more than the maximum weights are not eligible to compete.

Note: Refer to the BotsIQ Tournament Rules and Procedures for information on the exact weighing procedures.

2.1.1 Non-Walker Weights

Non-walking Mini Class BotsIQ robot weight restrictions are:

a. Minimum Weight: **10.0 pounds**

b. Maximum Weight: **15.0 pounds**

2.1.2 Walker Weights

A Mini Class BotsIQ robot that uses walking-type locomotion may qualify as a "Walker" and be allowed to be one-third heavier than a non-Walker BotsIQ robot, as follows:

a. Minimum Walker Weight: **10.0 pounds**

b. Maximum Walker Weight: **20.0 pounds**

For a BotsIQ robot to qualify as a Walker, it has to meet the requirements defined in Appendix B of this document.

2.1.3 Items Included/Excluded in Weight

The robot is weighed in its battle-ready configuration, with all accessory items on board. Safety covers and safety restraints can be removed.

2.1.4 Modular Design Weight

If the robot is of a modular design, allowing components to be exchanged, the weight of the heaviest configuration cannot exceed the maximum allowed for the type (Non-Walker or Walker).

2.2 Size and Mobility Requirements

2.2.1 Size Limits

A Mini Class BotsIQ robot, with all its moveable parts fully open and/or extended, and loaded on a transport dolly, must be able to pass easily through a **4 foot** wide, **8 foot** high combat arena access door.

2.2.2 Speed/Mobility

A Mini Class BotsIQ robot has to be able to demonstrate that it can move at a speed of at least **six inches-per-second** in an approximate straight line.

2.3 Construction Materials

To minimize arena fouling and risk to BotsIQ personnel, there are limitations on the materials used to construct a BotsIQ robot.

2.3.1 General Restrictions

In general, hazardous or dangerous materials are forbidden from use anywhere on a BotsIQ robot where they may contact humans.

Note: If there are questions on BotsIQ robot construction materials, check with BotsIQ Inc. as specified in "1.7 Contacting BotsIQ" 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., Polystyrene, Polyurethane) cannot be exposed on the exterior of the robot. Non-foamed plastics are allowed.
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. Expanded 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.

2.3.3 Construction Materials Not Allowed

The following types of materials cannot be used on a BotsIQ robot:

a. Toxic or heavy metals (e.g., Beryllium, Mercury).
b. Reactive metals (e.g., Lithium, Sodium).
c. Radioactive materials.
d. Toxic or hazardous fibers (e.g., asbestos, loose fiberglass).
e. Decayable organic substances (e.g., meat, plant matter).
f. Non-fibrous silicon-based glass (e.g., plate glass).

2.4 Robot Systems

2.4.1 Power System Types

The types of power systems that can be used on a Mini Class BotsIQ robot are:

a. Electric motors, as defined in "5.5 Electric Motors".
b. Low-pressure pneumatics, as defined in "6.0 Pneumatic Systems".
c. Springs, as defined in "7.5 Large Spring Weapons".

2.4.2 Internal Combustion Engines

Fuel-Powered engines of any kind are not allowed on a Mini Class BotsIQ robot.

2.4.3 Hydraulic Systems

Hydraulically-activated systems are not allowed on a Mini Class BotsIQ robot.

2.5 Safety Covers and Restraints

Safety Covers and Restraints are required to protect people from injuring themselves due to contact with the robot exterior. These are considered to be part of the overall robot design.

2.5.1 Safety Covers

Safety Covers are required 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.

2.5.2 Safety Restraints

Safety Restraints are removable attachments to the robot intended to protect people from injury due to the movement of an exterior part of the robot.

Safety Restraints are required to protect against two types of hazards:

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

2.5.3 Pinch/Motion Hazard Restraint

A pinch/motion hazard restraint can be either:

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

c. A method of physically disconnecting an actuator, such that the parts cannot move in a hazardous fashion.

2.5.4 Cover/Restraint Retention

All Safety 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 retained using friction, gravity, adhesive tape or any method that can deteriorate with repeated use.

"Vise-Grip" type pliers and C-clamps cannot be used as safety restraints.

2.6 External Lighting

2.6.1 Laser Lights

All lasers mounted on a BotsIQ robot are limited to **Class II**, with an output of less than **1 mW**, regardless of the color (wavelength) of the light.

2.6.2 Non-Laser Lighting

Non-laser lighting installed on a Mini Class BotsIQ robot is limited as follows:

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

2.7 Special Configurations

2.7.1 MultiBots

A MultiBot is defined as BotsIQ robot composed of **two** or more independently controllable segments that can move about the arena separately, but compete together as a single robot. MultiBots are allowed subject to the following:

a. All applicable rules for BotsIQ robot design, construction and fail-safe apply to each individual MultiBot segment.
b. All limits, such as weight, size, pneumatic volume, etc, apply to the combination of all MultiBot segments.
c. For a MultiBot to get the additional Walker weight allowance, as defined in Appendix B, all of the MultiBot segments have to qualify as a Walker.

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

2.7.2 Autonomous Robots and Components

An autonomous function is one that moves the robot 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.

Autonomous BotsIQ robots or autonomous components on a BotsIQ robot 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 system can be used to override and stop any and all robot and weapon system autonomous motion.
c. All autonomous systems comply with the requirements of "3.1.2 Fail-Safe Operation".
d. Each different autonomous system has a separate, clearly visible external light to indicate when that autonomous function is enabled.
e. Each autonomous function will automatically disable itself within **4 minutes** after the last time it received a remote enable command.

2.7.3 Hopping/Jumping BotsIQ Robot

A hopping or jumping BotsIQ robot is allowed provided that:

a. The maximum jump height is less than **two feet**.
b. The landing of the robot does not materially damage the combat arena floor or walls, where repairs would be required for the next scheduled Match to proceed.

2.7.4 Ground-Effect Machines

Ground-effect machines (Hovercraft) 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 Powered Flight

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

2.8 External Design and Decoration

2.8.1 Exterior Appearance

The exterior design and appearance of a BotsIQ robot is expected to conform to general standards of public decency, and to also consider the commercial sponsors of BotsIQ. Therefore:

a. The BotsIQ robot design and exterior surfaces cannot embody any form, words, pictures or graphics that impugn religious organizations, racial groups or nationalities, or are publicly indecent or offensive.
b. BotsIQ Inc., in its sole discretion, reserves the right to require removal or modification of any logos, signage or other materials or designs that it determines are offensive, inappropriate or in conflict with any BotsIQ sponsors.

2.8.2 Robot Name

The name of the robot has to be clearly written on the exterior of the robot in letters at least **one-quarter inch** high. The name has to be readable when the robot is in its normal pre-battle configuration with all safety covers and restraints installed.

3.0 Radio Control

3.1 Robot Operation

Primary control and fail-safe communications to a BotsIQ robot have to be via a remote radio link. Tethered control is specifically not allowed.

3.1.1 Number of Operators

A Mini Class BotsIQ robot may be controlled by a maximum of **two** Operators.

3.1.2 Fail-Safe Operation

A BotsIQ robot must have a robust radio fail-safe that electronically or mechanically shuts off all motion-system and weapons power within **one second** after the remote-control transmitter is switched off, or otherwise stops transmitting.

This fail-safe is required in addition to the Master Switch requirements specified in "5.4 Electrical System Requirements".

3.1.3 Movement Speed Control

Binary (on/off) movement speed control is not allowed. Any control of BotsIQ robot speed along the ground has to be continuously variable in both the forward and reverse directions, and the slowest speed has to be less than **one foot per second**.

BotsIQ robot weapons control may be of any type: proportional, discrete, or binary.

3.2 Spektrum DSM Controllers

BotsIQ strongly 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; a BotsIQ robot is specifically not allowed to use the AR7000 receiver.

3.3 IFI Robotics Controllers

BotsIQ Mini Class robots can use the robot remote control systems by IFI Robotics (IFI).

Note: If an IFI system is used, a backup battery system for the transmitter is recommended.

3.4 Crystal-Based Radio Control Equipment

Legacy crystal-based Radio Control (R/C) equipment can be used on a Mini Class BotsIQ robot, subject to several requirements.

3.4.1 Control Methods

Crystal-based R/C control methods are subject to the following:

a. Amplitude Modulated (AM) R/C equipment is not allowed.
b. Pulse-Code Modulation (FM/PCM) equipment is recommended. However, FM Pulse-Position Modulation (FM/PPM) and Intelligent Pulse Decoding (FM/IPD) R/C equipment may be used.

3.4.2 Operating Frequencies

Due to FCC rules and practical operational requirements:

a. Non-narrow-band (pre-1991) R/C systems are not allowed.
b. R/C equipment operating in the (aircraft) 72 MHz band is not allowed.
c. Only ground R/C frequencies (27, 40, 50, 53 and 75 MHz bands) may be used.
d. The R/C equipment has to allow for the changing of frequency crystals, unless a frequency-sythesized system is used.

For each Transmitter/Receiver pair, each Team must have **two or more** sets of crystals that allow operation on at least **two different** frequencies.

3.4.3 Simultaneous Frequencies

A single BotsIQ robot or MultiBot cluster using crystal-based R/C equipment can simultaneously use at most **two** R/C frequencies for control.

If two frequencies are used simultaneously, then the Team must have an additional **two sets** of crystals that operate at frequencies different than the other sets of crystals.

Note: Impound procedures will be applied to any non-Spektrum, non-IFI controllers. Refer to the BotsIQ Tournament Rules and Procedures document for more information.

3.5 External Control Equipment

With certain restrictions, a BotsIQ Team may use external accessory equipment located outside the combat arena as part of its control, location or targeting system.

3.5.1 Equipment Restrictions

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 BotsIQ personnel.
d. Not significantly interfere with the live audience's visibility.

Note: If there are questions on the use of External Control Equipment, check with BotsIQ Inc. as specified in "1.7 Contacting BotsIQ" before beginning construction.

4.0 Activation and Deactivation

4.1 Robot Operating States

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

4.1.1 Deactivated State

A Mini Class BotsIQ robot in its Deactivated State will meet the following minimum requirements:

a. Remote control transmitters and receivers are off.
b. Electrical primary-power Master Switches are off.
c. Pneumatic actuation components are depressurized.
d. No internal or external parts are moving.
e. Tension on spring-loaded devices is released.
f. Safety Covers and Restraints are installed.

4.1.2 Activated State

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

4.1.3 Activation/Deactivation Safety

A BotsIQ robot has to be designed and constructed 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.

In addition, the process of activating or deactivating the robot has to be completed in a reasonably short time with minimal risk to anyone near the robot.

4.2 Activation/Deactivation Requirements

The robot has to demonstrate that it meets the following requirements:

4.2.1 Activation Time

With the robot on the ground in a completely Deactivated State, the Activation of a Mini Class BotsIQ robot cannot require more than **30 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 Mini Class BotsIQ robot cannot require more than **45 seconds**.

4.2.3 Activation/Deactivation Conditions

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 more than **two inches** inside the external frame or shell of the robot.
d. The robot to 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.
f. Any assembly or disassembly of the robot.

For all Activation/Deactivation steps, there cannot be any hazardous powered movement of the robot or its weapons systems, regardless of the order in which the steps are performed.

4.2.4 Activation/Deactivation Tools

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

a. A maximum of **two** special tools or devices can be used for the Activation and Deactivation.
b. Any tool is required to have an identical backup spare.
c. If use of a tool requires its insertion through any access hole in the robot's external shell, the hole has to allow a minimum of **one-eighth inch** clearance on all sides of the tool.

At the discretion of an authorized BotsIQ Official, any tool access hole may be required to be enlarged beyond the minimum clearance specified above.

4.2.5 MultiBot Requirements

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

4.3 Spinning Parts

4.3.1 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 specified in "3.1.2 Fail-Safe Operation".

4.3.2 Spin-Down Time

When drive power is removed from any spinning part on an undamaged robot, the part is required to spin down to a full stop within 9**0 seconds** after power is removed.

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.

5.0 Electrical Power

5.1 Robot Electrical Systems

A BotsIQ robot has two general types of electrical systems: Primary-Power and Secondary-Power.

a. The Primary-Power electrical system is used to move the robot and directly or indirectly actuate any weapons systems. This system will have high voltage and current flow.
b. A low-voltage, low-current Secondary-Power system (either a battery or a voltage converter) is used to operate the remote control receiver.

5.2 Voltage Limitations

Mini Class BotsIQ robot voltage limits are as follows:

a. **24 volts DC** is the maximum allowed nominal DC voltage. With batteries fully charged, the electrical system is allowed to measure up to 28 volts.
b. AC voltage sources (e.g., generators) cannot be used.

A BotsIQ robot cannot use any voltage-conversion devices to generate higher voltages than those specified above. Switching transients above those voltages are allowed provided that the transients are the result of normal operation and not generated to increase the average voltage level.

5.3 Electrical Power Sources

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

5.3.1 Allowed Battery Types

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

a. Sealed Lead-Acid (SLA) batteries, provided they are of a leak-proof type, and meet the requirements defined in Appendix A.
b. Nickel-Cadmium (Ni-Cad) batteries.
c. Nickel-Metal Hydride (Ni-MH) batteries.
d. Lithium-Ion (Li-Ion) batteries.

Lithium-Polymer batteries are specifically not allowed.

5.3.2 Battery/Capacitor Mounting

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

5.4 Electrical System Requirements

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

5.4.1 Primary-Power Wiring

Primary-power electrical wiring has to be installed such that:

a. Multi-stranded wiring is used for connecting the primary-power batteries to the input of any Master Switch.
b. Exposed terminals and bare wire-ends from the primary-power batteries to the input of any Master Switch are covered with electrical insulation.
c. All wires are insulated using the factory-applied insulation, heat-shrink tubing, electrical tape and/or “Liquid Electrical Tape” coating.

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

5.4.2 Primary Power Master Switch

Any primary-power electrical system is required to have a Master-Switch or a combination of Master Switches. Each switch has to:

a. Directly shut off power from the primary-power batteries, and not indirectly shut off power using a relay or contactor.
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.

5.4.3 Secondary Power Deactivation

If the secondary-power system has an on-off switch, the switch has to be positioned such that it can be operated without placing any body part in the path of any weapon system or other powered moveable part of the robot.

5.5 Electric Motors

Electric motors are the primary method for powering the wheels, legs and/or weapons of most BotsIQ robots.

5.5.1 Electric Motor Types

Electric motors used on BotsIQ robots can be of any type, including DC or AC, brushed or brushless, permanent magnet, series or parallel wound. There are no specific restrictions on the physical size or the output power of any electric motors that can be used on a BotsIQ robot.

5.5.2 Motor Cooling

During BotsIQ 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 cannot be directly connected to any pneumatic component.
c. Liquid cooling of electric motors is not allowed.

5.6 Electromagnets

Externally-mounted electromagnets can be used on a BotsIQ 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.

6.0 Pneumatic Systems

6.1 Pneumatics Cautions

Even low-pressure pneumatic systems can be dangerous if not designed, constructed and tested properly. Moreover, damage can render any pneumatic system unsafe.

It is ultimately the responsibility of each BotsIQ Team to ensure the safety of their pneumatic system design.

6.2 Pneumatic System Gas Storage

6.2.1 Compressed Air

Only compressed air can be stored or used for pneumatic actuation aboard a Mini Class BotsIQ robot.

6.2.2 Pressure Tank

Multiple air pressure storage tanks may be used on a Mini Class BotsIQ robot.

6.2.3 Pneumatic Pressure and Volume

The maximum pneumatic pressure that may be stored or used anywhere aboard a Mini Class BotsIQ robot at any time is **150 psi**.

The maximum total volume of pressurized gas that may be stored on a Mini Class BotsIQ robot or on a MultiBot cluster is **8 cubic feet** at standard temperature and pressure.

6.2.4 Tank Standards

Each pressure storage tank is required to be currently rated or tested to **at least 150%** the pressure stored in that tank. Documentation of the tank rating will be required.

6.2.5 Pressure Relief

Each pressure storage tank is required to have a directly attached pressure relief device set to **no more than 130%** of the tank's pressure rating. This pressure relief must be upstream of the shut-off valve.

6.2.6 Tank Shut-Off Valve

The pressure storage tanks are required to have mechanical shut-off valves to isolate the gas stored in the tanks. This valves have to be mounted downstream of the high-pressure relief and upstream of any regulator or other pneumatic component.

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

6.2.7 Tank Pressure Gauge

Pressure tanks must have a gauge that allows direct reading the gas pressure in the tanks.

The maximum reading on the pressure gauge has to be **at least 20%** over, but **not more than double** the maximum pressure that the gauge is measuring.

6.2.8 Tank Mounting

At a minimum, the pressure tank has to be located within the structural frame of the robot, and secured to the robot structure such that:

a. The tank is constrained at multiple points, so that a load on any part of the tank will be taken primarily by the hold-down, not the tank structure or attached fittings.
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 not allowed.

6.2.9 Pressure Tank Damage

No pressure tank can have any damage that in any way compromises its structural integrity. Such damaged tanks cannot be used to store pressurized air aboard the robot.

6.3 Pneumatic Components

Pneumatic Components are those parts in a pneumatic system other than the pressure storage tanks.

6.3.1 Pressure Regulators

Pneumatic pressure regulators may be used.

6.3.2 Component Ratings

Each pneumatic component on the robot has to be clearly marked as being rated for at least the maximum pressure that that component will be subjected to during operation.

If any rating is not clearly marked, certified documentation of the rating or of equivalent testing will be required.

6.3.3 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 structure.
b. Pneumatic components are not used as a structural part of, or subject to any significant loads from, the robot's chassis.

Note: It is expected that actuators will be subject to loads due to the actuator operation.

6.3.4 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.

6.3.5 Component Damage

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

6.4 Purge Valves

A pneumatic system is required to have one or more purge valves to vent all pneumatic pressure.

6.4.1 Purge Valve Operation

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

The purge valve has to remain open and venting in the purge position. Spring-closure purge valves are not allowed, even if an external mechanism holds the valve open.

6.4.2 Purge Valve Location

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

6.4.3 Maximum Venting Time

The combined operation of all purge valves has to allow the fully-charged pneumatic system to be completely discharged (including the storage tank) within **60 seconds**.

6.5 Pressure Tank Filling

Pressure tank filling should be accomplished using a standard hand-pump.

An external or on-board electrical pump may be used as long as the pump's maximum output pressure does not exceed the limit specified in "6.2.3 Pneumatic Pressure and Volume".

7.0 Weapons

7.1 Weapon Design

The robot's weapons are expected 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, wedges).

7.1.1 Weapon Safety

When the robot has been Deactivated, any weapon system is required to be non-hazardous to all personnel and objects in the vicinity of the robot.

7.1.2 Damage to Arena

All BotsIQ robot weapon systems have to be designed and built so that during normal operation they will not damage the combat arena floor or walls, where repairs would be required for the next scheduled Match to proceed.

7.1.3 Modular Weapons

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

A BotsIQ robot may be approved for using multiple Modular Weapons, providing that:

a. Each robot/weapon combination complies with of all applicable BotsIQ Regulations.
b. The combined time for adding and removing each Modular Weapon is less than **thirty minutes** total.

7.2 Weapon Types Not Allowed

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

7.2.1 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 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.

7.2.2 Arena Fouling Weapons

Weapons that require significant cleanup, or in some way damage the combat arena 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.

7.2.3 Obscuration Weapons

Devices that impair the viewing of any robot by either the opponent, or by any BotsIQ 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.

Any smoke created cannot cause significant obscuration of the robot.

7.2.4 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. Flammable liquids such as gasoline, alcohol and MEK.
c. Flammable gasses such as propane, butane and acetylene.
d. High-temperature devices such as flame throwers or plasma torches

7.2.5 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. They include, but are not limited to:

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

7.3 Restricted Weapon Types

Certain types of weapons are allowed with restrictions.

7.3.1 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 **four feet** in length.
c. The tether can restrain the fired projectile, even after multiple full-power firings.

7.3.2 Covering Weapons

The 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.

7.3.3 Airbags/Balloons

The robot may use airbags or balloons as a weapon, provided that a deflated airbag/balloon is not used as a Mechanism Fouling Weapon.

Use of automotive airbag inflators is specifically prohibited.

7.4 Flywheel Weapons

A Flywheel 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. This includes the spinning exterior of a "Spinner" robot and a completely spinning "Thwackbot".

Note: Small, thin saw blades and small rotary cutters are not considered to be Flywheels.

7.4.1 Flywheel Power

A Flywheel has to be spun-up using another power source (batteries) stored on the robot. It cannot be spun up prior to the start of any competition Match.

7.4.2 Flywheel Safety and Spin-Down

Any Flywheel used on or within a BotsIQ robot has to comply with all the safety and spin-down time requirements defined in "4.3 Spinning Parts".

7.4.3 Flywheel Installation

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

7.4.4 BotsIQ Authority

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

7.5 Large Spring Weapons

Weapons powered by large springs are allowed provided that they meet certain safety standards.

7.5.1 Definition

A Large 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.

7.5.2 Deactivated Spring

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

7.5.3 Remote Arming Mechanism

Any robot part powered by Large 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.

7.5.4 Remote Release Mechanism

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

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

7.5.5 Safety Release

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

a. A single person can activate the release mechanism.
b. It cannot require more than **30 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.

7.6 Laser or Light Homing

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

7.6.1 Hand-Held Lasers

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

7.6.2 Non-Coherent Lights

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

Appendix A: Lead-Acid Batteries

A.1 **Sealed Lead-Acid Types**

The only types of Lead-Acid batteries that can be used on a BotsIQ robot are "Sealed Lead-Acid" (SLA) batteries that are both "spill-proof" and "leak-proof".

A "spill-proof" (or "non-spillable") battery means that it can be used in any position, including upside down, without leaking battery acid. A spill-proof battery is not necessarily leak-proof also.

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.3 **Pre-Approved SLA Batteries**

The following specific SLA battery series have been pre-approved for use on BotsIQ robots and require no additional documentation:

a. Hawker Genesis, Odyssey and Cyclon series.
b. Panasonic LC series.
c. Powersonic PS series.
d. Interstate AGM, BSL, DCS and YTX series.
e. Sonnenschein Dryfit A and AGM 8A series.
f. Steatite RG series.
g. Yuasa YT series.
h. SVR B series.
i. Lifeline AGM series.

Pre-approval of the above batteries is based upon the manufacturer's claims, not actual testing. If at any time it is determined that an above-named battery series does not meet the leak-proof requirement, it will be disallowed.

Note: Some of the above-named manufacturers also make battery series that are not AGM or Gel-Cell construction. Only the specific battery series specified above are pre-approved.

A.4 **Battery Documentation**

If a battery is not marked as "leak-proof", or is not in the list above, written or on-line documentation will be required to show that the battery uses AGM or Gel-Cell construction.

Appendix B: Walkers

B.1 **Definition**

A "Walker" is a true walking BotsIQ robot that moves using articulated legs.

B.2 **Walker Weight**

A Mini Class BotsIQ robot that qualifies as a Walker will be allowed an additional 33.3% weight advantage over a conventional non-Walker BotsIQ robot.

B.3 **Walker Requirements**

A BotsIQ robot may be considered a Walker if it satisfies all the following criteria:

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

b. All 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.

c. All 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.

d. When the robot is moving along the ground, no part of the robot's weight can be supported on the ground by any type of rolling or skidding mechanism.

Linear electric motors cannot be used as part of the locomotion method of a Walker.

B.4 **Specific Exclusions**

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

Note: If there are any questions regarding the eligibility of a BotsIQ robot as a Walker, contact BotsIQ Inc. as specified in "1.7 Contacting BotsIQ" before beginning construction.