BotsIQ
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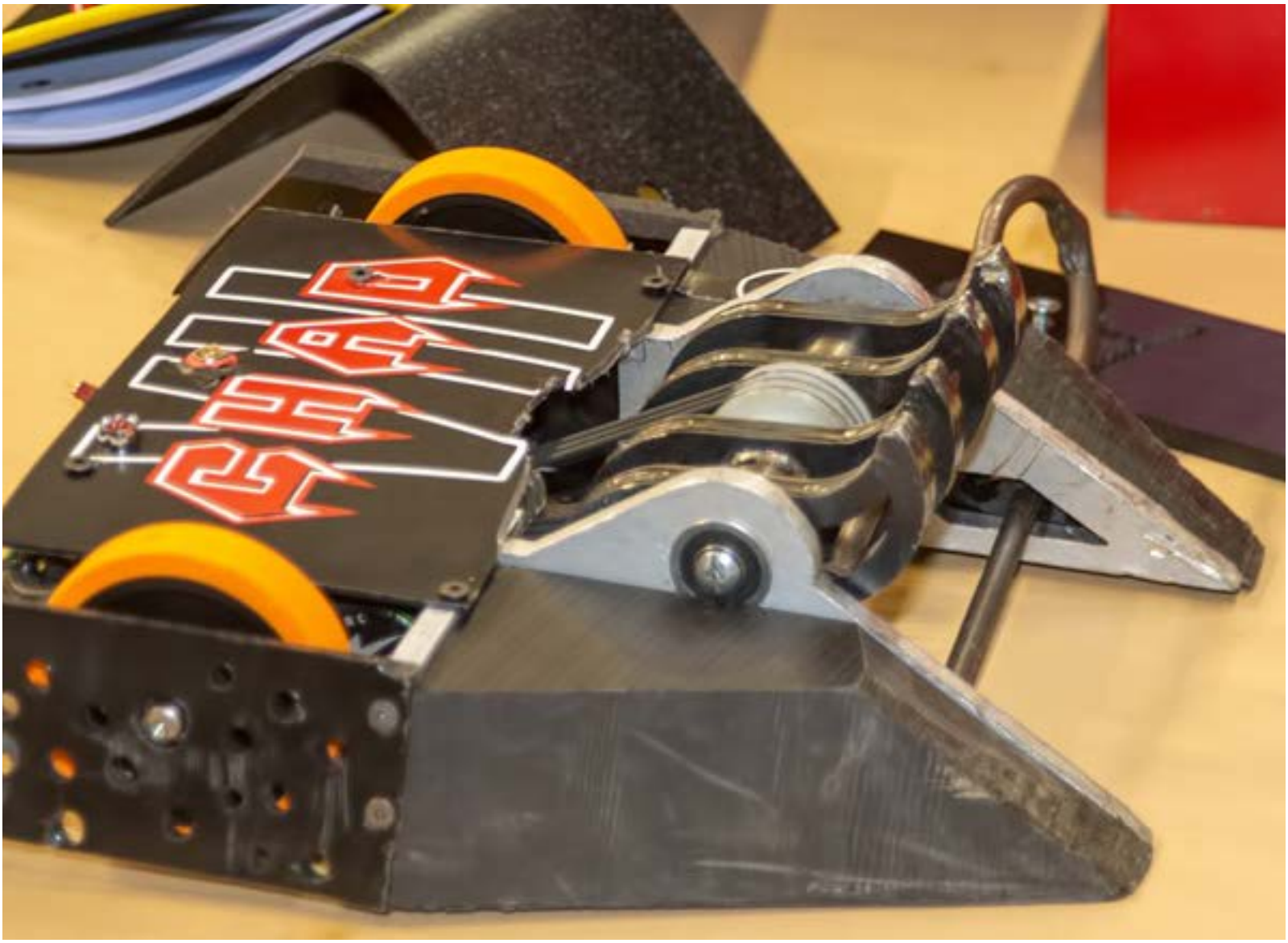
www.botsiqpa.org

TECHNICAL REGULATIONS



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INTRODUCTION

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1.0 Introduction

1.1 BotsIQ

Southwestern Pennsylvania BotsIQ's Combat Robotics program "BotsIQ" is an educational program of the Pittsburgh Chapter National Tooling and Machining Foundation (NTMF) that promotes science, technology, engineering and math (STEM), competitive sportsmanship and creativity among teams of high school students. These skills are promoted through the design and creation of competitive, battling Bots. The Bots the students are building are members of the 15 pound weight class, otherwise referred to as the "Mini Class".

This is a competition. As such there will be winning teams and losing teams. Some teams will achieve much higher overall scores than other teams. A Bot that took months to build may be destroyed in the first match and be unusable.

1.1.1 Teams

BotsIQ competitions are structured as a TEAM activity. On a team, multiple students collaborate under the guidance of one or more adult supervisors, advisors and mentors.

1.2 Safety/Warning Notice

The safety of all concerned must be foremost at all times during the design, construction, testing, shipping, preparation, maintenance, staging, activation, competition, deactivation and any other activity involving a BotsIQ Bot. Common sense and safety awareness is stressed in all areas of construction and operation.

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 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 High School students, inclusive, and 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. A QYO may enter up to two Teams into a BotsIQ competition.

1.3.2 Team Member Restrictions

Teams are not allowed to share members. No student may be a member of more than one Team. A Supervising adult and Technical Advisor may be a member of more than one team.

1.3.3 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 Bot(s).

INTRODUCTION

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 Bot(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 Bot(s). However, students should participate in parts fabrication whenever possible.

1.4 General Definitions

1.4.1 Southwestern Pennsylvania BOTSIQ

Southwestern Pennsylvania BotsIQ ("BotsIQ") refers, collectively, to the entity that manages and owns the program, and all its officers, employees and authorized agents.

1.4.2 BotsIQ Executive Officers

BotsIQ Executive Officers have jurisdiction on all BotsIQ matters. The BotsIQ Executive Officers may authorize certain persons to have specific Executive Officer rights for a specific time period.

1.4.3 BotsIQ Competition Officials

BotsIQ Competition Officials are authorized agents and volunteers of BotsIQ, who have jurisdiction in certain, possibly overlapping, BotsIQ activities. The following Competition Officials are included but not limited to:

a. Check-in Staff – Bot check-in procedures.

b. Document Evaluators – Evaluate and grade each team's documentation

c. Interviewers – Discuss with teams the design and building of their Bots.

d. Judges – Rules interpretation and winner determination for certain Matches.

e. Pit Coordinators/Runners – Pit, Queuing and Staging area operations.

f. Referees – Arena operations and Arena staging operations during Matches. Certain rule interpretations.

g. Safety/Tech Inspectors – Safety/Tech, Testing, Arena and Pit Area operations.

h. Security – Access to all areas.

i. Tournament Scoring & Scheduling – Timing and scoring of all Matches, Match postponements and Forfeits.

1.5 Rules Interpretation

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

1.5.1 Applicability

These Technical Regulations supersede all previous versions of the documents.

1.5.2 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.

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

1.5.4 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 Bots at any time. Authorized BotsIQ Officials may exclude from competition any Bot that, due to its design, construction or usage, they judge to be a hazard to safe competition, even if that Bot has met all of the requirements in these Technical Regulations.

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 ("Technical Regulations") define the requirements specific to the design and construction of a Mini Class BotsIQ Bot. The BotsIQ Competition Rules and Procedures document defines the rules and procedures for a safe, fair and efficient BotsIQ Tournament. There are other BotsIQ documents that provide additional information. The latest versions of all documents are on the BotsIQ website.

1.6.2 BotsIQ Internet Information
The BotsIQ website contains general information on BotsIQ and also makes available copies of BotsIQ documents. BotsIQ 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 its' e-mail regularly.

1.6.4 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
305 East Carson Street
Pittsburgh, PA 15219
Phone: 412/213-8486
Email: conklin@botsiqpa.com
www.botsiqpa.org

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GENERAL REQUIREMENTS

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2.0 General Requirements

2.1 Weight Limits
Weight limits are fundamental to Bot specification and are thus closely controlled. Bots weighing more than the maximum weight are not eligible to compete.

2.1.1 Weights
Bot weight restrictions are a maximum weight of 15.000 pounds as determined by the official scale of the tourney.

2.1.2 Items Included/Excluded in Weight
The Bot is weighed in its battle-ready configuration, with all accessory items on board. Safety covers and safety restraints can be removed.

2.1.3 Modular Design Weight
If the Bot is of a modular design, allowing components to be exchanged, the weight of the heaviest configuration cannot exceed the maximum allowed for the type.

2.2 Size and Mobility Requirements

2.2.1 Size Limits
A Bot, with all its movable 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.

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

2.3.1 General Restrictions
In general, hazardous or dangerous materials are forbidden from use anywhere on a Bot.

2.3.2 Restricted-Use Construction Materials
Certain materials cannot be used. For example:

a. Lead (Pb) metal cannot be exposed on the exterior of the Bot.

b. Rigid plastic foams (e.g., Polystyrene, Polyurethane) cannot be exposed on the exterior of the Bot. Non-foamed plastics are allowed.

c. Exposed permanent magnets have to be attached to the Bot using adhesive (e.g., epoxy, silicone) or some mechanical means (e.g., screws).

d. Expanded liquid foam cannot be used anywhere in the Bot where it encapsulates or otherwise obscures any wiring, plumbing or other non-structural part of the Bot.

2.3.3 Construction Materials Not Allowed
The following types of materials cannot be used on a Bot:

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).

REQUIREMENTS

2.4 Bot Systems

2.4.1 Power System Types
The types of power systems that can be used on a BotsIQ Bot 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 "6.5 LARGE SPRING WEAPONS".

2.4.2 Hydraulic Systems
Hydraulically-activated systems are not allowed on a Bot.

2.5 Safety Covers and Restraints
Safety Covers and Restraints are required to protect people from injuring themselves due to contact with the Bot exterior. These are considered to be part of the overall Bot design but are not part of the Bot's official weight.

The Bot shall be arranged such that the Safety Covers and Restraints remain in place when the Bots is placed in the arena or test box before activation. Carrying cases that substantially cover the Bot shall not be considered as meeting this requirement.

2.5.1 Safety Covers
Safety Covers are required on all external sharp points, corners and edges on the exterior of the Bot, installed such that they will prevent injury to someone bumping or striking those parts. Cardboard or any material easily pierced is not allowed.

2.5.2 Safety Restraints
Safety Restraints are removable attachments to the Bot intended to protect people from injury due to the movement of an exterior part of the Bot. 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. These hazards include motor-driven belts, chains and gears.

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 Prevention
A cover or guard is required on the Bot to prevent placing a body part in the area of the hazard. A method of physically disconnecting an actuator, such that the parts cannot move in a hazardous fashion, may also be used for this type of hazard prevention.

2.5.4 Cover/Restraint Retention
All Safety Covers, Restraints and protection devices:

a. Have to be secured to the Bot using a positive securing method such as a zip tie, 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.

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

2.6 External Lighting
All external lighting other than incandescent light needs to be approved by BotsIQ Official at least one month before competition.

2.7 Special Configurations

2.7.1 MultiBots

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

a. All applicable rules for Bot design, construction and fail-safe apply to each individual MultiBot segment.

b. All limits, such as weight, size, etc, apply to the combination of all MultiBot segments.

2.7.2 Autonomous Bots and Components

An autonomous function is one that moves the Bot 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. An autonomous Bot or autonomous components on a Bot are allowed, provided that:

a. When the Bot is activated, all autonomous functions are initially disabled, and require a specific remote command to become enabled.

b. The Bot's remote control system can be used to override and stop any and all Bot 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 30 seconds after the last time it received a remote enable command.

2.7.3 Hopping/Jumping Bot

A hopping or jumping Bot is allowed provided that:

a. The maximum jump height is less than two feet.

b. The landing of the Bot 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 Bot cannot move using powered flight. Movable 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 Bot is expected to conform to general standards of public decency, and to also consider the commercial sponsors of BotsIQ. Therefore:

a. The Bot 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 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.

REQUIREMENTS

REQUIREMENTS

2.8.2 Bot Name

The name of the Bot has to be clearly written on the exterior of the Bot. The name has to be readable when the Bot is in its normal pre-battle configuration with all safety covers and restraints installed.

RADIO CONTROL

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3.0 Radio Control

3.1 Bots Operation
Primary control and fail-safe communications to a Bot have to be via a remote radio link. Tethered control is specifically not allowed.

3.1.1 Number of Operators
A Bot may be controlled by a maximum of two Operators/Drivers.

3.1.2 Fail-Safe Operation
A Bot must have a robust radio fail-safe that 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 Bot speed along the ground has to be continuously variable in both the forward and reverse directions.

3.2 Bluetooth Controllers
Bluetooth systems must be approved by the BotsIQ safety committee prior to the competition. Operating plans, schematics, and a clear explanation of the controls must be presented for review.

BotsIQ should get this information at least one week before the preliminary competition so that we can verify it at the start of competition. The Bot must comply with all other regulations, meaning the Bot should be in a zero energy state when not in the test box or arena. All power must be off and dissipated. The student should not need to handle the Bot in order to bring the robot to a zero energy state. The battery must be disengaged by the master switch and any energy storing devices must automatically drain when the master switch is shut off. The energy storing should only take place when the Bot is on.

Any capacitors or electrical storage devices used in the system must be capable of being safely discharged without putting the students at risk.

3.3 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.

3.3.1 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 as specified in "1.6.4 CONTACTING BotsIQ" before beginning construction.

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ACTIVATION AND DEACTIVATION

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4.0 Activation and Deactivation

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

4.1.1 Deactivated State
A Bot 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. No internal or external parts are moving.

d. Tension on spring-loaded devices is released.

e. Safety Covers and Restraints are installed.

4.1.2 Activated State
The Bots 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 Bot 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 Bots. In addition, the process of activating or deactivating the Bots has to be completed in a reasonably short time with minimal risk to anyone near the Bots.

4.2 Activation/Deactivation Requirements
The Bot has to demonstrate that it meets the following requirements:

4.2.1 Activation Time
With the Bots on the ground in a completely Deactivated State, the Activation of a Bot cannot require more than 30 seconds.

4.2.2 Deactivation Time
Starting with the battle-ready, activated Bot on the ground in any stable position (including upside-down), the Deactivation of a Bot 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. Anything in the path of any weapon system or any other powered part of the Bot that can cause injury.

c. The Bots to be balanced in any unstable position.

d. The installation or removal of any panels, covers or fasteners from the Bots, other than the Safety Covers and Restraints.

e. Any assembly or disassembly of the Bots.

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

ACTIVATION/DEACTIVATION

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

a. A device 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 Bot's external shell, the hole has to allow a 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 single Bots and have to collectively meet all Activation and Deactivation conditions.

4.3 Spinning Parts

4.3.1 Spinning Part Fail-Safe
If the Bot 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 Bots, the part is required to spin down to a full stop within 45 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.

ELECTRICAL POWER

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5.0 Electrical Power

5.1 Bots Electrical Systems
A Bot may have two general types of electrical systems: Primary-Power and Secondary-Power.

a. The Primary-Power electrical system is used to move the Bots 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 is used to operate the remote control receiver.

5.2 Voltage Limitations
Bot power sources shall meet the following requirements:

a. 24 volts is the maximum allowed nominal DC supply voltage. With batteries fully charged and unloaded, the battery output is permitted to measure up to 28 volts.

b. AC voltage sources (e.g., generators or inverters) shall not be used.

c. Electrical capacitors shall only be permitted if approved by BotsIQ and arranged and connected such that they automatically discharge to less than 5 Volts within two seconds and to essentially zero Volts within ten seconds after the Main Switch(es) is(are) opened.

d. Voltage-conversion circuity shall be used only for voltage reduction below the nominal battery voltage. Circuitry intended to increase any voltage level above the nominal battery voltage shall not be permitted.

e. Switching transients (momentary variations of voltage above the permitted voltage) are allowed provided that the transients are the result of normal operation and not intentionally generated to increase the average voltage level.

f. A Bot cannot use any voltage-conversion devices or electrolytic capacitors unless authorized by BotsIQ.

5.3 Electrical Power Sources
Bots electrical power sources, at a minimum, have to comply with requirements below.

5.3.1 Allowed Battery Types
The battery pack (or packs) shall contain cells of an approved type. If the original labels on the cells are obscured by packaging, a new label containing the cell description shall be secured to the outside of the battery pack such as to be visible to an Inspector. 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

e. Lithium-Ferric Phosphate

BotsIQ Officials reserve the right to add additional batteries to this list after evaluation. Lithium-Polymer batteries are specifically not allowed.

The battery pack (or packs) shall include electrical connectors of the quick-disconnect type. Connections that must use a tool (ie scissors, screwdriver, etc), be unsoldered, cut, or untwisted shall not be permitted. The necessity of removing a battery mounting strap or screws shall not be considered as meeting the quick disconnect requirement.

ELECTRICAL POWER

5.3.2 Battery/Capacitor Mounting

Primary-Power batteries and any power handling electrolytic-type capacitors (as approved by 5.2.C.) have to be securely mounted and located so that they are enclosed within the structural frame of the Bots. The battery pack (or packs) shall be securely mounted to a **substantial part** of the Bot using a mechanical means. Tape, duct tape, Velcro or glue shall not be deemed as adequate to contain the battery against becoming dislodged. With the cover plate removed, the battery must remain secure and cannot move when pulled on.

Cells that have been damaged, are leaking or show signs of overheating shall not be used.

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. The Master Switch (or Switches) shall be connected such that the positive battery circuit is disconnected in the Switch Off position. All portions of the battery and control circuitry shall be electrically isolated from the metal chassis of the Bot.

The Master Switch (or Switches) shall be mounted securely to a substantial part of the Bot using a mechanical means. Tape, wire ties, or glue shall not be considered as meeting this requirement.

The Master Switch (or Switches) shall be accessible without the need to lift or turn the operating Bot or to remove any cover or grill. The location of the Master Switch (or Switches) shall be marked on the Bot exterior with a visible dot of red paint.

The Master Switch (or Switches) shall be readily operable without undue delay. If a tool is necessary to operate the Master Switch (or Switches) the tool shall be on hand with the operating Team at all times.

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.

e. Be positioned in such a way that it can be operated without placing any body part in the path of any weapon system or other powered movable part of the Bot.

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 it should 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 Bot.

5.4.4 Pilot Lights

A pilot light shall be connected in the power circuit immediately downstream of the main switch. If more than one main switch is used, each main switch shall have its own pilot light immediately downstream in the power circuit. The pilot light(s) shall be connected such that the light is illuminated any time the associated main switch is in the ON position. The illuminated pilot light(s) shall be easily visible from any viewing angle.

5.5 Electric Motors

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

5.5.1 Electric Motor Types

Electric motors used on a Bot 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 Bot.

5.5.2 Motor Cooling

During BotsIQ competitions, 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 Bot, 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 Bots radio control signals or with any Competition communications equipment

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PNEUMATIC SYSTEMS

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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.

6.1.1 Written Intent
BotsIQ Teams that plan to use a pneumatic bot are required to provide written intent to BotsIQ by December 15th of the competition year. (See 1.6.4 Contacting BotsIQ for contact information.) All teams using a pneumatic bot may be required to attend a safety meeting with BotsIQ before attending the competitions.

6.2 Pneumatic System Gas Storage

6.2.1 Compressed Air
Only compressed air can be stored or used for pneumatic actuation aboard a BotsIQ robot.

6.2.2 Pressure Tank
Multiple air pressure storage tanks may be used on a BotsIQ robot.

6.2.3 Pneumatic Pressure and Volume
The maximum pneumatic pressure that may be stored or used anywhere aboard a BotsIQ robot at any time is 150 psi. The maximum total volume of pressurized gas that may be stored on a 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.

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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 the 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.

6.3.4 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".

WEAPONS

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7.0 Weapons

7.1 Weapon Design
A Bot's weapons are expected to work by either taking control of the opposing Bots (e.g., lifting, grabbing), or by damaging through direct physical contact (e.g., hammers, flippers, spinners, wedges).

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

7.1.2 Damage to Arena
All Bot 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 Bots in a short period of time. A Bot may be approved for using multiple Modular Weapons, providing that:

a. Each Bot/weapon combination complies with of all applicable BotsIQ Regulations.

b. The combined time for adding and removing each Modular Weapon is less than 20 minutes total.

7.2 Weapon Type Not Allowed
For reasons of safety and practicality, certain weapon types cannot be used on a Bot.

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 by noisy electric motor brushes will be considered to be electromagnetic weapons if it can be shown to interfere with the radio control system of an opponent Bot.

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 Bots 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 Bot.

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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 gases 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 Bot. Such weapons are not allowed. They include, but are not limited to:

a. Fine/powdered substances deliberately dropped from or launched by the Bot, such as chopped fibers or metal filings.

b. Any non-controllable part deliberately dropped, thrown or detached from the Bot, 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 Bots.

d. Sticky substances such as adhesive-coated tape and "Liquid String" toy products.

e. Blankets, tarps, nets, or other flexible coverings.

f. Liquefied gases.

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 Bot 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 Bot 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 Bot, where the inertia of the part(s) stores a substantial amount of energy. This includes the spinning exterior of a "Spinner" Bot 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 Bot. 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 Bot 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 Bot's chassis structure, such that at maximum spinning speed, the Flywheel will not break apart, separate from the Bot, or significantly affect Bots controllability.

7.4.4 BotsIQ Authority
BotsIQ Officials reserve the right to exclude any Bots 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 Bot.

7.5.3 Remote Arming Mechanism
Any Bot part powered by a 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 Bot.

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 Bot part powered by a Large Spring. The remote-controlled release mechanism has to operate so that any armed Bot 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 Bots.

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
All lasers have to be approved by a BotsIQ Official.

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APPENDIX

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Appendix A: Walker

A.1 Definition
"Walker" is a true walking BotsIQ Bot that moves using articulated legs.

A.2 Walker Requirements
A BotsIQ Bot 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 Bot.

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 Bot is moving along the ground, no part of the Bot'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.

A.3 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 Bot as a Walker, contact BotsIQ as specified in "1.6.4 Contacting BotsIQ" before beginning construction.

Ver. 1.0 Original Issue

Ver. 1.1 "Velcro" was added to section "5.3.2 Battery/Capacitor Mounting"

Ver. 1.2 Section 2.5 Paragraph Added
Ver. 1.2 Section 2.5.2a Add Sentence
Ver. 1.2 Section 3.2 Section Modified
Ver. 1.2 Section 5.4.4 Add Section

Ver. 1.3 Section 3.1.1 Section Modified
Ver. 1.3 Section 5.2 Section Modified

Ver. 1.4 No Changes Made

Ver 1.5 Section 1.6.4 Contact Information Updated
Ver. 1.5 Section 5.3.1 Sentence Modified and Add Sentence

Ver 1.6 Section 5.3.2 Sentences Modified

Ver. 1.7 Section 5.2f Sentences Modified
Ver. 1.7 Section 5.4 Add Sentence

Ver 1.8 BotsIQ contact phone number updated throughout document
Ver. 1.8 Appendix A removed.
Ver 1.8 Appendix B renamed Appendix A
Ver. 1.8 Section 6.1.1 added

APPENDIX

APPENDIX

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