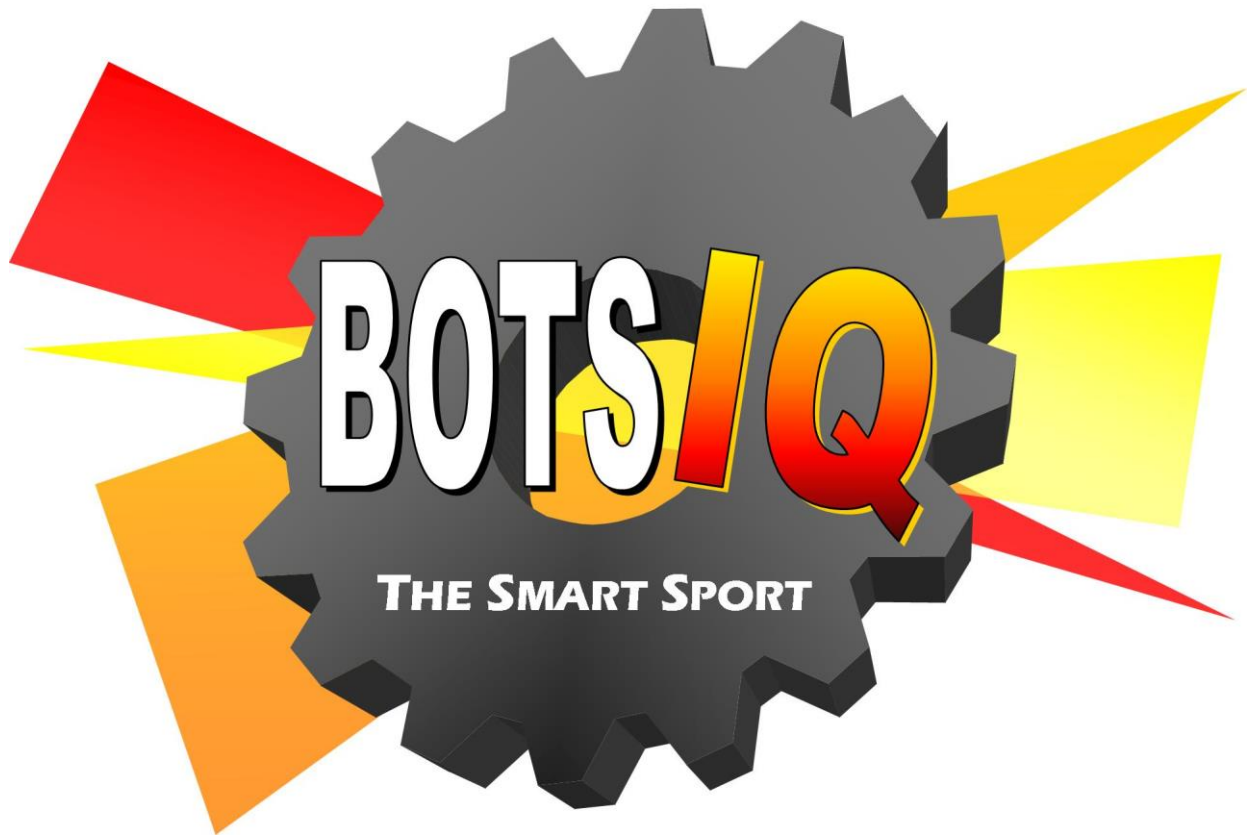


SOUTHWESTERN PENNSYLVANIA



Technical Regulations

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Version 1.1

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1.0 Introduction

1.1 SWPA BotsIQ

Southwestern Pennsylvania BotsIQ “SWPA BotsIQ” is an educational program 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

SWPA 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 SWPA BotsIQ Bot. Common sense and safety awareness is stressed in all areas of construction and operation.

1.3 SWPA BotsIQ Teams

SWPA 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 SWPA BotsIQ competition. Refer to the SWPA 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 SWPA BotsIQ competition.

A QYO Team is composed of the following:

- a. At least three High School students.
- 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 SWPA 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 SWPA 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).
- 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 BOTS IQ

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

1.4.2 SWPA BotsIQ Executive Officers

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

1.4.3 SWPA BotsIQ Competition Officials

SWPA BotsIQ Competition Officials are authorized agents and volunteers of SWPA BotsIQ, who have jurisdiction in certain, possibly overlapping, SWPA 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 SWPA 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 SWPA 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 SWPA BotsIQ website.

1.5.4 Final Authority

SWPA BotsIQ Executive Officers have the final authority over the interpretation of the rules, procedures and regulations in this and all other SWPA BotsIQ documents. At the discretion of SWPA BotsIQ Executive Officers, additional regulations and requirements may be applied to any and all SWPA BotsIQ Bots at any time. Authorized SWPA 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 SWPA BotsIQ. All Teams have to be familiar with the contents of these documents and sources.

1.6.1 Primary Documents

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

1.6.2 SWPA BotsIQ Internet Information

The SWPA BotsIQ website contains general information on SWPA BotsIQ and also makes available copies of SWPA BotsIQ documents. SWPA BotsIQ may send e-mail messages to current and former SWPA 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 SWPA BotsIQ Team to verify that they are referencing the last-updated version of any SWPA BotsIQ document available on the SWPA BotsIQ website. It is also each Team's responsibility to check its' e-mail regularly.

1.6.4 Contacting SWPA BotsIQ

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

Southwestern Pennsylvania BotsIQ

305 East Carson Street

Pittsburgh, PA 15219

Phone: 412/258-6629

Fax: 412/258-6625

Email: padnos@ncsqared.com

www.botsiqpa.org

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 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.

2.3 Construction Materials

To minimize arena fouling and risk to SWPA 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).

2.4 Bot Systems

2.4.1 Power System Types

The types of power systems that can be used on a SWPA 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.

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.
- 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 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 SWPA 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. 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 Bot is expected to conform to general standards of public decency, and to also consider the commercial sponsors of SWPA 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. SWPA 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 SWPA BotsIQ sponsors.

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.

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 three 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 Spektrum DSM Controllers

SWPA BotsIQ permits the use of the Spektrum DX6 or DX7 controller with the **BR6000** receiver. The DX6 or DX7 transmitter can be used only with the BR6000 receiver; a Bot is specifically not allowed to use the AR7000 receiver.

3.3 Bluetooth Controllers

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

SWPA 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.

3.4 External Control Equipment

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

3.4.1 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 SWPA 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 SWPA BotsIQ Inc. as specified in "1.6.4 CONTACTING SWPA BOTS IQ" before beginning construction.

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.

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 SWPA 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.

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

A Bot 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.
- c. Electrical Capacitors are not allowed unless approved by SWPA BotsIQ Official

A Bot cannot use any voltage-conversion devices or electrical capacitors unless authorized by SWPA BotsIQ. Switching transients, which are a momentary variation between voltages, 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

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

SWPA 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 be unsoldered, cut, or untwisted shall not be permitted.

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 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.

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.

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 moveable 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.

5.5 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 SWPA 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

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 SWPA 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 SWPA BotsIQ robot.

6.2.2 Pressure Tank

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

6.2.3 Pneumatic Pressure and Volume

The maximum pneumatic pressure that may be stored or used anywhere aboard a SWPA BotsIQ robot at any time is **150 psi**. The maximum total volume of pressurized gas that may be stored on a SWPA 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. These 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.

6.3.4 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".

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 SWPA 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 SWPA 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.

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 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 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 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 SWPA BotsIQ Authority

SWPA BotsIQ Officials reserve the right to exclude any Bots whose Flywheel installation or structural design, in their determination, poses a safety risk to SWPA 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 SWPA BotsIQ Official

Appendix A: Lead-Acid Batteries

A.1 Sealed Lead-Acid Types

The only types of Lead-Acid batteries that can be used on a SWPA BotsIQ Bot 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 SWPA BotsIQ Bots 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

"Walker" is a true walking SWPA BotsIQ Bot that moves using articulated legs.

B.2 Walker Requirements

A SWPA 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.

B.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 SWPA BotsIQ Bot as a Walker, contact SWPA BotsIQ Inc. as specified in "1.6.4 Contacting SWPA BotsIQ" before beginning construction.

Ver. 1.0 Original Issue

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