LARGE CLASS
TECHNICAL REGULATIONS

REVISION 2007.0

Reg changes from 2006.0 in blue text

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ALL TECHNICAL REGULATIONS SUBJECT TO CHANGE AT ANY TIME.

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1.0 INTRODUCTION

1.1 BOTSIQ

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

1.1.1 THE BOTSIQ "LARGE" CLASS

The design requirements for a "Large" class BotsIQ robot are a superset of the regs for the "Mini" Class BotsIQ robot, with a higher weight and fewer restrictions on design features.

When designing a Large Class BotsIQ robot, it is important to reference only this document.

There is also a "Mini" class for 15 lb. BotsIQ robot. Refer to the specific Mini Class Tech Regs for those design requirements. In addition, there is the TableTop class of BotsIQ robot.

Middle/High School and College students can enter BotsIQ robot in both the Mini Class and the Large Class. College students cannot enter the TableTop Class.

1.2 SAFETY/WARNING NOTICE

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

1.3 BOTSIQ TEAMS

BotsIQ is structured as a Team activity. The general requirements for Teams differ somewhat between the Middle/High School and College Divisions, and are specified below.

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

1.3.1 QYO TEAMS

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

A QYO Team is composed of the following:

a. At least **three** students, who are between the ages of **11 years** and **18 years** old, inclusive, who are members of the same QYO.
b. At least **one**, but not more than **two** Supervising Adults who are at least **21 years** old. Each Supervising Adult is responsible for the Team and must be affiliated with the Team's QYO.
c. Optionally, two additional non-student Technical Advisors at least **18 years** old, who need not be affiliated with the QYO.

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

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

1.3.2 PSEI TEAMS

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

PSEI Teams are not currently eligible to compete in the TableTop Class.

A PSEI Team is composed of the following:

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

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

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

1.3.3 ENTRIES PER TEAM

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

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

1.3.4 TEAM MEMBER RESTRICTIONS

Different Teams are generally not allowed to share members.

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

1.3.5 TEAM MEMBER PARTICIPATION

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

a. Each of the student members must have actively participated in the design, assembly, testing, promotion and/or support of the Team's robot(s).
b. The Adult Supervisor(s) and 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 robot(s).
c. Where necessary or prudent for reasons of safety or experience, Adult Supervisors, Technical Advisors, or other entities (e.g. machine shops) may fabricate components for the Team's robot(s). However, students should participate in parts fabrication whenever possible.

1.3.6 BOTSIQ SPECIFIC

A BotsIQ robot must have been specifically constructed for the purpose of entering BotsIQ, and cannot have previously competed in in any nationally televised robotic tournament.

1.4 GENERAL DEFINITIONS

1.4.1 BOTSIQ INC.

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

1.4.2 BOTSIQ EXECUTIVE OFFICERS

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

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

1.4.3 BOTSIQ OFFICIALS

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

1.5 RULES INTERPRETATION

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

1.5.1 APPLICABILITY

These Technical Regulations supercede all previous published regulations regarding Large Class BotsIQ robot design and construction.

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 FINAL AUTHORITY

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

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

1.5.4 CHANGE PUBLICATION

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

1.5.5 BOTSIQ INC. PRIVILEGES

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

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

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

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

There may be other BotsIQ documents that provide additional information.

1.6.2 BOTSIQ INTERNET INFORMATION

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

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

1.6.3 TEAM RESPONSIBILITY

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

1.7 CONTACTING BOTSIQ

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

BotsIQ Inc.

7865 SW 21 Terrace
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Phone: 305.264.1488

Fax: 305.267.2208

Questions: info@BotsIQ.org

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

2.0 GENERAL REQUIREMENTS

2.1 LARGE CLASS WEIGHT LIMITS

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

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

2.1.1 NON-WALKER WEIGHTS

Non-walking Large Class BotsIQ weight restrictions are:

a. Minimum Weight: **60.0 pounds**

b. Maximum Weight: **120.0 pounds**

2.1.2 WALKER WEIGHTS

A Large Class BotsIQ robot that uses walking-type locomotion may qualify as a "Walker" and be allowed to be 30% heavier than a non-Walker robot, as follows:

a. Minimum Walker Weight: **60.0 pounds**

b. Maximum Walker Weight: **156.0 pounds**

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

2.1.3 ITEMS INCLUDED/EXCLUDED IN WEIGHT

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

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

2.1.4 MODULAR DESIGN WEIGHT

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

2.2 SIZE AND MOBILITY REQUIREMENTS

2.2.1 SIZE LIMITS

Size limits for a Large Class BotsIQ robot are:

a. In its pre-battle configuration, the robot can be moved on its transport cart up the entrance ramp of the combat crena and through the **8-foot** by **8-foot** entry door.

b. With all its moveable parts fully open and/or extended, the robot can be moved on a dolly through the **8-foot** by **8-foot** combat arena exit door and down the exit ramp.

c. Arena entry or exit does not require any robot assembly or disassembly.

d. In pre-battle configuration, the robot fits inside an **8-foot** by **8-foot** square area.

Note: If the robot has a size greater than 4 feet by 5 feet, notify BotsIQ Inc. as specified in "1.7 CONTACTING BOTSIQ", as the robot may require a special pit location.

2.2.2 SPEED/MOBILITY

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

2.3 CONSTRUCTION MATERIALS

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

2.3.1 GENERAL RESTRICTIONS

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

Note: If there are questions on robot construction materials, check with BotsIQ Inc. as specified in "1.7 CONTACTING BOTSIQ" before beginning construction.

2.3.2 RESTRICTED-USE CONSTRUCTION MATERIALS

Certain materials can only be used as follows:

a. Lead (Pb) metal cannot be exposed on the exterior of the robot.
b. Rigid plastic foams (e.g., Polystyrene, Polyurethane) cannot be exposed on the exterior of the robot. Non-foamed plastics are allowed.
c. Exposed permanent magnets have to be attached to the robot using adhesive (e.g., epoxy, silicone) or some mechanical means (e.g., screws).
d. Expanding liquid foam cannot be used anywhere in the robot where it encapsulates or otherwise obscures any wiring, plumbing or other non-structural part of the robot.

2.3.3 CONSTRUCTION MATERIALS NOT ALLOWED

The following types of materials cannot be used on the robot:

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

2.4 POWER SYSTEMS

2.4.1 TYPES OF POWER SYSTEMS

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

a. Electric motors, as defined in "5.5 ELECTRIC MOTORS".
b. Fuel-Powered engines, as specified in "6.0 FUEL-POWERED ENGINES".
c. Pneumatics, as defined in "7.0 PNEUMATIC SYSTEMS".
d. Hydraulics, as defined in "8.0 HYDRAULIC SYSTEMS".
e. Mechanical, as defined in "9.5 LARGE SPRING WEAPONS".

2.4.2 NUMBER OF POWER SYSTEMS

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

2.5 SAFETY COVERS AND RESTRAINTS

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

2.5.1 SAFETY COVERS

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

2.5.2 SAFETY RESTRAINTS

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

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

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

2.5.3 PINCH/MOTION HAZARD RESTRAINT

A pinch/motion hazard restraint can be either:

a. A cover or guard that prevents placing a body part in the area of the hazard.
b. A pin, block, chain or similar restraint that prevents significant movement of hazardous parts.
c. A method of physically disconnecting an actuator, such that the parts cannot move in a hazardous fashion.

2.5.4 COVER/RESTRAINT RETENTION

All covers, restraints and protection devices:

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

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

2.5.5 REMOVAL AND INSTALLATION

Safety covers and restraints have to be designed such that their removal and installation can be done within the time limits, and also comply with the safety requirements specified in "4.0 ACTIVATION AND DEACTIVATION".

2.6 EXTERNAL LIGHTING

2.6.1 LASER LIGHTS

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

2.6.2 NON-LASER LIGHTING

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

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

2.7 SPECIAL CONFIGURATIONS

2.7.1 MULTIBOTS

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

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

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

2.7.2 AUTONOMOUS ROBOTS AND COMPONENTS

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

Autonomous robots or autonomous components on a BotsIQ robot are allowed, provided that:

a. When the robot is activated, all autonomous functions are initially disabled, and require a specific remote command to become enabled.
b. The robot's remote control system can be used to override and stop any and all robot and weapon system autonomous motion.
c. All autonomous systems comply with the requirements of "3.4.4 FAIL-SAFE OPERATION".
d. Each different autonomous system has a separate, clearly visible external light to indicate when that autonomous function is enabled.
e. Each autonomous function will automatically disable itself within **4 minutes** after the last time it received a remote enable command.

2.7.3 HOPPING/JUMPING ROBOT

A hopping or jumping robot is allowed provided that:

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

2.7.4 GROUND-EFFECT MACHINES

Ground-effect machines (Hovercraft) are allowed, provided that any lift is provided by an air cushion, and not directly by an external moving aerodynamic device (e.g., a rotor). Partial support by wheels or other ground-contact devices is allowed.

2.7.5 POWERED FLIGHT

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

2.8 EXTERNAL DESIGN AND DECORATION

2.8.1 EXTERIOR APPEARANCE

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

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

2.8.2 ROBOT NAME

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

2.8.3 PNEUMATICS INDICATOR STICKERS

Any robot with a pressurized pneumatic system is required to compete with **1.5" x 3"** bright orange stickers clearly visible on both the top and bottom of the robot. BotsIQ Inc. will supply stickers at the Tournament, but adequate space must be provided on the robot exterior.

3.0 REMOTE CONTROL

3.1 SPEKTRUM DSM CONTROLLERS

BotsIQ strongly recommends using the Spektrum DX6 or DX7 controller with the **BR6000** receiver. The DX6 or DX7 transmitter can be used only with the BR6000 receiver; a BotsIQ robot is specifically not allowed to use the AR7000 receiver.

3.2 IFI ROBOTICS CONTROLLERS

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

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

3.3 OTHER CONTROLLERS

For CY 2007 only, non-Spektrum, non-IFI controllers may be approved by BotsIQ on a case-by-case basis. Any such equipment must:

a. Be commercially-available, not custom-built.
b. Comply with all applicable FCC regulations for ground-vehicle control.
c. Have a fail-safe method that fully meets the requirements of section 3.4.4 below.

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

3.4 ROBOT CONTROL

3.4.1 NUMBER OF OPERATORS

A Large Class BotsIQ robot may be controlled by a maximum of **three** Operators.

3.4.2 MOVEMENT SPEED CONTROL

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

3.4.3 WEAPONS CONTROL

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

3.4.4 FAIL-SAFE OPERATION

A BotsIQ robot must have a radio fail-safe that electronically or mechanically shuts off all motion-system and weapons power within **one second** after the 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".

3.5 EXTERNAL CONTROL EQUIPMENT

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

3.5.1 EQUIPMENT RESTRICTIONS

External control equipment, at a minimum, has to:

a. Be set-up easily within **two minutes** prior to a Match.
b. Be removed easily within **two minutes** after a Match.
c. Not interfere with another contestant, or with any BotsIQ personnel.
d. Not significantly interfere with the live audience's visibility.

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

4.0 ACTIVATION AND DEACTIVATION

4.1 BOTSIQ ROBOT OPERATING STATES

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

4.1.1 DEACTIVATED STATE

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

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

4.1.2 ACTIVATED STATE

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

4.1.3 ACTIVATION/DEACTIVATION SAFETY

The robot has to be designed and constructed so that at any time when it is not in combat or being tested, it is completely non-hazardous to all personnel and objects near the robot.

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

4.2 ACTIVATION/DEACTIVATION REQUIREMENTS

A BotsIQ robot will have to demonstrate that it meets certain Activation/Deactivation requirements.

4.2.1 ACTIVATION TIME

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

4.2.2 DEACTIVATION TIME

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

In addition, all electrical power to weapons and drive systems (any system that could cause human bodily injury) must have a disconnect method that can be operated within **10 seconds**.

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

4.2.3 ACTIVATION/DEACTIVATION CONDITIONS

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

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

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

4.2.4 ACTIVATION/DEACTIVATION TOOLS

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

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

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

4.2.5 MULTIBOT REQUIREMENTS

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

4.3 SPINNING PARTS

4.3.1 SPINNING PART FAIL-SAFE

If the robot has any spinning parts, it will have to be demonstrated that with any part spinning at maximum speed, shutting off the remote-control transmitter will cause that spinning part to lose all drive power, as specified in "3.4.4 FAIL-SAFE OPERATION".

4.3.2 SPIN-DOWN TIME

When drive power is removed from any spinning part on an undamaged BotsIQ robot, the part is required to spin down to a full stop within **30 seconds** after power is removed.

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

5.0 ELECTRICAL POWER

5.1 ROBOT ELECTRICAL SYSTEMS

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

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

5.2 VOLTAGE LIMITATIONS

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

5.2.1 DC AND AC VOLTAGES

The voltage limits depend upon whether the voltage is DC or AC, as follows:

a. **48 volts DC** is the maximum nominal DC voltage in a BotsIQ robot. With batteries fully charged, the electrical system is allowed to measure up to 56 volts.
b. **–80 to +80 volts AC** is the minimum/maximum peak AC voltages allowed to be used in a BotsIQ robot. Thus, an AC voltage-meter cannot read more than 56.5 volts rms.

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

5.2.2 CHARGING UNIT VOLTAGE

70.0 volts is the maximum allowed output voltage of any BotsIQ robot battery-charging unit.

5.2.3 IGNITION SYSTEM VOLTAGE

It is understood that fuel-powered engine ignition systems will generate high voltage pulses. This is allowed provided that the ignition is generating high voltages only when the engine is running.

5.3 ELECTRICAL POWER SOURCES

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

5.3.1 ALLOWED BATTERY TYPES

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

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

Lithium-Polymer batteries are specifically not allowed.

5.3.2 BATTERY/CAPACITOR MOUNTING

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

5.3.3 GENERATORS AND ALTERNATORS

Generators and Alternators can be used on a BotsIQ robot, provided that their voltage output complies with the requirements of "5.2.1 DC AND AC VOLTAGES".

5.4 ELECTRICAL SYSTEM REQUIREMENTS

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

5.4.1 PRIMARY-POWER WIRING

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

a. Multi-stranded wiring is used for connecting the primary-power batteries to the input of any Master Switch.
b. Exposed terminals and bare wire-ends from the primary-power batteries to the input of any Master Switch are covered with electrical insulation.
c. Electrical wiring from the primary-power batteries to the input of any Master Switch is attached to or supported by the robot structure.
d. All wires are insulated using the factory-applied insulation and/or heat-shrink tubing and/or quality electrical tape.
e. All insulation is applied so that it cannot easily come loose or be penetrated.

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

5.4.2 PRIMARY POWER MASTER SWITCH

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

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

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

If a primary-power battery is connected to a conductive robot chassis, a switch is required to cut power between the battery and the chassis.

5.4.3 SECONDARY POWER DEACTIVATION

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

5.4.4 POWER INDICATOR LIGHT

It is recommended that the robot have an external light, or combination of lights, that are lighted whenever the primary power is turned on.

5.5 ELECTRIC MOTORS

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

5.5.1 ELECTRIC MOTOR TYPES

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

5.5.2 NOISE-SUPPRESSION CAPACITORS

It is recommended that noise-suppression capacitors be used on all Primary Power brush-type motors.

5.5.3 MOTOR COOLING

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

a. Internal and/or external air cooling is allowed (and recommended).
b. Cooling using an attached heat sink is allowed. However, the heat sink cannot be directly connected to any pneumatic or hydraulic component.
c. Liquid cooling of electric motors is not allowed.

5.6 ELECTROMAGNETS

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

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

6.0 FUEL-POWERED ENGINES

6.1 INTERNAL COMBUSTION ENGINE

The only type of fuel-powered device that can be installed on a BotsIQ robot is an Internal Combustion Engine (ICE). The robot may use more than one ICE, provided that each engine complies with the requirements below.

6.1.1 ICE DEFINITION

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

6.1.2 DISALLOWED ENGINE TYPES

The following fuel-burning engine types cannot be used on a BotsIQ robot:

a. ICE's using external liquid cooling.
b. An engine that burns fuel outside of an enclosed combustion chamber.
c. Turbo-Shaft, Turbo-Jet and Pulse-Jet engines.

6.1.3 REMOTE STARTING

Any ICE on the robot is required to have an on-board self-starting mechanism. This mechanism has to be activated using a specific command from the remote-control radio.

6.1.4 ICE IDLE SPEED

The Idle Speed of any ICE has to be less than **one-fourth** the maximum operating speed.

6.1.5 ENGINE NOISE

The noise emitted from an ICE at Idle Speed cannot exceed **110 dB(A)** (A-weighted decibels) as measured in an open area, **10 feet** from the robot in any direction.

6.1.6 ENGINE EXHAUST

The engine exhaust system has to be installed such that:

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

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

6.1.7 COMBUSTION-ENHANCING GASSES

Use of combustion-enhancing gasses is specifically prohibited. The only types of gasses that may be stored on a BotsIQ robot are those specified in "7.2.1 ALLOWED GAS TYPES".

6.2 LIQUID FUEL REQUIREMENTS

Liquid fuels may be carried aboard the robot solely for the purpose of powering ICE's.

6.2.1 FUEL QUANTITY LIMIT

8.0 fluid ounces is the maximum quantity of fuel that may be carried on a BotsIQ robot. This limit includes any lubricating oil blended into the fuel.

Note: The maximum fuel limit is the <u>total</u> for the robot, not for each engine.

6.2.2 ALLOWED FUELS

The only fuels that can be used on a BotsIQ robot are:

a. Commercially-available grades of Unleaded Gasoline.
b. A blend of Unleaded Gasoline, Methanol (optional) and lubricating oil. The blend cannot contain more than **40%** Methanol by volume.
c. Commercially-available glow-plug 2-stroke fuel blends, as is sold at hobby supply outlets. The blend cannot contain more than **15%** Nitromethane by volume.

6.3 FUEL SYSTEM

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

6.3.1 FUEL TANK SIZE

Fuel tanks have to be built or modified so that when all tanks are filled to their maximum capacity, they cannot contain any more fuel than is allowed in "6.2.1 FUEL QUANTITY LIMIT"

6.3.2 PRESSURIZED FUEL TANKS

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

6.3.3 FUEL TANK REQUIREMENTS

Fuel tanks have to be designed and installed such that:

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

6.3.4 FUEL LINE INSTALLATION

Fuel lines have to be installed such that:

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

6.3.5 FUEL PUMPS

Mechanical fuel pumps are allowed provided that any pump is mounted directly to the engine and is mechanically driven from the engine.

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

a. Be rated for at least the maximum output pressure of the fuel pump.
b. Be a single continuous hose from the pump to the engine.
c. Meet the other requirements for fuel lines as specified in "6.3.4 FUEL LINE INSTALLATION".

Electrically powered fuel pumps of any kind cannot be used on a BotsIQ robot.

Note: Pumps driven pneumatically using crankcase compression are considered to be mechanically driven.

6.4 LUBRICATION OIL

6.4.1 OIL SUMPS

If an ICE contains an integral oil sump, the venting system cannot allow oil to continuously spill out if the robot is inverted.

6.4.2 ENGINE OIL TANKS

Engine oil tanks are allowed solely for the purpose of providing lubricating oil to 2-stroke engines with integral oil injection systems, provided that:

a. Any oil tank complies with the same requirements as for fuel tanks, as described in "6.3.3 FUEL TANK REQUIREMENTS".
b. The oil line from any oil tank to any ICE meets the same requirements as fuel lines as described in "6.3.4 FUEL LINE INSTALLATION".

6.5 ICE FAIL-SAFE OPERATION

6.5.1 RADIO FAIL-SAFE

Upon loss of the remote-control signal, any ICE in a BotsIQ robot has to either shut off (cease producing power) or return to idle speed within **5 seconds** of signal loss.

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

6.5.2 AUTOMATIC MECHANICAL DISCONNECT

Any ICE in a BotsIQ robot requires a centrifugal clutch or other mechanical disconnect mechanism designed so that, while the engine is running at Idle Speed, there cannot be hazardous movement of the robot itself, or of any external weapon component driven by that engine.

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

6.5.3 REMOTE-CONTROL SHUT-OFF

Any ICE in a BotsIQ robot must be able to be completely shut off (cease producing power) using the remote control.

7.0 PNEUMATIC SYSTEMS

7.1 PNEUMATICS OVERVIEW

Pneumatics involve the storage, use and control of pressurized gas to power actuators.

7.1.1 CAUTIONS

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

7.1.2 TEAM RESPONSIBILITY

This section contains many requirements intended to promote the design of a safe and durable pneumatic system. However, it is ultimately the responsibility of each BotsIQ Team to ensure the safety of their pneumatic system design.

7.2 COMPRESSED GAS SPECIFICATIONS

7.2.1 ALLOWED GAS TYPES

The following gasses are the only types that can be stored or used aboard a BotsIQ robot:

a. Nitrogen (N_2), in compressed gaseous form only.
b. High-Pressure-Air (HPA). Also called "compressed air".

7.2.2 MAXIMUM STORAGE PRESSURE

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

7.2.3 MAXIMUM ACTUATION PRESSURE

150 psi is the maximum pneumatic pressure downstream of the regulator that may be used for actuation anywhere aboard a BotsIQ robot at any time.

7.2.4 GAS VOLUME LIMITS

The maximum total volume of pressurized gas that may be stored on a single BotsIQ robot or on a MultiBot cluster is:

a. **12 cubic feet** at standard temperature and pressure, if the gas is stored in a single pressure tank.
b. **18 cubic feet** at standard temperature and pressure, if the gas is stored in multiple pressure tanks, provided that no single tank stores more than **9 cubic feet**.

More than two tanks may be used.

7.2.5 POWERED PNEUMATIC PUMP

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

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

7.3 PRESSURE STORAGE TANKS

Pressure storage tanks refer to all pneumatic tanks or vessels used for primary gas storage. They do not refer to regulated-pressure downstream buffer tanks.

7.3.1 TANK STANDARDS

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

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

Pressure tanks may be aluminum or fiber-wound. Steel tanks are allowed but not recommended.

7.3.2 PRESSURE RELIEF

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

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

7.3.3 TANK SHUT-OFF VALVE

Each pressure storage tank on a BotsIQ robot is required to have a mechanical shut-off valve to isolate the high-pressure gas stored in that tank.

This valve has to be mounted directly to the tank, downstream of the high-pressure relief and upstream of a regulator or any other pneumatic component.

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

Adjusting a regulator to shut off pressure is not acceptable.

7.3.4 TANK MOUNTING

At a minimum, each 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 components.
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.

7.3.5 TANK PROTECTION

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

7.3.6 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 gas aboard the robot.

7.3.7 CUSTOM PRESSURE TANKS

All pressure storage tanks have to be commercially manufactured, distributed and sold. Custom-made or modified tanks are specifically not allowed.

7.4 PRESSURE REGULATORS

Pneumatic pressure regulators are required for any BotsIQ robot pneumatic system where gas is stored at a pressure is higher than specified in "7.2.3 MAXIMUM ACTUATION PRESSURE".

7.4.1 REGULATOR LOCATION

A regulator with a built-in high-pressure shut-off valve has to be mounted directly to each individual pressure storage tank. A basic regulator has to be mounted directly to a shut-off valve that is mounted directly to the tank. There cannot be connecting hoses or pipes between the shut-off valve and the regulator.

7.4.2 REGULATOR MAXIMUM PRESSURE

If a regulator is adjustable, the maximum possible pressure setting has to be less than or equal to **200%** of the pressure specified in "7.2.3 MAXIMUM ACTUATION PRESSURE".

7.4.3 REGULATOR ADJUSTMENT LOCK

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

The locking method has to be mechanical and cannot use any kind of adhesive tape.

7.5 PNEUMATIC COMPONENTS

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

7.5.1 COMMERCIAL COMPONENTS

All BotsIQ robot pneumatic components have to be commercially manufactured, distributed and sold. Custom-made or modified components are not allowed.

7.5.2 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 will be required.

7.5.3 BUFFER TANK RATINGS

Buffer tanks used downstream of the regulator have to be rated for at least **150%** of the maximum regulated pressure allowed, as defined in "7.2.3 MAXIMUM ACTUATION PRESSURE".

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

7.5.4 PRESSURE RELIEF VALVES

One or more burst disks or ASME pressure relief valves are required to be installed downstream of any regulator or compressor, as necessary, to limit pressure in all low-pressure areas of the pneumatic system.

Any pressure reliefs have to start relieving pressure at no more than **130%** of the pressure rating of the lowest-rated component in that area of the pneumatic system.

7.5.5 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. Where necessary, connecting hoses are constrained or routed to prevent pressurization, vibration or impact loads from applying a bending force to any hose fittings.
c. Pneumatic components 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.

7.5.6 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.
c. If the piston of a cylindrical weapon actuator strikes the rod-cap during its operation, there is a restraint, shield or other containment method that will retain or capture any parts that would come loose if the rod-cap separates from the actuator.

7.5.7 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 BotsIQ robot pneumatic system.

7.5.8 PNEUMATIC COMPONENT HEATING

No active heating system can be used for pressure tanks, or any other components of a pneumatic system on board a BotsIQ robot.

All pneumatic components have to be isolated or insulated against on-board heat sources.

7.6 PURGE VALVES

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

7.6.1 PURGE VALVE OPERATION

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

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

7.6.2 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).

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

Note: It is not required that the purge valve be upstream of the regulator. A purge valve downstream of the regulator is acceptable.

7.6.3 MAXIMUM VENTING TIME

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

7.7 PRESSURE TEST POINTS

Pressure test points are required to allow quick and accurate checking of all system pressures.

7.7.1 TANK PRESSURE

Every pressure storage tank is required to have a pressure gauge or test point which directly allows reading the gas pressure in that tank.

7.7.2 REGULATED PRESSURE

There has to be at least one pressure gauge or test point that allows reading of the system pressure downstream of each regulator.

7.7.3 PRESSURE GAUGE RESOLUTION

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

7.7.4 TEST POINT FITTINGS

If a gauge is not mounted to a test point, a Stauff SMA-20, SMA-15, SMA-12 or directly compatible fitting is allowed in lieu of a gauge.

A non-Stauff-compatible fitting can be used if the Team also supplies appropriate gauges compatible with the test fittings.

7.7.5 PRESSURE TEST ACCESSIBILITY

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

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

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

7.8 PRESSURE TANK FILLING

To allow safe and convenient filling of pressure storage tanks:

7.8.1 FILLING ACCESS

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

7.8.2 CONNECT/DISCONNECT

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

7.8.3 STANDARDIZED FILLING CONNECTION

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

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

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

8.0 HYDRAULIC SYSTEMS

8.1 HYDRAULICS OVERVIEW

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

8.1.1 CAUTIONS

Hydraulic systems use high-pressures and are dangerous if not designed and constructed properly. Moreover, damage caused by competition can render any hydraulic system unsafe.

8.1.2 TEAM RESPONSIBILITY

This section contains many requirements intended to assist in the design of a safe hydraulic system. However, it is ultimately the responsibility of each BotsIQ Team to ensure the safety of their robot's hydraulic system.

8.2 HYDRAULIC SYSTEM REQUIREMENTS

8.2.1 MAXIMUM HYDRAULIC PRESSURES

2000 psi is the maximum allowed hydraulic pressure used anywhere on board a BotsIQ robot.

8.2.2 PRESSURE RELIEF VALVE

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

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

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

8.2.3 HYDRAULIC FLUID

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

Hydraulic fluid is required to be stored aboard the robot so that:

a. Any hydraulic reservoir is reasonably protected within the structural frame of the robot.
b. The vent system for a hydraulic reservoir will not continuously leak fluid if the robot is inverted.

8.2.4 BYPASS/PURGE VALVES

Any BotsIQ robot hydraulic system is required to have bypass/purge valves to relieve all pressure in the hydraulic system. The minimum requirements are:

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

8.2.5 PRESSURE BOOSTERS NOT ALLOWED

A hydraulic pressure booster (intensifier) is a component designed to raise the operating pressure of the system. Hydraulic pressure boosters cannot be used aboard a BotsIQ robot.

8.2.6 ACCUMULATORS NOT ALLOWED

A hydraulic accumulator is a tank designed to temporarily store pressurized hydraulic fluid. Hydraulic accumulators cannot be used aboard a BotsIQ robot.

8.3 HYDRAULIC SYSTEM COMPONENTS

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

8.3.1 RATED COMPONENTS

Only rated pressurized hydraulic components can be used on a BotsIQ robot. Thus:

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

A hydraulic reservoir that is not pressurized to more than **30 psig** can be of custom manufacture, if it can be demonstrated that the reservoir is properly designed and constructed.

8.3.2 COMPONENT MOUNTING

Hydraulic components have to be mounted such that:

a. Any hydraulic pump is positively secured either to the robot structure or to the drive motor.
b. Other than pumps and hoses and piping, any hydraulic component, such as a valve, gauge or manifold, is positively secured to the robot structure.
c. Where necessary, hydraulic hoses are constrained or routed to prevent pressure, vibration or impact loading from applying a significant bending force to any fittings.

8.3.3 COMPONENT DAMAGE

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

8.4 PRESSURE TEST POINTS

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

8.4.1 SYSTEM PRESSURE

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

8.4.2 PRESSURE GAUGE RESOLUTION

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

8.4.3 TEST POINT FITTINGS

A Stauff SMK-20 or directly compatible fitting is allowed in lieu of the gauge.

A non-Stauff-compatible fitting can be used if the Team also supplies appropriate gauges, compatible with the test fittings.

8.4.4 PRESSURE TEST ACCESSIBILITY

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

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

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

9.0 WEAPONS

9.1 WEAPON DESIGN

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

9.1.1 WEAPON SAFETY

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

9.1.2 DAMAGE TO ARENA

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

9.1.3 MODULAR WEAPONS

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

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

a. Each robot/weapon combination complies with of all applicable BotsIQ Regulations.
b. The combined time for adding and removing each Modular Weapon is less than **30 minutes** total.

9.2 WEAPON TYPES NOT ALLOWED

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

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

9.2.2 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.

9.2.3 OBSCURATION WEAPONS

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

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

Any smoke created cannot cause significant obscuration of the robot.

9.2.4 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. Rapidly decomposing substances such as Sodium Azide.
c. Flammable liquids such as gasoline, alcohol and MEK.
d. Flammable gasses such as propane, butane and acetylene.
e. High-temperature devices such as flame throwers or plasma torches

Certain flammable liquids as defined in "6.2.2 ALLOWED FUELS" may be used to power ICE's, which may in turn be used to drive weapons.

9.2.5 MECHANISM FOULING WEAPONS

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

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

9.2.6 MUTUALLY-DESTRUCTIVE WEAPONS

A Mutually-Destructive Weapon is one designed with the intent that attacking an opponent will also disable the attacking robot. These are not allowed.

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

Also, the robot cannot use a flywheel or other component deliberately designed to fragment.

9.3 RESTRICTED WEAPON TYPES

Certain types of weapons are allowed with restrictions.

9.3.1 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 8 feet** in length.
c. The tether can restrain the fired projectile, even after multiple full-power firings.

9.3.2 COVERING WEAPONS

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

9.3.3 AIRBAGS/BALLOONS

A BotsIQ robot may use airbags or balloons as a weapon, provided that:

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

Use of automotive airbag inflators is specifically prohibited.

9.4 FLYWHEEL WEAPONS

A Flywheel is any heavy spinning part, or collection of parts, used on or within the robot, where the inertia of the part(s) stores a substantial amount of energy. This includes the spinning exterior of a "Spinner" robot and a completely spinning "Thwackbot".

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

9.4.1 FLYWHEEL POWER

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

9.4.2 FLYWHEEL SAFETY AND SPIN-DOWN

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

9.4.3 FLYWHEEL INSTALLATION

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

9.4.4 BOTSIQ AUTHORITY

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

9.5 LARGE SPRING WEAPONS

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

9.5.1 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.

9.5.2 DEACTIVATED SPRING

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

9.5.3 REMOTE ARMING MECHANISM

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

9.5.4 REMOTE RELEASE MECHANISM

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

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

9.5.5 SAFETY RELEASE

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

a. A single person can activate the release mechanism.
b. It cannot require more than **30 seconds**.
c. Using the release cannot require placing any body part in the path of any weapon system or other powered part of the robot.

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

9.6 LASER OR LIGHT HOMING

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

9.6.1 HAND-HELD LASERS

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

9.6.2 NON-COHERENT LIGHTS

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

Ultra-violet light sources cannot be used in a BotsIQ robot, as specified in "2.6.2 NON-LASER LIGHTING".

Appendix A: LEAD-ACID BATTERIES

A.1 SEALED LEAD-ACID TYPES

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

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

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

A.2 LEAK-PROOF REQUIREMENTS

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

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

A.3 PRE-APPROVED SLA BATTERIES

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

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

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

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

A.4 BATTERY DOCUMENTATION

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

Appendix B: WALKERS

B.1 DEFINITION

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

B.2 WALKER WEIGHT

A Large Class BotsIQ robot that qualifies as a Walker will be allowed an additional 30% weight advantage over a conventional non-Walker robot.

B.3 WALKER REQUIREMENTS

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

a. The drive mechanism for robot locomotion is powered solely by linear hydraulic or 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 robot parts that touch the ground for locomotion or support have to move forward and backward in a reciprocating motion relative to the center-of-gravity of the robot.

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

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

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

B.4 SPECIFIC EXCLUSIONS

If the locomotion drive system of the robot 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 the robot as a Walker, contact BotsIQ Inc. as specified in "1.7 CONTACTING BOTSIQ".