SECTION 5 THE ROBOT

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5 THE ROBOT

5.1 OVERVIEW

This section of the 2005 FIRST Robotics Competition Manual provides:

- NEW Rules applicable to the design and construction of the 2005 Robot.
- Descriptions of NEW mechanical and electrical systems that are based on parts provided in the 2005 Kit of Parts (KOP).

COMPLIANCE WITH ALL RULES IS MANDATORY.

Robots will be inspected at each FIRST event to verify rules compliance before being allowed to compete.

5.1.1 What is a FIRST Robot?

A FIRST robot is a remotely operated vehicle designed and built by a FIRST Robotic Competition team to perform specific tasks when competing in the 2005 competition "Triple Play."

5.1.2 Getting Started

Please be sure to thoroughly read and understand Sections 3, 4, 5, and 8 of this manual before designing your robot. In particular, pay attention to ***Section 5.2.1. General Design & Safety Rules*** and ***Section 5.2 Robot Rules*** before proceeding. There are then several matters that your team should carefully assess. The following are just a few important points offered to help teams in getting started:

1. Evaluate the Game's physical challenges and identify those that the robot will have to overcome.

Will it have to climb structures, pick and place items, push / pull goals, possess a low profile, extend its height, lift items, hang, etc.?

What are the game's implications regarding the robot's center of gravity?

Are there unique field surface characteristics that you should consider when determining robot driving mechanism tread design?

Are there any particular offensive / defensive capabilities important to the robot?

2. Review all items provided in the Kit of Parts (see Section 5.4) to gain an understanding of their basic features. Note that there are also links to suppliers' data sheets in the Part Kit tables for many of the components in the Kit.

3. We recommend that you print out and read through the manuals and documents listed in ***Section 5.1.3 Related Documents & Resources.***

4. Look over the specifications and technical notes provided for the various Kit components.

5. Note all Safety Rules relating to the robot's design.

The locations and ratings of circuit breakers where indicated in the wiring diagrams

Wire size

Stored energy guidelines

Attention to sharp corners and edges

5.1.3 Related Documents & Resources

In addition to this chapter, there are other sections in this manual and other documents you should review before proceeding with the robot design process:

- ***Section 3: The Arena***, ***Section 4: The Game*** and ***Section 8: The Tournament*** segments of this manual
- ***Section 11.2.8.2 Crate Shipping Deadlines*** as listed in the ***Robot Transportation*** section of this manual

Instruction Manuals for products provided by Innovation First, Inc. can be found on the Innovation First website at: http://www.innovationfirst.com

- CMUcam2 Vision System – Specifications, description, installation info, Getting Started guide, and Software info available for the Vision sensor.
- FIRST 2005 Transmission Manual Rev A – Instructions to assemble New Drive Transmissions.
- Chassis & Drive Train Assembly – Instructions for the KitBot Chassis and Drive Train assemblies.
- Wheel Assembly Instructions– How-to-do-it guide for assembling Skyway wheels.
- Drive Train Improvements – suggestions on enhancing the robot drive train performance.
- Chassis Sheet Metal Manufacturing- Forming the KitBot frame.
- FRC 2005 Drive Train Design Process – Development plans for KitBot and Transmissions.
- Instruction manuals for Robot and Operator Controllers, Spike Relays, Victor 884 Speed Controllers.

FIRST Manuals, Drawings, available at http://www.usfirst.org/robotics/doc_updt.htm include:

- FIRST Guidelines, Tips Good Practices – Provides useful guidance and advise to assist in robot assembly.
- FIRST 2005 Pneumatic Manual - Valuable information about the pneumatic components and ordering processes are included.
- How Accelerometers Work – A tutorial on measuring the "g" level of acceleration.
- 2005 Robot Power Distribution- The electrical interconnection diagram for the robot.

Additional Resources include:

- DC motor tutorial (motor speed/torque curves, etc.) available at http://lancet.mit.edu/motors.

5.1.4 Conventions

Specific methods are used throughout this section to highlight Warnings, Cautions, key words or phrases to alert the reader to important information designed to help teams in constructing a robot complying with the Rules in a safe and workmanlike manner.

- Warnings, Cautions, and Notes appear in bordered boxes.
- Key words, Phrases, or References appear in bold italics such as a ***Section Number*** reference.
- Operating keys, controls, buttons appear in bold capital letters (i.e. **OFF/ON** switch or **RESET** button).

This section includes hypertext. Clicking on the Underlined Italic text will link you to additional information related to that item or subject.

5.2 DEFINITIONS

COMPONENT – A robot part in its most basic configuration, which cannot be disassembled without damaging or destroying the part, or altering its fundamental function.

- Example 1: raw aluminum stock, pieces of steel, wood, etc., cut to the final dimensions in which they will be used on the robot, would all be considered components. Bolting pieces of extruded aluminum together as a robot frame would constitute a MECHANISM, and the collection of pieces would not be considered a COMPONENT.
- Example 2: a COTS circuit board is used to interface to a sensor on the robot, and it includes the physical circuit board and several electrical elements soldered to the board. The board is considered a COMPONENT, as this is the basic form in which it was purchased from the vendor, and removing any of the electrical elements would destroy the functionality of the board.

COTS – A "Commercial, Off-The-Shelf" COMPONENT or MECHANISM, in it's unaltered, unmodified state. A COTS item must be a standard (i.e. not custom order) part commonly available from the VENDOR, available from a non-team source, and available to all teams for purchase.

- Example 1: a team orders two robot grippers from RoboHands Corp. and receives both items. They put one on their storeroom and plan to use it later. On the other, they drill "lightening holes" to reduce weight. The first gripper is still classified as a COTS item, but the second gripper is now a "custom part" as they have made modifications to it in their shop.
- Example 2: a team obtains openly available blueprints of a drive component commonly available from Wheels-R-Us Inc. and has local machine shop "We-Make-It, Inc." manufacture a copy of the part for them. The produced part is NOT a COTS item, because it is not commonly carried as part of the standard stock of We-Make-It, Inc.

FABRICATED ITEM – Any COMPONENT or MECHANISM that has been altered, built, cast, constructed, concocted, created, cut, heat treated, machined, manufactured, modified, painted, produced, surface coated, or conjured into the final form in which it will be used on the robot.

- Example 1:A piece of extruded aluminum has been ordered by the team, and arrives in a 20-foot length. To make it fit in their storage room, the team cuts it into two ten-foot lengths. These would not be considered FABRICATED ITEMS, as they have not been cut to the final length in which they will be used on the robot.
- Example 2: A team has designed an arm mechanism that uses gears with a 1/2-inch face width. They order a 12-inch length of gear stock and cuts it into precise 1/2 inch slices. They have not yet bored out the mounting bores in the center of the gears. The slices are now considered FABRICATED ITEMS, as they have been cut to final size, even though all the machining operations (the center bore) may not yet be completed.

FIX-IT-WINDOWS – The 48-hour period following the deadline for shipping the robot, or following the close of a regional competition, in which parts may be manufactured in preparation for future competitions. During the FIX-IT WINDOWS, software for either the robot or operator interface may be developed without restriction.

MECHANISM – A COTS or custom assembly of COMPONENTS that provide specific functionality on the robot. A MECHANISM can be disassembled (and then reassembled) into individual COMPONENTS without damage to the parts.

SPARE PARTS – A COMPONENT or MECHANISM constructed as an identical duplicate of an existing part of the robot, for the purpose of replacing a broken or defective part. SPARE PARTS may be either

COTS items or FABRICATED ITEMS, but they must be physically and functionally identical to the original part.

REPLACEMENT PARTS – A COMPONENT or MECHANISM constructed as a functional duplicate of an existing part of the robot, for the purpose of replacing a broken or defective part. REPLACEMENT PARTS may be either COTS items or FABRICATED ITEMS. They must be functionally identical to the original part but may be modified to provide more robust performance of the function.

- Example 1: A lever arm made of lexan on your robot breaks. You manufacture a REPLACEMENT PART made of aluminum plate, using the design drawings of the original. As the new part provides the same function as the broken part, the new part is a valid REPLACEMENT PART.
- Example 2: A sensor on the robot is connected to the control system with 24guage single-strand wire, and runs across a hinged joint. The flexing of the wire causes it to break, and you want to replace it with 18-guage multi-strand wire. If the new wire follows the same path as the original and connects only the same devices, then it is a valid REPLACEMENT PART (i.e. it has added robustness without changing function). But if the wire is then used to connect an additional sensor to the same circuit, it is providing a functionally different capability, and is no longer a "replacement."

UPGRADE PARTS - A COMPONENT or MECHANISM intended to provide additional functionality not currently available on the robot. UPGRADE PARTS may be COTS items or custom FABRICATED ITEMS, and may either add to or replace existing functionality.

- Example 1: A robot is designed with a four-wheel drive system. The system works well on flat floors, but high-centers when trying to drive up steps. The team adds two more wheels on the centerline of the robot to prevent this problem, and the wheels are identical to those already on the robot. The new wheels would be considered UPGRADE PARTS even though they are the same as the ones already in place, as they alter the functionality of the robot and provide new capability.

VENDOR – A legitimate business source for COTS items that as a minimum, satisfies the following criteria:

- The VENDOR must have a Federal Tax Identification number.
    - The Federal Tax Identification number establishes the VENDOR as a legal business entity with the IRS and validates their status as a legitimate business.
- The VENDOR must be able to ship their product within five business days of receiving a valid purchase request.
    - The FIRST Robotics Competition build season is only six weeks long, so the VENDOR must be able to get their product to a team in a timely manner.

Note that this criterion may not apply to custom-built items from a source that is both a VENDOR and a fabricator. For example, a VENDOR may sell flexible belting that the team wishes to procure to use as treads on their drive system. The VENDOR cuts the belting to a custom length from standard shelf stock that is typically available, welds it into a loop to make a tread, and ships it to a team. The fabrication of the tread takes the VENDOR two weeks. This would be considered a FABRICATED ITEM, and the two weeks ship time is acceptable. Alternately, the team may decide to fabricate the treads themselves. To satisfy this criterion, the VENDOR would just have to ship a length of belting from shelf stock (i.e. a COTS item) to the team within five business days and leave the welding of the cuts to the team.

- The VENDOR makes their products available to all FIRST Robotics Competition teams.
- VENDORS must not limit supply or make a product available to just a limited number of FIRST Robotic Competition teams.
- Ideally, chosen VENDORS should have national distributors.

Example distributors include Home Depot, Lowes, MSC, Radio Shack. And McMaster-Carr. FIRST competition events are not usually near home. When parts fail, local access to replacement parts is often critical.

FIRST desires to permit teams to have the broadest choice of legitimate sources possible, and to obtain COTS items from the sources that provide them with the best prices and level of service available. The intent of this definition it to be as inclusive as possible to permit access to all legitimate sources, while preventing *ad hoc* organizations from providing special-purpose products to a limited subset of teams in an attempt to circumvent the cost accounting rules.

5.3 ROBOT RULES

These Rules establish the global robot construction and performance constraints dictated by the characteristics of the provided Kit of Parts along with the size and weight design limits specified in this section. **Compliance with the Rules is Mandatory. Any Robot construction not in compliance with the Rules (determined at inspection) must be rectified before a robot will be allowed to compete.**

When reading these Rules, please use technical common sense (engineering thinking) rather than a lawyer's interpretation. Try to understand the reasoning behind a rule.

5.3.1 General Design & Safety Rules

<R01> Each team may enter ONE robot into the 2005 FIRST Robotics Competition. That robot must be assembled using materials from the 2005 FIRST Kit of Parts, and other allowed materials as specified in the Rules, and must fully comply with all Rules.

<R02> Energy used by FIRST Robotics Competition robots, (i.e., stored at the start of a match), may only come from the following sources:

- Electrical energy derived from the onboard 12V and 7.2V batteries
- Compressed air stored in the pneumatic system, but only supplied by the compressor included in the kit, and stored at a maximum pressure of 120 PSI only in the two Clippard Instruments tanks provided in the Kit
- A change in the altitude of the robot's center of gravity
- Storage achieved by deformation of robot parts. Teams must be very careful when incorporating springs or other items to store energy on their robot by means of part or material deformation**.** A robot may be rejected at inspection if, in the judgment of the inspector, such items are unsafe.

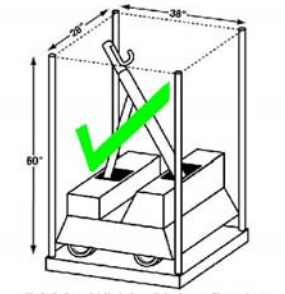
<R03> Protrusions from the robot must not pose hazards or be dangerous to team members or event staff. If, in the judgment of the inspectors or referees, a device on the robot poses a hazard (particularly puncture or impalement hazards) then the team will be required to remedy the situation before the robot will be allowed to play. If the robot includes protrusions that form the "leading edge" of the robot as it drives, and are less than one square inch in surface area, it will invite detailed inspection. For example, forklifts, lifting arms, grapplers. etc. may be carefully inspected for these hazards.

5.3.2 Robot Physical Rules

5.3.2.1 Robot Size

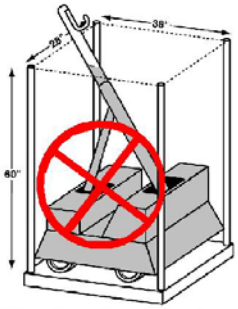
<R04> At the beginning of the match, the ***maximum allowed size of the robot*** is 28 inches (71.12cm) by 38 inches (96.52cm) by 60 inches (152.40cm) tall.

<R05> The starting configuration of a robot immediately prior to being enabled by the Arena Controller at the beginning of a match is the basis upon which a robot will be inspected for compliance with the maximum allowed size. This configuration of the robot must fit within a FIRST Sizing Device that has the following inside surface dimensions: a flat, level rectangular base 28 inches x 38 inches, and a height of 60 inches. Other than resting on the floor of the Sizing Device, no part of the robot may break the plane of the sides or top of the Sizing Device during size inspection. The robot must be self-supporting while in the Sizing Device.

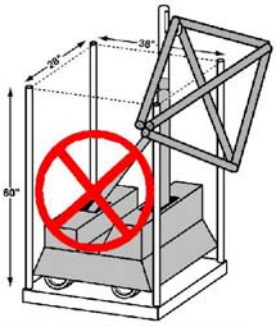


PASS - Within Sizing Device

<R06> If a robot has been designed such that it may have more than one possible starting configuration, the largest possible configuration must be the one used during size inspection.



FAIL - Arm Outside of Zone



FAIL - Arm Outside of Zone

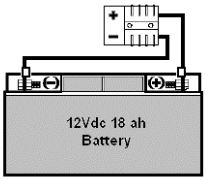
<R07> Once a match begins, robots may extend beyond the starting size under their own power. Any restraints (elastics bands, springs, etc.) that are used to maintain starting size must remain attached to the robot for the duration of the match.

5.3.2.2 Robot Weight

<R08> The maximum allowed weight of **all** robot configuration mechanisms combined, **not including an Exide battery and its associated half of the Anderson cable quick connect/disconnect pair** is 120 pounds (54.43 kg). At the time of weigh in, the basic robot structure and all elements of all additional mechanisms that might be used in different configurations of the robot must be weighed together**.** Included in the weight limit is the control system, back-up 7.2V battery, decorations, bumpers, and any other attached parts, but not the Exide ES18-12 battery and its associated half of the Anderson connection pair (including no more than 12 inches of cable per leg, the associated cable lugs, connecting bolts, and insulating electrical tape)

NOTE

Weight limit this year **excludes** the 12 volt Battery and Anderson cable half



- Example: A team has decided to design its robot such that, before any given match, it may quickly change the configuration of the robot based on perceived strengths or weaknesses of an opponent team's robot. The team accomplished this by constructing its robot as a basic drive train platform plus two versions of a Tetra gripper, each gripper being a quick attach / detach device such that either one or the other gripper (but not both) may be part of the robot at the beginning of a match. Their robot's platform weighs 107 lb, version A of the gripper weighs 6 lb, and version B weighs 8 lb. Although only one version will be on the robot during a match, both grippers (and all components of the grippers that would be used during the match) must be on the weight scale along with the robot

platform during weigh in. This would result in a **rejection** of the robot because its total weight comes to 121 lb.

5.3.2.3 Robot Visibility

<R09> *Robots must display their team number, sponsor and school names, and/or logos whenever the robot is on the field (including practice sessions).* The judges, referees, and announcers must be able to easily identify robots by Team Number. Teams must display their Team Number in four locations at approximately 90-degree intervals around the side of the robot. ***The numerals must be at least 4 inches high, at least in 3/4 inch stroke width and in a contrasting color from its background***. *Team Numbers must be clearly visible from a distance of not less than 100 feet.*

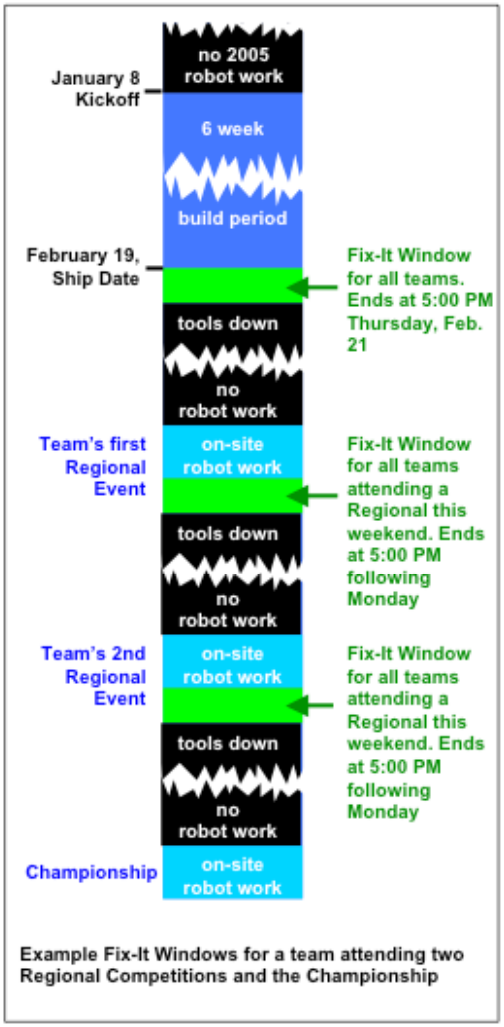
<R10> Robots must use the two Team Color LEDs provided at event registration to display their alliance color (red or blue). One Color LED must be mounted on each side of the robot such that their displayed color is visible from a distance of at least 100 feet. Instructions for connecting the Color LEDs are provided in the Innovation First Controller manual. The Robot Controller directly powers and controls the Team Color LEDs. The user has no control over the Team Color LEDs and no programming is required.

5.3.3 Fabrication Schedule

Teams must design and construct their robot within the schedule constraints defined as follows:

<R11> Prior to the Kick-off: Before the formal start of the robot Build Season, teams are encouraged to think all they want about their robots. They may develop prototypes, create proof-of-concept models, and conduct design exercises. Teams may gather all raw they stock materials and COTS items they want. But absolutely no fabrication or assembly of any elements intended for the final robot is permitted prior to the Kick-off presentation. Any MECHANISMS assembled prior to the Kick-off presentation may be used for prototyping or educational purposes, but MAY NOT be used on the final ROBOT.

<R12> During the Build Season: During the period between the Kick-off and robot shipment deadline, teams are to design and fabricate all the components and mechanisms required to complete their robot. They are encouraged to use all the materials, sources and resources available to them that are in compliance with the rules of the 2005 FIRST Robotics Competition. As the robot shipment deadline approaches, all work on the robot must cease and the robot must be placed in a "hands-off" condition. The entire robot (including all FABRICATED ITEMS intended for use during the competition in alternative configurations of the robot) must be crated up and out of team hands by the robot shipment date.



Example Fix-It Windows for a team attending two Regional Competitions and the Championship

<R13> During the "FIX-IT WINDOW" following the shipment of the robot and between regional competitions events: Teams may manufacture SPARE and REPLACEMENT PARTS for their robot at their home facility. Fabrication of UPGRADE PARTS is not permitted during this period. At the conclusion of a regional competition event, teams may take a limited amount of broken or malfunctioning COMPONENTS or MECHANISMS back to their home facility to make SPARE or REPLACEMENT PARTS. Teams may manufacture all the SPARE and REPLACEMENT parts they want, but the amount of parts they can bring to the competition event is limited (as specified in Rule <24>.

The purpose of this Rule is to allow teams to make critical repairs to existing parts to enable them to compete in following events. The intent is not to have teams take their entire robot back home and make large-scale revisions or upgrades to the robot.

The "FIX-IT WINDOW" following the robot shipment deadline closes at 5:00pm on the Thursday following robot shipment deadline. For the purposes of this definition, the FIRST Regional Competitions will be defined as ending at 5:00pm local time on the Saturday of the competition. The "FIX-IT WINDOWS" following these events will open at that time and close at 5:00pm on the Monday following the competition (the "FIX-IT WINDOW" will ALWAYS close at 5:00pm, regardless of the time the preceding competition may actually conclude).

<R14> Prior to the competitions: After the close of the "FIX-IT WINDOW" and prior to the competition, the team must put down their tools, cease fabrication of robot parts, and cease all software development. Take this opportunity to rest, recover from the build season, and relax. Teams may scout other teams, gather and exchange information, develop game-playing strategies, collect raw materials, prepare tool kits, plan how to make repairs, etc. in preparation for the upcoming competitions. But no construction or fabrication is allowed.

<R15> At the competitions: Teams are allowed to repair, modify or upgrade their competition robots while participating in a competition event event. To support this, teams may bring SPARE, REPLACEMENT and UPGRADE PARTS and COTS items to the competitions (within the limits specified in Rules <R23> and <R24>). Work may only be done on-site in the Pits or at any facility made available to all teams at the event (e.g., in a team's repair trailer or a local team's shop offered to all teams to use). Fabrication may be done when the Pit area is open for normal operations during the period starting with the opening of the Pit area on Thursday and ending at 4:00PM on Saturday. All work must be completed when the Pit area closes each evening. Parts may not be removed from the competition site and retained overnight after the Pit area closes.

<R16> During the "FIX-IT WINDOW" following the last Regional Event a team attends (i.e. prior to attending the FIRST Championship): Teams may manufacture SPARE, REPLACEMENT and UPGRADE PARTS for their robot at their home facility (not at the competition site). At the conclusion of a regional competition event, teams may take a limited amount of broken or malfunctioning COMPONENTS or MECHANISMS back to their home facility to make SPARE or REPLACEMENT PARTS. Teams may manufacture and/or repair all the parts they want, but the amount of parts they can bring to the competition event is limited (as specified in Rule <R24>).

The purpose of this Rule is to allow teams to make critical repairs to existing parts to enable them to compete in following events. The intent is not to have teams take their entire robot back home and make large-scale revisions or upgrades to the robot. For purposes of this definition, FIRST Regional Competitions will be defined as ending at 5:00pm local time on the Saturday of the competition. The FIX-IT WINDOW will open at that time and close at 5:00pm on the Monday following the competition (the FIX-IT WINDOW will ALWAYS close at 5:00pm, regardless of the time the preceding competition may actually conclude).

5.3.4 Robot Material Utilization Rules

<R17> Robots entered into the 2005 FIRST Robotics Competition must be fabricated and/or assembled from COMPONENTS, MECHANISMS and COTS items that are constructed from:

- Items provided in the FIRST supplied Kit of Parts (or their exact replacement part)
- Allowed Additional Parts and Materials as defined in this section in quantities consistent with the Cost Accounting rules.

<R18> Individual COMPONENTS from robots entered in previous FIRST competitions may be used on 2005 robots **IF** they satisfy **ALL** of the rules associated with materials/parts use for the 2005 FIRST Robotics Competition.

<R19> Individual COMPONENTS retrieved from previous robots and used on 2005 robots must have their undepreciated cost included in the 2005 robot cost accounting, and applied to the overall cost limits.

<R20> Motors, pumps, and, robot controllers from previous robots may not be used in addition to those provided in the 2005 kit of parts. They may be used as direct one-to-one SPARE PARTS for those provided if the provided part fails or is damaged. They may only be used if they are identical to the part being replaced (note that 2002 and 2003 Fisher-Price motors are not the same as those in the 2005 kit, and, therefore, cannot be used).

<R21> MECHANISMS from robots entered in previous FIRST competitions may not be used.

<R22> Only Victor 884 Speed Controllers are permitted. Victor 883 and 885 Speed Controllers may not be used.

<R23> Teams may acquire and bring an unlimited amount of COTS items to the competitions to be used to repair and/or upgrade their robot at the competition site.

<R24> Teams may bring a maximum of 25 pounds of custom FABRICATED ITEMS (SPARE PARTS, REPLACEMENT PARTS, and/or UPGRADE PARTS) to each competition event to be used to repair and/or upgrade their robot at the competition site. All other FABRICATED ITEMS to be used on the robot during the competition must arrive at the competition venue packed in the shipping crate with the robot.

<R25> Mechanisms or components on the robot must not pose obvious risk of entanglement. If, in the judgment of the inspectors, a device on the robot poses an entanglement risk then the team will be required to remedy the situation before the robot will be allowed to play. If the structure of a component permits easy penetration by an object less than four square inches in cross section, it will invite detailed inspection. For example, nets, loose rope or wire, voluminous sheets of fabric, etc. may be carefully inspected for these hazards. Willful entanglement actions are addressed in Rule <G25> in ***Section 4.3.3 – General Rules*** of "The Game" section.

<R26> No devices or decorations are permitted on the robot that are intended to jam or interfere with the operation of the vision system (i.e. changing robot color to confuse opponent's vision system).

<R27> Robot wheels, tracks, and other parts intended to provide traction on the playing field ("traction devices") may be purchased or fabricated. In no case will traction devices that damage the carpet or other playing surfaces be permitted. Traction devices may not have surface features such as metal, sandpaper, or hard plastic studs, cleats, or other attachments. Anchors, i.e. devices that are deployed/used to keep one's robot in one place and prevent if from being moved by another robot, cannot use metal in contact with the carpet or other playing surfaces to "stay put." Gaining traction by using adhesives or Velcro-like fastener material is not allowed.

<R28> Adhesive backed tapes are NOT allowed except as follows:

- Velcro tape or double-sided sticky foam may be used for attaching components to the robot.
- Reflective tape may be used with optical sensors in small amounts.
- Adhesive backed labels may be used for labeling purposes.
- Electrical tape may only be used as an electrical insulator.

<R29> Lubricants may be used only to reduce friction within the robot. Lubricants shall not be allowed to contaminate the playing field components, or other robots.

<R30> In order to help reduce the impact forces that the robot will experience during collisions with other robots, teams may add external "bumpers" to the robot. If used, bumpers must satisfy the following constraints:

- Bumpers may extend outside the normal robot starting dimensions (in the horizontal plane) up to 4." per side
- Bumpers must be located in a region from 2" to 8" above the playing field surface.
- Bumpers must not cause the weight of the robot to exceed the weight limit.
- Bumpers must be removable in order to allow the robot starting size to be easily measured during robot inspection.
- Bumpers must be designed to remain attached to the robot for the duration of the match.
- Bumpers and any bumper mounts that extend beyond the robot starting size *may not contain "hard" materials* such as metal, wood, or hard plastics. The definition of "hard" is one of common sense (i.e., if you can punch it and not hurt your bare hand, it is ok).

5.3.4.1 Kit of Parts Rules

<R31> So that every robot's maximum power level is the same, the motors in the kit may **not** be modified except as follows:

- It is acceptable to modify the mounting brackets and/or other structural parts of the motors (output shaft, housing, etc.) as long as the electrical system is not modified and the integral mechanical system of the moving parts (bearings, bushings, worm gear output stages, etc.) is not changed or removed.
- The gearboxes for the Fisher-Price, and Globe motors are not considered "integral" and may be separated from the motors. FIRST will not provide replacements for parts that fail due to modification.

<R32> Teams may replace lost or damaged Kit COMPONENTS only with identical COMPONENTS of the same material, dimensions, and treatment.

<R33> Materials in the Kit may not be changed chemically with the following exceptions:

- Rope ends may be singed to prevent loose ends or to bind them together

- Metal may be heat treated
- Metal may be plated or anodized

5.3.4.2 Additional Parts and Materials Rules

Besides items directly supplied in the 2005 Kit, teams are allowed to use Additional Parts and Materials in the construction of their robots.

<R34> The use of an Additional Part or Material shall not violate any design rule.

<R35> Additional Parts shall not be made from hazardous materials or be unsafe.

<R36> Additional Parts must be generally available from suppliers such that any other FIRST team, if it so desires, may also obtain them at the same price. A specific device **fabricated by a team** from non-2005 Kit materials does not have to be available to others; however, the materials it is made from must be available to other teams.

<R37> The costs of all Additional Parts and Materials must be in compliance with the Cost Accounting Rules of Section 5.3.4.3.

<R38> Specific items allowed include:

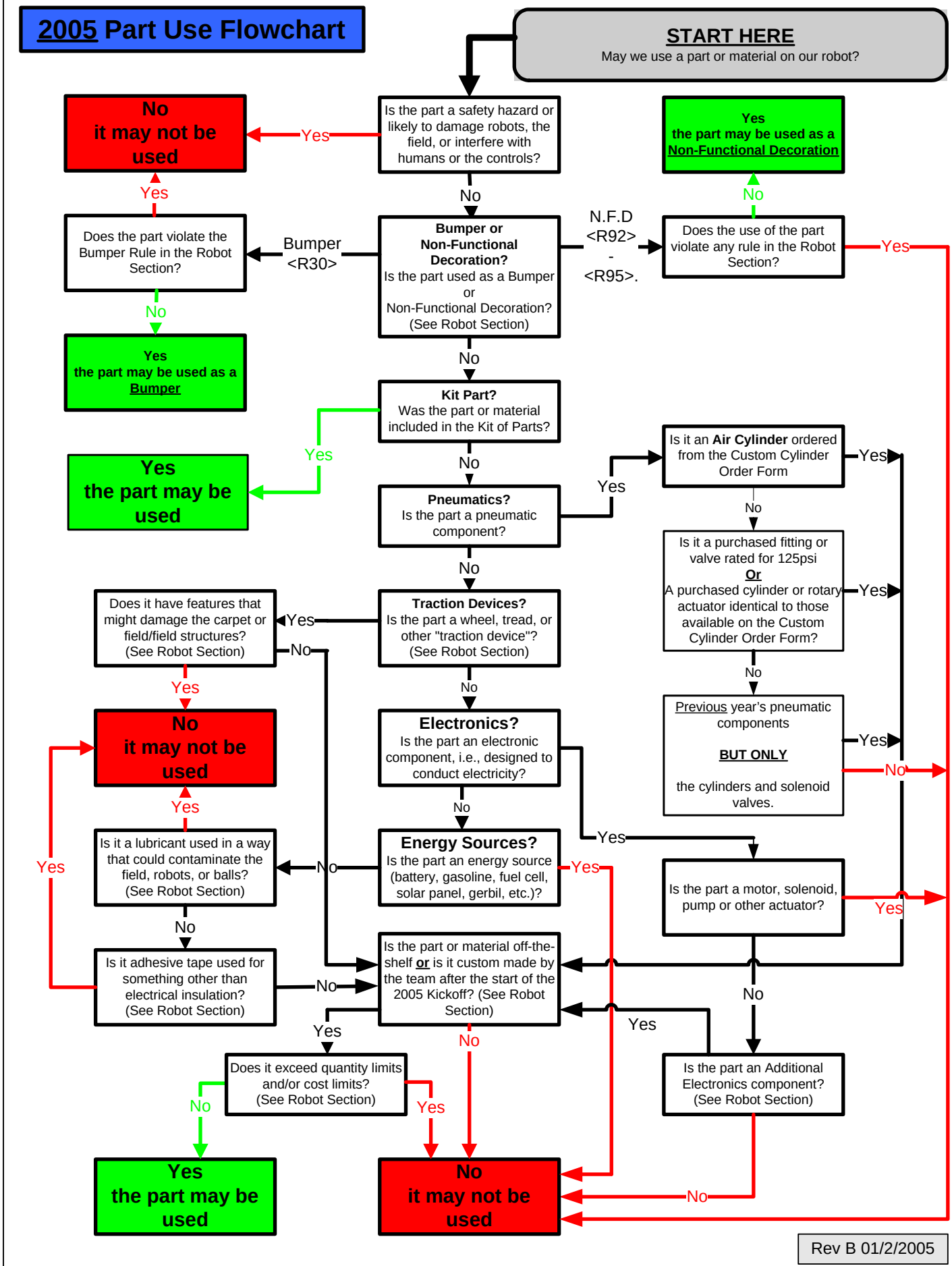
- Additional HITEC HS-322S servos
- Additional Victor 884 Speed Controllers and Spike Relays, as needed.
- Additional solenoid valves, air cylinders, and connecting fittings

<R39> Specific items NOT allowed include:

- Batteries different from or in addition to those provided in the Kit.
- Circuit breakers different from those provided in the Kit. Note: the Snap Action brand circuit breakers provided have unique “trip” characteristics. No substitute brands are permitted.
- Electric motors different from or in addition to those in the Kit.
- Any air compressor, pressure relief valves, or air storage tanks other than those provided in the Kit.
- Hydraulic fluids or hydraulic components.
- Materials classified as hazardous by their MSD Sheets (teams should provide MSD Sheets for any materials they use that might be considered questionable during robot inspection).

<R40> Additional electronic components for use on the robot must be either COTS items, or assembled from COTS items. Additional electronic components include any object that conducts electricity other than IFI relays and speed controllers, wires, connectors and solder.

<R41> Refer to the Part Use Flowchart on page 14 to help determine the legality of a part.


2005 Part Use Flowchart
START HERE
May we use a part or material on our robot?
Is the part a safety hazard or likely to damage robots, the field, or interfere with humans or the controls?
Yes
No it may not be used
Yes
Yes the part may be used as a Non-Functional Decoration
No
Bumper or Non-Functional Decoration?
Is the part used as a Bumper or Non-Functional Decoration? (See Robot Section)
Bumper <R30>
N.F.D <R92> - <R95>.
Does the part violate the Bumper Rule in the Robot Section?
Does the use of the part violate any rule in the Robot Section?
Yes
No
Yes the part may be used as a Bumper
Kit Part?
Was the part or material included in the Kit of Parts?
Yes
Yes the part may be used
Pneumatics?
Is the part a pneumatic component?
Yes
Is it an Air Cylinder ordered from the Custom Cylinder Order Form
Yes
No
Is it a purchased fitting or valve rated for 125psi Or A purchased cylinder or rotary actuator identical to those available on the Custom Cylinder Order Form?
Yes
No
Previous year's pneumatic components BUT ONLY the cylinders and solenoid valves.
Yes
No
Traction Devices?
Is the part a wheel, tread, or other "traction device"? (See Robot Section)
Yes
Does it have features that might damage the carpet or field/field structures? (See Robot Section)
No
Yes
No it may not be used
Electronics?
Is the part an electronic component, i.e., designed to conduct electricity?
Yes
Is the part a motor, solenoid, pump or other actuator?
Yes
Energy Sources?
Is the part an energy source (battery, gasoline, fuel cell, solar panel, gerbil, etc.)?
Yes
No
Is it a lubricant used in a way that could contaminate the field, robots, or balls? (See Robot Section)
Yes
No
Is it adhesive tape used for something other than electrical insulation? (See Robot Section)
Yes
No
Is the part or material off-the-shelf or is it custom made by the team after the start of the 2005 Kickoff? (See Robot Section)
Yes
No
Does it exceed quantity limits and/or cost limits? (See Robot Section)
No
Yes
Is the part an Additional Electronics component? (See Robot Section)
No
Yes
Yes the part may be used
No it may not be used
No
Rev B 01/2/2005

5.3.4.3 Cost Accounting Rules

<R42> The costs of all non-2005 Kit parts and materials used in the construction of a ROBOT (as defined in 5.1.1) must be recorded (in US dollars) by the team, and a copy of the list of all such items and their costs must be submitted at each robot inspection**. An Additional Part or Material is defined as an allowed additional quantity of any part provided in the 2005 Kit, or any item that was not included in the 2005 Kit's inventory list.**

<R43> All costs are to be determined as explained in ***Section 5.3.4.4 - Additional Parts - Cost Determination***.

<R44> The total cost of all non-Kit items may not exceed $3,500.00 USD. No individual COTS electronic component shall have a value of over $200.00 USD. No individual non-electronic item shall have a value of over $400.00. The total cost of components purchased in bulk may exceed $400.00 USD as long as the cost of an individual component does not exceed $400.00. The following items are EXCLUDED from the total cost calculation:

- The cost of any non-functional decorations
- The cost of individual fasteners, adhesives, or lubricants, unless any one component exceeds $1.00
- The costs of "spare" parts. A spare part is defined as a part that a team has obtained as a direct replacement for a failed or defective robot part (either Kit part or non-Kit part) that has already been included in the cost accounting
- The costs of additional Speed Controllers and Spike Relays obtained from Innovation First Inc. for use with Kit motors.
- All costs for the construction of devices used to control the robot from the Alliance Station (i.e. the operator interface and any associated custom equipment).

<R45> The costs of additional non-spare robot control system components obtained from Innovation First Inc. other than Speed Controllers and Spike Relays are to be included in the above $3500 limit.

5.3.4.4 Additional Parts - Cost Determination

The "cost" of each additional item is calculated based on the following criteria, as applicable:

- The purchase price of a COTS item offered for sale by a vendor to any customer.
- The total cost (materials + labor) of an item you pay someone else to make.
  - Example: A team orders a custom bracket fabricated by a vendor to the team's specification. The vendor's material cost and normally charged labor rate apply.
- The fair market value of an item obtained at a discount or as a donation. Fair market value is that price at which the item would be normally offered by the supplier to other customers. Also considered to be "fair market value" are the discounted prices offered to all teams by suppliers with established relations with FIRST.
  - Example: Special price discounts from MSC Industrial Supply Co., Newark InOne, and Terminal Supply Co. are offering to all FIRST teams. The discounted purchase price of items from these sources would be used in the additional parts accounting calculations.
- The cost of raw material obtained by a team + the cost of non-team labor expended to have the material processed further. Labor provided by team members and/or by a recognized team sponsor whose employees are members of the team does not have to be included. Note: it is in the best interests of the teams and FIRST to form relationships with as many organizations as possible. Teams are encouraged to be expansive in recruiting and including organizations in their team, as that exposes more people and organizations to FIRST. Recognizing supporting companies as sponsors

of, and members in, the team is encouraged - even if the involvement of the sponsor is solely through the donation of fabrication labor.

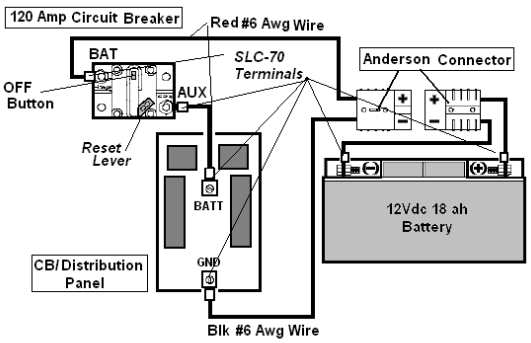
  - Example: A team purchases steel bar stock for $10.00 and has it machined by a local machine shop. The machine shop is not considered a team sponsor, but donates two hours of expended labor anyway. The team must include the estimated normal cost of the labor as if it were paid to the machine shop, and add it to the $10.00.
  - Example: A team purchases steel bar stock for $100 and has it machined by a local machine shop that is a recognized sponsor of the team. The machinists are considered members of the team, so their labor costs do not apply. The total applicable cost for the part would be $10.00.
- The cost of items purchased in bulk or large quantities may be prorated on the basis of the smallest commonly available unit that satisfies the need for the item.
  - Example: A team purchases a 4' x 4' sheet of aluminum, but only uses a piece 10" x 10" on their robot. The team identifies the source that sells aluminum sheet in 1' x 1' pieces. The team may base cost of their part on the basis of a 1' x 1' piece even though they cut the piece from a larger bulk purchase. They do not have to account for the entire 4' x 4' bulk purchase item.
- Shipping costs of Non-Kit items are not counted.
- COMPONENTS or MECHANISMS that teams purchase to replace kit parts that were not received from FIRST are not subject to the cost limitation (i.e., should not be charged against the $3,500 robot limit).

5.3.5 Electrical System Rules

<R46> The only legal main source of electrical energy on the robot is **one** of the two 12v DC non-spillable lead acid batteries provided in the Kit of Parts, or a spare of the same part number. The 7.2v "backup" battery is considered an integral part of the Robot Controller, and may not be used for any other purpose. The **only** 12V battery that may be used on your robot during **competition** (Friday and Saturday) is the Exide model ES18-12. (Additional ES18-12 batteries may be purchased through your local Exide supplier.) You may use other equivalent 12V batteries during Thursday practice rounds.

<R47> The ES-18-12 Battery may only be charged by a 6 Ampere rated Automatic Battery Charger between matches. When recharging Kit batteries, you may use the charger provided by FIRST or an automatic charger with an equivalent charging current rating.

<R48> The ES-18-12 Battery, the Main 120 Amp Circuit Breaker, and the IFI CB/Distribution panel must be connected as shown in the diagram. The ES-18-12 Battery must use the Anderson Connector and the copper SLU-70 lugs provided in the Terminal Supply Bag. The Battery terminals and the SLU-70 lugs must be insulated with shrink tubing and/or electrical tape. You may use additional lengths of #6 red and #6 black wire to reach the panel as needed to make the above connections. The circuit breaker must be readily accessible for inspection and testing at each competition event.



12Vdc Battery & Main Power Connections

<R49> All wiring and electrical devices must be electrically isolated from the robot frame; the robot frame may not be used to carry electrical current (this isolated ground arrangement is necessary due to polarity reversals that occur under certain operating conditions such as during motor direction reversals).

<R50> All 12v electric power used on the robot must be obtained from the load terminals of the Circuit Breaker/ Power Distribution Panel. Each branch circuit must be protected using the appropriate value circuit breaker as specified in Section 5.3.9.1 "Circuit Breaker/Fusing Rules."

5.3.6 Custom Circuit Rules

<R51> The use of additional electronics is intended to allow teams to construct custom circuits for their robots. The custom circuits may be used to indirectly affect the robot outputs by providing enhanced sensor feedback to the Robot Controller to allow it to more effectively decide how to control the robot. In addition to the required branch power circuit breaker, smaller value fuses may be incorporated in the custom circuits for additional protection. All outputs from the custom circuits must be connected to the analog inputs, digital I/O, TTL Serial Port, or Program Port on the Robot Controller.

<R52> Inputs to custom circuits may be connected to the following sources:

- Branch Circuit breaker outputs
- Speed Controller or Relay module outputs
- PWM or Relay outputs on Robot Controller
- Switches, Potentiometers, the outputs from Accelerometers, Sensors, and other additional electronics allowed.

<R53> Custom Circuits may **not:**

- Interfere with the operation of other robots
- Directly affect any output devices on the robot, such as by providing power directly to a motor, supplying a PWM signal to a speed controller or supplying a control signal to a relay module. (Custom high impedance voltage monitoring or low impedance current monitoring circuitry connected to the robot's electrical system is acceptable, because the effect on the robot outputs should be inconsequential.)
- Be used for wireless communication, such as sending or receiving a signal to and/or from the alliance station
- Connect to the radio or tether ports on the Robot Controller

5.3.7 Control System Rules

<R54> You must operate your robot with the wireless, programmable Innovation First 2005-Robot Control System. Note: you may use the 2004 Robot Controller, but must upgrade its firmware to the latest 2005 version code by downloading the new code from the IFI website.

<R55> The control system is provided to allow wireless control of the robots. The Operator Interface, Robot Controller, Vision System, Servos, Speed Controllers, Relay Modules, Radio Modems, Batteries, Battery Charger, AC Adapter, 9-pin cables, Circuit Breaker/ Power Distribution Panel, may not be tampered with, modified, or adjusted in any way, (tampering includes drilling, cutting, machining, gluing, rewiring, etc.) with the following exceptions:

- The dip switches on the Operator Interface may be set as appropriate.
- The user programmable code in the Robot Controller may be customized.
- The Speed Controllers may be calibrated as described in owner's manuals.

- The fuse on the Spike relay for the Air Compressor may be replaced with a 20 Amp Snap-Action circuit breaker.

<R56> Teams are responsible for any software bugs introduced into the Robot Controller's control program when using a custom program or for any unwanted or unanticipated robot behavior when using additional electronics.

<R57> The Robot Controller must be positioned within the robot so that its indicator lights may be seen during inspection and during operation in a match. This will greatly facilitate analysis in case of problems.

<R58> All circuit breakers must be accessible for inspection at each FIRST Robotics Competition event.

<R59> The team number settings on the Operator Interface must be set to the team number assigned to the team by FIRST, then the Robot Controller must be tethered to the Operator Interface to transfer the Team Number setting to the Robot Controller. This only needs to be done once after setting the Operator Interface.

<R60> Do not connect 12Vdc power, Relay Module outputs, Speed Controller outputs, or PWM outputs to the analog or digital I/O on the Robot Controller.

<R61> You must connect all outputs from the sensors and additional electronics circuits used on the robot directly to the analog or digital I/O on the Robot Controller. ***Sensors may not be wired to their loads to directly control those loads***. All loads must be controlled by PWM signals sent by the Robot Controller to relays or speed controllers. It is acceptable to wire switches used as sensors in series or parallel with each other.

<R62> The 7.2V Robot Control backup battery must be connected to the Controller as described in the Controller's manual (the 7.2v battery should be charged to at least 7.0v before entering a match). As a replacement for the FIRST supplied battery, any other 7.2V NiCad battery pack may be used.

<R63> A remote reset and remote programming switch may be wired to the Robot Controller's RESET/PROG header. Any switch may be used. See the ***Robot Controller Reference Guide*** for wiring information.

5.3.8 Operator Interface Rules

<R64> The team number settings on the Operator Interface must be set to the team number assigned to the team by FIRST.

<R65> The Operator Interface Console designed by your team must fit on the 69" wide by 12" deep shelf in the Alliance Station and the radio modem connected to the Operator Interface must be able to reach the mounting bracket on the operator stations. Be sure to leave at least 48" of slack in the 9-pin cable.

<R66> Teams are permitted to connect a portable computing device (Laptop computer, PDAs, etc.) to the RS232 Output of the Dashboard Port of the Operator Interface for the purpose of displaying feedback from the robot while competing in Competition matches. Please note that ***AC power will not be available at the playing field so these devices will have to run on internal batteries.***

<R67> Teams may not use Innovation First Operator Interfaces from previous years' competitions.

<R68> No external equipment may be connected to the Tether Port of the Operator Interface during a match.

<R69> All equipment connected to the Joystick Ports of the Operator Interface must be powered solely through the power available through the port. External power sources of any type are not permitted on any equipment connected to the Joystick Ports. Portable computing devices *may not* be connected to Joystick input ports on the Operator Interface.

<R70> The Competition Cable at the Alliance Station must connect directly to the Competition Port on the Operator Interface. No intermediate connectors, cables, or "pigtails" are permitted.

5.3.9 Wiring Rules

<R71> Electrical devices may only be wired in accordance with ***Section 5.2 Robot Rules.*** For your convenience, please refer to the ***2005 Robot Power Distribution Diagram*.**

<R72> All wires distributing power with a constant polarity (i.e., except for Relay Module, Speed Controller, or sensor outputs) must be color-coded as follows:

- Use Red, White, or Brown wire for +12 Vdc and +5 Vdc connections.
- Use Black or Blue wire for Common (-) connections.

<R73> *You must use **12 AWG or larger*** diameter wire for all circuits protected by a 40A Circuit Breaker.

<R74> *You must use **14 AWG or larger*** diameter wire for all circuits protected by a 30A Circuit Breaker.

<R75> *You must use **18 AWG or larger*** diameter wire for all circuits protected by a 20A Circuit Breaker.

<R76> *You must use **24 AWG** or larger* diameter wire for connecting sensors such as: switches, potentiometers, accelerometers, and other sensors. *You must use **24 AWG** or larger* diameter wire for connecting a Vision System to Robot Controller inputs, and for extending the PWM cables, for the small muffin fans, or for wiring LEDs. It is acceptable to use ribbon cable smaller than 24 AWG to connect to the 9 pin ports on the Robot Controller.

<R77> No more than one motor may be connected to each Speed Controller.

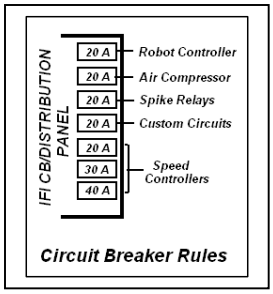
<R78> CIM motors and Fisher-Price motors must be connected to Speed Controllers. They may not be connected to Relay Modules.

5.3.9.1 Circuit Breaker / Fusing Rules

<R79> You must use the auto resetting Snap Action circuit breakers provided in the Kit Of Parts to protect all the active Circuit Breaker/ Power Distribution Panel branch circuits from overload.

<R80> You must protect the Robot Controller power feed with a 20A Circuit Breaker. You may **not** connect any other electrical load to this breaker.

<R81> You must protect the Air Compressor power feed with a 20A Circuit Breaker. You may **not** connect any other electrical load to this breaker.



<R82> You must protect the power feed to Custom Circuits and Additional Electronics with a 20A Circuit Breaker.

<R83> Speed Controllers may be protected by 20A, 30A, or 40A Circuit Breakers. Speed Controllers may power motors or devices of any size.

<R84> SPIKE Relay Modules must be protected with a 20A Circuit Breaker. Multiple devices may be connected to Relay Modules if desired (but only one motor may be connected to each Relay Module).

5.3.10 Pneumatic System Rules

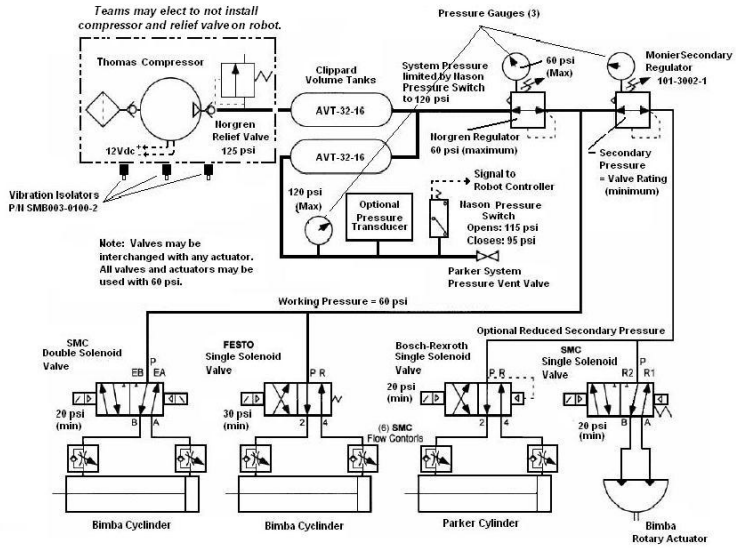
Please refer to the ***FIRST 2005 Pneumatics Manual*** for additional information about using pneumatics on your robot.

<R85> Pneumatic components supplied in the Kit compressor, regulators, pressure switches, cylinders, valves, fittings, tubing, etc.) may not be modified except as follows:

- The tubing may be cut.
- The wiring for the valves and pressure switch may be modified as necessary to interface with the rest of the control system.
- Mounting and connecting pneumatics components using the pre-existing threads, mounting brackets, etc., is not considered a modification of the components. Removing the pin from the rear of an air cylinder is allowed as long as the cylinder itself is not modified.
- Do not, for example, file, machine, or abrasively remove any part of an air cylinder. Consider pneumatic components sacred. They must remain in "out of the shipping box" condition.

<R86> The compressor may be mounted on the robot, or if teams prefer, they may leave it off their robot, and pre-charge and store compressed air in the storage tanks prior to bringing their robot onto the playing field. If you elect to use pneumatics on your robot, your pneumatic system must contain <u>as a minimum</u> the following components, connected in accordance with this section.

- A Pressure gage to display the working (stored) air pressure.
- An accessible pressure vent valve to manually relieve the stored pressure



AN EXAMPLE OF A TYPICAL PNEUMATICS SYSTEM

<R87> **Teams are not allowed to remove or adjust the 125 psi set relief valve attached to the compressor.** You may only use the Thomas Industries compressor and Clippard Instruments air storage tanks provided in the Kit to compress and store air on the robot. You may not use extraneous lengths of pneumatic tubing to increase the storage capacity of the air storage system.

<R88> The Nason Co. pressure switch must be connected to the output end of one of the Clippard tanks to sense the tank's pressure. The two wires from the pressure switch must be connected directly to a digital input and ground terminals on the Robot Controller, and the controller must be programmed to sense the state of the switch to operate the relay that powers the compressor. The Parker Pressure Vent valve must be connected to a Clippard tank such that, when manually operated, it will vent to the atmosphere to relieve any stored pressure. The valve must be placed on the robot so that it is visible and accessible.

<R89> "Working" air pressure on the robot must be no greater than 60psi. All working air must come from the Norgen adjustable pressure regulator, and all other pneumatic components must be downstream from this regulator. A pressure gauge must be placed adjacent to the pressure regulator and display the downstream pressure.

<R90> There is no limit to the number of solenoid valves, air cylinders, pressure regulators, and connecting fittings you may use on your robot. They must, however, be "off the shelf" pneumatic devices rated by their manufacturers for pressure of at least 125psi. Besides the "free" pneumatic components listed on the Pneumatic Components Order form, you may purchase additional air cylinders or rotary actuators, however, they must be identical to those listed on the Pneumatic Components Order form, and obtained from a Bimba or Parker Hannifan distributor.

<R91> The following pneumatics items may be added to your robot:

- You may use a previous year's Kit pneumatic cylinders and solenoid valves in addition to those items in the 2005 Kit, but you must account for their costs as explained in the Cost Limits and Accounting section.
- You may use a pressure transducer as long as it is rated to the operating air pressure at its mounting point in the pneumatic system.
- For the purposes of the FIRST competition, a device that creates a vacuum is not considered to be a pneumatic device and is allowed. This includes, but is not limited to, venturi-type vacuum generators and off-the-shelf vacuum devices (as long as they are powered by one of the Kit-of-Parts motors).
- For the purposes of the FIRST competition, closed-loop pneumatic (gas) shocks are not considered pneumatic devices, and are permitted additions to the robot.

5.3.11 Non-Functional Decoration Rules

Teams may add "Non-functional" decorations to robots under the following conditions:

<R92> Decorations must be on the robot at the time of final inspection, and must not cause the robot weight or size to exceed the Rule requirements.

<R93> Decorations must not affect the outcome of the match, and must be in the spirit of "Gracious Professionalism."

<R94> Any decorations that involve broadcasting a signal to/from the robot, such as remote cameras, must be cleared with FIRST Engineering prior to use. Teams may **not** use *900 MHz camera systems.*

<R95> Decorations may draw power from the 12v electrical system as long as they are powered via a dedicated 20A or 30A circuit breaker and do not affect the operation of other control system components.

5.3.12 Robot Inspection Rules

FIRST will post a copy of the Official Robot Inspection Sheet in approximately the first week of February. Use this sheet as a guide to pre-inspect your robot before it ships. Note that robot inspectors will be looking for sharp corners and edges that could cause injury. Please try to mitigate all sharp corners.

<R96> All robots must pass inspection for compliance with the Rules herein before being allowed to compete in the Qualification Rounds. At the time of inspection, teams must present a list of all Non-Kit part items and costs used in the construction of their robot to the inspector.

<R97> At Inspection, noncompliance with any robot construction Rule may result in disqualification of the machine at a FIRST competition event. The team must bring the robot into compliance before they will be allowed to compete in the Qualification Rounds. At the discretion of the lead Inspector, the robot may be allowed to participate in practice rounds before passing inspection.

<R98> If a team makes a modification to improve performance or reliability after its robot has passed inspection, that team must have the robot reinspected. If you observe that another team's robot may be in violation of the robot rule~~s~~, please approach FIRST officials to review the matter in question. This is an area where "Gracious Professionalism" is very important.

<R99> At the time of robot inspection, you must present ***all*** mechanisms (including ***all*** components of each mechanism) ***and configurations*** that you will use on the robot during the entire competition event. It is acceptable, however, for a robot to play matches with a **subset** of the mechanisms that were present during inspection. Only mechanisms that were present during the inspection may be added, removed or reconfigured between matches. If subsets of mechanisms are changed between matches, the reconfigured robot must still meet all inspection criteria.

<R100> If a robot is rejected because of a safety issue or concern related to the team's method of storing energy, the concerned mechanisms must be disabled or removed from the robot before it may compete in a match. The team bears the burden of proof that such a rejection is not valid. Teams should be prepared to provide justifiable test data or calculations during inspection to support their design.

<R101> FIRST Officials may randomly re-inspect robots participating in competition rounds to assure compliance with the Rules.

5.4 KIT OF PARTS

FIRST provides a Kit of Parts to each team. Only the exact parts provided in the Kit (or their exact replacement) are considered as Kit Parts. Some Kit Parts may legally be used in additional quantities. Additional quantities of these parts are considered to be "Additional Parts" and not "Kit Parts".

The FIRST 2005 Kit of Parts is provided in 5 containers. These include; 2 each - Large plastic containers (one black and one gray) of robot parts and construction materials, 1 each - KitBox Box, 1 each – Electronics Kit, and 1 each – Transmission Kit.

5.4.1 2005 Kit Changes

The following important changes for 2005 Kit Items have been made:

- New Sensors, including a new Vision System assembly (replacing Infrared sensor), Gear Tooth Sensor, and Accelerometer Sensor.
- Removed 2 Bosch drill motors & transmissions and replaced them with 2 CIM motors with FIRST transmissions.
- Removed the MAXI and the ATO fuse panels and replaced both with a single Circuit Breaker/Power Distribution panel.
- A New KitBox kit replaces the extruded aluminum stock materials provided last year.

The following part items will be found inside the Black container.

BLACK CONTAINER ITEM 1

	BATTERY BOX			
Check	**Part Name**	**Description**	**Part Number**	**Qty**
	Battery, Exide	12V, 18AH, Deep Cycle	ES18-12	2

BLACK CONTAINER ITEM 2

	LOOSE MATERIALS			
Check	**Part Name**	**Description**	**Part Number**	**Qty**
	Coil, Wire, Black	10' , # 6 AWG, Black	# 6 AWG Black	1
	Coil, Wire, Red	10' , # 6 AWG, Red	# 6 AWG Red	1
	Compressor, Thomas		405ADC38-12	1
	Volume Tank, Clippard	2" bore by 6" long	AVT-32-16	1
	Tetrahedron Discs	Plastic for Comp goals	3 Leafed Clover	4
	Wheel, wheelchair, 8"	Precision Hub	WHL70C	4

BLACK CONTAINER ITEM 3

	MSC BAG			
Check	**Part Name**	**Description**	**Part Number**	**Qty**
	MSC Bag	Documentation & CD		1

BLACK CONTAINER ITEM 4

Check	*PNEUMATICS BAG* Part Name	Description	Part Number	Qty
	Teflon Tape	¼" x 100'		1
	Pressure Gauges, Wika	1/8" NPT – 0-160 psi	9690242	3
	Solenoid, Festo, Single valve kit	Single solenoid valve	VPLE18-M5H-4/2-1/4	1
	Vibration isolators, Lord		SMB003-0100-2	3
	Secondary Regulator & Bracket, Monnier	Regulator & Mtg Kit	101-3002-1	1
	Pressure Switch, Nason	Opn; 115, Clse; 95psi	SM-2B-115R	1
	Main Regulator, Norgren, 60psi	60 psi Max output	R07-153-RNEA	1
	Regulator Mounting Kit	Bracket & Nut	18-025-003	1
	Relief Valve, Norgren, 120 psi	120 psi Relief Valve	16-004-074	1
	Gauge, Norgren,	Gauge, 0-160 psi	18-013-212	1
	Parker Brass Bag			1

BLACK CONTAINER ITEM 5

Check	*PNEUMATICS - SMC* Part Name	Description	Part Number	Qty
	Flow Control		NAS2201F-N01-07S	6
	Fitting, Straight	¼" tube	KQH07-34S	10
	Fitting, 90 Elbow	¼" tube	KQ2L07-34S	5
	Solenoid Valve, Double		SY3240-5LOZ	2
	Fitting, 90 Elbow	90 ^{o} Elbow ¼" tube	KQLO7-35 -S	10
	Fitting, Tee-Union	Tee union -1/4" tube	KQTO7-00	5
	Fitting, Male Run T	1/8 NPT- ¼" tube	KQY07-34S	2
	Fitting, Male Run T	1/4 NPT- ¼" tube	KQY07-35S	2
	Pilot Valve	12Vdc w/600mm lead wire	SY114-6LOZ	4
	Lead Wire Assy	12Vdc w/600mm lead wire	SY100-30-4A	4
	Fitting, 90 Elbow	Male, 90 Elbow, 5/32" tube- 1/8 NPT	KQ2L03-34S	1
	Fitting, Straight	Male Conn. 5/32" tube - 1/8 NPT	KQH03-34S	1

EVENT PICK-UP ITEM 6

Check	*EVENT PICK-UP* Part Name	Description	Part Number	Qty
	Led Light Cluster	Replaces revolving light		2

The following part items will be found inside the Gray container

GRAY CONTAINER ITEM 1

	BEARING BAG			
Check	**Part Name**	**Description**	**Part Number**	**Qty**
	Bearing S3KDD	3/8" wheel bearing	S3KDD	8
	Bearing, Transmission- 39KDD		39KDD	6
	Bearing, Transmission-9103KDD		9103KDD	2
	Tool, Ratcheting Screwdriver, 7 in 1	T-Top Auto Driver		1

GRAY CONTAINER ITEM 2

	MISCELLANEOUS BAG			
Check	**Part Name**	**Description**	**Part Number**	**Qty**
	Bolt, Elevator	3/8" x 16 x 1 zinc coated	EB616ZH	1
	Motor Bracket, CIM	Zinc coated		2
	Connector, Quick Disconnect	#6 Wire Pair, 12"	6331G1	2
	Fan, Muffin (Tiny)	12 Vdc	412	6
	Fan, Muffin, (Large)	12 Vdc	4212/19H-490	2
	Motor Shaft, Flexible	13.5" fits seat motor	16723160	2
	Latex Tubing	¼" ID, 3/8" OD, 5 feet	5234k44	2
	Magazine, Nuts and Volts			1
	Magazine, Servo			1

GRAY CONTAINER ITEM 3

	MISCELLANEOUS #2 BAG			
Check	**Part Name**	**Description**	**Part Number**	**Qty**
	Hardware, Set Screws	10-32 x 1/8"		4
	Washer, Flat Nylon	5/16" x .062" flat washer		8
	Anderson Power Products catalog			1
	Valve, BoschRexroth	Valve, 12V	5728400410	1
	Connector, BoschRexroth	Female Connector	H894101-02202	1
	Nut, BoschRexroth	Gray Nut – ¼" tubing	H893071-4904	3
	Gasket, BoschRexroth	Square gasket for conn.		1
	Screw, BoschRexroth	Screw for gasket		1

GRAY CONTAINER ITEM 4

	COUPLER BAG			
Check	**Part Name**	**Description**	**Part Number**	**Qty**
	Wheel Hub, Plastic	Hub for Skyway wheels		4
	Coupler, Flexible Shaft	Black		2
	Coupler, Nippon-Denso Motor	Inj. molded		2

GRAY CONTAINER ITEM 5

Check	*LOOSE MATERIALS* Part Name	Description	Part Number	Qty
	Motor, Globe, w/drive assy	12 Vdc	409A587	2
	Battery Charger, Automatic	6 Amp	CXC-2005	1
	Motor, CIM	Keyed output shaft	FR801-001	4
	Motor, Nippon-Denso, Window , RH			1
	Motor, Sliding Door	Taigene		2
	Joystick, Analog	AVB Top Shot Analog	GC-1000FR	2
	Motor, Window, Jideco	RH or LH provided		1
	Motor, Fisher-Price, w/21T #7 Gearbox	12 Vdc,, stall torque 532.19 (mNm)		2
	Cylinder	1.5” bore x 8” stroke; rear pivot mt.	1.5DPSR8.00	1
	Tubing, ¼” OD	20 meters	TIUB07B-20	1

GRAY CONTAINER ITEM 6

Check	*SENSOR ENVELOPE* Part Name	Description	Part Number	Qty
	Sensor Assembly, Gear Tooth Hall-Effect	Hall-Effect	ATS665LSG	2
	Accelerometer, w/connector harness		3LG20-15	1

GRAY CONTAINER ITEM 7

Check	*TERMINAL SUPPLY BAG* Part Name	Description	Part Number	Qty
	Circuit Breaker, 120A, Buss	120A,	185-120-F01-1	1
	Terminal Lug, Ring, Insul.	AWG 22-18	A532-06	20
	Terminal Lug, Ring, Insul.	AWG 16-14	B523-06	6
	Terminal Lug, Ring, Insul.	AWG 12-10	C528-06	24
	Terminal Lug, Spade, Insul.	AWG 22-18	A-850	6
	Terminal Lug, Spade, Insul.	AWG 16-14	B-850	34
	Wire Nut	Red	76-B	8
	Crimping Tool,.	10 AWG >		1
	Terminal Lug, SLU-70	6 AWG	SLU-70	6

KICK-OFF PICK-UP ITEM 8

Check	*KICK-OFF PICK-UP* Part Name	Description	Part Number	Qty
	Sub Base,	1/8” ports	SY3000-27-1T	2
	Motor, Mabuchi			1

INNOVATION FIRST, INC. ITEM 1

Check	*TRANSMISSION KIT* Part Name	Description	Part Number	Qty
	Chain, 10'	# 35		1
	Master Link, Chain	# 35		2
	Transmission, Drive Train Assy			2
	Sprocket, Large Wheel	28 Tooth		2
	Sprocket, Transmission, Small	21 Tooth		2

INNOVATION FIRST, INC. ITEM 2

Check	*ELECTRONICS KIT* Part Name	Description	Part Number	Qty
	Cable, 9 pin, M/F, Blk, 6"	DB9 M/F 6', Shielded	DB9MF	3
	Servo	42 oz/in peak torque, 0.19	HS-322S	2
	Radio Modem – Robot Controller	RS-422, 9 pin, F, Rubber Antenna		1
	Radio Modem – Op. Interface	RS-422, 9 pin, F, Metal Antenna		1
	Relay Module (Spike)	12v, 20A		4
	Robot Controller Unit	Module		1
	Operator Interface Unit	Module		1
	Power Supply, Op. Interface.	9VDC		1
	Cable, PWM/Relay	Hitec/JR -36"	PWM-EXT	9
	Cable, PWM/Relay - Y	Hitec/JR -24"	PWM-Y	2
	Speed Controller, Victor 884		Victor 884	4
	Cable, 9-Pin, 6', Red	DB9 Female/Female	DB9FF	1
	CMU Cam module			1
	IFI Circuit Breaker/ Distr. Panel			1
	Battery, 7.2V, NiCad, Backup	7.2V NiCad		1
	Battery Charger for 7.2V Battery	7.2V NiCad Charger		1
	Adapter, 7.2V Battery Charger	Old Connector to Spade-Lock		1
	Circuit Breaker Bag	20, 30, 40 Amp Breakers		1
	RS-232 TTL Board			1
	IFI Camera Base			1
	CBOT Compiler 2005			1
	Victor V884 Fan Screws	Fan screws		8

INNOVATION FIRST, INC. ITEM 3

	KITBOT BOX			
Check	**Part Name**	**Description**	**Part Number**	**Qty**
	Drive Train Chassis Kit			1

5.4.2 Missing Materials

5.4.2.1 General Information

FIRST is implementing a new procedure for reporting missing parts for the 2005 season. Because of the lessons learned from the missing parts / reporting of parts issues of 2004, we have implemented several new kit packing practices, which we feel will minimize missing parts and improve the process of reporting those parts that might be missing.

The most important change for the 2005 kit has been the addition of significantly improved **Quality Control** processes. These changes include:

- Solid communication with the suppliers supporting our needs.
- Performing receiving inspection ensuring proper material delivery and counts. This will limit any delays on kit deliveries and or replacement parts.
- Incoming inspection ensuring that damage is caught prior to the bagging / kitting process.
- 100% inspection of all bags to be placed in the kit.
- 100% inspection of the entire FIRST totes.
- Delivery tracking of all team kits.

Innovation First Inc., a major supplier of parts to FIRST, packs their material independent of FIRST. They have been very diligent in packing the components to be distributed directly from their operation in Texas.

FIRST is extremely confident that the 2005 Kit packing will be to a higher standard and of a higher quality.

5.4.2.2 How to Report Missing Parts

Reporting of missing parts will be on line through the TIMS. Each team will use their password to access a Missing Part Order Form and enter the quantity of each part they did not receive from the allotted amount that should have been in the kit. **A team can only place ONE order.** Once they hit the submit button, they cannot revise the order.

In order to make this system work effectively and let staff move on to other projects critical to preparing materials for the road, the teams will be required to:

- Take a **complete and thorough** inventory of their kit **immediately** after receiving it.
- Complete and submit their Missing Part Order Form prior to 12:01 AM EST on **Thursday, January 13, 2005**.

PLEASE RESPECT OUR REPORTING DEADLINE

Our goal is that all missing parts shipments will be made prior to the close of the business on Friday, January 14, 2005.

5.4.3 Obtaining Replacement or Spare Kit of Parts

We will have a listing of the VERY LIMITED set of parts available at events posted on the FIRST web site no later than January 16, 2005.

Please note – If your robot uses any parts no included on this list, and there is a reasonable possibility it may become damaged or broken during a competition event, then it is *STRONGLY RECOMMENDED* that you obtain and bring appropriate SPARE PARTS to events.

FIRST Loan policy for Control System Components:

Teams are responsible for all Innovation First products required at events. If at any event a team needs to borrow any part of the Control System, the team must provide a Credit Card number to ensure proper return of the items after the completion of the event.

If the part is not returned at the end of the event, FIRST retains the right to bill the provided credit card number for the borrowed items.

All "loan" items are available on a first-come, first-served basis.

Innovation First Products:

Please contact Innovation First (903-453-0802 or at http://www.innovationfirst.com for product support to obtain a Return Merchandise Authorization Number (RMA#) to return warranted control system parts, or to obtain transmission, CMUcam, or chassis components for replacement. Please do **not** contact FIRST for repair or replacement of these items.