

Section
1



FIRST® Robotics Competition

INTRODUCTION

TABLE OF CONTENTS

1	INTRODUCTION	2
1.1	WHAT IS THE <i>FIRST®</i> ROBOTICS COMPETITION (AKA FRC)?	2
1.2	GRACIOUS PROFESSIONALISM™, A <i>FIRST</i> CREDO	2
1.3	PROMINENT FRC AWARDS	3
1.3.1	<i>The Chairman's Award</i>	3
1.3.2	<i>The Woodie Flowers Award</i>	4
1.4	SAFETY: A <i>FIRST</i> CULTURE	4
1.5	LOGO MOTION™ SUMMARY	6
1.6	LOGO MOTION GLOSSARY	7
1.7	REVISION HISTORY	14

1 INTRODUCTION

1.1 WHAT IS THE *FIRST*[®] ROBOTICS COMPETITION (*aka FRC*)?

Take dedicated, enthusiastic students, teachers, engineers and other professionals, add six (6) weeks for design and fabrication and you get a wide range of amazing machines that are competition ready.

The *FIRST* Robotics Competition (FRC) is an exciting program that assimilates teams, sponsors, colleges and technical professionals with high school students to develop their solution to a prescribed engineering challenge in a competitive game environment. The competitions, also known as Coopertition[™](s), combine the practical application of science and technology with the fun, intense energy and excitement of a championship-sporting event. The program results in life-changing, career molding experiences for its participants and is a lot of fun.

In 2011, FRC will reach nearly 48,000 students representing approximately 2,000 teams. FRC teams come from every state in the United States, as well as from Brazil, Canada, the United Kingdom, Mexico, Chile, Germany, Israel, Turkey, Australia and The Netherlands. FRC has become an international program and is continuously growing. FRC teams will participate in 48 Regional Competitions, 9 Michigan District Events, and the Michigan State Championship. Approximately 300+ deserving teams will qualify to go to the *FIRST* Championship at The Edward Jones Dome in St. Louis, MO.

This year's challenge will be presented at the 2011 FRC Kickoff on Saturday, January 8, 2011. At the Kickoff event, all teams:

- see the 2011 game field for the first time;
- learn about the 2011 game rules and regulations; and
- receive a Kit of Parts (KOP). The KOP includes, but is certainly not limited to, motors, sensors, chassis hardware, transmissions, software packages, control systems and batteries. The intent of the kit is to provide a level starting point for all teams.

1.2 GRACIOUS PROFESSIONALISM[™], A *FIRST* CREDO

Dr. Woodie Flowers, *FIRST* National Advisor and co-founder of FRC, asks:

"Why do *FIRST* folks talk so much about that phrase?"

Dr. Flowers elaborates on the significance of Gracious Professionalism[™] in *FIRST*, at work and in life, below.

"*FIRST* does not celebrate being an incompetent jerk. *FIRST* does celebrate high-quality, well-informed work done in a manner that leaves everyone feeling valued. Gracious Professionalism[™] seems to be a good descriptor for a big part of the ethos of *FIRST*. It is one of the things that makes *FIRST* different and wonderful.

Gracious Professionalism[™] has purposefully been left somewhat undefined because it can and should mean different things to each of us. We can, however, outline some of its possible meanings. Gracious attitudes and behaviors are win-win. Gracious folks respect others and let that respect show in their actions. Professionals possess special knowledge and are trusted by society to use that knowledge responsibly. Thus, gracious professionals make a valued contribution in a manner pleasing to others and to themselves.

In *FIRST*, one of the most straightforward interpretations of Gracious Professionalism[™] is that we learn and compete like crazy, but treat one another with respect and kindness in the process. We try to avoid leaving anyone feeling like they have lost. No chest-thumping barbarian tough talk, but no sticky sweet platitudes either. Knowledge, pride and empathy comfortably blended.

Understanding that Gracious Professionalism™ works is NOT rocket science. It is, however, missing in too many activities. At *FIRST*, it is alive and well. Please help us take care of it.

In the long run, Gracious Professionalism™ is part of pursuing a meaningful life. If one becomes a professional, and uses knowledge in a gracious manner, everyone wins. One can add to society and enjoy the satisfaction of knowing that he or she has acted with integrity and sensitivity. That's good stuff!"

1.3 PROMINENT FRC AWARDS

FIRST recognizes both on-field and off-field team performance that promotes *FIRST*'s mission to change culture. Several awards celebrate team competencies including, but not limited to, technical expertise, community involvement, and safety practices. The two most prominent FRC awards are described below (however, for a complete list and description of awards available to teams, please reference *The FRC Administrative Manual, Section 6*).

1.3.1 The Chairman's Award

Every year, veteran FRC Teams have the opportunity to compete for *FIRST*'s most prestigious award; i.e., the Chairman's Award. This Award was created to maintain focus on changing culture in ways that would inspire greater levels of respect and honor for science and technology, as well as encourage more of today's youth to become scientists, engineers and technologists. It represents the spirit of *FIRST*. The Chairman's Award honors the team that best embodies the goals and purpose of *FIRST* and is a model for other teams to emulate.

One team is chosen at each regional to receive this award; these teams go on to be considered for the Chairman's Award at the *FIRST* Championship. Teams who have won the Chairman's Award at the Championship are entered into the *FIRST* Hall of Fame. Past Hall of Fame inductees are listed below.

Year	Team	Official Team Name
2010	341	DOW Chemical/Lockheed Martin/Cobham Defense
		Electronics/Comcast Cable/BAE Systems/Centocor Ortho
		BioTech/Johnson & Johnson PRD/JCPenney/PJM
		Interconnection/DeVry University & Wissahickon High School & North Montco Technical Career Center
		Dominion Millstone Power Station & Lyme-Old Lyme (CT) High School
2009	236	Honeywell / Arthur M. Blank Foundation / Science Foundation Arizona / Intel / Vegas Fuel / Wells-Fargo & Carl Hayden High School
2008	842	DuPont Engineering/DuPont CCRE/First State Robotics & MOE Robotics Group
2007	365	Motorola & Rolling Meadows High School & Wheeling High School
2006	111	General Motors Milford Proving Ground and Huron Valley Schools
2005	67	NASA Ames Research Center/Laron Incorporated/Unity Care Group/Line-X of San Jose/PK Selective Metal Plating, Inc. & Bellermine College Preparatory
2004	254	NASA/Amplifier Research/Custom Finishers/Lutron Electronics/BAE Systems & Palisades High School
2003	103	Hamilton Sundstrand Space Systems International/The New England Air Museum/Techni-Products/Veritech Media & Enrico Fermi High School
2002	175	NASA/JPL/Boeing/Rocketdyne/FADL Engineering/Decker Machine & Chatsworth High School
2001	22	

Year	Team	Official Team Name
2000	16	Baxter Healthcare Corporation & Mountain Home High School
1999	120	NASA Lewis Research Center/TRW, Inc./Battelle Memorial Institute & East Technical High School
1998	23	Boston Edison & Plymouth North High School
1997	47	Delphi Corporation & Pontiac Central High School
1996	144	Procter & Gamble & Walnut Hills High School
1995	151	Lockheed Sanders & Nashua High School
1994	191	Xerox Corporation & JC Wilson Magnet High School
1993	7	AT&T Bell Labs & Science High School
1992	191	Xerox Corporation & JC Wilson Magnet High School

1.3.2 The Woodie Flowers Award

The Woodie Flowers Award celebrates mentors who lead, inspire and empower their team. Woodie Flowers Award winners demonstrate effective communication in the art and science of engineering and design. Founded in 1996 by Dr. William Murphy, the Woodie Flowers Award is presented to an outstanding engineer or teacher participating in FRC who lead, inspire, and empower using excellent communication skills.

Students submit an essay that nominates one mentor from their team for consideration. Past winners of this award are listed below.

Year	Name	Title
2010	Mr. Chris Fultz	Program Director - RR500 and New Product Introduction, Defense Sector, Rolls Royce
2009	Mr. John Novak	Engineer, Baxter Healthcare Corporation
2008	Mr. Mark Breadner	Vice Principal, Toronto District School Board
2007	Mr. Dan Green	Director, New Technology Business Operations, Motorola
2006	Mr. Rob Mainieri	Teacher, The Preuss School at UCSD
2005	Mr. Paul Copioli	Staff Engineer, FANUC Robotics America
2004	Mr. David Kelso	Teacher, Central High School
2003	Mr. Andy Baker	President, AndyMark, Inc.
2002	Mr. David Verbrugge	Engineer, GM Proving Ground
2001	Mr. William Beatty	Beatty Machine & Manufacturing Company
2000	Ms. Kyle Hughes	Teacher, OSMTech Academy
1999	Mr. Ken Patton	Engineer, GM Powertrain
1998	Mr. Michael Bastoni	Teacher, Plymouth North High School
1997	Ms. Elizabeth Calef	Teacher, Bridgewater-Raynham Regional High School

1.4 SAFETY: A *FIRST* CULTURE

Safety is critical within *FIRST* and must be observed continuously by all participants. As a part of the Safety Awareness and Recognition Program, teams are observed and evaluated at many different levels and by many individuals at the event.

“Safety Advisors” evaluate team safety behavior and practices at Regional Competitions.

“Referees” observe safety on the playing field as well as adherence to the game rules.

“Judges” evaluate how teams have integrated safety into their robot designs when considering the team for technical awards.

Safe practices at the competitions are required. Teams are urged to adopt safe habits throughout the entire competition season including during travel to and from events and while working in their shops at home.

1.5 LOGO MOTION™ SUMMARY

LOGO MOTION is played by two competing alliances on a flat 27' x 54' foot field. Each alliance consists of three robots. They compete to hang as many inflated plastic shapes (triangles, circles, and squares) on their grids as they can during a 2 minute and 15 second match. The higher the teams hang their game pieces on their scoring grid, the more points their alliance receives.

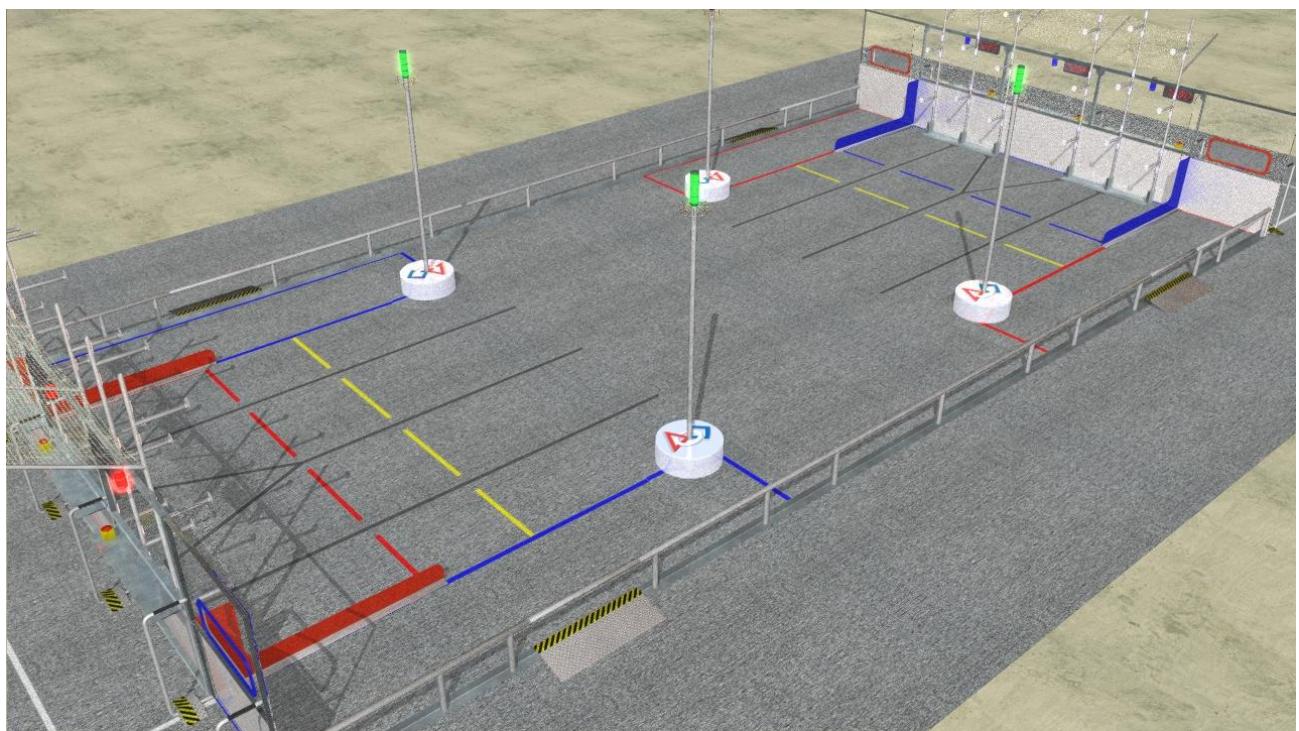
The match begins with one 15-second Autonomous Period in which robots operate independently of driver inputs and must hang Ubertubes to score extra points. For the rest of the match, drivers control robots and try to maximize their alliance score by hanging as many logo pieces as possible. Any logo piece hung on the same peg as an Ubertube receives double points. If teams assemble the logo pieces on their scoring grids to form the *FIRST* logo (triangle, circle, square, in a horizontal row in that order), the points for the entire row are doubled.

The match ends with robots deploying minibots, small electro-mechanical assemblies that are independent of the host robot, onto vertical poles. The minibots race to the top of the pole to trigger a sensor and earn additional bonus points. Scoring is summarized below:

Ubertubes hung during Autonomous	
On bottom row	2 points
On middle row	4 points
On top row	6 points

Logo pieces	Alone	Over Ubertube
On bottom ROW	1 point	2 points
On middle ROW	2 points	4 points
On top ROW	3 points	6 points

Minibot race bonus	
1st MINIBOT	30 points
2nd MINIBOT	20 points
3rd MINIBOT	15 points
4th MINIBOT	10 points



1.6 LOGO MOTION GLOSSARY

The following terms and definitions provide detail intended for all competitors in the 2011 FIRST Robotics Competition.

ALLIANCE – a set of three FRC TEAMS that work together during a MATCH to play *LOGO MOTION* against an opposing ALLIANCE. ALLIANCES are identified during the MATCH by their assigned color, either red or blue.

ALLIANCE CAPTAIN – the TEAM representative for each ALLIANCE lead.

ALLIANCE STATIONS – the areas located at either end of the ARENA, behind the ALLIANCE WALLS; they extend back eight feet from the ALLIANCE WALL, and across the 18-foot wide center section of the wall; include three identical PLAYER STATIONS each.

ALLIANCE WALL – a 6-1/2 feet high, 27 feet wide, wall that defines the ends of the FIELD.

ANALYST – a HUMAN PLAYER that assists the COACHES with strategy. There is one ANALYST per ALLIANCE.

ARENA - all elements of the game infrastructure that are required to play *LOGO MOTION*: the FIELD, the ALLIANCE STATIONS, the GAME PIECES, and all supporting communications, arena control, and scorekeeping equipment.

AUTONOMOUS PERIOD – DRIVER control of the ROBOT is not permitted at this time. During this period, the ROBOTS may react only to sensor inputs and commands programmed into the onboard control system. All ROBOT safety rules are still applicable during the AUTONOMOUS PERIOD.

AUTONOMOUS SCORE – the sum of points determined by the positions of the three ALLIANCE UBERTUBES at the conclusion of the AUTONOMOUS PERIOD.

BACKUP TEAM – one of the 8 highest seeded TEAMS remaining after ALLIANCE pairing that are available to play, should a HOSTBOT need replacing during the Elimination MATCHES.

BASE – a cylindrical section approximately 30 inches in diameter by 12 inches tall at the bottom of the TOWER. The BASE is considered part of the TOWER.

BUILD SEASON - the period between the Kick-off and the shipment deadline.

BUMPER – an assembly designed to attach to the exterior of the HOSTBOT and constructed as specified in **Section 4.3.2, Bumper Rules**.

BUMPERS are for absorbing shock and preventing damage from bumping. They are excluded from the weight and volume calculations specified in Rule <R11>.

BUMPER PERIMETER – the polygon defined by the outer-most set of exterior vertices of the BUMPERS when they are attached to the HOSTBOT. (To identify the BUMPER PERIMETER, wrap a string around the BUMPERS at the level of the BUMPER ZONE - the string describes the polygon.)

BUMPER ZONE – the volume contained between two virtual horizontal planes, one inch above the floor and seven inches above the floor.

CAUTION LINE – a 2-inch wide yellow line 4 feet in front of the ZONE that can be used as a field reference point for TEAMS.

CIRCLE – a white round inflated tube.

GAME PIECE – any one of the four plastic inflated objects used to score in *LOGO MOTION*.

COACH – a student or adult mentor identified as the person wearing the designated "COACH" pin or button during a MATCH. There is one COACH per TEAM.

COMPONENT – a ROBOT part in its most basic configuration, which can not 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 frame would constitute a MECHANISM, and the collection of pieces would not be considered a COMPONENT.

Example 2: a COTS (see immediately below) circuit board is used to interface to a sensor on the ROBOT, and it includes the 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 its 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 in their storeroom and plan to use it later. Into 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 it has been modified.

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.

Example 3: a team obtains openly available design drawings from a professional publication during the pre-season, and uses them to fabricate a gearbox for their ROBOT during the build period following kick-off. The design drawings would be considered a COTS item, and may be used as “raw material” to fabricate the gearbox. The finished gearbox itself would be a FABRICATED ITEM, and not a COTS item.)

For the purposes of the FRC, generally available software modules obtained from open sources (e.g. professional publications, commonly used FRC community-accessible web resources, industry source code repositories, etc.) that are not specifically affiliated with individual FRC teams shall be considered COTS items.

DEPLOYMENT – the act of positioning a MINIBOT on a TOWER. DEPLOYMENT starts when the MINIBOT breaks the vertical projection of the TOWER BASE circumference. DEPLOYMENT ends when the HOSTBOT is no longer in contact with the MINIBOT. (Related form, DEPLOY, verb)

DEPLOYMENT LINE – located on the POST, approximately 18 inches above the top surface of the BASE.

DRIVER – a pre-college student team member responsible for operating and controlling the HOSTBOT. There are two DRIVERS per TEAM.

END GAME – the final 10 seconds of a MATCH.

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 partially or completely 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 designs an arm mechanism that uses gears with a half-inch face width. They order a 12-inch length of gear stock and cut it into precise half-inch slices. They do not bore out the mounting bores in the center of the gears. The slices are now considered FABRICATED ITEMS, as the final fabrication process has started, even though all the machining operations (the center bore) may not yet be completed.)

FEEDER – a HUMAN PLAYER that feeds LOGO PIECES to ROBOTS. There are two FEEDERS per ALLIANCE.

FEEDER STATION – the area used to confine the FEEDER. The ALLIANCE'S two FEEDER STATIONS are located on either side of the opponent's ALLIANCE STATION.

FEEDING SLOT – openings in the ALLIANCE WALL that can be used by the FEEDER to pass LOGO PIECES to a ROBOT and enter them into play.

FIELD – the 27-foot by 54-foot carpeted playing area, bounded by two ALLIANCE WALLS and a Guardrail System.

FRAME PERIMETER – the polygon defined by the outer-most set of exterior vertices on the HOSTBOT (without the BUMPERS attached) that are within the BUMPER ZONE.

To determine the FRAME PERIMETER, wrap a piece of string around the HOSTBOT at the level of the BUMPER ZONE - the string describes this polygon.

Note: to permit a simplified definition of the FRAME PERIMETER and encourage a tight, robust connection between the BUMPERS and the FRAME PERIMETER, minor protrusions such as bolt heads, fastener ends, rivets, etc are excluded from the determination of the FRAME PERIMETER.

GAME PIECES – the TRIANGLE, CIRCLE, SQUARE and UBERTUBE.

HANGING – a GAME PIECE is HANGING when it is fully supported by a PEG through its center hole and released by the POSSESSING ROBOT. If a GAME PIECE on the floor is preventing a GAME PIECE that has been hung on a bottom PEG from becoming fully supported (that is, if the floor GAME PIECE was not there, the hung GAME PIECE would be scored) then that GAME PIECE will still be counted as scored.

HERDING – controlling the movement of a GAME PIECE. A GAME PIECE shall be considered HERDED if it is in contact with the floor and, as the ROBOT moves in the direction of the GAME PIECE, the GAME PIECE is pushed in the same direction in a controlled manner, but does not remain in the position relative to the ROBOT if the ROBOT changes direction or orientation.

HOSTBOT – the electromechanical assembly used to carry the MINIBOT. (ROBOT – MINIBOT = HOSTBOT). If a TEAM plays a MATCH without a MINIBOT, then the HOSTBOT is the ROBOT.

HUMAN PLAYER – a pre-college student team member that fills one of the ALLIANCE roles of FEEDER or ANALYST. There is one HUMAN PLAYER per TEAM.

KIT OF PARTS (KOP) – the collection of items listed in the **2011 Kit of Parts Checklist** provided on the FIRST website at <http://www.usfirst.org/frc/competitionmanual> and the items listed on the **FIRST Choice List** (posted here <http://www.usfirst.org/roboticsprograms/frc/content.aspx?id=18619>).

For rookie teams, all of these items will be provided to them by FIRST at the FRC Kickoff. For veteran teams, some of these items will be provided by FIRST and some must be either retrieved from previous ROBOTS or purchased separately. For the purposes of these rules, the 2011 versions of all of the items listed in the **2011 Kit of Parts Checklist** will be considered 2011 kit parts regardless of the method of acquisition.

LANE – a 4-foot, 3-inch wide area that extends for approximately 19-1/2 feet from each FEEDING SLOT toward the center of the FIELD.

LOGO – a series of LOGO PIECES on the same row of a single SCORING GRID in the order of TRIANGLE-CIRCLE-SQUARE when read from left to right on a single row while looking at a SCORING GRID from the FIELD.

LOGO BONUS – the added points granted to an ALLIANCE for creating a LOGO

LOGO PIECES – the TRIANGLE, CIRCLE, and SQUARE.

MATCH – a single iteration of play in which ALLIANCES attempt to complete the objectives of the *LOGO MOTION* game during a competition.

MATCH SCORE – the total number of points earned by an ALLIANCE during a MATCH less any PENALTIES.

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.

MINIBOT – an autonomous vehicle designed and built to perform specific tasks when competing in the 2011 competition *LOGO MOTION*. The MINIBOT must obviously follow a design approach intended to play the 2011 FRC END GAME and must be compliant with all MINIBOT rules defined in **Section 4.3.14**.

MINIBOT RACE – a competition in which MINIBOTS are DEPLOYED, climb the TOWER, and TRIGGER the TARGET. The MINIBOT RACE begins at the start of the END GAME.

OPERATOR CONSOLE – the collection of the hardware used to run the Driver Station software and any associated equipment, control interfaces, display systems, structure, decorations, etc. used by the DRIVERS to operate the ROBOT.

PEG SCORE – the sum of points determined by the position of GAME PIECES on the ALLIANCE'S SCORING GRIDS.

PENALTY – a 3-point decrement in the ALLIANCE score assigned when a deserving violation of the game rules has been identified by a Referee.

PLAYER STATION – positions behind the ALLIANCE WALL where each TEAM sets up their OPERATOR CONSOLE

PLAYING CONFIGURATION – one of any of an infinite number of postures a ROBOT may take once the MATCH has begun.

POSSESSION – controlling the position and movement of a GAME PIECE. A GAME PIECE shall be considered in POSSESSION if, as the ROBOT moves or changes orientation (e.g. backs up or spins in place), the GAME PIECE remains in approximately the same position relative to the ROBOT.

POST – a 1.75-inch diameter (O.D.) steel pipe that extends upward from the **BASE**. The **POST** is considered part of the **TOWER**.

RACE SCORE – the points assigned to an **ALLIANCE** based on their finish in the **MINIBOT RACE**.

RED CARD – an indication of disqualification of a **TEAM**.

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 can be modified to provide more robust performance of the function.

Example 1: A lever arm made of polycarbonate 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 **HOSTBOT** is connected to the control system with 24 AWG 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 AWG 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

ROBOT – the composite electromechanical assembly designed and built by a FRC team to perform specific tasks when competing in the 2011 competition *LOGO MOTION*. The **ROBOT** must include all the basic systems required to be an active participant in the game – power, communications, control, mobility, and actuation. The **ROBOT** implementation must obviously follow a design approach intended to play the 2011 FRC game (e.g. a box of unassembled parts placed on the **FIELD**, or a **ROBOT** designed to play a different game, would not satisfy this definition). The **ROBOT** includes both the **HOSTBOT** and one **MINIBOT** (**ROBOT** = **HOSTBOT** + **MINIBOT**).

SCORING GRID (GRID) – used to receive **GAME PIECES** placed by the **ROBOTS** as they play *LOGO MOTION*. There are four **SCORING GRIDS** on the **FIELD**, two located immediately in front of each **ALLIANCE STATION** and attached to the **ALLIANCE WALL**.

SCORING PEG (PEG) – one of nine round, horizontal pieces on each **SCORING GRID**. Each **PEG** can hold up to two **GAME PIECES**.

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.

SQUARE – a blue quadrangular inflatable **GAME PIECE**.

STARTING LINE – the line marked on the floor four feet back from the **ALLIANCE WALL**, and extends across the width of the **ALLIANCE STATION**.

STARTING CONFIGURATION – the physical configuration and orientation of the **ROBOT** when the **MATCH** is started. This is the state of the **ROBOT** immediately before being enabled by the Field Management System, before the **ROBOT** takes any actions, deploys any mechanisms, or moves away from the starting location. This configuration is static, and does not change during a single **MATCH** (although it may change from **MATCH** to **MATCH**).

SURROGATE – a **TEAM** randomly selected by the Field Management System (FMS) to play an extra Qualification **MATCH**. A **SURROGATE** receives no Qualification, Ranking, or Coopertition points for the extra **MATCH**.

TARGET – part of the TOWER, attached to the top of the POST. The TARGET is the “finish line” that indicates the MINIBOT has reached the top of the POST.

TEAM – four representatives from an FRC team that interact with their ROBOT and ALLIANCE partners to play *LOGO MOTION*. Positions on the TEAM are COACH, DRIVER and HUMAN PLAYER.

TELEOPERATED PERIOD – at the beginning of the TELEOPERATED PERIOD the OPERATOR CONSOLE controls are activated and DRIVERS may remotely control their HOSTBOTS. The DRIVERS continue to teleoperate their HOSTBOTS for the remainder of the MATCH. The TELEOPERATED PERIOD ends when the arena timer displays zero seconds. This also indicates the end of the MATCH.

TIMEOUT – a period of up to 6 minutes, which teams can use to pause Elimination Match progression. Each ALLIANCE is granted one, and only one, TIMEOUT.

TOWER – an assembly composed of a BASE, POST, and TARGET.

TRACKING LINE – lines on the FIELD that may be used to guide ROBOTS toward SCORING GRIDS.

TRIANGLE – a red three-cornered inflatable GAME PIECE.

TRIGGERED – the act of pushing the bottom disk of the TARGET so that the sensors are tripped and a signal is sent to the Field Management System (FMS). When a TARGET is TRIGGERED, the MINIBOT RACE on that TOWER is complete.

UBERTUBE – the yellow GAME PIECE used to score during the AUTONOMOUS PERIOD.

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: A HOSTBOT is designed with a c-channel frame. The system works well, but can be misshapen if hit aggressively. The team adds two more pieces of c-channel to brace the frame and prevent this problem. The c-channel is identical to that already on the HOSTBOT. The new pieces of c-channel would be considered UPGRADE PARTS even though they are the same as the ones already in place, as they alter the functionality of the HOSTBOT and provide new capability.

VENDOR – a legitimate business source for COTS items that satisfies all of the following criteria:

- A. The VENDOR must have a Federal Tax Identification number. In cases where the VENDOR is outside of the United States, they must possess an equivalent form of registration or license with the government of their home nation that establishes and validates their status as a legitimate business licensed to operate within that country.
- B. The VENDOR shall not be a “wholly owned subsidiary” of a team or collection of teams. While there may be some individuals affiliated with both a team and the VENDOR, the business and activities of the team and VENDOR must be completely separable.
- C. The VENDOR must be able to ship any general (i.e., non-*FIRST* unique) product within five business days of receiving a valid purchase request. (It is recognized that certain unusual circumstances (such as 1,000 *FIRST* teams all ordering the same part at once from the same VENDOR) may cause atypical delays in shipping due to backorders for even the largest VENDORS. Such delays due to higher-than-normal order rates are excused.)
- D. The VENDOR should maintain sufficient stock or production capability to fill teams’ orders within a reasonable period during the build season (less than 1 week). (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.)

- E. The VENDOR makes their products available to all FRC teams. VENDORS must not limit supply or make a product available to just a limited number of FRC teams.

The intent of this definition is 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. 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. Teams also need to protect against long delays in availability of parts that will impact their ability to complete their ROBOT. The FRC build season is brief, so the VENDOR must be able to get their product, particularly FIRST unique items, to a team in a timely manner. Ideally, chosen VENDORS should have national distributors (e.g. Home Depot, Lowes, MSC, Radio Shack, McMaster-Carr, etc.) Remember, FRC events are not usually near home – when parts fail, local access to replacement materials is often critical.

VISION TARGET – retro-reflective targets that may be used by ROBOTS to locate SCORING PEGS. The VISION TARGET is Reflexite Corporation part number GP010.

WITHHOLDING ALLOWANCE – a limited amount of FABRICATED ITEMS that are withheld from the shipping requirements (specified in the **2011 FRC Administrative Manual, Section 5**) and retained by the team following the shipping deadlines. These items are then hand-carried to a competition event by the team. The OPERATOR CONSOLE is automatically included in the WITHHOLDING ALLOWANCE. Beyond that, the incoming material maximums specified in Rule <R33> limits the amount of FABRICATED ITEMS included in the WITHHOLDING ALLOWANCE.

Please note that for “Bag & Tag” teams attending 2-day events, items within the WITHHOLDING ALLOWANCE cannot be exchanged for other FABRICATED ITEMS on the ROBOT during the “Robot Access Period” as described in **Attending a Bag and Tag Event, Section 4** posted on the FIRST website at www.usfirst.org/frc/competitionmanual.

YELLOW CARD – a warning of egregious ROBOT or FRC team member behavior.

ZONE – an area approximately 18 feet wide and 7 feet deep located immediately in front of the ALLIANCE WALL. The boundaries are marked with tape that matches the color of the ALLIANCE stationed directly behind the adjacent ALLIANCE WALL.

1.7 REVISION HISTORY

Revision	Release Date	Changes
-	1/5/11	Original release
A	1/11/11	Table of Contents: updated to include Section 1.7
		Throughout: converted “LogoMotion” to “LOGO MOTION”
		Section 1.5, Title: Added ™ to first instance of LOGO MOTION.
		Section 1.5: Deleted redundant “each”
		Section 1.6: DEPLOYMENT definition has been updated to specify when the DEPLOYMENT is over.
		Section 1.6: MINIBOT definition has been updated to reference the appropriate section of the Manual.
B	1/18/11	Section 1.6: ROBOT definition has been updated to specify only one MINIBOT per HOSTBOT
		Footer was updated from Rev – to Rev A
		Added <i>Section 1.7, Revision History</i>
		Section 1.6: DEPLOYMENT definition was revised to remove extraneous wording
		Section 1.6: KIT OF PARTS definition was revised to include items in FIRST Choice.
		Section 1.6: Fixed section reference typos in the definitions for BUMPER and MINIBOT
C	1/25/11	Section 1.6: HANGING definition was revised to specify that the PEG must go through the center hole of the GAME PIECE.
D	2/1/11	Section 1.6: HANGING definition was revised to be consistent with rules in <i>Section 3 – The Game</i>

Section
2



FIRST®Robotics Competition

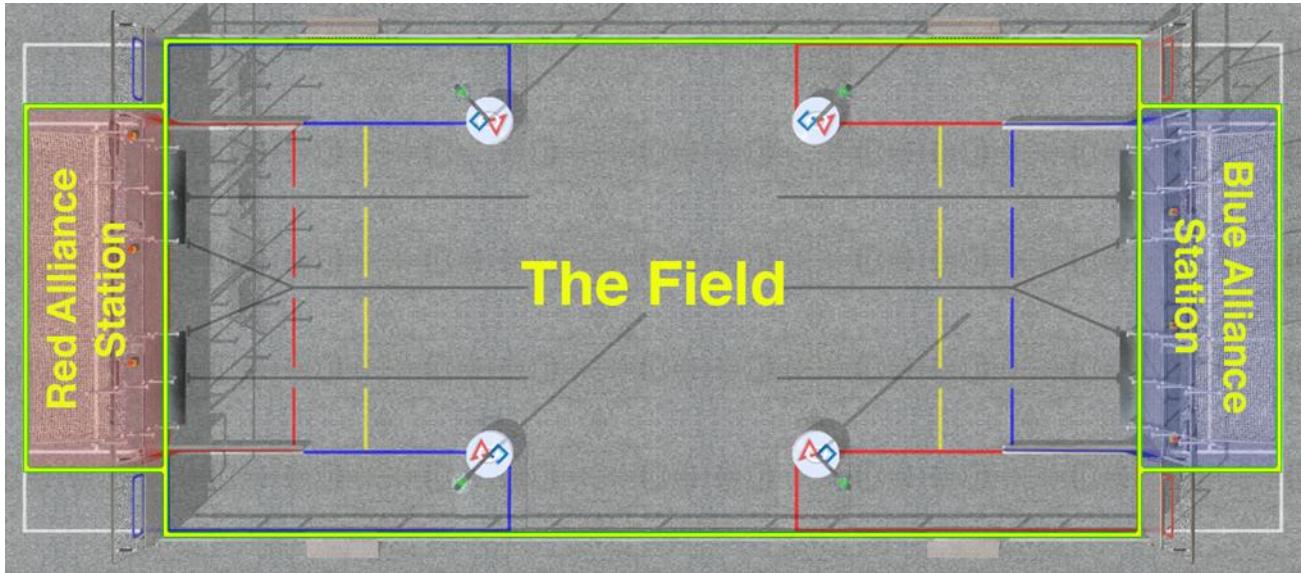
THE ARENA

TABLE OF CONTENTS

2 THE ARENA	2
2.1 OVERVIEW.....	2
2.1.1 Dimensions and Tolerances	2
2.2 THE ARENA	3
2.2.1 The FIELD	4
2.2.2 FIELD Markings.....	5
2.2.3 The SCORING GRID.....	5
2.2.4 The FEEDING SLOTS.....	7
2.2.5 The TOWERS.....	7
2.2.6 The ALLIANCE STATIONS	7
2.2.7 FEEDER STATIONS	8
2.2.8 The PLAYER STATIONS.....	8
2.2.9 GAME PIECES.....	9
2.3 Revision History	10

2 THE ARENA

2.1 OVERVIEW



Note: These illustrations are for a general visual understanding of the LogoMotion ARENA only. Please refer to the official drawings for exact dimensions and construction details.

The ARENA includes all elements of the game infrastructure that are required to play *LogoMotion*: the FIELD, the ALLIANCE STATIONS, the GAME PIECES, and all supporting communications, arena control, and scorekeeping equipment.

ROBOTS play *LogoMotion* on a 27 by 54-foot rectangular field known as the FIELD. The FIELD is bordered by a set of guardrails and ALLIANCE WALLS. During the game MATCHES, the ROBOTS are controlled from ALLIANCE STATIONS located outside the ends of the FIELD. These rectangular zones consist of three TEAM PLAYER STATIONS that provide connectivity between the controls used by the ROBOT operators and the ARENA. SCORING GRIDS are located directly in front of the PLAYER STATIONS, attached to the surface of the ALLIANCE WALLS facing the FIELD.

The specifications for the *LogoMotion* ARENA used in competition are listed below in Section 2.1.1. The referenced specifications and construction details of the ARENA can be found on the FIRST web site at www.usfirst.org/frc/2011/officialdrawings.html. Note that the web site also contains drawings for low-cost versions of the important elements of the ARENA. TEAMS may choose to build these versions for their own use during the construction and testing of the ROBOT. These drawings can be found at www.usfirst.org/frc/2011/teamdrawings.html.

2.1.1 Dimensions and Tolerances

The exact dimensions and construction details of the ARENA are contained on the official arena drawings. The relevant drawings include:

2011 FRC DRAWINGS			
TITLE	CATEGORY	DWG NO.	SHEET/S
2011 Arena Assembly*	Overall Arena Assembly	FE-00034*	5 Sheets
Outer Pole Assembly*	2011 Game Specific	GE-11000	1 Sheet
Middle Pole Assembly*	2011 Game Specific	GE-11003	1 Sheet
Base	2011 Game Specific	GE-11020	3 Sheets
Mounting Angle, Left	2011 Game Specific	GE-11021	2 Sheets
Mounting Angle, Right	2011 Game Specific	GE-11022	2 Sheets
Lane Divider Assembly*	2011 Game Specific	GE-11025	1 Sheet
Corner Glass Right	2011 Game Specific	GE-11027	1 Sheet
Corner Glass Left	2011 Game Specific	GE-11028	1 Sheet
Modified End Panel, Corner	2011 Game Specific	GE-11041	8 Sheets
Tower Assembly*	2011 Game Specific	GE-11049	2 Sheets
Net Support	2011 Game Specific	GE-11051	1 Sheet
Net	2011 Game Specific	GE-11055	1 Sheet
Guard	2011 Game Specific	GE-11060	1 Sheet
Top Rail	2009 Game Specific	GE-09031	1 Sheet
Drivers Station Support	Generic Field Drawing	FE-00001	2 Sheets
Corner Supports, Left and Right	Generic Field Drawing	FE-00002	2 Sheets
Rail Pin Assembly	Generic Field Drawing	FE-00003	1 Sheet
End Panel	Generic Field Drawing	FE-00004	3 Sheets
Field Top Rail	Generic Field Drawing	FE-00007	1 Sheet
Field Plastic "A"	Generic Field Drawing	FE-00008	1 Sheet
Field Plastic "B"	Generic Field Drawing	FE-00009	1 Sheet
Field Plastic "C"	Generic Field Drawing	FE-00010	1 Sheet
Field Plastic "G"	Generic Field Drawing	FE-00011	1 Sheet
Drivers Station Acrylic	Generic Field Drawing	FE-00012	1 Sheet
Field Outrigger	Generic Field Drawing	FE-00013	1 Sheet
Field Entry Ramp	Generic Field Drawing	FE-00014	2 Sheets
Field Trip Guard	Generic Field Drawing	FE-00015	1 Sheet
Hanger, Plastic "G"	Generic Field Drawing	FE-00016	1 Sheet
Field Rail Assembly - Middle*	Generic Field Drawing	FE-00022*	1 Sheet
Field Rail Assembly - End*	Generic Field Drawing	FE-00023*	1 Sheet
Field Rail Assembly – Gate*	Generic Field Drawing	FE-00029*	1 Sheet

*Refer to drawing for all part numbers required to build assemblies.

The competition ARENAS are modular constructions that are assembled, used, disassembled, and shipped many times during the competition season. They may undergo a significant amount of wear and tear. The ARENA is designed to withstand rigorous play and frequent shipping, and every effort is made to ensure that the ARENAS are as identical from event to event as possible.

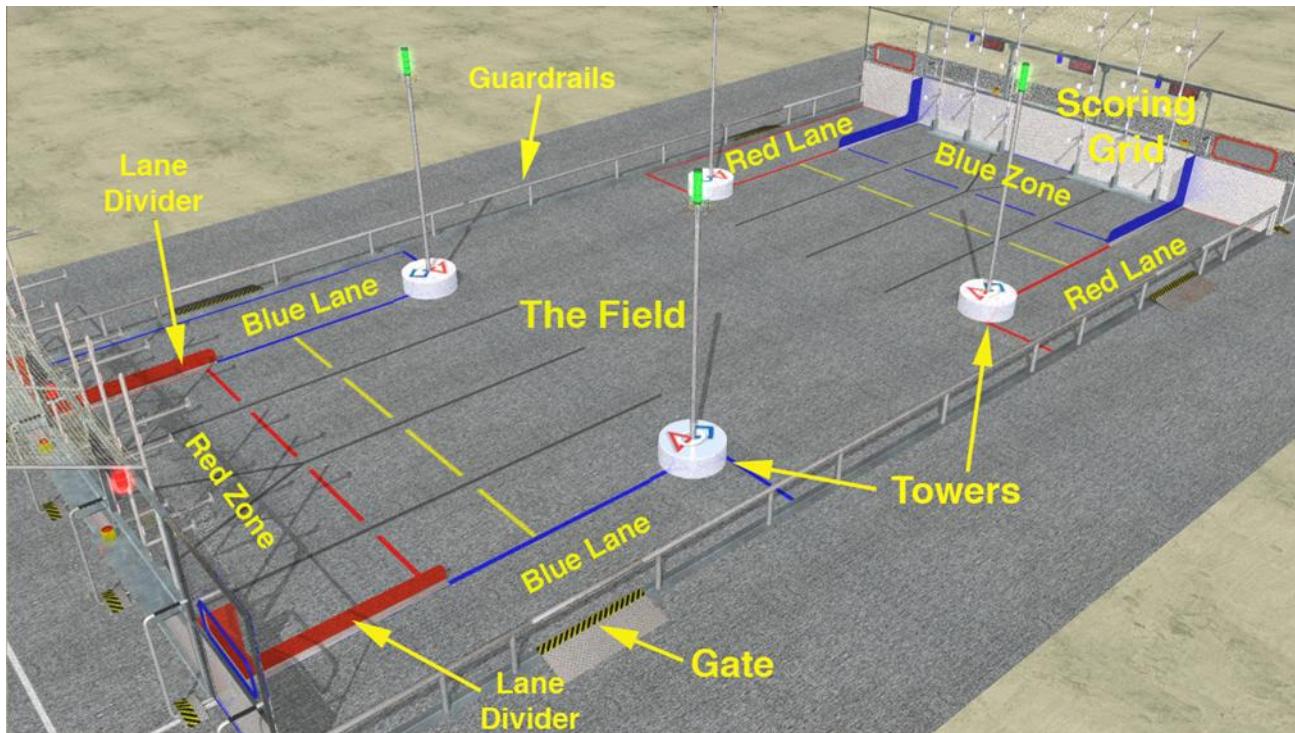
However, as the ARENAS are assembled in different venues by different event staff, some small variations do occur. Fit and tolerance on large assemblies (e.g. the TOWER) are ensured only to within 1/4 inch. Overall gross dimensions of the entire field may vary up to 4 inches. Successful TEAMS will design ROBOTS that are insensitive to these variations.

2.2 THE ARENA

Note: The official LogoMotion ARENA description, layout, dimensions and parts list are contained in the "FE-00034 - 2011 Arena Layout and Marking" Drawing. Diagrams and dimensions below are for illustrative purposes only.

2.2.1 The FIELD

The playing FIELD for *LogoMotion* is a 27-foot by 54-foot carpeted area, bounded by two ALLIANCE WALLS and a Guardrail System. The FIELD is covered with carpet (S&S Mills, Sequoia 20 Oz. Level Loop Pile, Color: Ground Pepper). SCORING GRIDS are located at the ends of the FIELD, immediately in front of the ALLIANCE STATIONS. Tape markings on the surface of the FIELD denote LANES, ZONES, CAUTION LINES, and TRACKING LINES used during the game. Four TOWERS are located near the mid-field and used during the END GAME period of *LogoMotion*.



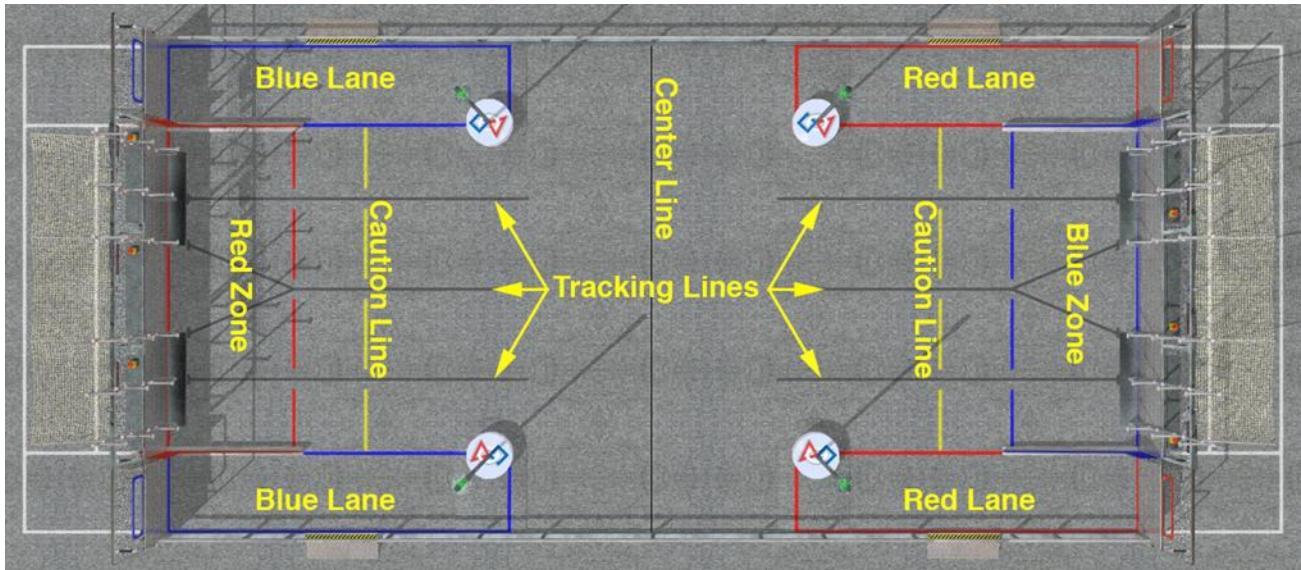
The ALLIANCE WALL is 6-1/2 feet high, 27 feet wide, and defines the ends of the FIELD. The ALLIANCE WALL is a barrier protecting the PLAYER STATIONS. This barrier is composed of a three-foot high base of diamond plate aluminum topped with a 3-1/2-foot high transparent polycarbonate panel. A protective safety net extends above the top of the ALLIANCE WALL to prevent GAME PIECES and/or ROBOT parts from exiting the FIELD and entering the ALLIANCE STATION area. At each side of the PLAYER STATION barrier is a 4-1/2 foot wide panel containing a FEEDING SLOT through which GAME PIECES can be passed.

The Guardrail System is a horizontal pipe 20 inches above the floor, supported by vertical struts mounted on a three-inch aluminum angle. A shield is attached on the inside of the Guardrail System, extending from the floor to the top of the guardrail, and running the length of the guardrail. The shield is intended to help prevent ROBOTS, in whole or in part, from inadvertently exiting the FIELD during a match. The Guardrail System defines the borders of the FIELD, except where it is bounded by the ALLIANCE WALL.

Four gates in the Guardrail System allow easy access to the FIELD for placement and removal of ROBOTS. The gates are 38 inches wide, and are closed and shielded during game play.

2.2.2 FIELD Markings

The FIELD is divided into several regions by 3-inch wide colored gaffers tape attached to the carpet. The regions are known as "ZONES" and "LANES." The color of the ZONES and LANES are indicated by the color of the gaffers tape used to mark them on the carpet (Pro Gaff Tape, "red" and "electric blue"). ZONES and LANES are areas safe from incursion by ROBOTS from the opposing ALLIANCE. The tape boundaries are considered "in" the bounded areas.



FIELD markings. For illustrative purposes only - please refer to Drawing FE-00034 for precise size and location of the FIELD markings.

There is one ZONE for each ALLIANCE, located immediately in front of the ALLIANCE WALL for that ALLIANCE. The ZONE is approximately 18 feet wide and 7 feet deep. There is a 2-inch wide yellow CAUTION LINE located 4 feet in front of the ZONE (Pro Gaff Tape, "yellow"). The CAUTION LINE is used as a visual warning indicator to the opposing ALLIANCE that their ROBOTS are getting close to the ZONE.

At the end of the FIELD opposite from the ALLIANCE STATION, LANES are marked on the carpet for each ALLIANCE. There are two LANES for each ALLIANCE, located in each of the opposing corners of the FIELD. Each LANE extends for approximately 19-1/2 feet from the opposing ALLIANCE WALL toward the center of the FIELD. Each LANE extends inwards approximately 4 feet 3 inches from the edge of the FIELD.

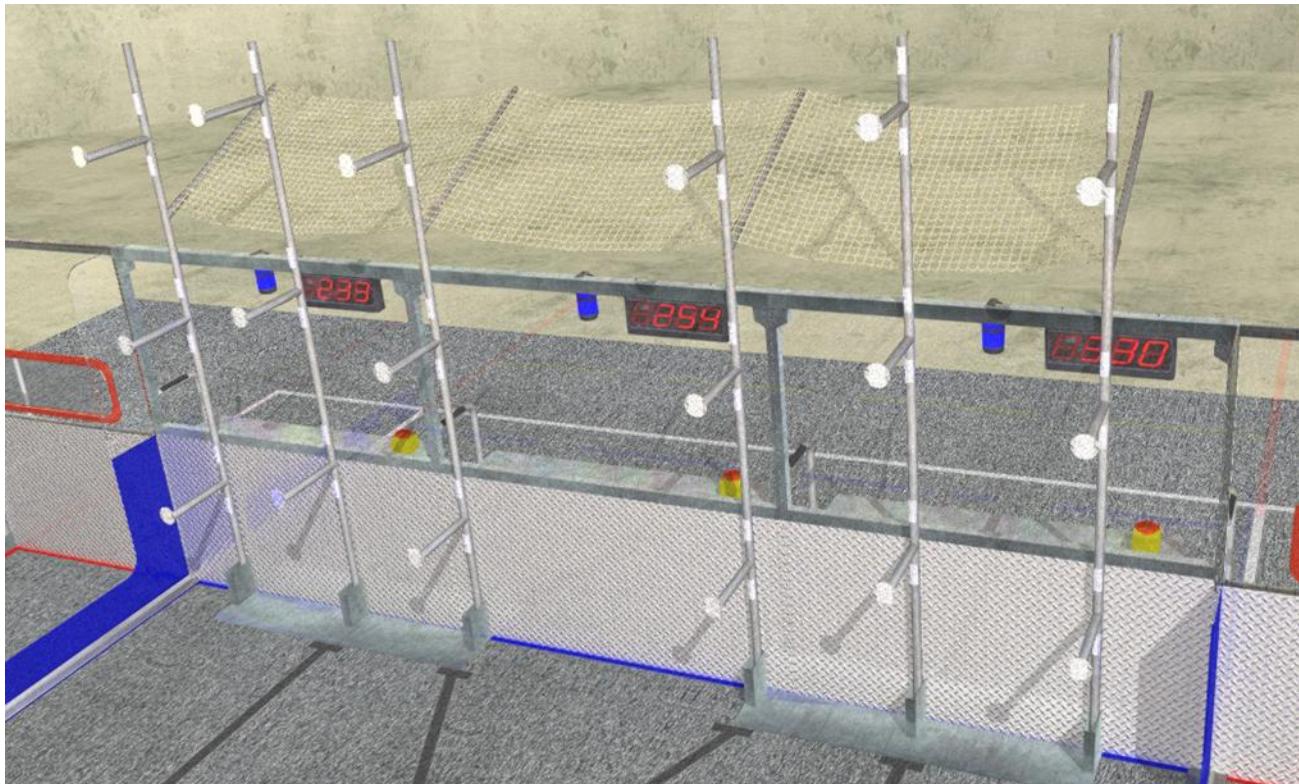
A mid-field is marked on the carpet with black permanent marker which equally divides the width of the FIELD in half.

TRACKING LINES are marked on the carpet with 2-inch wide grey gaffers tape (Pro Gaff Tape, "grey"). The TRACKING LINES are intended for use by the ROBOTS to locate the columns of SCORING PEGS on the SCORING GRIDS. Each of the outer TRACKING LINES extends from approximately one foot past the ends of the lanes to the base of the center columns of each of the SCORING GRIDS. The center TRACKING LINE extends approximately one foot past the ends of the lanes toward the SCORING GRIDS, and then bifurcates approximately 7 feet from the end, with each branch then leading to one of the two inner columns of the SCORING GRIDS. Each TRACKING LINE ends in a T to assist the ROBOT with recognizing when the end has been reached.

2.2.3 The SCORING GRID

The SCORING GRIDS are used to receive GAME PIECES placed by the ROBOTS as they play *LogoMotion*. There are four SCORING GRIDS on the FIELD. Two are located immediately in front of each ALLIANCE STATION and are owned by the ALLIANCE associated with the ZONE in which

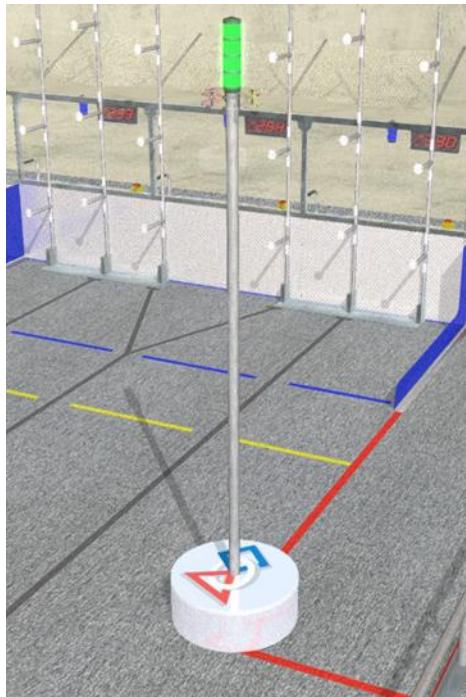
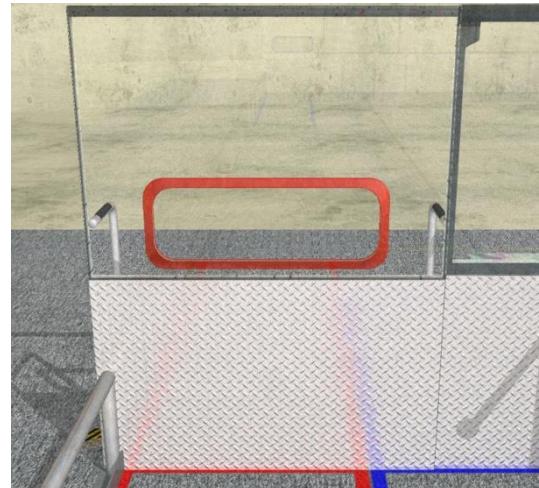
they are located (i.e. the two SCORING GRIDS in the red ZONE are the red ALLIANCE SCORING GRIDS). SCORING GRIDS are attached to the inside of the ALLIANCE WALL. Each SCORING GRID is composed of three vertical columns, with three horizontal SCORING PEGS attached to each column. The vertical columns are held in place by column bases. Each column base consists of three open-ended rectangular tubes affixed to a flat steel plate, which rests on the carpet. One base is used for each SCORING GRID. The rectangular tubes are approximately 2 inches wide, 8 inches high and 6 inches deep. One column is positioned inside each rectangular tube, toward the rear of the tube, to provide support. The columns and SCORING PEGS are constructed of 1.66-inch OD aluminum pipe. The columns within each SCORING GRID are spaced 30 inches center-to-center. The three SCORING PEGS located on each column extend 16 inches horizontally inward toward the center of the FIELD. The height of the SCORING PEGS on each of the three "levels" is staggered from their adjacent neighbor by up to 8 inches. This spacing is intended to allow tight visual "packing" of adjacent GAME PIECES, while leaving just enough room to minimize interference with GAME PIECES already located on SCORING PEGS as new pieces are placed.



A small "foot" is placed on the end of each SCORING PEG. The foot is a 2-3/4-inch diameter disk of 3/8-inch aluminum. The foot is intended to help retain any GAME PIECES on the SCORING PEG, and help prevent them from being knocked off once placed in position. A retro-reflective VISION TARGET, approximately the same size as the foot, is attached to the FIELD-facing surface of the foot. Additional retro-reflective VISION TARGETS, approximately 1 inch by 4 inch in size, are attached to each column, starting two inches above and below each foot. Each SCORING PEG, therefore, has associated with it three VISION TARGETS, one on the foot, one above the foot and one below the foot. These retro-reflective VISION TARGETS may be used to aid ROBOTS in locating SCORING PEGS.

2.2.4 The FEEDING SLOTS

The FEEDING SLOTS are openings in the ALLIANCE WALL that can be used by the FEEDER to pass GAME PIECES to a ROBOT and enter them into play. One FEEDING SLOT is located in the ALLIANCE WALL at the end of each LANE, in front of the FEEDER'S position. Each FEEDING SLOT is approximately 35 inches wide and 10 inches tall, and is centered 45 inches above the floor.



around the TOWER.

2.2.5 The TOWERS

TOWERS are located near the mid-field end of each LANE and are owned by the ALLIANCE associated with the LANE in which it is located (i.e. the TOWER intersecting the red LANE is owned by the red ALLIANCE). The TOWERS are climbed by MINIBOTS during the END GAME of a *LogoMotion* match. Each TOWER is composed of a BASE, a POST, and a TARGET. The BASE is a cylindrical section approximately 30 inches in diameter by 12 inches tall. The sides and top of the BASE are covered in translucent white LDPE plastic.

The BASE rests on a 48-inch by 76-inch floor protector made of 3/16-inch HDPE. The floor protector is velcroed to the FIELD surface, and covered with a piece of similar carpet. The edges of the floor protector cover are taped to the FIELD carpet (Pro Gaff Tape, "black", 2-inch). This taped seam forms a slight (approximately 1/4-inch) ridge in the FIELD

The POST extends upwards from the center of the BASE. The POST is constructed from a piece of 1.5" Steel Electrical Metal Tubing (EMT) with a nominal outer diameter of 1.74". The DEPLOYMENT LINE is located on the POST, approximately 18 inches above the top surface of the BASE. The DEPLOYMENT LINE is marked on the POST with black permanent marker to avoid significant changes to the surface properties of the POST (other than color).

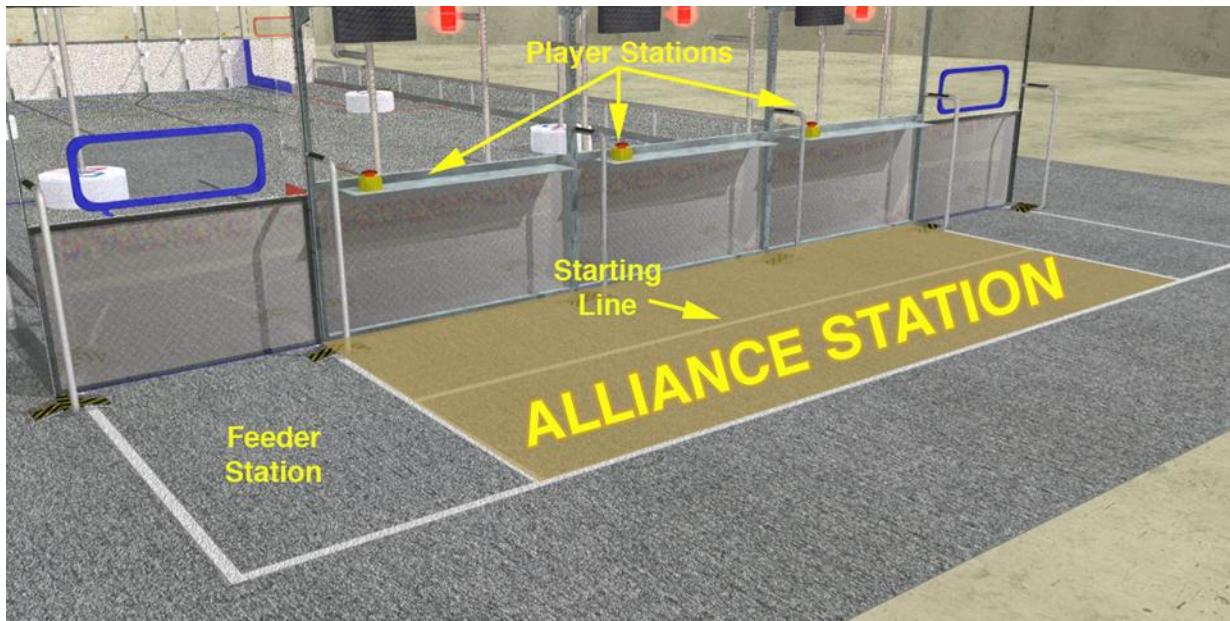
The TARGET is attached to the top of the POST. The TARGET is the "finish line" that indicates the MINIBOT has reached the top of the POST. The TARGET consists of a pair of 12-inch diameter polycarbonate disks, spaced approximately 2 inches apart. The bottom of the lower disk (i.e. the portion of the TARGET contacted by the climbing MINIBOT) is approximately 122 inches above the floor. As the MINIBOT climbs the POST and contacts the lower disk of the TARGET, the disk translates upwards approximately 1/4 inch as the sensors internal to the TARGET register the contact. A minimum contact force of approximately 2-4 Newtons, depending on contact location, is required to ensure the contact sensors in the TARGET trip reliably. The contact sensors and associated electronics are located between the upper and lower disks of the TARGET.

Colored lights inside the BASE and TARGET lights will illuminate at various stages of the MATCH.

2.2.6 The ALLIANCE STATIONS

The ALLIANCE STATIONS are located at either end of the ARENA, behind the ALLIANCE WALLS. The DRIVERS and COACHES of the competing TEAMS stand in their assigned ALLIANCE

STATION during the MATCH, from where they operate their HOSTBOTS and play *LogoMotion*.



The ALLIANCE STATION extends back eight feet from the ALLIANCE WALL, and across the 18-foot wide center section of the wall. The ALLIANCE STATION includes the three identical PLAYER STATIONS. The STARTING LINE is marked on the floor four feet back from the ALLIANCE WALL, and extends across the width of the ALLIANCE STATION. The ALLIANCE STATION includes the area behind the STARTING LINE. All boundaries for the ALLIANCE STATIONS are marked on the carpet with white tape (Pro Gaff Tape, “white”, 2-inch). The tape boundaries are considered “in” the bounded areas.

2.2.7 FEEDER STATIONS

A FEEDER STATION is located on either side of the ALLIANCE STATION. A FEEDER from the opposing ALLIANCE stands in the FEEDER STATION during the MATCH. The FEEDER STATION extends back eight feet from the ALLIANCE WALL, and from the line at the edge of the ALLIANCE STATION to the edge of the FIELD width.

2.2.8 The PLAYER STATIONS

Attached to the ALLIANCE WALL are three aluminum shelves to support the OPERATOR CONSOLES for the three TEAMS on the ALLIANCE. The support shelf measures approximately 60 inches wide by 12 inches deep. There is a 4-1/2-foot long by two-inch wide strip of Velcro tape (“loop” side) along the center of the support shelf that may be used to secure the OPERATOR CONSOLES to controls the ROBOT. Each setup location includes a competition cable (to provide Ethernet connectivity) that attaches to the Ethernet Port of the OPERATOR CONSOLE. The cable provides communications with the ROBOT.

Once plugged in to the Field Management System via the Ethernet cable provided, the ports that the teams will be able to access on the playing field are as follows:

- TCP 1180: This port is typically used for camera data from the cRIO to the DS when the camera is connected to port 2 on the cRIO. This port is bidirectional on the field.
- UDP 1130: Dashboard-to-Robot control data, directional
- UDP 1140: Robot-to-Dashboard status data, directional
- HTTP 80: Camera connected via switch on the robot, bidirectional
- HTTP 443: Camera connected via switch on the robot, bidirectional

All these ports are open on the playing field, so a team can use them as they wish if they do not employ them as outlined above (i.e. TCP 1180 can be used to pass data back and forth between the robot and the DS if the team chooses not to use the camera on port 2).

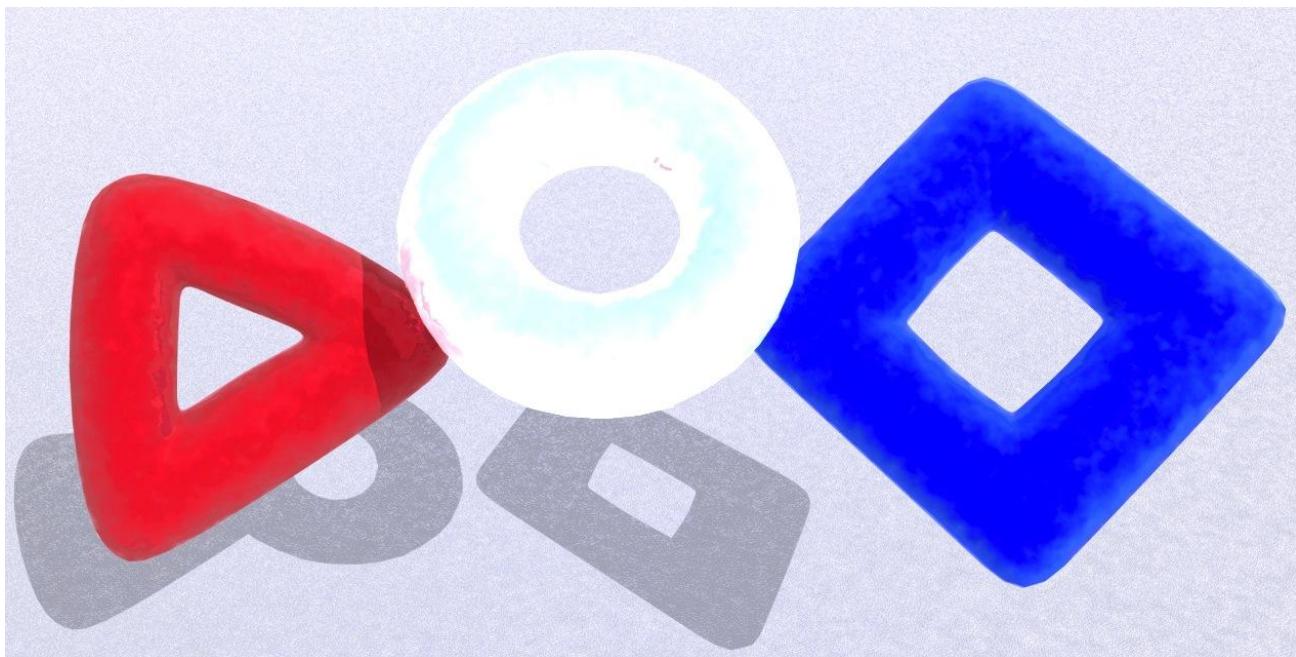
Each setup location also includes a power adaptor cable that may be used to power the Classmate laptops that were provided to teams in 2010 and 2011. Emergency Stop (E-Stop) buttons for each TEAM are located on the left end of each PLAYER STATION shelf. ARENA components (including team number displays, competition arena hardware, alliance lights, control hardware cabinets and clock displays) are also located above the PLAYER STATIONS and below the shelf.

2.2.9 GAME PIECES

While playing *LogoMotion*, HOSTBOTS manipulate GAME PIECES to accomplish the objectives of the game. Each GAME PIECE is an inflatable object constructed of 0.3 mm thick vinyl. The body of each GAME PIECE has a tubular cross-section, nominally between 7 and 8 inches in diameter at their narrowest. The GAME PIECES are inflated to nominal size, not a specific pressure.

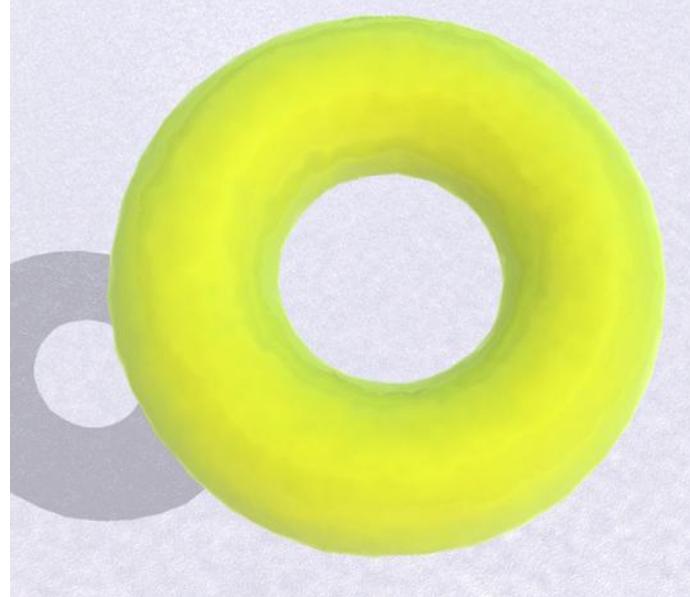
2.2.9.1 LOGO PIECES

During the majority of the MATCH, the HOSTBOTS manipulate GAME PIECES that are constructed in one of three shapes: a TRIANGLE, a CIRCLE or a SQUARE. The exterior dimensions of the GAME PIECES range between 25 inches (from side to side of the SQUARE) to 30 inches (from corner to corner of the TRIANGLE). The central opening in each GAME PIECE ranges between 9-1/2 inches (for the TRIANGLE) to 12 inches (for the CIRCLE and SQUARE) across. The TRIANGLE GAME PIECES are colored red, the CIRCLES are white, and the SQUARES are blue.



2.2.9.2 UBERTUBES

UBERTUBES are the GAME PIECES manipulated by the HOSTBOTS during the AUTONOMOUS PERIOD of the MATCH. UBERTUBES are constructed in the same manner as the CIRCLE, except they are colored yellow



2.3 REVISION HISTORY

Revision	Release Date	Changes
-	1/5/11	Original release
A	1/18/11	<u>Throughout: added detail for tape used on the ARENA.</u> <u>Section 2.2.5: included better description of material used for the POST.</u> <u>Added Section 2.3, Revision History</u>
B	1/25/11	Section 2.2.8: Added detail regarding port access



FIRST® Robotics Competition

THE GAME

TABLE OF CONTENTS

3 THE GAME.....	2
 3.1 GAMEPLAY RULES	2
3.1.1 <i>Periods</i>	2
3.1.2 <i>Pre-MATCH</i>	2
3.1.3 <i>AUTONOMOUS PERIOD</i>	3
3.1.4 <i>TELEOPERATED PERIOD</i>	3
3.1.5 <i>END GAME</i>	3
3.1.6 <i>Safety</i>	5
3.1.7 <i>General</i>	5
3.1.8 <i>Robot actions</i>	6
3.1.9 <i>Robot-Robot Interaction</i>	7
3.1.10 <i>Human actions</i>	8
 3.2 PENALTIES.....	8
 3.3 SCORING	9
 3.4 REVISION HISTORY	10

3 THE GAME

3.1 GAMEPLAY RULES

3.1.1 Periods

- <G01> A MATCH is 2 minutes and 15 seconds long. The AUTONOMOUS PERIOD is the first 15 seconds of the match. The TELEOPERATED PERIOD is the remaining 2-minute period.
- <G02> The AUTONOMOUS PERIOD ends when the ARENA timer displays zero seconds. The MATCH ends if all TOWERS are TRIGGERED or when the ARENA timer displays zero seconds, whichever comes first.

During the AUTONOMOUS PERIOD, the BASES will be illuminated in yellow. During the TELEOPERATED PERIOD, BASES will be illuminated with their ALLIANCE color. At 15 seconds before the end of the MATCH, BASES will flash yellow, while TARGET lights will flash green. At 10 seconds before the end of the MATCH, when HOSTBOTS may DEPLOY their MINIBOT without penalty, BASES will illuminate with the appropriate ALLIANCE color, while TARGET lights will show a green 'chase' sequence. This chase sequence will continue until a MINIBOT TRIGGERS the TARGET, or time expires, whichever comes first. If a MINIBOT TRIGGERS the TARGET within the set time period, the TARGET light will illuminate to indicate in which place the MINIBOT finished. 1st place will illuminate all four lights to indicate the maximum number of points have been scored. MINIBOTS finishing in subsequent positions will illuminate fewer lights, with the 4th place MINIBOT illuminating one light, to indicate the fewest points scored

3.1.2 Pre-MATCH

- <G03> Each ROBOT must be in its STARTING CONFIGURATION. The Head Referee may call for an inspector's recertification of the ROBOT size and weight prior to the start of any MATCH.
Violation: Prohibition from participating in the MATCH
- <G04> Each ROBOT must be positioned on the FIELD so that the BUMPER closest to it's ALLIANCE'S PLAYER STATION breaks the plane formed by the POSTS of the opposing ALLIANCE'S TOWERS.
Violation: The MATCH will not start until all ROBOTS are in legal positions. A YELLOW CARD may be assigned for repeated violations.
- <G05> Alignment devices (templates, tape measures, laser pointers, etc.) that are not part of the ROBOT and fully contained within the volume defined by the STARTING CONFIGURATION may not be used to assist with positioning the ROBOT.
Violation: TEAMS that use external alignment devices to position their ROBOT will have their ROBOT arbitrarily repositioned by a referee before the start of the MATCH.
- <G06> Each ROBOT must be in contact with one UBERTUBE. No more than one ROBOT may be contacting an UBERTUBE.
- <G07> Items other than the ROBOTS and the GAME PIECES shall not be placed on the FIELD prior to or during the MATCH.
Violation: PENALTY and YELLOW CARD

- <G08> Each TEAM provides a COACH, two DRIVERS and a HUMAN PLAYER. (Each ALLIANCE will have three HUMAN PLAYERS: two FEEDERS and one ANALYST.)
- <G09> All DRIVERS, COACHES and ANALYSTS must be standing in the ALLIANCE STATION and behind their STARTING LINE. FEEDERS must be in the FEEDER STATIONS.
Violation: PENALTY

- <G10> Each FEEDER STATION must contain 3 sets of LOGO PIECES.

3.1.3 AUTONOMOUS PERIOD

- <G11> ROBOTS may not break the plane of the CENTER LINE.
Violation: PENALTY

- <G12> TEAM members must remain within their assigned starting areas (COACH, DRIVERS, and ANALYSTS must be in the ALLIANCE STATIONS and behind the STARTING LINE; FEEDERS must be in the FEEDER STATIONS).
Violation: PENALTY

- <G13> TEAM members may not touch GAME PIECES.
Violation: PENALTY

- <G14> Any control devices worn or held by the DRIVERS must be disconnected from the OPERATOR CONSOLE, and not connected until after the AUTONOMOUS PERIOD.
Violation: PENALTY

- <G15> If a ROBOT should touch anything outside of the FIELD boundary during the AUTONOMOUS PERIOD, it will have a 10 second "grace period" to return to the FIELD at the beginning of the TELEOPERATED PERIOD.

Violation: If the ROBOT is unable to correct the situation within the grace period, it will be disabled for the remainder of the MATCH. If at any time the Head Referee should determine that the attempts to recover from the situation constitute unsafe operations, Rule <G26> will take precedence.

3.1.4 TELEOPERATED PERIOD

- <G16> UBERTUBES may not be HUNG.
Violation: PENALTY

<G16> disallows an unplaced UBERTUBE to be hung, a knocked-off UBERTUBE to be rehung, or movement of an UBERTUBE to a different PEG.

- <G17> HOSTBOTS may not DEPLOY a MINIBOT.
Violation: TOWER is disabled.

3.1.5 END GAME

- <G18> All TELEOPERATED PERIOD rules apply, except as modified in this section.

<G19> MINIBOTS must remain completely autonomous and move up the POST solely through electric energy provided after the start of DEPLOYMENT by the permitted, unaltered battery and converted to mechanical energy by the permitted unaltered motors (and associated, appropriate circuitry).

Violation: The TOWER on which the MINIBOT is DEPLOYED is disabled. If the MINIBOT is DEPLOYED on something other than a TOWER, then the ALLIANCE'S TOWER upon which the highest RACE SCORE was earned will be discounted.

<G19> means that HOSTBOTS are not allowed to launch the MINIBOT up the pole at the TARGET, or otherwise contribute to the vertical movement of the MINIBOT. Energy for vertical movement may not be stored in the MINIBOT before DEPLOYMENT (except that which is contained within the battery and excluding incidental kinetic energy stored in the motors or wheels, but NOT, for example, in a flywheel).

<G20> ROBOTS/HOSTBOTS may not contact their own TOWERS above the DEPLOYMENT LINE.

Violation: PENALTY for contact. TOWER is disabled if MINIBOT is DEPLOYED above the DEPLOYMENT LINE.

<G21> HOSTBOTS may DEPLOY MINIBOTS only onto their ALLIANCE'S TOWERS and entirely below the DEPLOYMENT LINE.

Violation: RED CARD

<G22> HOSTBOTS may not contact their ALLIANCE'S MINIBOT while any part of it is above the DEPLOYMENT LINE.

Violation: TOWER is disabled

<G23> Contact (via ROBOT or GAME PIECE) with the opposing ALLIANCE'S TOWERS is prohibited.

Violation: RED CARD

<G24> The opposing ALLIANCE may not interfere with the DEPLOYMENT or climbing of a MINIBOT.

Violation: RED CARD

Interference by an ALLIANCE refers to any action taken by that ALLIANCE that results in disruption of the MINIBOT's progress. This may include, but is not limited to,

- a) throwing a GAME PIECE at the MINIBOT/TOWER,
- b) driving a ROBOT or GAME PIECE into the TOWER, or
- c) directly contacting the MINIBOT or TOWER.

<G25> During the END GAME, ROBOTS/HOSTBOTS in contact with their ALLIANCE'S TOWER are protected and may not be contacted by an opponent.

Violation: PENALTY for inadvertent contact; plus a RED CARD for obviously intentional contact.

3.1.6 Safety

- <G26> If at any time a ROBOT'S operation or design is deemed unsafe, the ROBOT will be disabled for the remainder of the MATCH. If the safety violation is due to the ROBOT design, the Head Referee has the option to not allow the ROBOT back onto the FIELD until the design has been corrected. *Violation: PENALTY and Disablement*

An example of unsafe operation would be uncontrolled motion that cannot be stopped by the DRIVERS.

- <G27> TEAM members may not contact any ROBOT at any time during the MATCH.
Violation: PENALTY and Disablement

- <G28> TEAM members may not extend any part of their body into the FIELD during the MATCH.
Violation: PENALTY

- <G29> If a ROBOT becomes unsafe (e.g. the ROBOT begins to smoke, the battery falls out, etc.) it may be disabled by pressing the E-Stop button. This will cause the TEAM'S ROBOT to be disabled for the remainder of the MATCH. The E-Stop buttons are intended for remote shut down during a MATCH in the event of safety hazards and will not otherwise affect MATCH score or duration. Any TEAM member may press the E-Stop button.
Violation: Inappropriate use of the E-Stop button (i.e. not for safety reasons) will result in a RED CARD.

- <G30> Any ROBOT used during a MATCH must be in compliance with all ROBOT Rules (as defined in **Section 4 – The Robot**).
Violation: RED CARD

3.1.7 General

- <G31> ROBOTS, HOSTBOTS, nor MINIBOTS may not touch anything outside the FIELD boundary.
Violation: Disablement

<G31> is in place primarily for safety. It also includes touching a FEEDER or FIELD structure through the FEEDING SLOT.

- <G32> Neither ROBOTS, HOSTBOTS, nor MINIBOTS may break the planes of the vertically projected borders of the opponent's ZONES, including a GAME PIECE in their POSSESSION. Momentary incursions by a POSSESSED GAME PIECE will not be penalized if they do not make contact with anything in the ZONE.
Violation: PENALTY. G61 does not apply to this rule, however strategies aimed at taking advantage of this exception will result in a YELLOW CARD. If a ROBOT enters the opponent's ZONE and does not make immediate effort to leave OR if it contacts another ROBOT (or GAME PIECE in its POSSESSION) also in the ZONE, then the intruding TEAM will receive a RED CARD.

<G32> allows ROBOTS to complete HANGING a GAME PIECE, as designed, without being hindered.

- <G33> Neither ROBOTS, HOSTBOTS, nor MINIBOTS may break the planes of the vertically projected borders of the opponent's LANES.

Violation: PENALTY. G61 does not apply to this rule, however strategies aimed at taking advantage of this exception will result in a YELLOW CARD. If a ROBOT enters the opponent's LANE and does not make immediate effort to leave OR if it contacts another ROBOT (or GAME PIECE in its POSSESSION) also in the LANE, then the intruding TEAM will receive a RED CARD.

<G33> allows ROBOTS to retrieve LOGO PIECES from the FEEDER without being hindered.

- <G34>** ROBOTS or HOSTBOTS may only POSSESS or HERD one GAME PIECE at a time.
Violation: PENALTY

It is important to design your ROBOT so that it is impossible to inadvertently or intentionally control more than one GAME PIECE at a time. Inadvertent contact will be not be considered HERDING and will not be penalized.

- <G35>** GAME PIECES that exit the FIELD will be placed back on the FIELD approximately at the point of exit, at the earliest safe opportunity, by FIELD staff.
- <G36>** GAME PIECES may not be intentionally placed out of bounds.
Violation: PENALTY and YELLOW CARD
- <G37>** GAME PIECES that deflate during a MATCH will be considered identical to inflated GAME PIECES.
- <G38>** ROBOTS and HOSTBOTS may not intentionally deflate GAME PIECES. No violation will be assigned for unintentional deflation.
Violation: RED CARD for intentional deflation. Repeated unintentional deflation may result in a YELLOW CARD.
- <G39>** ROBOTS and FEEDERS may not SCORE on their opponent's PEGS or descore their opponent's GAME PIECES, or interfere with their opponent's TOWERS.
Violation: RED CARD.

3.1.8 Robot actions

- <G40>** ROBOTS or HOSTBOTS may not exceed PLAYING CONFIGURATION at any time.
Violation: PENALTY
- <G41>** MINIBOTS may not exceed a 12" x 12" x 12" volume.
Violation: The TOWER on which the MINIBOT is DEPLOYED is disabled. If the MINIBOT is not deployed on a TOWER, then the ALLIANCE's TOWER upon which the highest RACE SCORE was earned will be discounted
- <G42>** ROBOTS, MINIBOTS, or HOSTBOTS may not intentionally detach parts or leave MECHANISMS on the FIELD (with the exception of appropriate DEPLOYMENT of the MINIBOT).
Violation: PENALTY for each incident and potential RED CARD if an intentionally detached COMPONENT or MECHANISM impedes MATCH play.
- <G43>** ROBOTS and MINIBOTS may push or react against any elements of the ARENA, provided there is no damage or disruption of the ARENA elements. With the exception of the TOWER during the END GAME and while DEPLOYING a MINIBOT, ROBOTS may not grab, grasp, grapple, or attach to any ARENA structure.

Violation: A warning will be issued when a ROBOT violates this rule. If the referee determines that the TEAM is disregarding the warning, their ROBOT will be disabled for the remainder of the MATCH.

- <G44> ROBOTS, MINIBOTS, or HOSTBOTS that become entangled in the ARENA elements may be disabled and will not be freed until after the MATCH has finished. No PENALTY will be assigned.
- <G45> ROBOTS, MINIBOTS, or HOSTBOTS may not damage any part of the ARENA.
Violation: Potential Disablement if the Head Referee determines that further damage is likely to occur. Corrective action (such as eliminating sharp edges, removing the damaging MECHANISM, and/or re-inspection) may be required before the ROBOT will be allowed to compete in subsequent MATCHES.
- <G46> MINIBOTS may only be used to climb the TOWER.
Violation: YELLOW CARD
- <G47> From the start of the MATCH until it is DEPLOYED, the MINIBOT must remain on the HOSTBOT.
Violation: YELLOW CARD

3.1.9 Robot-Robot Interaction

- <G48> Strategies aimed at the destruction, attachment, damage, tipping or entanglement of ROBOTS, MINIBOTS, or HOSTBOTS are not in the spirit of the FRC and are not allowed. Contact with another ROBOT or HOSTBOT inside its FRAME PERIMETER is not allowed.
Violation: PENALTY, plus potential disablement and YELLOW CARD

High speed accidental collisions may occur during the MATCH and are an expected part of LOGO MOTION™. ROBOTS place mechanisms outside of the BUMPER PERIMETER at their own risk; no penalties will be assigned for incidental contact with such extended mechanisms. For example, use of wedge-like mechanisms to flip ROBOTS would be considered a violation.

- <G49> ROBOTS may not attempt to POSSESS a GAME PIECE that is being POSSESSED by an opponent ROBOT.
Violation: PENALTY
- <G50> An ALLIANCE may not pin an opponent ROBOT that is in contact with a field border or TOWER for more than 5 seconds. A ROBOT will be considered pinned until the ROBOTS have separated by at least 6 feet. The pinning ROBOT(S) must then wait for at least 3 seconds before attempting to pin the same ROBOT again.
Violation: 10 PENALTIES

If the pinned ROBOT chases the pinning ROBOT upon retreat, the pinning ROBOT will not be penalized per Rule <G61>, and the pin will be considered complete.

- <G51> Fallen (i.e. tipped over) ROBOTS attempting to right themselves (either by themselves or with assistance from an ALLIANCE partner) have one 10-second grace period per fallen ROBOT in which they may not be contacted by an opposing ROBOT. This protection continues for either 10 seconds or when the protected ROBOTS have completed the righting operation, whichever comes first.

Violation: PENALTY for inadvertent contact; plus a RED CARD for obviously intentional contact.

- <G52>** Intentionally falling down or tipping over to block the field is not allowed.

Violation: YELLOW CARD

- <G53>** Once the 10-second grace period for righting a fallen ROBOT has expired, opposing ROBOTS may interact with a fallen ROBOT with no PENALTY assessed as long as <G48> is not violated.

3.1.10 Human actions

- <G54>** Each ALLIANCE shall have no more than the four designated members of each of the three participating TEAMS in the ARENA during a MATCH. Any ALLIANCE with additional personnel in the ARENA must have the additional personnel leave the area before the MATCH may proceed.

Violation: YELLOW CARD for repeated offenses.

- <G55>** During the MATCH, TEAM members must stay within their assigned stations. The DRIVERS, COACH and ANALYST may travel anywhere within the ALLIANCE STATION. Exceptions will be allowed in cases involving TEAM member safety.

Violation: PENALTY

- <G56>** During a MATCH, the OPERATOR CONSOLE shall be operated solely by the DRIVERS of that TEAM.

Violation: Disqualification and RED CARD

- <G57>** During the TELEOPERATED PERIOD, FEEDERS may enter LOGO PIECES onto the FIELD by using the FEEDING SLOTS or by throwing the LOGO PIECE over the top of the FEEDER STATION wall. LOGO PIECES may not be thrown around the side of the FEEDER STATION wall.

Violation: PENALTY

- <G58>** COACHES, DRIVERS, and ANALYSTS may not touch GAME PIECES at any point during the MATCH.

Violation: PENALTY

- <G59>** MINIBOTS must be removed from the TOWER quickly and safely after each MATCH; this may be done by TEAMS while standing on the floor without special equipment, or by field crew using a retrieval hook. *Violation: The field crew will not be responsible for accidental MINIBOT damage. If the field crew cannot safely pull the MINIBOT down using their hook, a warning will be issued to the TEAM, after which repeated violations may result in a YELLOW CARD..*

3.2 PENALTIES

- <G60>** The actions of an ALLIANCE shall not cause an opposing ALLIANCE to violate a rule and thus incur PENALTIES. Any rule violations committed by the affected ALLIANCE shall be excused, and no PENALTIES will be assigned.

Unless otherwise noted, all PENALTIES assigned by referees are applied to the entire ALLIANCE.

3.3 SCORING

- <G61> Each ALLIANCE receives a MATCH SCORE which is the sum of its AUTONOMOUS SCORE, PEG SCORE, LOGO BONUS and RACE SCORE, less any assigned PENALTIES. The AUTONOMOUS SCORE is tabulated at the conclusion of the AUTONOMOUS PERIOD; all other scores are tabulated at the conclusion of the MATCH.
- <G62> If two GAME PIECES are HANGING from a single SCORING PEG, the outermost GAME PIECE will be counted for scoring purposes.
- <G63> The AUTONOMOUS SCORE is the sum of points determined by the positions of the three ALLIANCE UBERTUBES at the conclusion of the AUTONOMOUS PERIOD. The AUTONOMOUS PERIOD ends when the ARENA timer reaches zero seconds.

Not HANGING	0 points
HANGING on bottom row	2 points
HANGING on middle row	4 points
HANGING on top row	6 points

- <G64> The PEG SCORE is the sum of points determined by the positions of the GAME PIECES on each SCORING GRID. A LOGO PIECE HANGING in front of an UBERTUBE doubles the points for that SCORING PEG. The table below gives the value for each LOGO PIECE HANGING on a SCORING PEG.

LOGO PIECE:	Alone	Over UBERTUBE
Not HANGING	0 points	0 points
HANGING on bottom ROW	1 point	2 points
HANGING on middle ROW	2 points	4 points
HANGING on top ROW	3 points	6 points

Note that an UBERTUBE acts only as a modifier and carries no point value of its own after the AUTONOMOUS PERIOD.

- <G65> If three LOGO PIECES form a LOGO, the assigned points from the PEG SCORE in that row of that SCORING GRID are given as an additional LOGO BONUS, effectively doubling the score of the row.
- <G66> The RACE SCORE is assigned to each ALLIANCE based on the place of finish in the MINIBOT RACE (ties each receive the points for that place):

1 st MINIBOT to TRIGGER the TARGET	30 points
2 nd MINIBOT to TRIGGER the TARGET	20 points
3 rd MINIBOT to TRIGGER the TARGET	15 points
4 th MINIBOT to TRIGGER the TARGET	10 points

- <G67> Scores will be assessed when the MATCH ends and all objects in motion come to rest, or 10 seconds elapses, whichever comes first.

<G68> The minimum MATCH SCORE is zero points.

3.4 REVISION HISTORY

Revision	Release Date	Changes
-	1/5/11	Original release
A	1/11/11	Revised <G19> to clarify ways the MINIBOT may be propelled after DEPLOYMENT and added a Blue Box. Fixed capitalization of DEPLOYED and of the "S" in ALLIANCE'S in the Violation section of the rule.
		Revised <G41> to fix typo (disabled to disabled)
		Revised <G48>, Blue box, to change "LogoMotion" to "LOGO MOTION™"
		Revised <G65> to clarify the role and scoring of the UBERTUBE, fix a typo (PIECES to PIECE), and changed "GAME" to "LOGO" when referring to pieces on scoring pegs.
		Revised <G66> to clarify that it's the PEG SCORE that is doubled by a LOGO.
B	1/14/11	Added Section 3.4, Revision History
		Revised <G21> to clarify that the MINIBOT must be DEPLOYED entirely below the DEPLOYMENT LINE.
		Revised <G22> to clarify that the MINIBOT may not be touched after it has started to cross the DEPLOYMENT LINE.
C	1/18/11	Revised <G07> to include all GAME PIECES.
D	1/21/11	Revised <G32> to allow momentary incursions of GAME PIECES in the opponent's HOME ZONE.
		Revised <G39> to prohibit ALLIANCES for scoring on opponent's PEGS.
		Revised <G49> to allow alliance partner ROBOTS to hand off GAME PIECES to each other.
		Revised <G67> to fix spelling error
E	1/25/11	Fixed footer to include correct Section #.
		Revised <G19> to clarify timing of MINIBOT movement
		Revised <G21> to fix a misplaced modifier.
F	1/28/11	Revised <G05> to constrain alignment devices mounted on the ROBOT to the STARTING CONFIGURATION of the ROBOT.
		Revised <G32> and <G33> to make them exceptions to <G61>.
		Revised <G50> to change ROBOT to ALLIANCE regarding pinning. Also added blue box to clarify outcome if pinned ROBOT pursues pinning ROBOT.
		Revised <G59> to clarify what "quickly and safely" means.
G	2/1/11	Revised <G22> to clarify restriction on contact with MINIBOT once it's climbing the TOWER.
		Revised <G39> to prohibit interference with opponent's TOWERS.
		Revised <G59> to clarify consequences if MINIBOTS do not descend on their own.

Section
4



FIRST® Robotics Competition

THE ROBOT

TABLE OF CONTENTS

4	OVERVIEW	2
4.1	RELATED DOCUMENTS & RESOURCES	2
4.2	CONVENTIONS	2
4.3	ROBOT RULES.....	2
4.3.1	<i>Safety & Damage Prevention</i>	3
4.3.2	<i>Bumper Rules</i>	5
4.3.3	<i>General Robot Design</i>	9
4.3.4	<i>Budget Constraints</i>	11
4.3.5	<i>Cost Determination of Additional Parts</i>	12
4.3.6	<i>Fabrication Schedule</i>	13
4.3.7	<i>Material Utilization</i>	15
4.3.8	<i>Power Distribution</i>	16
4.3.9	<i>Motors & Actuators</i>	20
4.3.10	<i>Control, Command & Signals System</i>	22
4.3.11	<i>Pneumatic System</i>	26
4.3.12	<i>Operator Console</i>	29
4.3.13	<i>ROBOT Inspection</i>	30
4.3.14	<i>MINIBOT</i>	31
4.3.15	<i>MINIBOT Inspection</i>	32
4.1	REVISION HISTORY	34

4 OVERVIEW

This section of the 2011 *FIRST* Robotics Competition (FRC) manual provides rules applicable to the design and construction of the 2011 ROBOT. ROBOTS will be inspected at each FRC event to verify rules compliance before being allowed to compete.

4.1 RELATED DOCUMENTS & RESOURCES

In addition to this chapter, other sections in this manual and other documents should be reviewed before proceeding with the robot design process. Note that all referenced documents are available on the *FIRST* website at www.usfirst.org/frc/competitionmanual.

- A. **2011 FRC Game Manual**
- B. Kit of Parts item information and related documents posted on the *FIRST* website at: www.usfirst.org/frc/kitofparts.
- C. Crate constraints and deadlines as listed in **2011 FRC Manual, Section 5: Robot Transportation**

4.2 CONVENTIONS

Specific methods are used throughout this section to highlight warnings, cautions, key words or phrases. The intent is to alert the reader to important information designed to help teams in constructing a robot that complies with the rules in a safe and workmanlike manner.

Key words that have a particular meaning within the context of the 2011 FRC are defined in the Glossary (1.6) of **Section 1: Introduction** of the **2011 FRC Game Manual** and indicated in ALL CAPITAL letters throughout this text. References to other sections of the manual appear in ***bold italics***. References to specific rules within the manual are indicated with a bracketed reference to the rule (e.g. “Rule <R01>”). Operating keys, controls, buttons appear in bold capital letters (e.g. **OFF/ON** switch).

Warnings, cautions, and notes appear in blue boxes. These notes are intended to provide insight into the reasoning behind a rule, helpful information on understanding and interpreting a rule, and/or possible “best practices” for use when implementing systems affected by the rule. These notes are not part of the formal rules, and do not carry the weight of a rule (if there is an inadvertent conflict between a rule and a note, the rule applies). However, it is strongly recommended that you pay close attention to their contents.

4.3 ROBOT RULES

These rules establish the global ROBOT construction and performance constraints dictated by the characteristics of the provided KOP, along with the size and weight design limits. **Compliance with the rules is mandatory, and is the responsibility of every team! Any ROBOT construction not in compliance with the rules (as determined at inspection) must be rectified before a ROBOT will be allowed to compete.**

When constructing the ROBOT, the team is allowed to use the items in the **2011 KOP Checklist** and additional materials. Many of the rules listed below explicitly address what and how parts and materials may be used. There are many reasons for the structure of the rules, including safety, reliability, parity, creation of a reasonable design challenge, adherence to professional standards, impact on the competition, compatibility with the KOP, etc. When reading these rules, please use technical common

sense (engineering thinking) rather than “lawyering” the interpretation and splitting hairs over the precise wording in an attempt to find loopholes. Try to understand the reasoning behind a rule.

One of the purposes of the *FIRST* Robotics Competition is to provide team members with the experience of conceiving, designing, and constructing their solution to the annual competition challenge. We want each student to have the experience of creating a new system each year. As the team considers the creation of their machine, this aspect of the program should be kept in mind. Solutions that merely bolt together a minimum number of externally-designed COTS subsystems may not offer the students the opportunity to understand the “why” or “how” of an item’s design. Likewise, solutions that are merely minor modifications of a design utilized for a previous competition does not offer the current students complete insight into the full design process. Purchasing optimization and design re-use are both important concepts, however teams must be cautious not to over-utilize them to the point that the student’s experience is compromised.

This intent is clearly met when a team obtains a MECHANISM or COTS items that was designed for non-*FIRST* purposes, and then modifies or alters it to provide functionality for the ROBOT. For example, if a team obtains a gearbox from a power drill and modifies it to use on the ROBOT, they gain insight into the design of the original gearbox purpose, learn to characterize the performance of the original design, and implement the engineering design process to create their customized application for the gearbox.

However, COTS items that have been specifically designed as a solution to part of the FRC challenge may or may not fit within the FRC intent, and must be carefully considered. If the item provides general functionality that can be utilized in any of several possible configurations or applications, then it is acceptable (as the teams will still have to design their particular application of the item). However, COTS items that provide a complete solution for a major ROBOT function (e.g. a complete manipulator assembly, pre-built pneumatics circuit, or full mobility system) that require no effort other than just bolting it on to the ROBOT are against the intent of the competition, and will not be permitted.

In addition, another intent of these rules is to have all energy sources and active actuation systems on the ROBOT (e.g. batteries, compressors, motors, servos, cylinders, and their controllers) drawn from a well-defined set of options. This is to ensure that all teams have access to the same actuation resources, and to ensure that the inspectors are able to accurately assess the legality of a given part.

4.3.1 Safety & Damage Prevention

<R01> Energy used by FRC ROBOTS, (i.e., stored at the start of a MATCH), shall come only from the following sources:

- A. Electrical energy derived from the onboard 12V battery (see Rule <R34> for specifications and further details).
- B. Compressed air stored in the pneumatic system, stored at a maximum pressure of 120 PSI.
- C. A change in the altitude of the ROBOT center of gravity.
- D. 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.

<R02> ROBOT parts shall not be made from hazardous materials, be unsafe, or cause an unsafe condition. Items specifically *prohibited* from use on the ROBOT include (but are not limited to):

- A. Shields, curtains, or any other devices or materials designed or used to obstruct or limit the vision of any DRIVERS and/or COACHES and/or interfere with their ability to safely control their ROBOT
- B. Speakers, sirens, air horns, or other audio devices that generate sound at a level sufficient to be a distraction or hindrance affecting the outcome of a MATCH
- C. Any devices or decorations specifically intended to jam or interfere with the remote sensing capabilities of another robot, including vision systems, acoustic range finders, sonars, infrared proximity detectors, etc. (e.g. including imagery on your robot that, to a reasonably astute observer, mimics the VISION TARGET)
- D. Exposed lasers of any type (COTS devices with completely enclosed integral lasers, such as a laser ring gyro, are permitted)
- E. Flammable gasses
- F. Any devices intended to produce flames or pyrotechnics
- G. Materials that off-gas noxious or toxic gasses
- H. Materials that produce hazardous inhalable particles
- I. Caustic chemicals
- J. Hydraulic fluids or hydraulic components

Teams should provide MSD Sheets for any materials they use that might be considered questionable during ROBOT inspection.

<R03> Custom circuits and COTS electronics are expressly *prohibited* if they:

- A. Interfere with the operation of other ROBOTS.
- B. Directly affect any output devices on the ROBOT.

Examples of items that are considered directly affecting the output devices on the ROBOT include those that directly power a motor, supply a PWM signal directly to a speed controller or supply a control signal directly to a relay module (see Rules <R58> and <R59> for the specific exception regarding CAN-bus devices).

<R04> Protrusions from the ROBOT and exposed surfaces on the ROBOT shall not pose hazards to the ARENA, GAME PIECES or people.

If the ROBOT includes protrusions that form the “leading edge” of the ROBOT as it drives and are less than 1”² in surface area, it will invite detailed inspection. For example, forklifts, lifting arms, grapples, etc. may be carefully inspected for these hazards.

Reasonable efforts must be taken to remove, mitigate, or shield any sharp edges, pinch points, entanglement hazards, projectiles, extreme visual/audio emitters, etc. from the exterior of the ROBOT. All points and corners that would be commonly expected to contact a GAME PIECE should have a minimum radius of 0.125” to avoid becoming a snag/puncture hazard. All edges that would be commonly expected to contact a GAME PIECE should have a minimum radius of 0.030”.

<R05> MECHANISMS or COMPONENTS on the ROBOT shall not pose obvious risk of entanglement.

If the structure of a COMPONENT permits easy penetration by an object less than 4”² in cross section, it will invite detailed inspection.

Nets, loose rope or wire, voluminous sheets of fabric, etc. may be carefully inspected for these hazards. A 1/8” x 1/8” tight-mesh net (or very loose mesh fabric, depending on your point of view) may be a reasonable material that would not automatically pose an entanglement hazard. However, any flexible material has the potential to become an entanglement hazard if it is not firmly attached to an appropriate structure or left in a loose, voluminous configuration. Therefore, you must use your best judgment to determine if your particular use of the material will pose an entanglement hazard.

Actual performance on the playing field will determine if the potential for entanglement is significant or not. Willful entanglement *actions* are addressed in Rule <G48>.

<R06> ROBOT wheels, tracks, and other parts intended to provide traction on the carpet may be purchased or fabricated (“traction devices” include all parts of the ROBOT that are designed to transmit any propulsive and/or braking forces between the ROBOT and the FIELD). In no case will traction devices that damage the carpet or other playing surfaces be permitted. Traction devices shall not have surface features such as metal, sandpaper, hard plastic studs, cleats, or other attachments.

4.3.2 Bumper Rules

<R07> Teams are required to use BUMPERS on their ROBOTS while on the competition field.

BUMPERS have several advantages, such as reducing damage to ROBOTS when they contact other ROBOTS or ARENA elements, and being excluded from the calculation of ROBOT weight and volume constraints specified in Rule <R11>. The BUMPER location and design have been specified so that ROBOTS will make BUMPER-to-BUMPER contact during most collisions. If implemented as intended, a ROBOT that is pushed against a vertical wall in any STARTING CONFIGURATION will always have the BUMPER be the first thing to contact the wall. To achieve this, BUMPERS must be constructed as described below and illustrated in Figure 3-1.

General recommendations for BUMPER construction include:

- Using 1000 denier Cordura Plus® for the BUMPER cover
- Using lengths of aluminum angle to clamp the cover in place on the plywood.
- Considering methods for carrying the ROBOT while designing BUMPER mounts as BUMPERS typically do not make good handles.
- Noting that the use of BUMPERS may preclude the use of other technologies in their out-of-the-box configurations. Teams will need to carefully consider the interactions between BUMPER design options and other elements of their ROBOT design.

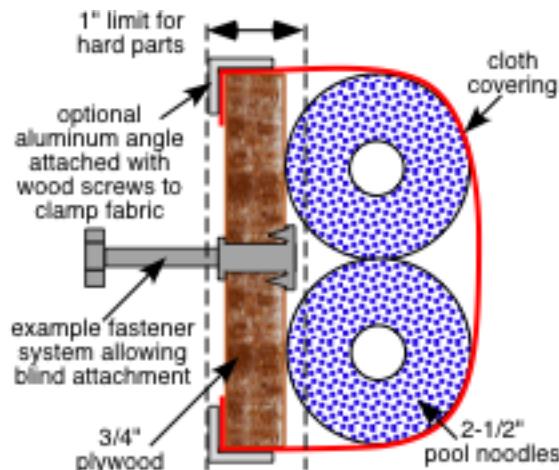


Figure 4-1

- A. BUMPERS must provide complete protection of the entire FRAME PERIMETER of the ROBOT (i.e. BUMPERS must wrap entirely around the ROBOT). As part of the 100% coverage, BUMPERS must protect all exterior corners of the FRAME PERIMETER. For adequate protection, a full segment of BUMPER must be placed on each side of the corner (see Figure 3-2).

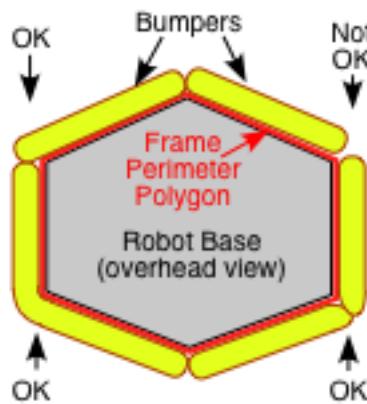


Figure 4-2

- B. The BUMPERS must be located entirely within the BUMPER ZONE when the ROBOT is standing normally on a flat floor, and must remain there (i.e. the BUMPERS must not be articulated or designed to move outside of the BUMPER ZONE).
- C. Joints between BUMPER segments and the radial projections of corners must be filled with "soft" BUMPER materials. This may be done with short pieces of vertically oriented pool noodle, by wrapping the pool noodles around the corners, or by beveling the ends between adjacent segments so they form a tight and complete protective surface (see Figure 3-2).
- D. BUMPER segments must have a minimum length of six inches (as defined by the BUMPER backing), and a maximum length that does not exceed the maximum horizontal dimension of the ROBOT (except for the soft cushion in the corner, as permitted by Rule <R07-C>).
- E. BUMPERs must use a stacked pair of 2½ inch "pool noodles" as the bumper cushion material.
- F. Each BUMPER segment must be backed by a piece of ¾" thick by 5" tall piece of plywood. Small clearance pockets and/or access holes in the plywood backing are permitted, as long as they do not significantly affect the structural integrity of the BUMPER.
- G. The exterior of the BUMPERs must be covered with a rugged, smooth cloth. The cloth must completely enclose all exposed surfaces of the plywood and pool noodle material.
- H. The fabric covering the BUMPERs must be a solid red or blue in color. Visually, the red or blue must be as close to the corresponding color in the FIRST logo as reasonable (i.e. to a reasonably astute observer, they appear similar). The only markings permitted on the BUMPER fabric cover are the team number (see Rule <R09>).
- I. Each set of BUMPERs (including any fasteners and/or structures that attach them to the ROBOT) must weigh no more than 20 pounds.
- J. BUMPERs must be designed for quick and easy installation and removal, to aid in weighing and inspection.

As a guideline, BUMPERS should be removable by one person in less than ten minutes.

- K. BUMPERS must attach to the FRAME PERIMETER of the ROBOT with a rigid fastening system to form a tight, robust connection to the main structure/frame (e.g. not attached with Velcro). The attachment system must be designed to withstand vigorous game play. All removable fasteners (e.g. bolts, locking pins, pip-pins, etc.) will be considered part of the BUMPERS.

If a multi-part attachment system is utilized (e.g. interlocking brackets on the ROBOT and the BUMPER), then the elements permanently attached to the ROBOT will be considered part of the ROBOT, and the elements attached to the BUMPERS will be considered part of the BUMPER. Each element must satisfy all applicable rules for the relevant system.

The BUMPER backing must be supported by the structure/frame of the ROBOT (i.e. the gap between the backing material and the frame must not be greater than 1/4" and no section of BUMPER greater than 8" may be unsupported). See Figure 3-3.

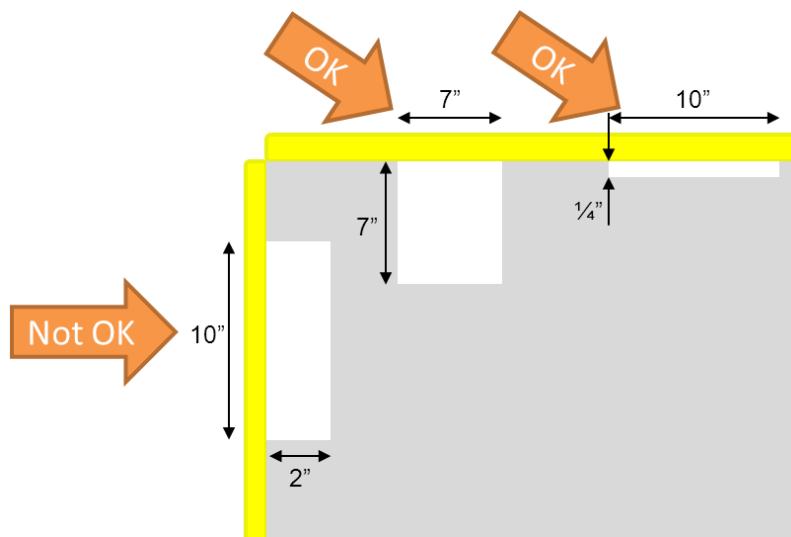


Figure 4-3

- L. “Hard” parts of the BUMPER (i.e. plywood backing, fastening system, and clamping angles) may extend up to a maximum of 1” beyond the FRAME PERIMETER. “Soft” parts of the BUMPERS (i.e. pool noodles and cloth covering) may extend up to 3½” beyond the FRAME PERIMETER.

<R08> The color of the BUMPERS will be used to identify the ALLIANCE to which the ROBOT has been assigned, red or blue. Therefore, each ROBOT must be able to display red BUMPERS and blue BUMPERS. This may be done via either of two acceptable methods:

- A. Each ROBOT may be built with two complete sets of interchangeable BUMPERS, one red and one blue. If this method is chosen, the BUMPERS must be identical except for the color of the covering fabric (see Rule <R07-H>).

- B. Alternately, the ROBOT may use changeable BUMPER covers. The BUMPER covers
- may be removable, reversible, or fixed
 - must completely enclose the BUMPERS
 - must show only red or blue such that when the BUMPER covers are in use, only fabric of the assigned ALLIANCE color may be visible.
 - must be constructed solely of fabric and a fastening/restraining system to hold the cover in place. The fastening/restraining system must extend no further than 1" beyond the FRAME PERIMETER (i.e. no further than any other hard parts of the BUMPER, see Rule <R07-L>).

Please note that the fastening/restraining system *must* be designed with robust performance in mind. The restraints must hold the cover in place during vigorous interactions with other ROBOTS and FIELD elements during the MATCH without allowing the cover to come off.

<R09> Teams shall display their team number on the BUMPERS in four locations at approximately 90° intervals around the perimeter of the ROBOT. The numerals must be at least 4" high, at least in $\frac{3}{4}$ " 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, so that judges, referees, and announcers can easily identify competing ROBOTS.

4.3.3 General Robot Design

<R10> Each registered FRC team can enter ONE (1) ROBOT into the 2011 FRC. That ROBOT shall fully comply with all rules specified in the **2011 FRC Game Manual**.

<R11> During the MATCH, the ROBOT may not exceed the volume constraints of either STARTING or PLAYING CONFIGURATIONS (note: these limits are defined in reference to the ROBOT, not the FIELD).

	Maximum Horizontal Dimensions	Maximum Height	Maximum Weight
STARTING CONFIGURATION	28" x 38" (71.12cm x 96.52cm) rectangular space	60" (152.40cm)	120 pounds (54.43Kg)
PLAYING CONFIGURATION	84" (213.4cm) diameter vertical right cylindrical volume	N/A	

When determining weight, the basic ROBOT structure and all elements of all additional mechanisms that might be used in different configurations of the ROBOT shall be weighed together. Included in the weight limit are the robot control system, decorations, and all other attached parts.

Example: A team has decided to design their ROBOT such that, before any given MATCH, they may change the configuration of the ROBOT based on perceived strengths or weaknesses of an opponent. The team accomplished this by constructing a basic drive train platform plus two versions of a GAME PIECE manipulator, each manipulator being a quick attach/detach device such that either one or the other (but not both) may be part of the ROBOT at the beginning of a MATCH. Their ROBOT platform weighs 107 lb, version A of the manipulator weighs 6 lb, and version B weighs 8 lb. Although only one version will be on the ROBOT during a MATCH, both manipulators (and all components of the manipulators that would be used during the MATCH) must be on the 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.

For the purposes of determining compliance with the weight and volume limitations, the items listed below are NOT considered part of the ROBOT and are NOT included in the weight and volume assessment:

- A. the 12V battery and its associated half of the Anderson cable quick connect/disconnect pair (including no more than 12" of cable per leg, the associated cable lugs, connecting bolts, and insulating electrical tape),
- B. BUMPER assemblies (including BUMPER covers, if appropriate) that are in compliance with Rules <R07> and <R08>,
- C. the OPERATOR CONSOLE, and
- D. the MINIBOT.

Note that the total weight of the ROBOT, MINIBOT, BUMPERS, and battery may approach 165 pounds. Please think carefully about lifting the weight safely. Teams are encouraged to use their forth TEAM member (typically in charge of the ROBOT cart) to carry the MINIBOT on to the FIELD separately. Teams are also encouraged to think about handles or lifting bars to aid in lifting and carrying the ROBOT.

<R12> The FRAME PERIMETER must be comprised of fixed, non-articulated structural elements of the ROBOT.

<R13> ROBOTS shall display their school name (or the name of the supporting youth organization, if appropriate), and primary sponsor name and/or logo whenever the ROBOT is competing.

The support provided by the corporate sponsors and mentors on your team is important, and is to be acknowledged with the appropriate display of their names/logos on the exterior of the ROBOT.

<R14> When a ROBOT is in its STARTING CONFIGURATION, no part of the ROBOT shall extend outside the vertical projection of the FRAME PERIMETER (with the exception of minor protrusions such as bolt heads, fastener ends, rivets, etc).

This means no “mushroom-bots.” If a ROBOT is designed as intended and in its STARTING CONFIGURATION, you should be able to push the ROBOT (with BUMPERS removed) up against a vertical wall, and the FRAME PERIMETER will be the only point of contact with the wall.

<R15> Any non-functional decorations included on the ROBOT must not affect the outcome of the MATCH, and must be in the spirit of Gracious Professionalism.

<R16> When positioned on the ROBOT, the primary battery must be secured so that it will not dislodge should the ROBOT be turned over or placed in any arbitrary orientation.

LOGO MOTION™ is a very vigorous game, with potential for changes in ROBOT orientation and significant interaction among ROBOTS. There is a high probability that your ROBOT will be overturned at some point. Should that happen, your design must prevent the battery from falling out and damaging itself, your ROBOT, or other ROBOTS.

<R17> Field power to the ROBOTS will **not** be re-enabled after a MATCH. ROBOTS must be designed to permit removal of GAME PIECES from the ROBOT, and removal of the ROBOT from other FIELD elements and/or other ROBOTS without requiring activation of the ROBOT power system.

4.3.4 Budget Constraints

<R18> All items and materials used in the construction of a HOSTBOT and their associated costs, shall be recorded (in US dollars) in a consolidated Bill Of Materials (BOM). KoP items must be recorded, but are accounted as an additional cost to of \$0.00 as this material is either donated or purchased by FIRST and supplied to each team. The BOM must use the FIRST-approved template available for download at www.usfirst.org/frc/competitionmanual. Please refer to Rule <R82> in **Section 4.3.13 - Robot Inspection** for information regarding submission of the BOM.

<R19> The total cost of all non-KOP items shall not exceed \$3,500.00 USD.

- A. All costs are to be determined as explained in **Section 3.4.5, Cost Determination of Additional Parts**.
- B. No individual 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.

<R20> The following items are *excluded* from the total cost calculation:

- A. all items provided in the 2011 KOP,
- B. the cost of any non-functional decorations,
- C. the cost of individual fasteners, adhesives, or lubricants, unless any one component exceeds \$1.00,

- D. the costs of SPARE PARTS. A SPARE PART used as a direct replacement for a failed or defective ROBOT part (either KOP item or non-KOP item) that has already been included in the cost accounting is covered by the accounting for the original part, and
- E. all costs for the construction of the OPERATOR CONSOLE.
- F. All costs for the MINIBOT.

<R21> Individual COMPONENTS or MECHANISMS retrieved from previous ROBOTS and used on 2011 ROBOTS must have their undepreciated cost included in the 2011 ROBOT cost accounting and applied to the overall cost limits.

4.3.5 Cost Determination of Additional Parts

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

- A. The purchase price of a COTS item offered for sale by a VENDOR to any customer.
- B. 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.

- C. The fair market value of an item obtained at a discount or as a donation. Fair market value is that price at which the supplier would normally offer the item 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 National Instruments and Texas Instruments are being offered to all FIRST teams. The discounted purchase price of items from these sources would be used in the additional parts accounting calculations.

- D. 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.

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 \$10.00 and has it machined by a local machine shop that is a recognized sponsor of the team. If the machinists are considered members of the team, their labor costs do not apply. The total applicable cost for the part would be \$10.00.

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.

- E. 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 a source that sells aluminum sheet in 1' x 1' pieces. The team may cost 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.

- F. Shipping costs are not counted.

- G. If the item is part of a modular system that can be assembled in several possible configurations or applications, then each individual module must fit within the price constraints defined in Rule <R19>. If the modules are designed to assemble into a single configuration, and the assembly is functional in only that configuration, then the total cost of the complete assembly including all modules must fit within the price constraints defined in Rule <R19>.

4.3.6 Fabrication Schedule

FIRST recognizes that it is the responsibility of each team to design and construct their ROBOT within the schedule constraints defined below. As compliance with these rules takes place outside of the competition venues, *FIRST* is not able to directly monitor compliance. One of the fundamental values of *FIRST* is the concept of "gracious professionalism." We are relying upon the honor, integrity, and professional behavior of each team to recognize and abide by the fabrication schedule rules.

Note that schedule rules apply to both hardware and software development. Hardware and software design processes are thought-intensive activities, and team members are likely to continue to consider and analyze their designs long after the ROBOT is "completed." Teams cannot be prevented from thinking about their hardware and software designs, and it is not our intention to do so. However, the timeline permitted for the development of the actual competition version of the ROBOT is intentionally restricted. Pondering software issues to be resolved, researching general case solutions, discussing solutions with teammates, collecting raw materials, sketching mechanisms, preparing tools, and outlining high-level descriptions of software algorithms are all reasonable activities before the scheduled build period. However, completing detailed dimensioned drawings of specific parts, and any actual fabrication of any hardware items intended to go on the actual competition ROBOT is prohibited outside of the approved fabrication periods. On the software side, writing actual lines of code, verification of syntax, final debugging, etc would all be considered development of the final software implementation, and must be completed during the approved fabrication periods.

<R22> No final design, fabrication, or assembly of any elements intended for the final ROBOT is permitted prior to the Kick-off presentation.

Please note that this means that FABRICATED ITEMS from ROBOTS entered in previous *FIRST* competitions may not be used on ROBOTS in the 2011 FRC.

Before the formal start of the Robot Build Season, teams are encouraged to think as much as they please about their ROBOTS. They may develop prototypes, create proof-of-concept models, and conduct design exercises. Teams may gather all the raw stock materials and COTS COMPONENTS they want.

Example: A TEAM designs and builds a two-speed shifting transmission during the fall as a training exercise. When designing their competition ROBOT, they utilize all the design principles they learned. To optimize the transmission design for their ROBOT, they improve the transmission gear ratios and reduce the size, and build two new transmissions, and place them on the ROBOT. All parts of this process are permitted activities.

Example: The same TEAM realizes that the transmission designed and built in the fall perfectly fits their need for a transmission to drive the ROBOT arm. They build an exact copy of the transmission from the original design plans, and bolt it to the ROBOT. This would be prohibited, as the transmission – although fabricated during the competition season – was built from detailed designs developed prior to kick-off.

Example: A TEAM developed an omni-directional drive system for the 2010 competition. Over the summer of 2010 they refined and improved the control software (written in C) to add more precision and capabilities. They decided to use a similar system for the 2011 competition. They copied large sections of unmodified code over into the control software of the new ROBOT (also written in C). This would be a violation of the schedule constraint, and would not be allowed.

Example: The same TEAM decides to use the LabView as their software environment for 2011. Following kickoff, they use the previously-developed C code as a reference for the algorithms and calculations required to implement their omni-directional control solution. Because they developed new LabView code as they ported over their algorithms, this would be permitted.

Example: A different team develops a similar solution during the fall, and plans to use the developed software on their competition ROBOT. After completing the software, they post it in a generally accessible public forum and make the code available to all teams. Because they have made their software generally available (per the Blue Box in the definition of COTS, it is considered COTS software and they can use it on their ROBOT.

<R23> During the BUILD SEASON, teams are to design and fabricate all the COMPONENTS and MECHANISMS required to complete their ROBOT. When the ROBOT shipment deadline arrives, 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 or bagged (as appropriate for your event), and out of team hands by the shipment deadline specified in the ***FRC Administrative Manual, Section 5*** (with the exception of the items covered by the WITHHOLDING ALLOWANCE).

Teams are encouraged to use all the materials, sources and resources available to them that are in compliance with the rules of the 2011 FRC during the BUILD SEASON. There is no limit to the amount of time that may be put into this effort during the BUILD SEASON, other than via the realities of the calendar.

<R24> During the period between ship date and the competitions, all teams may manufacture SPARE, REPLACEMENT, and UPGRADE PARTS, and develop software for their ROBOT at their home facility.

Teams may continue development of any items retained under the WITHHOLDING ALLOWANCE during this period, and then bring them to the competition events.

The primary intent of this rule is to allow teams to withhold the ROBOT control system, the OPERATOR CONSOLE, and selected relevant subsystems and access them after the shipping deadline. This will allow teams to have the maximum time possible prior to each competition event to develop and complete the software for their ROBOT while maximizing the potential capabilities provided by the control system.

<R25> While at competitions, teams may repair, modify or upgrade their competition ROBOT. To support this, teams may bring SPARE, REPLACEMENT and UPGRADE PARTS and COTS items to the competitions (within the limits specified in Rule <R33>). Work can 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 the first day of the competition event and ending at 4:00PM on last day of the event. All work must be stopped when the pit area closes each evening. Parts shall not be removed from the competition site and retained overnight after the pit area closes. At the conclusion of a regional competition event, the entire ROBOT (including all FABRICATED ITEMS intended for use during the competition in alternative configurations of the ROBOT) must be bagged or crated and out of team hands for shipping to the next event or back to the team.

Exception: A limited amount of FABRICATED ITEMS (not to exceed the limits specified in Rule <R33>) may be retained as part of the WITHHOLDING ALLOWANCE and brought back to the team's home facility for continued development.

<R26> During the periods between events, all teams (not just those teams attending a Regional Competition) may utilize the same opportunities, and must operate under the same restrictions as specified in Rule <R24>.

4.3.7 Material Utilization

<R27> Robots entered into the 2011 FRC shall be fabricated and/or assembled from COMPONENTS, MECHANISMS and COTS items that are constructed from:

- A. Items provided in the KOP (or their exact REPLACEMENT PART)
- B. Additional parts and materials as permitted in these Rules, in quantities consistent with the Budget Constraint rules (found in **Section 3.4.4**). The use of non-KOP items or materials shall not violate any other robot design or fabrication rule.

<R28> COTS items that are generally available may be used on the ROBOT. The parts shall 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-KOP materials for use by that team does not have to be available to others; however, the materials from which it is made must be available to other teams.

<R29> COTS items from ROBOTS entered in previous *FIRST* competitions or COTS items that are no longer commercially available may be used under the following conditions:

- A. The item must be functionally equivalent to the original condition as delivered from the VENDOR (e.g. a part that has non-functional label markings added would be permitted, but a part that has device-specific mounting holes added would be prohibited), and
- B. The item must satisfy ALL applicable 2011 FRC materials/parts use rules.

<R30> Parts custom-made for *FIRST* and provided to FRC teams in the KOP for previous FRC competitions (e.g. 2006 FRC transmissions, custom-made motor couplers, custom sensor strips, FRC CMUcam II modules, etc.) may be used if the part is still functionally equivalent to the original condition.

<R31> Lubricants may be used only to reduce friction within the ROBOT. Lubricants shall not be allowed to contaminate the FIELD or other ROBOTS.

<R32> 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.

<R33> Teams may bring a maximum of 30 pounds of custom FABRICATED ITEMS (SPARE PARTS, REPLACEMENT PARTS, and UPGRADE PARTS, plus all WITHHOLDING ALLOWANCE items) 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 shall arrive at the competition venue packed in the shipping crate or lockout bag with the ROBOT.

There are three exceptions to this rule:

- A. the OPERATOR CONSOLE is not included in the incoming parts weight restriction,
- B. the MINIBOT is not included in the incoming parts weights restriction, and
- C. any competition legal12V batteries and their associated half of the Anderson cable quick connect/disconnect pair (including no more than 12" of cable per leg, the associated cable lugs, connecting bolts, and insulating electrical tape) are not included in the incoming parts weight restriction.

4.3.8 Power Distribution

<R34> The only legal source of electrical energy for the ROBOT/HOSTBOT during the competition is one MK ES17-12 12VDC non-spillable lead acid battery, OR one EnerSys NP 18-12 battery, as provided in the 2011 KOP. Batteries integral to and part of a COTS computing device are also permitted (i.e. laptop batteries), provided they're only used to power the COTS computing device.

Teams may use other equivalent 12V batteries during development, testing and practice MATCHES.

<R35> Items specifically *prohibited* from use on the ROBOT include:

- A. any battery other than, or in addition to, the one primary battery permitted by Rule <R34> the MINIBOT battery, or a battery contained in a COTS computing device,
- B. circuit breakers used on the PD (PD) Board that are different from the Snap Action breakers provided in the KOP,
- C. PD panels and/or fuse panels different other than the single PD Board provided in the 2009, 2010, or 2011 KOP, and
- D. non-copper wiring.

<R36> All wiring and electrical devices, including all control system components, shall be electrically isolated from the ROBOT frame. The ROBOT frame must not be used to carry electrical current (e.g. this is necessary due to polarity reversals that occur under certain operating conditions such as during motor direction reversals).

The chassis for the cRIO-FRC and the supplied KOP camera have grounded enclosures. Under this rule (and for their protection), it is required that they be electrically isolated from the ROBOT frame when installed on the ROBOT.

<R37> The 12V battery, the main 120-amp circuit breaker, and the PD Board shall be connected as shown in Figure 3-4. In particular:

- A. The battery must be connected to the ROBOT power system through the use of the Anderson Power Products (APP) connector.
- B. The APP connector must be attached to the battery with either the copper lugs provided in the KOP or appropriately-rated and -sized lug connectors.
- C. The battery terminals and the connecting lugs must be insulated with shrink tubing and/or electrical tape.
- D. The main 120-amp circuit breaker must be directly connected to the hot (+) leg of the ROBOT-side APP connector. Only one 120-amp main circuit breaker is allowed. This breaker must not be bypassed.
- E. The PD Board must be directly connected to the APP connector and main 120-amp circuit breaker. No other loads may be connected to the main 120-amp circuit breaker.
- F. Each primary power connection between the battery and PD Board must be made with #6 AWG (4.11mm) red and black wire or larger.
- G. The 120-amp circuit breaker must be quickly accessible from the exterior of the ROBOT.

It is recommended that the 120-amp circuit breaker location be clearly and obviously labeled to permit it to be easily found by field personnel during a MATCH.

- H. The PD Board and all circuit breakers must be easily visible for inspection.

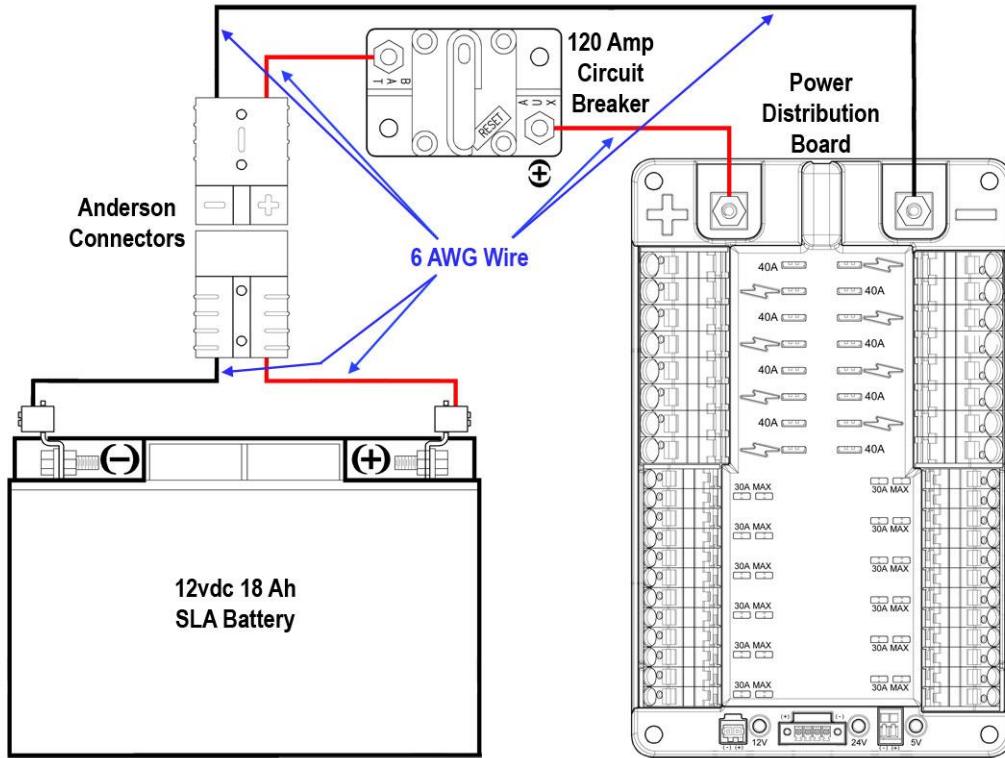


Figure 4-4

<R38> All electric power utilized by the ROBOT shall be distributed from the load terminals of the PD Board. Circuits may not bypass the PD Board to connect directly to the 120-amp loop.

- A. The cRIO-FRC power input must be connected to the 24 Vdc supply terminals on the PD Board. With the exception of one Solenoid Breakout Board, no other electrical load can be connected to these terminals.
- B. The radio power feed must be connected via the 5V converter (model # TBJ12DK025Z) to the marked 12 Vdc supply terminals located at the end of the PD Board (i.e. the terminals located between the indicator LEDs, and not the main WAGO connectors along the sides of the PD Board). No other electrical load can be connected to these terminals (please see the *2011 Robot Power Distribution Diagram* posted online at www.usfirst.org/frc/kitofparts for wiring information).
- C. All other branch circuits must connect to, and have power sourced solely by, a protected 12 Vdc WAGO connector pair on the PD Board.
- D. Only one wire shall be connected to each WAGO connector on the PD Board. If multi-point distribution of circuit power is required (e.g. to provide power to the three KOP breakout boards via one 20-amp circuit), then all incoming wires must be appropriately spliced into the main lead, and only one lead inserted into the WAGO connector to connect the circuit.

Sensors and custom circuits may be connected to the 5 Vdc sources on the Analog Breakout boards or the Digital Sidecars. By being logically downstream from the PD Board, they are protected by the 20-amp breaker at the circuit root.

Servos may be connected to the 6 Vdc sources on the Digital Sidecars (via the designated PWM connections, and with a “6Vdc enable” jumper in place for the corresponding port). By being logically downstream from the PD Board, they are protected by the 20-amp breaker at the circuit root. No other electrical load can be connected to these sources.

- <R39>** All active PD Board branch circuits shall be protected from overload with an appropriate value auto resetting Snap Action circuit breaker (from the KOP or identical equivalent).
- A. Each speed controller branch circuit must be protected by one and only one 20-amp, 30-amp, or 40-amp circuit breaker on the PD Board. No other electrical load can be connected to the breaker supplying this circuit.
 - B. Each relay module branch circuit must be protected with one and only one 20-amp circuit breaker on the PD Board. No other electrical load can be connected to the breaker supplying this circuit.
 - C. Each Digital Sidecar branch circuit must be protected with one and only one 20-amp circuit breaker on the PD Board. No other electrical load can be connected to the breaker supplying this circuit.
 - D. If the compressor is used, the relay module branch circuit supplying the compressor must be protected with a 20-amp circuit breaker. No other electrical load can be connected to the breaker supplying this circuit.
 - E. A single branch supply circuit may be spliced to supply power to one, two or three of the Analog/Solenoid Breakout Boards. This circuit must be protected with one and only one 20-amp circuit breaker on the PD Board. No other electrical load can be connected to the breaker supplying this circuit.
 - F. Custom circuits and sensors powered via the cRIO-FRC or the Digital Sidecar are protected by the breaker on the circuit(s) supplying those devices. Power feeds to all other custom circuits must be protected with a dedicated 20-amp circuit breaker on the PD Board.

In addition to the required branch power circuit breakers, smaller value fuses or breakers may be incorporated into custom circuits for additional protection.

<R40> All active PD Board branch circuits shall be wired with appropriately sized wire:

Application	Minimum wire size
40A circuit	12 AWG (2.052mm)
30A circuit	14 AWG (1.628mm)
20A circuit	18 AWG (1.024mm)
between the PD Board and the Analog and/or Solenoid Breakouts if a common power feed is used	18 AWG (1.024mm)
between the PD Board and the Analog and/or Solenoid Breakouts if individual power feeds are used	20 AWG (0.8128mm)
between the PD Board and the cRIO-FRC	20 AWG (0.8128mm)
between the PD Board and the radio	20 AWG (0.8128mm)
pneumatic valves	24 AWG (0.5106mm)

The branch circuit may include intermediate elements such as COTS connectors, splices, COTS flexible/rolling/sliding contacts, and COTS slip rings, as long as the entire electrical pathway is via appropriately gauged conductors.

<R41> All active PD Board branch circuit wiring with a constant polarity (i.e., except for relay module, speed controller, or sensor outputs) shall be color-coded as follows:

- A. Use red, white, brown, or black with stripe wire for +24 Vdc, +12 Vdc and +5 Vdc connections.
- B. Use black or blue wire for common (-) connections.

<R42> Each power-regulating device (speed controller or relay module) shall control one and only one electrical load (motor, actuator or compressor).

Exception: Multiple low-load, pneumatic solenoid valves may be connected to a single relay module. This would allow one relay module to drive multiple pneumatic actions. No other electrical load can be connected to a relay module used in this manner.

<R43> Custom circuits shall NOT directly alter the power pathways between the battery, PD Board, speed controllers, relays, motors, or other elements of the robot control system (including the power pathways to other sensors or circuits). 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.

<R44> Decorations may draw power from the 12 Vdc electrical system as long as they are powered via a dedicated 20 amp circuit breaker on the PD Board, and do not affect the operation of other control system components.

4.3.9 Motors & Actuators

<R45> Motors specifically permitted on 2011 FRC ROBOTS include:

- A. all motors, actuators, and servos listed in the **2011 KOP Checklist**,
- B. an unlimited number of COTS servos with a maximum power rating of 4W ,

The burden of proof that the servo meets the criteria is on the team. The team must show the appropriate data sheet to the inspector.

- C. one or two additional 2½" CIM motors (part #FR801-001, M4-R0062-12, AM802-001A, or PMR25R-45F-1003) in addition to those provided in the KOP. This means that up to four, and no more, 2½" CIM motors can be used on the ROBOT,
- D. up to four, in any combination, of the BaneBots motors provided in the KOP (acceptable part numbers are M7-RS775-12, M7-RS775-18, M5-RS550-12, M5-RS550-12-B, M5-RS540-12, and M3-RS395-12),

Example combinations include, but are not limited to,

- four RS-775s,
- one of each motor
- two RS-775s and two RS-550s,
- three RS-540s and one RS-395.

- E. identical one-to-one SPARE PARTS for motors, actuators, and servos provided in the 2011 KOP that may have failed or become damaged,
- F. drive motors or fans that are part of a speed controller or COTS computing device.

<R46> Items specifically PROHIBITED from use on the ROBOT include:

- A. Electric motors and/or servos different from, or in addition to, those listed in the **2011 KOP Checklist**, with the exception of those specifically permitted by Rule <R45>.
Electric solenoid actuators (note: electric solenoid actuators are NOT the same as pneumatic solenoid valves – the latter are permitted, the former are not).

<R47> Motors and servos used on the ROBOT shall not be modified in any way, except as follows:

- A. The mounting brackets and/or output shaft/interface of the motors may be modified to facilitate the physical connection of the motor to the ROBOT and actuated part.
- B. The electrical input leads on the motors may be trimmed to length as necessary.
- C. The locking pins on the window motors may be removed.
- D. The connector housings on the Window motors (PN 262100-3030 and 262100-3040) may be modified to facilitate lead connections.

The intent of this rule is to maintain the maximum power level for each ROBOT, yet still allow teams to modify mounting tabs and the like, not to gain a weight reduction by potentially compromising the structural integrity of any motor. The integral mechanical and electrical system of the motor is not to be modified.

<R48> All electrical loads (motors, actuators, compressors) must be supplied by an approved power regulating device (speed controller, relay module, or Digital Sidecar PWM port) that is controlled by the cRIO-FRC on the ROBOT.

- A. Each CIM motor and Fisher-Price motor must be connected to one and only one approved speed controller. These motors must not be connected to relay modules.
- B. Servos must be directly connected to the PWM ports on the Digital Sidecar. They must not be connected to speed controllers or relay modules.

- C. If used, the compressor must be connected to one and only one approved relay module.
- D. Each other electrical load (motor or actuator) must be supplied by one and only one approved speed controller, or one and only one relay module.

Power regulating devices are “approved” if they are listed in the **2011 Kit of Parts Checklist** or have been approved by FIRST. To seek approval for a different device, please contact frcparts@usfirst.org with the component specifications. Any approved devices beyond those on the **2011 Kit of Parts Checklist** will be published at www.usfirst.org/frc/kitofparts.

4.3.10 Control, Command & Signals System

The FRC robot control system has been designed to provide advanced capabilities for the ROBOTS. The system has been designed around an open architecture that will allow teams to easily develop custom software to control the ROBOT and add electronics and custom circuits to expand the functionality of the ROBOT. Custom circuits may be used to indirectly affect the robot outputs by providing enhanced sensor feedback to the cRIO-FRC to allow it to more effectively control the ROBOT.

Note that with increased capability comes increased responsibility. Teams are ultimately responsible for any software bugs introduced into the standard robot control software, or undesirable effects from added custom circuits. So, teams will have to exercise care to prevent these conditions. To assist with this, teams are encouraged to investigate, learn and practice industry-standard software Validation and Verification (V&V) techniques and develop thorough hardware testing plans.

The control system hardware is provided to rookie teams in the 2011 KOP. Veteran teams are required to reuse control system hardware provided in earlier KOP, or purchase exact SPARE PART equivalents for use on their 2011 FRC ROBOTS.

<R49> ROBOTS must be controlled via the programmable National Instruments cRIO-FRC (National Instruments part number 780406-01). Other controllers shall not be used.

As long as the CAN bus is wired legally so that the heartbeat from the cRIO is maintained, all closed loop control features of the Jaguar motor controller may be used. (That is, commands originating from the cRIO to configure, enable, and specify an operating point for all Jaguar closed loop modes fit the intent of <R49>.)

<R50> Connections to the cRIO-FRC Ethernet ports must be compliant with the following parameters:

- A. The DAP-1522 radio is connected to the cRIO-FRC Ethernet port 1 (either directly or via a CAT5 Ethernet pigtail).
- B. Ethernet-connected COTS devices or custom circuits may connect to either cRIO-FRC Ethernet port; however, these devices may not transmit or receive UDP packets using ports 1100-1200 except for ports 1130 and 1140.

<R51> The cRIO-FRC , Driver Station software, and radio must be configured to correspond to the correct team number (assigned to the team by FIRST). The procedures for configuring these devices are contained in the FRC control system documentation.

<R52> One D-Link DAP-1522 is the only permitted mechanism for communicating to and from the ROBOT during the MATCH. All signals must originate from the OPERATOR CONSOLE and/or the Field Management System, and be transmitted to the ROBOT via the official ARENA hardware. No other form of wireless communications shall be used to communicate to, from or within the ROBOT (e.g. radio modems from previous FIRST competitions and Bluetooth devices are not permitted on the ROBOT during competition).

<R53> The DAP-1522 radio must be mounted on the ROBOT such that the diagnostic lights are visible to FIELD personnel.

Teams are encouraged to mount the radio away from noise generating components such as the CIM motors. By making the diagnostic lights visible, FIELD personnel are in a better position to assist teams.

<R54> ROBOTS shall use the diagnostic Robot Signal Light (RSL) provided in the KOP. It must be mounted on the ROBOT such that it is easily visible while standing three feet in front of the ROBOT in the NORMAL CONFIGURATION. The team has no direct control over the RSL and no programming is required.

A. The RSL must be connected to the “RSL” supply terminals on a Digital Sidecar

See the **2011 Robot Data Diagram** on the KOP website (www.usfirst.org/frc/kitofparts) and the item bulletin online at <http://literature.rockwellautomation.com/idc/groups/literature/documents/in/41063-177-01.pdf> for connection details.

- B. The Digital Sidecar must be connected to a NI 9403 module in Slot 4 of the cRIO-FRC.
C. The RSL must be wired for “solid light” operation, by placing a jumper between the La and Lb terminals on the light per Figure 3-5.

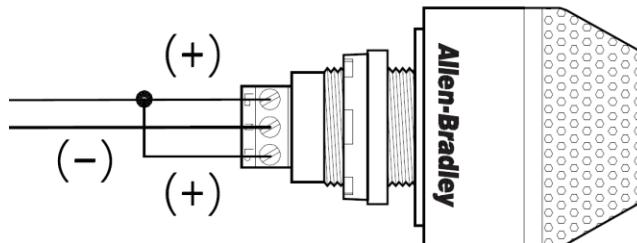


Figure 4-5

<R55> The control system is designed to allow wireless control of the ROBOTS. The Driver Station software, FirstTouch I/O module, cRIO-FRC, speed controllers, relay modules, radio, and batteries shall not be tampered with, modified, or adjusted in any way (tampering includes drilling, cutting, machining, gluing, rewiring, disassembling, etc.), with the following exceptions:

- A. User programmable code in the cRIO-FRC may be customized.
B. Dip switches on the cRIO-FRC may be set.
C. Speed controllers may be calibrated as described in owner's manuals.
D. The supplied fans attached to speed controllers may be powered from the power input terminals.

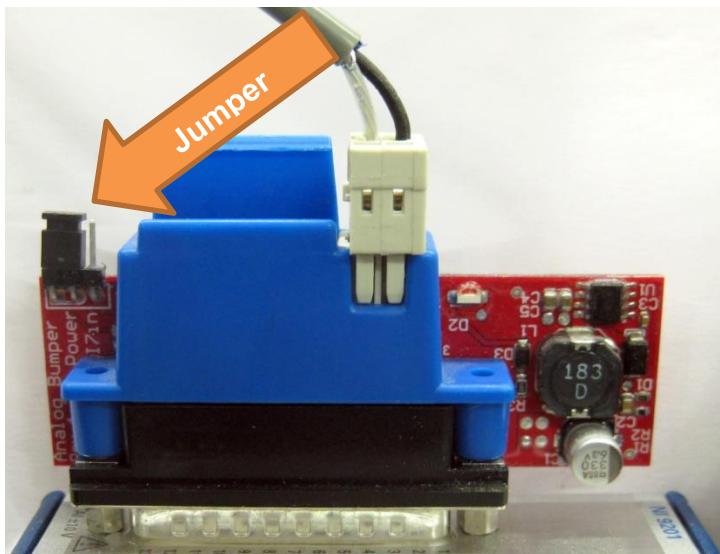
- E. A fuse on a relay feeding the compressor may be replaced with a 20 Amp Snap-Action circuit breaker.
- F. Wires, cables, and signal lines may be connected via the standard connection points provided on the devices.
- G. Fasteners may be used to attach the device to the OPERATOR CONSOLE or ROBOT.
- H. Labeling may be applied to indicate device purpose, connectivity, functional performance, etc.
- I. Brake/Coast jumpers on speed controllers may be changed from their default location.
- J. If CAN-bus functionality is used, limit switch jumpers may be removed from a Jaguar speed controller and a custom limit switch circuit may be substituted (so that the cRIO-FRC may read the status of the limit switches).
- K. If CAN-bus functionality is used, the Jaguar firmware may (must) be updated as required by *FIRST* (see Rule <R58-D>).
- L. The First Touch I/O module's firmware may be modified.

Please note that the Driver Station application is a separate application from the Dashboard. The Driver Stations software may not be modified, while teams are expected to customize their Dashboard code.

Note that if you are using the FirstTouch I/O module as part of the OPERATOR CONSOLE, you should not update the firmware if the manufacturer releases a new version. The new version will wipe out the *FIRST* custom firmware and your FirstTouch I/O module will no longer function with the Driver Station software.

- <R56> Relay module outputs, speed controller outputs, or PWM outputs must not be connected to the analog/solenoid breakout boards or the Digital Sidecar. 12Vdc power must not be connected to any terminal on the analog/solenoid breakout boards or the Digital Sidecar except the designated 12Vdc input terminals. (Doing so may damage or destroy components of the control system.)
- <R57> Every relay module, servo, and PWM speed controller shall be connected via PWM cable to the Digital Sidecar and be controlled by signals provided from the cRIO-FRC via the Digital Sidecar. They shall not be controlled by signals from any other source.
- <R58> Each Jaguar must be controlled with signal inputs sourced from the cRIO-FRC and passed via either a connected PWM cable or a CAN-bus connection.
 - A. The Jaguar must receive signals via either a PWM cable -OR- a CAN-bus connection. Both may not be used simultaneously.
 - B. PWM configuration: If the Jaguar speed controller is controlled via PWM communications, the PWM port on the Jaguar speed controller must be connected directly to a PWM port on the Digital Sidecar with a PWM cable. No other devices may be connected to these PWM ports. No other devices may be connected to any other ports on the Jaguar speed controller with the exception of connection to the coast/brake port.
 - C. CAN-bus configuration: If the Jaguar speed controller is controlled via CAN-bus communications, then each Jaguar speed controller must be connected to either the cRIO-FRC or another CAN-bus device with a CAN-bus cable.
 - D. If the CAN-bus configuration is used, the firmware on all Jaguar speed controllers must be updated to at least Version 92 of the official *FIRST* firmware.

- <R59>** If CAN-bus communications are used, the CAN-bus must be connected to the cRIO-FRC through either the Ethernet network connected to Port 1, Port 2, or the DB-9 RS-232 port connection.
- Ethernet-to-CAN bridges or RS-232-to-CAN bridges (including the “black” Jaguars, MDL-BDC24) may be used to connect the CAN-bus to the cRIO-FRC.
 - Additional switches, sensor modules, custom circuits, third-party modules, etc. may also be placed on the CAN-bus.
 - No device that interferes with, alters, or blocks communications between the cRIO-FRC and the Jaguars will be permitted (tunneling packets for the purposes of passing them through an Ethernet-to-CAN bridge is acceptable as the commands are not altered).
- <R60>** Solenoid Breakout outputs shall be connected to pneumatic valve solenoids or photoelectric sensors, PN 42EF-D1MNAK-A2, only. No other devices shall be connected to these outputs.
- <R61>** A National Instruments 9201 module must be installed in slot 1 of the cRIO-FRC . An analog breakout must be connected to this module. A jumper must be installed in the “Power” position (two outer pins) on the analog breakout. The analog breakout must be powered from the PD Panel. (Please refer to the 2011 FRC Control System Manual for details on these connections.)



These connections enable monitoring of the battery charge by the team and the Field Management System. This is a required element of the ROBOT configuration.

- <R62>** All outputs from sensors, custom circuits and additional electronics shall connect to only the following:
- other custom circuits, or
 - additional COTS electronics, or
 - input ports on the Digital Sidecar, or
 - input ports on the Analog Breakout, or
 - the RS-232 DB-9 RS-232 port on the cRIO-FRC, or
 - the Ethernet network connected to either Port 1 or Port 2 of the cRIO-FRC, or
 - the CAN-bus if and only if all Jaguar speed controllers on the CAN-bus are wired in full compliance with Rule <R58> and Rule <R59>, or

H. the sensor inputs on the Jaguar speed controller.

Custom circuits and additional electronics are allowed to utilize the Port 2 Ethernet bus and/or the CAN-bus to communicate between devices. Note however, that the ROBOT must be controlled by the cRIO-FRC (see Rule <R49>). Thus, any additional devices on the Ethernet or CAN-bus must not provide command signals that do not originate from the cRIO-FRC. It is our intent to incrementally open access to the full control system technologies in a controlled manner that reduces the risk of “unanticipated surprises” as we gain experience with the system.

<R63> A signal filter may be wired across motor leads or PWM leads. For the purposes of inspection and rules compliance, such filters will not be considered custom circuits, and will not be considered a violation of Rule <R47> or Rule <R62>. Acceptable signal filters are:

- A one microfarad (1 μ F) or less **non-polarized** capacitor may be applied across the power leads of any motor on your ROBOT (as close to the actual motor leads as reasonably possible)
- A resistor may be used as a shunt resistor for the PWM control signal feeding a servo

<R64> Any decorations that involve broadcasting a signal to/from the ROBOT, such as remote cameras, must be cleared with FIRST Engineering (via e-mail to frcteams@usfirst.org) prior to the event and tested for communications interference at the venue. Such devices, if reviewed and approved, are excluded from Rule <R52>.

4.3.11 Pneumatic System

<R65> To satisfy multiple constraints associated with safety, consistency, robot inspection, and constructive innovation, no pneumatic parts other than those explicitly permitted by the Pneumatic System Rules may be used on the ROBOT.

<R66> In addition to the items included in the KOP, pneumatic system items specifically permitted on 2011 FRC ROBOTS include the following items. All included items must be “off the shelf” COTS pneumatic devices rated by their manufacturers for working pressure of at least 125psi and burst pressure of 250psi, and used in their original, unaltered condition (except as required for assembly with other components).

- A. Pneumatic pressure vent plug valves functionally equivalent to those provided in the KOP,

Parker valves PV609-2 or MV709-2 are recommended.

- B. Solenoid valves with a maximum $\frac{1}{8}$ " NPT port diameter, and a maximum Cv of 0.32 (if non-KOP valves are used, the team will be required to provide part documentation validating that the valves meet these constraints).
- C. Solenoid valves that are rated for a maximum working pressure that is less than 125psi rating mandated above are permitted, however if employed, an additional pressure relief valve must be added to the low pressure side of the main regulator. The additional relief valve must be set to a lower pressure than the maximum pressure rating for the solenoid valve.
- D. Additional 0.160" inside diameter pneumatic tubing functionally equivalent to that provided in the KOP, with the pressure rating clearly factory-printed on the exterior of the tubing,

- E. Pressure transducers, pressure gauges, and connecting fittings,
- F. Pressure regulators with a maximum bypass pressure of no more than 60psi,
- G. For the purposes of the FRC, a device that creates a vacuum is not considered to be a pneumatic device and are not subject to the pneumatic rules (although they must still satisfy all other appropriate rules). These include, but are not limited to, venturi-type vacuum generators and off-the-shelf vacuum devices (as long as they are powered by provided or permitted motors).
- H. For the purposes of the FRC, closed-loop COTS pneumatic (gas) shocks are not considered pneumatic devices, and are not subject to the pneumatic rules (although they must still satisfy all other appropriate rules).
- I. For the purposes of the FRC, air-filled (pneumatic) wheels are not considered pneumatic devices, and are not subject to the pneumatic rules (although they must still satisfy all other appropriate rules).
- J. Pneumatic cylinders.
- K. Pneumatic storage tanks.

<R67> Items specifically PROHIBITED from use on the ROBOT include:

- A. Any pneumatic part or component rated for less than 125psi (with the exception of those expressly permitted in Rule <R66>).
- B. Any pneumatic part or component that has been altered, modified, machined, coated, or changed from its original “out of the box” condition, except as required for normal assembly with other components. The only acceptable modifications are:
 - Tubing may be cut.
 - Wiring for pneumatic devices may be modified to interface with the control system.
 - Assembling and connecting pneumatic components using the pre-existing threads, mounting brackets, quick-connect fittings, etc.
 - Removing the mounting pin from a pneumatic cylinder, provided the cylinder itself is not modified.
 - Labeling applied to indicate device purpose, connectivity, functional performance, etc.

Do not, for example, file, machine, or abrasively remove any part of a pneumatic cylinder – this would cause the part to become a prohibited item. Consider pneumatic components sacred.

<R68> If pneumatic components are used on the ROBOT, the pneumatic system on the ROBOT must contain as a minimum the following components, connected in accordance with this section.

- A. Pressure gauges to display the “stored” and “working” air pressure (see Rule <R70>),
- B. A pressure relief valve, calibrated and set to release at 125psi (see Rule <R71>),
- C. A pressure switch, calibrated and connected to the ROBOT control system (see Rule <R72>),
- D. An easily visible and accessible pressure vent plug valve to manually relieve the stored pressure (see Rule <R73>).

<R69> Compressed air for the pneumatic system on the ROBOT must be provided by one and only one compressor. This compressor may be either the compressor from the KOP, or an equivalent compressor that does not exceed any of the KOP compressor performance specifications (specifically: nominal 12v, 1.03 cfm flow rate, 120psi maximum working pressure). Compressed air shall not come from any other source. Off-board compressors must be controlled and powered by the ROBOT.

If an alternative compressor is used, the team may be required to provide documentation to show compliance with the performance specifications.

The only difference between an on- and off-board compressor is that the off-board compressor is physically removed from the ROBOT. The intent of this rule is to permit teams to take advantage of the weight savings associated with keeping the compressor off-board. However, using the compressor off-board of the ROBOT does NOT permit non-compliance with any other applicable rules.

The compressor may be mounted on the ROBOT, or it may be left off the ROBOT and used to pre-charge compressed air in the storage tanks prior to bringing the ROBOT onto the FIELD.

<R70> “Working” air pressure on the ROBOT must be no greater than 60psi. All working air must be provided through one primary Norgren adjustable pressure regulator.

- A. All “working” pneumatic components (e.g. valves, cylinders, rotary actuators, etc.) must be downstream from this regulator.
- B. Only the compressor, relief valve, pressure switch, pressure vent plug valve, pressure gauge, storage tanks, tubing, and connecting fittings may be in the high-pressure pneumatic circuit upstream from the regulator.
- C. Pressure gauges must be placed in easily visible locations upstream and downstream of the regulator to display the “stored” and “working” pressures.
- D. If the compressor is not included on the ROBOT (under the provisions of Rule <R69>), the regulator and high-pressure gauge may be located on-board or off-board, provided all other pneumatic rules are satisfied. Note that if the regulator is kept off-board the ROBOT with the compressor, then only low-pressure (60psi or less) “working” air can be stored on the ROBOT.

<R71> The relief valve must be attached directly to the compressor.

If necessary, teams are required to adjust the relief valve to release air at 125psi. The valve may or may not have been calibrated prior to being supplied to teams.

<R72> The pressure switch must be connected to the high-pressure side of the pneumatic circuit (i.e. prior to the pressure regulator) to sense the “stored” pressure of the circuit. The two wires from the pressure switch must be connected directly to a digital input and ground port on the Digital Sidecar, and the cRIO-FRC must be programmed to sense the state of the switch and operate the relay module that powers the compressor to prevent over-pressuring the system.

<R73> The pressure vent plug valve must be connected to the pneumatic circuit such that, when manually operated, it will vent to the atmosphere to relieve all stored pressure. The valve must be placed on the ROBOT so that it is visible and easily accessible. If the compressor is not used on the ROBOT, then an additional vent valve must be obtained and connected to the high-pressure portion of the pneumatic circuit off board the ROBOT with the compressor (see Rule <R69>).

<R74> Each commanded motion of a pneumatic cylinder or rotary actuator must be accomplished via the flow of compressed air through only one approved pneumatic valve. Plumbing the outputs from multiple valves together into the same input on a pneumatic cylinder is prohibited.

4.3.12 Operator Console

<R75> The Driver Station software provided on the FRC website (www.usfirst.org/frc/kitofparts) is the only tool permitted to specify and communicate the operating mode (i.e. Auto/Teleop) and operating state (enable/disable) to the ROBOT. The Driver Station software must be revision 01.05.11.00 or newer.

Teams are permitted to use a portable computing device of their choice (laptop computer, PDAs, etc.) to host the Driver Station software while participating in competition MATCHES.

Please note that 19V DC, 2A power will be provided at the PLAYER STATION for Classmates provided in the 2010 and 2011 KOPs via Classmate power adapters. The manufacturer has confirmed that the power supply provided at the PLAYER STATION is compatible with both 2010 and 2011 Classmate versions. No 120VAC port will be available.

The FMS will verify that the Driver Station software is correct before it will permit a ROBOT to operate on the FIELD.

<R76> Devices hosting the Driver Station software may only interface with the Field Management System (FMS) via the Ethernet cable provided at the PLAYER STATION. The Ethernet port on the OPERATOR CONSOLE must be easily and quickly accessible. This will greatly facilitate installation and removal of the OPERATOR CONSOLE from the ARENA, and analysis by field personnel in case of problems during the competition

Teams are strongly encouraged to use pigtails on the Ethernet port used to connect to the FMS. Such pigtails will reduce wear and tear on the port and, with proper strain relief employed, will protect the port from accidental jerks.

<R77> The OPERATOR CONSOLE designed by the team must fit on the 60" wide by 12" deep shelf in the ALLIANCE STATION (excluding any items that are held or worn by the DRIVERS during the MATCH).

<R78> The OPERATOR CONSOLE must include a graphic display to present the Driver Station diagnostic information. It must be positioned within the OPERATOR CONSOLE so that the screen display can be clearly seen during inspection and during operation in a MATCH.

<R79> Other than the system provided by the ARENA, no other form of wireless communications shall be used to communicate to, from or within the OPERATOR CONSOLE.

Examples of prohibited wireless systems include, but are not limited to, active wireless network cards and Bluetooth devices.

<R80> The E-Stop button provided in the KOP shall not be included as part of the OPERATOR CONSOLE during competition MATCHES.

Competition versions of this device is included in the ARENA, and the KOP version is duplicative.

4.3.13 ROBOT Inspection

<R81> At the time of inspection, the ROBOT must be presented with all MECHANISMS (including all COMPONENTS of each MECHANISM) and configurations that will be used 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.

<R82> At the time of inspection, teams must submit an electronic copy of their Bill Of Materials (BOM) of all items used in the construction of their HOSTBOT, and their associated costs, to the inspector (see Rule <R18>). BOMs must be transferred to inspectors at the event via USB drive (inspector or team provided).

<R83> The ROBOT will be inspected for compliance with the dimension constraints specified in Rule <R11> while in its STARTING CONFIGURATION, by being placed within a Sizing Device that has inside surface dimensions consistent with the rule. Other than resting on the floor of the Sizing Device, no part of the ROBOT can 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.

<R84> All decorations must be on the ROBOT at the time of final inspection.

<R85> Any ROBOT construction technique or element that is not in compliance with the Robot Rules must be rectified before a ROBOT will be allowed to compete or continue competing. ROBOTS must fully pass inspection before they will be allowed to compete in Qualification Rounds.

<R86> ROBOTS will normally be allowed to participate in scheduled practice MATCHES prior to passing inspection. However, the lead inspector and/or head referee may determine at any time that the ROBOT is unsafe, and may prohibit further participation in practice MATCHES until the condition is corrected and the ROBOT passes inspection.

<R87> If a ROBOT is rejected by inspectors due to a safety issue or concern related to the team's method of storing energy (see Rule <R01>), the concerned items must be disabled or removed from the ROBOT before it can 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.

<R88> If a ROBOT is modified after it has passed inspection, that ROBOT must be re-inspected.

If an observation is made that another team's ROBOT may be in violation of the robot rules, please approach FIRST officials to review the matter in question. This is an area where Gracious Professionalism is very important

<R89> FIRST Officials may randomly re-inspect ROBOTS participating in competition MATCHES to assure compliance with the rules.

<R90> For the safety of all those involved, inspections must take place with the ROBOT powered off, pneumatics unpressurized, and springs or other stored energy devices in their lowest potential energy states (i.e. battery removed). Power and air pressure should only be enabled on the ROBOT during those portions of the inspection process where it is absolutely required to validate certain system functionality and compliance with specific rules (firmware check, etc). Inspectors may allow the ROBOT to be powered up beyond the parameters above if both criteria below are met.

- A. The ROBOT design requires power or a charged stored energy device in order to confirm that the ROBOT meets volume requirements *AND*
- B. the team has included safety interlocks that prevent unexpected release of such stored energy.

4.3.14 MINIBOT

<R91> The MINIBOT may not exceed a 12" x 12" x 12" volume and weigh no more than 15 lbs.

MINIBOTS will be inspected for the volume constraint by being placed in a five-sided box with internal dimensions of 12" x 12" x 12". If the lid (the sixth side of the cube) does not seat properly, the MINIBOT does not pass this part of the MINIBOT inspection.

<R92> The following items are the only permitted materials for use on the MINIBOTS:

- A. TETRIX components that are not in violation of any other rules, (Tetrix components are listed in **Approved Tetrix Parts** at www.usfirst.org/frc/competitionmanual),
- B. no more than two motors (PN W739083/W739023) and an unlimited number of Tetrix servos),
- C. no more than one 12V rechargeable NiMH battery pack identical to those supplied in the FTC kit of parts (PN W739057) except the 20A fuse may be replaced with an equivalent type of lower amperage,
- D. No more than one HiTechnic DC motor controllers,
- E. No more than one NXT controller with the Bluetooth functionality disabled,
- F. Polycarbonate,
- G. Polycarbonate glue,
- H. Raw welding rod, aluminum sheet, 90° angle, u-channel, tube, bar, that is not sold in pre-perforated or pre-punched form.
- I. rivets,
- J. non-metallic rope or cord,
- K. wire nuts, solder, and crimps,
- L. cable ties,

- M. limit switches,
- N. no more than two common household light switches,
- O. electrical hookup wire,
- P. non-slip pad,
- Q. PVC or CPVC pipe and fittings,
- R. PVC cement or cleaner,
- S. Mechanical fasteners (e.g. screws, bolts, etc),
- T. Loctite or similar thread-locking product,
- U. Rubber bands,
- V. Surgical tubing,
- W. Electrical tape and shrink tubing,
- X. PWM extension cables,
- Y. Universal security clips to hold the PWM connectors together,
- Z. Hook and loop fastener (may not be used as tape),
- AA. Magnets,
- BB. NXT compatible sensors and related connectors/cables,
- CC. Grease, and
- DD. Non-functional decorations.

Please note that the Rule <R92> only allows specific Tetrix components. While Tetrix components are a subset of FTC components, it is essential to realize that not all FTC parts are Tetrix parts. As such, not all FTC parts are permitted on the MINIBOT. Please be sure to vet your components against the above list before constructing your MINIBOT.

Use of glues/ements may not be allowed in the pits at tournaments based on site-specific rules.

Please note that the FTC Samantha module is not considered a TETRIX component and is not permitted on the MINIBOT.

<R93> Motors may not be modified with exceptions of those in Rule <R47>.

<R94> The MINIBOT must be designed such that it can easily be removed from the TOWER at the end of the MATCH.

4.3.15 MINIBOT Inspection

MINIBOT use is independent of the ROBOT inspection. For example, any FTC team can bring a MINIBOT to an event, get it inspected, and if legal, that MINIBOT can compete with any FRC ROBOT (that has passed ROBOT inspection). There are legal HOSTBOTS and legal MINIBOTS; they are independent of each other regarding inspection.

<R95> At the time of inspection, the MINIBOT must be presented with all MECHANISMS (including all COMPONENTS of each MECHANISM), decorations, and configurations that will be used on the MINIBOT during the entire competition event. It is acceptable, however, for a MINIBOT 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 MINIBOT must still meet all inspection criteria.

<R96> Deleted.

- <R97>** The MINIBOT will be inspected for compliance with the dimension constraints specified in Rule <R91> by being placed within a Sizing Device that has inside surface dimensions consistent with the rule. Other than resting on the floor of the Sizing Device, no part of the MINIBOT can break the plane of the sides or top of the Sizing Device during size inspection.
- <R98>** Any MINIBOT construction technique or element that is not in compliance with the MINIBOT Rules must be rectified before a MINIBOT will be allowed to compete or continue competing.
- <R99>** MINIBOTS must fully pass inspection before being allowed to compete in any Qualification Matches.
- <R100>** MINIBOTS will normally be allowed to participate in scheduled practice MATCHES prior to passing inspection. However, the lead inspector and/or head referee may determine at any time that the MINIBOT is unsafe, and may prohibit further participation in practice MATCHES until the condition is corrected and the MINIBOT passes inspection.
- <R101>** If a MINIBOT is rejected by inspectors due to a safety issue or concern related to the team's method of storing energy, the concerned items must be disabled or removed from the MINIBOT before it can 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.
- <R102>** If a MINIBOT is modified after it has passed inspection, that MINIBOT must be re-inspected.
- <R103>** *FIRST* Officials may randomly re-inspect MINIBOTS participating in competition MATCHES to ensure compliance with the rules.

4.4 REVISION HISTORY

Revision	Release Date	Changes
-	1/5/11	Original release
A	1/11/11	Section 4.2: Revised text to describe the correct location of the definitions.
		Revised <R03> so that rule references were not highlighted
		Revised <R11> to change the maximum horizontal dimension for the ROBOT PLAYING CONFIGURATION from 60" to 84"
		Revised <R16>, Text box: replaced "LogoMotion" with "LOGO MOTION™"
		Revised <R45> to include alternate CIM motor part numbers AM802-001A and PMR25R-45F-1003.
		Revised <R75> to fix a typo (inserted "to")
		Revised <R92> to clarify that Tetrix parts must be legal per other rules and allow NXT sensors and related cables and connectors
		Added a Blue Box to the beginning of Section 4.3.15 to clarify the distinction between MINIBOT and HOSTBOT inspection
		Added Section 4.1, Revision History
		Revised <R66> to include pneumatic cylinders and storage tanks.
B	1/14/11	Revised <R91> to include information about how MINIBOT size will be inspected
		Revised <R92-O> to relieve constraint on wire guage on the MINIBOT
C	1/18/11	Revised <R20> to exclude the MINIBOT from cost calculations
		Revised <R40> to allow slip rings, et al.
		Revised <R92> to allow alternate motor part number, clarify battery limit, clarify hardware/fastener rule, and updated Blue Box text to add caution about assuming that all FTC parts are Tetrix parts and vice versa.
D	1/21/11	Revised <R49> to add note about Jaguar closed-loop control
		Revised <R92> to specify raw aluminum usage

Revision	Release Date	Changes
E	1/25/11	<p>Revised <R14> to clarify that minor protrusions outside the FRAME PERIMETER are acceptable.</p> <p>Enlarged blue box in Rule <R22> to show all text.</p> <p>Fixed typo in Rule <R33></p> <p>Revised Rule <R45-D> to include more detailed part numbers for the BaneBots motors included in the kit as well as added acceptable alternate part numbers.</p> <p>Revised Rule <R46> to allow connection of the photoelectric sensors provided in the kit to a solenoid breakout board.</p> <p>Revised Rule <R92> to clarify approved Tetrix parts, allow teams to change the fuse in the battery, allow solder and crimps, allow PVC fittings, allow grease, and allow non-functional decorations.</p> <p>Revised the Blue Box in <R92> for clearer wording</p> <p>Revised Rule <R103> to correct a spelling error.</p>
F	1/28/11	<p>Revised Rule <R47> to add ability to modify window motor connectors</p> <p>Added blue box to Rule <R48> to clarify “approved”</p> <p>Section 4.2: Corrected rule reference.</p> <p>Revised Rule <R18> to clarify KOP valuation for the BOM and deleted redundant blue box.</p>
G	2/1/11	<p>Revised Rule <R75> to clarify role of the Driver Station software.</p> <p>Revised Rule <R82> to clarify that HOSTBOT BOM is required at inspection.</p> <p>Revised Rule <R92> to allow welding rod (and thus welding).</p> <p>Deleted Rule <R96>.</p>

Section

5



FIRST® Robotics Competition

THE TOURNAMENT

TABLE OF CONTENTS

5 THE TOURNAMENT	2
5.1 OVERVIEW	2
5.2 PRACTICE ROUNDS.....	2
5.2.1 Schedule	2
5.3 QUALIFICATION MATCHES	2
5.3.1 Schedule	2
5.3.2 Match Assignment	2
5.3.3 Qualification Score (QS)	2
5.3.4 Ranking Score (RS).....	3
5.3.5 Coopertition Score (CS).....	3
5.3.6 Match Point Exceptions	3
5.3.7 Qualification Seeding	3
5.4 ELIMINATION MATCHES	4
5.4.1 Alliance Selection Process.....	4
5.4.2 Backup Teams	4
5.4.3 Elimination Match Ladder	5
5.4.4 Elimination Scoring	5
5.5 TOURNAMENT RULES	6
5.5.1 Safety Rules	6
5.5.2 Eligibility	6
5.5.3 Referee Interaction Rules	6
5.5.4 Yellow and Red Card Rules.....	6
5.5.5 Field Reset Rules.....	7
5.5.6 Timeout and Backup Team Rules.....	7
5.5.7 Special Equipment Rules.....	8
5.6 CHAMPIONSHIP ADDITIONS	8
5.6.1 Championship Pit Crews.....	9
5.6.2 Championship Backup Teams	9
5.6.3 FRC Championship Match Ladder.....	10
5.7 REVISION HISTORY	10

5. THE TOURNAMENT

5.1 OVERVIEW

Each 2011 FRC Regional or District Competition and the 2011 FRC Championship will be played in a tournament format. Each tournament will consist of three sets of matches called “practice matches,” “qualification matches,” and “elimination matches.” The purpose of the practice matches is to provide each TEAM a chance to run its ROBOT on the playing field prior to the start of the competition matches. The purpose of the qualification matches is to allow each TEAM to earn a seeding position that may qualify them for participation in the elimination matches. The purpose of the elimination matches is to determine the event Champions.

5.2 PRACTICE ROUNDS

5.2.1 Schedule

The practice rounds will be played on the first day of each competition. The practice round schedule will be available on the morning of the first day. Practice rounds will be randomly assigned with each TEAM being assigned an equal number of rounds. At some events, additional rounds may be available on a standby basis. Each practice round will be conducted as a “competition match” with approximately two minutes for set up, two minutes and fifteen seconds of regular game play (including operations), and one minute to clear the field.

5.3 QUALIFICATION MATCHES

5.3.1 Schedule

The qualification matches will consist of a series of matches, with an ARENA reset between each MATCH. The qualification match schedule will be available as soon as possible, but no later than 1 hour before qualification matches are scheduled to begin.

5.3.2 Match Assignment

The Field Management System (FMS) will assign each TEAM two ALLIANCE partners for each qualifying match played using a predefined algorithm. The algorithm employs the following criteria:

- A. Maximum time (in number of matches) between each match played for all TEAMS
- B. Minimum possible number of times a TEAM plays opposite any TEAM
- C. Minimum possible number of times a TEAM is allied with any TEAM
- D. Minimize the use of SURROGATESs.
- E. Even distribution of matches played on Blue and Red ALLIANCE (without sacrificing A, B, C and D)

All TEAMS will play the same number of qualification matches except if the number of TEAM appearances (number of TEAMS multiplied by number of rounds) is not divisible by six; in that case the FMS will randomly select some TEAMS to play an extra MATCH. For purposes of seeding calculations, those TEAMS will be designated as SURROGATES for the extra MATCH. If TEAMS play a MATCH as a SURROGATE, it will be indicated on the match schedule, and it will always be their third match.

5.3.3 Qualification Score (QS)

Qualification points are awarded to each TEAM at the completion of each qualification match and are dependant on the final score:

- Each TEAM on the winning ALLIANCE will receive two (2) qualification points.

- Each TEAM on the losing ALLIANCE will receive zero (0) qualification points.
- In the event of a tied score, all six TEAMS will receive one (1) qualification point.

The total number of qualification points earned by a TEAM throughout their qualification matches will be their qualification score.

5.3.4 Ranking Score (RS)

Each TEAM on the winning ALLIANCE will receive a number of ranking points equal to the unpenalized score (the score without any assessed penalties) of the losing ALLIANCE.

Each TEAM on the losing ALLIANCE will receive a number of ranking points equal to their final score (with any assessed penalties).

In the case of a tie, all participating TEAMS will receive a number of ranking points equal to their ALLIANCE score (with any assessed penalties).

The total number of ranking points earned by a TEAM throughout their qualification matches, divided by the number of matches played (excluding any SURROGATE matches), then truncated to two decimal places, will be their ranking score.

Note: because your ranking score is derived directly from the match scores of the losing ALLIANCES in the matches you play, it is in your best interest to support your opponents and win by helping each ALLIANCE score as many points as possible.

5.3.5 Coopertition Score (CS)

Any borrowed MINIBOT which scores points by legally triggering the TARGET during the MATCH receives one (1) Coopertition point for the FRC TEAM registered for the event that is affiliated with the MINIBOT.

The total number of Coopertition points earned by a TEAM throughout the qualification matches will be their Coopertition score.

5.3.6 Match Point Exceptions

A SURROGATE receives zero qualification points, zero ranking points, and zero Coopertition points.

A TEAM is declared a no-show if no member of the TEAM is in the ALLIANCE STATION at the start of the MATCH; a no-show TEAM will be disqualified from that MATCH.

During the qualification MATCHES, TEAMS can be individually disqualified in a MATCH. A disqualified TEAM will receive zero qualification points, zero ranking points, and zero Coopertition points.

In the very unlikely case that all three TEAMS on an ALLIANCE are disqualified, all three TEAMS on the winning ALLIANCE would get their own score as their ranking points for that match.

5.3.7 Qualification Seeding

All TEAMS in attendance will be seeded during the qualification matches. If the number of TEAMS in attendance is 'n', they will be seeded '1' through 'n', with '1' being the highest seeded TEAM and 'n' being the lowest seeded TEAM.

The FMS will use the following seeding method:

- TEAMS will be broken into tiers based on their qualification score. A tier is made up of all TEAMS with the same qualification score. Tiers will be seeded in decreasing order by qualification score.
- Within each tier, TEAMS will be seeded in decreasing order by their ranking score.
- If any TEAMS within a tier have the same ranking score, they will then be seeded in decreasing order by their highest match score.
- If any TEAMS within a tier have the same ranking score and the same highest match score, then they will be seeded based on a random sorting by the FMS.

5.4 ELIMINATION MATCHES

At the end of the qualification matches, the top eight seeded TEAMS will become the ALLIANCE Leads. The top seeded ALLIANCES will be designated, in order, ALLIANCE One, ALLIANCE Two, etc., down to ALLIANCE Eight. Using the ALLIANCE selection process described below, each TEAM will choose two other TEAMS to join their ALLIANCE.

5.4.1 Alliance Selection Process

Each TEAM will choose a student TEAM Representative who will proceed to the ARENA at the designated time (typically before the lunch break on the final day of the Competition) to represent their TEAM. The TEAM Representative for each ALLIANCE Lead is called the ALLIANCE CAPTAIN.

The ALLIANCE selection process will consist of two rounds during which each ALLIANCE CAPTAIN will invite a TEAM seeded below them in the standings to join their ALLIANCE. The invited TEAM must not already have declined an invitation.

Round 1: In descending order (ALLIANCE One to ALLIANCE Eight) each ALLIANCE CAPTAIN will invite a single TEAM. The invited TEAM Representative will step forward and either accept or decline the invitation.

If the TEAM accepts, it is moved into that ALLIANCE.

- If an invitation from a top eight ALLIANCE to another ALLIANCE Lead is accepted, all lower ALLIANCE Leads are promoted one spot and the next highest seeded unselected TEAM will move up to become ALLIANCE Eight.

If the TEAM declines, that TEAM is not eligible to be picked again and the ALLIANCE CAPTAIN extends another invitation to a different TEAM.

- If an invitation from a top eight ALLIANCE to another ALLIANCE Lead is declined, the declining TEAM may still invite TEAMS to join their ALLIANCE, however, it cannot accept invitations from other ALLIANCES.

The process continues until ALLIANCE Eight makes a successful invitation.

Round 2: The same method is used for each ALLIANCE CAPTAIN'S second choice except the selection order is reversed, with ALLIANCE Eight picking first and ALLIANCE One picking last. This process will lead to eight ALLIANCES of three TEAMS.

5.4.2 Backup Teams

Of the remaining eligible TEAMS, the highest seeded TEAMS (up to eight) shall remain on standby and be ready to play as a BACKUP TEAM. If a ROBOT from any TEAM in an elimination match becomes inoperable the ALLIANCE CAPTAIN may have the highest seeded BACKUP TEAM join the ALLIANCE. The resulting ALLIANCE would then be composed of four TEAMS, but only three TEAMS will be permitted to continue with tournament play. The replaced TEAM remains part of the ALLIANCE for awards but cannot play, even if their ROBOT is repaired.

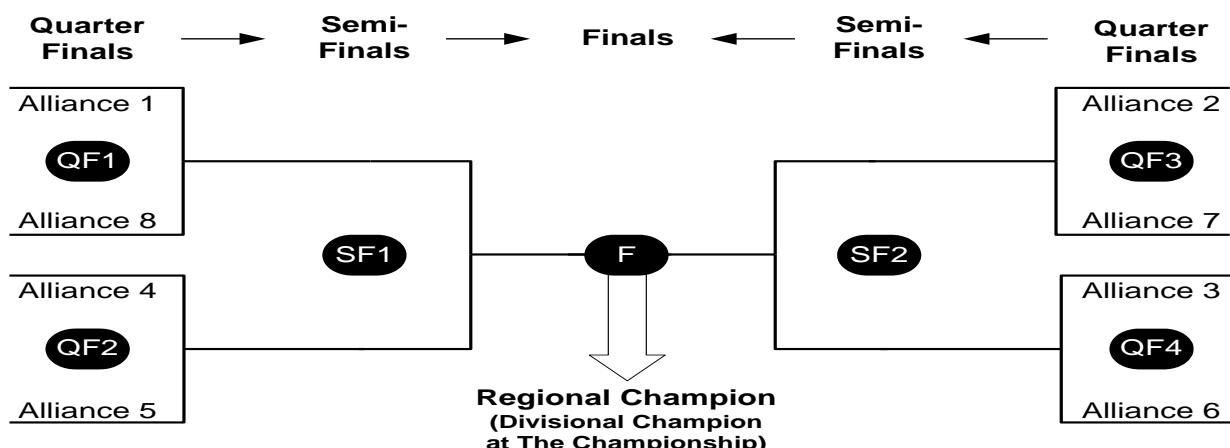
The original three-TEAM ALLIANCE shall only have one opportunity to draw from the BACKUP TEAMS. If a second ROBOT from the ALLIANCE becomes inoperable, then the ALLIANCE must play the following matches with only two (or even one) ROBOTS. It is in the best interest of all TEAMS to construct their ROBOTS to be as robust as possible to prevent this situation.

- Example: Three TEAMS, A, B and C, form an ALLIANCE going into the elimination matches. The highest seeded TEAM NOT on one of the eight ALLIANCES is TEAM D. During one of the elimination matches, TEAM C's ROBOT becomes inoperable. The ALLIANCE CAPTAIN decides to bring up TEAM D to replace TEAM C. TEAM C and their ROBOT may not play in any subsequent elimination matches.

In the case where a BACKUP TEAM is called up to the winning ALLIANCE, there will be a four-TEAM Champion ALLIANCE.

5.4.3 Elimination Match Ladder

The elimination matches will take place on the afternoon following completion of the qualification matches. Elimination matches are played in a ladder format as follows:



In order to allow equal time between matches for all ALLIANCES, the order of play will be:

QF1-1, QF2-1, QF3-1, QF4-1,
 Then QF1-2, QF2-2, QF3-2, QF4-2,
 Then QF1-3*, QF2-3*, QF3-3*, QF4-3*
 Then any QF replays due to ties*
 Then SF1-1, SF2-1, SF1-2, SF2-2, SF1-3*, SF2-3*
 Then any SF replays due to ties*
 Then F-1, F-2, F-3*
 Then any F replays due to ties*

(* - if required)

5.4.4 Elimination Scoring

In the elimination matches TEAMS do not earn qualification, ranking, or Coopertition points; they earn a win, loss or tie. Within each bracket of the elimination match ladder, the first ALLIANCE to win two MATCHES will advance.

In the case where the MATCH SCORE of each ALLIANCE is equal, the tie will be broken by awarding one (1) additional point to the ALLIANCE that won the MINIBOT RACE. If there was no MINIBOT RACE winner, the MATCH will be replayed.

5.5 TOURNAMENT RULES

5.5.1 Safety Rules

- <T01> All competition attendees must wear safety glasses while in the ARENA.
- <T02> Radio control mode of ROBOT operation is not permitted in areas anywhere outside the ARENA or practice field. ROBOTS must only be operated by tether when not within the ARENA or practice field.

5.5.2 Eligibility

- <T03> A TEAM will only be allowed to participate in a MATCH and receive qualification, ranking, and Coopertition points only if it has passed inspection. If it is learned after the start of the MATCH that a TEAM did not pass inspection, the TEAM's entire ALLIANCE will receive a RED CARD for that MATCH.

Please take note of this rule change for 2011. It is important that TEAMS make sure their ALLIANCE partners have passed inspection. Allowing a partner that has not passed inspection to play with you puts you at risk of disqualification. We recommend that you check with your ALLIANCE partners early and help them to pass inspection before your compete together.

5.5.3 Referee Interaction Rules

- <T04> The Head Referee has the ultimate authority in the ARENA during the competition, but may receive input from additional sources, particularly Game Design Committee members, FIRST personnel, and technical staff that may be present at the event. THE HEAD REFEREE RULINGS ARE FINAL! The referee will not review recorded replays under **any** circumstances.
- <T05> If a TEAM needs clarification on a ruling or score, a pre-college student from that TEAM should address the Head Referee after a field reset has been signaled. Depending on timing, the Head Referee may postpone any requested discussion until the end of the subsequent MATCH.

5.5.4 Yellow and Red Card Rules

- <T06> The Head Referee may assign a YELLOW CARD as a warning of egregious ROBOT or TEAM member behavior at the ARENA. A YELLOW CARD will be indicated by the Head Referee standing in front of the TEAM'S PLAYER STATION and holding a yellow card in the air after the completion of the MATCH. In the first MATCH that a TEAM receives a YELLOW CARD, it acts as a warning.
- <T07> Once a TEAM receives a YELLOW CARD, its team number will be colored yellow on the audience screen at the beginning of all subsequent MATCHES as a reminder to the TEAM, the referees, and the audience that they have been issued a YELLOW CARD.
- <T08> A TEAM will be issued a RED CARD (disqualification) in any subsequent MATCH that they receive an additional YELLOW CARD. This will occur after the completion of the MATCH. A RED CARD will be indicated by the Head Referee standing in front of the TEAM'S PLAYER STATION and holding a yellow card and red card in the air simultaneously. The TEAM will still carry their YELLOW CARD into subsequent matches.
- <T09> If the behavior is particularly egregious, a RED CARD may be issued without being preceded by a YELLOW CARD, at the Head Referee's discretion. The TEAM will still carry a YELLOW CARD into subsequent matches.

- <T10> YELLOW CARDS do not carry forward between qualification matches and elimination matches. All TEAMS move into the elimination matches with a clean slate.
- <T11> If a TEAM is disqualified during a MATCH for a reason other than receiving an additional YELLOW CARD, they will receive a RED CARD. This will occur after the completion of a MATCH and will be indicated by the Head Referee standing in front of the TEAM'S PLAYER STATION and holding a red card in the air.
- <T12> During the qualification matches, a TEAM that receives a RED CARD will receive zero qualification points and zero ranking points. The rest of the TEAMS in their ALLIANCE will still receive the earned qualification points and ranking points.
- <T13> During the elimination matches, a TEAM receiving a RED CARD will cause the disqualification of their entire ALLIANCE for that MATCH.

5.5.5 Field Reset Rules

- <T14> At the conclusion of a MATCH, all players shall remain in their assigned locations until the Head Referee issues the “field-reset” signal. Once the Head Referee issues this signal, the “match-reset” period will begin. The ARENA must be cleared of ROBOTS, MINIBOTS, and OPERATOR CONSOLES from the MATCH just ended, and the ROBOTS, MINIBOTS, and OPERATORS CONSOLES for the following MATCH must be placed in position and ready to start before the expiration of the “match-reset” period. Field Attendants will reset the ARENA elements during this time.

Teams are expected to use utmost care in removing MINIBOTS from the TOWERS and mitigate risk of a MINIBOT falling uncontrollably. If a MINIBOT is seen as unsafe, the REFEREE may consider it a violation of Rule <G26>. MINIBOTS seen as egregious threats to safety may earn the TEAM a YELLOW or RED CARD.

- <T15> Robots will not be re-enabled after the conclusion of the MATCH
- <T16> The qualification match schedule will indicate ALLIANCE partners and match pairings. It will also indicate the ALLIANCE color assignment, “red” or “blue,” for each MATCH. Before queuing for a match, the ALLIANCE members must choose which TEAM will occupy each of the three possible locations for each of the ROBOTS and HUMAN PLAYERS.
- <T17> If, in the judgment of the Head Referee, an “ARENA fault” occurs that affects either the play or the outcome of the MATCH, the MATCH will be replayed. Example ARENA faults include broken field elements, power failure to a portion of the field, improper activation of the field control system, errors by field personnel, etc.

5.5.6 Timeout and Backup Team Rules

- <T18> There are no time-outs in the qualification rounds. If a ROBOT cannot report for a MATCH, the queuing manager must be informed and at least one member of the TEAM should report to the field for the MATCH to avoid receiving a RED CARD.
- <T19> During the elimination rounds, if circumstances require an ALLIANCE to play in back-to-back MATCHES, they will be granted an additional minute of set-up time to reset and allow their ROBOTS to cool down.

- <T20>** In the elimination matches, each ALLIANCE will be allotted one TIMEOUT of up to 6 minutes. If an ALLIANCE wishes to call for a TIMEOUT, they must submit their TIMEOUT coupon to the Head Referee within two minutes of the Head Referee issuing the arena reset signal preceding their MATCH. When this occurs, the Time-out Clock will count down the six minutes starting with the expiration of the arena reset period. Both ALLIANCES will enjoy the complete 6-minute window. In the interest of tournament schedule, if an ALLIANCE completes their repairs before the Time-out Clock expires, the ALLIANCE CAPTAIN is encouraged to inform the Head Referee that they are ready to play and remit any time remaining in the TIMEOUT. If ALLIANCES are ready before the 6-minute window, the next MATCH will start. There are no cascading time-outs. An ALLIANCE may not offer their unused TIMEOUT to their opponent.
- <T21>** If during a TIMEOUT an ALLIANCE CAPTAIN determines that they need to call up a BACKUP TEAM, they must submit their BACKUP TEAM coupon to the Head Referee while there is still at least two minutes remaining on the Time-out Clock. After that point, they will not be allowed to utilize the BACKUP TEAM. Alternatively, an ALLIANCE CAPTAIN may choose to call up a BACKUP TEAM without using their TIMEOUT by informing the Head Referee directly within two minutes of the Head Referee issuing the Field Reset Signal preceding their match.
- <T22>** In the case where the ALLIANCE CAPTAIN'S TEAM is replaced with the BACKUP TEAM, the ALLIANCE CAPTAIN is allowed in the ALLIANCE STATION as a thirteenth ALLIANCE member so they can serve in an advisory role to their ALLIANCE.
- <T23>** In any case where a HEAD REFEREE has to stop an ELIMINATION MATCH (e.g. due to ARENA fault or a safety issue), it will be replayed immediately. ALLIANCES do not have the option to request either a TIMEOUT or BACKUP TEAM. The sole exception is if the replay is due to an ARENA fault that rendered a ROBOT inoperable.
- <T24>** If an ELIMINATION MATCH is replayed per <T23>, the Head Referee has the option of calling a TIMEOUT without charging any TEAM with a TIMEOUT.

5.5.7 Special Equipment Rules

- <T25>** The only equipment that may be brought on to the ARENA is the OPERATOR CONSOLE, reasonable decorative items, and special clothing and/or equipment required due to a disability. Other items, particularly those intended to provide a competitive advantage for the TEAM, are prohibited.
- <T26>** Devices used solely for the purpose of planning or tracking strategy of game play are allowed inside the ALLIANCE STATION, if they meet ALL of the following conditions:
- Do not connect or attach to the OPERATOR CONSOLE
 - Do not connect or attach to the FIELD or ARENA
 - Do not connect or attach to another ALLIANCE member
 - Do not communicate with anything or anyone outside of the ARENA.
 - Do not include any form of enabled wireless electronic communication (e.g. radios, walkie-talkies, cell phones, Bluetooth communications, WiFi, etc.)
 - Do not in any way affect the outcome of a MATCH, other than by allowing TEAM members to plan or track strategy for the purposes of communication of that strategy to other ALLIANCE members.

5.6 CHAMPIONSHIP ADDITIONS

For the 2011 FRC Championship, TEAMS will be split into four divisions. Each division will play exactly like a Regional Event and produce the Division Champions. Those four ALLIANCES will then proceed to the Championship Playoffs to determine the 2011 FRC Champions.

Procedures in Sections 5.1-5.5 apply during the Championship, with the following additions:

5.6.1 Championship Pit Crews

During the elimination matches, extra TEAM members are often needed to move the TEAM ROBOT from the TEAM's pit area to the queuing area and into the ARENA. For this reason, each TEAM is permitted to have three (3) additional "pit crew" members who can also help with needed ROBOT repairs/maintenance. We suggest that all TEAMS assume they may be chosen for an ALLIANCE and think about the logistics of badge distribution and set a plan prior to the pairings. It is each ALLIANCE CAPTAIN'S responsibility to get the TEAM'S badges to the TEAM pit crew members.

Only TEAM members wearing proper badges are allowed on the ARENA floor. *FIRST* will distribute these badges to the ALLIANCE CAPTAINS during the ALLIANCE CAPTAIN meeting, which takes place on the division fields. These badges will provide the necessary access to the ARENA for pit crew members.

5.6.2 Championship Backup Teams

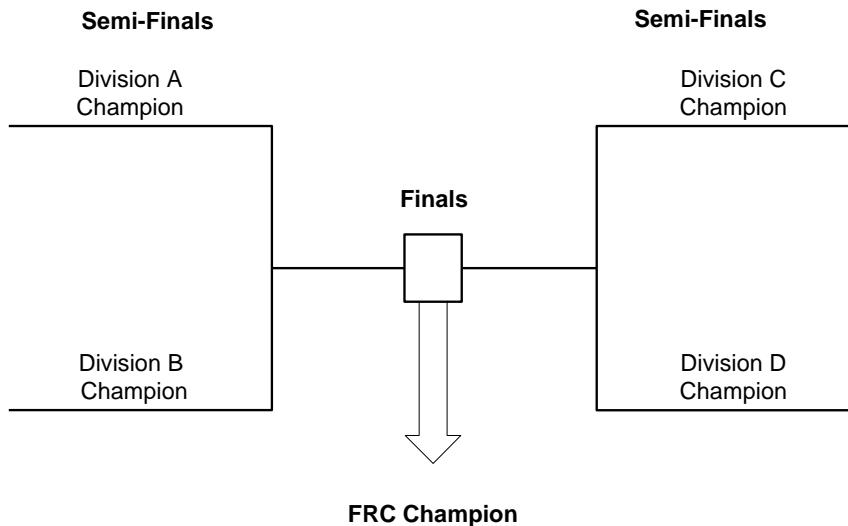
If an ALLIANCE has not previously brought in a BACKUP TEAM, and a ROBOT becomes disabled during the Championship Playoffs and can not continue, the ALLIANCE may request a BACKUP TEAM. The ALLIANCE CAPTAIN will be presented the option of having one of the three lead Division Finalist TEAMS, chosen randomly, from their division join the ALLIANCE as a BACKUP TEAM.

If an ALLIANCE has won their division with a BACKUP TEAM and moved on to the FRC Championship Playoffs, the BACKUP TEAM continues to play for the ALLIANCE in the Championship Playoffs.

As noted in Section 5.4.2, the original three-TEAM ALLIANCE shall only have one opportunity to draw from the BACKUP TEAMS. If the ALLIANCE has brought in a BACKUP TEAM during the division elimination matches or the Championship Playoffs, they cannot bring in a second BACKUP TEAM. If a second ROBOT from the ALLIANCE becomes inoperable during the Championship Playoffs, then the ALLIANCE must play the following matches with only two (or even one) ROBOTS.

In either case, the replaced TEAM remains part of the ALLIANCE for awards but can not rejoin tournament play, even if their ROBOT is repaired. If the ALLIANCE wins the Championship Playoffs, the FRC Champions will be all three original members of the Division Champion ALLIANCE and the BACKUP TEAM.

5.6.3 FRC Championship Match Ladder



The FRC Championship matches will play exactly like the Semi-Finals and Finals of the elimination matches.

5.7 REVISION HISTORY

Revision	Release Date	Changes
-	1/5/11	Original release
A	1/11/11	Corrected rule reference in blue box for Rule <T14>