

# THE GAME



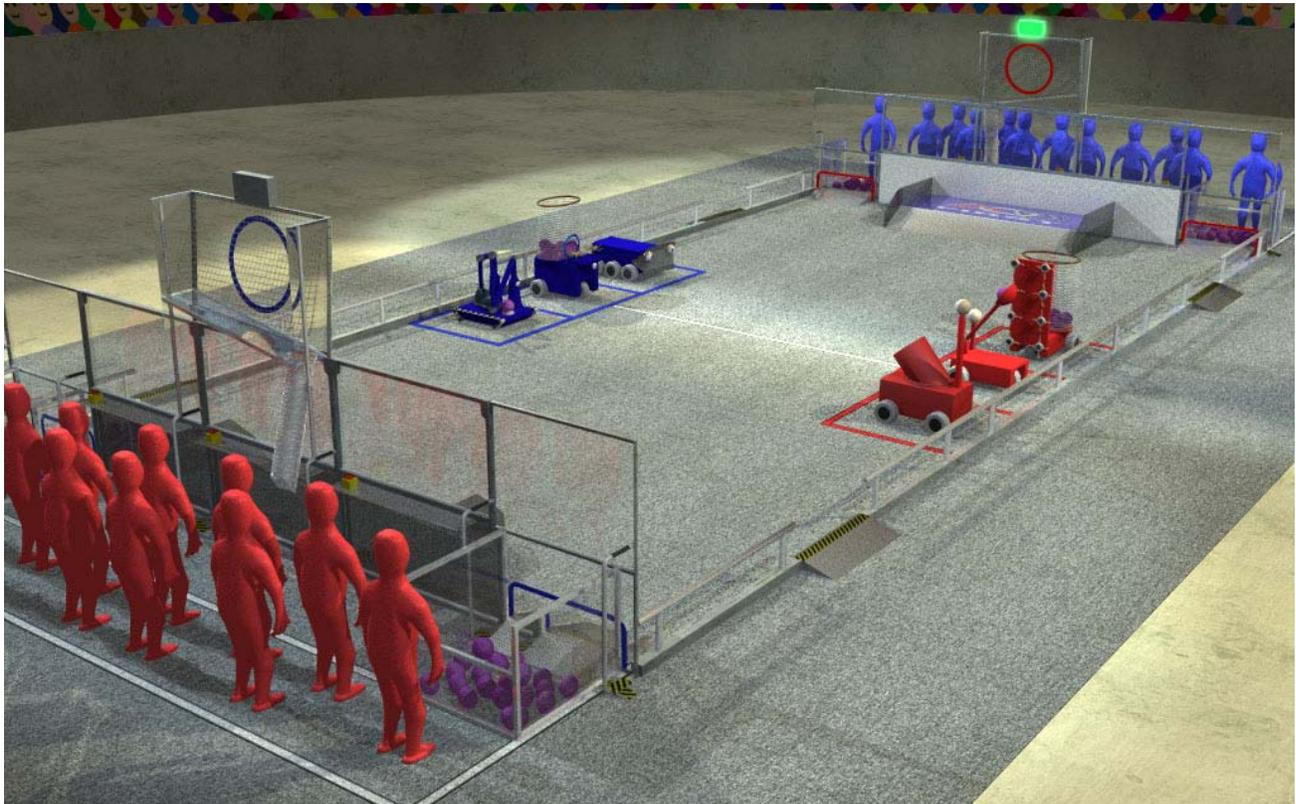
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## 4 THE GAME

### 4.1 GAME OVERVIEW

*AIM HIGH* is a game played on a field as illustrated in the figure below. Two alliances, one red and one blue, composed of three teams each, compete in each match. The object of the game is to attain a higher score than your opponent alliance by scoring balls in the center or corner goals, and/or by having ROBOTS on your platform or ramp at the end of the match. The point values for each of those actions are explained below.



*Note: The illustrations in this section of the manual are for a general visual understanding of the field and game only. Teams should refer to the drawings for exact dimensions and field construction.*

## 4.2 THE GAME

### 4.2.1 Definitions

**ALLIANCE:** A set of three FIRST Robotics Competition teams that work together during a match to play *AIM HIGH* against an opposing ALLIANCE. ALLIANCEs are identified during the match by alliance color, either red or blue.

**ALLIANCE PLATFORM:** The raised platform at each end of the field directly beneath the center goal. The ALLIANCE PLATFORM includes the horizontal platform, the ramp between the floor and the platform, and the vertical side walls on each side of the platform and ramp.

**ALLIANCE ZONE:** The 26' x 8' area behind the Alliance Station Wall at either end of the field, where the alliance team members stand during the match. The ALLIANCE ZONE includes the area behind the STARTING LINE.

**BACKBOT:** The robot that an ALLIANCE keeps on their offensive side of the field while their ALLIANCE is on defense. The BACKBOT can be any of the three ALLIANCE ROBOTS, and can change during the match.

**BUMPER ZONE:** The volume between two planes parallel to the floor, the lower bound being 2 1/2 inches above the floor, and the upper bound being 8 1/2 inches above the floor. The BUMPER ZONE is defined with respect to the robot at the start of the match and moves with the robot as it climbs the ALLIANCE PLATFORM.

**COACH:** A student or adult mentor designated as the team advisor during the match and identified as the person wearing a “COACH” pin or button.

**DRIVER:** A pre-college student team member responsible for operating and controlling the ROBOT.

**HUMAN PLAYER:** A pre-college student team member designated as the only team member permitted to enter balls onto the field.

**GAME PERIODS:**

- **AUTONOMOUS PERIOD:** The 10 second period at the beginning of the match in which the ROBOTS operate and react only to sensor inputs and to commands programmed by the team into the onboard robot control system.
- **SECOND PERIOD:** The first 40-second period after AUTONOMOUS PERIOD, following AUTONOMOUS PERIOD after a time delay.
- **THIRD PERIOD:** The second 40-second period after AUTONOMOUS PERIOD, immediately following the SECOND PERIOD.
- **FINAL PERIOD:** The third 40-second period after AUTONOMOUS PERIOD, immediately following the THIRD PERIOD.

**ON-SIDES:** The half of the field farthest from the ALLIANCE’s driver’s stations. This is the offensive half of the field for the ALLIANCE on defense. The centerline is part of the ON SIDES half of the field.

**ROBOT:** Anything that has passed ROBOT inspection that a team places on the field prior to the start of a match.

**ROBOT STARTING ZONE:** Three 5 by 5 foot areas on each side of the field marked by Blue or Red 2”-wide tape corresponding to the alliance colors.

**SHOOTING MECHANISM:** the mechanism that delivers the final dynamic impulse that ejects the ball from the robot, and any parts of the robot that contact the ball while and/or after this impulse is delivered.

**STARTING LINE:** A line 4 feet behind the Alliance Station Wall, indicated by a line of 2” white gaffer’s tape on the floor.

## 4.2.2 Match Format

A match is 2 minutes and 10 seconds long. An AUTONOMOUS PERIOD starts the match, which lasts 10 seconds. Following AUTONOMOUS PERIOD, there are 2 minutes of tele-operated game play, which are broken up into three 40-second periods. There may be a short pause between AUTONOMOUS PERIOD and the start of the tele-operated periods as the players stations are activated. The SECOND PERIOD and THIRD PERIOD are offense/defense, where only one ALLIANCE can score. During the FINAL PERIOD, both ALLIANCEs can score.

## 4.3 RULES

### 4.3.1 Safety

- <S01> If at any time a ROBOT's operation or design is deemed unsafe by the head referee, it will receive a 10-point penalty and 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 unless the design has been corrected. An example of unsafe operation is repeatedly throwing balls off the field at audience members, media personnel, judges, referees, etc. An example of an unsafe design is a SHOOTING MECHANISM that has a large mass that is stopped abruptly at the end of travel and is at risk of breaking off the ROBOT and becoming a projectile. Another example of an unsafe robot design is a bright targeting light or laser pointer that could interfere with driver's ability to control their robot.
- <S02> Muzzle Velocity - No ROBOT may throw a ball with an exit velocity of greater than 12 m/s (26.8 mph). As a reference, a ball traveling at this velocity when leaving the ROBOT at an angle of 30° from horizontal with no spin will travel approximately 35 feet. A robot that violates this rule will be considered unsafe per <S01>.
- <S03> The SHOOTING MECHANISM must remain inside the ROBOT - Any mechanism used to throw balls must be contained within the original 28" x 38" x 60" starting envelope of the ROBOT and must be shielded such that the mechanism cannot make contact with other ROBOTS. A ROBOT that violates this rule will be considered unsafe per <S01>.
- <S04> HP/DRIVER/COACH cannot touch a ROBOT - HUMAN PLAYERS, DRIVERS, and COACHES may not directly contact the ROBOT at any time during the match. Violating this rule will result in the disabling of the team's ROBOT for the remainder of the match.
- <S05> E-Stop - Three Emergency Stop (E-Stop) buttons are located in each alliance station, one for each team. Pressing an E-Stop button will cause the corresponding 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, including COACHES, may press the E-Stop button.

### 4.3.2 Game Periods

- <G01> AUTONOMOUS PERIOD - During AUTONOMOUS PERIOD both ALLIANCES may play offense or defense, and all goals are active for scoring. During AUTONOMOUS PERIOD the ROBOTS react only to sensor inputs and commands programmed into the onboard control system. Human control of the ROBOT is not permitted at this time. All ROBOT safety rules are still applicable during AUTONOMOUS PERIOD.
- <G02> SECOND PERIOD - The ALLIANCE with the highest score at the end of AUTONOMOUS PERIOD will play on defense during the SECOND PERIOD. In the event of a tie at the end of AUTONOMOUS PERIOD, the ALLIANCE playing on defense during SECOND PERIOD will be chosen at random. Any balls scored in the defensive ALLIANCE's goals (opposite their DRIVER's station) during this period will not be counted.
- <G03> THIRD PERIOD - The ALLIANCE that was on offense for the SECOND PERIOD will play on defense during the THIRD PERIOD. Any balls scored in the defensive ALLIANCE's goals during this time will not be counted.

<G04> FINAL PERIOD - Both ALLIANCES may play offense or defense during the FINAL PERIOD. Balls scored in all goals will be counted.

### 4.3.3 Scoring

<G05> In order for a ball to score, it must enter the goal and exit via the exit chute. A ball that bounces out of the goal is not scored. Once a ball is scored for a particular ALLIANCE, it cannot score again until it is entered onto the field by the opposing ALLIANCE's HUMAN PLAYER.

#### Point Values:

<G06> Center Goal - A ball scored in the center goal is worth 3 points for the ALLIANCE whose DRIVER's station is opposite the goal, when that ALLIANCE is designated as playing offense.

<G07> Corner Goal - A ball scored in the either of the corner goals is worth 1 point for the ALLIANCE whose DRIVER's station is opposite the goal, when that ALLIANCE is designated as playing offense.

<G08> AUTONOMOUS PERIOD Bonus - The ALLIANCE that has the highest point total at the end of AUTONOMOUS PERIOD will receive a 10 point bonus.

<G09> ROBOTS on ALLIANCE PLATFORMs - ROBOTS score points if they are entirely on an ALLIANCE PLATFORM when they come to rest at the end of the match. ALLIANCES receive points for ROBOTS belonging to either ALLIANCE that are on the ALLIANCE PLATFORM closest to the ALLIANCE's DRIVER station. If any part of the ROBOT is touching the carpet, the ROBOT is not considered on the platform. If a ROBOT is entirely on an ALLIANCE PLATFORM and is touching another ROBOT that is not entirely on the ALLIANCE PLATFORM, it still is considered on the platform. One ROBOT on a platform or ramp is worth 5 points, two ROBOTS are worth 10 points, 3 or more ROBOTS are worth 25 points.

### 4.3.4 Robot Operations

#### 4.3.4.1 Starting Conditions

<G10> Starting Positions - At the beginning of a match, the three alliance ROBOTS must be placed inside one of the three 5' x 5' robot starting zones located at mid-field to the right of the DRIVER's station and not touching the tape boundaries. It is the responsibility of the head referee to verify that this rule is satisfied prior to the start of the match. The match will not be started until all robots are in the starting position.

<G11> Alignment Devices - Alignment devices (templates, tape measures, etc.) that are not part of the ROBOT may not be used to assist with positioning the ROBOT. Teams that use external alignment devices to position their ROBOT will have their ROBOT arbitrarily repositioned by the head referee.

<G12> Starting Size - At the beginning of a match, each ROBOT must not exceed a volume of 28 inches by 38 inches by 60 inches tall, excluding its bumpers. It is the responsibility of the head referee to verify that this rule is satisfied prior to the start of the match. An offending ROBOT will be removed before the start of the match at the head referee's discretion.

<G13> Balls Contained in ROBOTS at the Start of a match - Each ALLIANCE will start a match with 40 balls. Each ROBOT may contain up to 10 balls at the start of a match. Any balls not contained within the robot will be distributed between **totes located outside** the alliance zone. All of the balls must be contained within the ROBOT's 28" x 38" x 60" starting volume and must be clearly visible from outside the

ROBOT. The Head Referee will require that balls outside of the starting volume be removed. It is the responsibility of the head referee to verify that this rule is satisfied prior to the start of the match.

#### 4.3.4.2 Robot Out Of Bounds

- <G14> ROBOT Out of Bounds - Any ROBOT that touches the floor (the surface co-planar with the playing surface) outside of the field boundary will be disabled for the remainder of the match. No penalty points will be assessed.
- <G15> Grace Period After Autonomous - If a ROBOT should touch the floor outside of the field boundary during the AUTONOMOUS PERIOD, it will have a 10 second “grace period” to right itself and return to the playing field at the beginning of the tele-operated period. If it is able to do so within the 10-second grace period, it will not be disabled. If at any time the referee should determine that the attempts to recover from the situation constitute unsafe operations, Rule <S01> will take precedence.

#### 4.3.4.3 Robot Dimensions

- <G16> Maximum Height - A ROBOT may not extend above 60” above the floor or the ALLIANCE PLATFORM in a stable configuration at any time during a match. Each violation shall result in a penalty of 5 points per occurrence or 5 points per ball shot or ball blocked during the occurrence, whichever is greater. ROBOTS designed to violate this rule are not allowed. For example, a ROBOT that extends a blocking device in front of the center goal will be disqualified. Transient conditions that may cause a diagonal dimension of the robot to momentarily exceed the 60” height restriction – such as during a tip-over or when climbing onto the ALLIANCE PLATFORM – are not subject to this rule. The one exception to the height restriction is provided in rule <R13> (flag rule).
- <G17> ROBOT Orientation - ROBOTS must maintain their vertical orientation with respect to their starting position throughout the match. ROBOTS may not intentionally tip over onto one of their initially vertical sides and operate with this side parallel to the ground. **“Flop-Down” robots will be disqualified.**
- <G18> ROBOT Extension Size – ROBOTS may not extend beyond a 60-inch limit in either horizontal cardinal dimension as specified in <R08>. Robots that violate this rule will be disqualified.

#### 4.3.4.4 Robot Interaction

- <G19> Field Interaction - ROBOTS may push or react against any elements of the field, provided there is no damage or disruption of the field elements. ROBOTS may not grab, grasp, grapple, or attach to any field structure. If a ROBOT violates this rule, the head referee will give one warning. If the referee determines that team is disregarding the warning, the team’s ROBOT will be disabled for the remainder of the match.
- <G20> Field Damage - The head referee may disable a ROBOT that has damaged the playing field, carpet, goals, etc. if the head referee feels that further damage is likely to occur. The head referee may require corrective action, such as eliminating a sharp edge, and re-inspection, before the ROBOT will be allowed to compete in subsequent matches.
- <G21> ROBOT Incursion into the Corner Goal – **Robots should not enter the corner goals.** Incidental incursion into the corner goal that occurs as a result of a ROBOT pushing balls into the goal is permitted, not to exceed a distance of approximately 3 inches. **The 3 inches does not include the deflection of the goal panel or structure.** Intentional incursion, for example to use a ball gathering mechanism to drop off balls inside the goal, or extending a portion of the ROBOT through the goal opening to activate the ball counting system, will result in disqualification of the offending ROBOT. **Any incursion substantially**

**beyond 3 inches, particularly if the robot extends over the lighted scoring system panel, will be considered intentional incursion.**

<G22> Intentional ROBOT - ROBOT Interaction - Strategies aimed solely at the destruction, damage, tipping over, or entanglement of ROBOTS are not in the spirit of the FIRST Robotics Competition and are not allowed. However, AIM HIGH is a highly interactive game, and some appropriate contact is allowed subject to the following guidelines:

- Rule <R35> in Section 5.3.4 establishes ROBOT BUMPER ZONES. Any contact within this zone is generally acceptable, with the exception of high speed long distance ramming. If two ROBOTS choose not to use bumpers, and they contact such that simultaneous contact occurs both in and out of the BUMPER ZONE, then this contact is considered within the BUMPER ZONE.
- Contact outside of the BUMPER ZONE is generally not acceptable, and the offending ROBOT will be assessed a 5-point penalty, and may be disqualified from the match if the offense is particularly egregious or if it results in substantial damage to another ROBOT. Incidental contact will not be penalized. Contact outside the BUMPER ZONE that is a result of tipping caused by contact within the BUMPER ZONE will be considered incidental contact.
- If a ROBOT extends outside of its 28 inch by 38 inch starting footprint, it is responsible for the extension's contact with other ROBOTS and must not use the extension to contact other ROBOTS outside of the BUMPER ZONE. Likewise, other ROBOTS will not be responsible for contact with the extension outside of the BUMPER ZONE. Again, incidental contact will not be penalized.
- Extension to extension contact between 2 robots with appendages outside the 28-inch by 38-inch starting envelope will generally not be penalized.
- Contact with a tilted robot such that the contact is outside the bumper zone will generally be considered incidental contact.

In all cases involving robot-to-robot contact, the Head Referee may assess a 5-point penalty and the robot may be disqualified, subject to these guidelines.

<G23> Accidental Entanglement - If, due to its own loose cables, hoses, cordage, etc., a ROBOT unintentionally but routinely entangles another ROBOT as a result of normal game interaction, the head referee may at his or her discretion disqualify the offending ROBOT and require that the entangling device be repaired prior to the ROBOT's next match.

<G24> Pinning - While on the carpeted field surface, a ROBOT cannot pin (inhibit the movement of another ROBOT while in contact with a field element or border) for more than 10 seconds. This rule does not apply if either ROBOT is entirely on an ALLIANCE PLATFORM. If a ROBOT has been pinned for 10 seconds, the team with the pinning ROBOT will be told by a referee to release the pinned ROBOT and back away approximately 3 feet. Once the pinning ROBOT has backed off by 3 feet, it may again attempt to pin its opponent, and if successful, the 10 second count will start over. If a referee determines that this rule has been violated, a 5-point penalty flag will be assessed for each violation.

#### **4.3.4.5 Match Play**

<G25> Balls Out of Play - Balls that leave the playing field over the side field boundaries will be placed on the field just inside the field boundary approximately where it left the field, provided it is safe to do so. Balls that leave the field over the player station will be given to a HUMAN PLAYER closest to where the ball left the field. Every attempt will be made to return balls to the field. However, if there are no balls available to replace balls thrown out of the immediate area, then the match will continue with the balls that remain on the field.

<G26> ROBOT Off Sides - During the SECOND and THIRD PERIODS the ALLIANCE on defense can have at most two (2) operable\* ROBOTS on the defensive end of the field (the near end of the field, from the ALLIANCE point of view). If the ALLIANCE has a third operable ROBOT, that ROBOT (the BACKBOT) must be positioned on the end of the field farthest from the ALLIANCE STATION.

If an ALLIANCE is determined to be "Off Sides" they will immediately receive a 5-point penalty. The ALLIANCE will receive an additional 5-point penalty every 5 seconds thereafter, until they have placed a valid BACKBOT in position at the far end of the field. In all situations if a BACKBOT is prevented by an offensive ROBOT from crossing the field centerline, then the ALLIANCE will not be penalized.

The mid-field line is included in both the defensive and offensive half of the field. Multiple ALLIANCE robots are permitted in the far half of the field. ROBOTS of the same ALLIANCE may dynamically change the designation of the BACKBOT during the defensive period as long as there is at least one BACKBOT during the entire period.

<Part A> If an alliance starts a defensive period with more than two operable\* ROBOTS on the defensive side of the field, then:

- If none of the ALLIANCE ROBOTS are moving toward the far end of the field at the start of the period, then the ALLIANCE will be considered Off Sides.
- If at least one of their ROBOTS is moving toward the far side of the field, then the ALLIANCE will have a 5 second grace period in which to position a ROBOT beyond the mid-field line and make it their BACKBOT. After the conclusion of the grace period, if the ALLIANCE does not have a valid BACKBOT they will be considered Off Sides.

<Part B> During the defensive period, if an ALLIANCE BACKBOT crosses the centerline to the defensive side of the field before another ALLIANCE ROBOT has taken position as BACKBOT, then the ALLIANCE will be considered Off Sides.

<Part C> During the defensive period, if an alliance BACKBOT is pushed across the center line and into a potential off-sides violation by an opposing ROBOT, the BACKBOT will continue to be considered "On Sides" unless and until it begins to play defensively. If the BACKBOT does not begin defensive play, then it may stay in the position in which it was deposited by the opposing ROBOT, or move back across the centerline at it's own pace. If the BACKBOT does begin to play defensively, then (given that another ALLIANCE ROBOT has not moved to become the new BACKBOT) the ALLIANCE will be considered Off Sides.

\* Note: a ROBOT will be considered operable unless the robot has fallen over and cannot be righted, or the ROBOT has been disabled by the field control system, or the team has pushed the "E-Stop" button to disable the ROBOT. Loss of control due to operator error, user software errors, or faulty mechanical systems are not sufficient to cause a ROBOT to be classified as "inoperable."

<G27> ROBOTS Must Throw the Balls into the Center Goal - Only a ROBOT may throw a ball into the center goal. The kinetic energy of the ball must be supplied by the ROBOT. A HUMAN PLAYER may not bounce a ball off a ROBOT and score it in the center goal. A violation of this rule will result in a 5-point penalty.

<G28> ROBOTS Can Pick Up Balls - ROBOTS are permitted to pick up balls from the field.

<G29> Detaching Mechanisms - ROBOTS may not intentionally detach parts or leave multiple mechanisms on the field. Violations will result in a 5-point penalty. If an intentionally detached component or mechanism impedes access to a ramp or a goal, the offending ROBOT will be disqualified from the match.

<G30> Field Reset, ROBOT Ball Release - ROBOTS must be designed to permit the release and removal of any balls from the ROBOT without being powered up after a match. If a ROBOT violates this rule, the head referee will warn the offending team and request that they modify the ROBOT. If the modification is not made, the head referee may not allow the ROBOT to compete in future matches.

#### 4.3.5 Team Member Actions

<G31> Number of people in the ALLIANCE ZONE - Each team shall include a maximum of one HUMAN PLAYER, two DRIVERS, and one COACH. A team with additional personnel in the ALLIANCE ZONE will be assessed a 5-point penalty, and the additional person will be asked to immediately leave the ALLIANCE ZONE.

<G32> Travel Within the ALLIANCE ZONE - All team members may travel anywhere within the ALLIANCE ZONE.

<G33> HUMAN PLAYER Shooting Zone - The HUMAN PLAYER must remain behind the STARTING LINE and within the ALLIANCE ZONE when they are entering a ball onto the field. Each violation will result in a 5-point penalty. Human players may jump to enter a ball onto the field. However, if their momentum carries them across the starting line, even after they release the ball, a penalty will be assessed. Extreme jumping, sitting or standing on the shoulders of another human player, or any behavior that is potentially hazardous to the team members or field personnel, or damaging to the robots, will be considered a violation of Rule <S01>.

<G34> HUMAN PLAYER/COACH/DRIVER Out of ZONE - All team members must stay within their ALLIANCE ZONE during the match. Each violation will result in a 5-point penalty.

<G35> HP/COACH/DRIVER Over The STARTING LINE During AUTONOMOUS PERIOD - No team member may pass the STARTING LINE in the ALLIANCE ZONE until the conclusion of the AUTONOMOUS PERIOD (when the field timer displays zero seconds). Each violation will result in a 5-point penalty. Exceptions will be made in cases involving personal safety or the safety of the ROBOT controls.

<G36> HUMAN PLAYER Entering Balls on the Field During AUTONOMOUS PERIOD - A HUMAN PLAYER may not enter a ball onto the field during AUTONOMOUS PERIOD. A violation of this rule will result in a 5-point penalty.

<G37> Team Member Ball Handling - Any HUMAN PLAYER, DRIVER, or COACH may handle balls that are in the ALLIANCE ZONE during a match.

<G38> Entering balls onto the field - Only the HUMAN PLAYERS may enter a ball onto the field, either by attempting to throw it to a ROBOT, attempting to throw it in a corner goal, or throwing it onto the field for pickup by a ROBOT. Balls must be thrown over the top of the Alliance Station Wall, and may not be thrown around the side of the Alliance Station Wall. Violations of this rule will result in a 5-point penalty per ball entered onto the field.

<G39> Scoring interference - HUMAN PLAYERS, DRIVERS, or COACHes may not reach into a ball chute or in any way interfere with the ball counting system. Violations of this rule will result in disqualification.

<G40> COACHes Operating ROBOTS - During a match, the ROBOTS may be remotely operated solely by the DRIVERS and/or by software running in the on-board control system. Any violation of this rule, such as

a COACH touching the controls, will result in the ROBOT being disabled and disqualified from the match.

<G41> Respect and Professional Demeanor - FIRST Competitions promote respect and professional demeanor. In the event that team members who are on the playing field (DRIVERS, COACHES, or HUMAN PLAYERS) are uncivil towards competition field personnel (including referees, tech advisors, FIRST field volunteers, etc.) or other teams, the team may be disqualified from the match. This rule only applies to team field personnel while on the playing field. Teams may not receive penalties for actions off the field, however they will be held accountable.

#### 4.3.6 Referee Interactions

<G42> Any discussions regarding rules, scores, or penalties must be between the DRIVERS or HUMAN PLAYERS (pre-college team members) and the head referee.

<G43> The Head Referee may at his or her discretion receive input from other sources, particularly Game Design Committee members that may be present at an event. However, the Head Referee's decision is final (reference Rule <T01>).