2016-2017 FIRST® Tech Challenge
VELOCITY VORTEX℠
Game Manual Part 2
Volunteer Thank You

Thank you for taking the time to volunteer for a FIRST Tech Challenge Event. FIRST and FIRST Tech Challenge rely heavily on Event Volunteers, Coaches, and Mentors alike to ensure Events run smoothly and to support students through their FIRST Tech Challenge journey. The experience these students receive in the FIRST Tech Challenge program will surely shape their lives in many positive ways, which could not happen without people like you. With over 4,500 Teams competing annually, your dedication and commitment are paramount to the success to the FIRST Tech Challenge program. Thank you for your time and effort in supporting the mission of FIRST!

Sponsor Thank You

Thank you to our generous sponsors for your continued support of the FIRST Tech Challenge!
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Introduction

What is FIRST® Tech Challenge?
FIRST Tech Challenge is a student-centered activity that focuses on giving students a unique and stimulating experience. Each year, Teams participate in a new Game that requires them to design, build, test, and program autonomous and driver-operated robots that must perform a series of tasks.

The playing field for the Game consists of the FIRST Tech Challenge game pieces set up on a foam-mat surface, surrounded by a metal and polycarbonate Field frame. Each Tournament features Alliances, which are comprised of two Teams, competing against one another on the playing field. Teams work to overcome obstacles and meet challenges, while learning from, and interacting with their peers and adult Mentors. Students develop a greater appreciation of science and technology and how they might use that knowledge to impact the world around them in a positive manner. They also cultivate life skills such as:

- Planning, brainstorming, and creative problem-solving.
- Research and technical skills.
- Collaboration and teamwork.
- Appreciation of differences and respect for the ideas and contributions of others.

To learn more about FIRST Tech Challenge and other FIRST Programs, visit www.firstinspires.org.

FIRST Tech Challenge Core Values
Volunteers are integral to the FIRST community. FIRST Tech Challenge relies on Volunteers to run the program at many levels, from managing a region to Mentoring an individual Team. Our Affiliate Partners coordinate the program in each region or state. These Affiliate Partners fundraise, run Tournaments, hold workshops and demonstrations, market FIRST Tech Challenge locally, handle public relations, and recruit Volunteers and Teams. They are a tremendous resource for Mentors and FIRST would not exist without them.

FIRST asks everyone who participates in FIRST Tech Challenge to uphold the following values:

- We display Gracious Professionalism® with everyone we engage with and in everything we do.
- We act with integrity.
- We have fun.
- We are a welcoming community of students, Mentors, and Volunteers.
- What we learn is more important than what we win.
- We respect each other and celebrate our diversity.
- Students and adults work together to find solutions to challenges.
- We honor the spirit of friendly competition.
- We behave with courtesy and compassion for others at all times.
- We act as ambassadors for FIRST and FIRST Tech Challenge.
- We inspire others to adopt these values.

Gracious Professionalism® - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
**Gracious Professionalism®**

*FIRST* uses this term to describe our programs’ intent. This is one of the most important concepts that can be taught to a young person who is learning to get along in the work world. At *FIRST*, Team members help other Team members, but they also help other Teams.

*Gracious Professionalism®* is not clearly defined for a reason. It can and should mean different things to everyone.

Some possible meanings of *Gracious Professionalism®* include:

- 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.
- Gracious Professionals make a valued contribution in a manner pleasing to others and to themselves.

In the context of *FIRST*, this means that all Teams and participants should:

- Learn to be strong competitors, but also treat one another with respect and kindness in the process.
- Avoid leaving anyone feeling as if they are excluded or unappreciated.
- Knowledge, pride and empathy should be comfortably and genuinely blended.

In the end, *Gracious Professionalism®* is part of pursuing a meaningful life. When professionals use knowledge in a gracious manner and individuals act with integrity and sensitivity, everyone wins, and society benefits.

Watch Dr. Woodie Flowers explain *Gracious Professionalism®* in this [short video](#).

"The *FIRST* spirit encourages doing high-quality, well-informed work in a manner that leaves everyone feeling valued. *Gracious Professionalism* seems to be a good descriptor for part of the ethos of *FIRST*. It is part of what makes *FIRST* different and wonderful."

- Dr. Woodie Flowers, National Advisor for *FIRST*

**Gracious Professionalism® for Volunteers**

It is a good idea to spend time going over this concept with Volunteers. Provide Volunteers with real-life examples of *Gracious Professionalism* in practice before, during, and after the event and recognize great *Gracious Professionalism* when you see it in action!
Youth Protection Program

The purpose of the FIRST® Youth Protection Program (FIRST YPP) is to provide Coaches, Mentors, Volunteers, employees, others working in FIRST programs, team members, parents, and guardians of team members with information, guidelines, and procedures to create safe environments for everyone participating in FIRST programs.

The FIRST YPP sets minimum standards recommended for all FIRST activities. Adults working in FIRST programs must be knowledgeable of the standards set by the FIRST YPP, as well as those set by the school or organization hosting their team.

Youth Protection Expectations and Guidelines

Coaches and Mentors are expected to read and follow elements in the FIRST Youth Protection Program guide that are labeled as required are mandatory in the United States and Canada, and may not be waived without the approval of the FIRST Youth Protection Department.

FIRST recommends that the standards set forth in the FIRST Youth Protection Program guide be applied outside of the United States and Canada to the extent possible. At a minimum, local regulations regarding youth protection must be complied with.

Forms are available here: http://www.firstinspires.org/sites/default/files/uploads/about/FORMS.zip


Information on the Canadian Screening process is available here: http://vimeo.com/30137373

You can find FAQ and additional information about the FIRST Youth Protection Program on the FIRST website at: http://www.firstinspires.org/resource-library/youth-protection-policy

NOTICE OF NON-DISCRIMINATION

United States Foundation for Inspiration and Recognition of Science and Technology (FIRST®) does not discriminate on the basis of race, color, national origin, sex, disability, or age in its programs and activities. The following person has been designated to handle inquiries regarding the non-discrimination policies: Lee Doucette, Youth Protection Program Manager, 200 Bedford Street, Manchester, NH 03101, 603-666-3906, Ext. 250.

Everyone working with FIRST Teams should be familiar with the FIRST YPP policies.
1.0 The Game

1.1 Introduction
This document describes VELOCITY VORTEX™ presented by Qualcomm®, the FIRST® Tech Challenge game for the 2016-2017 season. Teams must comply with all rules and requirements stated in this document and in Part 1 of the Game Manual. Clarifications to the game rules are issued on the Question & Answer section of the game forum at http://www.firstinspires.org/resource-library/ftc/game-and-season-info. Forum rulings take precedence over information in the game manuals.

1.2 Game Description
Matches are played on a Playing Field initially set up as illustrated in Figure 1.3-1 below. Two Alliances – one “Red” and one “Blue,” composed of two Teams each – compete in each Match. The object of the game is to attain a higher Score than the opposing Alliance by scoring Particles into the Corner Vortex and the Center Vortex, lifting Cap Balls, Capping the Center Vortex with a Cap Ball, Claiming Beacons, and navigating to specific parts of the Playing Field. The Scoring Elements for the game are 10 Alliance-specific Particles (5 per Alliance) and 2 Alliance-specific Cap Balls (1 per Alliance). The game is played in two distinct periods: Autonomous and Driver-Controlled.

The Match starts with a 30-second Autonomous Period in which Robots operate using pre-programmed instructions only. Alliances earn points by: (1) Claiming Beacons, (2) moving the Cap Ball off of the Center Vortex Assembly onto the field floor, (3) scoring Particles in their Alliance’s Center Vortex or Corner Vortex, and (4) by parking their Robot in contact with the Center Vortex Assembly or Corner Vortex Ramp.

The two minute Driver-Controlled Period follows the Autonomous Period. During this period, Teams earn points for their Alliance by: (1) scoring Particles into their Alliance’s Center Vortex, (2) scoring Particles in their Alliance’s Corner Vortex and (3) Claiming Beacons for their Alliance.

The final 30 seconds of the Driver-Controlled Period is called the End Game. In addition to the previously listed Driver-Controlled Period Scoring activities, Alliances earn points by (1) raising the Cap Ball off of the Playing Field Floor or (2) by placing the Cap Ball into their Center Vortex.
### 1.3 Playing Field Illustrations

The following illustrations identify the Game Elements and give a general visual understanding of the game. Teams should refer to the official Playing Field documents available at [http://www.firstinspires.org/resource-library/ftc/game-and-season-info](http://www.firstinspires.org/resource-library/ftc/game-and-season-info) under the “FIRST Tech Challenge Game & Season Materials” for the exact Game Element layout and dimensions. Please note: Playing Field wall heights may be different depending on the manufacturer. Please incorporate that into the design of your Robot.

![Figure 1.3-1](image-url) 

Figure 1.3-1 – Isometric view of the Playing Field
Figure 1.3-2 – View of the Center Vortex Assembly (dimensions in inches)

Figure 1.3-3 – Dimensions (in inches) and Isometric view of the Red Alliance Corner Vortex

Figure 1.3-4 – Field view of Beacon with vision target
1.4 Game Definitions

The following definitions and terms are used in VELOCITY VORTEX™:

**Alliance** – A grouping of two Teams that work together for a given Match. Alliances are designated as either “Red” or “Blue.”

**Alliance Station** – The designated “Red” or “Blue” Alliance Area adjacent to the Playing Field where the Drivers and Coach stand or move within during a Match.

**Area** – The space defined by the vertical projection of the outside edge of a region’s boundary (e.g. gaffers tape, goal, Playing Field Wall). The boundary element (tape, wall, markings, etc.) is considered to be part of the Area for the purposes of determining Inside and Outside.

**Autonomous Period** – A thirty second period in which the Robots operate and react only to sensor inputs and to commands pre-programmed by the Team onto the onboard Robot control system. Human control of the Robot is not permitted during this time.

**Beacon** – An object that Robots “Claim” at any point in the Match to earn points for their Alliance. VELOCITY VORTEX™ is played with four Beacons which are mounted on top of Playing Field Walls in the locations shown in Figure 1.3-1. Each Beacon has two buttons on its front face and a vision target mounted on the outside of the Playing Field Perimeter as depicted in the illustration. Each of those buttons has LEDs above it that will be illuminated as either red or blue. Each Beacon also has a randomization button; when it is pressed prior to the start of a Match, it will randomly choose to illuminate red LEDs above one button and blue LEDs above the other.

**Block / Blocking** – Preventing an opposing Alliance Robot from accessing an Area or Alliance specific Game Element for an extended period of time by obstructing ALL paths of travel to the object or Area. See also Trap/Trapping (which may be considered the same except it is FROM a Game Element or Area of the Playing Field).

**Cap / Capping** – Placing a Cap Ball into the Center Vortex.

**Cap Ball** – An Alliance-specific Scoring Element for the game. The Cap Ball measures 53.3 cm (21 inches) in diameter and weighs approximately 1,103 gm (38.9 ounces). There is one Cap Ball per Alliance.

**Card** – See Penalty.

**Center Vortex Assembly** – Two Center Vortexes, one for each Alliance, and their support structure.

**Center Vortex Base Area** – The base plate used to support the Center Vortexes on the Playing Field. The Center Vortex Base Area measures 61 cm x 61 cm (2 ft. x 2 ft.).

**Claiming a Beacon** – Pressing a button on the Beacon to change its illumination state to benefit an Alliance.

**Coach** – A student Team member or adult mentor designated as the Team advisor during the Match and identified by wearing a “Coach” badge or identifying marker.

**Competition Area** – The area where all the Playing Fields, Alliance Stations, Scoring tables, on-deck queuing tables, event officials, and other tournament items relating to Match play are located. The Team Pit area and practice Playing Fields are not part of the Competition Area.
**Control / Controlling** – An object is considered to be *Controlled* by a *Robot* if the object is following the movement of the *Robot*. Objects that are *Controlled* by a *Robot* are considered to be part of the *Robot*. See *Possess / Possessing* to learn about a related term. Examples include, but are not limited to:

- Carrying – holding *Game Elements* *Inside* or *Outside* of a *Robot*.
- Herding – intentionally pushing or impelling *Game Elements* to a desired location or direction.
- Holding – holding one or more *Scoring Elements* against a *Game Element*, *Playing Field Wall*, or *Robot* in an attempt to shield or guard them.
- Launching – shooting *Game Elements* into the air or throwing in a forceful way.

Examples of interaction with *Game Elements* that are not *Control* include, but are not limited to:

- Plowing – *Inadvertent* contact with *Game Elements* while in the path of the *Robot* moving about the *Playing Field*.
- Deflecting – being hit by *Game Elements* that bounce into or off of a *Robot*.

**Corner Vortex Ramp** – The inclined surface of the *Corner Vortex* as shown in Figure 1.3-3.

**Disable / Disabled** – A *Robot* that is no longer active for the remainder of the *Match* due to a *Robot* failure or by the request of a referee. If a referee *Disables* a *Robot* during a *Match*, he/she will ask the *Team* to drive their *Robot* to a neutral position on the *Playing Field*, issue a stop command with the *Driver Station*, and to place their *Driver Station* in a hands-off location on a tournament-provided structure or the *Alliance Station* floor.

**Disqualified / Disqualification / Disqualify** – A *Team* that is *Disqualified* from a *Match* has their *Robot* *Disabled* and will not receive credit for the *Match* (i.e., no Qualifying or Ranking points).

**Drive Team** – Up to three representatives (two *Drivers* and one *Coach*) from the same *Team*.

**Driver** – A pre-college student *Team* member responsible for operating and controlling the *Robot* and identified by wearing a tournament supplied “*Driver*” badge or identifying marker.

**Driver-Controlled Period** – The two minute time period in which the *Drivers* operate the *Robots*.

**Driver Station** – Hardware and software used by a *Drive Team* to control their *Robot* during a *Match*. The *Driver Station* consists of an Android device, *FIRST* Tech Challenge supplied Android App, adapter cable(s), optional unpowered USB Hub, an optional commercial off the shelf USB external battery connected to the USB Hub to charge the Android device at any time, and up to two controllers to drive the *Robot*. *Teams* may use one of two models of controller device(s) – either the Logitech F310 Gamepad Controllers or the Xbox 360 Controller for Windows (Part #: 52A-00004).

**End Game** – The last thirty seconds of the *Driver-Controlled Period*.

**Fully Illuminated** – A *Beacon* is said to be *Fully Illuminated* when both halves of its lights are the same color.

**Game Element** – Any item *Robots* interact with to play the game. *Game Elements* for this year’s game include: *Corner Vortextes*, *Cap Balls*, *Particles*, *Beacons*, and the *Center Vortex Assembly*.

**In (Inside) / Completely In (Completely Inside)** – An object that has crossed into the upwards vertical (i.e. at a right angle to the *Playing Field* tile floor) extension of a defined *Area*’s boundary is *Inside* the *Area*. An
object that is entirely within the upwards vertical extension of a defined Area’s boundary is **Completely Inside** the Area.

**Inadvertent** – An outcome that is not a planned strategy and not the predictable result of persistent or repeated actions.

**Inconsequential** – An outcome that does not have an effect on **Scoring** or gameplay.

**Match** – A head-to-head competition between two **Alliances**. A **Match** consists of a thirty second **Autonomous Period** followed by a two minute **Driver-Controlled Period** for a total time of two minutes and thirty seconds.

**Off / Completely Off** – Not physically in contact with or **Supported** by an object, surface, etc.

**On / Completely On** – An object that is physically in contact with and at least partially **Supported** by an object, surface, etc. is considered **On**. An object that is entirely **Supported** by another object, surface, etc. is defined as **Completely On** the object, surface, etc.

**Out / Outside** – An object that has NOT crossed into any part of a defined Area is **Outside** the Area.

**Park / Parked** – A **Robot** that is motionless.

**Particle** – An **Alliance**-specific **Scoring Element** for the game. The **Particles** measure 9.5 cm (3.75 inches) in diameter and weigh approximately 56.13 gm (1.98 ounces). There are up to five (5) **Particles per Alliance**.

**Particle Return** – The portion of the **Corner Vortex** that **Particles** travel down to return to the **Playing Field Floor**. See Figure 1.3-3.

**Penalty** – The consequence imposed for a rule or procedure violation that is identified by a referee. When a **Penalty** occurs, points will be awarded to the **Alliance** that did not incur the **Penalty**. **Penalties** are further defined into **Minor Penalties** (ten points) and **Major Penalties** (forty points). **Penalties** may also escalate to issuing of a **Yellow Card** or **Red Card** as a result of a continued occurrence of a rule violation and upon discretion of the Referee.

**Yellow Cards and Red Cards** – In addition to rule violations explicitly listed in section 1.6 – **Rules of Game Play**, **Yellow Cards** and **Red Cards** are used in the **FIRST** Tech Challenge to manage **Team** and **Robot** behavior that does not align with the mission of **FIRST**.

The Head Referee may assign a **Yellow Card** as a warning, or a **Red Card** for **Disqualification** in a **Match**, as a result of egregious **Robot** or **Team** member behavior, or repeated (3 or more) violations of a rule at the event. A **Yellow Card** or **Red Card** is indicated at the end of a **Match** by the Head Referee standing in front of the **Team’s Alliance Station** and holding a **Yellow Card** and/or **Red Card** in the air.

**Yellow Cards** are additive, meaning that a second **Yellow Card** is automatically converted to a **Red Card**. A **Team** is issued a **Red Card** for any subsequent incident in which they receive an additional **Yellow Card**, including earning a second **Yellow Card** during a single **Match**. A second **Yellow Card** is indicated by the Head Referee standing in front of the **Team’s Alliance Station** and holding a **Yellow Card** and **Red Card** in the air simultaneously after the completion of the **Match**. A **Team** that has received either a **Yellow Card** or a **Red Card** carries a **Yellow Card** into subsequent **Matches**, except as noted below. A **Red Card** results in **Match Disqualification**. Multiple **Red Cards** may lead to **Tournament Disqualification**. Once a **Team** receives a **Yellow Card**, an indicator will be presented next to the **Team** number on the audience screen at the beginning of all subsequent **Matches** as a reminder to the **Team**, the referees, and the audience that they carry a **Yellow Card**.

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Yellow Cards do not carry over from the Qualification Matches to the Elimination Matches. During the Elimination Matches, Yellow and Red Cards count against the entire Alliance, not to a specific Team. If a Team receives a Yellow Card or Red Card, it results in the entire Alliance receiving the Yellow Card or Red Card for that Match. If two different Teams on the same Alliance are issued Yellow Cards, the entire Alliance is issued a Red Card. A Red Card results in zero (0) points for that Match, and the Alliance loses the Match. If both Alliances receive Red Cards, the Alliance which committed the action earning the Red Card first chronologically loses the Match.

**Pin / Pinning** – Preventing the movement in ALL directions of an opposing Alliance Robot while it is in contact with the Playing Field Wall, one or more Game Elements, or another Robot.

**Playing Field** – The part of the Competition Area that includes the 3.66 m x 3.66 m (12 ft. x 12 ft.) field and all of the Game Elements described in the official field documents. The Playing Field is divided into two equal-sized Alliance Areas (Red and Blue) separated by red and blue gaffers tape as shown in the illustration of the Playing Field in section 1.3. From the audience viewpoint, the Red Alliance Area is on the right side of the Playing Field.

**Playing Field Damage** – A physical change to a Game Element or Playing Field that affects game play or an action that causes harm to the playability of a Game Element or Playing Field.

For example: Black tire marks on an Element is not considered Playing Field Damage. However, digging a hole into the Playing Field tiles can be considered Damage.

**Playing Field Floor** – The surface of the tiles that make up the base of the Playing Field.

**Playing Field Perimeter** – The outermost boundary of the Playing Field defined by the outside face of the Playing Field Wall.

**Playing Field Wall** – An approximate 0.3m (1 ft.) tall, 3.66 m (12 ft.) long by 3.66 m (12 ft. wide) wall surrounding the soft foam tile floor of the Playing Field.

**Possess / Possessing** – An object is considered to be in Possession by a Robot if, as the Robot moves or changes orientation (e.g. moves forward, turns, backs up, spins in place), the object remains in approximately the same position relative to the Robot. Objects in Possession of a Robot are considered to be Controlled, and they are part of the Robot. See also Control/Controlling.

**Robot** – Any mechanism that has passed inspection and a Team places on the Playing Field prior to the start of a Match. A detailed definition of Robot is in the Robot rules section 5 in Part 1 of the Game Manual.

**Scoring / Score** – Robots earn points for their Alliance by interacting with Cap Balls and Particles, Vortexes, Beacons, and Parking in specific Areas of the Playing Field. Scoring Elements are considered to be Scored when they are placed In the appropriate Vortex and are no longer in contact with a Robot from the corresponding Alliance. Particles are not eligible to be Scored again until they make contact with the Playing Field Floor. The Scoring achievements and their point values are described in section 1.5.
**Center Vortex Scoring** - Particles are Scored in the Center Vortex when they are released into and roll through the Vortex. Particles entered upward through the bottom spokes of the Center Vortex will not count as Scored. Cap Balls are counted as Scored when they Cap the Center Vortex.

**Corner Vortex Scoring** - Particles are Scored in the Corner Vortex when they roll under the Vortex Bar AND roll down one of the Particle Return sides.

**Scoring Elements** – Objects that Robots place in specific Areas to earn points for their Alliance. The Scoring Elements for VELOCITY VORTEX℠ are Cap Balls and Particles.

**Support / Supported / Completely Supported** – A Robot is Supported by an object if that object is bearing at least some of the weight of the Robot. If the object is bearing all of the Robot’s weight, the Robot is fully Supported by the object.

**Team** – Mentors, supporters, and pre-college-aged students affiliated with an entity registered with FIRST and for the competition.

**Trap / Trapping** – Preventing an opposing Alliance Robot escaping from a constrained Area of the Playing Field or from a Game Element for an extended period of time by obstructing ALL paths of travel from the object or Area. See also Block/Blocking (which may be considered the same except it is TO a Game Element or Area of the Playing Field).

**Vortex** – An Area where Robots place or launch Cap Balls or Particles into to earn points for their Alliance.

**Center Vortex** – An Alliance-specific goal supported by the Center Vortex Assembly where Robots Score Particles throughout the Match and Cap with a Cap Ball during the End Game.

**Corner Vortex** – An Alliance-specific goal located in a corner of the Playing Field as shown in Figure 1.3-1 where Robots Score Particles throughout the Match.

### 1.5 Game Play

Prior to the start of the Match, Drive Teams perform some basic Robot setup steps that are described in section 1.5.1. Matches are made up of several periods totaling two minutes and thirty seconds. There is a thirty second Autonomous Period, followed by a two minute Driver-Controlled Period. The last thirty seconds of the Driver-Controlled Period is called the End Game.

**1.5.1 Pre-Match**

Teams will receive an Alliance-colored Robot-identification flag from field personnel; this flag must be securely mounted on the Robot as defined in the Robot rules. Drive Teams place their Robots in any orientation on the Playing Field with the following constraints:

a. Robots must be Completely Inside their Alliance’s Area of the Playing Field.

b. Robots must be in contact with the Playing Field Wall that is along the boundary of their Alliance Station. Transitive contact through Particles or Alliance Flags do not count as part of the Robot for the purpose of Pre-Match set up.

c. Robots may not be in contact with a Corner Vortex.

d. Robots may not extend beyond the outside edge of the Playing Field Wall.

e. Teams within an Alliance are required to pre-position or pre-load a total of three Alliance specific Particles for the Autonomous Period. Each Particle must be Completely Inside the Alliance’s Playing Field Area and in contact with a single Robot. No more than two Particles may touch a single Robot.

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The *Particles* may also touch the *Playing Field*. An *Alliance* with only one *Robot* on the *Playing Field* may pre-load up to two *Particles*. A Referee will place the remaining *Particle(s)* anywhere against the *Playing Field Wall* on the Alliance’s side, not touching a *Robot* (e.g. as depicted in Figure 1.3-1).

After placing their *Robot* on the *Playing Field*, the *Drive Team* selects their *Autonomous Period* Operational Mode (Op Mode) on their *Driver Station* Android device and initializes their *Robot* by triggering the Team’s initialization event software. *Drive Teams* wait Completely Inside their assigned *Alliance Station* for the beginning of the *Match* with their *Driver Station* in a hands-off location.

Field personnel will press the randomization button on the *Beacons*. Once the first *Beacon* has been initialized,

1) *Teams* may no longer touch their *Robots* until the conclusion of the *Match*, and
2) *Teams* may not touch their *Driver Stations* or Controllers until the *Autonomous Period* has ended, except to start their *Autonomous* program with a single touch to the *Driver Station* Android device screen.

*Center Vortexes* are designed to rotate around the vertical support bar. Prior to the start of the *Match*, Field Personnel will rotate the *Center Vortex Assembly* into the starting orientation shown in Figure 1.3-1.

1.5.2 *Autonomous Period*

The *Match* starts with a thirty second *Autonomous Period* where *Robots* are operated via pre-programmed instructions only. *Teams* are not allowed to control *Robot* behavior with the *Driver Station* or any other actions during the *Autonomous Period*. The *Driver Station* is placed in a hands-off location during the *Autonomous Period* so that it is evident that there is no human control of *Robots*. The only exception is to allow *Drive Teams* to start their *Robot* with a single start command issued on the *Driver Station* Android device using the built-in thirty second timer. The *Autonomous Period* begins following a start countdown (e.g. 3-2-1-go) by field personnel, signaling *Drive Teams* with *Robots* that plan to run an *Autonomous* Op Mode to issue a *Robot* start command with their *Driver Station*. Failure to adhere to this procedure may subject the *Team* and/or *Alliance* to a *Penalty* as specified in the game rules in Section 1.6.2.

The *Autonomous Score* is based on the number of *Particles* placed in *Vortexes* during the *Period*, and the states of the *Beacons*, *Cap Balls*, and *Robots* at the end of the *Period* after all *Game Elements* and *Robots* have come to rest. Points are awarded for the following achievements:

1. **Beacons** – The *Beacons* are randomly set up at the start of a *Match* so that *Robots* must use onboard sensors to identify the correct button to trigger the *Beacon* in favor of their *Alliance*. *Beacons* are randomized independently of each other.

   During the *Autonomous Period*, each *Beacon* is allowed to be triggered by pressing a button under either the red or blue LEDs. The *Alliance* matching the color that is triggered at the end of the *Autonomous Period* will receive thirty (30) points per *Beacon*, regardless of which *Alliance Robot* triggered it, so *Robots* should choose carefully. Alliances of the corresponding color will also receive a bonus *Particle* to be used during the *Driver-Controlled Period* for each *Claimed Beacon* (up to a maximum of two). The states of all the *Claims* determines how many bonus *Particles* are released. If no buttons are pressed during the *Autonomous Period*, the LEDs will not brighten or change color, indicating that zero points are awarded for that *Beacon*. To help prevent accidental resetting of a *Beacon* twice by a single *Robot*, there is a five second delay after a button is released before the buttons become active and are able to trigger the *Claim* again.

   Between the end of the *Autonomous Period* and the start of the *Driver-Controlled Period*, the bonus *Particles*, if any, will be introduced onto the field by the Referees by placing them into the

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corresponding Alliance’s Corner Vortex for the Alliance that earned them so that they roll down one of the Particle Returns. No Corner Vortex points are earned for the introduction of the bonus Particles onto the Playing Field.

2. **Cap Ball on Floor** – A Cap Ball in contact with the Playing Field soft foam tile floor will earn the corresponding Alliance five (5) points regardless of which Alliance Robot dislodged it from its starting location.

3. **Particle Scoring** – Particles Scored into an Alliance-specific Center Vortex earn fifteen (15) points each for the Alliance corresponding to that Vortex (regardless of Particle color). Particles Scored into a Corner Vortex earn five (5) points each for the Alliance corresponding to that Vortex (regardless of Particle color). Particles must make contact with the Playing Field Floor before they are eligible to be Scored again.

4. **Robot Parking** – There are four Robot Parking options in two Areas available for Teams to earn points (of which only the higher value Score will count - <G22>):
   
   a. Robots Parked On the Center Vortex Base Area earn five (5) points for their Alliance.
   b. Robots Parked Completely On the Center Vortex Base Area earn ten (10) points for their Alliance.
   c. Robots Parked On a Corner Vortex earn five (5) points for their Alliance.
   d. Robots Parked Completely On a Corner Vortex earn ten (10) points for their Alliance.

### 1.5.3 Driver-Controlled Period

At the conclusion of the Autonomous Period, referees fill out scoresheets, award bonus Particles, and Drive Teams pick up their Driver Stations. When the referees are ready, field personnel will instruct Teams to select their Driver-Controlled Op Mode and initialize their Robots by triggering the Teams’ initialization event software with their Driver Station Android device. A two minute Driver-Controlled Period begins following a start countdown (e.g. 3-2-1-go) by field personnel. Teams start their Robots by pressing the start button on their Driver Station Android device. Failure to adhere to this procedure may subject the Team and/or Alliance to a Penalty as specified in the game rules in Section 1.6.2.

The Driver-Controlled Score is based on the number of Particles Scored into the Corner and Center Vortexes during the Period, the state of the Beacons, and the locations of the Cap Balls and Robots at the end of the Match after all Game Elements and Robots have come to rest. During the Driver-Controlled Period, points are awarded for the following achievements:

1. **Particle Scoring** – Particles Scored into an Alliance-specific Center Vortex earn five (5) points each for the corresponding Alliance (regardless of Particle color). Particles Scored into the Alliance-specific Corner Vortex earn one (1) point each for the corresponding Alliance (regardless of Particle color). Particles must make contact with the Playing Field Floor before they are eligible to be Scored again.

2. **Beacons** – Robots may Claim any of the four Beacons on the Playing Field any number of times during the Driver-Controlled Period. Beacons are Scored based on their color at the end of the Match (i.e. they are not Scored multiple times throughout the Match). An Alliance will earn ten (10) points for each Beacon that is Fully Illuminated with their Alliance color at the end of the Match.

The first time a Beacon is triggered, both LEDs above the selected button become illuminated with the chosen color. The next time it is triggered; both LEDs on the Beacon are illuminated with the opposite color, so care should be taken as to how many times a button is pressed. The last

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illuminated color of the Beacon determines which Alliance has Claimed it for the Driver-Controlled Period.

1.5.4 End Game
The last thirty seconds of the Driver-Controlled Period is called the End Game. During the End Game – and not before in the Driver-Controlled Period – Robots may raise the Cap Balls Completely Off the floor, or place the Cap Balls into the Center Vortex. Robots may continue to perform all of the other Driver-Controlled scoring activities during the End Game. Points are awarded for the following End Game achievements:

1. **Cap Ball Off the Playing Field** – A Robot that raises the Cap Ball Completely Off the Playing Field Floor and keeps it raised at the end of the Match, will receive points based on how high it is raised.

   a. **Low height** – The lowest point of the Cap Ball is lower than 76 cm (30 inches) – the approximate height of the Center Vortex crossbar – 10 points.

   b. **High height** – The lowest point of the Cap Ball is above 76 cm (30 inches) – the approximate height of the Center Vortex crossbar – 20 points.

   c. **Capping** – The Cap Ball is supported by an Alliance-specific Center Vortex and not in contact with a Robot on the corresponding Alliance – 40 points.

At the conclusion of the Driver-Controlled Period, Teams are required to press the “Stop” button on their Driver Station Android Device.

1.5.5 Post Match
During the Match, field personnel will record the number of Particles Scored into Vortextes. After the Match is over, referees record the locations of the Cap Balls, Robots, and the number of Beacons illuminated. After they are finished scoring the Playing Field, referees will signal for the Drive Teams to enter the Playing Field and retrieve their Robots. Teams should not step on or over the Corner Vortex ramps when retrieving their Robots. The Drive Teams should return Particles and Cap Balls that are Possessed by the Robot to the Playing Field and return the Alliance-colored Robot identification flag to the field personnel. The Playing Field reset crew will set up the Playing Field for the next Match.

1.5.6 Penalty Scoring
Penalty points are added to the non-offending Alliance’s Score at the end of the Match. Minor Penalties give the non-offending Alliance ten (10) points per occurrence. Major Penalties give the non-offending Alliance forty (40) points per occurrence.

1.5.7 Flowchart of Match Play
The following figure shows the flow of the Match and the actions taken on the Driver’s Station Android device.
1.6 Rules of Game Play

Game play is restricted by the Safety rules (<S#>), the General rules (<G#>), and the Game Specific rules (<GS#>). Other rules to pay close attention to are the Robot rules, the inspection rules, and the tournament rules defined in Part 1 of the Game Manual. Violation of rules may lead to Penalties, Yellow Cards and/or Red Cards, a Disabled Robot, Disqualification of the offending Team and/or Alliance from either a Match or the Tournament. Rules apply to all periods of play unless specifically called out as omitted. If rules are in conflict, Safety rules take precedence over all rules and Game Specific rules take precedence over General rules. The official FIRST Tech Challenge Question & Answer Forum rulings take precedence over all information in the game manuals.

1.6.1 Safety Rules

<S1> Unsafe Robot and Playing Field Damage – If at any time the Robot operation is deemed unsafe or has damaged the Playing Field or another Robot, by the determination of the referees, the offending Robot may be Disabled and the Team may be issued a Yellow Card. Re-inspection of the Robot is required before it may play another Match.

The intent of this rule is to immediately stop unsafe Robot actions or Playing Field Damage that is likely to persist with continued Robot operation. Robots that are able to continue safe operation without damaging the Playing Field will receive a warning and may continue to play the Match. Robots will be Disabled for unsafe operation or Playing Field Damage that occurs after the first warning for the Tournament.

<S2> Robot Extension Outside the Playing Field Perimeter – If any portion of the Robot makes contact with anything Outside the Playing Field Perimeter, the Team will be issued a Yellow Card and it may be Disabled immediately for the remainder of the Match, unless allowed by game-specific rule(s) listed in Section 1.6.3. See the game definitions in section 1.4 for a complete description of the Playing Field Perimeter.
<S3> Safety Gear – All members of the Drive Team are required to wear safety glasses and shoes with closed-toes and a closed-back. If any member of the Drive Team is not wearing these safety items, the referee will issue a warning and if the situation is not remedied within thirty seconds, the offending member(s) of the Drive Team must leave the Competition Area for the remainder of the Match and may not be replaced by another Team member. Failure to comply with a request to leave the Competition Area violates rule <G26>.

1.6.2 General Game Rules

<G1> Drive Team – Each Drive Team shall include up to two Drivers and one Coach. Electronic communications (cell phone, two-way radio, Wi-Fi, Bluetooth, etc.) by Drive Team members after an Alliance has been called from the queue to the Playing Field for its Match are not allowed. The first instance of violating this rule will result in a warning, with any following instances during the tournament resulting in a Minor Penalty. Items that may be mistaken by a casual observer as being in violation should not be brought to the Playing Field. The Driver Station is exempt from this rule, but must be used only for operating the Robot.

<G2> Pre-Match Robot Setup – At the beginning of a Match, each Alliance Robot must be set up on the Playing Field in accordance with section 1.5.1 Pre-Match. After Robots have been set up on the Playing Field, Drive Teams are required to stand Completely Inside the Alliance Station at the location (Station one or Station two) specified by the Qualification Match schedule.

a. During the Qualification Matches, the Blue Alliance Robots are set up on the Playing Field first, unless the Red Alliance waives their right to set up on the Playing Field second.

b. During the Elimination Matches, the lower seeded (e.g. 3rd seed is lower than 2nd seed) Alliance Robots are set up on the Playing Field first, unless the higher seeded Alliance waives their right to set up on the Playing Field second. Alliance color doesn’t change the seeding of a Team during the Elimination Matches. If the 4th seed defeats the 1st seed in the Semi-Finals, they will still have to place their Robot on the field first in the Finals because their seeding will be lower than the 2nd or 3rd seed.

c. Teams may implicitly waive their right to place their Robots on the Playing Field last by placing their Robots on the Playing Field before or in conjunction with the opposing Alliance. There is no need to notify the referees; Teams waive their right by the act of placing their Robots on the Playing Field.

d. Teams that unnecessarily delay the beginning of a Match and/or field reset will incur a Minor Penalty for each offense.

Drive Teams are expected to stage their Robots for a Match, and remove it from the Playing Field afterwards, safely and swiftly. Drive Team efforts that either intentionally or unintentionally delay the start of a Match or the Field reset are not allowed. Examples include, but are not limited to:

- Late arrival to the Playing Field.
- Robot maintenance once on the Playing Field.
<G3> **Robot Starting Volume** – Before the start of a *Match*, each *Robot* in its starting location must not exceed a volume of 45.7cm (18 inches) wide by 45.7cm (18 inches) long by 45.7cm (18 inches) tall. The *Alliance* identification flag and pre-loaded *Scoring Elements* may extend *Outside* the 45.7cm (18 inches) cube volume constraint. An offending *Robot* will be *Disabled* and powered off for the *Match* at the Head Referee’s discretion and must remain on the *Playing Field* in its starting location for the length of the *Match*. After the start of a *Match*, the *Robot* may extend in any dimension unless restricted by the Game-Specific Rules detailed in Section 1.6.3.

<G4> **Robot Setup Alignment Devices** – Alignment devices are allowed during pre-*Match* setup if they are constructed from legal components, they are part of the *Robot*, and remain *Completely Inside* the 45.7cm (18 inches) cube starting volume constraint during the set up process. A *Minor Penalty* will be assessed to the *Team* for violation of this rule.

The intent of this rule is to prohibit the use of devices external to the *Robot* and to prevent the extension of any object or tool *Outside* the 45.7cm (18 inches) cube starting volume. Humans standing on the other side of the field to aide in aligning the *Robot* are not allowed.

<G5> **Alliance Station** – During a *Match*, the *Drivers* and *Coach* must remain *Completely Inside* their *Alliance Station*. The first instance of leaving the *Alliance Station* will result in a warning, with any following instances resulting in a *Minor Penalty*. Leaving the *Alliance Station* for safety reasons will not result in a warning or *Penalty*.

<G6> **Starting Game Play Early** – *Robots* that start play of the game (*Autonomous* or *Driver-Controlled Period*) prior to competition personnel announcing the start of a *Match* period receive a *Minor Penalty*. Referees have the option of issuing a *Major Penalty* in place of the *Minor Penalty* if the early start results in a competitive advantage for the offending *Alliance*.

<G7> **Late Start of the Autonomous Period** – *Teams* participating in the *Autonomous Period* are expected to press the "start with 30-second" button on their *Driver Station* Android Device and then place the *Driver Station* in a hands-off location without delay when field personnel signal the start of the *Autonomous Period*. A *Minor Penalty* is assessed for violating this rule. Referees have the option of issuing a *Major Penalty* in place of the *Minor Penalty* if the late start results in a competitive advantage for the offending *Alliance*.

<G8> **Stopping Game Play Late** – *Robots* that do not stop playing the game at the end of the *Autonomous* or *Driver-Controlled Periods* when competition personnel or timer software announce the end of a *Match* period receive a *Minor Penalty* and the actions of the *Robot* occurring after the end of a *Match* period do not count towards their *Alliance’s Score*. Referees have the option of issuing a *Major Penalty* in place of the *Minor Penalty* if the late stop results in a competitive advantage (other than *Scoring*) for the offending *Alliance*.

*Scoring Elements* that were *Launched* before the end of the period are eligible to be counted as *Scored*. Other *Robot Scoring* achievements that occur after the announced end of the *Autonomous Period* and before the start of the *Driver-Controlled Period* do not count towards the *Score* for the *Autonomous* or *Driver-Controlled Periods*. Referees may remove any *Scoring Elements* from a goal that are improperly *Scored* in this manner.

The intent of this rule is for *Robots* to stop playing the game within a reasonable human reaction time following the start of the game sound (i.e. buzzer) signaling the end of the *Match*. *Drive Teams* should make their best effort to stop game play immediately when the end of *Match* game sound begins. Before the *Penalties* come into play, referees will use their discretion to give *Drive Teams* an approximate one second grace period following the conclusion of the game sound signaling the end of the *Match for Robots* to stop playing the game.

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Drive Team Contact with the Playing Field or Robot – During a Match, the Drivers and Coaches are prohibited from making contact with the Playing Field, any Game Element, or any Robot. The first instance of contact will result in a warning, with any following instances resulting in a Minor Penalty. Contact that affects Scoring and/or game play will result in issuance of a Yellow Card at the discretion of the referees. Contact with the Playing Field, a Game Element, or a Robot for safety reasons will not result in a warning or Penalty.

For example, a Particle is launched from a Robot on the Playing Field and it Inadvertently hits a Team member in the Driver’s Station and is deflected back onto the field. The Team would NOT receive a Penalty because the Team member was protecting him/herself (safety). However, if that same Particle is caught and/or directed to a specific location on the Playing Field, the Team may be issued a Penalty.

Autonomous to Driver-Controlled Period Transition – At the conclusion of the Autonomous Period the Head Referee at his or her discretion will untangle Robots, place Robots on their drivetrains, make minor adjustments to Robot position, etc. so that the Robots can participate in the Driver-Controlled portion of the Match. The referees will do this after finding out from the Drive Team where the best place is to touch their Robot to be moved or lifted. At this time, if a Robot has lost its Wi-Fi Direct connection to the Team’s Driver Station or if it is locked-up, the Robot Controller can be restarted and power to the Robot may be reset under supervision of the Field Technical Advisor as long as the Match is not extraordinarily delayed. If the Robot is not controllable after attempts to get it working with the Team’s Driver Station, it will be Disabled and remain in place on the Playing Field for the remainder of the Match.

When instructed by field personnel to do so, Drive Teams may use their Driver Station to select an Op Mode, initialize, start, and reset their Robot as appropriate. See Section 1.5 – Game Play for details.

Drive Team Coach Driver Station Control – During the Driver-Controlled Period, Robots must be remotely operated only by the Drivers using the Gamepads connected to the Team’s Driver Station and/or by software running in the on-board Robot control system. The first instance of Coach controlling (e.g. operating a Gamepad) will result in a warning, with any following instances resulting in a Major Penalty. During the Driver-Controlled Period, Drive Team Coaches and/or Drivers are allowed to hold the Team’s Driver Station Android Device and interact with it to select an Op Mode, view information displayed on the screen, and initialize, start, stop, and reset the Robot.

Recording the Score After Objects Come to Rest – Referee scoresheets will be filled out at the end of the Autonomous and Driver-Controlled Periods when all objects on the Playing Field have come to rest. A change in the state of a Game Element or Robot that occurs before a referee records the Score on the scoresheet will affect the Match Score. A change in state of a Game Element or Robot after its Score is recorded on the scoresheet will not change an already-recorded Score.

Robots Deliberately Detaching Parts – Robots may not deliberately detach parts during a Match, or leave mechanisms on the Playing Field. Consequence of deliberately detaching a part is a Minor Penalty if it does not Block an opposing Alliance Robot or goal. If a deliberately-detached component or mechanism affects gameplay by any Robot, the offending Robot will receive a Major Penalty and will be issued a Yellow Card. Robot parts that are released but remain connected by a tether and interfere with an opposing Alliance Robot are considered detached for the purposes of this rule.
<G14> **Robots Grasping Game Elements** – *Robots* may not grab, grasp and/or attach to any *Game Element* or structure other than *Scoring Elements*, unless specifically allowed by game-specific rule(s) listed in Section 1.6.3. The first instance will result in a warning with any following violations resulting in a *Major Penalty*.

<G15> **Destruction, Damage, Tipping, etc.** – Strategies and/or mechanisms aimed solely at the destruction, damage, tipping over, or entanglement of *Robots* or *Game Elements* are not in the spirit of the FIRST Tech Challenge and are not allowed. However, FIRST Tech Challenge games are highly interactive and *Robot-to-Robot* contact and defensive game play should be expected. Some tipping, entanglement, and damage may occur as a part of normal game play. If the tipping, entanglement, or damage is ruled to be deliberate or chronic, the offending *Team* will receive a *Major Penalty* and a *Yellow Card*.

<G16> **Pinning, Trapping, or Blocking Robots** – A *Robot* cannot cause an opposing *Alliance Robot* to become *Pinned*, *Trapped*, or *Blocked* for more than five seconds. If a referee determines this rule is violated, the offending *Alliance* will receive a *Minor Penalty* for every five seconds that they are in violation. If a referee declares a *Pinning*, *Trapping*, or *Blocking* warning during the *Match*, the offending *Robot* must move away at least 0.9 m (3 feet), approximately 1.5 floor tiles, from the *Pinned*, *Trapped*, or *Blocked* *Robot*.

A *Robot* cannot incur this type of *Penalty* during the *Autonomous Period* unless it is determined by the Referee to be part of a deliberate strategy. If the violation happens during the *Autonomous Period*, the first action done by the offending *Robot* during the *Driver-Controlled Period* must be to move away from the *Pinned*, *Trapped*, or *Blocked* *Robot* or a *Minor Penalty* will be assessed immediately and again for every five seconds that they are in violation. Game-specific rule(s) listed in Section 1.6.3 that further define *Pinning*, *Trapping*, or * Blocking* take precedence over this general game rule.

<G17> **Forcing an Opponent to Break a Rule** – The actions of an *Alliance* or their *Robots* shall not cause an opposing *Alliance* or *Robot* to break a rule and thus incur *Penalties*. Any forced rule violations committed by the affected *Alliance* shall be excused, and no *Penalties* will be assigned.

<G18> **Removing Game Elements from the Playing Field** – *Robots* may not deliberately remove *Game Elements* from the *Playing Field* during a *Match*. *Game Elements* that incidentally fall *Outside* the *Playing Field* will be returned to the *Playing Field* by field personnel at the earliest safe and convenient opportunity. *Game Elements* removed from the *Playing Field* in an attempt to *Score* are also not subject to this *Penalty*. *Teams* deliberately removing *Game Elements* from the *Playing Field* will incur a *Minor Penalty* per *Game Element* removed from the *Playing Field*. Game-specific rule(s) listed in Section 1.6.3 that allow the removal of *Scoring Elements* from the *Playing Field* take precedence over this general game rule.

*Game Elements* removed from the *Playing Field* in an attempt to *Score* are not subject to this *Penalty*. For example, a *Robot* launches a *Particle* towards the *Center Vortex*. If that *Particle* exits the *Playing Field* having missed the *Center Vortex*, a *Penalty* will not be assessed.

<G19> **Scoring Elements in Contact with Robots** – *Scoring Elements* that are in contact with a *Robot* on the corresponding *Alliance* for the *Vortex* have zero *Score* value when referees record the *Score* at the end of the *Autonomous* and *Driver-Controlled Periods*. Game-specific rule(s) listed in Section 1.6.3 that allow *Robot* contact with *Scoring Elements* take precedence over this general game rule.

<G20> **Post-Match Removal of Game Elements from Robots** – *Robots* must be designed to permit easy removal of *Game Elements* from any grasping, containing, or holding mechanism after the *Match*. *Robots*

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should also be able to be removed from the Playing Field without damaging the Playing Field. A Minor Penalty will be assessed for violations of this rule.

The intent of this rule is to have timely removal of Robots from the Playing Field following a Match.

*Drive Teams are expected to stage their Robots for a Match, and remove it from the Playing Field afterwards, safely and swiftly. Drive Team efforts that either intentionally or unintentionally delay the start of a Match or the Field reset are not allowed. Examples include, but are not limited to:

- Failing to exit the Playing Field once instructed by the Referee
- Failing to remove Driver Stations in a timely manner*

<G21> **Robot Manipulation of Scoring Elements** – Scoring Elements that are Possessed by a Robot are considered to be part of the Robot.

<G22> **Robot or Scoring Elements In Two or More Scoring Areas** – Robots or Scoring Elements that are In two or more Scoring Areas earn points only for the highest value achievement. If the achievement values are equal, only one achievement counts as Scored. Exceptions to this general rule may be specified in the Game Play section or in the game-specific rules.

<G23> **Disabled Robot Eligibility** - If a referee Disables a Robot, it will not be eligible to Score or earn points for the remainder of the Match. A Disabled Robot (whether referee induced or failure) will not be able to earn penalties after becoming Disabled.

<G24> **Playing Field Tolerances** – Playing Field and Game Elements will start each Match with tolerances that may vary by as much as +/-2.5cm (1.0 inch). Teams must design their Robots accordingly.

<G25> **Match Replay** – Matches are replayed at the discretion of the Head Referee only for a failure of a Game Element or verified Wi-Fi interference that was likely to have impacted which Alliance won the Match.

Unexpected Robot behavior in itself will not result in a Match replay. Team-induced failures, such as low battery conditions, processor sleep time-outs, Robot mechanical/electrical/software/communication failures, etc. are NOT valid justifications for a replaying of a Match.

<G26> **Egregious Behavior** – Egregious Robot or Team member behavior at the Playing Field, as determined by the referees, will result in a Major Penalty and issuance of a Yellow Card and/or Red Card. Subsequent violations will result in Team Disqualification from the tournament. Egregious behavior includes, but is not limited to, repeated and/or flagrant violation of game rules, unsafe behavior or actions, and uncivil behavior towards Drivers, Coaches, competition personnel, or event attendees.

1.6.3 Game-Specific Rules

<GS1> **Controlling/Possessing Particles** – Once a Match begins, a Robot may Control or Possess any quantity of their Alliance’s Particles.

<GS2> **Particle Scoring Eligibility** – After Scoring, Particles must make contact with the Playing Field Floor before they are eligible to be Scored again. Any Particles Scored in violation of this rule will have a Score value of zero (0).
<GS3> **Corner Vortex Scoring Violations** – Robots may not make contact with the **Particle Return**, break the vertical plane of the outside (facing the **Playing Field Wall**) vertical face of the Vortex Bar (see Figure 1.3-3), or interact with a **Particle** once it has been released through the **Corner Vortex**. Teams will be assessed a **Minor Penalty** for every occurrence of violating this rule. Actions that are **Inadvertent** and **Inconsequential** will not be **Penalized**. Robots are allowed to make contact with the **Corner Vortex Wall**.

<GS4> **Drive Teams Touching Robots or Driver Stations after Beacon Randomization** – Drive Teams are not allowed to touch or interact with their Robots or Driver Stations once field personnel have randomized the first **Beacon**. If this occurs, a **Minor Penalty** will be assessed per Robot and the affected Robots are not eligible to **Claim a Beacon** in the **Autonomous Period**. This **Penalty** only affects the offending Team. The non-offending **Alliance Partner Robot** remains eligible for the **Beacon Scoring** achievement.

<GS5> **Drive Team or Robot Pressing the Beacon Randomization Button** – Drive Teams and Robots are not allowed to press the randomization button (or power button if it exists) on the **Beacon** at any time. A **Major Penalty** will be assessed for violating this rule.

<GS6> **Opposing Alliance’s Beacon during Autonomous Period** – Robots are not allowed to press the buttons on a **Beacon** located in the opposing Alliance’s **Area** during the **Autonomous Period**. A **Major Penalty** will be assessed for violating this rule and the illegally **Claimed Beacon** will have zero **Autonomous Score** value for the offending Alliance. Bonus **Particles** will not be awarded to the offending Alliance as well. However, the non-offending Alliance remains eligible to earn a **Beacon Score** and bonus **Particle**. Field Personnel will randomize an illegally **Claimed Beacon** before the start of the **Driver-Controlled Period**.

<GS7> **Autonomous Period Robot Keep Out Area** – Robots may not go **Inside** the opposing Alliance’s **Area** of the **Playing Field** during the first ten seconds of the **Autonomous Period**. A **Major Penalty** will be assessed for violating this rule and any **Scoring** that occurs in the opposing Alliance’s **Area** by the offending Robot will not benefit the offending Alliance. The red and blue gaffers tape on the **Playing Field Floor** bisect the **Playing Field** into equal-sized **Alliance Areas**. Robots may enter the black painted **Area** of the **Center Vortex Base** at any time.

The intent of this rule is to delay the start of defensive strategies by requiring Robots to stay **Completely Inside** their Alliance’s **Area** during the first ten seconds of the **Autonomous Period**. The unpredictability of events during the **Autonomous Period** may result in unintentional entry into the opposing Alliance **Area**. For example, **Robot** collisions may result in an **Inadvertent** ingress into the opposing Alliance **Area**. Ingress into the opposing Alliance **Area** that is **Inadvertent** and **Inconsequential** will not be **Penalized**. Entering into the opposing Alliance **Area** during the first ten seconds of the **Autonomous Period** that results in an Alliance gaining an advantage is not **Inconsequential** nor **Inadvertent** and it will be **Penalized**.

<GS8> **Robot Height** – Robots may not extend higher than 29 inches (73.6 cm), the approximate clearance height of the **Center Vortex Particle** deflector, except during the **End Game**. An immediate **Minor Penalty** will be assessed per occurrence for violating this rule. Additional **Minor Penalties** will be assessed for each five second interval that this situation continues.

The height of the **Alliance Flag** is not subject to this rule. However, the height of **Possessed Scoring Elements** are considered to be part of the **Robot** and is subject to this rule.

<GS9> **Particle Interference** – A **Particle** that has been fully released from a **Robot** (i.e. it is not in contact with any part of the **Robot** that released it) and is above 18 inches (45.7 cm) from the **Playing Field** with a

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realistic intention of Scoring into any of the Vortexes may NOT be intentionally interfered with by an opposing Alliance’s Robot. Each interfered Particle will be awarded the points it would have received had it Scored. A Particle that contacts an opposing Alliance Robot after a missed Scoring attempt in a Vortex is not protected by this rule.

Mechanisms designed for the sole purpose of interfering with launched Particles are prohibited.

Repeated or continued violations of this rule are likely to escalate to issuance of Yellow Cards rapidly (i.e. the threshold for egregious or repeated violations is relatively low).

It is expected that Particles will collide in mid-air. If that happens, there will not be Penalty. This rule is intended to insure that Robots do not block Particles in the air with mechanisms on the Robot.

<GS10> **Controlling or Blocking an Opposing Alliance’s Scoring Elements** - Robots may not Control or Block Access to the opposing Alliance’s Cap Ball or Particles. The first instance will result in a warning with any following violations resulting in a Major Penalty and an additional Minor Penalty assessed for every five seconds that the rule violation persists. If the referee declares a Blocking Access warning during the Driver-Controlled Period, the offending Robot must move away at least 0.9 m (3 feet), approximately 1.5 floor tiles from the Blocked Scoring Element.

The intent of this rule is to allow Teams access to and from their Scoring Elements. Blocking and Trapping means denying ALL access, so general Robot movement with respect to other Robots should not be considered in violation unless there is no other way to traverse the Playing Field or get the Scoring Element. Also note that this rule requires attempted action on the part of the opposing Alliance. See also Rule <G16>.

Robots should be designed to prevent unintentional Possession of opposing Alliance Scoring Elements.

<GS11> **Cap Ball Interference** – During the End Game, Robots may not interfere with an opposing Alliance Robot that Possesses a lifted Cap Ball above the Playing Field Floor. A Major Penalty will be assessed per occurrence for violating this rule and a Minor Penalty will be assessed for every five seconds that the condition persists.

The intent of this rule is to allow Robots to Score the Cap Ball without interference. A Robot interaction with an opposing Alliance Robot may be ruled at the referee’s discretion to be Inconsequential and Inadvertent and will not be Penalized.

<GS12> **De-Scoring a Capped Center Vortex** – Robots may not de-Score an opposing Alliance’s Capped Center Vortex during the Driver-Controlled Period. The offending Alliance will be assessed two Major Penalties for violating this rule.

<GS13> **Blocking an Opposing Alliance’s Center Vortex** – A Robot may not place any Cap Ball or Robot part in the opposing Alliance’s Center Vortex. A Major Penalty and Yellow Card will be assessed and
additional *Minor Penalties* will be assessed every five seconds for the remainder of the *Match* or until the blockage is removed by the offending *Alliance*.

**<GS14> Blocking Access to an Opposing Alliance’s Corner Vortex** - During the *Driver-Controlled Period*, a *Robot* may not obstruct ALL access, prevent a *Robot* from escaping, or interfere with the opposing Alliance’s Corner Vortex when an opposing Alliance *Robot* is actively attempting to access or escape from it. The offending Alliance will immediately incur a *Minor Penalty*. Additional *Minor Penalties* will be assessed for every five seconds that the condition persists. Repeated or continued violations of this rule are likely to escalate to issuance of *Yellow Cards* rapidly (i.e. the threshold for egregious or repeated violations is relatively low).

The intent of this rule is to allow reasonable *Robot* ingress and egress to an Alliance’s Corner Vortex. A *Robot In* an opposing Alliance Corner Vortex that is not *Inconsequential* and *Inadvertent* is *Blocking Access* and it will be *Penalized*. Driving in front of the opposing Alliance’s Corner Vortex while the opponent is not trying to *Score* there can be considered *Inconsequential* and *Inadvertent*.

**<GS15> Starting the End Game Achievements Early** – *Robots* may not *Intentionally* perform any *End Game* scoring achievements prior to the start of the *End Game*. A *Robot* that begins the *End Game* achievements early will cause the *Alliance* to lose the right to *Score* those achievements. *Intentional Controlled* movement of an Alliance’s own *Cap Ball* is allowed at all times.

The intent of this rule is to prevent *Robots* from deliberately starting the *End Game* achievements early. The movement of *Robots* around the *Playing Field* will likely cause the *Cap Balls* to make *Inadvertent* contact with a Corner Vortex or to rise slightly above the *Playing Field* floor tiles during normal game play. These and similar *Inadvertent* and *Inconsequential* actions will not be *Penalized*.

**<GS16> Cap Balls in Contact with a Robot** - *Cap Balls* in contact with a *Robot* on any *Alliance* remain eligible to be counted as *Scored*. If a *Cap Ball* that *Caps a Center Vortex* is in contact with the *Robot* on the corresponding *Alliance*, it will only count as being at the *Low* or *High Height* for the purposes of *Scoring*.  

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1.7 Scoring Summary

The following table shows the possible Scoring achievements and their point values. The table is a quick reference guide and not a substitute for a thorough understanding of the game manual.

<table>
<thead>
<tr>
<th>Scoring Achievement</th>
<th>Autonomous Points</th>
<th>Driver-Controlled Points</th>
<th>End Game Points**</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beacons Triggered</td>
<td>30 / Claim +</td>
<td>10 / Claim</td>
<td>1.5.2.1 and 1.5.4.2</td>
<td></td>
</tr>
<tr>
<td>- State of Claim is all lit at end of period</td>
<td>Bonus Particle awarded (up to 2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cap Ball</td>
<td>5</td>
<td>10</td>
<td>1.5.2.2 and</td>
<td></td>
</tr>
<tr>
<td>- On Playing Field</td>
<td></td>
<td></td>
<td>1.5.4.1a</td>
<td></td>
</tr>
<tr>
<td>- Off Playing Field below crossbar</td>
<td></td>
<td></td>
<td>1.5.4.1b</td>
<td></td>
</tr>
<tr>
<td>- Raised above crossbar</td>
<td></td>
<td></td>
<td>1.5.4.2c</td>
<td></td>
</tr>
<tr>
<td>- Capped Center Vortex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particle</td>
<td>15*</td>
<td>5*</td>
<td>1.5.2.3 and</td>
<td></td>
</tr>
<tr>
<td>- Scored in Center Vortex</td>
<td></td>
<td></td>
<td>1.5.3.1</td>
<td></td>
</tr>
<tr>
<td>- Scored in Corner Vortex</td>
<td>5*</td>
<td>1*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robot Parked</td>
<td>5</td>
<td>10</td>
<td>1.5.2.4a</td>
<td></td>
</tr>
<tr>
<td>- On Center Vortex Base</td>
<td></td>
<td></td>
<td>1.5.2.4b</td>
<td></td>
</tr>
<tr>
<td>- Completely On Center Vortex Base</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- On Corner Vortex Ramp</td>
<td>5</td>
<td></td>
<td>1.5.2.4c</td>
<td></td>
</tr>
<tr>
<td>- Completely On Corner Vortex Ramp</td>
<td>10</td>
<td></td>
<td>1.5.2.4d</td>
<td></td>
</tr>
</tbody>
</table>

* - Scored in real time by field personnel
** - The End Game occurs during the last thirty seconds of the Driver-Controlled Period.

1.8 Rule Summary

The following table shows the possible rule violations and their consequences. The table is a quick reference guide and NOT a substitute for a thorough understanding of the complete rule descriptions in section 1.6.

<table>
<thead>
<tr>
<th>Rule #</th>
<th>Rule</th>
<th>Consequence</th>
<th>Warning Disable</th>
<th>Minor Penalty</th>
<th>Major Penalty</th>
<th>Card Issued</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;S1&gt;</td>
<td>Unsafe Robot.</td>
<td>Disable if unsafe operation is likely to persist. Optional Yellow Card.</td>
<td>D</td>
<td></td>
<td></td>
<td>YC*</td>
</tr>
<tr>
<td></td>
<td>Damage to the Playing Field.</td>
<td>Warning escalating to Disable.</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;S2&gt;</td>
<td>Contact Outside the Playing Field.</td>
<td>Immediate Yellow Card. Optional Disable unless allowed by rule.</td>
<td>D*</td>
<td></td>
<td></td>
<td>YC</td>
</tr>
<tr>
<td>&lt;S3&gt;</td>
<td>Drive Team missing safety gear.</td>
<td>Warning and if not resolved within 30 seconds, the offending member(s) of the Drive Team must leave the Competition Area and may not be replaced.</td>
<td>W+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rule #</td>
<td>Rule</td>
<td>Consequence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G1&gt;</td>
<td>Drive Team using disallowed electronic communication.</td>
<td>Warning followed by a Minor Penalty.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G2&gt;</td>
<td>Pre-Match Robot setup – Deliberately delaying the start of the Match.</td>
<td>Minor Penalty for each offense.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G3&gt;</td>
<td>Robot starting volume.</td>
<td>Robot is Disabled and powered off in a valid starting Area on the Playing Field.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G4&gt;</td>
<td>Illegal Robot setup alignment devices.</td>
<td>Minor Penalty for each offense.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G5&gt;</td>
<td>Drive Team member(s) leaving the Alliance Station.</td>
<td>Warning for the first instance with any following instances resulting in a Minor Penalty.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G6&gt;</td>
<td>Starting Game Play Early.</td>
<td>Minor Penalty with the option of a Major Penalty if the early start results in a competitive advantage for the offending Alliance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G7&gt;</td>
<td>Late Start of the Autonomous Period.</td>
<td>Minor Penalty with the option of a Major Penalty if the late start results in a competitive advantage for the offending Alliance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G8&gt;</td>
<td>Stopping Game Play Late.</td>
<td>Minor Penalty and the actions of the Robot that occur after the end of game play do not count towards their Alliance’s Score.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G9&gt;</td>
<td>Drive Team contact with the Playing Field or Robot.</td>
<td>Warning for the first instance with any following instances resulting in a Minor Penalty. Contact for safety reasons will not result in a warning or Penalty. Optional Yellow Card if contact affects scoring and/or gameplay.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G10&gt;</td>
<td>Autonomous to Driver-Controlled Period transition – Robot failure.</td>
<td>A Robot that cannot be controlled by the Drive Team will be Disabled and remain in place for the remainder of the Match.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G11&gt;</td>
<td>Drive Team Coach Driver Station Control.</td>
<td>Warning for the first instance with any following instances resulting in a Major Penalty.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G13&gt;</td>
<td>Robots deliberately detaching parts.</td>
<td>Minor Penalty, Major Penalty and a Yellow Card if it affects gameplay.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G14&gt;</td>
<td>Robots illegally grasping Game Elements.</td>
<td>Warning for the first instance with any following instances resulting in a Major Penalty.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G15&gt;</td>
<td>Destruction, damage, tipping, etc.</td>
<td>Deliberate or chronic violations of this rule will receive a Major Penalty and a Yellow Card.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Rule #</th>
<th>Rule</th>
<th>Consequence</th>
<th>Warning Disable</th>
<th>Minor Penalty</th>
<th>Major Penalty</th>
<th>Card Issued</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;G16&gt;</td>
<td>Pinning, Trapping, or Blocking for more than 5-seconds in the Driver-Controlled Period.</td>
<td>Minor Penalty for every five seconds the Robot violates this rule.</td>
<td></td>
<td></td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;G18&gt;</td>
<td>Deliberately removing Game Elements from the Playing Field.</td>
<td>Minor Penalty per Game Element removed from the Playing Field.</td>
<td></td>
<td></td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;G19&gt;</td>
<td>Scoring Elements in contact with Robots of the corresponding Alliance.</td>
<td>Points are not earned for any Scoring Elements in contact with Robots of the corresponding Alliance (except for the &lt;GS16&gt; exception).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G20&gt;</td>
<td>Delay caused by removal of Robots from the Playing Field and Game Elements from Robots.</td>
<td>A Minor Penalty will be assessed.</td>
<td></td>
<td></td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;G26&gt;</td>
<td>Egregious behavior.</td>
<td>Major Penalty and a Yellow Card. Possible Match Disqualification. Subsequent violations result in Team Disqualification for the tournament.</td>
<td></td>
<td></td>
<td>1x</td>
<td>YC RC</td>
</tr>
</tbody>
</table>

**Game-Specific Rules**

<table>
<thead>
<tr>
<th>Rule #</th>
<th>Rule</th>
<th>Consequence</th>
<th>Warning Disable</th>
<th>Minor Penalty</th>
<th>Major Penalty</th>
<th>Card Issued</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;GS2&gt;</td>
<td>Particle Scoring Eligibility.</td>
<td>Particles will not count as Scored unless prior contact made with Playing Field.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;GS3&gt;</td>
<td>Corner Vortex Scoring Violations.</td>
<td>Minor Penalty if Robot breaks the vertical plane of Vortex Bar, makes contact with Particle Return, or interacts with a Particle once it is released.</td>
<td></td>
<td></td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;GS4&gt;</td>
<td>Drive Teams touching Robots or Driver Stations after Beacon randomized.</td>
<td>Minor Penalty plus not eligible to Claim a Beacon during the Autonomous Period.</td>
<td></td>
<td></td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;GS5&gt;</td>
<td>Pressing Beacon randomization or power button.</td>
<td>Major Penalty is assessed.</td>
<td></td>
<td></td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;GS6&gt;</td>
<td>Pressing Opposing Alliance Beacon buttons during Autonomous Period.</td>
<td>Major Penalty is assessed and violator is not eligible to earn a Beacon or bonus Particle for the affected Claim.</td>
<td></td>
<td></td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;GS7&gt;</td>
<td>Robot crosses into opposing Alliance’s Area during first 10 seconds of Match.</td>
<td>Major Penalty is assessed.</td>
<td></td>
<td></td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;GS8&gt;</td>
<td>Robot height violation.</td>
<td>Minor Penalty is assessed plus additional Minor Penalties per 5 seconds in violation.</td>
<td></td>
<td></td>
<td>1x+</td>
<td></td>
</tr>
<tr>
<td>Rule #</td>
<td>Rule</td>
<td>Consequence</td>
<td>Warning Disable</td>
<td>Minor Penalty</td>
<td>Major Penalty</td>
<td>Card Issued</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>-------------</td>
<td>----------------</td>
<td>--------------</td>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>&lt;GS9&gt;</td>
<td>Particle Interference.</td>
<td>Released Particle Blocked by an Alliance is given the points it would have earned. More occurrences of violations of this rule will escalate to Yellow Cards quickly.</td>
<td></td>
<td></td>
<td></td>
<td>Pts YC*</td>
</tr>
<tr>
<td>&lt;GS10&gt;</td>
<td>Controlling or Blocking Access to opposing Alliance’s Game Elements.</td>
<td>Major Penalty is assessed plus additional Minor Penalties per 5 seconds in violation.</td>
<td>W</td>
<td>1x+</td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;GS11&gt;</td>
<td>Cap Ball Interference during End Game.</td>
<td>Major Penalty is assessed plus additional Minor Penalties per 5 seconds in violation.</td>
<td></td>
<td>1x+</td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;GS12&gt;</td>
<td>De-Scoring a Capped Center Vortex.</td>
<td>Double Major Penalty.</td>
<td></td>
<td></td>
<td></td>
<td>2x</td>
</tr>
<tr>
<td>&lt;GS13&gt;</td>
<td>Blocking Opposing Alliance’s Center Vortex.</td>
<td>Major Penalty and Yellow Card plus additional Minor Penalties per 5 seconds in violation.</td>
<td>1x+</td>
<td>1x</td>
<td></td>
<td>YC</td>
</tr>
<tr>
<td>&lt;GS14&gt;</td>
<td>Blocking Access to Opposing Alliance’s Corner Vortex during Driver-Controlled Period.</td>
<td>Minor Penalty plus additional Minor Penalties per 5 seconds in violation. More occurrences of violations of this rule will escalate to Yellow Cards quickly.</td>
<td>1x+</td>
<td></td>
<td></td>
<td>YC*</td>
</tr>
<tr>
<td>&lt;GS15&gt;</td>
<td>Starting End Game early.</td>
<td>Alliance loses right to Score End Game achievements.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Column Key**

- **W**: Warning
- **D**: Robot Disabled
- **YC**: Yellow Card issued
- **YC***: Yellow Card optionally issued
- **Pts**: Points that would have counted without violation
- **RC**: Red Card issued

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2016-2017 FIRST® Tech Challenge
Game Manual Part 2

Appendices
Appendix A – Resources

Game Forum Q&A
http://ftcforum.usfirst.org/forum.php

Anyone may view questions and answers within the FIRST® Tech Challenge Game Q&A forum without a password. In order to submit a new question, you must have a unique Q&A System User Name and Password for your team.

FIRST Tech Challenge Game Manuals
Part I and II - http://www.firstinspires.org/node/4271

FIRST® Headquarters Pre-Event Support
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Mon – Fri
8:30am – 5:00pm
Email: FTCTeams@firstinspires.org

FIRST Website: firstinspires.org
FIRST Tech Challenge Page – For everything FIRST Tech Challenge.
FIRST Tech Challenge Volunteer Resources – To access public Volunteer Manuals.
FIRST Tech Challenge Event Schedule – Find FIRST Tech Challenge events in your area.

FIRST Tech Challenge Social Media
FIRST Tech Challenge Twitter Feed - If you are on Twitter, follow the FIRST Tech Challenge Twitter feed for news updates.
FIRST Tech Challenge Facebook page - If you are on Facebook, follow the FIRST Tech Challenge page for news updates.
FIRST Tech Challenge YouTube Channel – Contains training videos, Game animations, news clips, and more.
FIRST Tech Challenge Blog – Weekly articles for the FIRST Tech Challenge community, including Outstanding Volunteer Recognition!
FIRST Tech Challenge Team Email Blasts – contain the most recent FIRST Tech Challenge news for Teams.
FIRST Tech Challenge Google+ community - If you are on Google+, follow the FIRST Tech Challenge community for news updates.

Feedback

We strive to create support materials that are the best they can be. If you have feedback regarding this manual, please email ftcteams@firstinspires.org. Thank you!

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Appendix B – Vision Patterns for Beacons

Vision Targets will be placed under each Beacon to assist Robots with navigation. The patterns will remain in the same locations for every Match. Teams are encouraged to use the Vision Targets and Vuforia™ Navigation software, which is part of the default application library software available from FIRST Tech Challenge, to enhance their Robot’s autonomous navigation accuracy.

Thumbnail size Vision Target images for the four Beacons are shown below. The full size images are available to download from the FIRST website: http://www.firstinspires.org/resource-library/ftc/game-and-season-info

The printing and placement instructions for the images are contained in the AndyMark Field Setup Guide that is available for download from the same webpage that hosts the image files.

<table>
<thead>
<tr>
<th>Gears</th>
<th>LEGO®</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Gears Image" /></td>
<td><img src="image2.png" alt="LEGO Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tools</th>
<th>Wheels</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="Tools Image" /></td>
<td><img src="image4.png" alt="Wheels Image" /></td>
</tr>
</tbody>
</table>