FIRST TECH CHALLENGE

Training and Support

VELOCITY VORTEX℠

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QUALCOMM®

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!

Revision History		
Revision	**Date**	**Description**
1	8/15/2016	Affiliate Partner limited release
1.1	9/10/2016	• Kickoff Release • Section 1.6.3 Rule GS8 – Changed "Pebble" to "Particle" • Minor formatting fixes throughout document
1.2	9/19/2016	• Section 1.3 – Figure 1.3-1 Updated image with correct height measurements

Contents

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:

> **FIRST Tech Challenge is MORE THAN ROBOTS**SM**!** While competing, students develop personal and professional skills they will be able to rely on throughout their life.

- 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®

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:

An example of *Gracious Professionalism*® is patiently listening to a Team's question and providing support despite having several pressing things to do on the day of the event.

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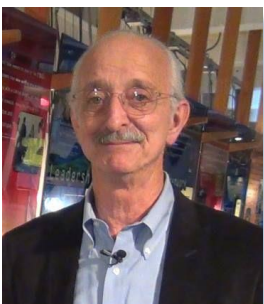
"The FIRST spirit encourages doing high-quality, well-informed work in a manner that leaves everyone feeling valued. Gracious Professionalism seems to be a good descriptor for part of the ethos of FIRST. It is part of what makes FIRST different and wonderful."

- 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 US Screening process is available here:
http://www.firstinspires.org/sites/default/files/uploads/about/us-screening-2016-2017.pdf

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

> **Everyone working with *FIRST* Teams should be familiar with the *FIRST* YPP policies.**

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.

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 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*.
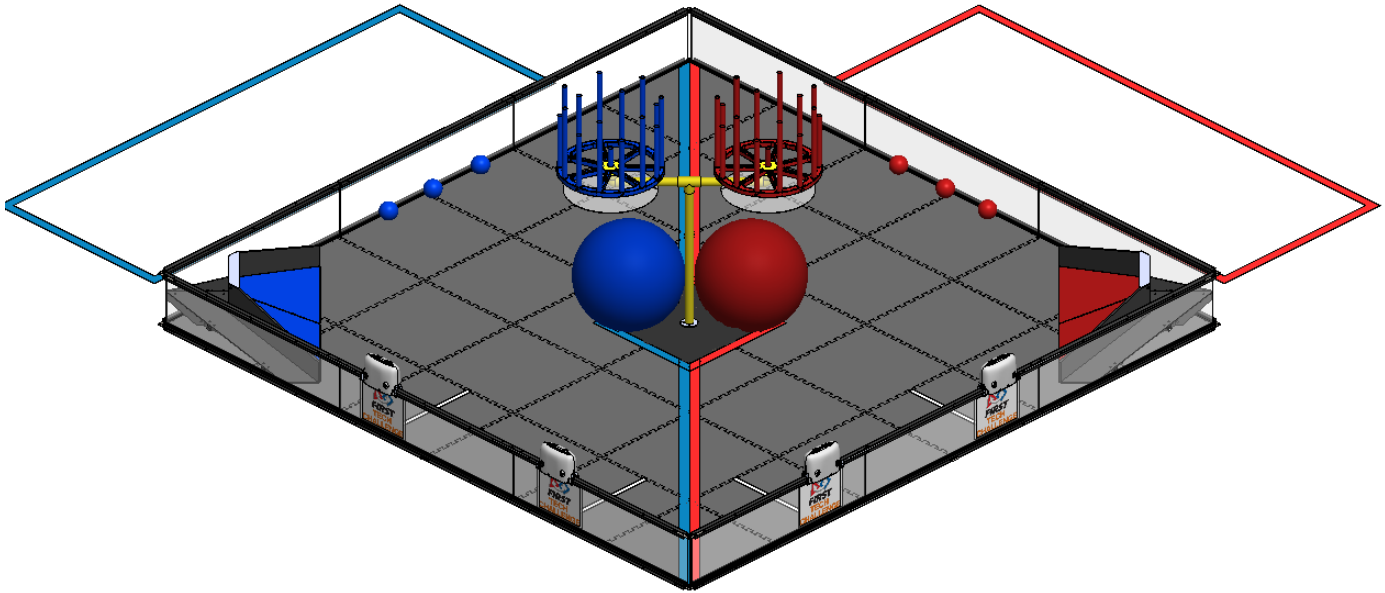

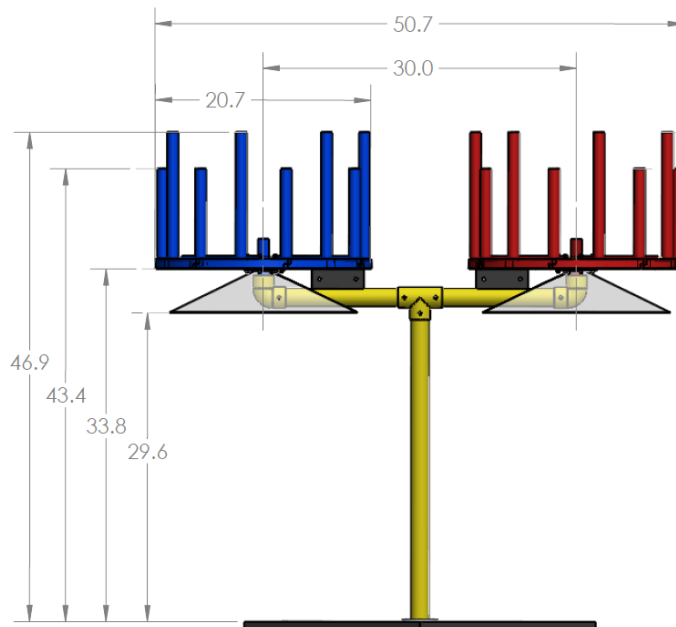Figure 1.3-1 – Isometric view of the *Playing Field*

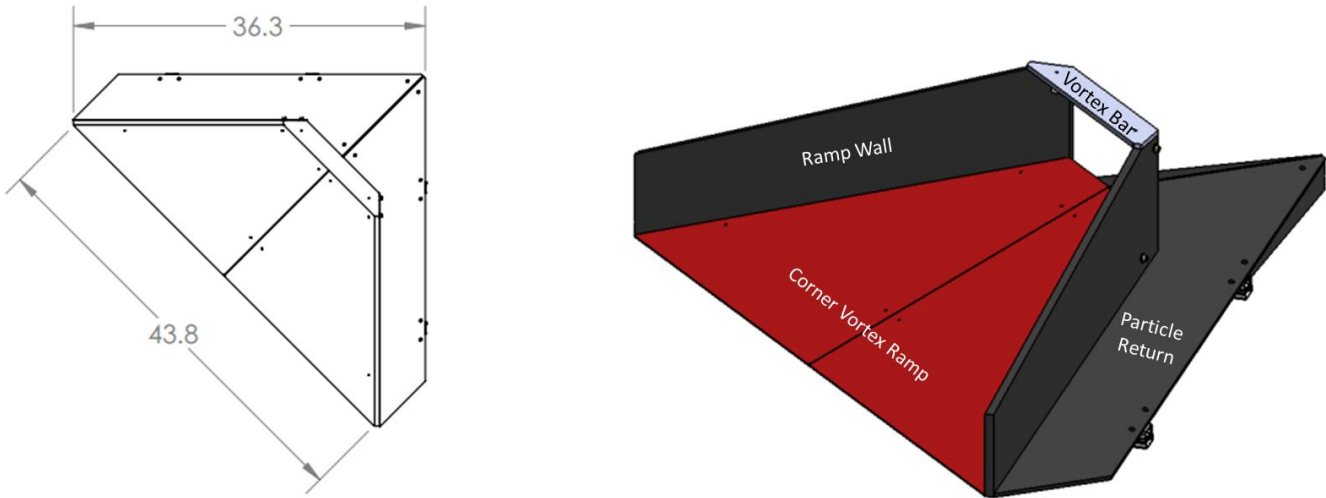Figure 1.3-2 – View of the *Center Vortex Assembly* (dimensions in inches)

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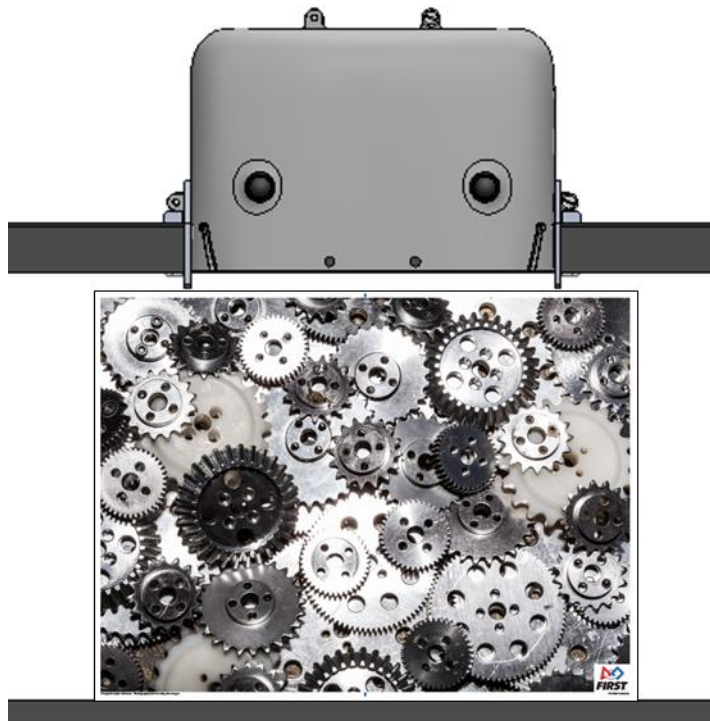

Figure 1.3-4 – *Field* view of *Beacon* with vision target

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 Vortexes, 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*.

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*.

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

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

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* of 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 *Vortexes*. 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 <u>added</u> 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
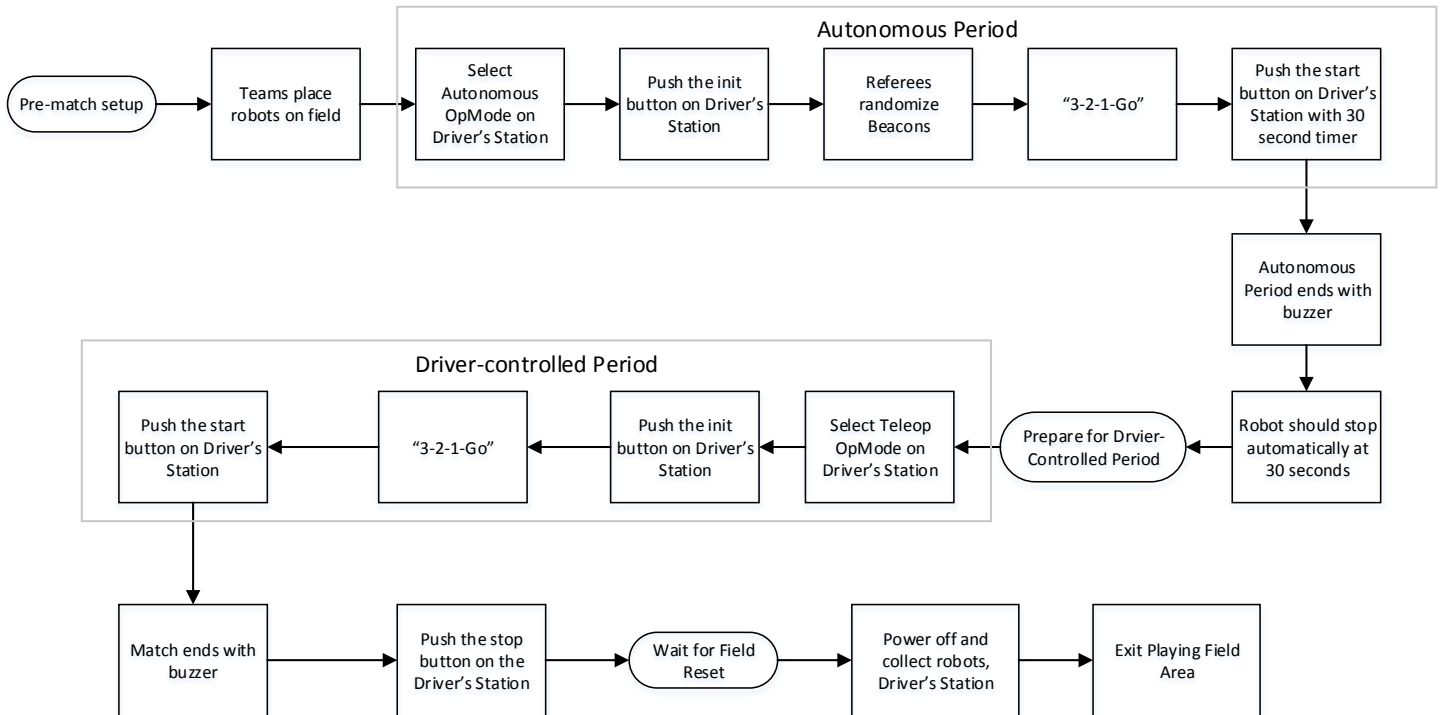The following figure shows the flow of the *Match* and the actions taken on the *Driver's Station* Android device.

Figure 1.5-1 *Match* Play Flowchart

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 <u>conclusion</u> of the game sound signaling the end of the *Match* for *Robots* to stop playing the game.

<G9> *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.*

<G10> *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.

<G11> *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*.

<G12> **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*.

<G13> *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*

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* <u>during the *Autonomous Period*</u>. 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* bisects 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

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.*

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.

Scoring Achievement	*Autonomous* Points	*Driver-Controlled* Points	*End Game* Points**	Reference
Beacons Triggered - State of *Claim* is all lit at end of period	30 / *Claim* + Bonus *Particle* awarded (up to 2)	10 / *Claim*		1.5.2.1 and 1.5.4.2

Cap Ball
  - *On Playing Field*
  - *Off Playing Field below crossbar*
  - *Raised above crossbar*
  - *Capped Center Vortex*
	5
	-
	-
	-
			
			10
			20
			40
				1.5.2.2 and 1.5.4.1a 1.5.4.1b 1.5.4.2c

Particle
  - *Scored in Center Vortex*
  - *Scored in Corner Vortex*
	15*
	5*
		5*
		1*
				1.5.2.3 and 1.5.3.1

Robot Parked
  - *On Center Vortex Base*
  - *Completely On Center Vortex Base*
  - *On Corner Vortex Ramp*
  - *Completely On Corner Vortex Ramp*
	5
	10
	
	5
	
	10
		-
		-
		
		-
		
		-
				1.5.2.4a 1.5.2.4b 1.5.2.4c 1.5.2.4d

* - *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.

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
Safety Rules						
<S1>	Unsafe *Robot*.	*Disable* if unsafe operation is likely to persist. Optional *Yellow Card.*	D			YC*
	Damage to the *Playing Field*.	Warning escalating to Disable.	W D			
<S2>	Contact *Outside* the *Playing Field*.	*Immediate Yellow Card.* Optional *Disable* unless allowed by rule.*	D*			YC
<S3>	*Drive Team* missing safety gear.	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.	W+			

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
General Rules						
<G1>	*Drive Team* using disallowed electronic communication.	Warning followed by a *Minor Penalty*.	W	1x		
<G2>	*Pre-Match Robot* setup – Deliberately delaying the start of the *Match*.	*Minor Penalty* for each offense.		1x		
<G3>	*Robot* starting volume.	*Robot* is *Disabled* and powered off in a valid starting *Area* on the *Playing Field*.	D			
<G4>	Illegal *Robot* setup alignment devices.	*Minor Penalty* for each offense.		1x		
<G5>	*Drive Team* member(s) leaving the *Alliance Station.*	Warning for the first instance with any following instances resulting in a *Minor Penalty*.	W	1x		
<G6>	Starting Game Play Early.	*Minor Penalty* with the option of a *Major Penalty* if the early start results in a competitive advantage for the offending *Alliance*.		1x	1x	
<G7>	Late *Start of the Autonomous Period.*	*Minor Penalty* with the option of a *Major Penalty* if the late start results in a competitive advantage for the offending *Alliance*.		1x	1x	
<G8>	Stopping Game Play Late.	*Minor Penalty* and the actions of the *Robot* that occur after the end of game play do not count towards their *Alliance's Score.*		1x	1x	
<G9>	*Drive Team* contact with the *Playing Field* or *Robot*.	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 game play.	W	1x		YC*
<G10>	*Autonomous* to *Driver-Controlled Period* transition – *Robot* failure.	A *Robot* that cannot be controlled by the *Drive Team* will be *Disabled* and remain in place for the remainder of the *Match*.	D			
<G11>	*Drive Team Coach Driver Station* Control.	Warning for the first instance with any following instances resulting in a *Major Penalty*.	W		1x	
<G13>	*Robots* deliberately detaching parts.	*Minor Penalty, Major Penalty* and a *Yellow Card* if it affects gameplay.		1x	1x	YC
<G14>	*Robots* illegally grasping *Game Elements*.	Warning for the first instance with any following instances resulting in a *Major Penalty*.	W		1x	
<G15>	Destruction, damage, tipping, etc.	Deliberate or chronic violations of this rule will receive a *Major Penalty* and a *Yellow Card*.			1x	YC

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
<G16>	*Pinning, Trapping, or Blocking* for more than 5-seconds in the *Driver-Controlled Period.*	*Minor Penalty* for every five seconds the *Robot* violates this rule.		1x		
<G18>	Deliberately removing *Game Elements* from the *Playing Field.*	*Minor Penalty* per *Game Element* removed from the *Playing Field.*		1x		
<G19>	*Scoring Elements* in contact with *Robots* of the corresponding *Alliance.*	Points are not earned for any *Scoring Elements* in contact with *Robots* of the corresponding *Alliance* (except for the <GS16> exception).				
<G20>	Delay caused by removal of *Robots* from the *Playing Field* and *Game Elements* from *Robots.*	A *Minor Penalty* will be assessed.		1x		
<G26>	Egregious behavior.	*Major Penalty* and a *Yellow Card.* Possible *Match Disqualification.* Subsequent violations result in *Team Disqualification* for the tournament.			1x	YC RC
Game-Specific Rules						
<GS2>	*Particle Scoring* Eligibility.	*Particles* will not count as *Scored* unless prior contact made with *Playing Field.*				
<GS3>	*Corner Vortex Scoring* Violations.	*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.		1x		
<GS4>	*Drive Teams* touching *Robots* or *Driver Stations* after *Beacon* randomized.	*Minor Penalty* plus not eligible to *Claim* a *Beacon* during the *Autonomous Period.*		1x		
<GS5>	Pressing *Beacon* randomization or power button.	*Major Penalty* is assessed.			1x	
<GS6>	Pressing Opposing *Alliance Beacon* buttons during *Autonomous Period.*	*Major Penalty* is assessed and violator is not eligible to earn a *Beacon* or bonus *Particle* for the affected *Claim.*			1x	
<GS7>	*Robot* crosses into opposing *Alliance's Area* during first 10 seconds of *Match.*	*Major Penalty* is assessed.			1x	
<GS8>	*Robot* height violation.	*Minor Penalty* is assessed plus additional *Minor Penalties* per 5 seconds in violation.		1x+		

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
<GS9>	*Particle* Interference.	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.			Pts	YC*
<GS10>	*Controlling* or *Blocking Access* to opposing *Alliance's Game Elements*.	*Major Penalty* is assessed plus additional *Minor Penalties* per 5 seconds in violation.	W	1x+	1x	
<GS11>	*Cap Ball* Interference during *End Game*.	*Major Penalty* is assessed plus additional *Minor Penalties* per 5 seconds in violation.		1x+	1x	
<GS12>	*De-Scoring a Capped Center Vortex*.	Double *Major Penalty*.			2x	
<GS13>	*Blocking* Opposing *Alliance's Center Vortex*.	*Major Penalty* and *Yellow Card* plus additional *Minor Penalties* per 5 seconds in violation.		1x+	1x	YC
<GS14>	*Blocking Access* to Opposing *Alliance's Corner Vortex* during *Driver-Controlled Period*.	*Minor Penalty* plus additional *Minor Penalties* per 5 seconds in violation. More occurrences of violations of this rule will escalate to *Yellow Cards* quickly.		1x+		YC*
<GS15>	Starting *End Game* early.	*Alliance* loses right to *Score End Game* achievements.				

Column Key	
W: Warning	1x: *Penalty* at normal (single) cost
D: *Robot Disabled*	2x: *Penalty* at double cost
YC: *Yellow Card* issued	Pts: Points that would have counted without violation
YC*: *Yellow Card* optionally issued	RC: *Red Card* issued

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

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Phone: 603-666-3906
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8:30am – 5:00pm
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FIRST Website: firstinspires.org
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FIRST Tech Challenge Event Schedule – Find *FIRST* Tech Challenge events in your area.

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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!

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.

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