

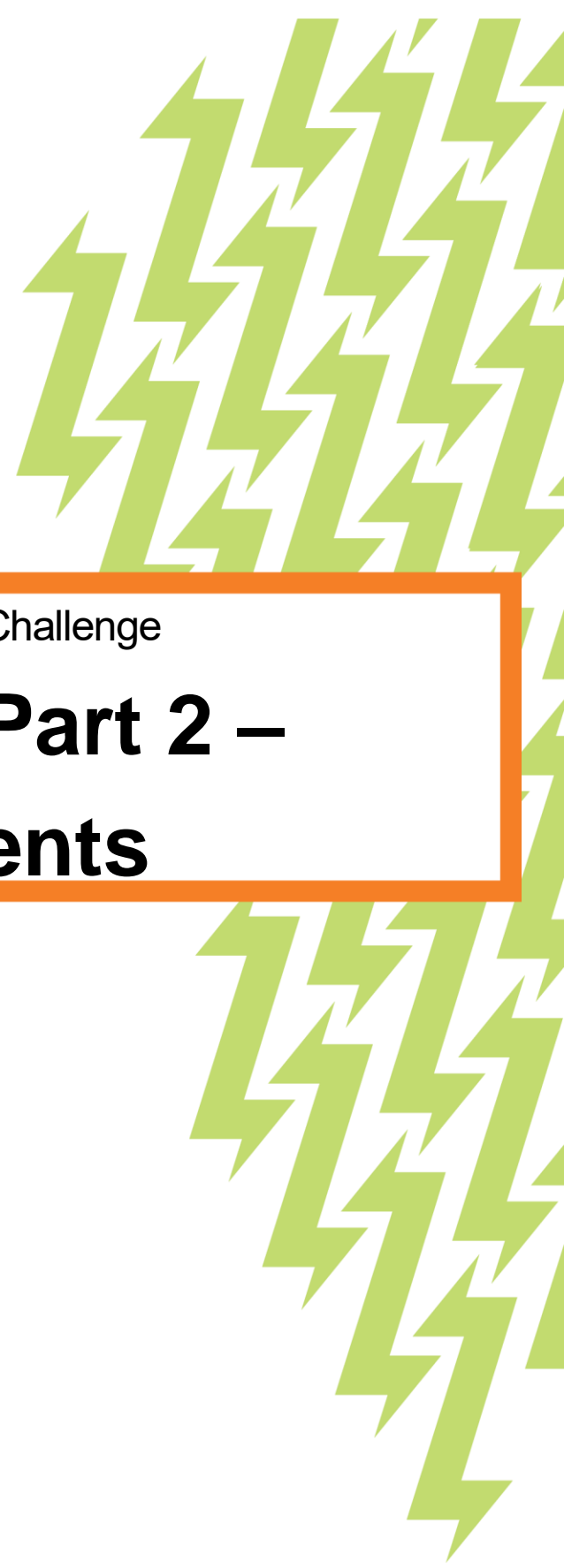


FIRST® ENERGIZE<sup>SM</sup>  
presented by Qualcomm

[firstinspires.org/robotics/ftc](http://firstinspires.org/robotics/ftc)

2022-2023 FIRST® Tech Challenge

# Game Manual Part 2 – Remote Events



## Sponsor Thank You

Thank you to our generous sponsor for your continued support of the *FIRST*® Tech Challenge!



# Raytheon Technologies

Revision History		
Revision	Date	Description
1	8/31/2022	Program Delivery Partner release
1.1	9/10/2022	<ul style="list-style-type: none"> <li>• Kickoff Release</li> <li>• Section 4.3 – Updated Junction height measurements</li> <li>• Section 4.5.3 – Added &lt;GS1&gt;c, exception to rule &lt;G6&gt;</li> </ul>
1.2	10/26/2022	<ul style="list-style-type: none"> <li>• Section 4.2.2 <ul style="list-style-type: none"> <li>○ Autonomous description, 1. Changed in to defined term “In”</li> <li>○ Driver-Controlled description 1. Added “In Terminals”</li> </ul> </li> <li>• Section 4.3 – Definition of Capping c) changed defined term “completely” to non-defined term</li> </ul>

## Contents

Contents .....	3
1.0 Introduction.....	5
1.1 What is FIRST® Tech Challenge? .....	5
2.0 <i>Gracious Professionalism</i> ®.....	5
3.0 How to Use This Document .....	5
4.0 The Game .....	6
4.1 Introduction .....	6
4.2 Game Description .....	6
4.2.1 Field Illustration .....	6
4.2.2 Gameplay Overview .....	7
4.2.3 Gameplay Technology .....	8
4.3 Game Definitions .....	8
4.4 Gameplay.....	13
4.4.1 Pre-Match.....	13
4.4.2 Autonomous Period.....	14
4.4.3 Driver-Controlled Period .....	15
4.4.4 End Game .....	15
4.4.5 Post Match .....	16
4.4.6 Penalties.....	16
4.4.7 Flowchart of Match Play .....	16
4.5 Rules of Gameplay.....	17
4.5.1 Safety Rules .....	17
4.5.2 General Game Rules .....	17
4.5.3 Game-Specific Rules.....	21
4.6 Scoring Summary.....	23
4.7 Rule Summary .....	24
Appendix A – Resources .....	29

Game Forum Q&A .....	29
Volunteer Forum .....	29
<i>FIRST</i> Tech Challenge Game Manuals.....	29
<i>FIRST</i> Headquarters Pre-Event Support .....	29
<i>FIRST</i> Websites.....	29
<i>FIRST</i> Tech Challenge Social Media .....	29
Feedback.....	29
Appendix B – <i>Playing Field</i> Layouts.....	30
Appendix C – <i>Playing Field</i> Details.....	32
Appendix D – <i>Scoring</i> Element.....	37
Appendix E – Randomization.....	38
Appendix F – <i>Scoring</i> Examples.....	42
Appendix G – <i>Navigation Images</i> .....	47
Appendix H – <i>Circuit Patterns</i> .....	48

## 1.0 Introduction

---

### 1.1 What is FIRST® Tech Challenge?

FIRST® Tech Challenge is a student-centered program that focuses on giving students a unique and stimulating experience. Each year, teams engage in a new game where they design, build, test, and program autonomous and driver operated robots that must perform a series of tasks. Participants and alumni of FIRST programs gain access to education and career discovery opportunities, connections to exclusive scholarships and employers, and a place in the FIRST community for life. To learn more about FIRST® Tech Challenge and other FIRST® Programs, visit [www.firstinspires.org](http://www.firstinspires.org).

## 2.0 Gracious Professionalism®

---

FIRST® uses this term to describe our programs' intent.

*Gracious Professionalism®* is a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community.

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

## 3.0 How to Use This Document

---

The Game Manual Part 2 – Remote Events is a resource for all FIRST® Tech Challenge *Teams* for information specific to the 2022-2023 season's game. There are two types of event formats a *Team* might experience this season: traditional events and remote events. This manual describes the game and rules for remote events. Remote events were developed to mimic traditional FIRST Tech Challenge events, while practicing social distancing guidelines. In some Regions *Teams* are not able to gather and compete in the traditional head-to-head competition format, the season's official full *Playing Field* and rules have been adapted to allow *Teams* to play *Matches* as a single *Team*. Remote *Teams* may order an official partial version of this season's field or compete using a low-cost version of the field.

The intent of this manual is that the text means exactly, and only, what it says. Please avoid interpreting the text based on assumptions about intent, implementation of past rules, or how a situation might be in "real life". There are no hidden requirements or restrictions. If you have read everything, you know everything.

Key words that have a specific meaning within this document are defined in the Game Definitions section and are indicated with the first letter capitalized, and the entire word in *Italics*.

## 4.0 The Game

### 4.1 Introduction

This document describes the remote game version of POWERPLAY<sup>SM</sup> presented by Raytheon Technologies, the FIRST® Tech Challenge game for the 2022-2023 season. We recommend viewing the traditional event game and rules animation prior to reading this manual to gain a general understanding of the similar traditional game. The animation is not intended as a replacement for official game rules. The animation can be accessed on our website under “Videos and Promotional Materials”: <https://www.firstinspires.org/resource-library/ftc/game-and-season-info>.

Teams must comply with all the rules and requirements stated in this document and in the Game Manual Part 1 - Remote Events. Clarifications to the game rules are issued on the question & answer section of the forum at <https://ftc-qa.firstinspires.org>. Forum rulings take precedence over information in the game manuals.

Teams should refer to the [Game Manual Part 1 – Remote Events](#) for information about the competition such as how rankings work (Ranking and TieBreaker Points), advancement, judged awards, *Robot* rules, and general competition rules.

### 4.2 Game Description

#### 4.2.1 Field Illustration

The following illustrations identify the *Game Elements* and give a general visual understanding of the game. Teams should refer to [andymark.com/FTC](http://andymark.com/FTC) for the exact *Game Element* dimensions. The official *Playing Field* documents, including the official Field Setup and Assembly Guide, are available at <https://www.firstinspires.org/resource-library/ftc/game-and-season-info>. Please note: *Playing Field Wall* heights are different depending on the manufacturer. *Playing Field Wall* height measurements for each manufacturer are in the official Field Setup and Assembly Guide. During the season, Teams that participate in Remote events may also transition to Traditional events that use *Playing Field Walls* from different manufacturers. Please incorporate that into the design of your *Robot*. The following illustrations show the *Playing Field* with the optional perimeter wall as the *Playing Field Boundary*.

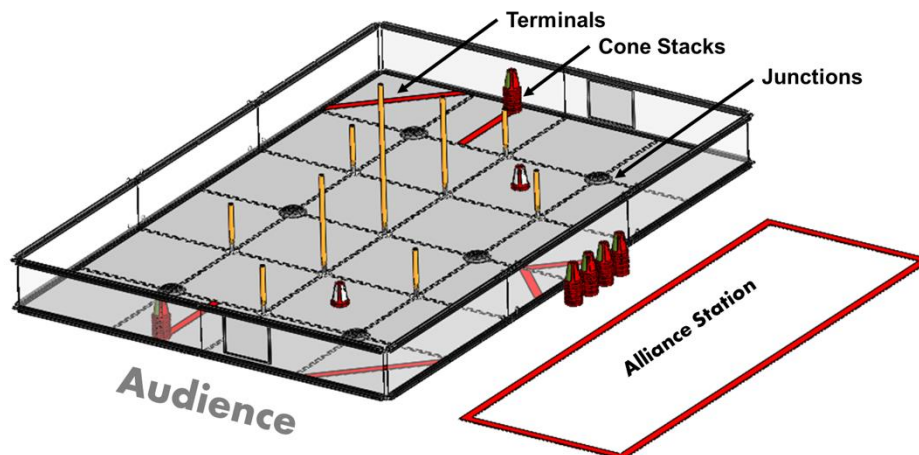
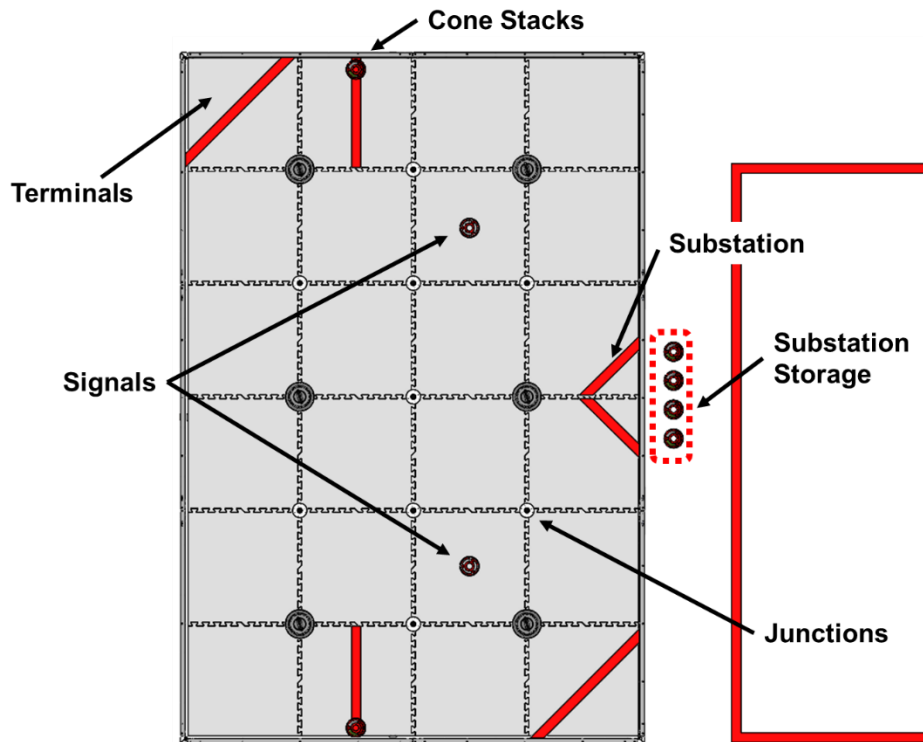


Figure 4.2-1 – Isometric view of the remote *Playing Field*



**Figure 4.2-2 – Top view of the remote *Playing Field***

#### 4.2.2 Gameplay Overview

Welcome to POWERPLAY<sup>SM</sup> presented by Raytheon Technologies. Remote *Matches* are played on a *Playing Field* initially set up as illustrated in Figure 4.2 -1. The object of the game is to earn as many points as possible by performing the achievements outlined below.

The *Match* starts with a 30-second *Autonomous Period* in which *Robots* operate using only pre-programmed instructions and sensor inputs. The following *Robot* actions earn points during the *Autonomous Period*:

1. Each *Cone* placed *In a Terminal* or on a *Junction* earns points.
2. *Navigating* to their *Terminal* or *Substation*.
3. *Robots* can also earn points by *Parking* in the *Signal Zone* that corresponds with the randomly selected indicator image, and *Teams* that use the *Team-supplied Signal Sleeve* earn more points for this task.

The two-minute *Driver-Controlled Period* follows the *Autonomous Period*. *Teams* earn points by:

1. Placing *Cones* *In Terminals* or on *Junctions*.
2. *Owning a Junction*.
3. Creating a continuous *Circuit of Junctions* from one *Terminal* to the other *Terminal* that follows a precise *Circuit Pattern* (defined in Appendix H).

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, *Teams* earn points by:

1. *Capping a Junction*.
2. *Parking* in a *Terminal*.

### 4.2.3 Gameplay Technology

Each game comes with its own unique set of challenges. In POWERPLAY<sup>SM</sup> there are multiple ways *Teams* can utilize technology to assist them in solving these challenges. *Teams* may use the built-in technology, or they can come up with their own solutions to solve the challenges.

This season, the challenges include:

1. Object Identification
  - a) The *Robot* can use its on-board control system to identify an object.
  - b) *Teams* can use the built-in TensorFlow technology to identify the images on the *Signal*.
2. Field Navigation
  - a) A *Robot* can use the *Navigation Images* along with the built-in vision processing software, Vuforia, and an on-board camera to help identify their location on the field. This is especially useful during the *Autonomous Period*.
  - b) Tape on the *Playing Field Floor* helps a *Robot* with color and/or vision sensors locate the *Cone* stacks, *Terminals*, and *Substations*.
3. Sensor Use
  - a) *Teams* can add sensors to their *Robot* to help it identify the *Cones* and *Junctions*.

For resources on how to use the available technologies, please visit <https://github.com/FIRST-Tech-Challenge>.

### 4.3 Game Definitions

The following definitions and terms are used for POWERPLAY<sup>SM</sup>. Game definitions are Capitalized and *italicized* throughout the manual.

**Alliance Station** – The designated red or blue *Alliance Area* adjacent to the *Playing Field* where the *Drive Team* stands during a *Match*.

**Area** – The space defined by the vertical projection of the outside edge of a region’s boundary (for example, gaffer tape, goal, *Playing Field Boundary*). The boundary element (tape, wall, markings, etc.) is part of the *Area* for the purposes of determining *Inside* and *Outside*.

**Autonomous Period** – The initial thirty-second *Match* period in which the *Robot* operates and reacts 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** – The *Team Scoring Element* for this season. A *Team* designed and manufactured part that may be used in the *Match*. A detailed definition of *Team Scoring Element* is in section 7.4 of the Game Manual Part 1 Remote Events. Compliance with construction rules will be verified during *Robot Inspection*. *Robots* use the *Beacon* to permanently *Own* a *Junction* by *Capping* the *Junction* during the *End Game*.

**Brace** - Stabilizing (without grasping) a *Cone* or stack of *Cones* to maintain their position while the *Robot* is attempting to *Score*.



**Cap/Capping** - Placing a *Beacon* on a *Junction* to indicate permanent *Ownership* and to prevent *Scoring* additional *Cones* or *Beacons* on that *Junction*. A *Junction* is successfully *Capped* when one of the following conditions is satisfied:

- a) *Beacon* is *Completely On* a *Junction*.
- b) *Beacon* is *Completely On* a *Scored Cone* on a *Junction*.
- c) *Beacon* is completely around the circumference of a *Junction* pole.

**Circuit** – A defined path of *Connected Owned Junctions* that links the two (2) *Owned Terminals*. Each *Match* will have a separate defined path to successfully create the *Circuit* for that *Match*. See Appendix F for examples and Appendix H for the *Match* specific paths. Please note that *Match* specific *Circuit* paths are not used in *Traditional* event gameplay.

**Circuit Pattern** – A specific set of *Scoring* locations where *Cones* must be placed in order for the *Team* to earn a *Circuit* bonus.

**Coach** – A *Student Team* member or adult mentor designated as the *Drive Team* advisor during the *Match*.

**Competition Area** – The *Area* where all the *Playing Field* is located.

**Cone** – A *Game Element* that is 4 inches (10.16 cm) in diameter at the base and 5 inches (15.2 cm) tall. It weighs 2.55 oz. (72.4 grams). The game is played with thirty (30) *Cones*.

**Connect/Connection** – A *Connection* is formed when two (2) adjacent *Junctions* or a *Terminal-Junction* pair are *Owned* by the *Team*. See Appendix F-1.

**Control / Controlling** – An object is *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 a part of the *Robot*. See also the definition of *Possess / Possessing*. Examples of interaction with *Game Elements* that are *Controlled* include, but are not limited to:

- a) Carrying one or more *Game Elements*.
- b) *Propelling Game Elements* are considered *Controlled* until they make contact with something other than the *Playing Field Floor* or *come to rest*. See also the definition of *Propelled* in this section.
- c) *Herding of Game Elements* is considered *Control*. See also the definition of *Herding* in this section.
- d) *Trapping* one or more *Scoring Elements* against a *Game Element* or *Playing Field Boundary* to shield or guard them. See also the definition of *Trapping* in this section.

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

- e) *Plowing of Game Elements* is not considered *Control*. See also the definition of *Plowing* in this section.
- f) *Inadvertent* contact with a *Propelled Game Element* as it bounces off the *Playing Field* or a *Robot*. See also the definition of *Inadvertent* in this section.

**Disable / Disabled** – A *Robot* that is no longer active for the remainder of the *Match* due to a *Robot* failure.

**Drive Team** – Up to four (4) representatives; two (2) *Drivers*, one (1) *Human Player* and one (1) *Coach* from the same *Team*.

**Driver** – A *Student Team* member responsible for operating and controlling the *Robot*.

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

**Driver Station** – Hardware and *FIRST* supplied software used by a *Drive Team* to control their *Robot* during a *Match*. A detailed description of the *Driver Station* rules is listed in [Game Manual Part 1 – Remote Events](#).

**End Game** – The last thirty (30) seconds of the two-minute *Driver-Controlled Period*.

**End of the Period/Match** - The moment when the *Match* timer reaches 2:00 for the *Autonomous Period* or 0:00 for the *Driver-Control Period* and which coincides with the start of the sound that designates the *End of the Period*.

**Field Personnel** – People selected by the *Team* to help run an official remote competition *Match*. Typical activities performed by *Field Personnel* include preparing the *Playing Field* for a *Match*, randomizing the *Signal*, keeping track of the *Match Score*, running the cloud-based scoring system, and providing as needed technical assistance to the *Drive Team* during pre-*Match* setup. One person may fill several roles. At a Traditional competition, these activities are performed by trained volunteers. *Teams* may select anyone except for the *Drive Team* to be *Field Personnel*. Some *Field Personnel* roles require specialized knowledge. For example, the person scoring the *Match* should be able to recall rules and *Penalties* in real time while watching an official *Match*.

**Game Element** – Any item *Robots* interact with to play the game. *Game Elements* for this year’s game include *Junctions*, *Cones*, *Signals*, *Signal Sleeves*, *Navigation Images*, and *Beacons*.

**Herding** – Pushing or moving one or more *Scoring Elements* to a desired location or direction that gains a strategic advantage beyond moving the *Robot* around the *Playing Field*. See also the related definition of *Plowing* in this section.

**Human Player**– A *Student Team* member responsible for handling *Scoring Elements*.

**In (Inside) / Completely In (Completely Inside)** – An object that has crossed into the upwards vertical extension (i.e., at a right angle to the *Playing Field Floor*) 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*. The boundary element (tape, wall, markings, etc.) is part of the *Area* for the purposes of determining *Inside* and *Outside*, unless otherwise specified.

**Inadvertent** – An unintended side effect of a *Robot* action. Unforced or unexpected *Robot* actions based on software commands are not considered to be *Inadvertent*.

**Inconsequential** – An outcome that does not influence *Scoring* or gameplay.

**Junction** – There are fifteen (15) *Junctions*. There are four types of *Junctions*:

- a) **Ground Junction:** A 6 inch (152 mm) diameter disc with a 4.25 inch (108 mm) diameter x 0.5 inch (12.7 mm) recess. There are six (6) *Ground Junctions* on the *Playing Field*.
- b) **Low Junction:** A spring-mounted 1 inch (25.4 mm) diameter pole that is 13.5 inches (343 mm) tall. There are eight (8) *Low Junctions* on the *Playing Field*.
- c) **Medium Junction:** A spring-mounted 1 inch (25.4 mm) diameter pole that is 23.5 inches (597 mm) tall. There are four (4) *Medium Junctions* on the *Playing Field*.
- d) **High Junction:** A spring-mounted 1 inch (25.4 mm) diameter pole that is 33.5 inches (851 mm) tall. There are four (4) *High Junctions* on the *Playing Field*.

Note: The at rest vertical angle of the pole may vary from *Match* to *Match* and during gameplay.

**Launching** – *Propelling Game Elements* through the air or water above the *Playing Field Floor*.

**Match** - *Matches* are made up of several periods totaling two minutes and thirty seconds (2:30). There is a thirty (30) second *Autonomous Period*, followed by a two (2) minute *Driver-Controlled Period*. The last thirty (30) seconds of the *Driver-Controlled Period* is called the *End Game*. There is an eight-second transition between the *Autonomous Period* and the *Driver-Controlled Period* for *Teams* to pick up the controllers and switch programs.

**Match Manager** – Any person selected by the *Team* to oversee an official *Match* and *Field Personnel*. The *Match Manager* cannot be a part of the *Drive Team*.

**Navigating** – A *Scoring* task where a *Robot* is *Parked In* or *Completely In* a specified *Area*.

**Navigation Image** - Two (2) unique images mounted on the *Playing Field Walls* that *Robots* can use to navigate around the *Playing Field*. Images are printed on standard letter size paper, 8 1/2 inches x 11 inches (216 mm x 279 mm) or A4 (210 mm x 297 mm) paper. Images are mounted on the outside of the *Playing Field* as described in Appendix G.

**Off / Completely Off** – Not physically in contact with or *Supported* by an object, surface, etc. Objects that are *Off* are also considered *Completely Off*.

**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 an object, surface, etc. is *Completely On*.

**Out / Outside** – An object that does not extend into any part of a defined *Area* is *Outside* the *Area*.

**Own / Owned** – A *Team* *Owens* a *Junction* when that *Team* has a *Scored Cone* or a *Scored Beacon* on that *Junction*. A *Terminal* is *Owned* when it has at least one (1) *Scored Cone*.

**Park / Parked** – The condition where a *Robot* is motionless.

**Penalty** – The consequence imposed for a rule or procedure violation that is identified by specified *Field Personnel*. When a *Penalty* occurs, points will be deducted from the *Score* of the *Robot* that incurred the *Penalty*. *Penalties* are further defined as *Minor Penalties* and *Major Penalties*.

**Playing Field** – The part of the *Competition Area* that includes the 12 ft. x 8 ft. (3.66 m x 2.44 m) field and all the *Game Elements* described in the official field documents. There are two equivalent official versions of the *Playing Field*: red or blue, that are mirror images of each other.

**Playing Field Boundary** – A taped line or a wall that marks the *Area* where a *Robot* operates.

**Playing Field Damage** – A physical change to a *Game Element* or *Playing Field* that affects gameplay.

**Playing Field Floor** – The top surface of the *Area* inside the *Playing Field Boundary*.

**Plowing** – *Inadvertent* contact with *Game Elements* while in the path of the *Robot* moving about the *Playing Field* that provides no additional advantages beyond field mobility. See also the definition of *Herding* in this section.

**Possess / Possessing** – An object is *Possessed* by a *Robot* if, as the *Robot* moves or changes orientation (for example, moves forward, turns, backs up, spins in place), the object remains in approximately the same

position relative to the *Robot*. Objects *Possessed* by a *Robot* are considered to be *Controlled*, and they are part of the *Robot*. See also *Control/Controlling*.

**Pre-Load** - A *Game Element* that a *Drive Team* positions during pre-*Match* setup so that it touches a *Robot* or is *Possessed* by a *Robot* at the start of the *Autonomous Period*.

**Propel / Propelling** – Giving *Game Elements* enough force such that they move independent of contact with the *Robot* or *Human Player*. Movement solely due to gravity is not *Propelling*.

**Robot** – Any mechanism that has passed *Robot* inspection and a *Drive Team* places on the *Playing Field* prior to the start of a *Match*. A detailed definition of *Robot* is in the *Robot* rules section in the [Game Manual Part 1 – Remote Events](#).

**Rolling** – *Propelling Game Elements* along the *Playing Field Floor*.

**Score / Scoring** – A *Robot* earns points by interacting with *Scoring Elements* and *Navigating* to specific *Areas* of the *Playing Field*.

The specific method for each *Scoring* achievement is stated in the achievement’s description in Section 4.4. Individual *Scoring* achievements are determined by one of three methods:

- a) **Scored as Completed**: The achievement is considered *Scored* the moment it is successfully completed, i.e., all criteria are met.
- b) **Scored at End of the Period**: The achievement’s *Scoring* status is determined based on the *Robot* or *Scoring Element*’s position at the *End of the Period* (*Autonomous* or *Driver-Controlled*).
- c) **Scored at Rest**: The achievement is considered *Scored* based on the position of the *Robot* or *Scoring Element* when the entire field has come to rest after the *Period* (*Autonomous* or *Driver-Controlled*) ends.

Use of the real-time scoring system display is intended to help the *Team* keep up with the action on the *Playing Field* and give a general sense of the *Match Score*. Those watching should keep in mind that the *Scoring* for the *Match* is not official until the *Field Personnel* finalize the *Score* after the *End of the Match*.

**Scoring Elements** – Objects that *Robots* manipulate to earn points for their *Team*. The *Scoring Elements* for POWERPLAY<sup>SM</sup> are *Cones* and *Beacons*. A *Signal* is not a *Scoring Element*.

**Secured** – A *Cone* is *Secured* in a *Ground Junction* when the 4-inch diameter base of the *Cone* is *Completely In* the recess of the *Junction* or *Completely On* a *Secured Cone*. A *Cone* is *Secured* in a *Low*, *Medium*, or *High Junction* when the pole passes through the 1.25” diameter hole of the *Cone* or it is *Completely On* a *Secured Cone*. A *Cone* is *Secured* only if the large opening is facing toward the *Playing Field Floor*.

**Signal** – A *Game Element* that is constructed from a standard *Cone*. The *Signal* is 4 inches (10.16 cm) in diameter (base) and 5 inches (15.2 cm) tall. It weighs approximately 2.55 oz. (72.4 grams). There are two (2) *Signals*, each *Signal* has the same set of three specific images, 120 degrees apart. The *Signal* is used only during the *Autonomous Period* to indicate the randomization state and may not be *Scored*. A *Signal* is not a *Scoring Element*.

**Signal Sleeve** – A *Team* designed and manufactured *Game Element* that *Teams* may choose to use in the *Match*. A detailed definition of the *Signal Sleeve* is in section 7.4 of the *Game Manual Part 1 – Remote Events*.

Compliance with construction rules will be verified during *Robot Inspection*. The *Signal Sleeve* is used to cover the standard *Signal* images with *Team*-provided images that are different from the standard images for use during the *Autonomous Period*.

**Signal Zone** – A location on the *Playing Field* that *Robots* *Navigate* to during the *Autonomous Period*. There are three (3) distinct *Signal Zones*, each one corresponding to an image on the *Signal* or *Signal Sleeve*. See Appendix E, Figure E-3 for details.

**Sliding** – *Propelling Game Elements* along the *Playing Field Floor*.

**Student** - A person who has not completed high-school, secondary school, or the comparable level as of September 1<sup>st</sup> prior to the season Kickoff.

**Substation** - A taped off location on the *Playing Field* where the *Human Player* places *Cones* or *Beacons*.

**Substation Storage** – The designated area outside of the *Playing Field* directly adjacent to the *Substation* where the *Team's Beacon* and additional *Cones* are stored to be introduced by the *Human Player*. There is one (1) *Substation Storage* area.

**Support / Supported / Completely Supported** – An object (i.e., *Robot*, *Scoring Element*, *Game Element*, etc.) is *Supported* by another object if the second object is bearing at least some of the weight of the first object. If the second object is bearing all the weight of the first object, it is *Completely Supported* by the second object.

**Team** – Mentors, supporters, and *Students* affiliated with an entity registered with *FIRST* and for the competition.

**Terminals** – Taped off *Scoring Areas* on the *Playing Field*. There are two (2) *Terminals*.

**Tile** – An approximate 24-inch x 24-inch (610 mm x 610 mm) foam rubber mat.

## 4.4 Gameplay

Prior to the start of the *Match*, the *Drive Team* performs some basic *Robot* setup steps that are described in section 4.4.1. *Matches* are made up of several periods totaling two minutes and thirty seconds (2:30). There is a thirty (30) second *Autonomous Period*, followed by a two (2) minute *Driver-Controlled Period*. The last thirty (30) seconds of the *Driver-Controlled Period* is called the *End Game*. There is an eight-second transition between the *Autonomous Period* and the *Driver-Controlled Period* for the *Team* to pick up their controllers and switch programs.

### 4.4.1 Pre-Match

- 1) *Field Personnel* set up the *Playing Field* as depicted in Figure 4.2-1.
  - a) One (1) *Signal* is placed at each *Signal* location with image **1** facing the *Alliance Station*.
  - b) Ten (10) *Cones* (red or blue) are placed in two (2) stacks of five (5) *Cones* each *Inside* the *Playing Field*.
  - c) Twenty (20) *Cones* (red or blue) are placed in four (4) stacks of five (5) *Cones* each in the *Substation Storage Area*.
- 2) The *Drive Team* sets up their *Robot* on the *Playing Field* with the following constraints:
  - a) **Starting Location**
    - i. The *Drive Team* selects their *Robot's* starting location.

- ii. *Robots and their Pre-Load Cone must be placed Completely Inside the Playing Field Boundary.*
  - iii. *The Drive Team must place their Robot, in any orientation, touching the Playing Field Boundary adjacent to their Alliance Station.*
  - iv. *The Robot cannot start in the Substation or Terminal.*
  - b) **Pre-Loaded Cones** – *The Drive Team may Pre-Load exactly one (1) Cone. If used, a Pre-Loaded Cone is taken from Substation Storage.*
  - c) **Beacon** – *The Team’s Beacon corresponding to its Alliance color is placed in Substation Storage.*
  - d) **Signal Sleeve** – *A Drive Team intending to use their Signal Sleeve must place it on top of the Signal closest to their Robot with “Team Image 1” (see Appendix E, Figure E-7, for Signal Sleeve nomenclature) facing the associated Alliance Station.*
  - e) **Op Mode** – *The Drive Team uses their Driver Station Android device to:*
    - i. *Select an Autonomous Op Mode. If the Team does not have an Autonomous Op mode, steps ii and iii can be skipped.*
    - ii. *The thirty-second timer must remain enabled.*
    - iii. *Press the Driver Station “Init” button.*
    - iv. *Robot must be motionless prior to the start of the Match.*
    - v. *The Drive Team may not touch their Driver Station 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.*
- 3) Once the *Match Manager* signals that set-up is complete:
- a) *The Drive Team may no longer touch their Robot until the conclusion of the Match.*
  - b) *The Drive Team may not touch their Driver Station or controllers until the Autonomous Period has ended.*
  - c) *Field Personnel will rotate the Signal into one of three (3) orientations that is randomly chosen by the scoring system or by a die throw as specified in Appendix E. All Signals will have the same orientation as seen from their associated Alliance Station.*

#### **4.4.2 Autonomous Period**

The *Match* starts with a thirty (30) second *Autonomous Period* where *Robots* are operated only via pre-programmed instructions. The *Team* is 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 the *Robot*. The only exception is to allow the *Drive Team* to start their *Robot* with the “start” command issued on the *Driver Station* touch screen. The *Team* must use the built-in thirty-second timer.

Following a countdown by field personnel, the *Autonomous Period* begins. The *Drive Team* may issue a *Robot* start command with their *Driver Station* Android device to run the *Autonomous Op Mode* that was selected during *Pre-Match* setup. Failure to adhere to this procedure may subject the *Team* to a *Penalty* as specified in

the game rules in section 4.5.2. The *Drive Team* is not required to start executing an Op Mode during the *Autonomous Period*.

*Autonomous* points are *Scored at Rest* for the following achievements:

- 1) **Navigating** –
  - a) A *Robot Parked In* their *Substation* earns two (2) points.
  - b) A *Robot Parked In* either of their *Terminals* earn two (2) points
- 2) **Cone** – A *Robot* placing *Cones* earn points as follows:
  - a) Each *Cone* placed *In* a *Terminal* earns one (1) point.
  - b) Each *Cone Secured* (see Appendix F) on a *Junction* earns points as follows:
    - i. *Ground Junction*: two (2) points.
    - ii. *Low Junction*: three (3) points.
    - iii. *Medium Junction*: four (4) points.
    - iv. *High Junction*: five (5) points.
- 3) **Signal Bonus** – A *Robot* earns points for *Parking Completely In* the *Signal Zone* that corresponds to the randomly selected *Signal* image (see Appendix E).
  - a) If using the *Playing Field*-supplied *Signal*, a *Robot* will earn ten (10) points.
  - b) If using the *Team*-supplied *Signal Sleeve*, a *Robot* will earn twenty (20) points.

*Cones* that are *Scored* in the *Autonomous Period* will earn additional points at the end of the *Driver-Controlled Period* if they remain in place.

#### **4.4.3 Driver-Controlled Period**

Directly following the end of the *Autonomous Period*, the *Drive Team* has five (5) seconds plus a "3-2-1-go" countdown to prepare their *Driver Station* for the start of the 120 second *Driver-Controlled Period*. On the countdown word "go," the *Driver-Controlled Period* starts, and the *Drive Team* presses their *Driver Station* start button to resume playing the *Match*.

*Driver-Controlled* tasks are *Scored at Rest* for the following achievements:

- 1) **Cone** – A *Robot* placing *Cones* earns points as follows:
  - a) Each *Cone* that is placed *In* a *Terminal* earns one (1) point.
  - b) Each *Cone Secured* (see Appendix F) on a *Junction* earns the following points.
    - i. *Ground Junction*: two (2) points.
    - ii. *Low Junction*: three (3) points.
    - iii. *Medium Junction*: four (4) points.
    - iv. *High Junction*: five (5) points.

#### **4.4.4 End Game**

The last thirty seconds of the *Driver-Controlled Period* is called the *End Game*. *Driver-Controlled Period* *Scoring* can still take place during the *End Game*. A *Beacon* introduced prior to the start of the *End Game* is not eligible for *Scoring*. All other achievements can be started at any time.

*End Game* tasks are *Scored at Rest*.

1) **Junction Ownership** – A Robot earns points for *Owning a Junction*. There are two mutually exclusive ways to *Own a Junction*:

- a) *Ownership* conveyed by the top *Scored Cone* is worth three (3) points; or
- b) *Ownership* conveyed by a *Beacon* successfully *Capping a Junction* earns ten (10) points.

If both (a) and (b) are met, a *Beacon* (condition b) takes precedence over the top *Scored Cone* (condition a).

Subsequent *Cones* placed on the *Junction* after it is *Capped* have zero (0) *Score* value.

2) **Circuit** – Each *Match* has a predefined *Circuit* that must be completed to earn points (see Appendix H). A completed predefined *Circuit* earns the *Team* twenty (20) points. Only one (1) *Circuit* bonus can be earned per *Match*.

**Important Note:** A *Cone Scored* on a *Junction* outside of the predefined *Circuit* negates the *Circuit* bonus.

3) **Navigating** – A *Robot Parked In a Terminal* earns two (2) points.

#### 4.4.5 Post Match

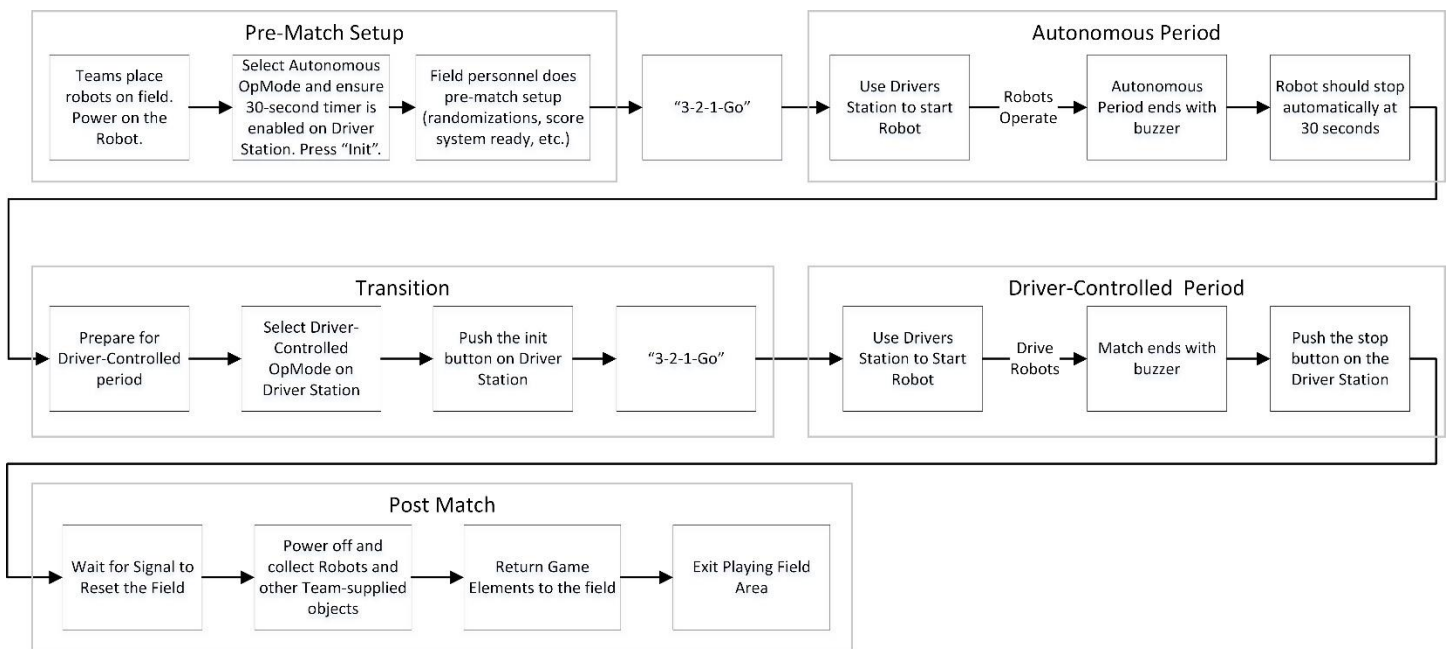
After the *Match*, *Field Personnel* will finalize the *Score*. The *Match Manager* will signal for the *Drive Team* to enter the *Playing Field* and retrieve their *Robot*, *Team Signal Sleeve*, and *Beacon*. The *Drive Team* should return any *Game Elements* that are *Possessed* by the *Robot* to the *Playing Field*. *Field Personnel* will set up the *Playing Field* for the next *Match*.

#### 4.4.6 Penalties

*Penalty* points are subtracted from the offending *Team’s Score* at the *End of the Match*. *Minor Penalties* subtract ten (10) points per occurrence. *Major Penalties* subtract thirty (30) points per occurrence.

#### 4.4.7 Flowchart of Match Play

The following figure shows the typical flow of the *Match* and the actions taken on the *Driver’s Station* Android device.





## 4.5 Rules of Gameplay

Gameplay is restricted by the Safety rules (<S#>), the General rules (<G#>), and the Game-Specific rules (<GS#>). Violation of rules may lead to *Penalties and/or a Disabled Robot*. Rules apply to all periods of play unless otherwise specified. 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.**

There are rules in the Game Manual Part 2 – Traditional Events, that do not apply to *Teams* competing remotely. Those rules have been removed from this manual; however, the numbering of the rules has been kept the same for consistency. The remaining rules may have modifications as appropriate for single *Robot* gameplay.

### 4.5.1 Safety Rules

<S1> **Unsafe Robot or Playing Field Damage** – If at any time the *Robot* operation is deemed unsafe or has damaged the *Playing Field*, the *Robot* may be *Disabled* by *Field Personnel*.

<S2> **Robot Extension Outside the Playing Field Boundary** – If any portion of the *Robot* contacts anything *Outside* the *Playing Field Boundary*, the *Team* will be issued a *Major Penalty*. See the game definitions in section 4.4 for a complete description of the *Playing Field Boundary*.

The intent of this rule is not to *Penalize* a *Team* for *Inadvertent*, safe *Robot* extension *Outside* the *Playing Field Boundary*. Intentional *Robot* extension *Outside* the *Playing Field* is not permitted.

<S3> **Safety Gear** – *Matches* must not be played until all members of the *Drive Team* are wearing approved eye protection and shoes with closed-toes and a closed-back.

### 4.5.2 General Game Rules

<G1> **Autonomous to Driver-Controlled Period Transition** – At the conclusion of the *Autonomous Period*, the *Robot* will remain in a hands-off state. *Field Personnel* will not enter the field and will not touch the *Robot* on the field during the *Autonomous* to *Driver-Controlled* transition. The scoring system display will provide visual and audio cues for the *Drive Team* to pick up their *Driver Station*. The *Drive Team* will have five (5) seconds to pick up and prepare their *Driver Station*. After five (5) seconds, there will be a “3-2-1 go” countdown and the *Driver-Controlled Period* of the *Match* will begin.

<G2> **Score Certification at the End of the Match** – *Scores* will be tracked by *Field Personnel* throughout the *Autonomous* and *Driver-Controlled Periods* of the *Match*. At the *End of the Match*, the final *Score* will be certified as quickly as possible. A change in state of a *Game Element* or *Robot* at the *End of the Match* after its final *Score* is recorded will not change an already-recorded *Score*. *Scoring Elements* will not be recounted after the *End of the Match* unless otherwise specified by a Game-Specific rule.

<G4> **Robot Manipulation of Scoring Elements** – *Scoring Elements* that are *Controlled* or *Possessed* by a *Robot* are part of the *Robot* except when determining the location of the *Robot* or otherwise specified by a Game-Specific rule.

For Example: If a *Robot* Possesses a *Scoring Element*, and only that *Scoring Element* breaks the plane of a *Scoring Area*, the *Robot* does not receive points for being *In* that *Area*.

**<G5> 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.

**<G6> Scoring Elements in Contact with Robots** – Scoring Elements in a Scoring Area that are in contact with or Controlled by a Robot for the Scoring Area have zero Score value.

**<G7> Disabled Robot Eligibility** - A Disabled Robot is not eligible to Score or earn points for the remainder of the Match.

**<G8> Playing Field Tolerances** – Playing Field and Game Elements will start each Match with tolerances that may vary by +/-1.0 inch (25.4 mm). Teams must design their Robots accordingly.

Commercial Off The Shelf and Do it Yourself Playing Field and Game Elements are expected to be manufactured, assembled, and set up using a high standard for dimensional and location accuracy. The intent of the generous +/- 1.0 inch tolerance is to accommodate unintentional size and location variations that may occur. The tolerance is not an excuse for intentional or imprecise accuracy in construction or setup.

**<G9> Match Replay** – Once started, Matches are not paused or replayed. Unexpected Robot behavior will not result in a Match replay. Team-induced failures, such as low battery conditions, processor sleep time-outs, Robot mechanical, electrical, software, or communication failures, etc. are NOT valid justifications for a replaying of a Match.

**<G10> Inadvertent and Inconsequential** - Robot actions that violate a rule may be ruled by Field Personnel to be Inconsequential and Inadvertent and will not be Penalized.

**<G12> Playing Field Access** – Drive Team members must not enter the Playing Field for any reason other than to place/retrieve their Robots. While placing the Robot, the Team may not measure, test, or adjust Game Elements Inside or Outside of the Playing Field unless allowed by Section 4.4.1.

The consequences for violating this rule are:

- a) *Minor Penalty* for violations during Match setup or following the End of the Match.
- b) *Major Penalty* for violations that delay the start of the Match.

If a Team feels the Playing Field is not set up correctly, Teams should notify Field Personnel prior to the start of the Match.

**<G13> Pre-Match Robot Placement** – At the beginning of a Match, the Robot must be set up on the Playing Field according to section 4.4.1 Pre-Match. After the Robot is set up on the Playing Field, the Drive Team must stand Inside the Alliance Station.

**<G14> Robot Starting Volume** – Before the start of a Match, the Robot in its starting location must not exceed a volume of 18 inches (457.2 mm) by 18 inches (457.2 mm) by 18 inches (457.2 mm). A Pre-Loaded Scoring Element may extend Outside the 18-inch (457.2 mm) cube volume constraint. Match play must not begin until the Robot's starting volume constraint is satisfied.

After the start of a *Match*, the *Robot* may extend in any direction unless otherwise specified by the Game-Specific rules detailed in section 4.6.3.

**<G15> Robot Setup Alignment** – The *Drive Team* may align their *Robot* during *Pre-Match* setup if they do so with legal components that are part of the *Robot* and can be reset to be within the 18-inch (457.2 mm) cube starting volume constraint. *Robot* setup alignment devices that extend outside the 18-inch starting volume constraint cannot be powered. A single member of the *Drive Team* may also align the *Robot* by sight if they are next to the *Robot* and their action does not delay the start of a *Match*. A *Minor Penalty* will be assessed to the *Team* for violation of this rule.

**<G16> Alliance Stations** – During a *Match*, the *Drive Team* must remain *In* their *Alliance Station*.

- a) The *Drive Team* may be anywhere in their *Alliance Station*.
- b) The first instance of leaving the *Alliance Station* will result in a *Warning*, with any following instances during the *Match* resulting in a *Minor Penalty*. Leaving the *Alliance Station* for safety reasons will not result in a *Warning* or *Penalty*.

The intent of this rule is to prevent *Drive Team* members from leaving their assigned *Station* during a *Match* to gain a competitive advantage. For example, moving to another part of the *Field* for better viewing, reaching into the *Field*, etc. Simply breaking the plane of the *Station* during normal *Match* play is not a *Penalty*.

**<G17> Post-Match Removal of Robots** – *Robots* must be designed to permit easy removal of *Game Elements* from the *Robot* after the *Match*. The *Robot* 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.

**<G18> Starting Gameplay Early** – A *Robot* that starts playing the game (*Autonomous* or *Driver-Controlled Period*) prior to the start of a *Match Period* receive a *Minor Penalty*.

**<G19> Late Start of the Autonomous Period** – A *Drive Team* that starts their *Robot's Autonomous Op Mode* late will receive a *Minor Penalty*. Any delay in *Robot* movement must be done by its programming.

**<G20> Robot Actions at End of the Period** –

- a) The *Robot* must *Park* at the end of the *Autonomous* and *Driver-Controlled Periods*. A *Robot* that is not *Parked* at the conclusion of the “game sound” receives a *Minor Penalty* and the following actions of the *Robot* do not count towards their *Team's Score*. The *Drive Team* should make their best effort to stop gameplay immediately when the *End of the Period* game sound begins. *Field Personnel* 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 *Team*.
- b) *Scoring* achievements that were started (unless disallowed by Game-Specific rules) before the *End of the Period* are eligible to be counted as *Scored*.
- c) *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*.

**<G21> Robot Control During Autonomous Period** - During the *Autonomous Period*, the *Drive Team* may not directly or indirectly control or interact with their *Robot* or *Driver Station*. Early stopping of the *Robot* while running its *Autonomous* code is not allowed, except in cases of personal or equipment safety, and any

achievements earned due to early stoppage will not Score points. A *Major Penalty* will be assessed for violating this rule. *Teams* that stop their *Robots* during the *Autonomous Period* are allowed to participate in the *Driver-Controlled Period* provided it can be done safely.

**<G22> Drive Team Contact with the Playing Field or Robot** – During a *Match*, the *Drive Team* is prohibited from making contact with the *Playing Field*, any *Robot*, or any *Game Element* unless allowed by Game-Specific rules. The first instance of contact will result in a *Warning*, with any following instances during the competition resulting in a *Minor Penalty*. Contact that affects *Scoring* and/or gameplay will result in a *Major Penalty*. 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 *Game Element* is *Launched* from a *Robot* on the *Playing Field* and it *Inadvertently* hits a *Team* member in the *Alliance Station* and is deflected back onto the field. The *Team* would not receive a **<G22> Penalty** because the *Team* member was protecting themselves (safety). However, if that same *Game Element* is caught and/or directed to a specific location on the *Playing Field*, the *Team* may be issued a **<G22> Penalty**.

**<G23> Drive Team Coach Driver Station Control** – During the *Driver-Controlled Period*, the *Robot* must be remotely operated only by the *Drivers* using the Gamepads connected to the *Team's Driver Station* and/or by software running on the on-board *Robot* control system. The first instance of the *Coach* operating a gamepad will result in a *Warning*, with any following instances during the competition resulting in a *Major Penalty*. During the *Driver-Controlled Period*, the *Drive Team Coach* 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*.

**<G24> Robots Deliberately Detaching Parts** – A *Robot* may not deliberately detach parts during a *Match* or leave mechanisms on the *Playing Field* unless permitted by a Game-Specific rule. *Possessed* or *Controlled Scoring Elements* are not considered to be a part of the *Robot* for the purpose of this rule. The consequence of deliberately detaching a part is a *Minor Penalty* per occurrence. If a deliberately detached component or mechanism affects gameplay, the offending *Robot* will receive a *Major Penalty*. *Robot* parts that are released but remain connected by a tether are considered detached for the purposes of this rule.

**<G25> Robots Grasping Game Elements** – A *Robot* may not grab, grasp and/or attach to any *Game*

Tethered components that move independently of the main *Robot* are considered a detached component and are illegal.

*Element* or structure other than *Scoring Elements*, unless specifically allowed by Game-Specific rule(s) listed in section 4.5.3. The first instance will result in a *Warning* with any following violations during the competition resulting in a *Major Penalty*.

**<G26> Destruction, Damage, Tipping, etc.** – *Robot* actions aimed at the destruction, damage, tipping over, or entanglement of *Game Elements* are not in the spirit of the *FIRST* Tech Challenge and are not allowed unless permitted by Game-Specific rules. Some tipping, entanglement, and damage may occur as a part of normal gameplay. If the tipping, entanglement, or damage is ruled to be deliberate or chronic, the offending *Team* will receive a *Major Penalty*.

**<G27> Removing Game Elements from the Playing Field** – A Robot may not deliberately remove Game Elements from the Playing Field during a Match. Game Elements that Inadvertently fall Outside the Playing Field will be returned to the Playing Field by Field Personnel at the earliest safe and convenient opportunity at a non-Scoring location approximately where it left the field. Game Elements removed from the Playing Field in an attempt to Score are also not subject to this Penalty. A Team deliberately removing Game Elements from the Playing Field will incur a Minor Penalty per Game Element removed from the Playing Field. Game-Specific rules listed in section 4.5.3 that address the removal of specified Scoring Elements from the Playing Field take precedence over this general game rule.

**<G29> Illegal Usage of Game Elements** - Robots may not deliberately use Game Elements to ease or amplify the difficulty of any Scoring or game activity. A Major Penalty will be assessed for violations of this rule.

#### **4.5.3 Game-Specific Rules**

**<GS1> General Rule Exceptions** - The following instances of gameplay are Game-specific exceptions to General Game Rules in section 4.5.2:

- a) As a part of pre-Match Robot placement or post-Match Robot retrieval, the Drive Team may also place or retrieve their Team supplied Signal Sleeve as an exception to rule <G12>.
- c) Contact with a Cone in a Terminal is allowed as an exception to rule <G6> as long as the Cone is not Possessed by the Robot.

**<GS2> Drive Teams Touching Robots or Driver Stations after Randomization** – The Drive Team is not allowed to touch or interact with their Robot or Driver Station once Field Personnel have begun the randomization process. If this occurs, a Minor Penalty will be assessed to the Team, and the Team is not eligible to earn the Signal Bonus in the Autonomous Period.

**<GS4> Launched Scoring Elements** - Scoring Elements may not be Launched. Each violation of this rule results in a Minor Penalty. Rolling or Sliding Scoring Elements or Signals is allowed.

**<GS6> Control/Possession Limits of Scoring Elements** –

- a) A Robot may Control or Possess a maximum of one (1) Cone and one (1) Beacon at a time. Controlling or Possessing more than the allowed quantity of Cones is an immediate Minor Penalty for each Scoring Element above the limit plus an additional Minor Penalty per Scoring Element in excess of the limit for each 5-second interval that this situation continues.
- d) Scoring a Cone or Beacon while in Control or Possession of more than the allowed quantity will result in a Minor Penalty per Element Scored.
- e) Control/Possession limit exceptions:
  - i. Robots may temporarily Brace Scored Cones while placing a Scoring Element onto those Cones. Braced Cones are not subject to the Control/Possession limit.
  - ii. Knocking over your own Alliance stack of unscored Cones is allowed.
  - iii. Plowing through any quantity of Scoring Elements is allowed. Pushing an unsecured Cone off of a Junction is considered Plowing.

**<GS7> Junction and Terminal Constraints** -

- a) A Cone must be placed on a Junction with the large opening toward the Playing Field Floor to Score. A Cone placed on a Junction in any other orientation is not Scored and may be removed by the Robot.
- b) A Cone may be placed in the Terminal in any orientation to Score.
- d) A Cone added to a Junction that has been Capped has zero (0) Score value.

**<GS9> Signal Constraints** - A *Signal* is not a *Scoring Element*.

- a) A *Robot* may *Herd* or *Plow* the *Signal*. Any other form of *Control* of the *Signal* is not allowed. An immediate *Minor Penalty* plus an additional *Minor Penalty* for each 5-second interval that this situation continues will be assessed. *Signal* damage is handled per rule <G26>. *Signal Sleeve* damage may occur during gameplay. A *Team* should take this into account and create multiple *Signal Sleeves* for their *Competition*. *Signal Sleeve* damage is discouraged, but will not be *Penalized*.
- b) A *Signal* Scores zero (0) points if *Secured* on a *Junction* or *In* a *Terminal*. *Cones* and *Beacons* may continue to be *Scored* in those *Areas* as if the *Signal* was not there.

**<GS11> Scoring while In a Substation**- A *Robot* must be *Completely Outside* of the *Substation* in order to *Score* a *Cone* or *Beacon*. Each violation of this rule results in a *Minor Penalty*.**<GS13> Human Player Constraints** – Each violation of this rule results in a *Minor Penalty*.

- a) *Scoring Elements* *In* the *Substation Storage Area* may not be handled until after the *Match* has begun with the exception of *Pre-Load Scoring Elements*.
- b) *Scoring Elements* may only be introduced onto the *Playing Field* via the *Substation*.
- c) *Scoring Elements* may only be placed into the *Substation* during the *Driver-Control Period*.
- d) A *Human Player* may only place *Scoring Elements* *In* the *Substation* and may not *Propel* them *Out* of the *Substation*.
- e) The *Drive Team* may not use tools or devices to handle a *Scoring Elements*. Accommodations and exceptions for a *Human Player* with disabilities or extenuating circumstances will be made at the discretion of *Field Personnel*.
- f) A *Human Player* may place only one (1) *Scoring Element* *In* a *Substation* at a time. There is no limit to the number of *Scoring Elements* that may be *In* the *Substation* at a time.
- g) A *Human Player* cannot break the vertical plane of the *Playing Field Perimeter* or hand-deliver a *Scoring Element* to the *Playing Field* when there is a *Robot* *In* the *Substation*.
- h) A *Robot* cannot enter the *Substation* while a *Human Player* is placing a *Scoring Element* in the *Substation*.

The intent of this rule is to prevent *Robot* to human contact and is meant to ensure *Human Player* safety.

**<GS14> Beacon Constraints** –

- a) A *Beacon* introduced into the *Playing Field* prior to the start of the *End Game* is not eligible for *Scoring*.
- b) A *Robot* may *Score* at most one *Beacon* per *Match*. Each violation of this rule results in a *Major Penalty*. The additional *Beacon* is not eligible for *Scoring*.
- c) A *Beacon*'s color must correspond with the *Alliance* in order to be used by that *Alliance*. If the color does not correspond, it cannot be used.

## 4.6 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. All achievements are *Scored at Rest*.

<b>Scoring Achievement</b>	<b>Autonomous Points</b>	<b>Driver-Controlled Points</b>	<b>End Game Points</b>	<b>Reference</b>
<i>Navigating: Robot Parked in Terminal or Substation</i>	2			
<i>Placement: Cone placed in a Terminal</i>	1			
<i>Placement: Cone Secured on Junction:</i> <i>Ground Junction</i>	2			
<i>Low Junction</i>	3			
<i>Medium Junction</i>	4			
<i>High Junction</i>	5			
<i>Signal: Robot Parked only on the Signal Zone that corresponds to the Signal image</i>	10			
<i>Signal: Robot Parked only on the two Tiles that corresponds to the team supplied Signal Sleeve image</i>	20			
<i>Placement: Cone Scored In Terminal</i>		1		
<i>Placement: Cone Secured on Junction:</i> <i>Ground Junction</i>		2		
<i>Low Junction</i>		3		
<i>Medium Junction</i>		4		
<i>High Junction</i>		5		
<i>Navigating: Robot Parked In Terminal</i>			2	
<i>Ownership: Junction Owned by Cone</i>			3	
<i>Ownership: Junction Owned by Beacon</i>			10	
<i>Circuit: Completed predefined Circuit</i>			20	

### 4.7 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 4.5.

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty
<b>Safety Rules</b>					
<S1>	Unsafe Robot or Damage to the <i>Playing Field</i> .	<i>Disable</i> if unsafe operation is likely to persist.	D*		
<S2>	Contact <i>Outside</i> the <i>Playing Field</i> .	<i>Major Penalty</i>	D*		1x
<S3>	<i>Drive Team</i> missing safety gear.	<i>Warning</i> , Match cannot be played until issue is resolved	W+		
<b>General Rules – Further definitions, no Penalties earned</b>					
<G1>	<i>Autonomous</i> to <i>Driver-Controlled</i> <i>Period</i> transition				
<G2>	Certifying the <i>Score</i> at <i>End of the Match</i>				
<G4>	<i>Scoring Elements</i> <i>Controlled</i> or <i>Possessed</i> are part of the <i>Robot</i> for <i>Robot</i> location				
<G5>	<i>Robot</i> or <i>Scoring Element</i> in two or more <i>Scoring</i>				
<G6>	<i>Scoring Elements</i> in contact with <i>Robots</i>	Points are not earned for any <i>Scoring Elements</i> in a <i>Scoring Area</i> in contact with <i>Robots</i> of the corresponding <i>Alliance</i> .			
<G7>	<i>Disabled Robot</i> eligibility				
<G8>	<i>Playing Field</i> Tolerances				
<G9>	<i>Match</i> Replay				
<G10>	<i>Inadvertent</i> and <i>Inconsequential</i>				



Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty
<b>General Rules – Pre-Match and Post-Match Penalties</b>					
<G12>	Measure, test, or adjust <i>Game Elements</i> . <i>Playing Field</i> inspection to determine <i>Score</i>	<i>Minor Penalty</i> for pre- <i>Match</i> or post- <i>Match</i> violations. <i>Major Penalty</i> if delay start of <i>Match</i> .		1x	1x
<G14>	<i>Robot</i> starting volume.	<i>Robot</i> is removed from the <i>Playing Field</i> if not resolved within 30 seconds.			
<G15>	<i>Robot</i> setup alignment devices/ <i>Match</i> Delay.	<i>Minor Penalty</i> for each offense.		1x	
<G16>b	<i>Drive Team</i> member(s) leaving the <i>Alliance Station</i> .	<i>Warning</i> for the first instance with any following instances resulting in a <i>Minor Penalty</i> .	W	1x	
<G17>	Delay caused by the removal of <i>Robots</i> or damage to the <i>Playing Field</i> and <i>Game Elements</i> from <i>Robots</i> .	A <i>Minor Penalty</i> will be assessed.		1x	
<b>General Rules – Gameplay Penalties</b>					
<G18>	Starting <i>Gameplay</i> Early.	A <i>Minor Penalty</i> will be assessed.		1x	
<G19>	Late <i>Start of the Autonomous Period</i> .	A <i>Minor Penalty</i> will be assessed.		1x	
<G20>	<i>Robot</i> is not <i>Parked</i> at the end of period.	<i>Minor Penalty</i> and the actions of the <i>Robot</i> that occur after the end of <i>gameplay</i> do not count towards their <i>Team's Score</i> .		1x	
<G21>	<i>Robot</i> control during <i>Autonomous Period</i> / Early stopping of the <i>Autonomous</i> code.	<i>Major Penalty</i> . Achievements earned during that time result in zero <i>Score</i>			1x

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty
<G22>	<i>Drive Team</i> contact with the <i>Playing Field</i> , <i>Game Element</i> , or <i>Robot</i> .	<i>Warning</i> for the first instance with any following instances resulting in a <i>Minor Penalty</i> . <i>Major Penalty</i> if contact affects <i>Scoring</i> and/or gameplay.	W	1x	1x*
<G23>	<i>Drive Team Coach Driver Station</i> control.	<i>Warning</i> for the first instance with any following instances resulting in a <i>Major Penalty</i> .	W		1x
<G24>	<i>Robots</i> deliberately detaching parts.	<i>Minor Penalty</i> . <i>Major Penalty</i> if it affects gameplay.		1x	1x
<G25>	<i>Robots</i> illegally grasping <i>Game Elements</i> .	<i>Warning</i> for the first instance with any following instances resulting in a <i>Major Penalty</i> .	W		1x
<G26>	Destruction, damage, tipping, etc.	Deliberate or chronic violations of this rule will receive a <i>Major Penalty</i> .			1x
<G27>	Deliberately removing <i>Game Elements</i> from the <i>Playing Field</i> .	<i>Minor Penalty</i> per <i>Game Element</i> deliberately removed from the <i>Playing Field</i> .		1x	
<G29>	Illegal Use of <i>Game Elements</i> to ease or amplify <i>Scoring</i> .	<i>Major Penalty</i> will be assessed.			1x
<b>Game-Specific Rules – Gameplay Penalties</b>					
<GS2>	Touching controller after <i>Randomization</i>	<i>Minor Penalty</i> for each offense. <i>Team</i> does not earn <i>Autonomous Bonus</i>		1x+	
<GS4>	<i>Launched Scoring Elements</i>	<i>Minor Penalty</i> for each offense		1x	
<GS6>a	Possession of more than the allowed quantity of elements	Immediate <i>Minor Penalty</i> for each offense plus additional <i>Minor Penalty</i> every 5 seconds		1x+	
<GS6>d	<i>Scoring</i> while in <i>Possession</i> of excess quantity.	Immediate <i>Minor Penalty</i> per <i>Element Scored</i>		1x	
<GS7>a	<i>Cone</i> placed on a <i>Junction</i> in any orientation that is not <i>Secured</i>	<i>Cone</i> does not <i>Score</i>			

<b>Rule #</b>	<b>Rule</b>	<b>Consequence</b>	<b>Warning Disable</b>	<b>Minor Penalty</b>	<b>Major Penalty</b>
<GS7>d	<i>Cone added to Junction with Beacon</i>	<i>Zero (0) Score value and no ownership</i>			
<GS9>a	<i>Robots Controlling a Signal</i>	<i>Immediate Minor Penalty plus additional Minor Penalty every 5 seconds</i>		1x+	
<GS9>b	<i>Signal placed On Junction</i>	<i>Signal Cone does not Score</i>			
<GS11>	<i>Scoring from Inside Substation</i>	<i>Minor Penalty for each offense.</i>		1x	
<GS13>a	<i>Scoring Elements in Substation Storage may not be handled until start of Match</i>	<i>Minor Penalty for each offense</i>		1x	
<GS13>b	<i>Cones/Beacon may only be introduced into the Substation</i>	<i>Minor Penalty for each offense</i>		1x	
<GS13>c	<i>Human Players placing Scoring Elements before start of Driver-Controlled Period</i>	<i>Minor Penalty for each offense</i>		1x	
<GS13>d	<i>Human Players may only place Cones/Beacons in Substation and may not Propel them</i>	<i>Minor Penalty for each offense</i>		1x	
<GS13>e	<i>Using tools to place Cone or Beacon</i>	<i>Minor Penalty for each offense</i>		1x	
<GS13>f	<i>Placing more than one Cone/Beacon in Substation</i>	<i>Minor Penalty for each offense</i>		1x	

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty
<GS13>g	Human Player cannot break the vertical plane of the Playing Field Boundary while a Robot is In the Substation	Minor Penalty for each offense		1x	
<GS13>h	Robot enters Substation while Human Player is In the Substation	Minor Penalty for each offense		1x	
<GS14>b	Robot Scores more than one Beacon	Major Penalty for each offense			1x

Table Key	
W: Warning	1x: Penalty at single cost
D: Robot Disabled	1x+: Penalty at single cost every 5 seconds
* Indicates optional	2x: Penalty at double cost

## Appendix A – Resources

---

### Game Forum Q&A

<https://ftc-qa.firstinspires.org/>

Anyone may view questions and answers within the *FIRST*® Tech Challenge game Q&A forum without a password. To submit a new question, you must have a unique Q&A system user name and password for your team.

### Volunteer Forum

Volunteers can request access to role specific volunteer forums by emailing [FTCTrainingSupport@firstinspires.org](mailto:FTCTrainingSupport@firstinspires.org). You will receive access to the forum thread specific to your role.

### FIRST Tech Challenge Game Manuals

Part 1 and 2 - <https://www.firstinspires.org/resource-library/ftc/game-and-season-info>

### FIRST Headquarters Pre-Event Support

Phone: 603-666-3906

Mon – Fri

8:30am – 5:00pm

Email: [Firsttechchallenge@firstinspires.org](mailto:Firsttechchallenge@firstinspires.org)

### FIRST Websites

*FIRST* homepage – [www.firstinspires.org](http://www.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.

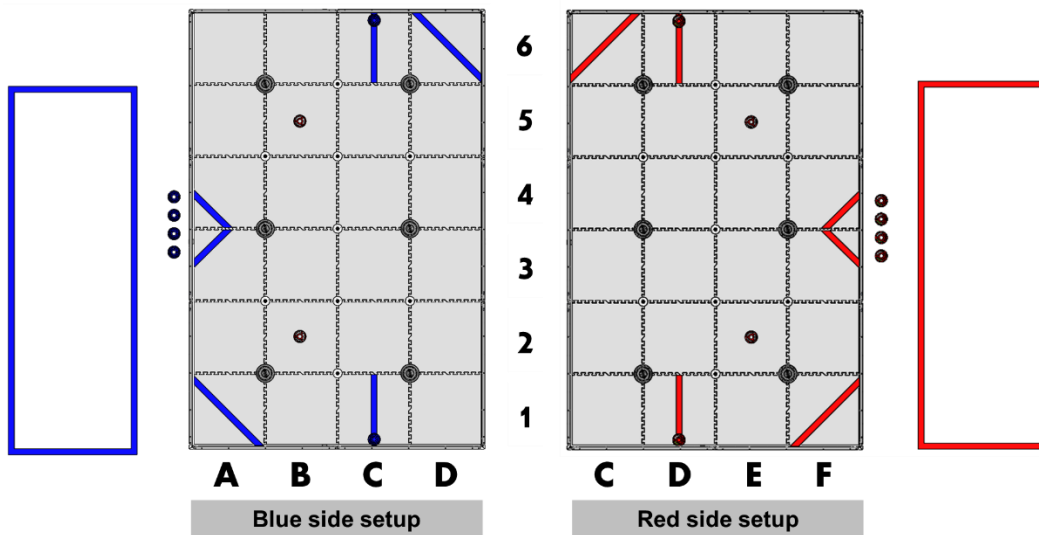
[FIRST Tech Challenge Blog](#) – Weekly articles for the *FIRST* Tech Challenge community, including outstanding volunteer recognition!

[FIRST Tech Challenge Team Email Blasts](#) – contain the most recent *FIRST* Tech Challenge news for teams.

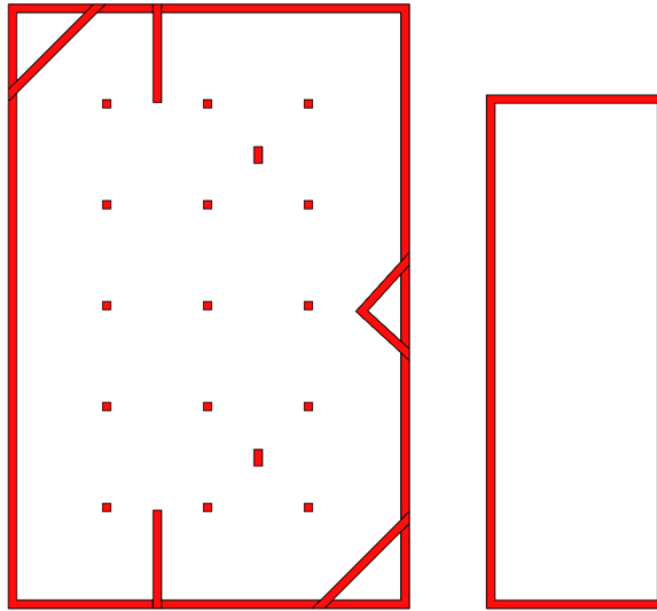
### Feedback

We strive to create support materials that are the best they can be. If you have feedback about this manual, please email [firsttechchallenge@firstinspires.org](mailto:firsttechchallenge@firstinspires.org). Thank you!

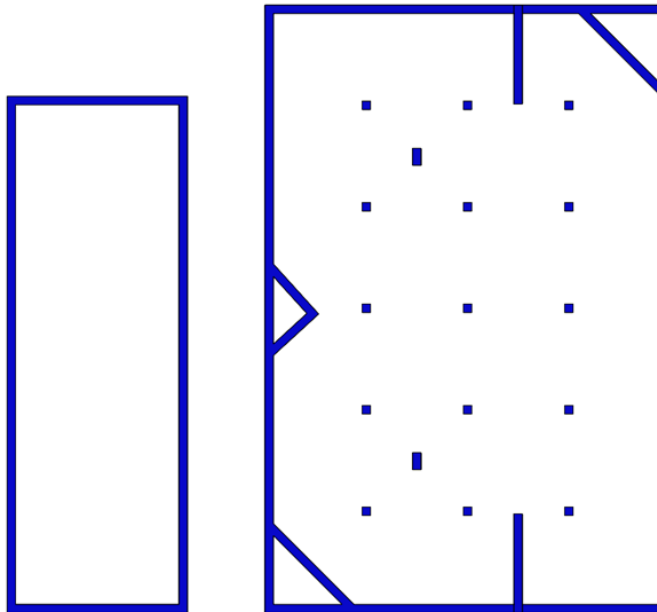
## Appendix B – Playing Field Layouts



B-1 Layout for *Fields* built with perimeters and Tiles



**Red side tape layout**

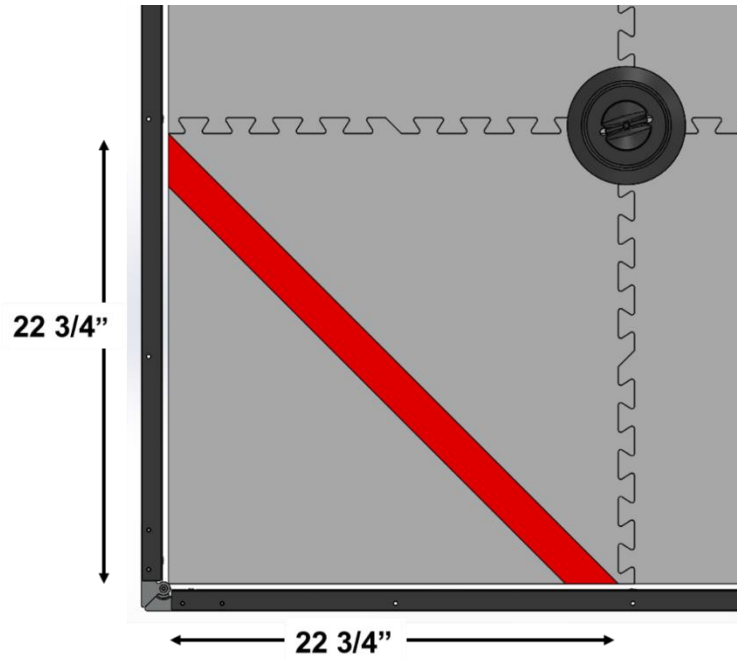


**Blue side tape layout**

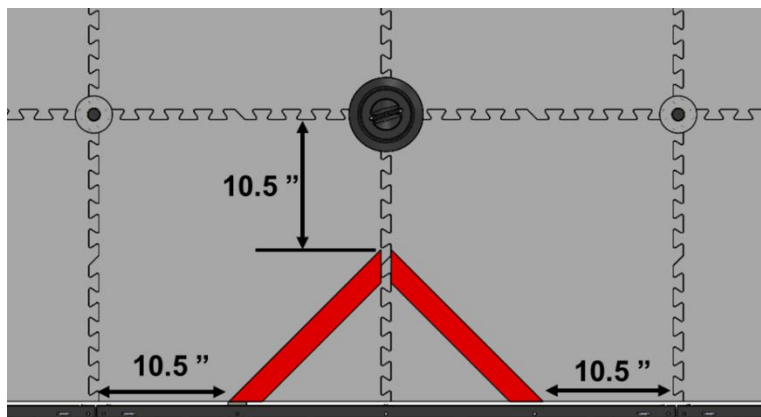
**B-2 Layout for *Fields* made with tape boundaries (no field borders or tiles)**

**Detailed dimensions can be found in the Remote Field Setup Requirements Guide**

## Appendix C – Playing Field Details

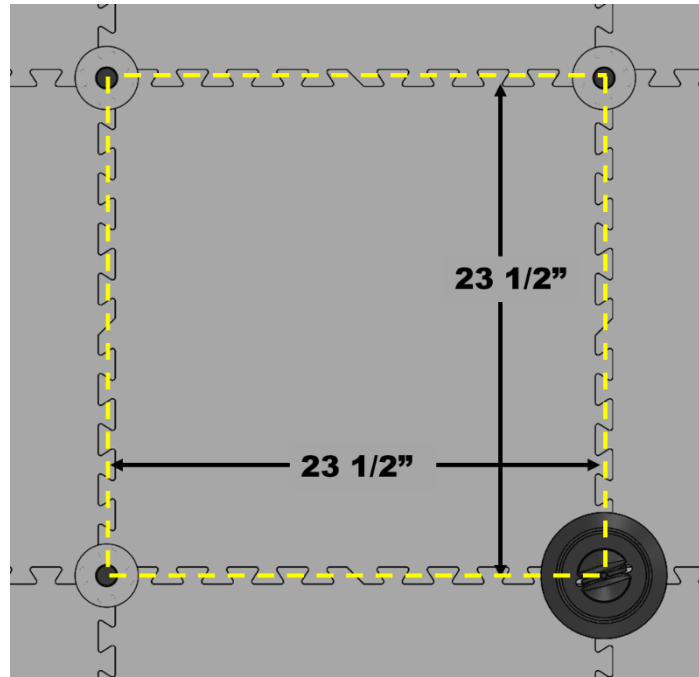


**C-1 Terminal, Typical**

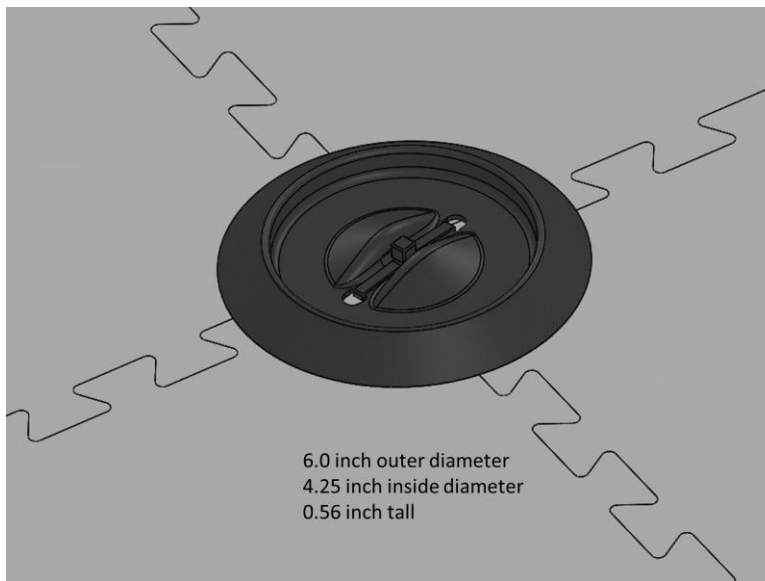


**C-2 Substation, Typical**

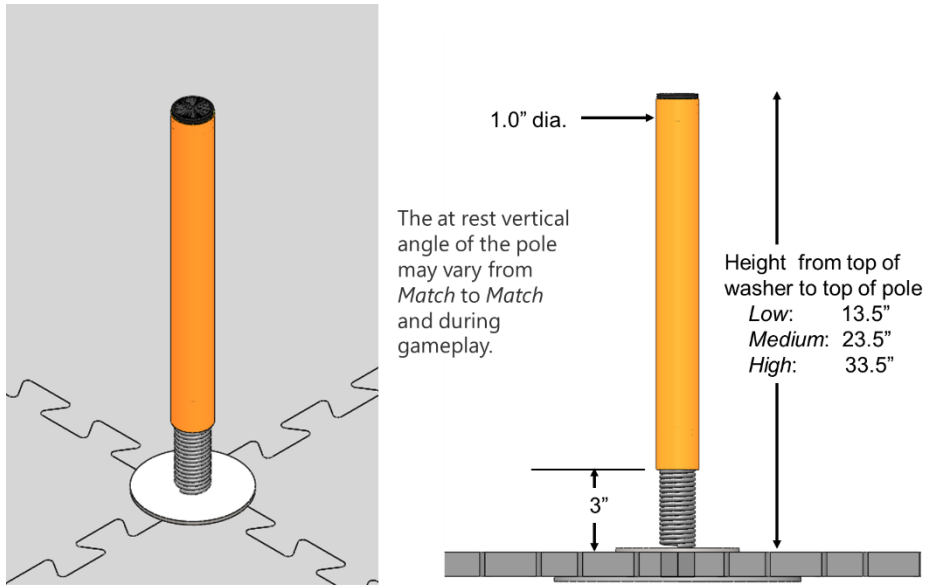




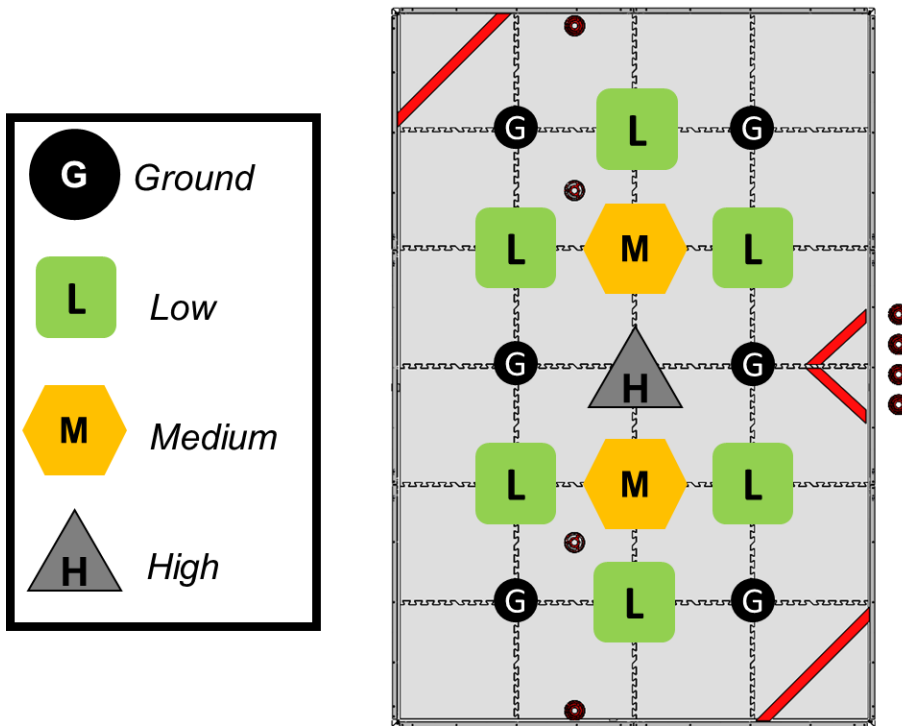
**C-3 Junction Spacing, Typical**



**C-4 Ground Junction**

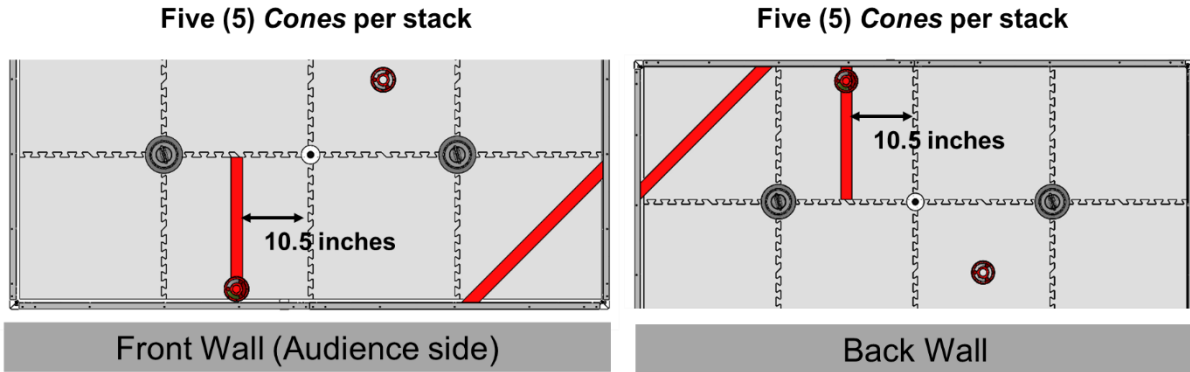


**C-5 Low, Medium, High Junctions**

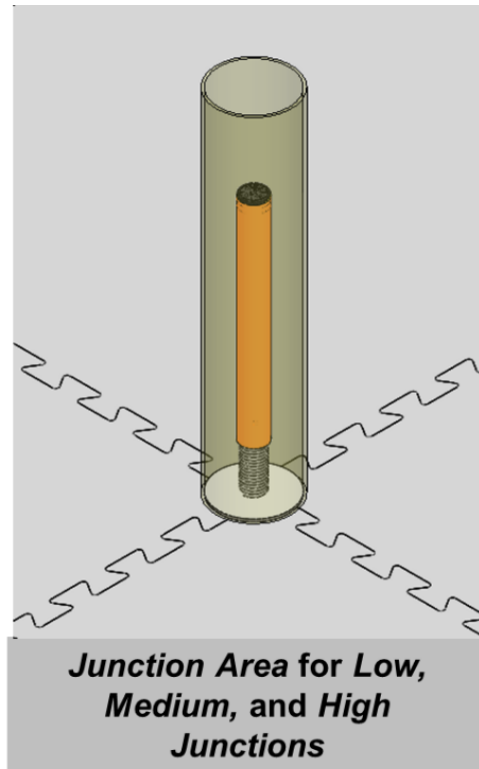
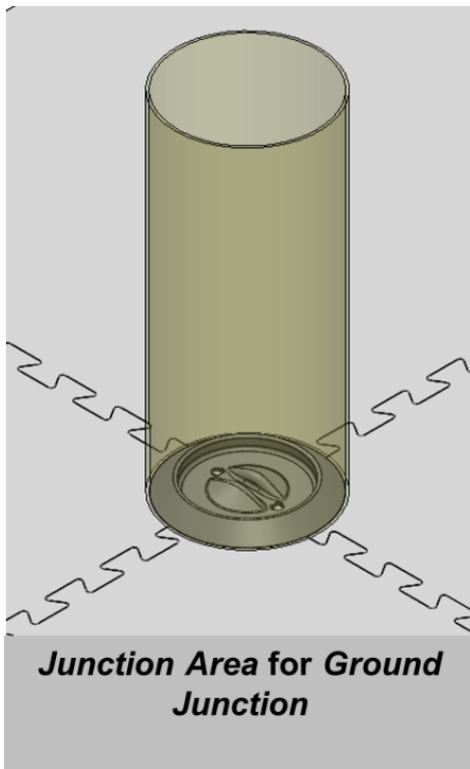


**Audience**

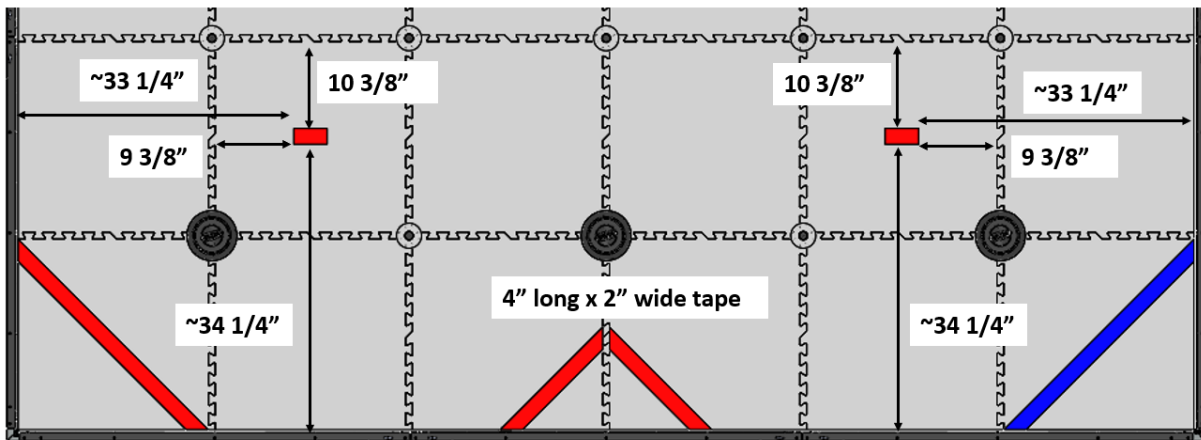
**C-6 Junction Locations**



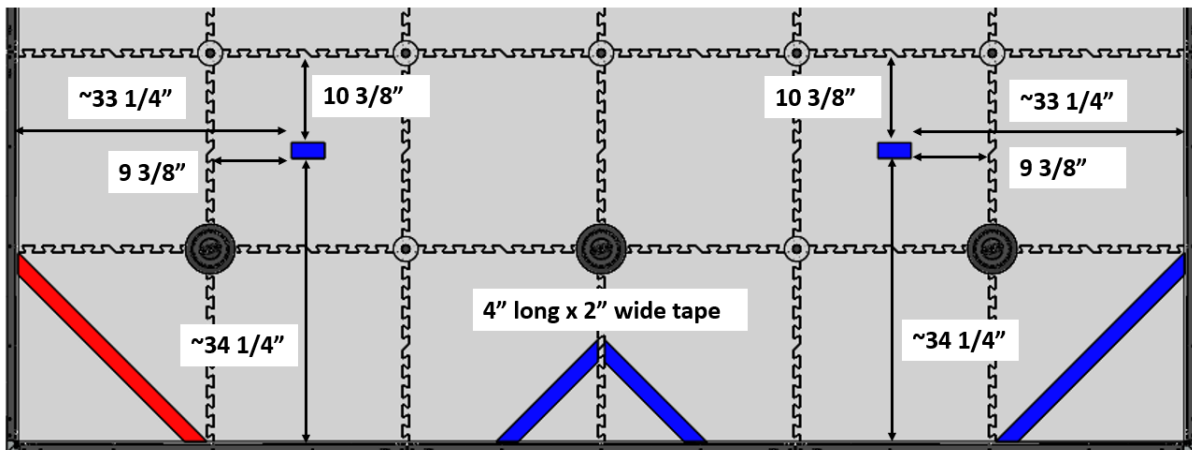
### C-7 In-Field Cone Stacks



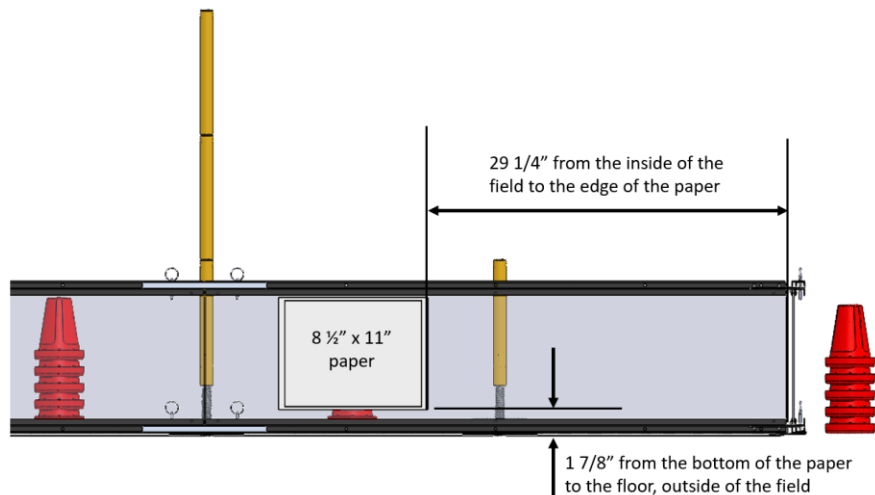
### C-8 Junction Area



**C-9 Red Signal tape locations**

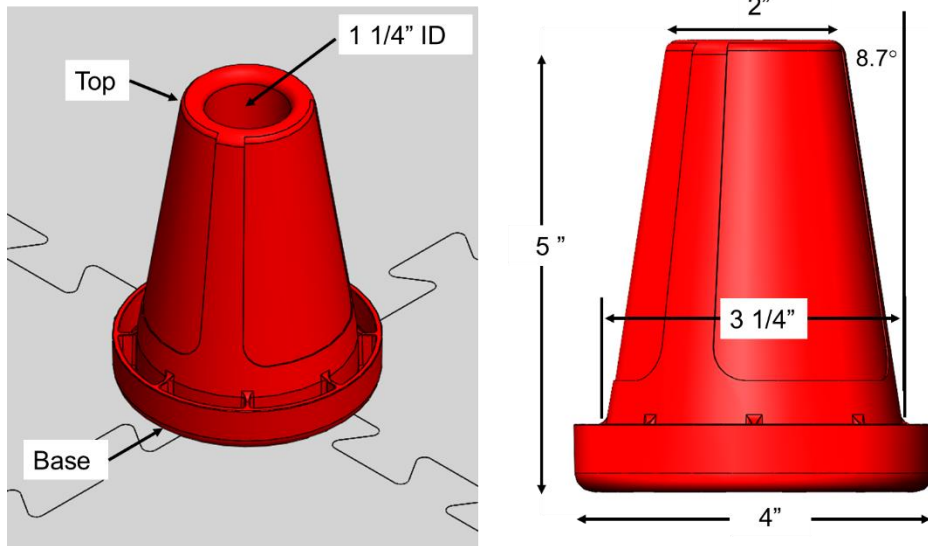


**C-10 Blue Signal tape locations**



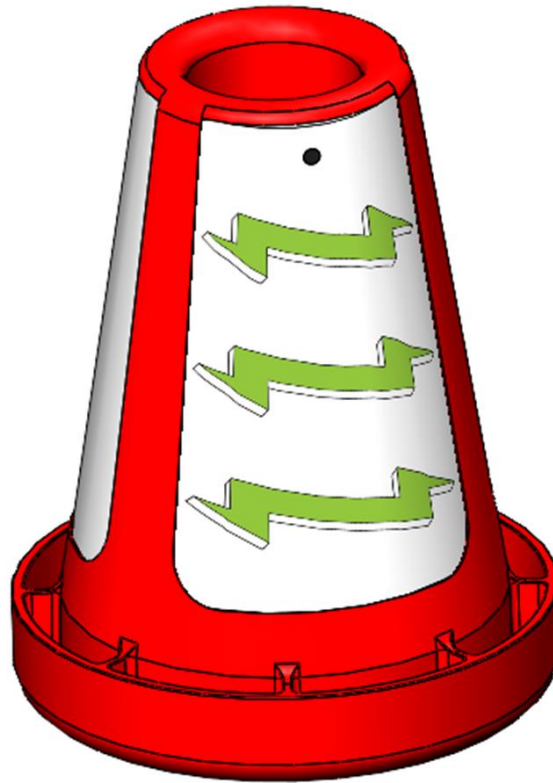
**C-11 Typical dimensions for Navigation Images**

## Appendix D – Scoring Element



**D-1 Cone, Approximate Dimensions**

## Appendix E – Randomization



E-1 – Signal

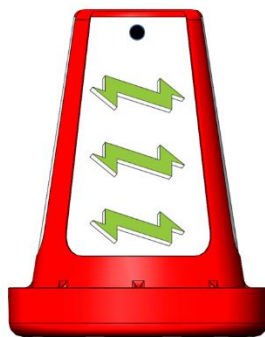
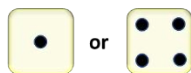


Image 1



Dice Roll

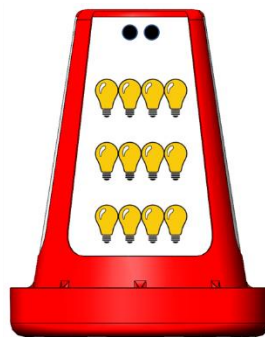
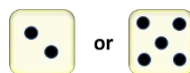


Image 2



Dice Roll

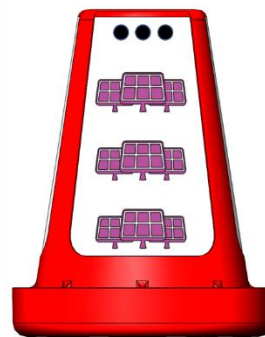
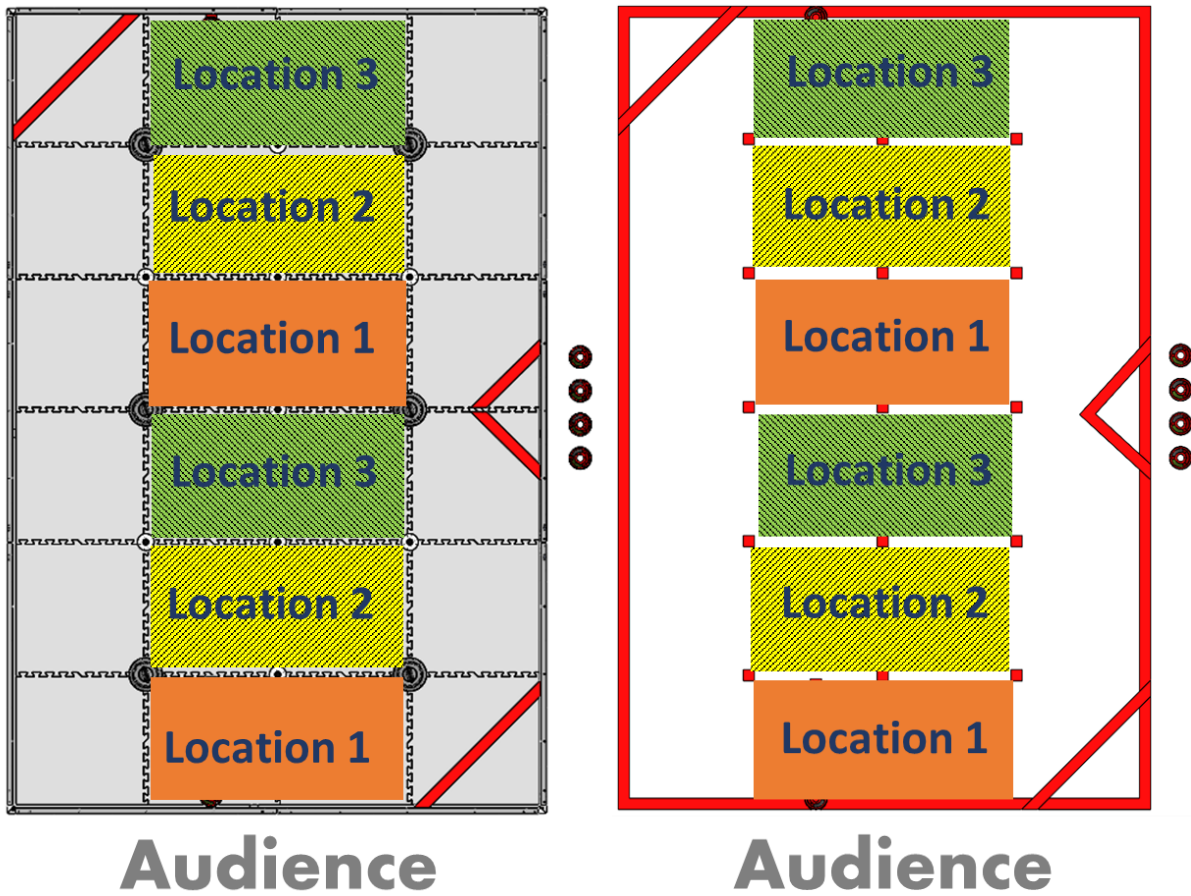


Image 3

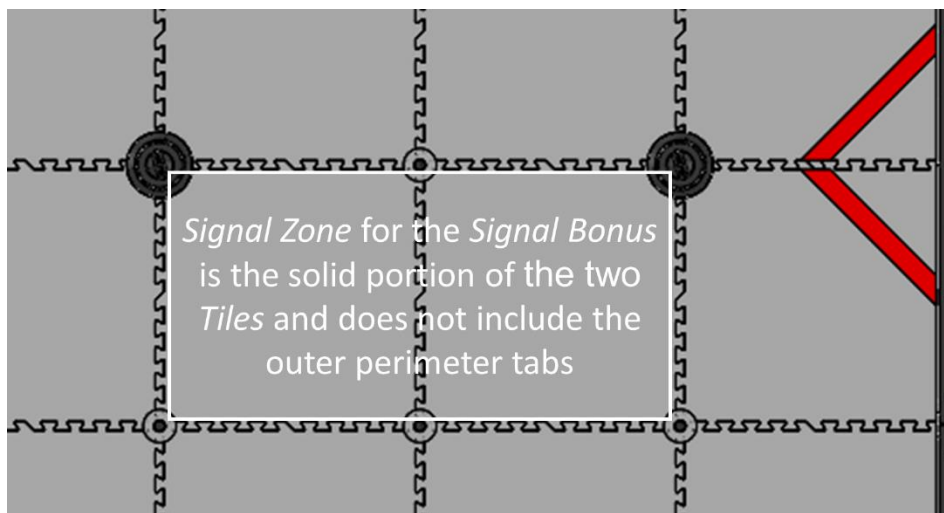


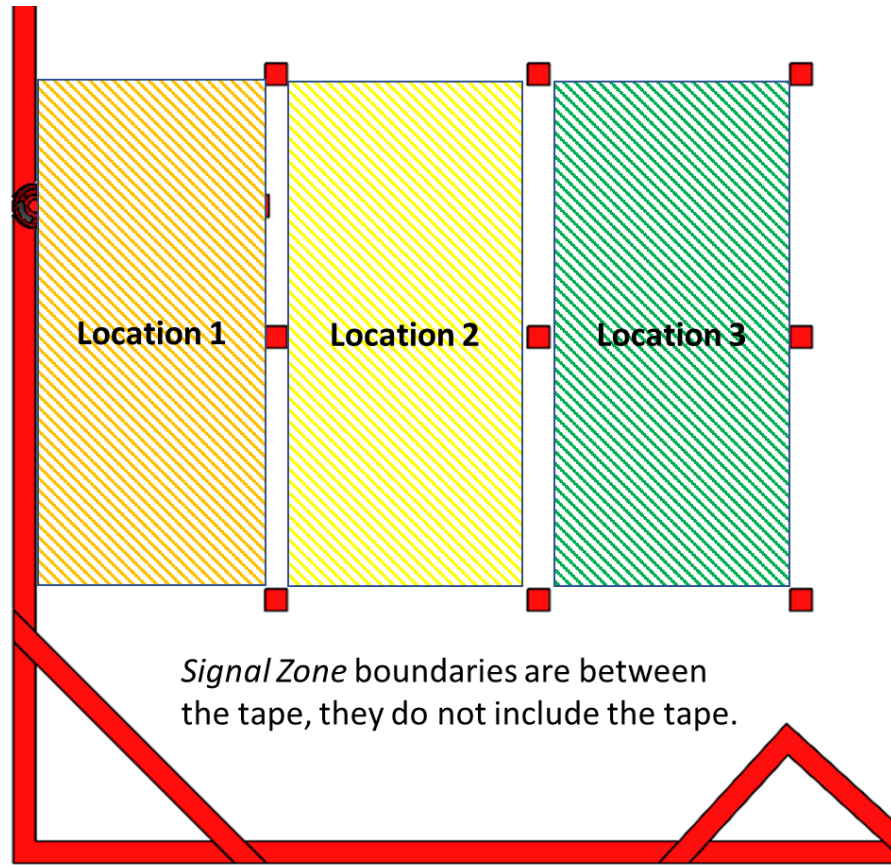
Dice Roll

E-2 – Signal Patterns



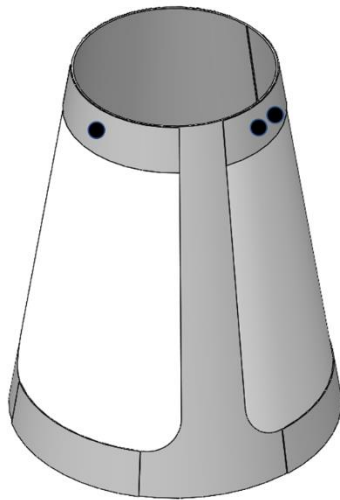
E-3 – Signal Zone Locations - Red



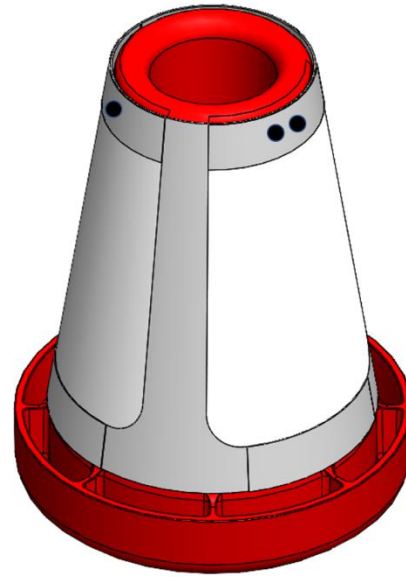


**E-4 – Signal Zone Boundary Locations**

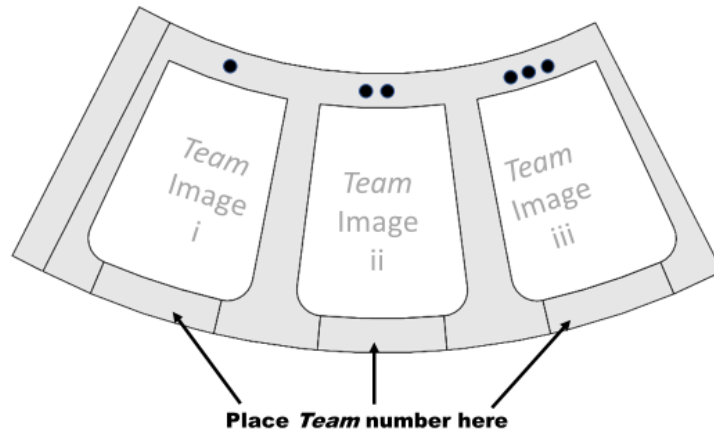




**E-5 – Team Supplied Signal Sleeve Template**



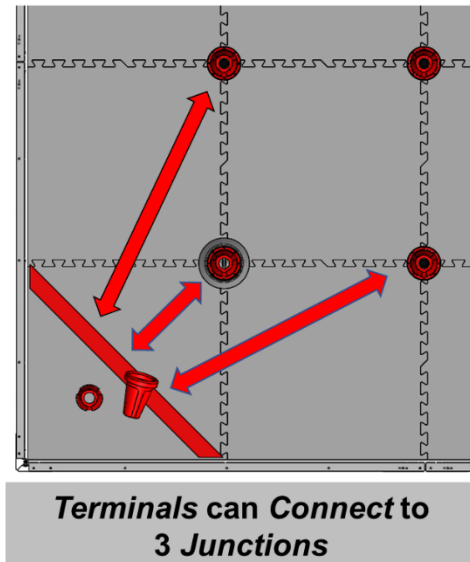
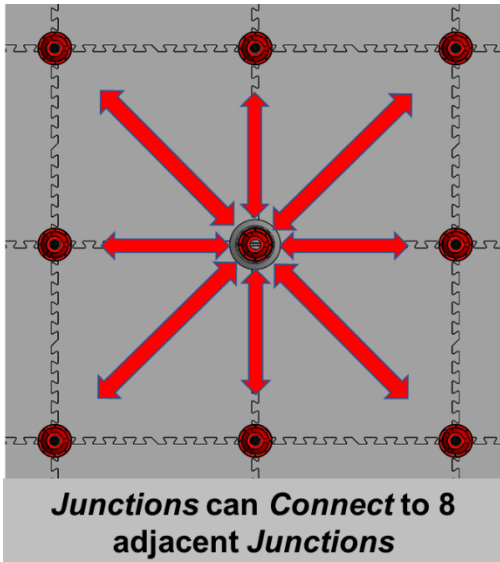
**E-6 – Team Supplied Signal Sleeve Template on a Signal**



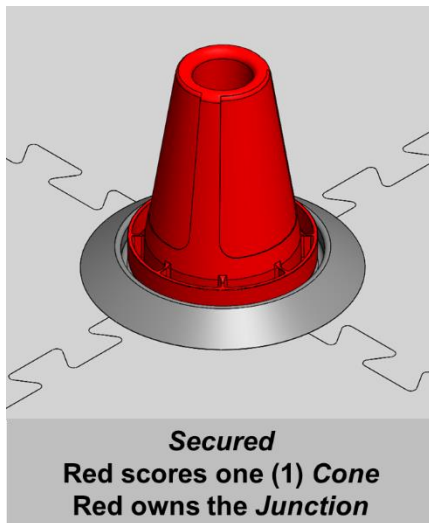
**E-7 – Template for Team supplied Signal Sleeve**

The *Signal Sleeve* template and instructions are located at <https://www.firstinspires.org/resource-library/ftc/game-and-season-info>.

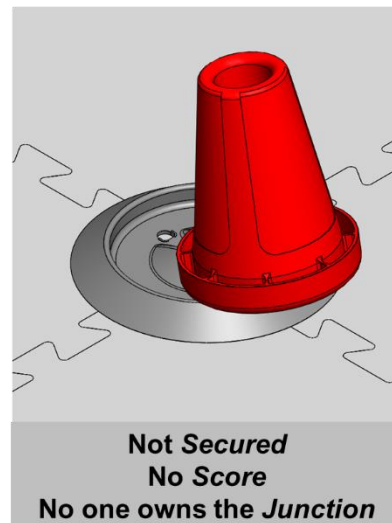
## Appendix F – Scoring Examples



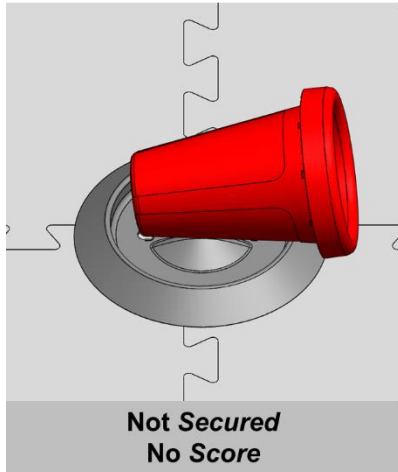
F-1 Allowable *Junction* and *Terminal* Connections



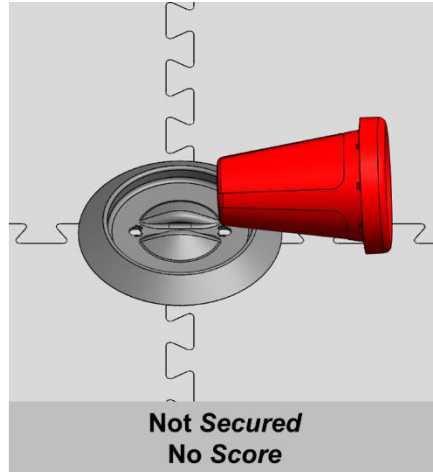
F-2



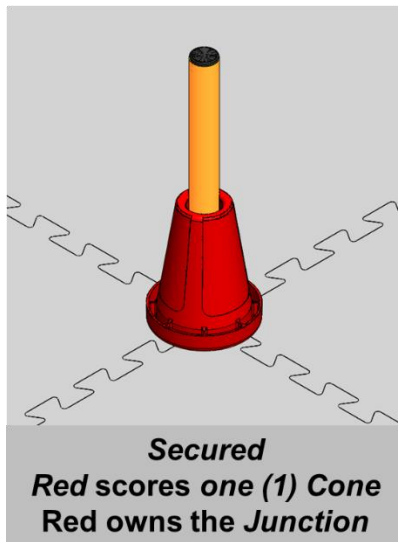
F-3



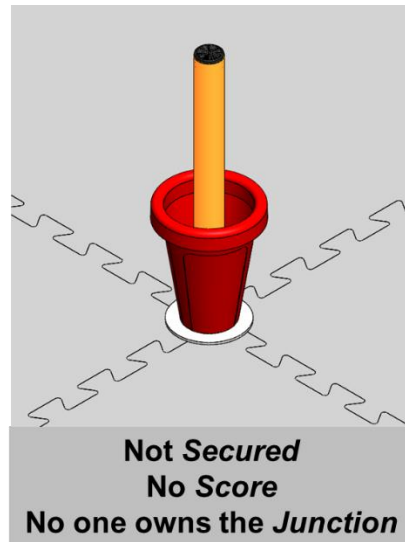
**F-4**



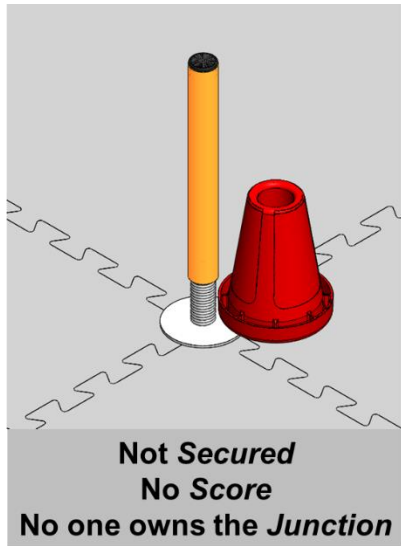
**F-5**



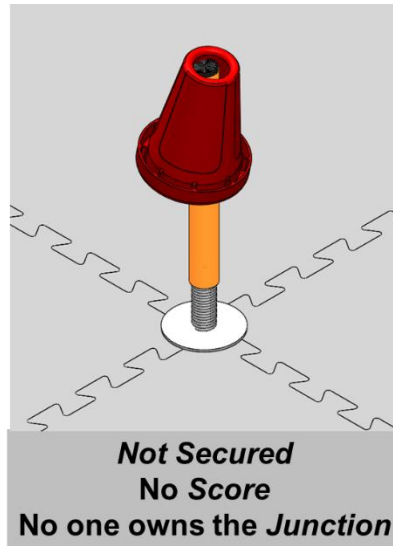
**F-6**



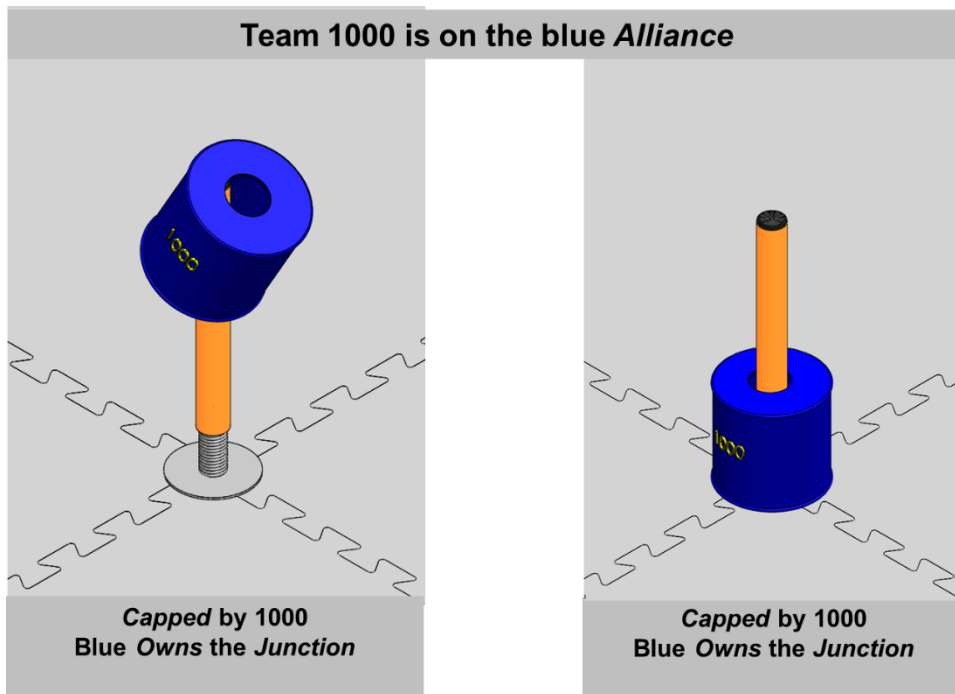
**F-7**



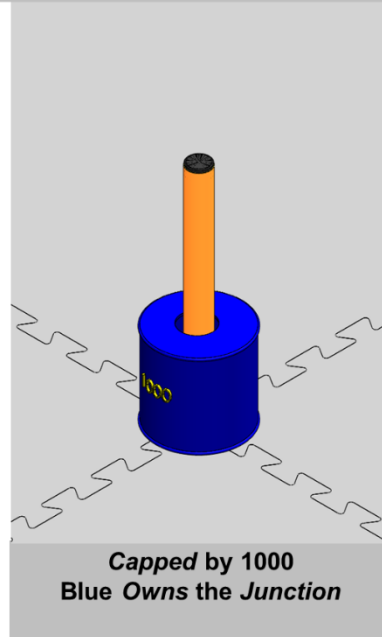
**F-8**



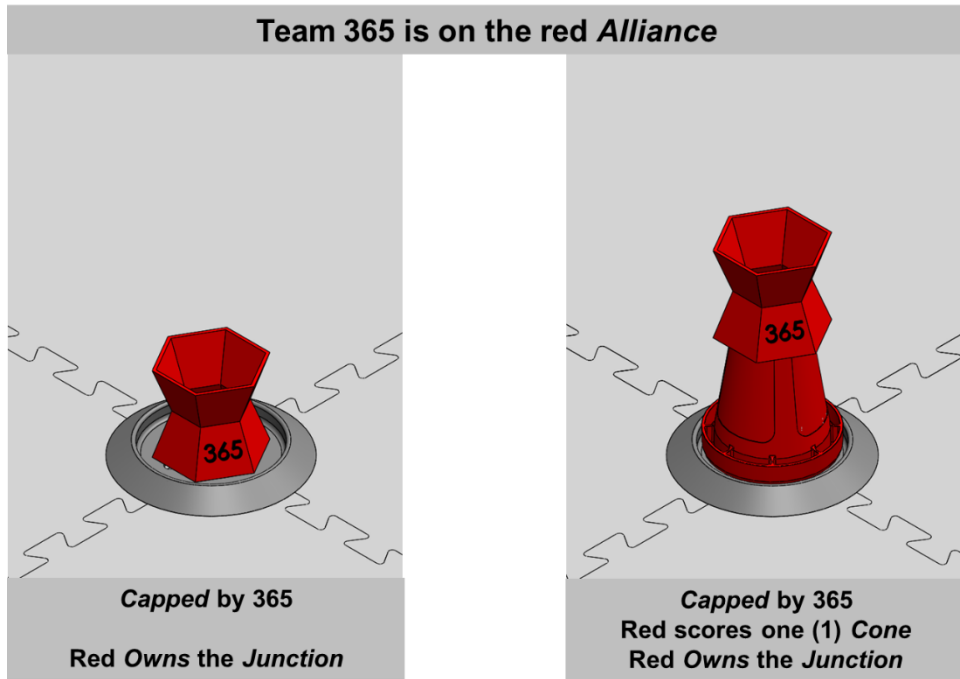
**F-9**



**F-10**

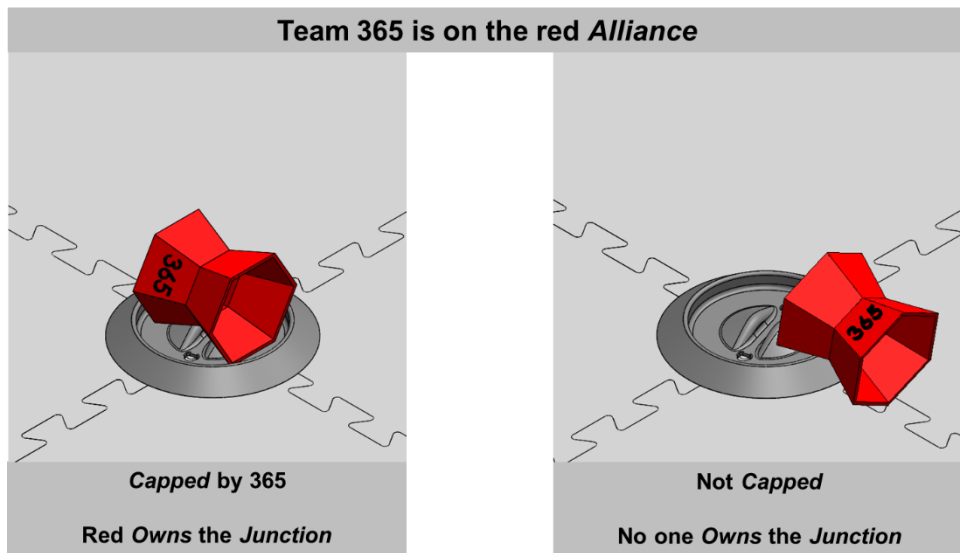


**F-11**



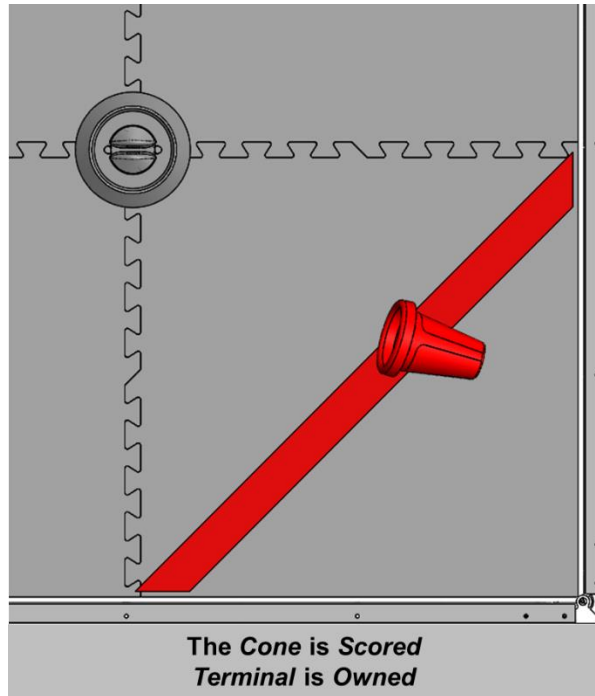
**F-12**

**F-13**



**F-14**

**F-15**

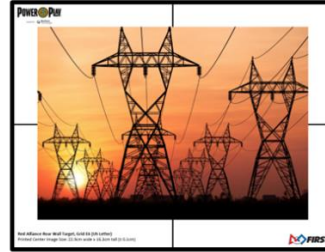


F-16

## Appendix G – Navigation Images



**Image B6**  
Blue Alliance Rear Wall



**Image E6**  
Red Alliance Rear Wall



**Image B1**  
Blue Alliance  
Audience Wall



**Image E1**  
Red Alliance  
Audience Wall

Images are labeled corresponding to the centers of the tile nomenclature listed in Appendix B, figure B-1.

Image B1 – The center of the image is on the *Playing Field Wall* closest to the *Audience* and is aligned to the center of the second *Tile* in from the blue *Alliance Station*.

Image B6 – The center of the image is on the *Playing Field Wall* opposite of Image B1 and is aligned to the center of the second *Tile* in from the blue *Alliance Station*.

Image E1 – The center of the image is on the *Playing Field Wall* closest to the *Audience* and is aligned to the center of the second *Tile* in from the red *Alliance Station*.

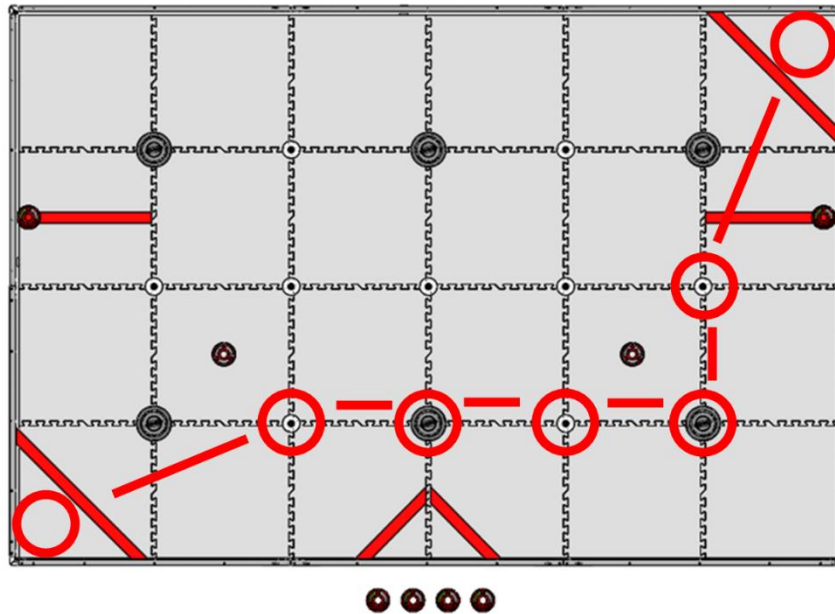
Image E6 – The center of the image is on the *Playing Field Wall* opposite of Image E1 and is aligned to the center of the second *Tile* in from the red *Alliance Station*.

**Do not print the images from this manual for practice purposes, as they are not to the same scale as *Teams* will see in actual competition. Please refer to the [website](#) for printable versions of these images.**

## Appendix H – Circuit Patterns

A *Team* must follow the corresponding pattern for the specific *Match* exactly in order to *Score Junction* points. A *Cone Scored* on a *Junction* outside of the predefined *Circuit* negates the *Circuit* bonus. *Junctions* where a *Cone* must be *Scored* are shown as red circles in the diagrams below.

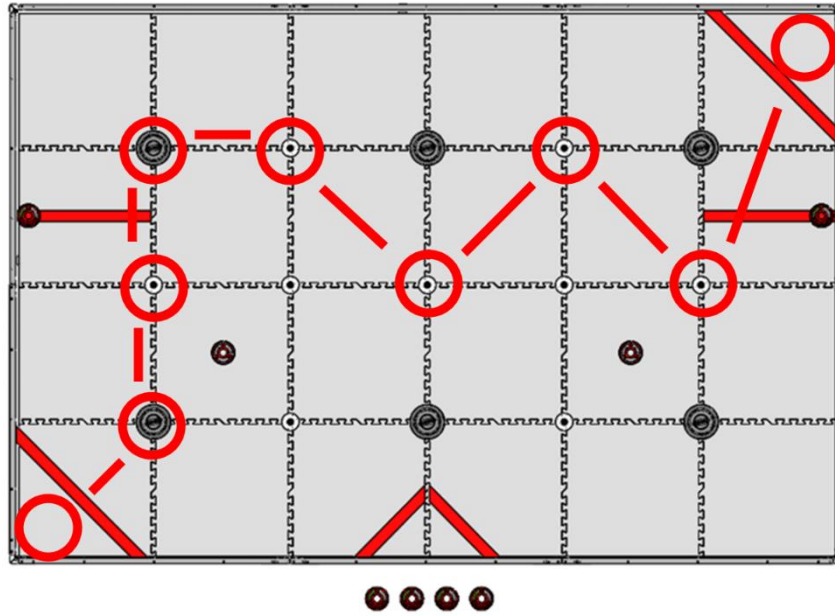
### CIRCUIT PATTERN 1



H-1 – Pattern for Remote Match 1

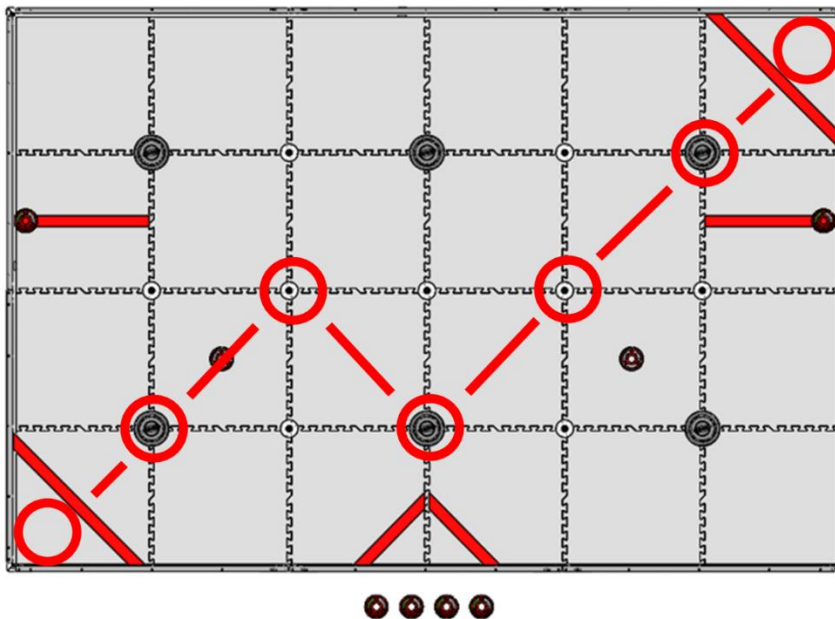


### CIRCUIT PATTERN 2



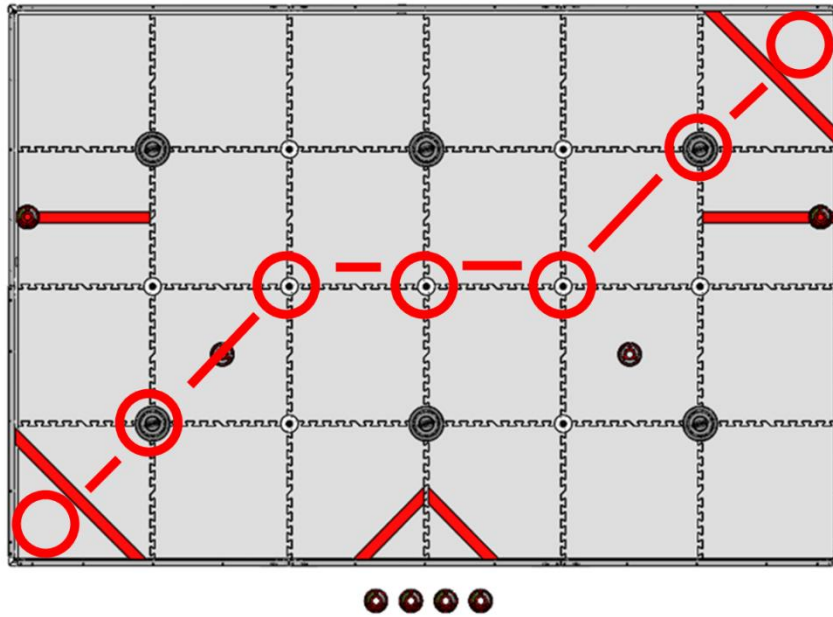
H-2 – Pattern for Remote Match 2

### CIRCUIT PATTERN 3



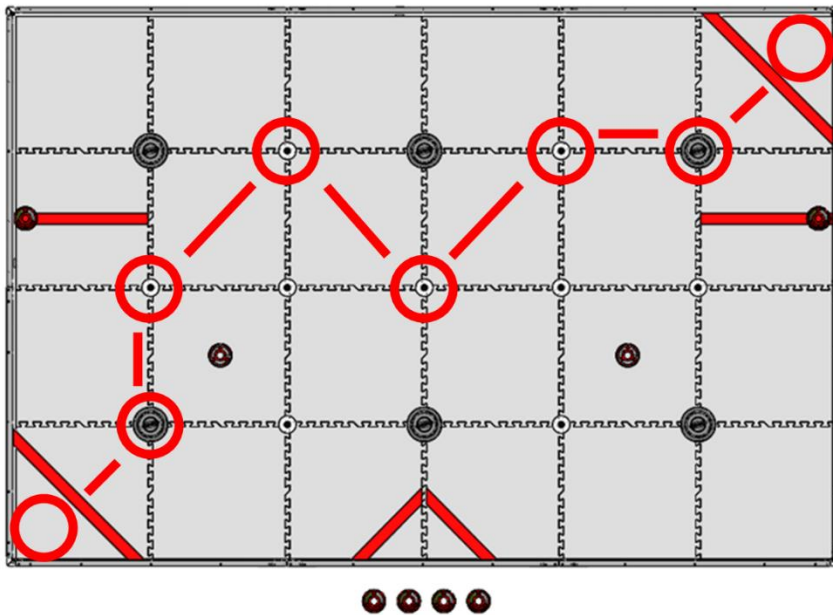
H-3 – Pattern for Remote Match 3

### CIRCUIT PATTERN 4



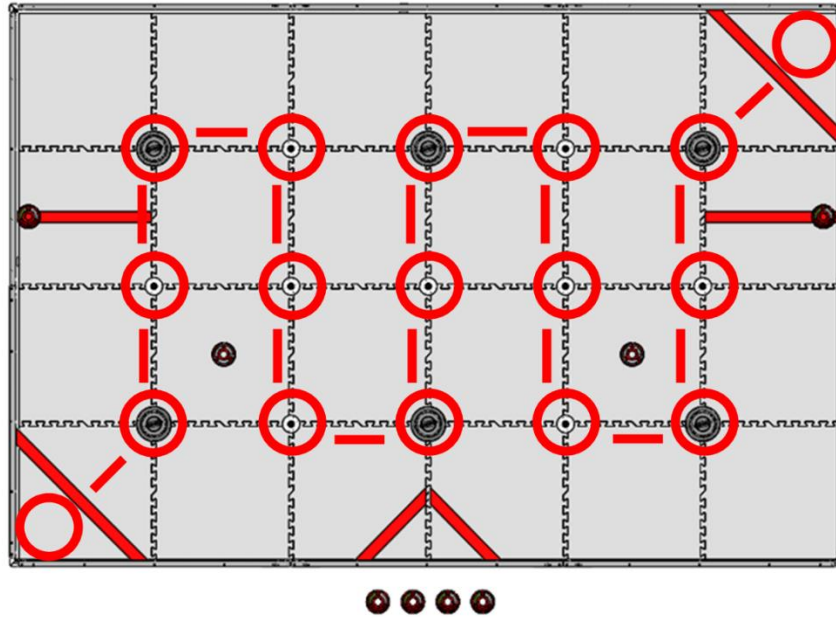
H-4 – Pattern for Remote Match 4

### CIRCUIT PATTERN 5



H-5 – Pattern for Remote Match 5

## CIRCUIT PATTERN 6



H-6 – Pattern for Remote Match 6