2023-2024 *FIRST*® Tech Challenge

Game Manual Part 2 – Remote Events

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Revision History		
Revision	**Date**	**Description**
1	9/9/2023	Initial Release
1.1	10/11/2023	• Section 4.1 and 4.2.2 – Updated Raytheon Technologies to RTX • Section 4.3 – Corrected referenced images in Mosaic definition • Section 4.4.1 – Pre-Match 3.c) – Clarification that only one Drone may be brought to each match • Section 4.5.3 – Added <GS11>h. • Section 4.7 – Added new rules to Rule Summary

Contents

1.0 Introduction

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.

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 2023-2024 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 CENTERSTAGE^{SM} presented by RTX, the *FIRST*® Tech Challenge game for the 2023-2024 season. We recommend viewing the game animation prior to reading this manual to gain a general understanding of the similar traditional game. The animation is a brief summary of the game; it is not intended to provide the necessary information to fully understand the 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* construction 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 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*.
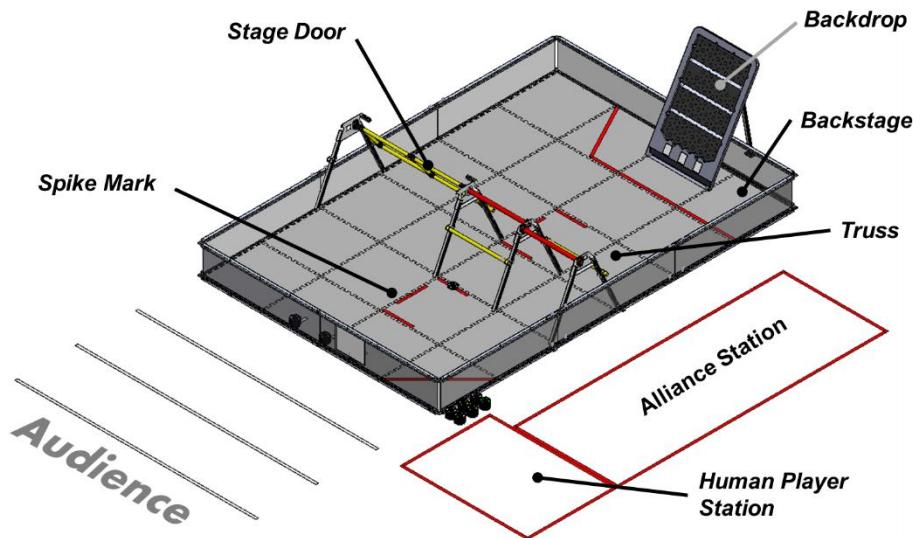
**Figure 4.2-1 – Isometric view of the remote *Playing Field***
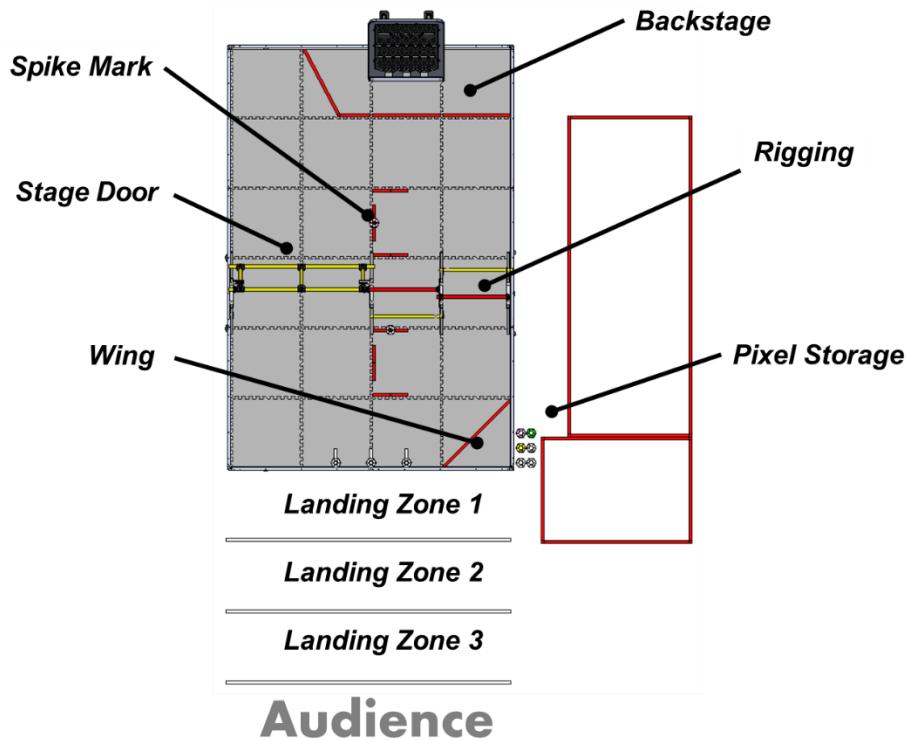
Figure 4.2-2 – Top view of the remote *Playing Field*

4.2.2 Gameplay Overview

Welcome to CENTERSTAGE℠ presented by RTX. 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. *Navigating* to their *Backstage.*

2. Placing *Pixels On* their *Backdrop* or *In* their *Backstage.*

3. Identifying the *Randomization Object* on the randomly selected *Spike Mark. Robots* can earn points by:

    a. *Placing* a purple *Pixel On* the randomly selected *Spike Mark.*

    b. *Placing* a yellow *Pixel On* the *Backdrop* in the location corresponding to the randomly selected *Spike Mark.*

    Additional points are earned for these tasks when a *Team* uses their *Team Prop* in place of the a white *Pixel.*

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

1. Placing *Pixels On* their *Backdrop* or *In* their *Backstage.*

2. Creating *Mosaics.*

3. *Scoring Pixels* that cross the *Set Line.*

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, *Robots* earn points by:

1. *Suspending* from their *Rigging.*

2. *Parking In* their *Backstage.*

3. *Parking* their *Launched Drone In Landing Zone* 1, 2, or 3.

4.2.3 Gameplay Technology

Each game comes with its own unique set of challenges. In CENTERSTAGE℠ there are multiple ways a *Team* can utilize technology to assist them in solving these challenges. A *Team* 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) A *Robot* can use their on-board control system and sensors to identify *Game Elements.*

    b) A *Robot* can use the built-in TensorFlow technology to decode the randomized *Autonomous* task.

2. Field Navigation: Built-in *AprilTag* technology helps the *Robot* identify and navigate to important locations on the *Playing Field.*

3. Situational Awareness: Sensors provide situational awareness during the *Autonomous Period,* automate operations, and provide feedback during the *Driver-Controlled Period.* Cameras, IMUs, motor encoders, distance, and color sensors are useful for solving gameplay tasks.

For resources on how to use the available technologies, please visit https://ftc-docs.firstinspires.org/control_hard_compon/rc_components/sensors/sensors.html.

4.3 Game Definitions

The following definitions and terms are used for CENTERSTAGE[SM]. Defined terms begin with a capital letter and are italicized throughout the manual (for example, *Alliance*). Game rules mean exactly and only what it plainly says. If a word isn't given a game definition, then you should use its common conversational meaning.

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

AprilTag – A visual fiducial system, useful for a wide variety of tasks including augmented reality, robotics, and camera calibration[1]. Three (3) *AprilTags* are affixed to the *Backdrop* to identify target locations for the *Autonomous* randomization task outlined in section 4.4.2. One additional set of *AprilTags* is placed at the audience side of the field for assistance with field localization. Information about *AprilTags* may be found here: https://april.eecs.umich.edu/software/apriltag.

[1] See https://april.eecs.umich.edu/software/apriltag accessed on 5/18/2023.

Area – The space defined by the vertical projection of the outside edge of a region's boundary (for example, gaffer tape, goal, *Playing Field Wall*). 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.

Backdrop – A structure upon which a *Robot* places *Pixels* to score points. There is one (1) *Backdrop* located on the *Playing Field*. See Appendix C-2 for specifications.

Backstage – The *Area* beneath a *Backdrop*. The *Backstage* is defined by nominal 1-inch (24 mm) wide tape and is approximately 72-inches (183 cm) long by 23-inches (58.4 cm) deep.

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, scoring areas,* and other competition items relating to *Match* play are located.

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) *Herding* of *Game Elements.* See also the definition of *Herding* in this section.

    c) *Propelled 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. *Inadvertent* loss of *Control* of a *Scoring Element* is not considered *Propelling*.

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

    d) *Plowing* of *Game Elements* is not considered *Control*. See also the definition of *Plowing* in this section.

    e)   *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 S*tudent Team* member responsible for operating and controlling the *Robot*.

Driver-Controlled Period – The two-minute *Match* time in which the *Drivers* operate their *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](#).

Drone – A paper airplane *Scoring Element* built and supplied by a *Team*. The *Drone* must be constructed using materials and methods described in Game Manual Part 1 – Remote Events and has passed inspection.

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*, performing *the Playing Field* randomization task, 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 a *Robot* interact with to play the game. *Game Elements* for this year's game include *Pixels, Backdrops, Trusses, Stage Door, Riggings, Team* Prop, and *Drone.*

Grasp – Securely holding an object.

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*.

Human Player Station – The designated *Area* adjacent to the *Playing Field* where the *Human Player* is located during a *Match*.

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.

Landing Zone – The *Area* outside the *Playing Field Perimeter* on the audience side of the *Playing Field Boundary*. There are three (3) *Landing Zones*:

a)   *Landing Zone 1* – A 144-inch (3.66 m) wide x 24-inch (610 mm) deep area immediately adjacent to the audience side *Playing Field Boundary*.

b)   *Landing Zone 2* – A 144-inch (3.66 m) wide x 24-inch (610 mm) deep area immediately adjacent to *Landing Zone 1.*

c)   *Landing Zone 3* – A 144-inch (3.66 m) wide x 24-inch (610 mm) deep area immediately adjacent to *Landing Zone 2.*

*Th*e first white tape line from the *Playing Field Boundary* is part of *Landing Zone 1,* the second white tape line is part of *Landing Zone 2,* and the third white line is part of *Landing Zone 3.* (see Appendix C-9).

Recognize that *Landing Zone* surfaces and marking materials may vary from event to event. Potential surfaces include hardwood floors, carpeting, gym tarp, cement, tiles, mats, etc. Potential marking materials include tape, paint, etc. *Teams* should plan for these variances when competing at different events.

Launch / 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 the *Drive Team* to pick up the controllers and switch programs.

Mosaic – A cluster of three (3) non-white *Pixels Scored On* a *Backdrop.* See Appendix F, figures F-2 and F-3 for examples.

1.   A *Mosaic* consists of three (3) non-white *Pixels,* either all the same color (all green, all purple or all yellow) or each *Pixel* a different color (one (1) green, one (1) purple, and one (1) yellow).

2.   A completed *Mosaic* cannot be in contact with another non-white *Pixel*.

3.   Each *Pixel* in a *Mosaic* must be in contact with the other two (2) *Pixels* of that *Mosaic*.

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

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*.

Park / Parked – The condition where a *Robot* or *Drone* 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. Penalties* are further defined as *Minor Penalties* and *Major Penalties*

Pixel – A hexagonal shaped *Scoring Element*, 3-inches (76.2 mm) across by 0.5-inches (12.7 mm) thick. There are thirty-two (32) white *Pixels*, five (5) yellow *Pixels*, five (5) green *Pixels*, and five (5) purple *Pixels.*

Pixel Storage – The designated area outside of the *Playing Field Boundary* directly adjacent to the *Wing* (see Figure 4.2-2) where *Pixels* are stored to be introduced by the *Human Player*. There is one (1) *Pixel Storage* area.

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

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. Launching*, *Rolling*, and *Sliding* are forms of *Propelling*.

Randomization Object – A white *Pixel* or *Team Prop* that is placed in one of three randomly chosen locations. There are two (2) *Randomization Objects*, one (1) placed on each center *Spike Mark*.

Randomization Task – An *Autonomous Period Scoring* achievement designated by the target *Randomization Object*.

Rigging – Part of the *Truss* from which *Robots Suspend*. There are two (2) *Riggings*, either two (2) red or two (2) blue.

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 a*chievement is stated in the achievement's description in Section 4.4. Individual *Scoring* achievements are determined by one of three methods:

1. **Scored as Completed**: The achievement is considered *Scored* the moment it is successfully completed, i.e., all criteria are met.

2. **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).*

3. **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 a *Robot* manipulates to earn points for their *Alliance*. The *Scoring Elements* for CENTERSTAGE℠ are *Pixels* and *Drones.*

Set Bonus – *Scoring* achieved by *Robots* when they place *Pixels* that cross the bottom edge of a *Set Line* on the *Backdrop*.

Set Line – A line on the *Backdrop* that indicates a height achievement. There are three (3) *Set Lines* on the *Backdrop.*

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

Spike Mark – A one (1) inch by eighteen (12) inch long tape line. There are three (3) *Spike Marks* in each of the *Tiles. Spike Marks* are located in *Tiles* B2 and B4 for blue field setup, or *Tiles* E2, and E4 for red field setup. They are positioned on the left, center, and right of the *Tiles* from the corresponding *Alliance Station* perspective. The *Spike Marks* identify locations for the *Autonomous Randomization Task* outlined in section 4.4.2.

Stage Door – A horizontally hinged, height restricting barrier that spans the gap between the *Trusses*. A *Robot* can manipulate to allow their passage from one side of the *Playing Field* to another. The *Stage Door* opens towards the rear of the *Playing Field* (see Appendix C for a drawing of the *Stage Door's* range of motion).

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

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.

Suspend / Suspended – A *Robot* is *Suspended* when it is *Completely Supported* by the *Rigging* and is not in contact with any other *Game Element* or the *Playing Field Floor.* Incidental contact with *Scoring Elements,* the *Truss,* or the *Stage Door* is allowed *(*for example, *Possession* of *Scoring Elements* is allowed). *Teams* are encouraged to make these actions obvious and unambiguous.

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

Team Prop – A *Team* designed and supplied *Game Element* used during the *Autonomous Period.* The *Team Prop* must meet the specifications described in Game Manual Part 1 – Remote Events.

Tile – An approximate 24-inch x 24-inch (610 mm x 610 mm) foam rubber mat. *Tile* size may vary depending on which manufacturer's *Tile* is used at the event. *Robots* should be built to interact with all legal *Tiles. Tile* size variation may affect locations of *Game Elements* and gap sizes between the *Tile* and *Playing Field Boundary*.

Truss – A structure that contains two (2) *Riggings.*

Wing – A Taped off location on the *Playing Field Floor* where a *Human Player* places *Pixels* and a *Drone.*

Warning – An alert given by *Field Personel* to an individual or to the *Team. Warnings* are applied to the entire *Team,* and they have no effect on an *Team's Score. Warnings* are used as a way to point out rule violations while not issuing formal *Penalties..*

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 the controllers and switch programs. When the *Match* is over and *Field Personnel* signal, the *Drive Team* collects their *Robot* and *Team Supplied Game Element*, return *Possessed Game Elements* to the *Playing Field,* and exit the *Competition Area*.

4.4.1 Pre-*Match*

1. *Field Personnel* set up the *Playing Field* as depicted in Figure 4.2-1.

2. *Pixel* placement

   a) On-Field:

      i. Three (3) stacks of five (5) white *Pixels*

   b) *Pixel Storage*: there is one *Pixel Storage* location, either red or blue. A *Pixel Storage* contains the following:

      i. Three (3) stacks of five (5) white *Pixels*

      ii. One (1) stack of five (5) purple *Pixels*

      iii. One (1) stack of five (5) yellow *Pixels*

      iv. One (1) stack of five (5) green *Pixels*

   c) *Randomization Task*

      i. Two (2) white *Pixels,* one (1) for each set of *Spike Marks*. The *Pixels* will start in the center of the center *Spike Marks.*

3. 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. Blue *Alliance Robots* must start *Completely In Tile* A2 or A4, red *Alliance Robots* must start *Completely In Tile* F2 or F4. See Appendix B for *Tile* nomenclature.

iii. The *Drive Team* must place their *Robot*, in any orientation, touching the *Playing Field Boundary* adjacent to their *Alliance Station*.

b) **Pre-Loaded Pixels** – The *Drive Team* may *Pre-Load* exactly one (1) yellow *Pixel a*nd/or one (1) purple *Pixel.* If used, *Pre-Loaded Pixels are* taken from *Pixel Storage.* When loaded, the *Pre-Loaded Pixels* must be *Outside* all *Scoring Areas.*

c) **Drone** – The *Drive Team* may either *Pre-Load* exactly one (1) *Drone* or place one (1) *Drone* into the *Pixel* storage area.

d) **Team Prop** – The *Drive Team* intending to use their *Team Prop* must place it centered on top of the center *Spike Mark* closest to their *Robot.* If *a Team Prop* is used, the white *Pixel* is placed into *Pixel Storage.*

e) **Op Mode** –

i. The *Drive Team* use their *Driver Station* to select an *Autonomous* Op Mode. If the *Team* does not have an *Autonomous* Op mode, steps ii and f) below can be skipped.

ii. Press the *Driver Station* "Init" button.

f) **Autonomous Time**r – The thirty-second timer must remain enabled.

g) **Robot Mo**tion - *Robot* must be motionless prior to the start of the *Match*.

h) **Driver Station** – The *Drive Team* may not touch their *Driver Station* or controllers until the *Autonomous Period* has ended, except to start their *Autonomous* program (if applicable) with a single touch to the *Driver Station* Android device screen.

4. Once the *Field Personnel* signal 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. Exceptions to this include using the *Driver Station* to start their *Autonomous* program or to *Disable* their *Robot* as instructed by *Field Personnel*.

c) The Scoring System will choose one of the *Spike Marks* (left, center, right) as the target for the *Randomization Tasks*. *Field Personnel* will move the *Randomization Object* to the chosen *Spike Mark* as specified in Appendix E.

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 *Robots*. The only exception is to allow the *Drive Team* to start their *Robot* with the "start" command issued on the *Driver Station* touch screen. *Teams* must use the built-in thirty-second timer.

Following a countdown by *Field Personnel*, the *Autonomous Period* begins. The *Drive Team* may issue *Robot* start commands 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 *Robot* that *Parks In* the *Backstage* earn five (5) points*.*

2. ***Randomization Tasks –*** There are two distinct tasks based on the *Spike Mark* location that was designated during Randomization:

    a) A purple *Pixel* placed *On* the *Robot's* designated *Spike Mark* in the *Tile* immediately adjacent to the starting location, earns points depending on the *Randomization Object* used:

        i. Ten (10) points for using the white *Pixel*; or

        ii. Twenty (20) points if *Team Prop* is used.

    b) A yellow *Pixel* on the *Backdrop* in the location corresponding to the designated *Spike Mark* earns points depending on the *Randomization Object* used:

        i. Ten (10) points for using the white *Pixel*; or

        ii. Twenty (20) points if *Team Prop* is used.

3. ***Pixels*** – A *Robot* placing *Pixels* earn points as follows:

    a) All Pixels On the recessed Scoring area of their Backdrop earn five (5) points per Pixel.

    b) Pixels In their Backstage earn three (3) points per Pixel.

    c) Pixels 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. ***Pixel*** – *Robots* placing *Pixels* earn points as follows:

    a) *Pixels On* the recessed *Scoring* area of their *Backdrop* earn three (3) points per *Pixel*.

    b) *Pixels In* the *Backstage* earn one (1) point per *Pixel*.

2. ***Artist Bonus*** – *Mosaics* earn ten (10) points per *Mosaic*.

3. ***Set Bonus*** – A Team earns ten (10) points when *Scored Pixels On* a *Backdrop* extend *In* a horizontal *Set Line*. Vertically crossing *In* each *Set Line* earns one (1) *Set Bonus*, regardless of the number of *Pixels* that cross it. The maximum *Set Bonus* for a *Team* is thirty (30) 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. End Game* achievements, other than *Navigating,* begun before the start of *End Game* are worth zero (0) points.

1. ***Robot* Location –** There are two mutually exclusive location-based *Scoring* opportunities. A *Robot* may only earn points for one of these tasks. The *Team* is encouraged to make these actions obvious and unambiguous. *Robot* Location is *Scored at End of the Period*.

    a) ***Suspended from the Rigging*** - A *Robot Suspended* by the *Rigging earns* twenty (20) points.

    b) ***Parked In the Backstage*** – A *Robot* that *Parks In* the *Backstage* earns five (5) points.

2. ***Drone Launching –*** A *Launched Drone* that end up *Parked In* a *Landing Zone* earn points as shown below. A *Launched Drone* must pass over the *Truss* and/or *Stage Door for* each scoring attempt to earn points. *Drone Launching* is *Scored at Rest*.

     a) *Landing Zone 1* earns thirty (30) points.

     b) *Landing Zone 2 e*arns twenty (20) points.

   c) *Landing Zone 3* earns ten (10) points.

4.4.5 Post Match
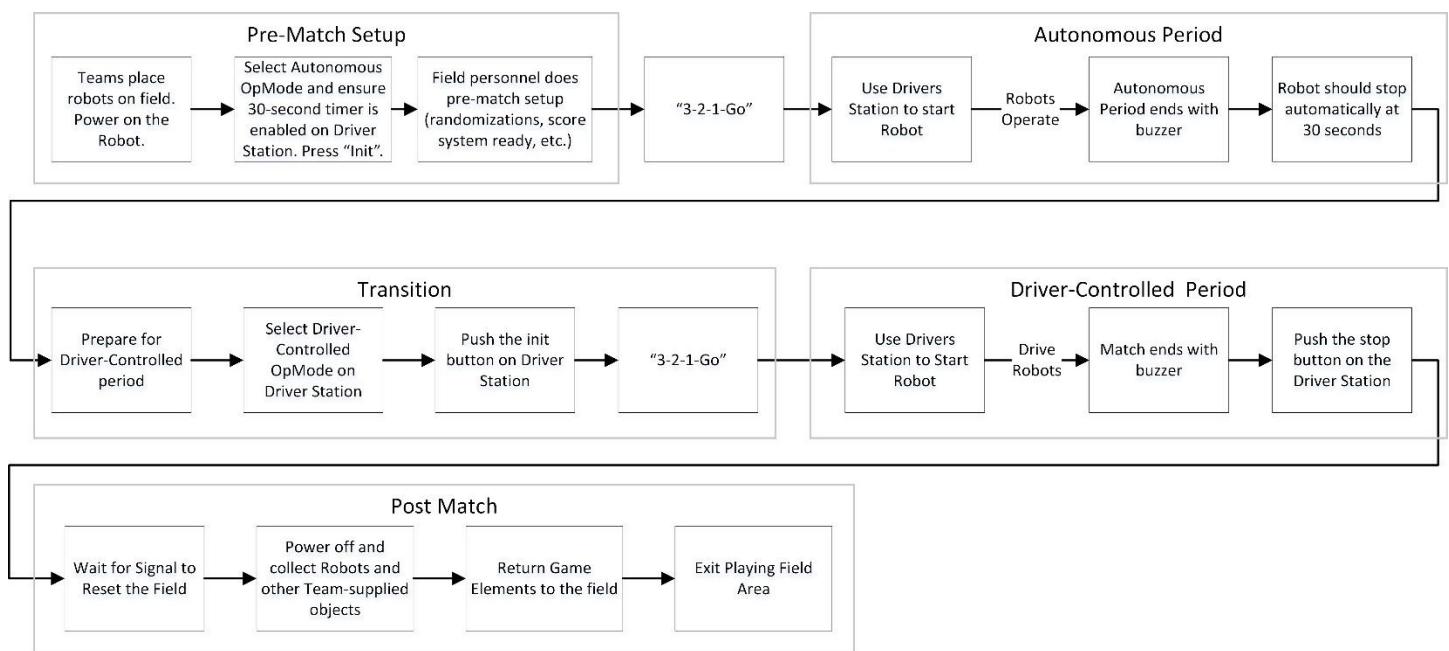
By the conclusion of the stop *Match* sound, *Drive Team*s must press the stop button on their *Driver Stations.* *Field Personnel* will then finalize the *Score*. *Field Personnel* will signal for the *Drive Team* to enter the *Playing Field* and retrieve their *Robot* and *Drone*. The *Drive Team* should return any *Game Elements* that are *Possessed* by the *Robot* to the *Playing Field*. The *Playing Field* reset crew will set up the *Playing Field* for the next *Match*.

4.4.6 Penalties

Penalty points are deducted from the *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. *Warnings* have no effect on a *Team's Score.*

4.4.7 Flowchart of *Match* Play

The following figure shows the typical flow of the *Match* and the actions taken on the *Driver 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.**

4.5.1 Safety Rules

<S01> 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*.

<S02> *Robot* Extension *Outside* the *Playing Field Perimeter* – 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 Perimeter*. Intentional *Robot* extension *Outside* the *Playing Field* is not permitted.

<S03> 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

<G01> *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.

<G02> *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.

<G04> *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*.

<G05> *Robot* or *Scoring Elements In* Two or More *Scoring Areas* – A *Robot* or *Scoring Elements* that are eligible for two or more *Scoring* achievements earn points only for the highest value achievement. If the achievement values are equal, only one achievement counts as *Scored*.

<G06> *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.

<G07> *Disabled Robot* **Eligibility** – A *Disabled Robot* is not eligible to *Score* or earn points for the remainder of the *Match*.

<G08> *Playing Field* **Tolerances** – Competition provided *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.

> *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.

<G09> *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* – *Team* members must not enter the *Playing Field* for any reason other than to place/retrieve their *Robot*. While placing their *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*.

<G13> *Pre-Match Robot Placement* – At the beginning of a *Match*, the *Robot* must be set up on the *Playing*

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

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). Flexible materials (i.e., zip tie, surgical tube, string, etc.) may extend up to 0.25 inches (0.635 cm) beyond the 18 inch (45.72 cm) size constraint. 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 4.5.3.

<G15> *Robot* **Setup Alignment** – The *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 *Alliance* for violation of this rule.

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

   a) The *Drive Team* may be anywhere in their respective *Alliance Station* or *Human Player Station*.

   b) The first instance of leaving the *Alliance* or *Human Player Station* will result in a *Warning*, with any following instances during the *Match* resulting in a *Minor Penalty*. Leaving the *Alliance* or *Human Player 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*.

   d) After the *Robot* is set up on the *Playing Field*, and before the *Match* starts, the *Drive Team* must stand *Inside* their respective *Alliance* or *Human Player Station*. Once the *Match* starts, the members of the *Drive Teams* may stand, sit, or kneel for the remainder of the *Match*. Violations of this rule (for example, lying down in the *Alliance Station*) will result in a *Minor Penalty*.

<G17> Post-*Match* Removal of *Robots* – The *Robot* 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 unnecessary delay or 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 <u>conclusion</u> of the "game sound" receives a *Minor Penalty* and the following actions of the *Robot* do not count towards the *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. A *Team* that stops their *Robot* 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*, their *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 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 themself (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*.

<G25> *Robots* **Grasping Game Elements** – A *Robot* may not *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 4.5.3. The first instance will result in a *Warning* with any following violations during the competition resulting in a *Major Penalty*.

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

<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* unless specifically allowed by Game-Specific rule(s) listed in

section 4.5.3. *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* – A *Robot* 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

<GS01> General Rule Exceptions – The following instances of gameplay are Game-specific exceptions to General Game Rules in section 4.5.2:

  a) *Robot* contact with a *Pixel* in a *Backstage* is allowed as an exception to rule <G06> if the *Pixel* is not *Possessed* by the *Robot*.

  b) *A Robot* is allowed to *Grasp* the *Rigging* as an exception to rule <G25>.

  c) A *Robot* may *Launch* their *Drone* to the *Outside* of the *Playing Field* as an exception to rule <G27>.

<GS02> *Drive Team* Touching their *Robot* or *Driver Station* after Randomization – The *Drive Team* is not allowed to touch or interact with their *Robot* or *Driver Station* once *Field Personnel* have begun the *Playing Field* randomization process. If this occurs, a *Minor Penalty* will be assessed, and the *Team* is not eligible to earn points for the *Randomization Tasks* in the *Autonomous Period*.

<GS05> *Robot Control/Possession* Limits for *Scoring Elements* –

  a) A *Robot* may *Control* or *Possess* a maximum of two (2) *Pixels* and one (1) *Drone* at a time. *Controlling* or *Possessing* more than the allowed quantity of *Scoring Elements* 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 the situation continues.

  b) *Scoring* a *Pixel* while in *Control or Possession* of more than the allowed quantity of *Scoring Elements* will result in a *Minor Penalty* per *Element Scored*.

  c) *Control/Possession* limit exceptions*:*

      i. Knocking over *a* stack of unscored *Pixels* is allowed.

      ii. *Inadvertent* and *Inconsequential* movement of a pre-set stack of unscored *Pixels is allowed.* Moving the stack *Completely Off* the tape is considered consequential.

      iii. *Plowing* through any quantity of *Scoring Elements* is allowed.

      iv. *Pixels In* the *Backstage* that are directly *Supported* by the *Playing Field Floor* or *Supported* by a *Pixel* that is directly *Supported* by the *Playing Field Floor,* are exempt from the *Control/Possession* limit*.* The intent of this rule is to prevent penalizing a *Robot* maneuvering *In* the *Backstage*.

      v. *Pixels On* the *Backdrop* are exempt from the *Control/Possession* limit*.*

<GS06> *Truss* Constraints –

  a) A *Robot* may only *Grasp* one of either *Rigging* of their *Truss.* Contact with the other parts of the *Truss* is allowed for stabilization of the *Robot* while *Suspended.* The intent is that the *Rigging* is the primary support for the *Robot.* Violation of this rule results in zero *Score* value for the *Suspend* task.

  b) A *Robot* may not *Grasp* or *Suspend* from any other part of the *Truss* structure. Violation of this rule results in a *Minor Penalty* per occurrence.

<GS07> *Stage Door* Constraints –.

  a) A *Robot* may not *Grasp* the *Stage Door.* Violation of this rule results in a *Major Penalty.*

<GS08> *Backdrop* and *Backstage* Constraints –

  d) A *Robot* located *In Tile* rows 1, 2, or 3 may not *Score* into the *Backstage* or *Backdrop.* Each violation will receive a *Minor Penalty.*

<GS09> *Wing* Constraints –

  d) There can be a maximum of six (6) *Pixels In* the *Wing* at any one time. A *Minor Penalty* will be assessed for each additional *Pixel* beyond the maximum. *Pixels* in the *Possession* of a *Robot* do not count towards this limit.

<GS10> *Pixel* Constraints – *Pixels* may not be *Propelled.* Each violation of this rule results in a *Minor Penalty.*

<GS11> *Drone* Constraints –

  a) A *Drone* is pre-loaded onto the *Robots during Pre-Match* setup as described in section 4.4.1 or introduced into the *Playing Field* during the *Driver Controlled Period* via the *Wing.*

  c) A *Drone Launched* before the *End Game* have zero (0) *Score* value.

  d) A *Drone* may be *Launched* from *Suspended Robots.*

  e) For each scoring attempt (*Launch*, fly, land), a *Launched Drone* must pass over a *Rigging* or top pole of the *Stage Door* before it is eligible to *Score* points.

  f) To *Score* a *Drone,* the *Drone* must be in a legal configuration. Altering a *Drone* after inspection or during *Match* play to better the chance of *Scoring* is not in the spirit of this rule and will not be considered a *Scored Drone.*

  g) *Drone* Interference:

    v. The *Drive Team, Field Personnel*, or physical structures outside of the *Playing Field Boundary* may not directly or indirectly affect the flight of a *Drone.* Affecting the *Drone's* flight results in no points for that *D*rone. The *Drone* flight barrier outlined in the [Remote Field Requirements](#) guide is excluded from this rule.

  h) *Drones* must be *Parked Completely Outside* the *Playing Field Perimeter* to be eligible to *Score* points.

<GS12> *Human Player* Constraints – Each violation of this rule results in a *Minor Penalty.*

  a) A *Drone* and *Pixels In* the *Pixel Storage Area* may not be handled until after the *Match* has begun with the exception of the *Pre-Load Scoring Elements*.

  b) A *Drone* and *Pixels* may be placed or dropped only *In* the *Wing* and only during the *Driver-Controlled Period.* A *Drone* and *Pixels* can be in any orientation and may be in contact with *Pixels In* the *Wing.*

  c) The *Human Player* may place a maximum of two (2) *Pixels* or one (1) *Drone In* a *Wing* at a time.

  d) Once a *Pixel* or *Drone* has been placed in the *Wing,* a *Human Player* may not pick it up or reposition it.

e) The *Human Player* may not *Propel Pixels* or the *Drone Out* of the *Wing.*

> *The Human Player* should take care when releasing *Scoring Elements* into the *Wing.* The final resting place of the *Pixel* or *Drone* is the responsibility of the *Human Player,* regardless of what the *Pixel* or *Drone* hits as it is released*.*

f) The *Human Player* may enter the area between the *Human Player Station* and the adjacent *Playing Field Boundary* while placing a *Pixel* or *Drone In* the *Wing*, provided that it is done safely.

g) The *Human Player* may not use tools or devices (including another *Pixel)* to manipulate a *Pixel* or *Drone.* Accommodations and exceptions for *Human Players* with disabilities or extenuating circumstances will be made at the discretion of the *Field Personnel.*

h) For safety reasons, a *Human Player* cannot break the vertical plane of the *Playing Field Perimeter* or hand-deliver a *Pixel* or *Drone* to the *Playing Field* when there is a *Robot In* the *Wing.*

i) A *Robot* cannot enter the *Wing* while a *Human Player* is In the *Wing.*

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

<GS13> *Truss/Stage Door* **Safety** – The *Drive Team* may never step/jump over any section of the *Truss* and/or *Stage Door.* The first instance will result in a warning to the *Team*. The next instance will be a *Major Penalty*.

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* except for *Robot* location during *End Game*, which is scored at *End of the Period*.

Scoring Achievement	Autonomous Points	Driver-Controlled Points	End Game Points	Reference
Navigating: Robot Parked In Backstage	5			4.4.2
Placement*: Pixel* placed *On* the *Team's Backdrop*	5			4.4.2
Placement*: Pixels* placed *In* the *Team's Backstage*	3			4.4.2
Randomization: Purple *Pixel* placed on the designated *Spike Mark* using white *Pixel*	10			4.4.2
Randomization: Yellow *Pixel* placed *On* the *Team's* designated *Backdrop* location using white *Pixel*	10			4.4.2
Randomization: Purple *Pixel* placed *On* the designated *Spike Mark* using *Team Prop*	20			4.4.2
Randomization: Yellow *Pixel* placed *On* the *Team's* designated *Backdrop* location using *Team Prop*	20			4.4.2
Placement: Pixels placed *In* the *Team's Backstage*		1		4.4.3
Placement: Pixels placed *On* the *Team's Backdrop*		3		4.4.3
Artist Bonus: Completed *Mosaic*		10		4.4.3
Set Bonus: Scored Pixel extends *In* a *Backdrop Set Line*		10		4.4.3
Robot Location*: Robot Suspended* from *Rigging*			20	4.4.4
Robot Location*: Robot Parked In* the *Backstage*			5	4.4.4

Drone Launch
    Zone 1
    Zone 2
    Zone 3
			
			30
			20
			10
				4.4.4

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
<S01>	Unsafe *Robot* or Damage to the *Playing Field.*	*Disable* if unsafe operation is likely to persist.	D*		
<S02>	Contact *Outside* the *Playing Field.*	*Major Penalty* per offense*.*			1x
<S03>	*Drive Team* missing safety gear.	*Match* will not begin until resolved.			
<G01>	*Autonomous* to *Driver-Controlled Period* transition.				
<G02>	Certifying the *Score* at *End of the Match.*				
<G04>	*Scoring Elements Controlled* or *Possessed* are part of the *Robot* except for *Robot* location.				
<G05>	*Robot* or *Scoring Element* in two or more *Scoring Areas.*	*Robot* or *Scoring Element* eligible for two or more *Scoring* achievements earn points only for highest achievement value.			
<G06>	*Scoring Elements* in contact with a *Robot.*	Points are not earned for any *Scoring Elements* in a *Scoring Area* in contact with a *Robot.*			
<G07>	*Disabled Robot* eligibility.	A *Disabled Robot* does not earn points. *Penalties* do not apply to *Disabled Robots* except as outlined in GS rules.			
<G08>	*Playing Field* Tolerances.				
<G09>	*Match* Replay.				
<G10>	*Inadvertent* and *Inconsequential.*	*Inadvertent* and *Inconsequential* rule violations are not *Penalized* at *Field Persone's* discretion.			
<G12>	Measure, test, or adjust *Game Elements. Playing Field* inspection to determine *Score.*	*Minor Penalty* for pre-*Match* or post-*Match* violations. *Major Penalty* if delay start of *Match.*		1x	1x
<G13>	*Pre-Match Robot* placement.	*Robot* must be set up on the *Playing Field* according to section 4.4.1.			

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty
<G14>	*Robot* starting volume.	*Robot* is removed from the *Playing Field* if not resolved within 30 seconds.			
<G15>	*Robot* setup alignment devices/*Match* delay.	*Minor Penalty* for each offense.		1x	
<G16>b	*Drive Team* member(s) leaving the *Alliance Station.*	*Warning* for the first instance with any following instances resulting in a *Minor Penalty*.	W	1x	
<G16>d	*Drive Teams* may only sit, stand, or kneel in *Driver Station.*	*Minor Penalty* for each offense.		1x	
<G17>	Post-*Match* removal of *Robot* causes a delay or damage to the *Playing Field.*	A *Minor Penalty* will be assessed.		1x	
<G18>	Starting Gameplay early.	A *Minor Penalty* will be assessed.		1x	
<G19>	Late start of the *Autonomous Period.*	A *Minor Penalty* will be assessed.		1x	
<G20>	*Robot* is not *Parked* at the end of period.	*Minor Penalty* and the actions of the *Robot* that occur after the end of gameplay do not count towards their *Team's Score*. *Major Penalty* if the late stop results in a competitive advantage for the offending *Team*.		1x	1x*
<G21>	*Robot* control during *Autonomous Period /* early stopping of the *Autonomous* code.	*Major Penalty* will be assessed.. Achievements earned during that time result in zero *Score*.			1x
<G22>	*Drive Team* contact with the *Playing Field, Game Element*, or *Robot.*	*Warning* for the first instance with any following instances resulting in a *Minor Penalty*.	W	1x	
<G23>	*Drive Team Coach Driver Station* control.	*Warning* for the first instance with any following instances resulting in a *Major Penalty*.	W		1x
<G24>	*Robos* deliberately detaching parts.	*Minor Penalty. Major Penalty* if it affects gameplay.		1x	1x
<G25>	*Robot* illegally *Grasping Game Elements.*	*Warning* for the first instance with any following instances resulting in a *Major Penalty* except as outlined in GS rules.	W		1x
<G26>	Destruction, damage, tipping, etc.	Deliberate or chronic violations of this rule will receive a *Major Penalty*.			1x
<G27>	Deliberately removing *Game Elements* from the *Playing Field.*	*Minor Penalty* per *Game Element* deliberately removed from the *Playing Field* except as outlined in GS rules.		1x	
<G29>	Illegal Use of *Game Elements* to ease or amplify *Scoring.*	*Major Penalty* will be assessed..			1x

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty
<GS01>	General Game rule exceptions.				
<GS02>	*Drive Team* touching *Robot* or *Driver Station* after *Randomization.*	*Minor Penalty* and *Robot* not eligible for *Autonomous* tasks.		1x	
<GS04>	Descoring.	*Minor Penalty* for each *Pixel* descored.		1x	
<GS05>a	Control of more *Scoring Elements* than allowed.	*Minor Penalty* for each *Scoring Element* above the limit plus additional *Minor Penalty* per *Scoring Element* above the limit every 5 sec.		1x+	
<GS05>b	*Scoring* a *Pixel* while *Controlling* more *Scoring Elements* than allowed.	*Minor Penalty* for each *Pixel Scored* while in possession of more than the allowed *Scoring Elements.*		1x	
<GS06>a	A *Robot* may only *Grasp* one *Rigging.*	Zero *Score* value for the *Suspend* task.			
<GS06>b	A *Robot* may not *Grasp* or *Suspend* from any other part of the *Truss* structure.	*Minor Penalty* per occurrence.		1x	
<GS07>a	*Grasping* the *Stage Door.*	*Major Penalty* for each offense.			1x
<GS08>d	*Robot Scoring Pixels* from *Tile* rows 1, 2, 3.	*Minor Penalty* for each offense.		1x	
<GS09>d	Exceeding allowed quantity of *Pixels* in *Wing.*	*Minor Penalty* for each *Pixel* over the maximum of 6 *Pixels* in *Wing.*		1x	
<GS10>	*Propelling Pixels.*	*Minor Penalty* for each offense.		1x	
<GS11>g.iii	*Drive Team, Field Personell,* or physical structures affects the flight of a *Drone.*	Affecting own *Team's Drone* results in no *Score* value for the *Drone.*			
<GS11>h	*Drones Parked*	*Drones* must *Park Completely Outside* of the *Playing Field Perimeter* to *Score.*			
<GS12>a	*Scoring Elements* in *Pixel Storage* may not be handled until start of *Match.*	*Minor Penalty* for each offense.		1x	
<GS12>b	The *Human Player* may only place *Pixels* or their *Drone* in *Wing* during *Driver-Controlled Period.*	*Minor Penalty* for each offense.		1x	
<GS12>c	Placing more than 2 *Pixels* or more than 1 *Drone* in the *Wing* at a time.	*Minor Penalty* for each offense.		1x	

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty
<GS12>d	Repositioning already placed *Scoring Elements* in *Wing.*	*Minor Penalty* for each offense.		1x	
<GS12>e	*Propelling Pixels* or a *Drone Out* of the *Wing.*	*Minor Penalty* for each offense.		1x	
<GS12>g	Using tools to place *Pixels* or a *Drone.*	*Minor Penalty* for each offense.		1x	
<GS12>h	*Human Player* cannot break the vertical plane of the *Playing Field Perimeter* while a *Robot* is in the *Wing.*	*Minor Penalty* for each offense.		1x	
<GS12>i	*Robot* enters *Wing* while *Human Player* is *In* the *Wing.*	*Minor Penalty* for each offense.		1x	
<GS13>	The *Drive Team* stepping/jumping over *Truss* or *Stage Door.*	First instance results in a *Warning.* Subsequent violations will result in a *Major Penalty.*	W		1x

Table Key	
W: *Warning*	1x: *Penalty* at single cost
D: *Robot Disabled*	1x+: *Penalty* at single cost every 5 seconds
YC: *Yellow Card* issued	2x: *Penalty* at double cost
RC: *Red Card* issued	* Indicates optional
DQ: *Disqualification*	

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. 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

FIRST Websites

FIRST homepage – 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.
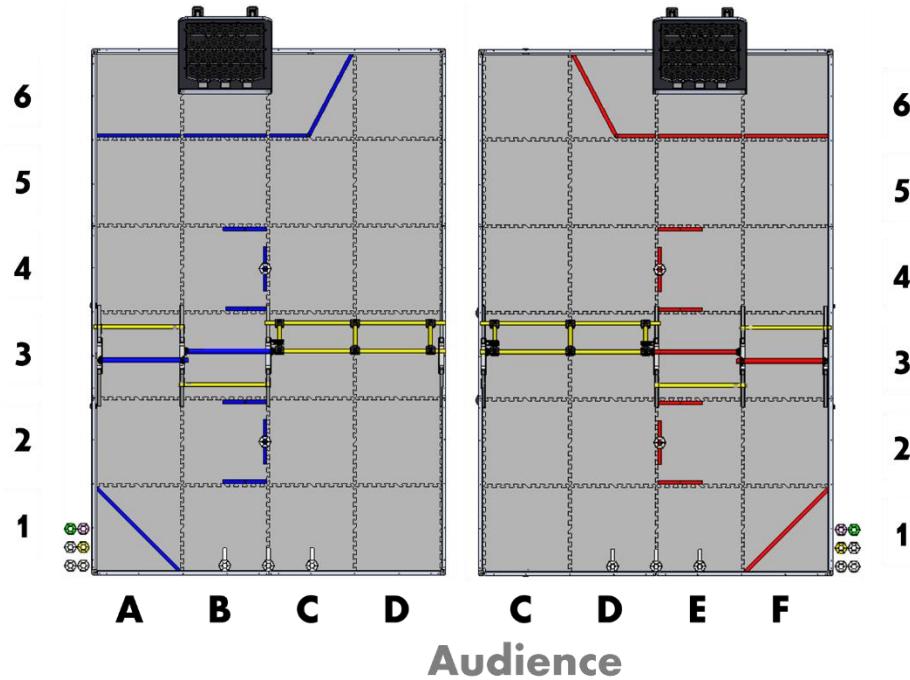
FIRST Tech Challenge Blog – Weekly articles for the *FIRST* Tech Challenge community, including outstanding volunteer recognition!

FIRST Tech Challenge Team Email Blasts – contain the most recent *FIRST* Tech Challenge news for teams.
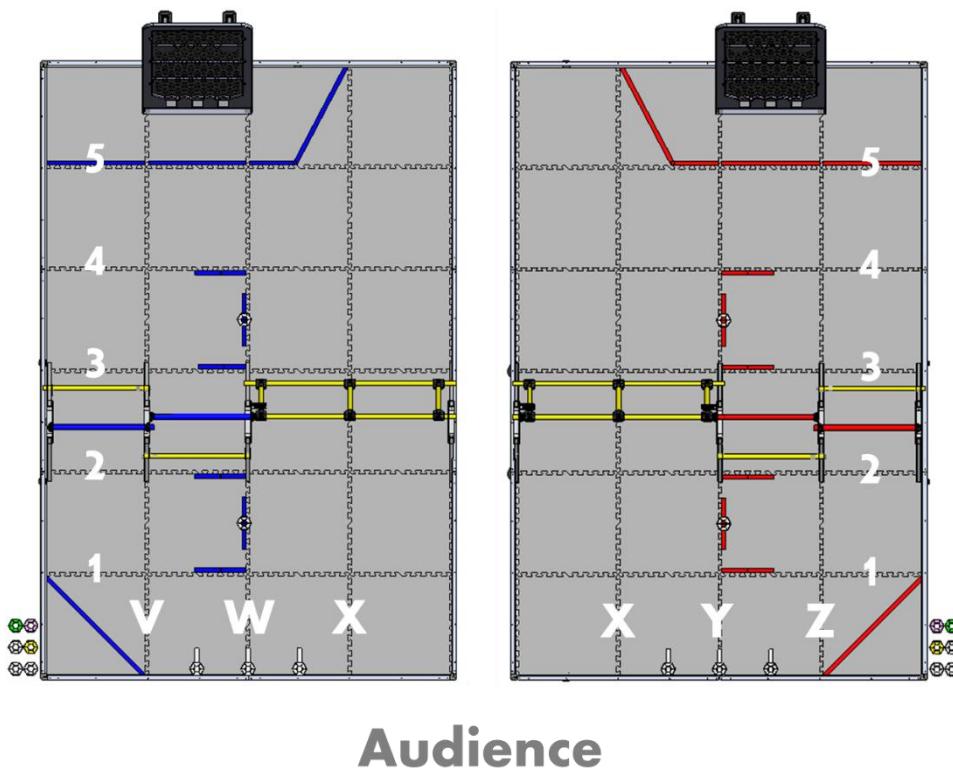
Feedback

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. Thank you!

Appendix B – *Playing Field* Locations

B-1 *Tile* Locations
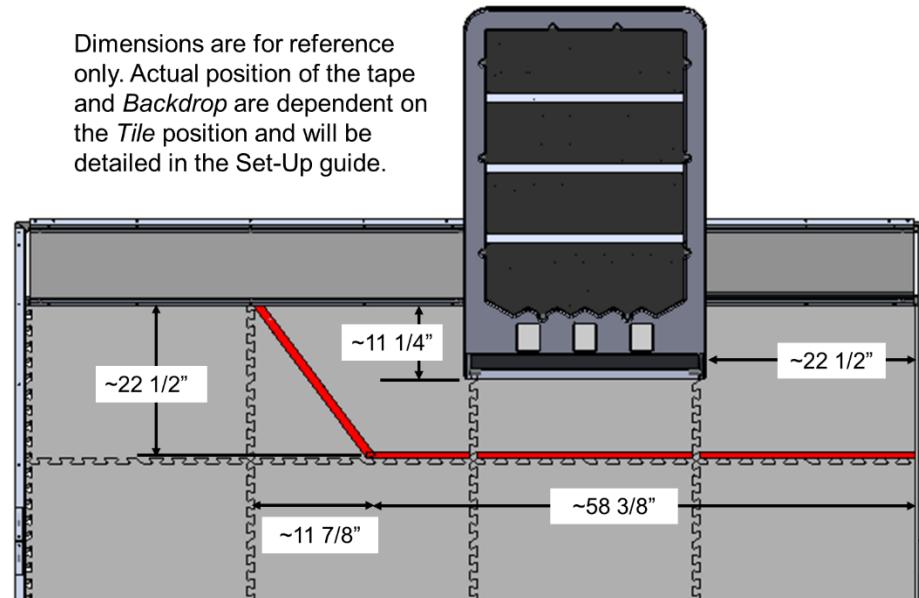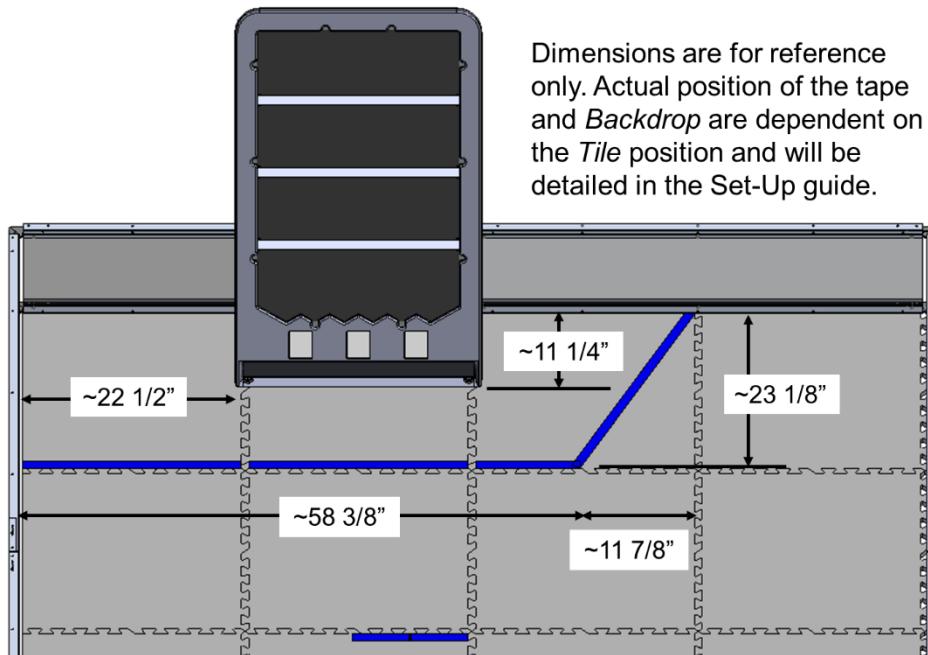
B-2 Intersection Locations
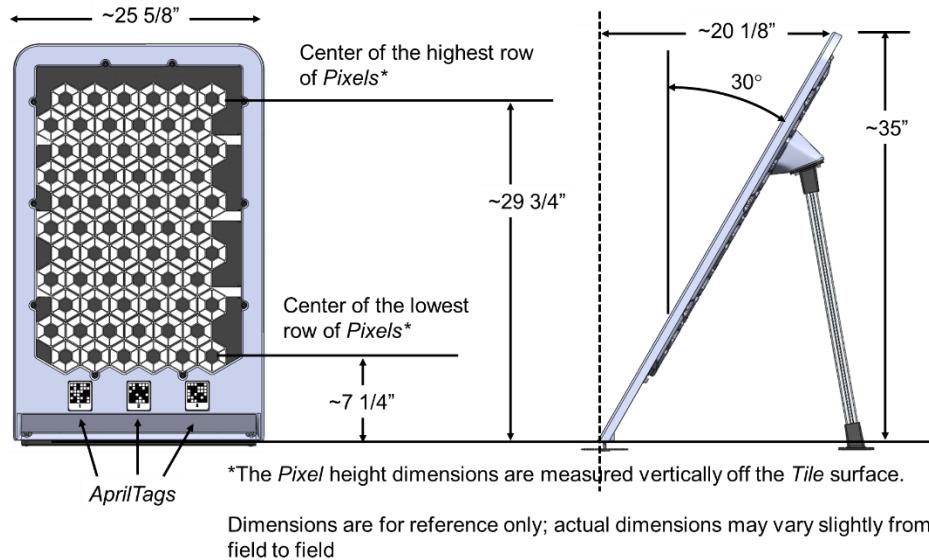
Appendix C – *Playing Field* Details
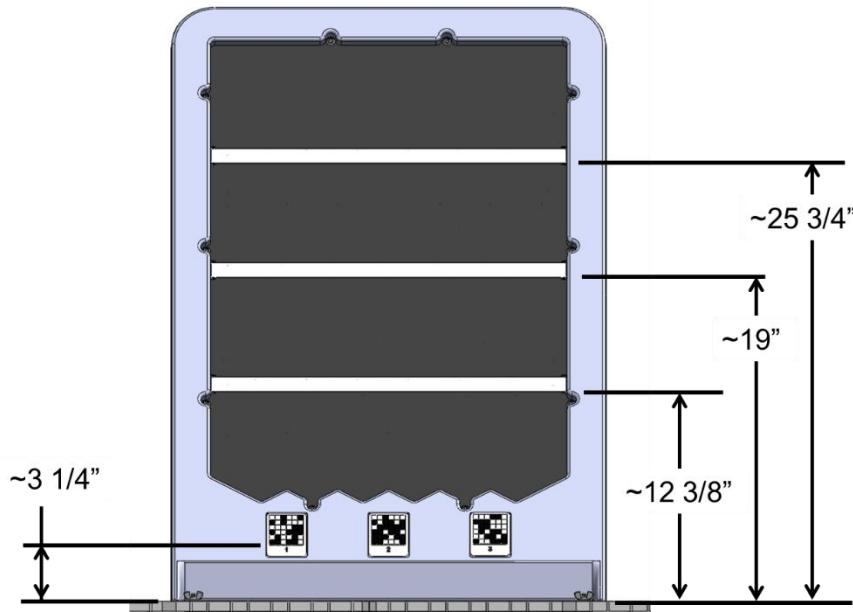
Important Note: The measurements in this section are nominal and may vary based on manufacturing and assembly tolerances (including *Tile* and *Playing Field Wall* variances). For critical measurements and *Game Element* placement for field setup and assembly, please reference the AndyMark Field Setup and Assembly Guide. To view individual *Game Element* component measurements, please reference the field CAD file located on AndyMark's [website](#).

Dimensions are for reference only. Actual position of the tape and *Backdrop* are dependent on the *Tile* position and will be detailed in the Set-Up guide.

~11 1/4"

~22 1/2"

~23 1/8"

~58 3/8"

~11 7/8"

Dimensions are for reference only. Actual position of the tape and *Backdrop* are dependent on the *Tile* position and will be detailed in the Set-Up guide.

~11 1/4"

~22 1/2"

~22 1/2"

~58 3/8"

~11 7/8"

C-1 *Backstage* and *Backdrop* locations

~25 5/8"

Center of the highest row of *Pixels**

~20 1/8"

30°

~35"

~29 3/4"

Center of the lowest row of *Pixels**

~7 1/4"

AprilTags

*The *Pixel* height dimensions are measured vertically off the *Tile* surface.

Dimensions are for reference only; actual dimensions may vary slightly from field to field
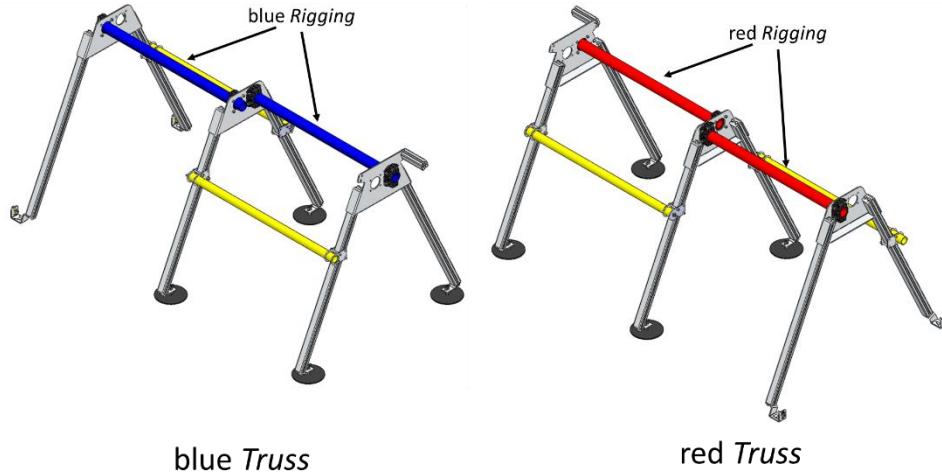
C-2 *Backdrop* dimensions

~25 3/4"

~19"

~3 1/4"

~12 3/8"

The dimensions are measured vertically off the *Tile* surface.
Dimensions are for reference only. Actual dimensions may vary slightly.
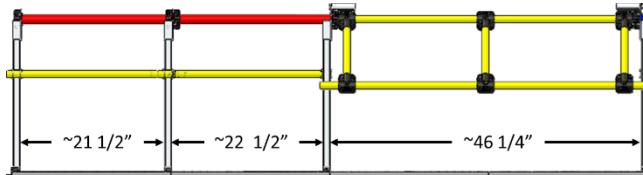
C-3 *Backdrop* dimensions
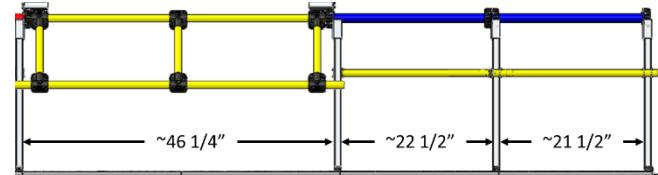
blue *Truss*   red *Truss*

C-4 *Truss* and *Rigging*

~21 1/2"   ~22 1/2"   ~46 1/4"   ~46 1/4"   ~22 1/2"   ~21 1/2"
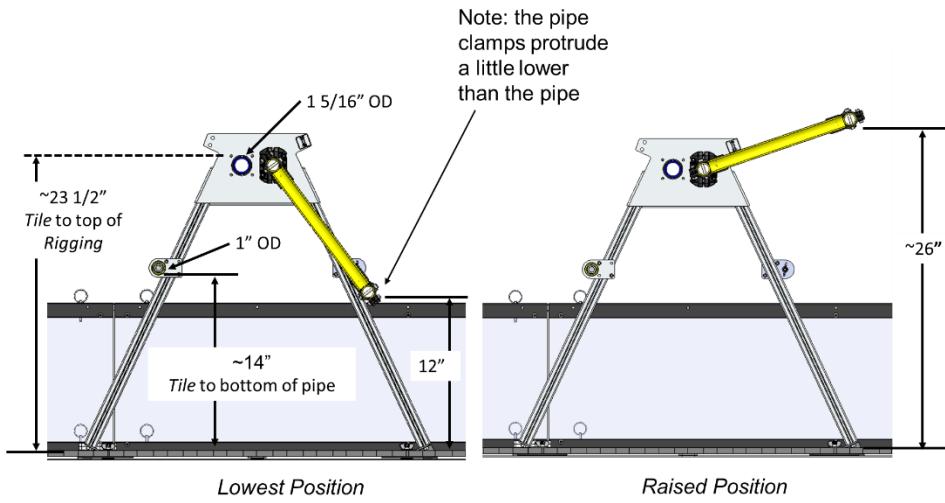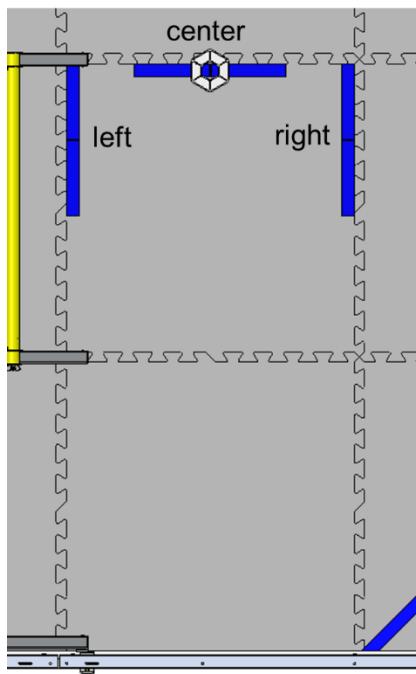
Red *Alliance Truss* and *Rigging*   Blue *Alliance Truss* and *Rigging*

C-5 *Truss* and *Stage Door* spacing

Note: the pipe clamps protrude a little lower than the pipe

1 5/16" OD

~23 1/2" *Tile* to top of *Rigging*

1" OD

~14" *Tile* to bottom of pipe

12"

~26"

Lowest Position   *Raised Position*

Dimensions are for reference only; actual dimensions may vary slightly from field to field

C-6 *Truss* and *Rigging*
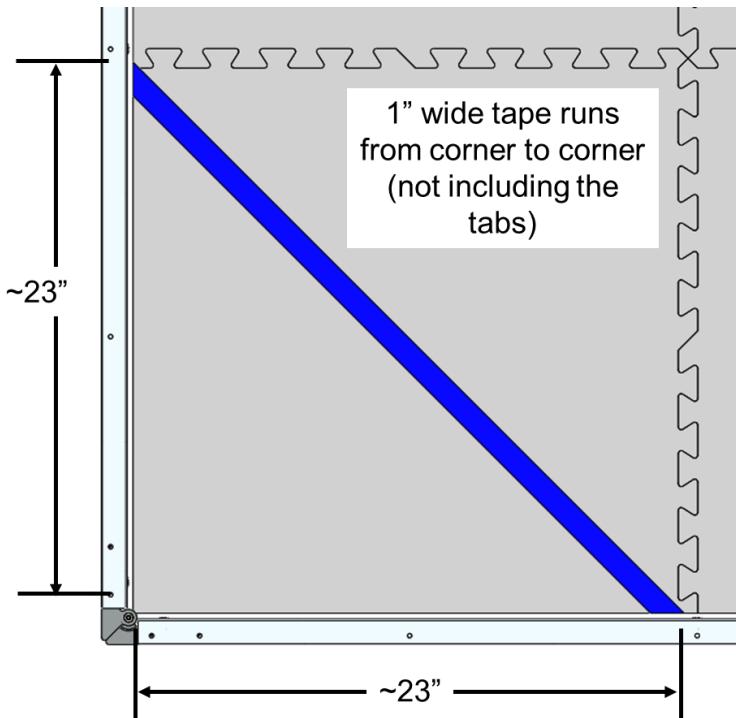
~1 inch wide by 12" long tape strips.

The strips are aligned to the *Tile*, against the root of the tabs.
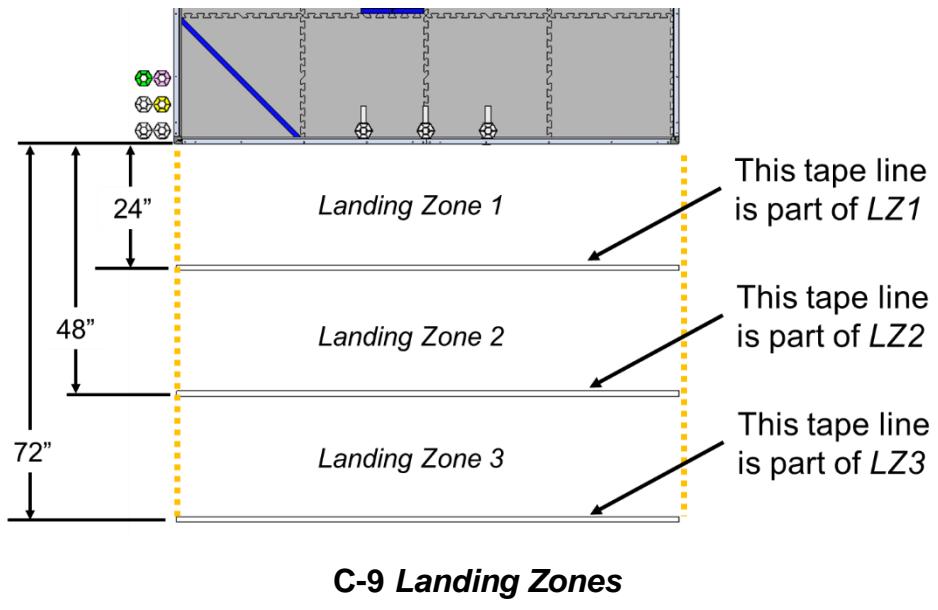
The center strip is centered on the *Tile*
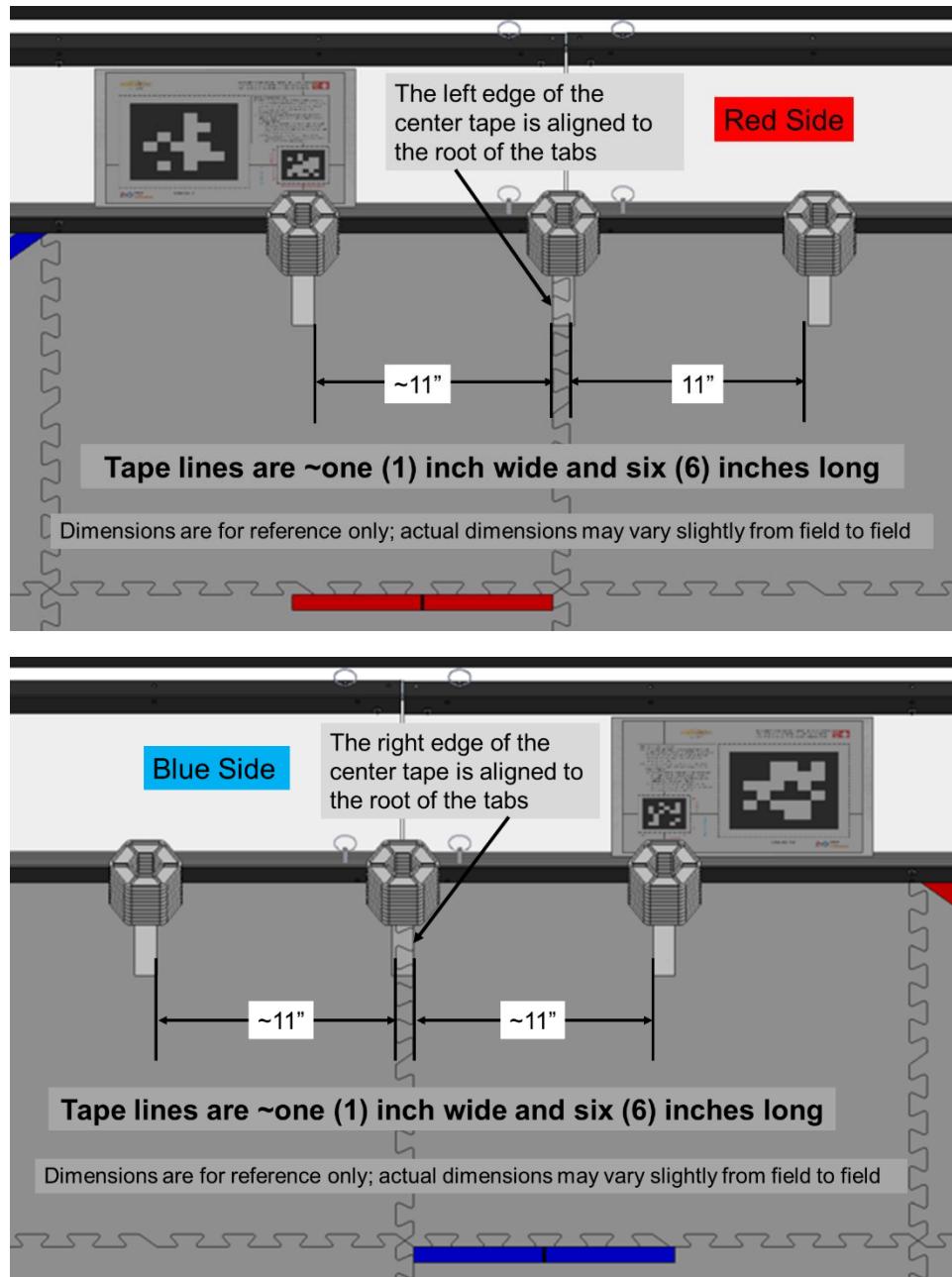
There is a black mark in the center of each strip to indicate the starting position of the *Pixel* or *Team Prop.*

C-7 *Spike Marks,* typical

1" wide tape runs from corner to corner (not including the tabs)

C-8 *Wing* typical

C-9 *Landing Zones*

The left edge of the center tape is aligned to the root of the tabs

Red Side

~11"

11"

Tape lines are ~one (1) inch wide and six (6) inches long

Dimensions are for reference only; actual dimensions may vary slightly from field to field

Blue Side

The right edge of the center tape is aligned to the root of the tabs

~11"

~11"

Tape lines are ~one (1) inch wide and six (6) inches long

Dimensions are for reference only; actual dimensions may vary slightly from field to field

C-10 *Pre-Match* setup of on-field *Pixels* – locations
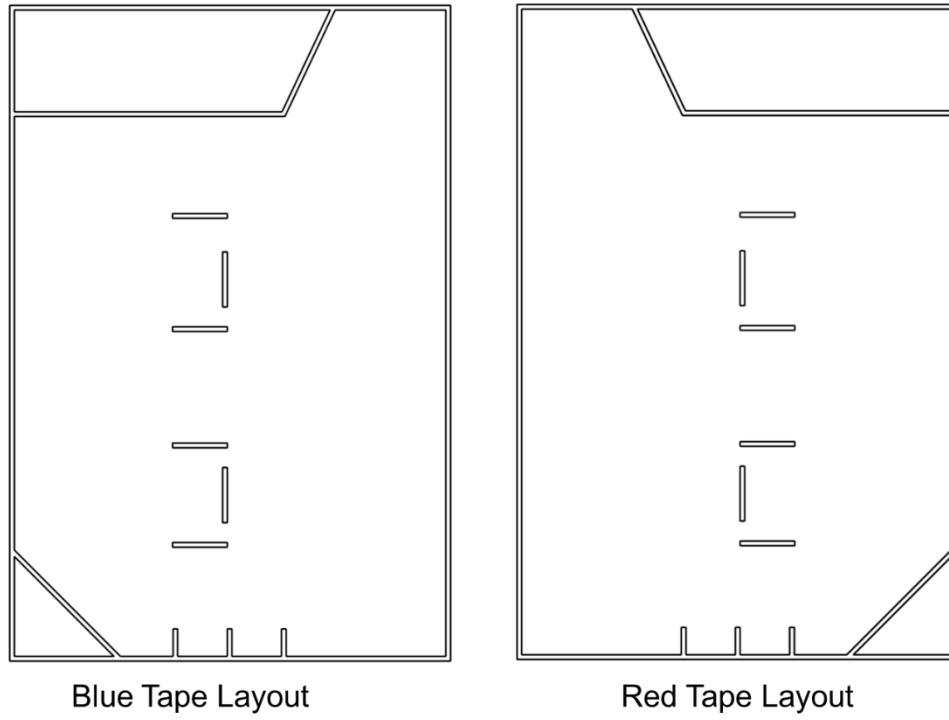
C-11 Location of Boundary *AprilTags*

Note: locations of the stacks are approximate
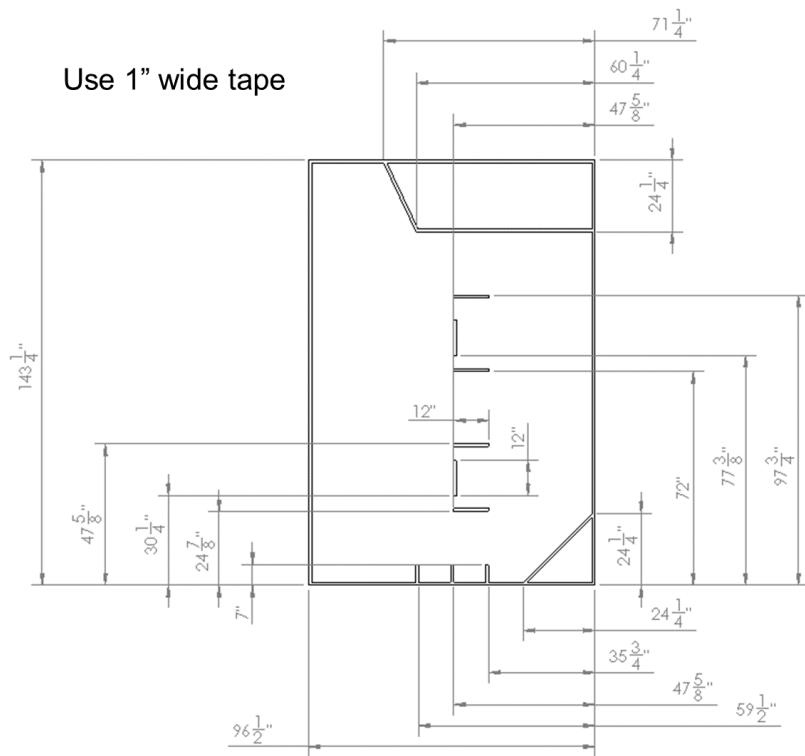
three (3) stacks of five (5) white *Pixels*
one (1) stack of five (5) purple *Pixels*
one (1) stack of five (5) yellow *Pixels*
one (1) stack of five (5) green *Pixels*

C-12 P*re-Match* setup of *Pixel Storage*

Blue Tape Layout

Red Tape Layout
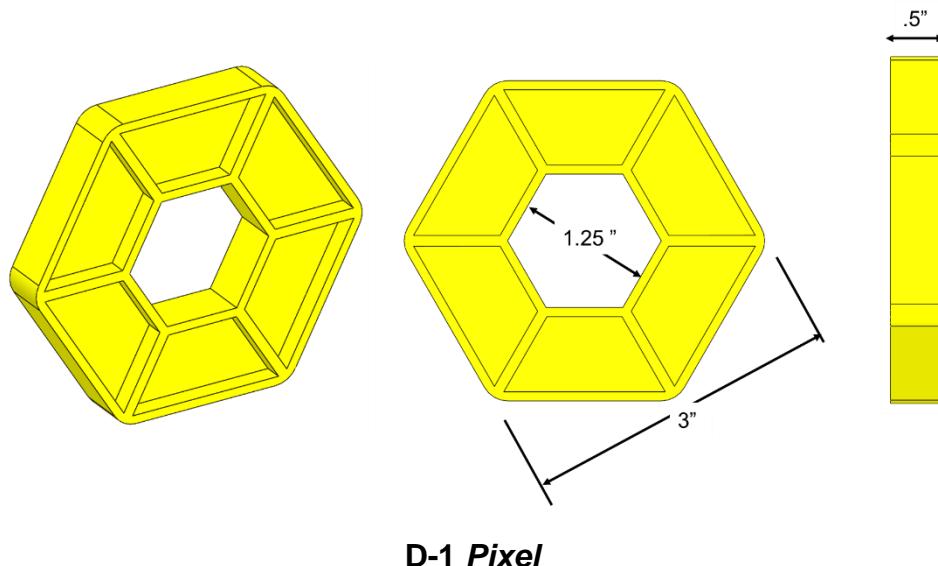
C-13 Layout of taped field (no perimeter walls)

Use 1" wide tape
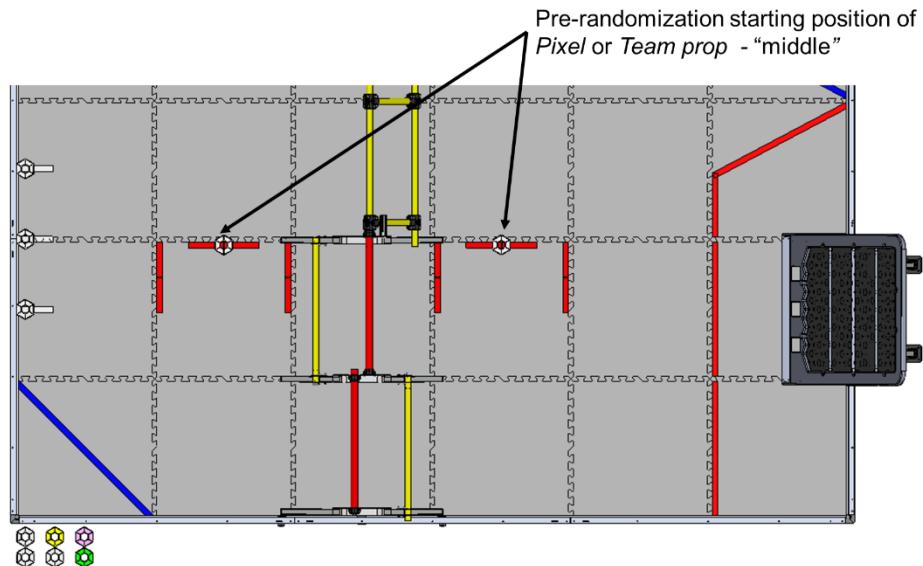
C-14 Dimensions of taped field (red side shown)

Appendix D – *Scoring* Element
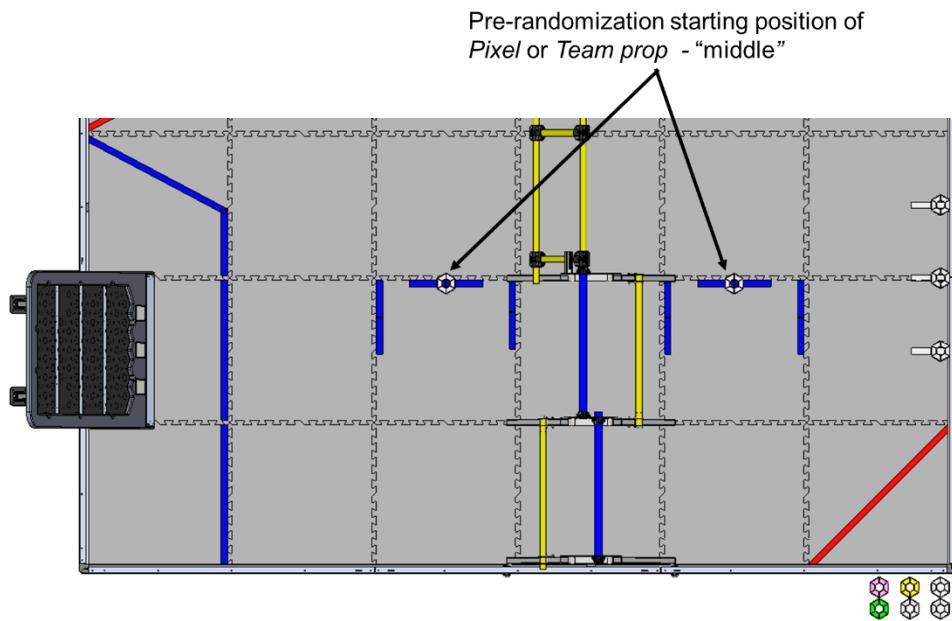
D-1 *Pixel*
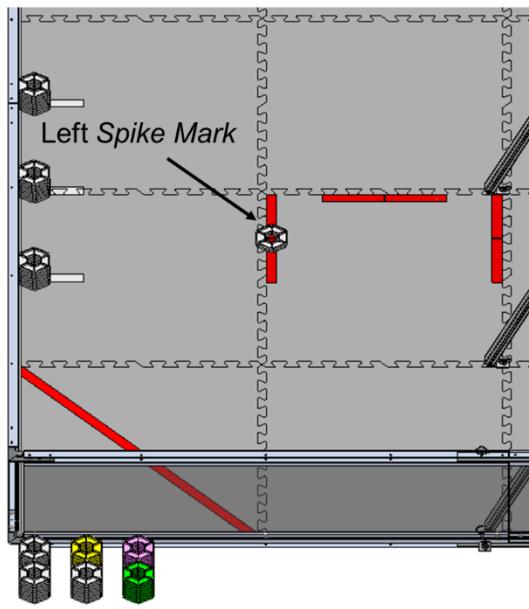
Appendix E – Randomization

E-1 – *Randomization Objects* **– pre-randomization starting positions – red** *Alliance*
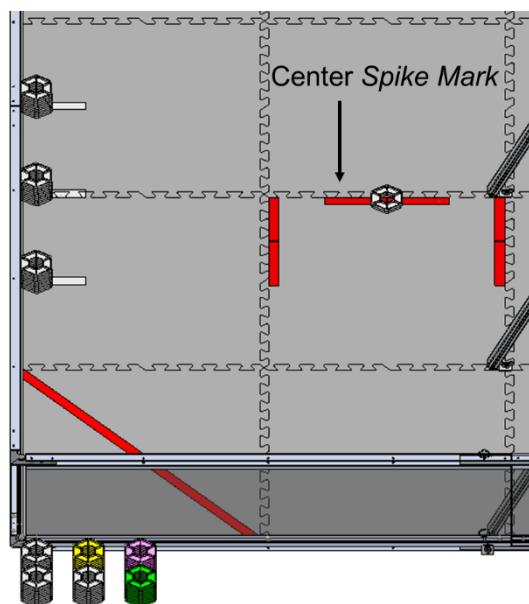
E-2 – *Randomization Objects* **– pre-randomization starting position - blue** *Alliance*
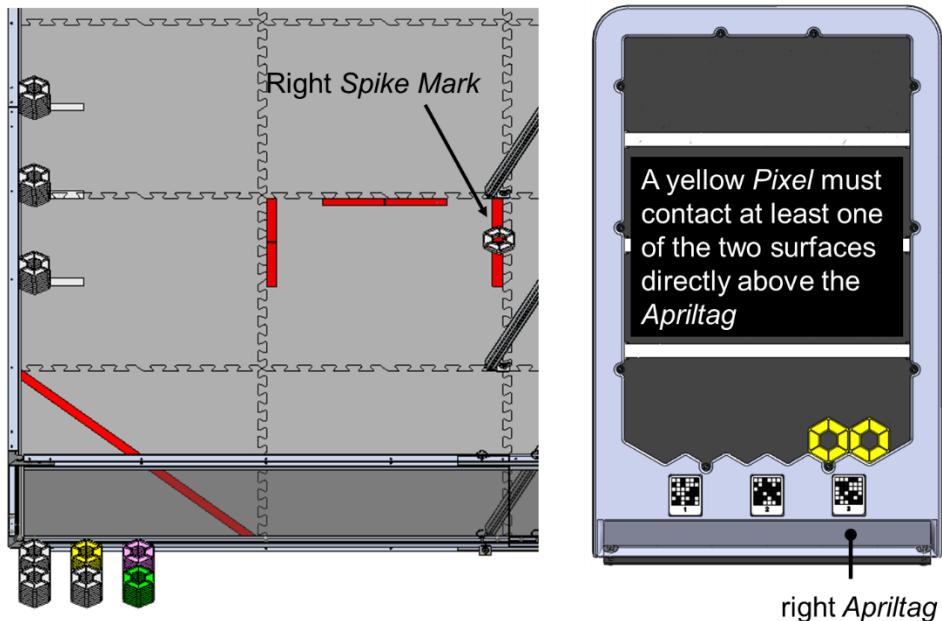
Randomization Object- left side scoring locations

E-3 – left side *Scoring*

Randomization Object- center scoring locations

E-4 – center *Scoring*

Right *Spike Mark*

A yellow *Pixel* must contact at least one of the two surfaces directly above the *Apriltag*

right *Apriltag*
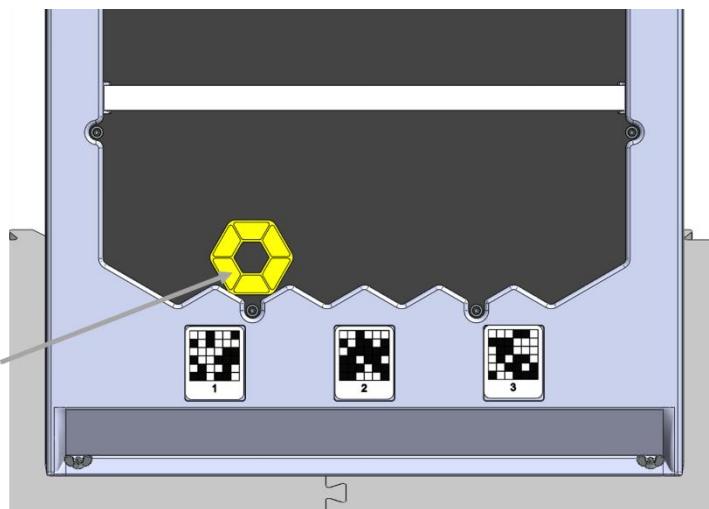
***Randomization Object*- right side scoring locations**
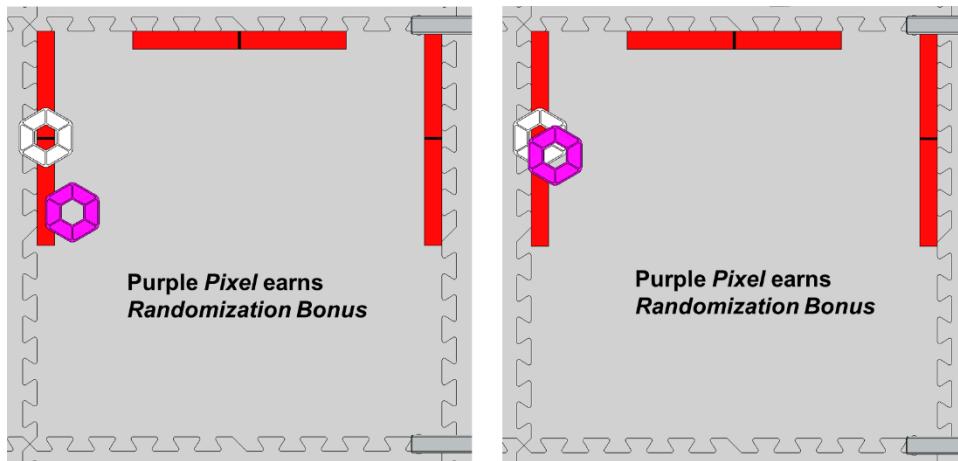
E-5 – right *Scoring*

During the Autonomous period, the yellow *Pixel* only has to touch the correct surface (in this example it is the Left randomized position)
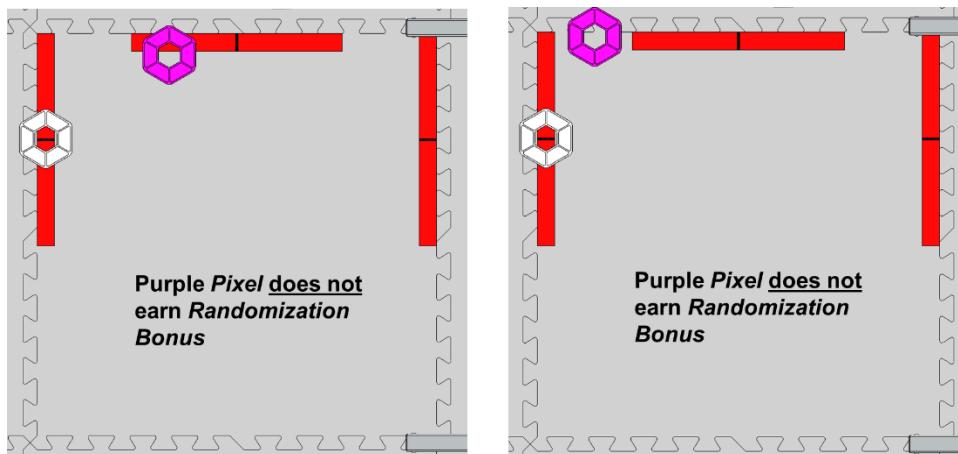
This is a legally scored *Pixel* and earns the autonomous points
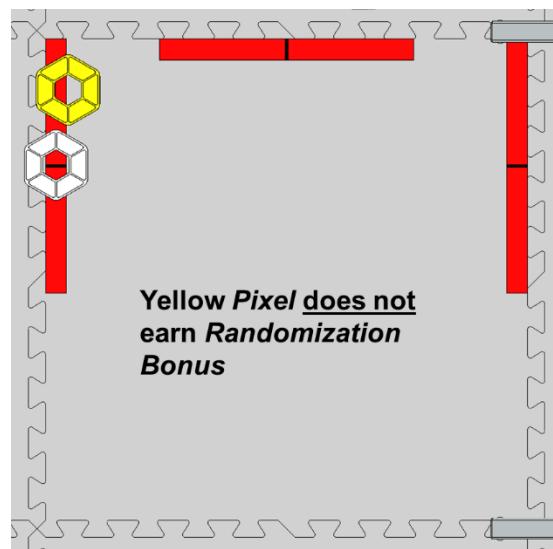
E-6 – *Pixel* position

E-7 – Scoring Examples
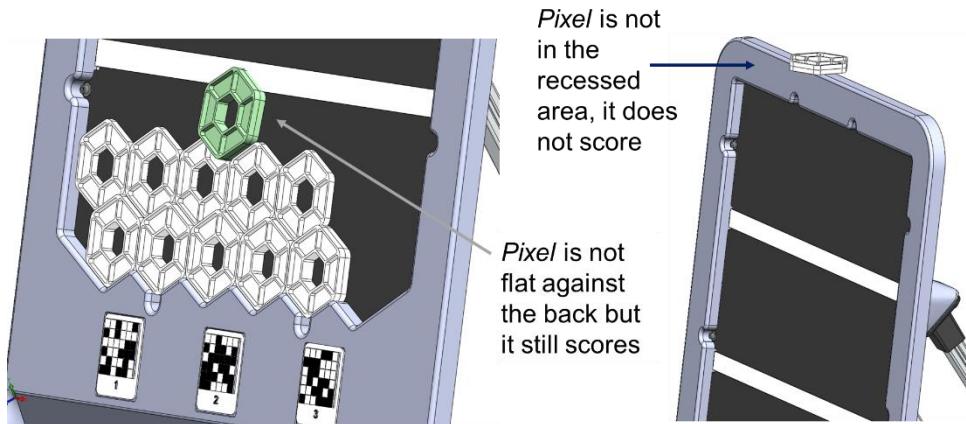
E-8 – Scoring Examples
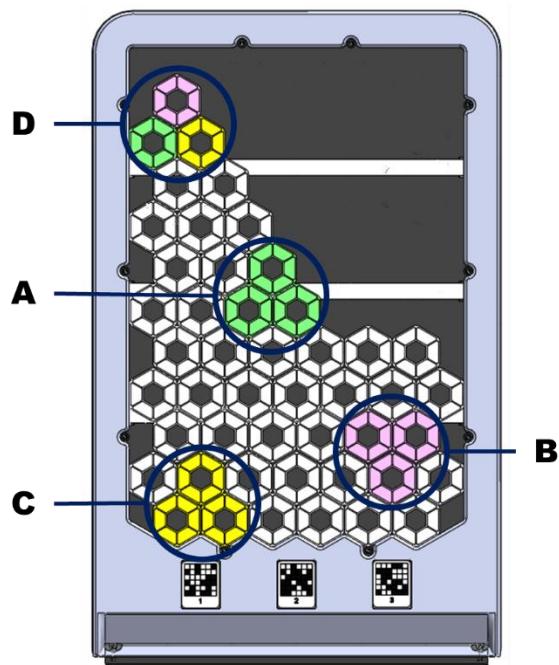
E-9 – Scoring Examples
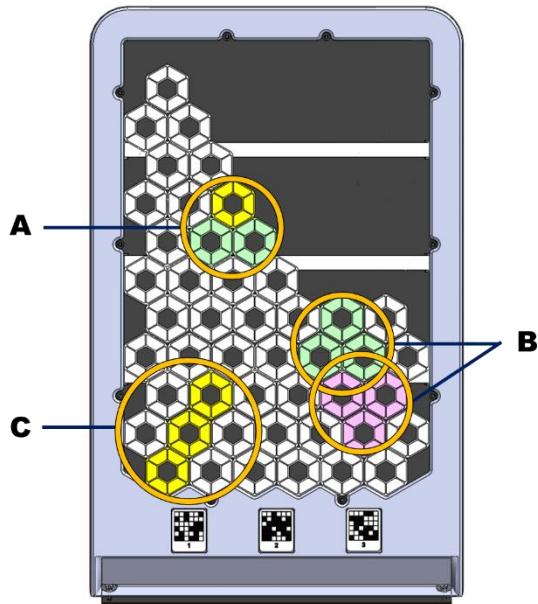
Appendix F – *Scoring* Examples

Pixel is not in the recessed area, it does not score

Pixel is not flat against the back but it still scores

F-1 *Pixel Scoring*

A, B, C *Mosaic* consists of three (3) non-white *Pixels,* all the same color (all green, all purple or all yellow) and in contact with the other two (2) *Pixels* of that *Mosaic*.

D *Mosaic* consists of three (3) non-white *Pixels,* all different colors (one (1) green, one (1) purple and one (1) yellow) and in contact with the other two (2) *Pixels* of that *Mosaic*.

F-2 *Mosaics*

Not legal *Mosaics*:
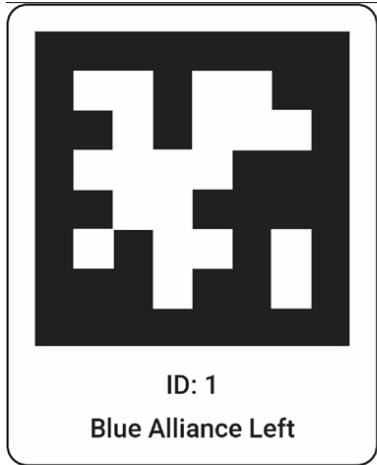
A. A *Mosaic* must consist of three (3) non-white *Pixels*, either all the same color (all green, all purple or all yellow) or each *Pixel* a different color (one (1) green, one (1) purple, and one (1) yellow).

B. A *Mosaic* cannot be in contact with another non-white *Pixel*.

C. Each *Pixel i*n a *Mosaic* must be in contact with the other two (2) *Pixels* of that *Mosaic*.

F-3 Not *Mosaics*

Alliance earns one (1) Set Line Bonus

Alliance earns two (2) Set Line Bonuses

Alliance earns three (3) Set Line Bonuses

F-4 *Set Bonus*

R1 – *In Landing Zone 2*   **R3** – *In Landing Zone 3*
R2 – *In Landing Zone 1*   **R4** – *Outside of Landing Zones*
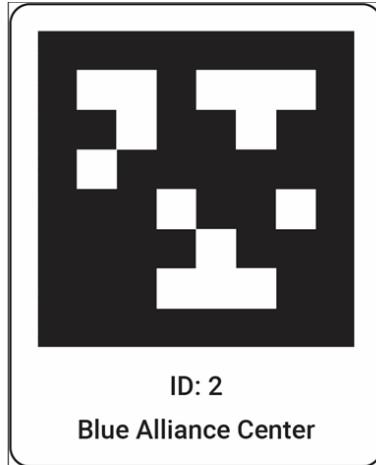
F-5 *Landing Zone Scoring*
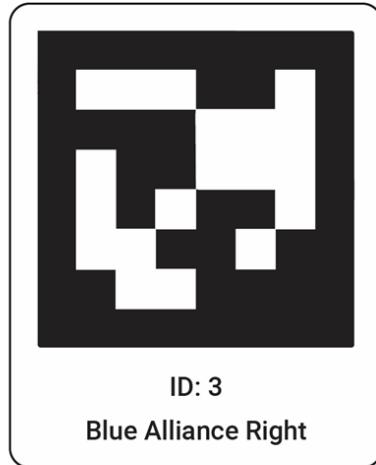
Appendix G – *AprilTags*
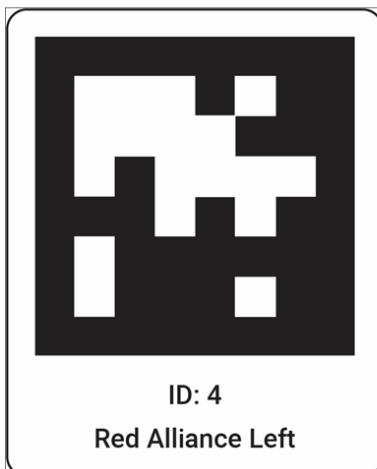
ID: 1
Blue Alliance Left
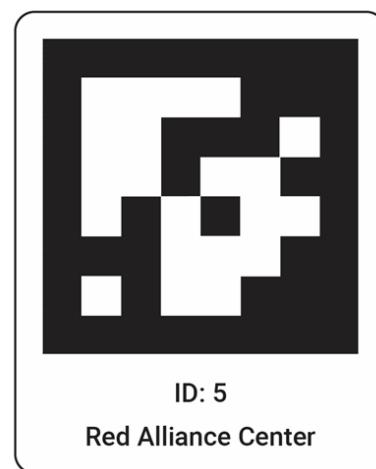
ID: 2
Blue Alliance Center
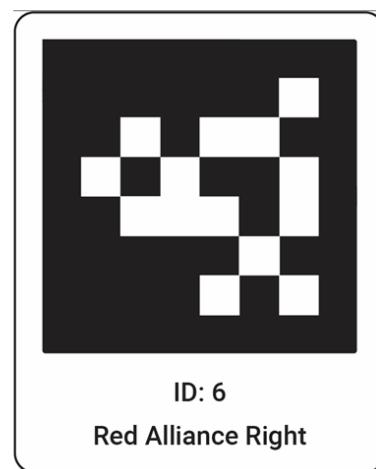
ID: 3
Blue Alliance Right

ID: 4
Red Alliance Left

ID: 5
Red Alliance Center
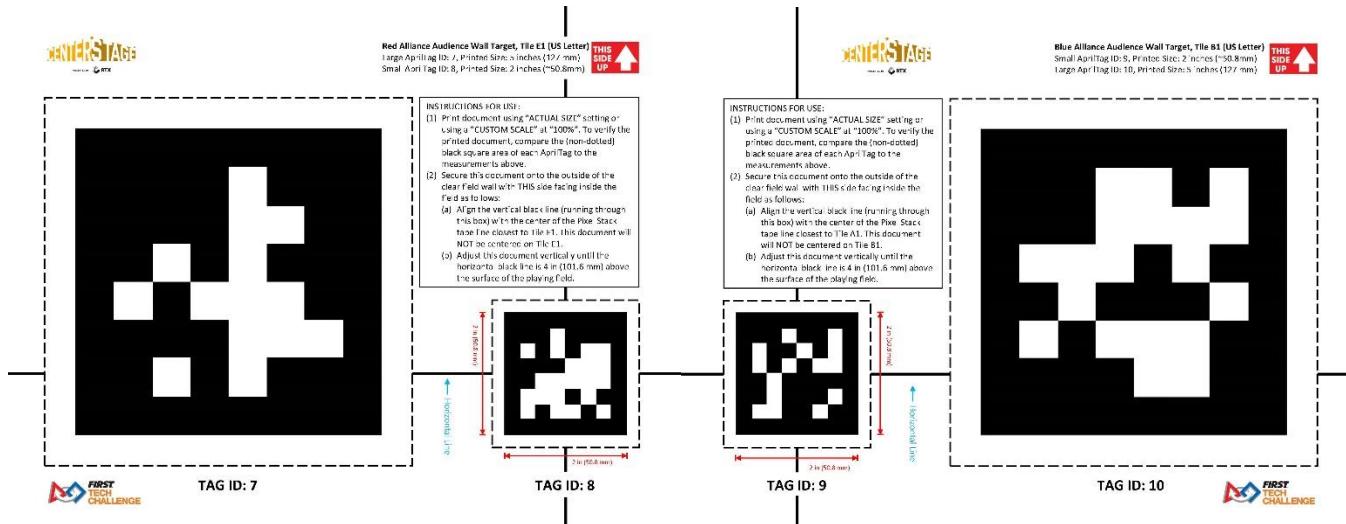
ID: 6
**Red Alliance Right**

G-1 *AprilTags* for *Backdrop*

You do not need to print these images if you are purchasing a full field kit from AndyMark. The *AprilTags* for the backdrop are included in the full and partial field kits.

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.

G-2 *AprilTags* **for** *Playing Field Wall*

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.