Sponsor Thank You

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

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9/7/2021</td>
<td>Limited Program Delivery Partner Release</td>
</tr>
<tr>
<td>1.1</td>
<td>9/18/2021</td>
<td>• Kickoff Release</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Figure 4.3-1 – New image showing correct location of Alliance Shipping Hub</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Figure 4.3-2 – New image showing correct location of Alliance Shipping Hub</td>
</tr>
<tr>
<td>1.2</td>
<td>10/19/2021</td>
<td>• Section 4.2 – Deleted duplicate text</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Section 4.4 – Corrected number of Freight for remote event gameplay in Freight definition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Section 4.5.4 – Capping – Remote teams may only score one Team Shipping Element</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Section 4.5.7 – New match states image</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Section 4.6.3 – Rule &lt;GS6&gt; - Further rule clarification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Section 4.6.3 –&lt;GS9&gt;d</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Changed penalty from Major to Minor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Early Delivery of Duck or Team Shipping Element receives zero points for Delivery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Section 4.6.3 – Added rule &lt;GS9&gt;i</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Section 4.6.3 – Added rule &lt;GS11&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Appendix B – Updated image of Carousel with correct height measurement</td>
</tr>
<tr>
<td>1.3</td>
<td>1/26/2022</td>
<td>• Section 4.4 – Updated number of Cargo from 20 to 10</td>
</tr>
</tbody>
</table>

Contents

1.0 Introduction ............................................................................................................................... 4

1.1 What is FIRST® Tech Challenge? ................................................................................................ 4

2.0 Gracious Professionalism® ......................................................................................................... 4

3.0 How to Use This Document ....................................................................................................... 5

4.0 The Game ....................................................................................................................................... 5

4.1 Introduction ................................................................................................................................. 5

4.2 Game Description ........................................................................................................................ 5

4.2.1 Game Narrative ...................................................................................................................... 5

4.2.2 Gameplay Overview ................................................................................................................ 6

4.2.3 Gameplay Technology ............................................................................................................ 6

4.3 Playing Field Illustrations ......................................................................................................... 7

4.4 Game Definitions ........................................................................................................................ 8

4.5 Gameplay ....................................................................................................................................... 8

4.5.1 Pre-Match .............................................................................................................................. 13

4.5.2 Autonomous Period ............................................................................................................... 13

4.5.3 Driver-Controlled Period .................................................................................................... 14

4.5.4 End Game ............................................................................................................................. 15

4.5.5 Post Match ............................................................................................................................ 16

4.5.6 Penalties ............................................................................................................................... 16

4.5.7 Flowchart of Match Play ....................................................................................................... 17

4.6 Rules of Gameplay ....................................................................................................................... 17

Gracious Professionalism® - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
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. 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 competing in a remote event format. 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. Since Teams are not able to gather and compete in the traditional head-to-head competition format, the season’s official full Playing Field has been adapted to allow Teams to play Matches as a single Team. Remote Teams may order an official half 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 Italic.

4.0 The Game

4.1 Introduction

This document describes FREIGHT FRENZYSM presented by Raytheon Technologies, the FIRST® Tech Challenge game for the 2021-2022 season. We recommend viewing the game animation prior to reading this manual to gain a general understanding of the 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 ftcforum.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 Game Narrative

The world of transport is undergoing some of the greatest changes of its time, all the while natural disasters, humanitarian crises, and food shortages are happening all around us. Of all the technological advances continuously inserted into our daily lives, which ones will help us transport hard to move goods and solve these global challenges?

Providing basic needs are necessary for cultivating a safe and more equitable world. But doing so can be quite complex. Our world depends on a strong transportation system to get essential items into the hands of those who need it most and move those in danger to safety. When our transportation networks improve with efficiency and scale, our people, our animals, and our livelihoods prevail.

The future of transporting relief to those in need is about inventing creative solutions, pushed by the recognition of the inefficiencies, inequities, and the choices we make around them.
Will we be able to work together and deliver a solution in the race against time? Only time will tell. A better, safer world is possible.

4.2.2 Gameplay Overview
Welcome to FREIGHT FRENZY™ presented by Raytheon Technologies. Matches are played on a Playing Field initially set up as illustrated in Figure 4.3-1. The object of the game is to the highest Score 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. During the Autonomous Period, Teams earn points by: Delivering Pre-Loaded Boxes to a randomly selected level of the Alliance Shipping Hub. Teams may opt to use the Duck placed on the field, or may use their Team Shipping Element, which provides more points when Freight is delivered to the correct level of the Alliance Shipping Hub. Teams also earn points for Navigating to the Storage Unit or Warehouse, Scoring Freight in the Storage Unit or Alliance Shipping Hub, and Delivering Ducks onto the Playing Field Floor via the Carousel.

The two-minute Driver-Controlled Period follows the Autonomous Period. Teams earn points by collecting Freight from the Warehouse and Scoring the Freight in the Storage Unit or their Alliance Shipping Hub.

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 may Deliver Ducks onto the Playing Field. If the Team Shipping Element was not introduced during pre-Match setup, Teams may now Deliver their Team Shipping Element. The Team Shipping Element may be used to Cap their Alliance Shipping Hub to earn points. A Team will earn Balance points for the Alliance Shipping Hub being Balanced.

4.2.3 Gameplay Technology
Each game comes with its own unique set of technology challenges. In FREIGHT FRENZY, there are multiple ways Teams can utilize technology to assist them in the challenge. 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 placed on one of the three Barcode locations. Correctly locating the object and then placing their Pre-Loaded Box onto the Scoring Level that corresponds to the Barcode location earns the Team bonus points.

   b. Teams can use the built-in TensorFlow technology to identify the default object, a yellow Duck, but Teams that can train technologies like TensorFlow or use more traditional sensors to identify their Team-built Team Shipping Element will earn additional points.

2. Field Navigation
   a. Teams 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.

3. Sensor Use
   a. Teams can add sensors to their Robot to help it identify the Boxes, as there are three different weighted Boxes located in the Warehouse.

For resources on how the available technologies please visit https://github.com/FIRST-Tech-Challenge.
4.3 Playing Field Illustrations

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 Guide, are available at https://www.firstinspires.org/resource-library/ftc/game-and-season-info. Please Note: The following illustration shows the Playing Field with optional perimeter wall as the Playing Field Boundary.

![Isometric view of the Playing Field](image)

Figure 4.3-1 – Isometric view of the Playing Field
4.4 Game Definitions
The following definitions and terms are used for FREIGHT FRENZY℠. Game definitions are capitalized and italicized throughout the manual.

Alliance Shipping Hub - An Alliance Specific Game Element with three (3) Scoring Levels. There is one (1) Alliance Shipping Hub. The three Scoring Levels are as follows (all dimensions are approximate):

a) Level 1: 18 inches (457 mm) diameter and 3 inches (76.2 mm) above the Playing Field Floor.

b) Level 2: 15 inches (381 mm) diameter and 8.5 inches (215.9 mm) above the Playing Field Floor.

c) Level 3: 12 inches (305 mm) diameter and 14.75 inches (374.6 mm) above the Playing Field Floor.

Alliance Station – The designated Team Area adjacent to the Playing Field where the Drivers and Coach stand 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, markings, etc.) is part of the Area for the purposes of determining Inside and Outside.
Autonomous Period – A 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.

Balanced / Unbalanced – A Shipping Hub is Balanced when it is Completely Supported by the Playing Field Floor and only the Shipping Hub domed base is touching the Playing Field Floor. All other states are Unbalanced.

Barcode – The two locations on the Playing Field Floor that consist of three taped squares each, where a Duck or Team Shipping Element is placed during pre-Match setup.

Barrier – Approximate 1-inch high by 5.5-inch wide (25.4 mm x 139.7 mm) obstacles on the Playing Field that delineate Areas. Barriers do not belong to nor do they form the boundary of any defined Area.

Cap / Capping – Placing a Team Shipping Element on top of the Alliance Shipping Hub pipe.

Carousel - The Carousel is located in the corner of the Playing Field adjacent to the Alliance Station. There is one (1) Carousel. The Carousel is not self-powered and may only be rotated by a Robot on the Playing Field in a manner described in Section 4.5. The following are components of the Carousel:

a) Platform – A rotating portion of the Carousel used to Deliver Ducks and Team Shipping Elements into the Playing Field.

b) Rim – The vertical surface at the perimeter of the Platform where Robot contact is allowed.

c) Sweeper Plate – The stationary portion of the Carousel that causes the Duck or Team Shipping Element to fall from the Platform and into the Playing Field.

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

Competition Area – The Area where the Playing Field is 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 include, but are not limited to:

a) Carrying one or more Game Elements.

b) Launched 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 Launching 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 Launched Game Element as it bounces off the Playing Field or a Robot. See also the definition of Inadvertent in this section.

Deliver / Delivered – The action of introducing a Duck or Team Shipping Element onto the Playing Field. A legal Delivery follows this sequence:

Gracious Professionalism® - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
a) Drive Team places a Duck or Team Shipping Element onto the Carousel Platform Completely In the Drive Team side of the Sweeper Plate. The Duck or Team Shipping Element must be in contact with the Sweeper Plate; then

b) The Robot must rotate the Carousel Platform, then

c) The Sweeper Plate must knock the Duck or Team Shipping Element off the Carousel onto the Playing Field Floor.

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

**Drive Team** – Up to three (3) representatives; two (2) Drivers and one (1) Coach from the same Team.

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

**Driver-Controlled Period** – The two-minute 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 Driver Station rules are listed in Game Manual Part 1 – Remote Events.

**End Game** – The last thirty 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 Barcode, 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.

**Freight** – Freight consists of Cargo, Boxes, and Ducks.

a) **Cargo** – 2.75 inch (69.9 mm) diameter balls, weight: 1.18 oz. (33.5 grams). Quantity: Ten (10)

b) **Boxes** – 2 inch (50.8 mm) cubes. There are four (4) types of Boxes:

   i. **Pre-Load** – 1.79 oz (50.5 grams). Quantity: Two (2)
   
   ii. **Light** – 1.79 oz (50.5 grams). Quantity: Thirteen (13)
   
   iii. **Medium** – 3.28 oz (93.1 grams). Quantity: Ten (10)
   
   iv. **Heavy** - 4.78 oz. (135.4 grams). Quantity: Five (5)

c) **Ducks** – 2.125 inches x 2.0 inches x 2.0 inches (54.0 mm x 50.8 mm x 50.8 mm) rubber ducks, weight: 0.56 oz. (15.8 grams). Quantity: Ten (10)

**Game Element** – Any item a Robot interacts with to play the game. Game Elements for this year’s game include: Alliance Shipping Hub, Carousel, Team Shipping Element, and Freight.
**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 definition of *Plowing* in this section.

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

**Launching** – Propelling *Game Elements* with enough force such that they move independent of contact with the *Robot*. Movement solely due to gravity is not *Launching*.

**Loading Dock** – The unmarked *Area* outside the *Playing Field* located between the *Playing Field Boundary* and the *Alliance Station*.

**Match** – A *Match* consists of a thirty (30) second *Autonomous Period*, an eight (8) second transition and a two (2) minute *Driver-Controlled Period* for a total time of two minutes and thirty-eight seconds (2:38).

**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** – An *Autonomous Period Scoring* task where a *Robot* is *Parked In* or *Completely In* a specified *Area*.

**Navigation Image** – Three (3) unique images mounted on the *Playing Field Boundary* that a *Robot* 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. For detailed locations please see the official Field Setup Guide, as well as Appendix F for general image locations.

**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* is motionless.

**Penalty** – The consequence imposed for a rule or procedure violation that is identified by a referee. When a *Penalty* occurs, points will be deducted from the *Score* of the *Alliance* that incurred the *Penalty*. *Penalties* are defined into *Minor Penalties* and *Major Penalties*.

**Playing Field** – The *Area* that includes the 12 ft. x 8 ft. (3.66 m x 2.44 m) field and where the *Game Elements* are located, and the *Robot* plays *Matches*. There are two equivalent official versions of the *Playing Field*: red and 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.

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

**Possess / Possessing** – An object is in *Possession* 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 in *Possession* 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*.

**Robot** – Any mechanism that has been built to compete in the game challenge and complies with the *Robot* rules outlined in Section 7 of *Game Manual Part 1 – Remote Events*.

**Scoring / Score** – A *Robot* earns points by interacting with *Scoring Elements* and *Parking* in specific *Areas* of the *Playing Field*. *Scoring Elements* still in contact with a *Robot* have zero score value, unless stated otherwise in Section 4.5 or 4.6.

**Scoring** determination is done by one of three methods: “*Scored Live*”, “*Scored at End of the Period*”, and “*Scored at Rest*.” The specific method for each *Scoring* achievement will be stated in the achievement’s description in Section 4.5.

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

- **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*.

- **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 *Match Period* ends.

**Scoring Elements** – Objects that a *Robot* manipulates to earn points for their *Team*. The *Scoring Elements* for FREIGHT FRENZY are *Freight* and a *Team Shipping Element*.

**Storage Unit** – An approximate 22.75-inch by 22.75-inch (57.8 cm x 57.8 cm) *Scoring Area* where the *Robot* can place *Freight*. The *Storage Unit* is located toward the audience side of the *Playing Field*.

**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 pre-college-aged students affiliated with an entity registered with *FIRST* and for the competition.

**Team Shipping Element** – A *Team* designed and manufactured part that may be used in the *Match*. A detailed definition of *Team Shipping Element* as well as construction rules are located in section XXX of the Game Manual Part 1 – Remote Events.
Tile – An approximate 24 inch x 24 inch (610 mm x 610 mm) foam rubber mat.

Warehouse – An approximate 43.5-inch x 43.5-inch (110.5 cm x 110.5 cm) Area of the Playing Field that is bounded on two sides by white tape and two sides by the Playing Field Boundary.

Warehouse Operation - In order to remove a piece of Freight from the Warehouse, a Robot must perform the following sequence:

   a) Start Completely Out of the Warehouse, then
   b) Drive Completely In the Warehouse, then
   c) Collect one (1) piece of Freight, then
   d) Drive Completely Out of the Warehouse with the collected Freight.

Warning - Warnings apply to the entire Team. Warnings have no effect on a Teams’ Score. Individual actions of a single Team member will count as a Warning for the entire Team.

4.5 Gameplay
Prior to the start of the Match, the Drive Team performs some basic Robot setup steps that are described in section 4.5.1. Matches are made up of several periods totaling two (2) minutes and thirty (30) seconds. 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.

4.5.1 Pre-Match
1) Field Personnel set up the Playing Field as depicted in Figure 4.3-1.
   a) One (1) Pre-Load Box is placed at the Robot starting location for Pre-Loading by the Drive Team.
   b) The remaining Freight (Cargo, Light Box, Medium Box, Heavy Box) is placed in the Warehouse as described in Appendix B.
   c) The Alliance Shipping Hub is placed at its starting location.
   d) Ten (10) Ducks are placed as follows:
      i. One (1) Duck is placed on the Carousel in contact with the outer vertical surface of the Sweeper Plate. See Appendix B-4 for position and orientation.
      ii. One (1) Duck is placed on each center Barcode. See Appendix D for position and orientation.
      iii. The remaining Ducks are placed In the Loading Dock.

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. The Robot and its Pre-Load Box must be placed Completely Inside the Playing Field Boundary.

Gracious Professionalism® - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
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 Warehouse, in contact with the Carousel, or On a Barrier.

b) **Pre-Loaded Freight** – A Robot must Pre-Load exactly one (1) Pre-Load Box.

c) **Team Shipping Element** – A Drive Team intending to use their Team Shipping Element have two options:

i. The Team Shipping Element may be placed in the Loading Dock, or

ii. The Team Shipping Element may be placed on their corresponding center Barcode with the Duck moved to the Loading Dock.

d) **Op Mode** – Drive Teams use their Driver Station Android device to:

i. Select an Autonomous Op Mode. If the Team does not have an Autonomous Op mode, these steps can be skipped.

ii. The thirty-second timer must remain enabled.

iii. Press the Driver Station “Init” button.

iv. Drive Teams may not touch their Driver Stations or controllers until the Autonomous Period has ended, except to start their Autonomous program with a single touch to the Driver Station Android device screen using the built-in thirty-second timer.

3) Once the Match Manager gives the set-up complete signal:

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 Stations 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 a referee.

c) After the Robot set-up process is complete, Field Personnel will randomize the field into one of three (3) configurations as chosen by the scoring system or a dice throw as shown in Appendix D. Field Personnel will attempt to maintain the orientation of the Team Shipping Element as it was placed on the field by the Drive Team.

### 4.5.2 Autonomous Period

The Match starts with a thirty (30) second Autonomous Period where the Robot is 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 a “start” commands 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 initialized 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 4.6.2. The Drive Team is not required to start executing an Op Mode during the Autonomous Period.

During the Autonomous Period, the Drive Team may not place Ducks or the Team Shipping Element On the Carousel.

Autonomous points are Scored at Rest for the following achievements:

1) **Carousel** – Delivering the preplaced Duck from the Carousel earns ten (10) points.

2) **Navigating** –
   a) A Robot Parked In the Storage Unit earns three (3) points.
   b) A Robot Parked Completely In the Storage Unit earn six (6) points.
   c) A Robot Parked In the Warehouse earns five (5) points.
   d) A Robot Parked Completely In the Warehouse earns ten (10) points.

3) **Freight** – A Robot placing Freight earns points as follows:
   a) Each piece of Freight positioned Completely In the Storage Unit earns two (2) points.
   b) Each piece of Freight placed Completely On the Alliance Shipping Hub, regardless of Level, earns six (6) points.

4) **Autonomous Bonus** – A Robot will earn ten (10) bonus points for placing its Pre-Loaded Box on the Alliance Shipping Hub level (#1, #2, #3) that corresponds to the randomly selected Barcode location (#1, #2, #3). A Robot may earn only one (1) bonus for correctly placing its own Pre-Loaded Box.
   a) A Robot that uses the pre-placed Duck to detect the correct Level earns ten (10) points
   b) A Robot that uses the Team Shipping Element to detect the correct Level earns twenty (20) points.

**4.5.3 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.

During the Driver-Controlled Period, the Carousel may not be rotated until the End Game.

Driver-Controlled tasks are Scored at Rest:

1) **Freight** –
   a) Each piece of Freight Scored Completely In the Storage Unit earns one (1) point.
   b) Each piece of Freight Scored In the Alliance Shipping Hub earns two (2) points for being Completely On Level #1, four (4) points for being Completely On Level #2, and six (6) points being Completely On Level #3.
4.5.4 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 tasks, with the exception of Parking and the Balance position of the Shipping Hub, started prior to the start of the End Game will earn zero (0) points for those tasks.

End Game tasks are Scored at Rest.

1) **Duck and Team Shipping Element Delivery** – Each Duck or Team Shipping Element Delivered to the Playing Field Floor earns six (6) points.

2) **Shipping Hub Status** – If the Alliance Shipping Hub is Balanced, the Team receives ten (10) points.

3) **Parking** –
   a) A Robot Parked In the Warehouse earns three (3) points.
   b) A Robot Parked Completely In the Warehouse earns six (6) points.

4) **Capping** – A Team Shipping Element that is fully Supported by the center pole above Level #3 of their Alliance Shipping Hub earns fifteen (15) points. One Scored Team Shipping Elements is the maximum Capping Score achievement for a Team.

4.5.5 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 and Team Shipping Element. 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.

4.5.6 Penalties

Penalty points are subtracted 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.
4.5.7 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.

4.6 Rules of Gameplay
Gameplay is restricted by the Safety rules (<S#>), the General rules (<G#>), and the Game-Specific rules (<GS#>). Other rules to pay close attention to are the Robot rules, the inspection rules, and the tournament rules defined in the Game Manual Part 1 – Traditional Events. Violation of rules may lead to Penalties, Yellow Cards, Red Cards, a Disabled Robot, or Disqualification of the offending Team or Alliance from either a Match or the tournament. 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.

4.6.1 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 Perimeter – For safety reasons, no portion of the Robot may contact anything Outside the Playing Field Boundary. A Major Penalty will be assessed per occurrence. 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.

4.6.2 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 – A Robot 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 as much as +/-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.
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.

Playing Field Access – Drive Team members must not enter the Playing Field for any reason other than to place/retrieve their Robot. While placing the Robot, the Team may not measure, test, or adjust Game Elements unless allowed by Section 4.5.1.

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.

Pre-Match Robot Placement – At the beginning of a Match, the Robot must be set up on the Playing Field according to section 4.5.1 Pre-Match. After the Robot is set up on the Playing Field, the Drive Team must stand Inside their Alliance Station.

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.

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. 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.

Alliance Stations – During a Match, the Drivers and Coach must remain In their Station.

a) The Drive Team may be anywhere in their Alliance Station.

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

Gracious Professionalism® - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
<G17> Post-Match Removal of the Robot – 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 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. Field Personnel have the option of issuing a Major Penalty in place of the Minor Penalty if the early start results in a competitive advantage for the offending Team.

The intent of this rule is to have timely removal of the Robot from the Playing Field following a Match. The Drive Team is expected to stage their Robot for a Match, and remove them from the Playing Field afterwards, safely and swiftly. Drive Team efforts that either intentionally or unintentionally delay the start of a Match or the Playing Field reset are not allowed. Examples include, but are not limited to:

1) Failing to exit the Playing Field once instructed by Field Personnel.
2) Failing to remove Driver Stations in a timely manner.

<G19> Late Start of the Autonomous Period – A Drive Team that starts their Robot’s Autonomous Op Mode late will receive a Minor Penalty. Referees have the option of issuing a Major Penalty in place of the Minor Penalty if the late start results in a competitive advantage for the offending Alliance.

<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 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 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, the Robot, or any Game Element. The first instance of contact will result in a Warning, with any following instances resulting in a Minor Penalty. Contact that affects Scoring and/or 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, a 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 Coach operating a gamepad will result in a Warning, with any following instances resulting in a Major Penalty. During the Driver-Controlled Period, Drive Team Coaches and/or Drivers are allowed to hold the Team’s Driver Station Android device and interact with it to select an Op Mode, view information displayed on the screen, and initialize, start, stop, and reset the Robot.

<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. A Robot will receive a Minor Penalty each time gameplay is affected by the deliberately detached component or mechanism. Robot parts that are released but remain connected by a tether are considered detached for the purposes of this rule.

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

<G25> Robots Grasping Game Elements – A Robot may not grab, grasp and/or attach to any Game Element or structure other than Scoring Elements, unless specifically allowed by Game-Specific rule(s) listed in section 4.6.3. The first instance will result in a Warning with any following violations 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. Teams 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 4.6.3 that address the removal of specified Scoring Elements from the Playing Field take precedence over this general game rule.

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

4.6.3 Game-Specific Rules

<GS1> General Rule Exceptions - The following instances of gameplay are Game-specific exceptions to General Game Rules in section 4.6.2:

a) The Drive Team may interact with Scoring Elements in the Loading Dock at any time during the Match as an exception to rule <G22>.

b) As a part of pre-Match Robot placement or post-Match Robot retrieval, the Drive Team may also place or retrieve their Team Shipping Element as an exception to rule <G12>.

<GS3> Alliance Shipping Hub Constraints - the following are constraints placed on the Robot with respect to the Alliance Shipping Hub:

a) A Robot may not intentionally relocate the Alliance Shipping Hub. Inadvertent and Inconsequential contact is allowed but intentional movement that affects gameplay is assessed a Major Penalty.

b) The Shipping Hub Balance shall be determined only by the weight and position of the Shipping Hub, the Scored Freight, and the Scored Team Shipping Element.
   i. A Robot contacting the Alliance Shipping Hub at the End of the Match will result in that Shipping Hub being considered Unbalanced.

<GS5> Freight Constraints -

a) Freight removed from the Warehouse must follow defined Warehouse Operations. Pre-Loaded Freight is considered to be already removed from the Warehouse.

b) A Robot must be Completely Outside of the Warehouse to Score Freight.

Each violation of this rule will result in a Minor Penalty.

<GS6> Launching Scoring Elements - Scoring Elements may not be Launched. Ducks or Team Shipping Elements falling from the Carousels are exempt from this rule (depending on the circumstances, rule <GS9>b may still apply). Each violation of this rule results in a Minor Penalty.

<GS7> Carousel Constraints – A Robot may not:

a) Intentionally place items On the Carousel. Each violation of this rule results in a Minor Penalty.

b) Contact the top or bottom surfaces of the Carousel Platform. A Robot may only contact the Carousel Rim. An immediate Minor Penalty for each violation and an additional Minor Penalty for every 5 seconds of contact will be assessed.

c) Contact a Scoring Element On the Carousel. A Minor Penalty is assessed for each violation.

The intent of this rule is that the Robot may only interact with the Carousel at the Rim, incidental contact with the top or bottom of the Carousel will not be penalized.
Control/Possession Limits of Scoring Elements – A Robot may Control or Possess a maximum of one (1) Freight and one (1) Team Shipping Element at a time.

a) Plowing through any quantity of Scoring Elements is allowed but Herding or directing Scoring Elements above the allowed limit to gain a strategic advantage (for example., Scoring, accessibility) is not allowed. The Penalty for Controlling or Possessing more than the allowed quantity 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.

b) A Major Penalty will be assessed for each Scoring Element that is Scored while a Robot Controls or Possesses more than the allowed quantity.

c) Freight already Scored in a Robot’s Alliance Scoring Area does not count towards the Control/Possession limit.

d) During the Autonomous Period, Robot contact with their Team’s Duck or Team Shipping Element that starts the Match on their Barcode and remains in contact with the Playing Field Floor is considered Plowing and is allowed.

Delivery Constraints - The following are constraints placed on the Robots with respect to Delivery:

a) Delivered Ducks and the Team Shipping Element must contact the floor before a Robot may Control them. Each violation of this rule results in a Minor Penalty. Inadvertent and Inconsequential contact with the Robot will not be penalized.

b) Once the Match begins, Ducks and Team Shipping Elements may only be introduced onto the Playing Field via Delivery. Each violation of this rule results in a Major Penalty.

c) The Drive Teams may not place or interact with Ducks or the Team Shipping Element On the Carousel during the Autonomous Period. Each violation of this rule results in a Major Penalty.

d) Ducks or Team Shipping Elements may only be Delivered onto the Playing Field Floor during the Autonomous and End Game Periods of a Match. Each violation of this rule results in a Minor Penalty and zero (0) Delivery Score value.

e) Only one (1) Duck or Team Shipping Element is allowed On the Carousel at a time. Each violation of this rule receives a Major Penalty.

f) Ducks or Team Shipping Elements on the Carousel must be in contact with the Sweeper Plate before a Robot can rotate the Carousel. Each violation of this rule results in a Major Penalty.

g) Once the Carousel begins to move; the Drive Team can no longer touch a placed Duck or Team Shipping Element unless it falls off on its own outside of the Field. Each violation of this rule results in a Major Penalty. Ducks that fall outside the Field will be placed back in the Loading Dock by the Drive Team or Field Personnel depending on where it falls.

h) The Drive Team may not interact with the Carousel (for example, touching, placing a Duck or Team Shipping Element) when the Carousel is in motion. Each violation earns a Major Penalty.

i) Once a Duck or Team Shipping Element is Delivered, it is not eligible to be Delivered again.

Teams Touching Robots or Driver Stations after Barcode Randomization – Teams are 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, and the Robot is not eligible to earn the Autonomous Bonus in the Autonomous Period.

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

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

<table>
<thead>
<tr>
<th>Scoring Achievement</th>
<th>Autonomous Points</th>
<th>Driver-Controlled Points</th>
<th>End Game Points</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carousel: Delivering a Duck</td>
<td>10</td>
<td></td>
<td></td>
<td>4.5.2.1</td>
</tr>
<tr>
<td>Parking: Robot In Storage Unit</td>
<td>3</td>
<td></td>
<td></td>
<td>4.5.2.2a</td>
</tr>
<tr>
<td>Parking: Robots Completely In Storage Unit</td>
<td>6</td>
<td></td>
<td></td>
<td>4.5.2.2b</td>
</tr>
<tr>
<td>Parking: Robot In Warehouse</td>
<td>5</td>
<td></td>
<td></td>
<td>4.5.2.2c</td>
</tr>
<tr>
<td>Parking: Robot Completely In Warehouse</td>
<td>10</td>
<td></td>
<td></td>
<td>4.5.2.2d</td>
</tr>
<tr>
<td>Freight Completely In Self Storage Unit</td>
<td>2</td>
<td></td>
<td></td>
<td>4.5.2.3a</td>
</tr>
<tr>
<td>Freight Completely On Shipping Hub</td>
<td>6</td>
<td></td>
<td></td>
<td>4.5.2.3b</td>
</tr>
<tr>
<td>Auto Bonus: Pre-Load Freight Completely On randomized Level using Duck</td>
<td>10</td>
<td></td>
<td></td>
<td>4.5.2.4</td>
</tr>
<tr>
<td>Auto Bonus: Pre-Load Freight Completely On randomized Level using Team Shipping Element</td>
<td>20</td>
<td></td>
<td></td>
<td>4.5.2.5</td>
</tr>
<tr>
<td>Freight Completely In Storage Unit</td>
<td></td>
<td>1</td>
<td></td>
<td>4.5.3.1a</td>
</tr>
<tr>
<td>Freight On Alliance Shipping Hub – Level 1</td>
<td></td>
<td>2</td>
<td></td>
<td>4.5.3.1b</td>
</tr>
<tr>
<td>Freight On Alliance Shipping Hub – Level 2</td>
<td></td>
<td>4</td>
<td></td>
<td>4.5.3.1b</td>
</tr>
<tr>
<td>Freight On Alliance Shipping Hub – Level 3</td>
<td></td>
<td>6</td>
<td></td>
<td>4.5.3.1b</td>
</tr>
<tr>
<td>Duck or Team Shipping Element Delivered</td>
<td></td>
<td></td>
<td>6</td>
<td>4.5.4.1</td>
</tr>
<tr>
<td>Alliance Shipping Hub: Balanced</td>
<td></td>
<td></td>
<td>10</td>
<td>4.5.4.2a</td>
</tr>
<tr>
<td>Parking In Warehouse</td>
<td></td>
<td></td>
<td>3</td>
<td>4.5.4.3a</td>
</tr>
<tr>
<td>Parking Completely In Warehouse</td>
<td></td>
<td></td>
<td>6</td>
<td>4.5.4.3b</td>
</tr>
<tr>
<td>Capping: each Team Shipping Element</td>
<td></td>
<td></td>
<td>15</td>
<td>4.5.4.4</td>
</tr>
</tbody>
</table>
### 4.8 Rule Summary

The following table shows the possible rule violations and their consequences. The table is a quack reference guide and not a substitute for a thorough understanding of the complete rule descriptions in section 4.6.

<table>
<thead>
<tr>
<th>Rule #</th>
<th>Rule</th>
<th>Consequence</th>
<th>Warning Disable</th>
<th>Minor Penalty</th>
<th>Major Penalty</th>
<th>Card Issued</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety Rules</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;S1&gt;</td>
<td>Unsafe Robot or Damage to the Playing Field Boundary. Disable if unsafe operation is likely to persist. Optional Yellow Card. Significant damage and/or delays may escalate to Red Card.</td>
<td></td>
<td></td>
<td>D*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;S2&gt;</td>
<td>Contact Outside the Playing Field Boundary. Major Penalty</td>
<td></td>
<td></td>
<td>D*</td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;S3&gt;</td>
<td>Drive Team missing safety gear. Warning, Match cannot be played until issue is resolved</td>
<td></td>
<td></td>
<td>W</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>General Rules – Further definitions, no Penalties earned</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G1&gt;</td>
<td>Autonomous to Driver-Controlled Period transition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G2&gt;</td>
<td>Certifying the Score at End of the Match</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G4&gt;</td>
<td>Scoring Elements Controlled or Possessed are part of the Robot for Robot location</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G5&gt;</td>
<td>Scoring Elements Controlled or Possessed are part of the Robot for Robot location Points are not earned for any Scoring Elements in a Scoring Area in contact with Robots of the corresponding Alliance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G6&gt;</td>
<td>Scoring Elements in two or more Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G7&gt;</td>
<td>Disabled Robot eligibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G8&gt;</td>
<td>Playing Field Tolerances</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G9&gt;</td>
<td>Match Replay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G10&gt;</td>
<td>Inadvertent and Inconsequential</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Gracious Professionalism®**: “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
<table>
<thead>
<tr>
<th>Rule #</th>
<th>Rule</th>
<th>Consequence</th>
<th>Warning Disable</th>
<th>Minor Penalty</th>
<th>Major Penalty</th>
<th>Card Issued</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;G12&gt;</td>
<td>Measure, test, or adjust Game Elements. Playing Field inspection to determine Score</td>
<td>Minor Penalty for pre-Match or post-Match violations. Major Penalty if delay start of Match.</td>
<td>1x</td>
<td>1x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G14&gt;</td>
<td>Robot starting volume.</td>
<td>Match cannot start until in compliance with starting volume.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G15&gt;</td>
<td>Robot setup alignment devices/Match Delay.</td>
<td>Minor Penalty for each offense.</td>
<td>1x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G16&gt;b</td>
<td>Drive Team member(s) leaving the Alliance Station.</td>
<td>Warning for the first instance with any following instances resulting in a Minor Penalty.</td>
<td>W</td>
<td>1x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G17&gt;</td>
<td>Delay caused by the removal of Robots from the Playing Field and Game Elements from Robots.</td>
<td>A Minor Penalty will be assessed.</td>
<td>1x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**General Rules – Gameplay Penalties**

<table>
<thead>
<tr>
<th>Rule #</th>
<th>Rule</th>
<th>Consequence</th>
<th>Warning Disable</th>
<th>Minor Penalty</th>
<th>Major Penalty</th>
<th>Card Issued</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;G18&gt;</td>
<td>Starting Gameplay Early.</td>
<td>Minor Penalty with the option of a Major Penalty if the early start results in a competitive advantage for the Team</td>
<td>1x</td>
<td>1x*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G19&gt;</td>
<td>Late Start of the Autonomous Period.</td>
<td>Minor Penalty with the option of a Major Penalty if the late start results in a competitive advantage for the Team.</td>
<td>1x</td>
<td>1x*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G20&gt;</td>
<td>Robot is not Parked at the end of period.</td>
<td>Minor Penalty and the actions of the Robot that occur after the end of gameplay do not count towards the Team’s Score. Major Penalty if the late stop results in a competitive advantage for the Team.</td>
<td>1x</td>
<td>1x*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rule #</td>
<td>Rule</td>
<td>Consequence</td>
<td>Warning Disable</td>
<td>Minor Penalty</td>
<td>Major Penalty</td>
<td>Card Issued</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------</td>
<td>----------------</td>
<td>----------------</td>
<td>--------------</td>
</tr>
<tr>
<td>&lt;G21&gt;</td>
<td>Robot control during Autonomous Period / Early stopping of the Autonomous code.</td>
<td>Major Penalty. Achievements earned during that time result in zero Score.</td>
<td></td>
<td></td>
<td></td>
<td>1x</td>
</tr>
<tr>
<td>&lt;G22&gt;</td>
<td>Drive Team contact with the Playing Field, Game Element, or Robot.</td>
<td>Warning for the first instance with any following instances resulting in a Minor Penalty. Optional Major Penalty if contact affects Scoring and/or gameplay.</td>
<td>W 1x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G23&gt;</td>
<td>Drive Team Coach Driver Station control.</td>
<td>Warning for the first instance with any following instances resulting in a Major Penalty.</td>
<td>W 1x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G24&gt;</td>
<td>Robots deliberately detaching parts.</td>
<td>Minor Penalty per occurrence.</td>
<td></td>
<td></td>
<td></td>
<td>1x</td>
</tr>
<tr>
<td>&lt;G25&gt;</td>
<td>Robots illegally grasping Game Elements.</td>
<td>Warning for the first instance with any following instances resulting in a Major Penalty.</td>
<td>W 1x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;G26&gt;</td>
<td>Destruction, damage, tipping, etc.</td>
<td>Deliberate or chronic violations of this rule will receive a Major Penalty.</td>
<td></td>
<td></td>
<td></td>
<td>1x</td>
</tr>
<tr>
<td>&lt;G27&gt;</td>
<td>Deliberately removing Game Elements from the Playing Field.</td>
<td>Minor Penalty per Game Element deliberately removed from the Playing Field.</td>
<td></td>
<td></td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>&lt;G29&gt;</td>
<td>Illegal Use of Game Elements to ease or amplify Scoring.</td>
<td>Major Penalty will be assessed with any following instances resulting in a Yellow Card.</td>
<td></td>
<td></td>
<td>1x</td>
<td>YC</td>
</tr>
</tbody>
</table>

**Game-Specific Rules – Gameplay Penalties**

| <GS3>a | Relocate Alliance Shipping Hub | Major Penalty for each offense | 1x |  |
| <GS5>  | Violating Warehouse Operations | Minor Penalty for each offense | 1x |  |
| <GS6>  | Launching Scoring Elements     | Minor Penalty for each offense | 1x |  |
| <GS7>a | Robots placing items on Carousel | Minor Penalty for each offense | 1x |  |
| <GS7>b | Robot contact on top or bottom of Carousel | Immediate Minor Penalty for each violation plus additional Minor Penalty every 5 seconds | 1x+ |  |

**Gracious Professionalism®** - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
<table>
<thead>
<tr>
<th>Rule #</th>
<th>Rule</th>
<th>Consequence</th>
<th>Warning Disable</th>
<th>Minor Penalty</th>
<th>Major Penalty</th>
<th>Card Issued</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;GS7&gt;c</td>
<td>Contact with Scoring Element while on Carousel.</td>
<td>Minor Penalty for each offense</td>
<td></td>
<td>1x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;GS8&gt;a</td>
<td>Herding Scoring Elements</td>
<td>Immediate Minor Penalty for each offense plus additional Minor Penalty every 5 seconds</td>
<td></td>
<td></td>
<td>1x+</td>
<td></td>
</tr>
<tr>
<td>&lt;GS8&gt;b</td>
<td>Scoring while in Possession of excess quantity.</td>
<td>Major Penalty for each offense. May escalate to Yellow Cards</td>
<td></td>
<td></td>
<td>1x</td>
<td>YC</td>
</tr>
<tr>
<td>&lt;GS9&gt;a</td>
<td>Duck/Team Shipping Element must touch floor before a Robot can Control it.</td>
<td>Minor Penalty for each offense</td>
<td></td>
<td>1x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;GS9&gt;b</td>
<td>Delivery only by Carousel</td>
<td>Major Penalty for each offense</td>
<td></td>
<td>1x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;GS9&gt;c</td>
<td>Placing Ducks/Team Shipping Element on Carousel during Autonomous</td>
<td>Major Penalty for each offense</td>
<td></td>
<td>1x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;GS9&gt;d</td>
<td>Delivery only during Autonomous or End Game</td>
<td>Major Penalty for each offense</td>
<td></td>
<td>1x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;GS9&gt;e</td>
<td>Only one Duck / Team Shipping Element at a time.</td>
<td>Major Penalty for each offense</td>
<td></td>
<td>1x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;GS9&gt;f</td>
<td>Duck not loaded correctly</td>
<td>Major Penalty for each offense</td>
<td></td>
<td>1x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;GS9&gt;g</td>
<td>Drive Team touching the Duck while Carousel in motion</td>
<td>Major Penalty for each offense</td>
<td></td>
<td>1x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;GS9&gt;h</td>
<td>Drive Team touching Carousel when in motion</td>
<td>Major Penalty for each offense</td>
<td></td>
<td>1x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table Key**

- **W:** Warning | 1x: Penalty at single cost
- **D:** Robot Disabled | 1x+: Penalty at single cost every 5 seconds
- **DQ:** Disqualification | 2x: Penalty at double cost

* Indicates optional
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**


**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!

Gracious Professionalism® - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
Appendix B – Playing Field Details

Note: Freight that is placed into the Warehouse during Pre-Match Setup will be placed Completely In the corner Tile.

B-1 Warehouse

B-2 Storage Unit
B-3 Barcode Locations

B-4 Barrier
B-5 Carousel

15-inch dia.

13.25 inches from the top of tile to the top of Carousel

B-6 Carousel
B-7 Alliance Shipping Hub

B-8 Alliance Shipping Hub

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

Cargo
2.75” Diameter

Duck

2.125”

C-1 Freight

Pre-Load Box

Light Box

Medium Box

Heavy Box
Appendix D – Randomization

**Scoring Level 1**

- Dice Roll: \[ \begin{array}{c} \bullet \\ or \\ \bullet \bullet \bullet \end{array} \]

**Scoring Level 2**

- Dice Roll: \[ \begin{array}{c} \bullet \bullet \\ or \\ \bullet \bullet \bullet \bullet \end{array} \]

**Scoring Level 3**

- Dice Roll: \[ \begin{array}{c} \bullet \bullet \bullet \\ or \\ 8 \end{array} \]

**D-1 - Randomization**

Orientation of the *Duck* during field setup is as shown.
Appendix E – Scoring Examples

E-1 Team Shipping Element Scoring

**Balanced**
The rim of the Hub is not in contact with the floor

**Balanced**
Robot in contact with opposing Alliance’s Hub

E-2 Balanced
Gracious Professionalism® - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
Appendix F – Navigation Images

Field built with blue 
Alliance components

Field built with red 
Alliance components

Image 1
Blue Alliance Wall

Image 4
Red Alliance Wall

Image 2
Audience Wall
Blue Side

Image 3
Audience Wall
Red Side

Image 1 - The center of the image is on the Playing Field Wall closest to the blue Alliance Station and is aligned to the center of the fourth Tile in from the Playing Field Wall closest to the audience.

Image 2 - 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 3 - 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 4 - The center of the image is on the Playing Field Wall closest to the red Alliance Station and is aligned to the center of the fourth Tile in from the Playing Field Wall closest to the audience.

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.