



Training and
Support

2018-2019 *FIRST*[®] Tech Challenge Game Manual Part 1

ROVER RUCKUS



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Thank you for taking the time to volunteer for a *FIRST®* Tech Challenge event. *FIRST®* and *FIRST®* Tech Challenge rely heavily on volunteers to ensure events run smoothly and are a fun experience for teams and their families, which could not happen without people like you. With over 5,500 teams competing yearly, your dedication and commitment are essential to the success of each event and the *FIRST* Tech Challenge program. Thank you for your time and effort in supporting the mission of *FIRST*!

Revision History		
Revision	Date	Description
1	7/11/2018	Initial Release
1.1	9/8/2018	<ul style="list-style-type: none"> Updated table of contents Section 4.3, Rule <T5> - Changed the wording “Wi-Fi Direct” to “Wi-Fi”. Section 8.2.1 – Removed reference to Core Legacy Module in the definition of the Core Power Distribution Module and the USB Mini Type B Cable. Section 8.3.1. Rule <RG04> - Added kilogram equivalent to maximum robot weight. Section 8.3.3. Rule <RE14>I – Electrically grounding the Robot electronics to the frame of the Robot is allowed with REV resistor cable. Section 9.4, Rule <I1> - Changed “required” to “highly recommended” for Team self-inspections. Section 10 – Added Judging and Award Criteria Section. Appendix B – Robot Inspection Checklist, updated rule <RE14>I. Appendix E – Added Control Award Submission Form.
1.2	9/13/2018	<ul style="list-style-type: none"> Section 10.4.8 – Updated Promote Award PSA for the 2018-2019 season.

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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.

1.2 FIRST Core Values

We express the FIRST® philosophies of *Gracious Professionalism*® and *Coopertition*® through our Core Values:

- **Discovery:** *We explore new skills and ideas.*
- **Innovation:** *We use creativity and persistence to solve problems.*
- **Impact:** *We apply what we learn to improve our world.*
- **Inclusion:** *We respect each other and embrace our differences.*
- **Teamwork:** *We are stronger when we work together.*
- **Fun:** *We enjoy and celebrate what we do!*

2.0 Gracious Professionalism®

FIRST® uses this term to describe our programs' intent and *Gracious Professionalism*® is not clearly defined for a reason. It has different meanings to everyone. Some possible meanings of *Gracious Professionalism* include:

- Gracious attitudes and behaviors are win-win.
- Gracious folks respect others and let that respect show in their actions.
- Gracious Professionals make valued contributions in a way that is pleasing to others and to themselves.

In the end, *Gracious Professionalism*® is part of everyday life. When professionals use their knowledge graciously and individuals act with integrity and sensitivity, everyone wins, and society benefits.

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

2.1 Gracious Professionalism for Volunteers

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

3.0 Youth Protection Program

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

3.1 Youth Protection Expectations and Guidelines

Coaches and mentors should read and follow the [FIRST Youth Protection Program guide](#). Anything labeled as required is mandatory in the United States and Canada, and cannot be waived without approval from the FIRST Youth Protection Department. FIRST recommends that the standards set forth in the FIRST Youth

Protection Program guide be applied outside of the United States and Canada to the extent possible. At a minimum, local regulations regarding youth protection must be complied with.

Most up to date forms are available here: <http://firstinspires.org/resource-library/youth-protection-policy>

The US Screening process, the Canadian Screen process, Frequently Asked Questions (FAQ), and additional information are on the FIRST Youth Protection Program Website: <http://firstinspires.org/resource-library/youth-protection-policy>

3.2 NOTICE OF NON-DISCRIMINATION

For Inspiration and Recognition of Science and Technology (FIRST®) does not discriminate based on race, color, national origin, sex, disability, age, status as a veteran who served in the military, religion, gender, gender identity, or gender expression in its programs and activities.

Keep updated at: <http://www.firstinspires.org/about/legal-notice>

4.0 The Tournament – Definitions and Rules

4.1 Overview

Students that engage in the FIRST Tech Challenge program develop STEM skills and practice engineering principles (like keeping an engineering notebook), while realizing the value of hard work, innovation, and sharing ideas. Tournaments are exciting sporting events with head-to-head competition, judging interviews, and *Teams* and *Robot* performance awards. This section provides critical information that will help *Teams* have a fun and successful tournament day.

4.2 Tournament Definitions

Alliance – Each FIRST Tech Challenge match consists of two, two-*Team Alliances*. These two *Teams* compete against an opposing *Alliance* (also made up of two *Teams*) to complete the game challenge and to earn the highest score. At tournaments with more than 20 *Teams*, the semi-final and final round *Alliances* consists of three *Teams* each. However, only two of those *Teams* compete during any one match.

Alliance Captain – The student representative from an *Alliance*'s highest ranked *Team* chosen to represent an *Alliance* during *Alliance Selection* and for the final *Elimination Matches*. The entire *Team* is called the *Alliance Captain*.

Alliance Selection – The process by which top-ranked *Teams* choose *Alliance Partners* for the *Elimination Matches*.

Alliance Station – The designated “Red” or “Blue” *Alliance* area next to the *Playing Field* where the *Drivers* and *Coach* stand or move within during a match. *Station One* is the *Alliance Station* closest to the audience.

Competition Area – The *Area* where all the *Playing Fields*, *Alliance Stations*, scoring tables, and other tournament officials and tables are located.

Drive Team - Up to three representatives (two *Drivers* and one *Coach*) from the same *Team*. The *Drivers* are two student *Team* members. The *Coach* of the *Drive Team* can be a student *Team* member, or the adult coach of the *Team*.

Elimination Matches – A match used to decide the Winning *Alliance*. *Alliances* of two or three *Teams* face off in a series of matches, with two *Teams* per *Alliance* playing in each match. The first *Alliance* to win two matches continues to the next round.

Playing Field – The part of the *Competition Area* that includes the 12 ft. x 12 ft. (3.66 m. x. 3.66 m) field and all the elements described in the official field drawings.

Pit Area – The *Pit Area* is a separate space from the *Competition Area* where *Teams* can work on their *Robot* between matches. The *Team* is provided a pit space which includes a table, a power source, and is 10 ft. (3.05 m) x. 10 ft. (3.05 m). Some pit spaces may vary based on tournament venue size limits. Check with your Tournament Director for official pit space sizes.

Practice Match – A match used to provide time for *Teams* to get familiar with the official *Playing Field*.

Qualification Match – A match used to decide the *Teams* that qualify for the *Alliance Selection* and move on to the *Elimination Matches*. *Alliances* compete to earn *Ranking Points* and *TieBreaker Points*.

Ranking Points – The first basis for ranking *Teams*. *Teams* earn *Ranking Points* for winning (two points), tying (one point), and losing (zero points) in a *Qualification Match*.

Robot - Any mechanism that has passed inspection and a *Team* places on the *Playing Field* before the start of a *Match*. To be legal, *Robots* must comply with the *Robot Build* rules in Section 8 of this manual.

Sports Start – A model of competition where *Teams* start and stop their *Robot* after the 3-2-1 countdown.

Surrogate Match – *Surrogate Matches* are scheduled into the Qualification rounds of a tournament if the number of *Teams* at the tournament is not evenly divisible by four. The *Surrogate Match* is a way to ensure all *Teams* compete in a minimum of five matches. This is an extra *Qualification Match* for those *Teams* scheduled in a *Surrogate Match* and does not count in the standings for *Ranking Points* or *TieBreaker Points*. These matches are important in the entire standings of the tournament. These matches should be played as if they were regular *Qualification Matches*. *Surrogate Matches* will be marked on the official *Qualification Match* schedule.

Team – An official *FIRST* Tech Challenge *Team* consists of no more than 15 student *Team* members. All *Teams* in North America are required to register through the [Team Registration System](#). *Teams* must have a minimum of TWO Lead Coaches or Mentors that have registered through the *Team* Registration System and have passed the [Youth Protection Program](#) screening. The *Team* must be in good standing through the registration system to compete in *FIRST* Tech Challenge official tournaments.

TieBreaker Points – The second basis of ranking *Teams*. *TieBreaker Points* are used as the tiebreakers when *Teams* have equal *Ranking Points*. *TieBreaker Points* are awarded in the amount of the final score of the losing *Alliance* in a *Qualification Match*. Both *Alliances* receive the pre-penalized score of the losing *Alliance* as their *TieBreaker Points*.

4.3 Tournament Rules

<T1> Egregious behavior by any *Team*, *Team* member, or other representative of the *Team* is not tolerated at a *FIRST* Tech Challenge tournament. Violations of this rule result in penalties to the *Team*, and/or the issuance of a Yellow or Red Card. Egregious behavior includes, but is not limited to, repeated and/or flagrant violation of game rules, unsafe behavior or actions, uncivil behavior towards volunteers, competition personnel, or tournament attendees.

<T2> Yellow cards and red cards are used in the *FIRST* Tech Challenge to manage *Team* and *Robot* behavior that does not align with the [mission of FIRST](#). Yellow and red cards are not limited to just the

Competition Area. Teams that display egregious behavior in the *Pit Area*, judging rooms, stands, or any other location of the tournament can be issued a yellow or red card for egregious behavior.

Egregious or repeated (3 or more) *Robot* or *Team* member behavior at the tournament can result in a yellow and/or Red card. Yellow cards are additive, meaning that a second yellow card is automatically converted to a red card. A *Team* is issued a red card for any subsequent incident in which they receive an additional yellow card, for example, earning a second yellow card during a single match.

Yellow and Red Cards at the Competition Field

The Head Referee may assign a yellow card as a warning, or a red card for *Disqualification* in a match. A yellow card or red card is signaled by the Head Referee standing in front of the *Team's Alliance Station* and holding a yellow card and/or red card in the air.

To issue the second yellow card, the Head Referee will stand in front of the *Team's Alliance Station* and hold a yellow card and red card. The Head Referee will signal the second yellow card after the match has ended.

A *Team* that has received either a yellow card or a red card carries a yellow card into following matches, except as noted below. A red card results in match Disqualification. Multiple red cards may lead to tournament disqualification. Once a *Team* receives a yellow card or red card, the *Team* number is presented with a yellow background on the audience screen at the beginning of all following matches. This is a reminder to the *Team*, referees, and audience the *Team* carries a yellow card.

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

Yellow and Red Cards off the Competition Field

Teams can incur yellow and red cards for their actions off the competition field. Egregious behavior off the competition field should be reported to the Tournament Director. The Tournament Director will first consult with the coach of the *Team* about the behavior of the team or its members, explain the ways in which the behavior is considered egregious, and give a warning to discontinue this behavior. If the behavior persists, the Tournament Director will work with *FIRST* Headquarters to assess whether or not the behavior exhibited by the team is considered egregious and if a yellow and/or red card should be issued. If it is determined that the *Team* should receive a yellow and/or red card, the Tournament Director will report to the Head Referee. The yellow and/or red card will be recorded into the scoring software based on the next match played by the team during *Qualification Matches*. If a *Team* is competing in *Elimination Matches* receives a yellow or red card between the *Qualification Matches* and *Elimination Matches*, the card will be applied to the first *Elimination Match*. If a *Team* receives a yellow or red card during the *Elimination Matches* for off field behavior, the yellow or red card applies to the current or just completed *Elimination Match*.

<T3> Referees have final game play and scoring authority during the competition. Their rulings are final.

- a. The referees will not review any recorded match replays or photographs.
- b. All questions about a match or scores must be brought forward to the Referees by using the Referee

question box located in the *Competition Area*. Only one **student** from an *Alliance* can enter the question box. All questions must be brought forward within the outlined time:

- i. *Qualification Matches*: A *Team* must enter the question box to dispute a Match within a period of three (3) matches following the disputed Match. Teams participating in the final two *Qualification Matches* must report to the question box within 5 minutes after scores after the announcement of the match score.
- ii. *Elimination Matches* and *Final Matches*: A *Team* must enter the Referee Question Box to dispute a match before the start of the next match played by the *Alliance*, regardless if the *Team* is playing in the next match. The next match played could involve different *Alliances*. Questions about the last match of the Finals must be brought to the question box no later than 5 minutes after the announcement of the match score.

Students must support their questions by referencing specific rules or posts to the Q&A section of the official [FIRST Tech Challenge Forum](#). *Team* members must ask their questions in a gracious and respectful manner.

- c. *Team* members cannot enter the *Playing Field* for any reason other than to place or retrieve their *Robots*. Inspection of the *Playing Field* elements by *Team* members to determine scoring is not allowed. Individuals and *Teams* that violate this rule will be subject to possible *Team* penalties that could include match disqualifications or even removal from the tournament.

<T4> No *Team*, *Team* Member, or tournament attendee is allowed to set up their own Wi-Fi 802.11 (2.4GHz or 5GHz) wireless communication in the venue. Non-allowed wireless communications include, but are not limited to:

- a. Cellular hot spots (for example, cell phones, tablets, MiFi).
- b. Ad-hoc networks.
- c. Nintendo DS peer-to-peer.
- d. Bluetooth communication with *Robots* in the *Competition Area*.

No *Team*, *Team* Member, or tournament attendee shall interfere with a *Team*'s Wi-Fi Direct® communication with their own *Robot*.

The Penalty for violating rule **<T4>** is disqualification of the entire *Team* from the tournament and their removal from the venue property. *Teams* may not appeal the penalty and no refunds will be given for registration fees, prepaid meals, etc. *FIRST* may conduct a post-tournament review and decide if any added penalties will be imposed on the offending *Team*.

Teams are encouraged to report wireless security vulnerabilities to the Field Technical Advisor (FTA) at a tournament. *Teams* should always keep in mind *Gracious Professionalism*®, and therefore only report valid and verifiable violations of this rule. After the Field Technical Advisor is alerted of a potential rule violation, he or she will confer with the Head Referee. The Field Technical Advisor and Head Referee will further explore the potential violation of this rule. The Head Referee will work with *FIRST* Headquarters staff to determine if rule **<T4>** has been violated, and to disqualify the offending *Team*.

<T5> Wi-Fi connectivity between the Android devices used as the *Robot* Controller and the Drivers Station is allowed. Additionally, in the Pits only, Wi-Fi connectivity between the same Android devices and a computing device (phone, tablet or computer) is allowed for *Robot* programming purposes only. No other wireless communication is allowed.

The penalty for violating rule **<T5>** is disqualification of the entire *Team* from the tournament and their removal from the venue property. The Head Referee will work with *FIRST* Headquarters staff to determine if rule **<T5>** has been violated, and to disqualify the offending *Team*. *Teams* may not appeal the penalty and no refunds will be given for registration fees, prepaid meals, etc. *FIRST* may conduct a post- tournament review and determine if any additional penalties are to be imposed on the offending *Team*.

<T6> *Team* members may be asked by the Tournament Director to use a specific Wi-Fi channel on the tournament day. *Teams* must comply with the request of the Tournament Director if asked to use a specific Wi-Fi Channel when supported by an approved Android Device. *Teams* that have Android Devices that support channel changing must comply with the request of the Tournament Director to switch their channel before playing in the next match.

<T7> Each registered *Team* may enter only one *Robot* (a *Robot* built to play the current season's game challenge) into the *FIRST* Tech Challenge competition. It is expected that *Teams* will make changes to their *Robot* throughout the season and at competitions.

- a. It is against this rule to compete with one *Robot* while a second is being adjusted or assembled at a tournament.
- b. It is against this rule to switch back and forth between multiple *Robots* at a tournament.
- c. It is against this rule to register and attend concurrent tournaments with a second *Robot*.
- d. It is against this rule to use a *Robot* built by another *Team* at a tournament.

Violations of this rule will immediately be considered egregious and a deliberate violation of the rule.

<T8> Only three *Team* representatives are allowed in the *Competition Area*; two (2) student drivers, and one (1) coach who are identified by badges labeled 'driver' or 'coach.' These badges are interchangeable within a *Team* between matches. Only student *Team* members wearing a badge labeled as 'driver' may drive the *Robot* during the match. *Team* representatives beyond the two student drivers and one coach will be asked to leave the *Competition Area* immediately.

<T9> Pre-Match Robot Setup - *Team* members cannot enter the *Playing Field* for any reason other than to place/retrieve their *Robots*. *Teams* may not measure, test, or adjust field or game elements prior to the start of a match. Inspection of the *Playing Field* elements by *Team* members to determine scoring is not allowed. Individuals and *Teams* that violate this rule will be subject to possible penalties that could include match disqualifications or even removal from the tournament.

<T10> Pre-Match Robot Placement – At the beginning of a match, each *Alliance Robot* must be set up on the *Playing Field* according to Section 1.5.1 Pre-Match in the Game Manual Part 2. After *Robots* are set up on the *Playing Field*, *Drive Teams* must stand completely inside the *Alliance Station* at the location (Station one or Station two) specified by the *Qualification Match* schedule.

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

- c. During *Elimination Matches*, 3 *Team Alliances* may only place *Robots* that are intended to compete in that match. Once two *Robots* are placed for the two teams competing in a match, the *Alliance* cannot swap in the 3rd *Alliance's* *Robot* for a *Robot* already placed.
- d. *Teams* may implicitly waive their right to place their *Robots* on the *Playing Field* last by placing their *Robots* on the *Playing Field* before or with the opposing *Alliance*. There is no need to tell the referees; *Teams* waive their right by the act of placing their *Robots* on the *Playing Field*.
- e. *Teams* that unnecessarily delay the beginning of a match and/or field reset will incur a Minor Penalty for each offense.

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

- Late arrival to the *Playing Field*.
- *Robot* maintenance once on the *Playing Field*.

<T11> The state of the field (game and scoring elements) is recorded as the match is played by the Score Tracker. *Scores* may not be announced to *Teams* until some time after the match is complete. At some tournaments, live scoring software may be used to show the status of the match as it is played, with the final, official score displayed at the end of the match.

<T12> There are no time-outs during the *Qualification Matches*.

<T13> If no member of the *Drive Team* is present in the *Driver Station* at the start of a match, that *Team* is declared a “no show”. If a *Robot* cannot report for a match, at least one member of the *Drive Team* should report to the *Playing Field* for the match.

<T14> *Teams* will receive a minimum of five minutes (5:00) between consecutive matches.

<T15> During the elimination rounds, each *Alliance* will be allotted ONE time-out of no more than three minutes (3:00). Time-outs must be called at least two minutes (2:00) before their next match's starting time. The time-out begins at the time their match was going to start.

<T16> All *Team* members, coaches, and their guests must wear ANSI Z87.1 certified safety glasses while in the *Pit* or *Competition Area*. Prescription glasses with ANSI Z87.1 approved commercial off the shelf side shields are also allowed.

NOTE: *FIRST* requires all *Teams* to bring and supply ANSI-approved safety glasses for its *Team* members, mentors, and guests for each competition. Tinted lenses are allowed if tournament personnel can see the volunteer's, spectator's, or *Team* member's eyes through the safety glasses. Sunglasses or deeply shaded safety glasses used in our indoor tournament environment are not acceptable.

<T17> Skateboards, roller skates, ‘hover boards’, and drones are not allowed at any tournament. These items can create safety hazards to the *Teams*, spectators, or volunteers attending the tournament.

<T18> No live bands are allowed in the audience or *Pit*. No loud music, audio systems, whistles, banging sticks, blow horns, etc. are allowed. They prevent *Teams* from hearing important announcements. Power may be shut off and/or noisemakers confiscated.

<T19> Batteries must be charged in an open, well-ventilated area.

<T20> Painting or applying harmful products, sprays, or aerosols are not allowed anywhere in the tournament. This includes the *Pit*, *Competition*, and spectator areas.

Note: *Teams* may apply antistatic spray to their *Robot* if done outside the venue.

<T21> *Pit* displays may not exceed 10 ft. (3.05 m) x. 10 ft. (3.05 m) x. 10 ft. (3.05 m) or a limit set by the venue, whichever is less.

<T22> *Teams* are not allowed to use radios and walkie-talkies anywhere in the venue.

<T23> There is no running anywhere during the tournament. This is a safety hazard.

<T24> *Teams* are not allowed to save seating space as there is often not enough seating to hold everyone. Repeated offenses could be considered egregious, and *Teams* could face consequences for violating this rule.

<T25> Soldering, gluing, brazing, or large power tools are not allowed in the *Pit* or *Competitions Areas* unless the Tournament Director specifically allows them.

<T26> Because of site rules or contracts, *FIRST* cannot allow *Teams* or individuals to sell items, such as T-shirts, pins, etc., at any tournaments. Fundraising for a cause is allowed with consent of the Tournament Director; fundraising for a *Team* is not allowed.

<T27> Check with the Tournament Director before bringing food to a tournament, as some venues will not allow outside food on-site because of contracts and agreements.

<T28> Open-toed or open-backed shoes are not allowed in the *Pit Area* or in the *Competition Area*.

<T29> Once the *Autonomous* portion of the *Match* ends, *Drive Teams* will have 5 seconds to pick up their *Driver Station*. The scoring system display will provide visual and audio cues for *Drive Teams* to pick up their *Driver Stations*. After the 5 seconds, there will be a 3-2-1 countdown and the *Driver Controlled* period of the *Match* will begin.

<T30> Teams competing in a Meet, League Tournament, Qualifying Tournament, and Championship Tournament will compete in no fewer than 5 Matches, and no more than 6 Matches.

5.0 Tournament Day Outline

FIRST Tech Challenge tournaments pack many activities into one day. The main events for a tournament (Qualifying Tournament, League Tournament, State Championship, World Championship) are as follows:

1. *Team Check-in*
2. *Robot and Field Inspection*
3. *Judges' Interviews*
4. *Drivers' Meeting*
5. *Opening Ceremony*
6. *Qualification Matches*
7. *Alliance Selection*
8. *Elimination Matches*
9. *Awards and Closing Ceremony*

Teams competing in a League and attending Meets will only participate in the following activities during the meet:

1. *Team* Check-in
2. *Robot* and Field Inspection
3. Driver's Meeting
4. *Qualification Matches*

5.1 Tournament Schedule

Tournament schedules will be available through the Tournament Director before or at the tournament.

Qualification Match schedules are created on tournament day after all *Teams* have checked-in and have passed all Inspections.

5.2 Team Check-In

5.2.1 Consent and Release Forms

Each student competing at a FIRST Tech Challenge tournament must have a signed consent and release form completed by a parent or legal guardian. **Students cannot compete without a signed consent and release form.** These forms can be filled out electronically or by hard copy.

- Electronically – A printed roster showing that each student's parent or guardian has electronically filled out the consent and release form online. This is shown on the roster with a green checkmark.
- Hard copy – The coach or mentor must bring a signed hard copy of the form signed by the student's parent or legal guardian.

The roster from the Team Registration System **MUST** be handed in at event registration, regardless if the coach is handing in hard copies of each consent and release form. If the roster from the Team Registration System is blank, the coach should write in the names of each student competing at the tournament.

5.2.2 Team Check-In Packets

Once checked in, the Coach will receive their *Team* packet. *Team* Packets generally include *Drive Team* badges, a judging schedule, a map of the venue, and other information that is important to the *Teams*. The *Team* should review the schedule of events for the day. *Teams* should set up their *Pit Area* and get familiar with the venue, including where the practice and *Playing Fields* are and where judging takes place.

5.3 Robot and Field Inspection

FIRST Tech Challenge *Robots* are required to pass *Robot* and Field inspections before being allowed to compete. These inspections ensure that all *Robot* rules are met. A copy of the official FIRST Tech Challenge "Robot Inspection Sheet" and "Field Inspection Sheet" are found in Appendices A and B of this manual. The "Robot Inspection Sheet" must be used by *Teams* as a guide to pre-inspect their *Robot*.

5.4 Judges' Interviews

At FIRST Tech Challenge tournaments, there are three parts to the judging process: 1) interview with judges; 2) evaluation of performance during the tournament; and 3) evaluation of the Engineering Notebook. Each *Team* will have a ten to fifteen minute "fact-finding" interview with a panel of two or three judges. At the start of the interview, students will get a minimum of 5 minutes to present to the judges. After the *Teams* five-minute presentation, the Judges will have the opportunity to ask questions about the *Team*, the *Robot*, outreach efforts, etc.

The judges' interviews take place before any *Qualification Matches* so the entire *Team* may be interviewed. When *Teams* arrive at the tournament, the interview schedule should be included in the registration materials. *Teams* must know when they will be interviewed and arrive to the interview room early. Each *Team* should have at least two student *Team* representatives and the *Robot* available; the entire *Team* is encouraged to join

in. Mentors (no more than two) are welcome to watch the Judges' Interview at most tournaments, but cannot take part in the interview.

Teams may **not** opt out of Judges' Interviews. *Teams* may attend their scheduled Judges' Interviews if their *Robots* have not passed inspection.

5.5 Drivers' Meeting

The Drivers' Meeting takes place before the start of *Qualification Matches* and is a time when the *Drive Team* meets with the referees. During this time, the Head Referee gives a brief outline of what is expected of *Teams*. They will provide venue specific information, such as queuing paths, and explains any signals and commands referees will give during matches.

5.6 Practice Time

At some tournaments, practice fields are available for *Teams* to practice throughout the tournament. Practice time is offered on a first-come, first-served basis. *Teams* should check with the Tournament Director if practice time will be allowed on tournament day.

5.7 Opening Ceremony

The opening ceremony is the official kickoff of the tournament for the *Teams*, volunteers, and spectators. During the opening ceremony, a tournament official or the Emcee will welcome the *Team*, introduce dignitaries and other special guests, and introduce the judges and the referees. Then the game will be described (usually with a video) and immediately after, the *Qualification Matches* take place.

Teams that are scheduled in the first four *Qualification Matches* will be asked by volunteers to line up before the opening ceremonies. The *Qualification Match* schedule will be available before the start of opening ceremony. It is the *Team's* responsibility to check the schedule and make sure they are on time for their matches.

5.8 Qualification Matches

Teams are randomly assigned to *Qualification Matches* and *Alliances*. The *Qualification Match* schedule is available before opening ceremonies on the day of the tournament. This schedule shows *Alliance* partners and match pairings. It also shows the *Alliance's* color (red or blue) and the position in the *Alliance Station* (1 or 2) for the *Drive Team*. These matches start immediately after the opening ceremonies and follow the *Qualification Match* schedule. The queue volunteer crew works together throughout the day to line up *Teams* for the matches and maintain the schedule. *Teams* must pay attention to the match schedule and listen for announcements throughout the day. *Teams* need to know when they will compete, find out the number of the last match before lunch, and find out which match is the last match of the tournament day.

All *Teams* are ranked based on the same number of *Qualification Matches*. *Team* may be required to play a *Surrogate Match*, which is an extra *Match* marked by an asterisk on the match schedule. The additional *Surrogate Match* does not count towards their standings during the tournament.

At the conclusion of each match, *Ranking Points* and *TieBreaker Points* are awarded:

- *Teams* receive *Ranking Points* based on the following:
 - Winning *Teams* of a *Qualification Match* each receive two (2) *Ranking Points*.
 - Losing *Teams* of a *Qualification Match* receive zero (0) *Ranking Points*.
 - If a *Qualification Match* ends in a tie, all four *Teams* receive one (1) *Ranking Point*.
 - If a *Team* is disqualified or does not show up for a match, they receive zero (0) *Ranking Points*.
- *TieBreaker Points* are awarded based on the following:

- The number of *TieBreaker Points* assigned for each match is that of the losing *Alliance's* score. Both *Alliances* receive the pre-penalized score of the losing *Alliance* as their *TieBreaker Points*.
- If a match ends in a tie, both *Alliances* receive the same number of *TieBreaker Points*, equal to the lowest pre-penalized score. If a *Team* is disqualified, they receive zero (0) *TieBreaker Points*.
- If both *Teams* on an *Alliance* are disqualified, the *Teams* on the winning *Alliance* are awarded their own score as their *TieBreaker Points* for that match.

Example:

Match	Result	Red	Blue
Q-1	30-15 R	5555	8888
		4444	6666
Q-2	15-45 B	1111	7777
		3333	2222
Q-3	30-30 T	8888	4444
		7777	3333
Q-4	25-45 B	2222	5555
		6666	1111

- Q-1 – The red *Alliance* has won the match 30-15. *Teams* 5555 and 4444 will receive two (2) *Ranking points*, and *Teams* 8888 and 6666 receive zero (0) *Ranking Points*. *Teams* from both *Alliances* will receive 15 *TieBreaker Points*.
- Q-2 – The blue *Alliance* has won the match 45-15. *Teams* 7777 and 2222 will receive two (2) *Ranking Points*, and *Teams* 1111 and 3333 will receive zero (0) *Ranking Points*. *Teams* from both *Alliances* will receive 15 *TieBreaker Points*.
- Q-3 – This match ended in a tie, which will result in *Teams* from both *Alliances* receiving one (1) *Ranking Point* and thirty (30) *TieBreaker Points*.
- Q-4 – The red *Alliance* originally had a match score of 15 points (not shown in image), the blue *Alliance* had a match score of 45 points. The blue *Alliance* then incurred a Minor penalty, which added 10 points to the red *Alliances* score. The result is the blue *Alliance* wins, and therefore *Teams* 5555 and 1111 each receives two (2) *Ranking Points*. The red *Alliance* (*Teams* 2222 and 6666) receives zero (0) *Ranking Points*. However, the lowest **pre-penalized** score between the *Alliances* is still 15, therefore both *Alliances* will receive 15 *TieBreaker Points*.

Teams may receive credit for a *Qualification Match* if their *Robot* is not functioning. To receive credit for the match, the *Robot* has passed inspection and at least one member of the *Drive Team* is present in the *Alliance Station* for the scheduled match.

Questions about a match or scores must be brought forward to the Referees by using the referee question box located in the *Competition Area*. Only one **student** from an *Alliance* can enter the question box, and must do so within a period of three (3) matches following the disputed match.

After all *Qualification Matches*, the *Teams* are ranked from first through last based on their total *Ranking Points*. If multiple *Teams* have the same *Ranking Points* total, these *Teams* are ranked based on their total *TieBreaker Points*. If multiple *Teams* have the same *TieBreaker Points* total as well, then these *Teams* are ranked based on their highest match score. If still tied, the next highest match score is used until the tie is

broken. In the unlikely event there is still a tie based on identical match scores, then the *Teams* are ranked by a random electronic draw. These rankings are done automatically through the scoring system software.

5.9 Alliance Selection

The number of *Teams* in the *Elimination Matches* is based on the number of *Teams* in the tournament. If there are 21 or more *Teams* in the tournament, the *Elimination Matches* consist of *Alliances* of 3 *Teams* each. If there are 20 *Teams* or less, then the *Alliances* consist of 2 *Teams* each. There are four (4) *Alliances* that will compete in the *Elimination Matches*.

The *Alliance Selection* consists of several rounds of selections so all *Alliance Captains* form *Elimination Match Alliances*. These *Alliances* participate in a ladder-type tournament to determine the tournament's Winning *Alliance*. The *Alliance Selection* is as follows:

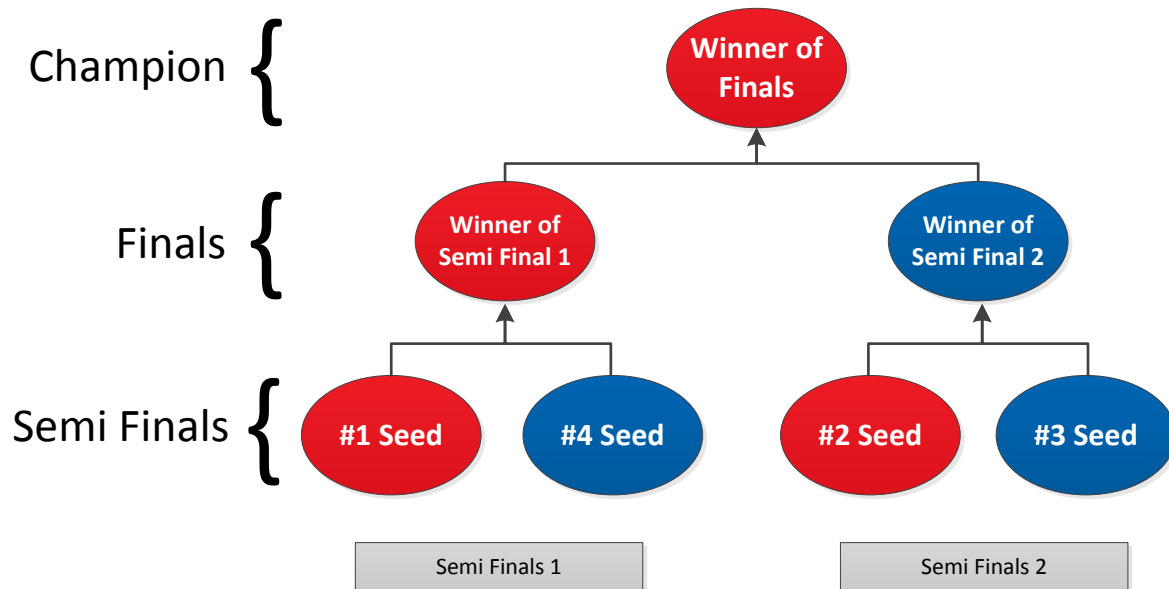
- Each *Team* chooses one student to act as the *Team's* representative. These representatives will continue to the *Competition Area* at the appointed time to represent their *Teams* in the *Alliance Selection*.
 - *Teams* can bring their scouting documents or communicate by phone with other teammates in the venue to aid them with their *Alliance* choices. *Teams* must remember that if they are communicating with teammates by phone, they must be gracious and considerate and not hold up *Alliance Selection*.
- The top four ranked teams are called to the floor first. The student representative of the highest ranked *Team* is asked to step forward as the *Alliance Captain* to invite another available *Team* to join their *Alliance*.
- A *Team* is available if they are not already part of an *Alliance*, or has not already declined an *Alliance* invitation. If a *Team* accepts, they are moved into that *Alliance*. **If a *Team* declines, they CANNOT be invited to another *Alliance***, but are still available to select their own *Alliance* if the opportunity arises. If a *Team* declines, the *Alliance Captain* from the inviting *Team* must extend an invitation to another *Team*.
- The selection continues until all four *Alliance Captains* have been appointed and chosen one *Alliance* partner.
- If there are more than 20 *Teams*, the same method is used for each *Alliance Captain's* second choice. The third member of each *Alliance* from highest seed to lowest seed (that is, 1 → 2 → 3 → 4). Any *Teams* remaining after the lowest seeded captain makes their choice do not compete in the *Elimination Matches*.

5.10 Elimination Matches

The *Elimination Matches* are when the *Alliances* compete to determine who the winning *Alliance* is. The matches are played in a seeded format where the top seed goes up against the 4th seed, and the number 2 seed goes up against the 3rd seed. *Alliance* colors are assigned as follows:

- Semi Finals
 - Seed #1 and Seed #4 compete against each other in the Semi Finals 1; Seed #1 is assigned as the red *Alliance* and Seed #4 is assigned as the blue *Alliance*.
 - Seed #2 and Seed #3 compete against each other in the Semi Finals 2; Seed #2 is assigned as the red *Alliance*, and Seed #3 is assigned as the blue *Alliance*.
- Finals
 - The winner of Semi Finals 1 is assigned as the red *Alliance*.
 - The winner of Semi Finals 2 is assigned as the blue *Alliance*.

In the *Elimination Matches*, *Teams* do not get *Ranking Points*; they get a win, loss or tie. Within each bracket (Semi-Finals or Finals) of the elimination, matches are played to determine which *Alliance* advances. The advancing *Alliance* is the first *Team* to win two matches. Any tied matches are replayed until one *Alliance* has two wins and advances. An example tournament bracket appears here:



During the *Elimination Matches*, two *Teams* from an *Alliance* compete on the *Playing Field*. If the *Alliance* has three *Teams*, the *Team* that sits out the first match must play in the second match, with no exceptions. If the *Alliances* play more than two matches in any bracket, any combination of two *Alliance Robots* may be used. The *Alliance Captain* is not required to participate in every match. No special accommodations are made for *Robots* that fail during the Semi Final and Final Rounds. *Teams* should consider the robustness of the *Robots* when picking *Alliance* partners.

If a *Team* is disqualified during an *Elimination Match*, the entire *Alliance* is disqualified and the match is recorded as a loss. Before each *Elimination Match*, the *Alliance Captain* must let the referee know which two *Teams* are playing in the next match two (2) minutes before the start of the match.

All questions about a match or scores must be brought forward to the Referees by using the referee question box located in the *Competition Area*. Only one **student** from an *Alliance* is allowed to enter the question box. A *Team* must enter the referee question box to dispute a match before the start of the next match played by the *Alliance*, regardless if the *Team* is participating in the next match. The next match played could involve different *Alliances*. Questions about the last match of the Finals must be brought to the question box no later than 5 minutes after the announcement of the match score.

5.11 Awards and Closing Ceremony

The awards and closing ceremony celebrates the *Teams* and their accomplishments throughout the tournament, as well as the volunteers who helped make the tournament possible. At the awards and closing ceremony, the finalists and winners of each award are announced. At most tournaments, the judges will line up to high five each *Team* as they receive an award.

5.12 Team Spirit & Styling

Competing as a *Team* is exciting as well as rewarding. Part of the fun and reward of being a *Team* member is the way the *Team* styles itself with *Team* T-shirts, trading buttons, hats, cheers, and costumes.

When deciding on a *Team* name or acronym, consider how to work a theme around it to make the *Team* more fun and recognizable. Refer to the Marketing and Outreach section of the website for information about *FIRST* and *FIRST* Tech Challenge logo use requirements: <https://www.firstinspires.org/brand>

5.13 Banners and Flags

Sponsors provide *FIRST* with banners so we can display them in specified areas as a way of thanking them for their generosity. We encourage *Teams* to bring *Team* flags or sponsor banners, but we ask that you adhere to the following:

- Do not use banners or flags to section off seating. Saving group seats is not allowed.
- Hang banners in pit stations only, not on the pit walls.
- *Teams* may bring banners to the *Competition Area*, but please do not hang them there. This area is designated for official *FIRST* sponsors' banners.

5.14 Spectators and Etiquette

Teams are allowed to have 2 student drivers and 1 coach (the *Drive Team*) at the *Playing Field* during their scheduled matches. Spectators are not allowed in the designated *Competition Area* at any time. Some tournaments may provide media passes for one additional *Team* member to gain access to a designated "media area". Access to this area is only allowed with a media pass and only while the media representative's *Team* is on the *Playing Field*. Spectators blocking the sidelines or accessing the media area without a pass will be asked to move. Repeated violations of this rule are considered egregious behavior.

5.15 Scouting

During the *Qualification Matches*, the scoring system selects each *Team's* ally and opponent for each match. In elimination rounds, top ranking *Teams* can choose their own *Alliance* partners. *Teams* should select *Alliance* partners with abilities that complement their own strengths. Scouting during the qualifying rounds is a good way to learn the abilities and limits of the *Teams* and *Robots* competing at the tournament.

The following scouting strategy has been provided by the 2007 *FIRST*® Robotics Competition Chairman's Award winners, *FIRST* Robotics Competition *Team* #365, the Miracle Workerz.

Teams use different methods to record information about other *Teams* – paper, computer, tablets, etc. Use whatever method is most comfortable for your *Team*. Scouting is important to find out how you complement other *Teams* in your *Alliance* and how you match up against your opponents. No matter how you record it, focus on information which will be useful to your *Team* when you meet your *Alliance* partners to discuss strategy.

Some possible areas to gather information include:

- CAPABILITIES – what can the *Robot/Team* do and what does it not do?
- STRATEGIES – what does the *Robot/Team* do during the match? How does the *Team* play the game?
- PERFORMANCE – how well does the *Robot/Team* do what it attempts? What are the *Robot's* strengths and weaknesses?
- AUTONOMOUS – what does the *Robot* do in autonomous mode? Does the *Team* have multiple program options?

The more data points you can collect on strategies and performance, the better understanding you will have of a given *Team*. Information on a *Team's* capabilities can be obtained by visiting the *Team* in the *Pit Area* or watching match play.

6.0 Tournament Types

There are several types of tournaments that *Teams* and other organizers hold throughout the *FIRST* Tech Challenge season and off-season. The tournament types are listed in the following section.

6.1 Scrimmage

A scrimmage is an unofficial *FIRST* Tech Challenge Event where *Teams* do not advance. *Teams* compete at a scrimmage solely to prepare for an official tournament. Anyone can host a scrimmage to prepare for an official tournament. *Teams* hosting a scrimmage are encouraged to notify their local [Affiliate Partner](#) that such a tournament is taking place. *Teams* that choose to create and host a local tournament are responsible for finding a location, organizing the format for the day, and inviting other *Teams* to participate. *Teams* may also have to secure the field elements, computers, and other items.

6.2 Meets and League Play

A League Meet is a one-field competition that uses the same field and game as other tournaments. *Teams* may take part in as few or as many League Meets as they choose, but competing in more improves a *Teams* League ranking. Some of the standard tournament guidelines may be adapted for those regions that participate in the League format. *Teams* should contact their [Affiliate Partner](#) for more information about the scheduling, structure, advancement, and processes that are unique to the League/Meet in their region.

6.3 Qualifying Tournaments and League Tournaments

Hosted and managed by *FIRST* Tech Challenge Affiliate Partners or Affiliate Partner-appointed hosts. Qualifying tournaments follow the judging, game guidelines, and format outlined in sections 5.4 and 10.0 of the Game Manual Part 1. Qualifying Tournaments are usually held before Championship Tournaments in regions where there are many *Teams*. The number of *Teams* advancing to the State Championship Tournament depends on the capacity of the State Championship Tournament, the number of Qualifying Tournaments, and the number of *Teams* attending the Qualifying Tournament. The Advancement Criteria for moving up to the next level of tournament is detailed in section 7.0.

6.4 Super-Qualifying Tournaments

These tournaments are held in regions with a large number of *Teams* and/or Leagues. In these regions, *Teams* advance from either a League Championship or Qualifying Tournament to a Super-Qualifying Tournament, and then to the regional or State Championship. Super-Qualifying Tournaments adhere to *FIRST* standards in format, judging, and awards.

6.5 Championship Tournaments

Hosted and managed by a *FIRST* Tech Challenge Affiliate Partner, Championship Tournaments abide by certain standards in format, judging, awards, and overall quality. Some Championship Tournaments require that *Teams* advance from a Qualifying Tournament or League Tournament to advance to the State/Regional Championship. Championship Tournaments may include *Teams* from a geographic region, province, state, country, or several countries. *Teams* should expect a higher level of competition, both on the field and in the judging room at Championship Tournaments.

7.0 Eligibility and Advancement Criteria

7.1 Eligibility to Compete in Official *FIRST* Tech Challenge Tournaments:

To compete in an official *FIRST* Tech Challenge tournament at any level, a *Team* must be registered and in good standing with *FIRST*.

- ✓ The *Team* has completed the registration process.

- ✓ The *Team* registration fee is paid. *For North America *Teams*. *Teams* outside North America should consult the Affiliate Partner for their region.
- ✓ In North America, two adults must pass the [Youth Protection](#) screening process.

7.2 Eligibility for Judged Awards

Teams are eligible to be considered for all Judged Awards (except the Inspire Award, please see Inspire section for details) at any of the first three tournaments they participate in at each of the following levels. *Teams* may compete at each level in any region that will accept them. Affiliate Partners have the authority to decide if their tournament is open to *Teams* from other regions, or only for *Teams* within their region.

- League Tournament
- Qualifying Tournament
- Super Qualifying Tournament
- Championship Tournament

7.2.1 Inspire Award Eligibility

Teams that have won the Inspire Award at another event of the same level, regardless of the region, cannot be considered for the Inspire Award or as an Inspire Award Finalist at additional tournaments at that level.

All *Teams* are eligible to be considered for all Judged Awards at a World Championship Tournament.

7.3 Eligibility for Advancement

Teams are eligible for advancement at any one of the first three tournaments they participate in at any of the following levels, **regardless of the region**. This applies to both *Teams* in North America, and *Teams* outside of North America:

- League Tournament
- Qualifying Tournament
- Super Qualifying Tournament
- Championship Tournament

A *Team* can only earn a spot to one World Championship event per season.

Tournament Type	Advances To	Special Considerations
Qualifying Tournament	State or Regional Championship Tournament	<p>A <i>Team</i> is eligible to advance to the next competition tier from one of the first three Qualifying, League, or Super-Qualifying Tournaments they attend.</p> <p>A <i>Team</i> may participate in more than three Tournaments in the same competition tier, but they are not eligible for consideration for advancement or Awards at Tournaments beyond their third.</p>
League Tournament		
Super-Qualifying Tournament		

State or Regional Championship Tournament	FIRST Tech Challenge World Championship	Teams advance from a State or Regional Championship Tournament to one of the FIRST Tech Challenge World Championships.
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7.4 Order of Advancement

If the *Team* listed has already advanced or there is no *Team* fitting that description (as in 2nd *Team* selected at smaller tournaments), the advancement will continue in order.

1. Optional – Qualifier Host *Team* (NOTE: Each region's Affiliate Partner decides if this advancement opportunity will be offered, and if so, when the host *Team* must be identified. The *Team* MUST compete at one other tournament within the region and must meet the criteria set forth by the Affiliate Partner in the agreement. This advancement applies to Qualifying Tournament hosts only, and does NOT apply to host Teams of Meets, League Championships or Championship Tournaments).
2. Inspire Award Winner
3. Winning *Alliance* Captain
4. Inspire Award 2nd place
5. Winning *Alliance*, 1st *Team* selected
6. Inspire Award 3rd place
7. Winning *Alliance*, 2nd *Team* selected
8. Think Award Winner
9. Finalist *Alliance* Captain
10. Connect Award Winner
11. Finalist *Alliance*, 1st *Team* selected
12. Rockwell Collins Innovate Award Winner
13. Finalist *Alliance*, 2nd *Team* selected
14. Design Award Winner
15. Motivate Award Winner
16. Control Award Winner
17. Highest Ranked *Team** not previously advanced, from the Winning Division.
18. Think Award 2nd Place
19. Highest Ranked *Team** not previously advanced, from the Finalist Division.
20. Connect Award 2nd Place
21. Highest Ranked *Team** not previously advanced, from the Winning Division.
22. Rockwell Collins Innovate Award 2nd Place
23. Highest Ranked *Team** not previously advanced, from the Finalist Division.
24. Design Award 2nd Place
25. Highest Ranked *Team** not previously advanced, from the Winning Division.
26. Motivate Award Winner 2nd Place
27. Highest Ranked *Team** not previously advanced, from the Finalist Division.
28. Control Award Winner 2nd Place
29. Highest Ranked *Team** not previously advanced, from the Winning Division.
30. Think Award 3rd Place
31. Highest Ranked *Team** not previously advanced, from the Finalist Division.
32. Connect Award 3rd Place

33. Highest Ranked *Team** not previously advanced, from the Winning Division.
34. Rockwell Collins Innovate Award 3rd Place
35. Highest Ranked *Team** not previously advanced, from the Finalist Division.
36. Design Award 3rd Place
37. Highest Ranked *Team** not previously advanced, from the Winning Division.
38. Motivate Award 3rd Place
39. Highest Ranked *Team** not previously advanced, from the Finalist Division.
40. Control Award 3rd Place
41. Highest Ranked *Team** not previously advanced, from the Winning Division.
42. Highest Ranked *Team** not previously advanced, from the Finalist Division.
43. Highest Ranked *Team** not previously advanced, from the Winning Division.
44. Highest Ranked *Team** not previously advanced, from the Finalist Division.
45. Highest Ranked *Team** not previously advanced, from the Winning Division.
46. Highest Ranked *Team** not previously advanced, from the Finalist Division.
47. Highest Ranked *Team** not previously advanced, from the Winning Division.
48. Highest Ranked *Team** not previously advanced, from the Finalist Division.
49. Highest Ranked *Team** not previously advanced, from the Winning Division.
50. Highest Ranked *Team** not previously advanced, from the Finalist Division.
51. Highest Ranked *Team** not previously advanced, from the Winning Division.
52. Highest Ranked *Team** not previously advanced, from the Finalist Division.

*Refers to *Qualification Match* ranking. These advancements are in order. There is no normalizing of rank between divisions.

8.0 The Robot

8.1 Overview

A *FIRST* Tech Challenge *Robot* is a remotely operated vehicle designed and built by a registered *FIRST* Tech Challenge *Team* to perform specific tasks when competing in the annual game challenge. This section provides rules and requirements for the design and construction of a *Robot*. *Teams* should be familiar with the *Robot* and game rules before beginning *Robot* design.

8.2 Robot Control System

A *FIRST* Tech Challenge *Robot* is controlled by an Android based platform powered by Snapdragon processors. *Teams* will use two (2) Android devices to control their *Robot* and compete in a “*Sports Start*” model of competition. One Android device will be mounted directly onto the *Robot* and act as a *Robot Controller*. The other Android device will be connected to a pair of gamepads and will act as the *Driver Station*.

For more information, tutorials, and to access our Android Technology forum, please visit:

<https://www.firstinspires.org/resource-library/ftc/robot-building-resources>

8.2.1 Robot Technology Definitions

Core Device Interface Module – A USB-enabled device that can be used to provide input/output ports for the *Robot Controller*. The *Core Device Interface Module* has 8 digital I/O ports, 8 analog input ports, 2 analog output ports, 2 PWM output ports and 6 high speed (100kHz) I²C ports.

Core Motor Controller – A USB-enabled DC motor controller with two (2) motor control channels.

Core Power Distribution Module – The electronic device that connects the *Robot Controller* Android device to one or more USB-enabled modules such as the *Core Motor Controller*, *Core Servo Controller*, and the *Core Device Interface Module*. The *Core Power Distribution Module* draws power from an approved 12V battery to power an internal USB Hub, DC motor controllers and servo controllers, and certain specified electronics.

Core Servo Controller – A USB-enabled servo controller with six (6) servo control channels.

Driver Station – Hardware and software used by a *Drive Team* to control their *Robot* during a match. The *Driver Station* consists of an Android device, *FIRST* Tech Challenge supplied Android App, adapter cable(s), optional non-powered (i.e., does not draw power from a DC power input port) USB Hub, an optional commercial off the shelf USB external battery connected to the USB Hub to charge the Android device at any time, and up to two controllers to drive the *Robot*. *Teams* may use either of the two models of controller device(s) in any combination– either the Logitech F310 Gamepad Controllers or the Xbox 360 Controller for Windows (Part #: 52A-00004). The *Driver Station* also includes any components used to hold the above listed legal devices.

Java – The recommended programming language for the *Robot Controller*.

Logic Level Converter – An electronic device that allows an encoder or sensor that operates using 5V logic levels to work with the *REV Expansion Hub*, which operates using 3.3V logic levels. This device may contain a step-up voltage converter (from 3.3V to 5V) and a dual channel, bidirectional logic level converter. This device may be used directly with a 5V digital sensor, or with an *I²C Sensor Adaptor Cable* to a 5V I²C sensor.

I²C Sensor Adapter Cable – An adapter to change the pin orientation of the REV Robotics *Logic Level Converter* to match a Modern Robotics compatible I²C sensor.

Mini USB to OTG (On-The-Go) Micro Cable – The connection between the *Robot Controller* and the *Core Power Distribution Module* or *REV Expansion Hub*.

Modern Robotics Core Control Modules – The *Core Motor Controller*, the *Core Servo Controller*, the *Core Power Distribution Module*, and the *Core Device Interface Module* are all considered to be *Core Control Modules*.

Modern Robotics Sensors – Sensors designed by Modern Robotics that connect to the *Core Device Interface Module*.

Op Mode – An *Op Mode* (short for "operational mode") is software that is used to customize the behavior of a competition *Robot*. The *Robot Controller* can execute a selected *Op Mode* to perform certain tasks during a match.

OTG Micro Adapter – Connects a USB hub to Micro USB OTG (On-The-Go) port on the *Driver Station* Android device.

REV Expansion Hub – An integrated electronic device with four (4) DC motor channels, six (6) servo channels, eight (8) digital I/O channels, four (4) analog input channels, and four (4) independent I²C buses. The *REV Expansion Hub* draws power from an approved 12V battery to power these input/output channels.

REV SPARK Mini Motor Controller - An electronic device that accepts a PWM control signal (from a servo controller) and supplies 12V power to a DC motor.

REV Robotics Sensors – Sensors designed by REV Robotics that connect to the *REV Expansion Hub*.

REV Servo Power Module – An electronic device that boosts the power supplied to 3-wire servos. A *REV*

Servo Power Module has 6 input servo ports and 6 matching output ports. It draws power from a 12V source and provides 6V power to each output servo port. A *REV Servo Power Module* can provide up to 15A of current across all output servo ports for a total of 90 Watts of power per module.

Robot Controller – An Android device located on the *Robot* that processes *Team* written software, reads on board sensors, and receives commands from the *Drive Team* by way of the *Driver Station*. The *Robot Controller* sends instructions to the motor and servo controllers to make the *Robot* move.

USB Mini Type B Cable – These cables are used to connect the USB-enabled modules (*Core DC Motor Controller*, *Core Servo Controller* and *Core Device Interface*) to the *Core Power Distribution Module*. The cables provide 5V DC power to the modules and send information to/from the modules.

UVC Compatible Camera – A USB Video Class (UVC) Compatible Camera is a digital camera that conforms to the [USB Video Class specification](#). UVC Compatible Cameras have USB Type A cables and are powered by the *Robot Controller* through a non-powered USB hub that is connected to the *Robot Controller* through an OTG adapter.

8.3 Robot Rules

Anyone that has attended a *FIRST* Tech Challenge tournament knows that *Teams* think outside the kit-of-parts to create unique and creative *Robots*. The intent of the *Robot* construction rules is to create a level playing field and a framework for *Teams* to build *Robots* that safely play the annual game challenge. *Teams* should read all the *Robot* rules before building. *Teams* can also reference our [Legal and Illegal Parts List](#) on our website for common legal and illegal *Robot* parts. Some supplier's websites may claim that a part is *FIRST* Tech Challenge approved. The only official references for the legality of parts and materials are the Game Manual Part 1, the [Legal and Illegal Parts List](#), and the [Official Game Q&A Forum](#).

8.3.1 General Robot Rules

It is the intent of *FIRST* to encourage creativity in design to the extent that it does not present a safety hazard or unfairly affect the opportunities of any opposing-*Alliance Teams* to compete. Although there is significant creative freedom allowed in the *Robot* design rules, *Teams* should consider the adverse effects of any design decisions that they make. When considering your *Robot* design and your game strategy, ask yourself the following questions. If the answer to any of these questions is yes, the design part is not allowed:

- Could it damage or disable another *Robot*?
- Could it damage the *Playing Field*?
- Could it injure a participant or volunteer?
- Is there already a rule that prohibits this?
- If everybody did this, would the game play be impossible?

<RG01> **Illegal Parts** - The following types of mechanisms and parts are not allowed:

- a. Those used in a *Robot* drive system that could potentially damage the *Playing Field* and/or Scoring Elements such as high traction wheels (for example, AM- 2256) and high grip tread (for example, Rough top).

Black tire marks on an Element is not considered *Playing Field* damage. However, digging a hole into the *Playing Field* tiles can be considered damage.

- b. Those that could potentially damage or flip other competing *Robots*.

- c. Those that contain hazardous materials such as mercury switches, lead, or lead containing compounds, or lithium polymer batteries (except for the Android devices' internal batteries).
- d. Those that pose an unnecessary risk of entanglement.
- e. Those that contain sharp edges or corners.
- f. Those that contain animal-based materials (because of health and safety concerns).
- g. Those that contain liquid or gel materials.
- h. Those that contain materials that would cause a delay of game if released (for example, loose ball bearings, coffee beans, etc.).
- i. Those that are designed to electrically ground the *Robot* frame to the *Playing Field*.
- j. Closed gas devices (for example, gas storage vessel, gas spring, compressors, etc.).
- k. Hydraulic devices.

<RG02> Maximum Starting Size - The maximum size of the *Robot* for starting a match is 18 inches (45.72 cm) wide by 18 inches (45.72 cm) long by 18 inches (45.72 cm) high. A *Robot Sizing Tool* will be used as the official gauge to make sure *Robots* comply with this rule. To pass inspection a *Robot* must fit within the sizing tool while in its match start configuration without exerting force on the sides or top of the sizing tool. *Robots* may expand beyond the starting size constraint after the start of the match. The *Alliance* flag and pre-loaded game elements may extend outside the starting volume constraint.

The *Robot* must be self-supporting while in the *Robot Sizing* tool by either:

- a. A mechanical means with the *Robot* in a power-OFF condition. Any restraints used to maintain starting size (that is, zip ties, rubber bands, string, etc.) MUST remain attached to the *Robot* for the entire match.
- b. A *Robot* Initialization Routine in the Autonomous Op Mode that may pre-position the servo motors, with the *Robot* in a power-ON condition, to the desired stationary position.
 - i. If the *Robot* Initialization Routine does move the servos when a program is executed, there must be an indicator on the *Robot* of this fact. A warning label placed near the *Robot*'s main power switch is required. Attach the image ("WARNING! - *Robot* moves on Initialization") to your *Robot* near the *Robot* main power switch if servos are commanded to move during the initialization routine. To be easily seen by field personnel the label should be at least 1 in x 2.63 in (2.54 cm x 6.68 cm, Avery Label # 5160) and placed on a flat surface (not wrapped around corners or cylinders):



<RG03> Robot Controller Mount – It is recommended the *Robot Controller* be accessible and visible by competition personnel. If a *Team's Robot Controller* is not accessible and/or visible to competition personnel,

the *Team* may not receive adequate support from the field personnel.

The *Robot Controller* should be mounted so the display screen is protected from contact with the *Playing Field* elements and other *Robots*. This and other electrical parts (batteries, motor and servo controllers, switches, sensors, wires, etc.) make poor bumpers and are unlikely to survive the rigors of game play when attached in a *Robot-to-Robot* contact area.

Important Note: The *Robot Controller* contains a built-in wireless radio that communicates with the Android device in the *Driver Station*. In addition to protecting the device from impact, the *Robot Controller* should not be obscured by metal or other material that could block or absorb the radio signals from the *Robot Controller*.

<RG04> Maximum Robot Weight – *Robots* must not weigh more than 42 pounds (19.05 kg) including battery. To account for variances between scales, there will be a .5 pound (.23kg) overage allowance on top of the 42 pound weight limit. This weight constraint does not include the *Alliance Flag* or *Team Marker*. If a *Team* is using multiple mechanisms that will be swapped out from one match to the next, all components and the robot must be weighed together during weight inspection and must not weigh more than 42 pounds.

<RG05> Alliance Flag Holder - *Robots* MUST include a mounting device to securely hold one tournament supplied FIRST Tech Challenge *Robot Alliance* Identification Flag throughout an entire match. The flag MUST be mounted at the TOP of the *Robot* and be clearly visible throughout the match to clearly identify a *Robot's Alliance*. Flag posts are typically a soda straw or wooden dowel. Dimensions of each are close to 0.25 inches (0.635 cm) outer diameter x 0.20 inches (0.5 cm) inner diameter x 8.25 inches (21 cm) length with a triangular flag 4.0 inches (10.16 cm) high x 6.0 inches (15.24 cm) wide. These may vary from tournament to tournament; *Alliance Flag* Holders should be able to securely hold both solid core dowels and open core straws. Mounting devices that damage the flag post are not acceptable.

<RG06> Team Number Display - *Robots* MUST prominently display their *Team* number (numerals only, for example “12345”) on two separate signs.

- a. The judges, referees, and announcers must be able to easily identify *Robots* by *Team* number.
- b. *Team* number must be visible from at least **two** opposite sides of the *Robot* (180 degrees apart).
- c. The numerals must each be at least 2.5 inches (6.35 cm) high, at least 0.5 inches (1.27 cm) stroke width, and in a contrasting color from their background. *Teams* can use Arial Font, Bold, 250 point to meet the minimum size requirements.
- d. *Team* numbers must be robust enough to withstand the rigors of match play. Example robust materials include: 1) self-adhesive numbers (that is, mailbox or vinyl numbers) mounted on polycarbonate sheet, wood panel, metal plate, etc.; 2) Ink jet or laser printed numbers on paper and laminated.

<RG07> Allowed Energy Sources - Energy used by FIRST Tech Challenge *Robots*, (that is, stored at the start of a match), shall come only from the following sources:

- a. Electrical energy drawn from approved batteries.
- b. A change in the position of the *Robot* center of gravity.
- c. Storage achieved by deformation of *Robot* parts. *Teams* must be careful when incorporating spring-like mechanisms or other items to store energy on their *Robot* by means of part or material deformation.

<RG08> Launching Robot Parts - Parts of the *Robot* itself may not be launched, even if the part launched is

still connected to the *Robot* by a tether (for example, wire, rope, or cable).

<RG09> Launching Game Scoring Elements – *Robots* are allowed to launch Scoring Elements through the air unless limited by a game specific rule. It is expected that *Teams* will launch the elements with just enough velocity to score. If the referees feel that a *Robot* is launching Scoring Elements with excessive velocity that would cause a safety issue if they were to leave the field, the *Robot* will be required to be inspected. *Robots* must then demonstrate that a launched Game Element cannot travel in the air more than a distance of 16 ft. (4.88 m) or more than 6 ft. (1.83 m) in elevation.

8.3.2 Robot Mechanical Parts and Materials Rules

<RM01> Allowed Materials - *Teams* may use raw and post-processed materials to build their *Robots*, provided they are readily available to the majority of *Teams* from standard distributors (for example, McMaster-Carr, Home Depot, Grainger, AndyMark, TETRIX/PITSCO, MATRIX/Modern Robotics, REV Robotics, etc.).

Examples of allowed raw materials are:

- Sheet goods
- Extruded shapes
- Metals, plastics, wood, rubber, etc.
- Magnets

Examples of allowed post-processed materials are:

- Perforated sheet and diamond plate
- Injection molded parts
- 3D printed parts
- Cable, string, rope, filament, etc.

Springs of all types: compression, extension, torsion, surgical tubing, etc.

<RM02> Commercial Off The Shelf Parts - *Teams* may use Commercial Off The Shelf (COTS) mechanical parts that have a single degree of freedom. A single degree of freedom is a system whose motion is defined just by a single independent co-ordinate (or function)¹.

It is the intent of *FIRST* is to encourage *Teams* to design their own mechanisms rather than purchasing pre-designed and pre-manufactured solutions to achieve the game challenge. Purchased mechanism kits (for example, grippers) that violate the single degree of freedom rule, either assembled or requiring assembly, are not allowed. COTS drive chassis (for example, AndyMark TileRunner, REV Robotics Build Kit) are allowed provided none of the individual parts violate any other rules.

¹ See <https://www.scribd.com/document/357151975/STRC201-SDOF-JMWB-pdf> Accessed on 7/10/2018

Examples of allowed single degree of freedom parts:

- Linear Slide
- Single Sped (non-shifting) gearboxes
- Pulley
- Lazy Susan
- Lead screws

Examples of illegal multiple degrees of freedom parts:

- Gripper assemblies or kits
- Ratcheting wrenches

<RM03> Holonomic Wheels - Holonomic wheels (omni or mecanum) are allowed.

<RM04> Modifying Materials and COTS Parts - Allowed materials and legal COTS parts may be modified (that is, drilled, cut, painted, etc.), as long as no other rules are violated.

<RM05> Allowed Assembly Methods - Welding, brazing, soldering, and fasteners of any type are legal methods for assembling a *Robot*.

<RM06> Lubricant - Any type of COTS lubricant is allowed, if it doesn't contaminate the *Playing Field*, game elements, other *Robots*, etc.

8.3.3 Robot Electrical Parts and Materials Rules

There are many possible ways to build and wire a *Robot*. These rules provide specific requirements on what is and is not allowed. *Teams* must ensure that electrical and electronic devices are used consistently with manufacturer's requirements and specifications. *Teams* are encouraged to review the [FIRST Tech Challenge Robot Wiring Guide](#) for suggestions on how to build a *Robot* with safe and reliable wiring.

<RE01> Main Power Switch - The *Robot* Main Power Switch must control all power provided by the *Robot* main battery pack. *FIRST* requires *Teams* to use either the TETRIX (part # W39129), MATRIX (part # 50-0030), or REV (REV-31-1387) power switch. This is the safest method for *Teams* and field personnel to shut down a *Robot*.

The *Robot* main power switch **MUST** be mounted or positioned to be readily accessible and visible to competition personnel. A Main *Robot* Power label must be placed near the Main Power Switch of the *Robot*. Attach the image ("POWER BUTTON") to your *Robot* near the Main Power Switch. To be easily seen by field personnel the label should be at least 1 in x 2.63 in (2.54 cm x 6.68 cm, Avery Label # 5160) and placed on a flat surface (not wrapped around corners or cylinders).



The *Robot* Main Power Switch should be mounted on the *Robot* so it is protected from *Robot-to-Robot* contact to avoid inadvertent actuation or damage.

<RE02> Battery Mount - Batteries MUST be securely attached (for example, VELCRO, zip tie, rubber band) to the *Robot* in a location where they will not make direct contact with other *Robots* or the *Playing Field*.

<RE03> Robot Main Battery – All *Robot* power is provided by a single 12 V *Robot* main battery.

The only allowed *Robot* main power battery packs are:

- a. TETRIX (W39057, formally 739023) 12 VDC battery pack
- b. Modern Robotics/MATRIX (14-0014) 12 VDC battery pack
- c. REV Robotics (REV-31-1302) 12 VDC Slim Battery pack

Note: There are similar looking batteries available from multiple sources but the ONLY legal batteries are those listed above.

<RE04> Fuses - Where present, fuses must not be replaced with fuses of higher rating than originally installed or according to manufacturer's specifications; fuses may not be shorted out. Fuses must not exceed the rating of those closer to the battery; if necessary, a fuse may be replaced with a smaller rating. Fuses must be single use only, self-resetting fuses (breakers) are not allowed.

<RE05> Robot Power - *Robot* power is constrained by the following:

- a. Allowed electronic devices may only be powered by power ports on the *Core Power Distribution Module* or the *REV Expansion Hub* except as follows:
 - i. The *Core Power Distribution Module* or *REV Expansion Hub* is powered by the *Robot* main battery.
 - ii. *REV SPARK Mini Motor Controllers* are powered by the *Robot* main battery.
 - iii. Allowed sensors connected to the *Core Device Interface Module* and/or the *REV Expansion Hub*.
 - iv. Light sources per <RE12>.
 - v. Video cameras per <RE13>.
- b. The *Robot Controller* Android device must be powered by its own internal battery or by the built-in charging feature of the *REV Expansion Hub*; external power is not allowed.

<RE06> Android Devices - The following Android devices are allowed:

- ZTE Speed
- Motorola Moto G 2nd Generation
- Motorola Moto G 3rd Generation
- Motorola Moto G4 Play
- Motorola Moto G5
- Motorola Moto E4

- Google Nexus 5*
- Samsung Galaxy S5*
 - a. No other devices may be used as *Robot Controllers* or in *Driver Stations*. See Rule <RS03> for the approved list of Android Operating System versions.
 - b. Exactly one (1) Android device must be used as the *Robot Controller* and the USB interface may only connect to the *Core Power Distribution Module*, a *REV Expansion Hub*, or a non-powered USB hub.
 - c. The *Robot Controller* Android device must be powered by its own internal battery or by the built-in charging feature of the *REV Expansion Hub*; external power is not allowed.

<RE07> Control Module Quantities - *Robot* control module quantities are constrained as follows:

- a. Exactly one (1) *Core Power Distribution Module* is required for *Teams* using any *Modern Robotics Core Control Modules*.
- b. No more than two (2) *Core Device Interface Modules* are allowed.
- c. Any quantity of *Core Motor*, or *Core Servo Controllers* are allowed.
- d. Any quantity of *REV Servo Power Modules* is allowed.
- e. No more than two (2) *REV Expansion Hubs* are allowed.
- f. Any quantity of *REV SPARK Mini Motor Controllers* are allowed.
- g. The *REV Control Hub* is not allowed.
- h. The *Core Legacy Module* is not allowed.

<RE08> Motor and Servo Controllers - Motor and Servo Controllers are allowed in the following configuration.

- a. *Core Motor Controllers*, *Core Servo Controllers*, *REV Expansion Hub*, *REV Servo Power Module*, and *REV SPARK Mini Motor Controllers* in any combination.

<RE09> DC Motors – A maximum of eight (8) DC motors are allowed. The only allowed motors are:

- a. TETRIX 12V DC Motor
- b. AndyMark NeveRest series 12V DC Motors
- c. Modern Robotics/MATRIX 12V DC Motors
- d. REV Robotics HD Hex 12V DC Motor
- e. REV Robotics Core Hex 12V DC Motor

No other DC motors are allowed.

* Does not support Wi-Fi Direct channel changing through the Robot Controller app.

<RE10> Servos – A maximum of twelve (12) servos are allowed. Any servo that is compatible with the attached servo controller is allowed. Servos may only be controlled and powered by an allowed Servo Controller, *REV Expansion Hub* or *REV Servo Power Module* (when used with an allowed Servo Controller or *REV Expansion Hub*). Servos may be rotary or linear but are limited to 6V or less and must have the three-wire servo connector.

Teams should be prepared during *Robot* inspection to show documentation confirming that the servos individually and together on the same servo controller do not exceed the manufacturer specifications for the controller.

The VEX EDR 393 motor is considered a servo and it is subject to the overall total maximum of twelve (12) servos. *Core Servo Controllers* may control up to two (2) VEX EDR 393 Motors per module. A VEX Motor Controller 29 must be used between a servo module and each VEX EDR 393 motor. *REV Expansion Hubs* must use a *REV Servo Power Module* between the *REV Expansion Hub* and the VEX Motor Controller 29. A maximum of two (2) VEX EDR 393 Motors may be controlled/powered per *REV Servo Power Module*.

<RE11> Sensors - Sensors are subject to the following constraints:

- a. Compatible sensors from any manufacturer may be connected to the *Core Device Interface Module* or *REV Expansion Hub*.
- b. Compatible sensors from any manufacturer may be connected to the *Logic Level Converter and/or the I²C Sensor Adapter Cable*. Refer to Rule <RE14.k> for details on the use of *Logic Level Converter* and the *I²C Sensor Adapter Cable*.
- c. Passive electronics may be used as recommended by sensor manufacturers at the interfaces to the sensors.
- d. Voltage sensors are allowed; except on an output port of a motor or servo controller.
- e. Current sensors are allowed; except on an output port of a motor or servo controller.
- f. Simple I²C multiplexers are allowed and they may only be connected to and powered from the I²C connections available on the *Core Device Interface Module* or the *REV Expansion Hub*.
- g. Voltage and/or current sensors are also allowed to connect between the battery pack and the *REV Expansion Hub* or *Core Power Distribution Module*.

<RE12> Light Sources - Functional and/or decorative light sources (including LEDs) are allowed with the following constraints:

- a. Focused or directed light sources (for example: lasers and mirrors) are not allowed except for the REV Robotics 2m Distance sensor (REV-31-1505).
- b. Light source control by compatible ports on the REV Expansion Hub and Modern Robotics Core Control Modules is allowed.
- c. Commercial off the Shelf interface modules (without user programmable microprocessors) are allowed between the light source and the components listed in <RE12>b.
- d. The only approved power sources for lights are as follows:
 - i. Internal (as supplied by the Commercial off the Shelf manufacturer) battery pack or battery holder.

- ii. Power ports on the *Core Power Distribution Module*.
- iii. Motor-control ports on the *Core Motor Controller Module*.
- iv. REV Expansion Hub Motor-control ports, spare XT30 ports, 5V auxiliary power ports, and I2C sensor ports.

<RE13> Video Cameras

- a. Self-contained video recording devices (GoPro or similar) are allowed providing they are used only for non-functional post-match viewing and the wireless capability is turned off. Approved self-contained video cameras must be powered by an internal (as supplied by the manufacturer) battery.
- b. *UVC Compatible Cameras* are allowed for computer vision-related tasks. *UVC Compatible Cameras* should be powered by the *Robot Controller* through a non-powered USB hub that is connected to the *Robot Controller* through an OTG adapter.

<RE14> Robot Wiring - Robot wiring is constrained as follows:

- a. USB Surge Protectors connected to USB cables are allowed.
- b. Ferrite chokes (beads) on wires and cables are allowed.
- c. A *Mini USB to OTG (On-The-Go) Micro Cable* or any combination of a *Mini USB cable*, a *non-powered USB hub*, and an *OTG Micro Adapter* may be used to connect the *Robot Controller* Android device to the *Robot* electronics. These devices may connect to the *Robot* electronics in the following ways:
 - i. Built-in USB input port of the *Core Power Distribution Module*, or
 - ii. Built-in USB input port of the *REV Expansion Hub*, or
 - iii. A non-powered USB hub that connects to the built-in USB input port of the *REV Expansion Hub*.
- d. Non-powered USB hubs connected to the *Core Power Distribution Module* are allowed.
- e. Anderson PowerPole, and similar crimp or quick connect style connectors are required to connect downstream electronics with the *Core Power Distribution Module* and are recommended for joining electrical wires throughout the *Robot*. Power distribution splitters are recommended where appropriate to reduce wiring congestion. All connectors and distribution splitters should be appropriately insulated.
- f. Installed connectors (such as battery-pack connectors, battery charger connectors, and *Core Power Distribution Module* power input connectors) may be replaced with Anderson PowerPole or any compatible connector.
- g. Power and motor control wires must use consistent color coding with different colors used for the positive (red, white, brown, or black with a stripe) and negative/common (black or blue) wires.
- h. Wire and cable management products of any type are permitted (for example, cable ties, cord clips, sleeving, etc.).
- i. Wire insulation materials of any type are permitted when used to insulate electrical wires or secure motor control wires to motors (for example, electrical tape, heat shrink, etc.).
- j. Power, motor control, servo, encoder, and sensor wires and their connectors may be extended,

modified, custom made, or COTS subject to the following constraints:

- i. Power wires are 18 AWG or larger.
- ii. Motor control wires as follows:
 - ii 22 AWG or larger for TETRIX Max 12V DC motors and REV Robotics Core Hex (REV-41-1300) 12V DC motors
 - ii 18 AWG or larger for all other 12V DC motors
- iii. PWM (servo) wires are 20 AWG or 22 AWG.
- iv. Sensor wires should be the same size or larger than the original wiring.

Teams should be prepared during Robot inspection to show documentation confirming the wire gauges used; particularly for multi-conductor cables.

- k. *Logic Level Converters* – *Logic Level Converters* that are used to connect a *REV Expansion Hub* to a 5V-compatible I²C sensor or a 5V-compatible digital sensor are allowed. Exactly one *Logic Level Converter* per I²C device and one *Logic Level Converter* per digital sensor are allowed. A *Logic Level Converter* should only draw power from the *REV Expansion Hub*.
- l. Electrically grounding the Control System electronics to the frame of the *Robot* is only permitted using a *FIRST*-approved, commercially manufactured Resistive Grounding Strap. The only Resistive Grounding Strap approved for use is the REV Robotics Resistive Grounding Strap (REV-31-1269). Teams that have electronics with Powerpole-style connectors may also use the REV Robotics Anderson Powerpole to XT30 Adapter (REV-31-1385) in conjunction with the REV Robotics Resistive Grounding Strap. No other grounding straps or adapters are permitted. For additional details on installation of the grounding strap or adapter, please see the [Robot Wiring Guide](#).”

<RE15> Modifying Electronics - Approved electrical and electronic devices may be modified to make them more usable; they may not be modified internally or in any way that affects their safety.

Examples of modifications that are allowed:

- Shortening or extending wires
- Replacing or adding connectors on wires
- Shortening motor shafts
- Replacing gearboxes and/or changing gears

Examples of modifications that are **not** allowed:

- Replacing an H-Bridge in a motor controller
- Rewinding a motor
- Replacing a fuse with a higher value than specified by the manufacturer
- Shorting out a fuse

<RE16> Driver Station Constraints – Teams provide their own *Driver Station* and it must comply with the following constraints:

- a. The *Driver's Station* must consist only of:
 - i. One (1) Android device
 - ii. One (1) OTG Cable
 - iii. No more than one (1) USB hub
 - iv. No more than two (2) gamepads
 - v. Any components used to hold the above listed legal devices.
- b. The *Driver Station* Android device USB interface may only connect to either:
 - i. A Mini *USB to OTG* (On-The-Go) cable or combination of cables connected to a non-powered USB Hub, or
 - ii. One (1) gamepad and an OTG Micro Adapter.
- c. One optional COTS USB external battery connected to the USB Hub to charge the Android device is allowed.
- d. The only allowed gamepads are listed below. They may be used in any combination.
 - i. Logitech F310 gamepad (Part# 940-00010)
 - ii. Xbox 360 Controller for Windows (Part# 52A-00004)
- e. The touch display screen of the *Driver Station* must be accessible and visible by competition personnel.

Important Note: The *Driver Station* is a wireless device with a built-in wireless radio. During a match, the *Driver Station* should not be obscured by metal or other material that could block or absorb the radio signals from the *Driver Station*.

<RE17> Additional Electronics – Electronic devices that are not specifically addressed in the preceding rules are not allowed. A partial list of electronics that are not allowed includes: Arduino boards, Raspberry Pi, relays, and custom circuits.

8.3.4 Robot Software Rules

<RS01> Android Device Names - Each *Team* MUST “name” their *Robot Controller* with their official *FIRST* Tech Challenge *Team* number and –RC (for example, “12345-RC”). Each *Team* MUST “name” their *Driver Station* with their official *Team* number and –DS (for example, 12345-DS). Spare Android devices should be named with the *Team* number followed by a hyphen then a letter designation beginning with “B” (for example, “12345-B-RC”, “12345-C-RC”).

<RS02> Recommended Programming Language - *Java* and the Blocks Development Tool are the recommended programming languages for the *FIRST* Tech Challenge. The minimum allowed app version number is 4.0. Programming must be done using one of the following applications:

- a. FTC Blocks Development tool – a visual, blocks-based programming tool hosted by the *Robot*

Controller.

- b. Android Studio – a text-based integrated development environment.
- c. Java Native Interface (JNI) & Android Native Development Kit (NDK) – *Teams* can incorporate native code libraries into their apps using the JNI framework and the Android NDK.
- d. FTC OnBot Java Programming tool – a text-based integrated development environment hosted by the Robot Controller.

If mandatory updates are announced by *FIRST* later in the season, *Teams* must install them before the time of competition. Additionally, beta versions of the software are allowed at official tournaments.

<RS03> Allowed Android Operating Systems - The only allowed operating systems for the *Robot Controller* and *Driver Station* Android devices are:

- a. ZTE Speed: 4.4 or higher (Kit Kat)
- b. Motorola Moto E4: 7.1 or higher (Nougat)
- c. Motorola Moto G 2nd Generation, Motorola Moto G 3rd Generation, Google Nexus 5, Samsung Galaxy S5: 6.0 or higher (Marshmallow)
- d. Motorola Moto G4 Play: 6.0.1 or higher (Marshmallow)
- e. Motorola Moto G5: 7.0 or higher (Nougat)

IMPORTANT: Rules <RS02> or <RS03> do not require that *Teams* upgrade to the latest version of the software. A mandatory upgrade would only be required if *FIRST* determined there was a critical software fix that must be adopted by *Teams*. Mandatory upgrades will be communicated in the following ways:

- Via [Team Blast](#) – The mandatory upgrade and version number will be communicated to *Teams* on the *Team Blast*, which will also show the date the required upgrade must be made.
- Online – the minimally required software will be listed on our [Technology Resources](#) page, with the date *Teams* are required to make the mandatory software upgrade.
- Forum – The minimally required software will be listed in the [Technology Forum](#) page, with the date *Teams* are required to make the mandatory software upgrade.

Templates for all programming choices are available through the links located at <http://www.firstinspires.org/node/5181>.

<RS04> Autonomous to Driver-Controlled Transition - *Teams* that expect to operate their *Robot* during the Autonomous period must demonstrate during Field Inspection the *Driver Station* switches the *Robot Controller* between Autonomous mode and Driver-Controlled mode.

<RS05> Robot Controller App - The *Robot Controller* must have a designated “FTC *Robot Controller*” app that is the default application for the *Core Robot modules* (*Servo, Motor, and Device Interface*) or the *REV Expansion Hub*.

<RS06> Driver Station App - *Teams* must install the official “FTC *Driver Station*” app onto their *Driver Station* Android Device and use this app to control their *Robot* during a match. The *Driver Station* software version number must match the version number of the *Robot Controller* app.

<RS07> Android Device Operating System Settings - The *Robot Controller* and *Driver Station* must be set to airplane mode, and Bluetooth must be turned off.

<RS08> Wi-Fi Direct Channel Changing App - The *Robot Controller* must have the *FIRST Tech Challenge* “Wi-Fi Direct Channel Changing” App installed (ZTE Speed ONLY).

<RS9> Software Modification - *Teams* are not allowed to modify the *FIRST Tech Challenge Driver Station* application or *Robot Controller* SDK in any fashion.

<RS10> Driver Station Communication - Communication between the *Robot* and *Driver Station* is only allowed via the *Robot Controller* and *Driver Station* applications.

Communication between the *Robot Controller* and the *Driver Station* is limited to the unmodified mechanisms provided by the official *FIRST Tech Challenge* (FTC) software, which consists of the official FTC Software Development Kit (SDK), the FTC *Robot Controller* app, and the FTC *Driver Station* app. *Teams* are not permitted to stream audio, video or other data using third party software or modified versions of the FTC software. *Teams* may only use the unmodified telemetry feature included with the FTC software to transfer additional data between the *Robot Controller* and the *Driver Station*. Software that is preinstalled by an approved phone’s manufacturer and cannot be disabled is exempt from this constraint.

During a Match a *Team’s Robot Controller* and a *Team’s Driver Station* are not allowed to be connected wirelessly to any other device besides each other.

8.4 Team Marker Rules

The Team Marker is a new, game specific scoring element that will be used in the ROVER RUCKUSSM Presented by Qualcomm® game. The Team Marker must pass Inspection before it allowed to be used in a Match.

<TM01> Material Constraints - The Team Marker is subject to the *Robot Mechanical Parts and Materials* Rules in section 8.3.2.

<TM02> Size Constraints - The maximum size of the *Team Marker* is 4 inches (10.16 cm) by 4 inches (10.16 cm) by 8 inches (20.32 cm). The minimum size of the *Team Marker* is 3 inches (7.62 cm) by 3 inches (7.62 cm) by 4 inches (10.16cm).

<TM03> Team Number - Team Markers must be labeled with their *Team* number (numerals only, for example “12345”) The letters must be legible when viewed from a distance of 12 inches away. The Team number needs to appear only once on the Team Marker.

<TM04> Illegal Parts - The following types of mechanisms and parts are not allowed:

- a. Electronics.
- b. Any other part or material that violates *Robot* construction rules outlined in section 8.3.

9.0 Robot Inspection

9.1 Overview

This section describes *Robot* Inspection for the *FIRST* Tech Challenge competition. It also lists the inspection definitions and inspection rules.

9.2 Description

The *FIRST* Tech Challenge *Robot* will be required to pass *Robot* and Field inspections before being cleared to compete. These inspections will ensure that all *Robot* rules and regulations are met. Initial inspections will take place during *Team* check-in/practice time. The official “*Robot* Inspection Checklists” are located in Appendices B and C.

9.2.1 Team Self-Inspection

Teams are highly recommended to conduct a self-inspection of their *Robot* and submit the completed *Robot* Inspection forms to the *Robot* Inspectors. *Teams* should go through each checklist at least a week before the competition to make sure their *Robot* is made up of legal parts. *Teams* should bring their self-inspection sheets to the competition and hand them in to the *Robot* and Field Inspectors.

9.3 Definitions

Robot Initialization Routine – A set of programming instructions that runs after Init is pressed on the Driver Station, but before Start for both Driver Controlled and Autonomous periods.”

Robot Sizing Tool – A sturdily constructed device with the interior dimensions: 18 inches (45.72 cm) wide by 18 inches (45.72 cm) long by 18 inches (45.72 cm) high that has one open side with an interior opening size of 18 inches (45.72 cm) wide by 18 inches (45.72 cm) long. The Sizing Tool is used for *Robot* Inspection as outlined in section 8.3.1.

9.4 Inspection Rules

<I1> Inspection - Every *Robot* will be required to pass a full inspection before being cleared to compete. This inspection ensures that all *FIRST* Tech Challenge *Robot* rules and regulations are met. *Teams* are highly recommended to conduct a self-inspection of their *Robot* and submit the completed inspection forms at their designated *Robot* Inspection appointment.

All *Robot* configurations must be inspected before being used in competition.

- a. If significant changes are made to a *Robot* after passing initial inspection, it must be re-inspected before it will be allowed to compete.
- b. Referees or inspectors may request the re-inspection of a *Robot*. The *Robot* is not allowed to participate in a match until it passes re-inspection. Refusal to submit to re-inspection will result in *Team* disqualification from the tournament.
- c. Appendices B and C of this manual contain copies of the *Robot* and Field Inspection forms and provide additional information about the inspection process.
- d. A *Robot* may be rejected at inspection if the Lead Inspector considers it unsafe.

<I2> Practice Matches - *FIRST* Tech Challenge *Teams* must submit their *Robot* for inspection before participating in *Practice Matches*. At the discretion of the Lead Inspector, the *Robot* may be allowed to participate in practice rounds before passing inspection.

<I3> Qualification Matches - The *Team's Robot* must pass all inspections before participating in *Qualification Matches*. Noncompliance with any *Robot* design, construction rule, or programming requirements may result in disqualification of the *Team* at a *FIRST* Tech Challenge tournament.

<I4> Re-Inspection – *Teams* that modify their *Robot* to improve performance or reliability are required to request a re-inspection of their *Robot* by an Inspector.

<I5> Safety - It is the Inspector's responsibility to evaluate *Robots* to insure each *Robot* has been designed to operate and function safely. Section 8 of this manual, and Game Manual Part 2, section 1.6.1 specify the safety rules and limits that apply to the design and construction of all *Robots*.

<I6> Passing Inspection - *Robot* inspection is a Pass/Fail process. A *Robot* has passed inspection when ALL requirements listed on the official *FIRST* Tech Challenge "*Robot* and Field Inspection Sheets" have been successfully met and recorded as passed by an Inspector.

<I7> All Mechanisms are Inspected - At the time of Inspection, the *Robot* must be presented with all mechanisms (including all components of each mechanism), configurations, and decorations that will be used on the *Robot* during the competition. It is acceptable for a *Robot* to play matches with a subset of the mechanisms that were present during inspection. Only mechanisms that were present during inspection may be added, removed, or reconfigured between matches. The *Robot* should be assembled in a typical configuration used for match play when reporting for inspection.

- a. *Robot* and all mechanisms must be inspected in every starting configuration.
- b. If mechanisms are swapped out between matches, the reconfigured *Robot* must still meet all *Robot* rules and inspection criteria.
- c. The sum of all electronics (motors, servos, *Core* modules, Android devices, etc.) used to construct all mechanisms and base *Robot*, whether they are used on the *Robot* at the same time or not, may not exceed the constraints specified in the *Robot* construction rules.

<I8> Wheel/Tread *Playing Field* Damage Test - *Robot* Inspectors have the authority to request that a *Team* test their wheels/treads that they feel might cause damage to the *Playing Field*. Since not every tread or wheel can be evaluated and posted as a legal or illegal part, the tread test is a quick way to determine if a *Team's* wheels/treads are competition legal.

The *Robot* Inspector should place the *Robot* on top of a field tile and against an immovable surface (wall), and run the wheels at full power for 15 seconds. If there is any physical damage to the floor tile, the wheels will not be allowed. Discoloration or black marks alone are not considered field damage. The test must be made with the *Robot* at the weight it will be at during the competition since this will affect the degree of damage.

<I9> Team Marker Inspection - Team Markers will be inspected prior to the start of the competition, and concurrently with *Robot* inspection. A Team Marker must be re-inspected if it is modified after initial inspection.

10.0 Judging & Award Criteria

10.1 Overview

This section provides descriptions of all the *FIRST* Tech Challenge Awards; the judging process, award criteria, Engineering Notebook guidelines, and philosophy that *Teams* need to be aware of in preparation for participating at *FIRST* Tech Challenge Tournaments.

Teams have spent a significant amount of time designing, building, programming their *Robot*, and learning what it takes to be part of a *Team*. For many *Teams*, the Event is the reward for all their hard work throughout the season. While there are several types of Events, they all offer a fun and exciting way for *Teams* to show the results of their efforts.

The judged awards represent a positive way we recognize *Teams* who embody important values like *Gracious Professionalism*®, Teamwork, creativity, innovation, and the value of the engineering design process. These judging guidelines are a part of the road map to success.

FIRST Tech Challenge judging sessions do not include written or verbal feedback for students. The judging is a subjective process; and students are encouraged to learn the important life skill of self-evaluation. This helps students prepare for professional interviews while developing other real world life skills. For a copy of the FIRST Tech Challenge *Team* Judging Session Self-Reflection Sheet please visit the website:

<http://www.firstinspires.org/node/5226>

10.2 Engineering Notebook

10.2.1 Overview

This section describes the requirements for creating the Engineering Notebook, including formatting guidelines, and the use of various forms of engineering support. It also provides links for sample pages from award winning Engineering Notebooks.

10.2.2 What is an Engineering Notebook?

One of the goals of FIRST and FIRST Tech Challenge is to recognize the engineering design process and “the journey” that a *Team* makes during the phases of the problem definition, concept design, system-level design, detailed design, test and verification, and production.

Throughout the process of building and designing a *Robot*, *Teams* will come across obstacles, lessons learned, and the need to draw things out on paper. This is where *Teams* will use an Engineering Notebook. These notebooks follow the *Team* from kickoff throughout the Competitions. Judges review a *Teams* Engineering Notebook to better understand the journey, design, and *Team* as a whole.

The Engineering Notebook is a complete documentation of the *Team*, outreach and fundraising efforts, business or strategic plans, and the *Robot* design. This documentation should include sketches, discussions and *Team* meetings, design evolution, processes, obstacles, and each *Team* member’s thoughts throughout the journey for the entire season. A new notebook should be created for each new season.

Please visit our website for a complete guide on writing and managing a Team Engineering Notebook.

http://www.firstinspires.org/sites/default/files/uploads/resource_library/ftc/engineering-notebook-guidelines.pdf.

10.2.3 Engineering Notebook Formats

Teams may choose to record their season with either handwritten or electronic documents. There is no distinction made between handwritten and electronic Engineering Notebooks during judging; each format is equally acceptable.

- **Electronic:** *Teams* may choose to use electronic programs to create their Engineering Notebook. For the purposes of judging, *Teams* must print out their Engineering Notebooks and place them in a binder, no larger than 3 inches (7.62 cm). Only one copy is required per *Team*.
- **Handwritten:** *Teams* can choose from spiral-bound, laboratory, or documentation notebooks available through their school or local office supply store. *Teams* can also use loose leaf paper and place them in a three ring binder no larger than 3 inches (7.62 cm).

10.2.4 Engineering Notebook Requirements

Engineering Notebooks will **NOT** be considered without the following information.

1. *Teams* may not submit more than two notebooks at a competition.
2. The *Team* Number must appear on the outside front cover of the Engineering Notebook.
3. Attach a summary page to the front cover of the Engineering Notebook. This should include:
 - a. The *Team* number.
 - b. A brief, one-page narrative about the *Team*, the school or organization, and an overview of the highlights of the *Team*'s season.
 - c. The summary page must point the Judges to pages in the Engineering Notebook that the *Team* would most like the Judges to consider.
4. The Engineering Notebook must be divided into multiple sections, including:
 - a. An Engineering section that includes the *Robot* design processes.
 - b. A *Team* section that includes information about the *Team* and outreach activities.
 - c. A business plan, strategic plan or sustainability plan.

The *Team* summary page is a vital part of the Engineering Notebook. This tells the Judges what they need to know about the *Team*, and which parts of the Engineering Notebook they should focus on. Remember, Judges have a limited amount of time to read each notebook!

Teams can use the [Team Engineering Notebook Self-Reflection sheet](https://www.firstinspires.org/sites/default/files/uploads/resource_library/ftc/2016-2017-season/eng-notebook-self-assessment.pdf) as a way to be sure their Engineering Notebook meets the requirements for specific awards. Find the Engineering Notebook Self-Reflection sheet here: https://www.firstinspires.org/sites/default/files/uploads/resource_library/ftc/2016-2017-season/eng-notebook-self-assessment.pdf

10.2.5 Engineering Notebook Requirements by Award

The chart below provides a quick overview of the Engineering Notebook requirements by Award:

Engineering Notebook Requirements by Award	
Inspire Award	<ul style="list-style-type: none"> <i>Team</i> must submit an Engineering Notebook. The Engineering notebook must include an Engineering section, a Team section and a Business or Strategic Plan. The entire Engineering Notebook must be high quality, thoughtful, thorough, detailed and well organized.
Think Award	<ul style="list-style-type: none"> Engineering Notebook must have an Engineering section that includes entries describing underlying science, mathematics, and game strategies. The Engineering Notebook must show that the Team has a clear understanding of the engineering design process, with pictures or drawings and details documenting all stages of Robot design. Notebook must recount the Team's journey, experience and lessons learned throughout the season. Engineering Notebook must be organized and follow the formatting guidelines provided by FIRST and include a Summary Page. Note: Teams should review the Engineering Notebook resources published in the Team Management section of the FIRST website.
Connect Award	<ul style="list-style-type: none"> <i>Team</i> must submit an Engineering Notebook. The Engineering Notebook must include a Business or Strategic plan. The plan could

	include the future goals of the team, and the steps they will take to reach those goals. The plan could include fund-raising goals, sustainability goals, timelines, outreach, and community service goals.
Rockwell Collins Innovate Award	<ul style="list-style-type: none"> • <i>Team</i> must submit an Engineering Notebook. The Engineering Notebook must include an Engineering section that documents the design process and how the <i>Team</i> arrived at their design solution.
Design Award	<ul style="list-style-type: none"> • <i>Team</i> must submit an Engineering Notebook with an Engineering section that includes detailed <i>Robot</i> design drawings.
Motivate Award	<ul style="list-style-type: none"> • <i>Team</i> must submit an Engineering Notebook. The Engineering Notebook must include a Business or Strategic plan. The plan could include the future goals of the team, and the steps they will take to reach those goals. The plan could include fund-raising goals, sustainability goals, timelines, outreach, and community service goals
Control Award	<ul style="list-style-type: none"> • The <i>Team</i> must submit an Engineering Notebook. The Engineering Notebook must include an Engineering section that documents the control components.

10.2.6 Notebook Examples

Scanned copies of award-winning Engineering Notebook examples are posted on the [FIRST website](#). It is strongly encouraged for *Teams* to look over these as great examples of what the judges will be looking for when reading through the Engineering Notebooks.

10.3 Judging Process, Schedule, and Team Preparation

The schedules at the *FIRST* Tech Challenge Tournaments may vary from site to site. Exact times for both the matches and meeting with judges cannot be given within this manual. All *Teams* receive the schedule prior to or during check-in at the Competition.

10.3.1 Judging Process

At *FIRST* Tech Challenge Championship Tournaments, there will be three parts to the judging process:

1. Interview with the judges.
2. Evaluation of performance.
3. Evaluation of the Engineering Notebook.

Each *Team* will have an interview with a panel of two or three judges. No awards will be determined on the basis of this interview alone. Judges use the guidelines provided in this section to assess each *Team*.

Teams should present their Engineering Notebooks at the Pit Administration Table during check-in unless otherwise directed by the Tournament officials. The Engineering Notebooks are generally provided to the judges prior to the *Team* interviews.

After the judges review the submitted Engineering Notebooks, complete the initial *Team* interviews and evaluate the *Team* and *Robot* performance during matches, they convene to review their assessments and create a list of top candidates for the various judged awards. Judges may require additional impromptu discussions with *Teams* if necessary. Deliberations are usually completed during the *Elimination Matches*. When the judges have finished their deliberations, the Engineering Notebooks are returned to *Teams*.

Teams are asked to bring their *Robot* to the judge interview. This is the best chance for *Teams* to explain and demonstrate their *Robot* design to the judges in a quiet and relaxed environment.

10.3.1.1 Feedback to Teams

FIRST Tech Challenge does not permit feedback provided to *Teams* during or after their Interview has taken place at official Tournaments. FIRST Tech Challenge judging is a subjective process; the goal is to prepare student *Team* members with real life Interview skills, and to continue to build upon those skills from Event to Event.

FIRST encourages *Teams* to utilize the [Self-Reflection Sheet](#) to evaluate themselves through the Interview, and the [Team Engineering Notebook Self-Reflection Sheet](#) to evaluate their Engineering Notebook. These sheets are accessible online. *Teams* should not ask the Judges for feedback after the interview is complete. An essential aspect of FIRST Tech Challenge Judging is the subjectivity, and that FIRST Tech Challenge encourages students to learn how to self-evaluate. Although it may be that *Teams* are discouraged by this, learning this process is an invaluable life skill.

10.3.2 Judging Schedule

The judging generally takes place in a separate area away from the noise of the Competition and pit. *Teams* follow the schedule that outlines *Team* interview times and locations. In some cases, *Teams* may receive this information in advance, but more often, *Teams* will receive this information when they check-in on the morning of the Event.

Upon arrival, *Teams* should familiarize themselves with where the judging will occur and allow enough time to get there. To keep this process on time throughout the Event, we require that all *Teams* arrive at the judge queuing area five minutes before their scheduled judging interview.

10.3.3 Team Preparation

Teams are strongly encouraged to read and understand the award requirements for each award to assess where they are within an award category and help them establish higher goals. These guidelines are the same ones used by the judges during each Tournament, and at the FIRST Tech Challenge World Championship Tournaments. Please see the [Award Categories](#) section of this manual for award requirements, and also look over the [Engineering Notebook Requirements by Award](#) to ensure the *Team's* Engineering Notebook meets the required criteria by award.

The judges want to know highlights about the *Team*; its history and make up; what the *Team* achieved during the Competition season; and the experiences that were gained. *Team* representatives' abilities to answer the questions or elaborate on *Robot* design functions or attributes are evaluated during the *Team* interview. Check with the Event organizer to see if Mentors and Coaches are allowed to observe the *Team* interview. Mentors may not contribute to the judging process. Mentors should always keep in mind that the FIRST Tech Challenge is a student-centered activity and it is about giving the students a unique and stimulating experience in all aspects of the program.

10.3.4 Video Award Submission Guidelines

The submission process for this award may vary by Tournament. Please check with the Event Director for details. Winning videos will be submitted to FIRST and used to promote the higher values of FIRST Tech Challenge. *Teams* can also send their Promote videos directly to FIRST; however, these submissions will not be formally judged.

- The video must be submitted at least one week prior to Tournament day. Instructions for submitting videos may vary from Tournament to Tournament. Please check with the Event Director for details.
- Videos must be submitted in AVI, WMV, MOV or better format. Submission through use of a streaming service such as YouTube is not acceptable. Remember the winning video may be shown on a large screen during the awards ceremony. *Teams* should use the best resolution available for the final

version.

- Only one video submission per *Team* will be considered. *Teams* may submit new or updated videos at each Tournament.
- *Teams* must have permission from the copyright owners for music used in the video.

10.4 Award Categories

Each Award listed below has a list of non-negotiable requirements. Please note that each award has a set of required criteria. *Gracious Professionalism*® is listed as the first criteria for every award. This is a mandatory requirement for every FIRST Tech Challenge Award. Teams who behave in an ungracious way are not eligible for consideration for any Award.

10.4.1 Inspire Award

This judged award is given to the *Team* that embodied the ‘challenge’ of the FIRST Tech Challenge program. The *Team* that receives this award is a strong ambassador for FIRST programs and a role model FIRST *Team*. This *Team* is a top contender for many other judged awards and is a gracious competitor. The Inspire Award winner is an inspiration to other *Teams*, acting with *Gracious Professionalism*® both on and off the *Playing Field*. This *Team* shares their experiences, enthusiasm and knowledge with other *Teams*, sponsors, their community, and the Judges. Working as a unit, this *Team* will have showed success in performing the task of designing and building a *Robot*.

The Inspire Award celebrates a *Team* that, in the opinion of the Judges, is a strong contender in many Award categories. The reliability of the *Robot* during the *Robot* competition is one aspect of this Award, but it does not carry more weight than any

Required criteria for the Inspire Award:

- *Team* shows respect and *Gracious Professionalism*® to everyone they meet at a FIRST Tech Challenge event.
- *Team* is a strong contender for several other Judged awards. The Inspire Award celebrates the strongest qualities of all the Judged Awards.
- The *Team* is an ambassador for FIRST programs. They demonstrate and document their work in their community.
- *Team* is positive and inclusive, and each *Team* member contributes to the success of the *Team*.
- *Team* must submit an [Engineering Notebook](#). The Engineering notebook must include an Engineering section, a Team section and a Business or Strategic Plan. The entire Engineering Notebook must be high quality, thoughtful, thorough, detailed and well organized.
- *Robot* design is creative and innovative, and the *Robot* performs reliably on the field. *Team* communicates clearly about their *Robot* design and strategy to the judges.
- *Team* presentation is professional and engaging.

10.4.2 Think Award

Removing engineering obstacles through creative thinking.

This judged award is given to the *Team* that best reflects the journey the *Team* took as they experienced the engineering design process during the build season. The Engineering section of the notebook is the key reference for judges to help identify the most deserving *Team*. The *Team*’s Engineering section must focus on the design and build stage of the *Team*’s *Robot*. Journal entries must include descriptions of the underlying science and mathematics of the *Robot* design and game strategies, the designs, redesigns, successes, and opportunities for improvement. A *Team* is not a candidate for this award if they have not completed the Engineering section of the Engineering Notebook.

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

Required criteria for the Think Award:

- **Team** shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.
- **Team** must submit an [Engineering Notebook](#). The Engineering Notebook must have an Engineering section that includes entries describing underlying science, mathematics, and game strategies.
- The Engineering Notebook must show that the **Team** has a clear understanding of the engineering design process, with pictures or drawings and details documenting all stages of *Robot* design.
- Notebook must recount the **Team's** journey, experience and lessons learned throughout the season.
- Engineering Notebook must be organized and follow the [formatting guidelines](#) provided by *FIRST* and include a Summary Page. Note: **Teams** should review the Engineering Notebook resources published in the [Team Management](#) section of the *FIRST* website.

Strongly suggested criteria for the Think Award:

- **Teams** should tab or flag 6 to 8 pages of the Engineering section to support entries on the summary page.

10.4.3 Connect Award

Connecting the dots between community, *FIRST*, and the diversity of the engineering world.

This judged award is given to the **Team** that most connects with their local science, technology, engineering and math (STEM) community. A true *FIRST* **Team** is more than a sum of its parts, and recognizes that engaging their local STEM community plays an essential part in their success. The recipient of this award is recognized for helping the community understand *FIRST*, the *FIRST* Tech Challenge, and the **Team** itself. The **Team** that wins the Connect Award aggressively seeks and recruits engineers and explores the opportunities available in the world of engineering, science and technology. This **Team** has a clear Business or Strategic Plan and has identified steps to achieve their goals.

Required criteria for the Connect Award:

- **Team** shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.
- **Team** must submit an [Engineering Notebook](#). The Engineering Notebook must include a Business or Strategic plan that identifies their future goals and the steps they will take to reach those goals. Examples of what the plan could include are fund-raising goals, sustainability goals, timelines, outreach, and community service goals.
- **Team** provides clear examples of developing in person or virtual connections with individuals in the engineering, science, or technology community.
- **Team** actively engages with the engineering community to help them understand *FIRST*, the *FIRST* Tech Challenge, and the **Team** itself.

10.4.4 Rockwell Collins Innovate Award

Bringing great ideas from concept to reality.

The Rockwell Collins Innovate Award celebrates a *Team* that thinks outside the box, and has the ingenuity and inventiveness to make their designs come to life. This judged award is given to the *Team* that has the most innovative and creative *Robot* design solution to any specific components in the *FIRST* Tech Challenge game. Elements of this award include elegant design, robustness, and 'out of the box' thinking related to design. This award may address the design of the whole *Robot*, or of a sub-assembly attached to the *Robot*. The creative component must work consistently, but a *Robot* does not have to work all the time during Matches to be considered for this award. The *Team's* Engineering Notebook must include journal entries to show the design of the component or components and the *Team's Robot* to be eligible for this award. Entries must describe how the *Team* arrived at their solution.

Required criteria for the Rockwell Collins Innovate Award:

- *Team* shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.
- *Team* must submit an [Engineering Notebook](#). The Engineering Notebook must include an Engineering section that documents the design process and how the *Team* arrived at their design solution.
- *Robot* or *Robot* sub-assembly must be elegant and unique in its design.
- Creative component must be stable, robust, and work reliably.
- *Robot* design is efficient and consistent with *Team* plan and strategy.

10.4.5 Design Award

Industrial design at its best.

This judged award recognizes design elements of the *Robot* that are both functional and aesthetic. The Design Award is presented to *Teams* that incorporate industrial design elements into their solution. These design elements could simplify the *Robot's* appearance by giving it a clean look, be decorative in nature, or otherwise express the creativity of the *Team*. The winning design should not compromise the practical operation of the *Robot* but complement its purpose.

Required criteria for the Design Award:

- *Team* shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.
- *Team* must submit an [Engineering Notebook](#) with an Engineering section that includes detailed *Robot* design drawings.
- *Team* demonstrates industrial design principles, striking a balance between form, function, and aesthetics.
- *Robot* distinguishes itself from others by its aesthetic and functional design.
- Basis for the design is well considered (that is inspiration, function, etc.).

10.4.6 Motivate Award

Sparking others to embrace the culture of *FIRST*!

This *Team* embraces the culture of *FIRST* and clearly shows what it means to be a *Team*. This judged award celebrates the *Team* that represents the essence of the *FIRST* Tech Challenge competition through *Team*

building, *Team* spirit and displayed enthusiasm. This is a *Team* who makes a collective effort to make *FIRST* known throughout their school and community, and sparks others to embrace the culture of *FIRST*.

Required criteria for the Motivate Award:

- *Team* shows respect and **Gracious Professionalism®** to everyone they meet at a *FIRST* Tech Challenge event.
- *Team* must submit an [Engineering Notebook](#). The Engineering Notebook must include a Business or Strategic plan that identifies their future goals and the steps they will take to reach those goals. Examples of what the plan could include are fund-raising goals, sustainability goals, timelines, outreach, and community service goals.
- The *Team* is an ambassador for *FIRST* programs.
- *Team* can clearly show the successful recruitment of new *Teams*, mentors, coaches and volunteers who were not already active within the STEM community.
- *Team* can explain the individual contributions of each *Team* member, and how these apply to the overall success of the *Team*.

Strongly suggested criteria for the Motivate Award:

- All *Team* members take part in their presentation, and actively engage with the judges.
- *Team* shows a creative approach to materials that market their *Team* and *FIRST*.

10.4.7 Control Award

Mastering *Robot* intelligence.

The Control Award celebrates a *Team* that uses sensors and software to increase the *Robot's* functionality on the field. This award is given to the *Team* that demonstrates innovative thinking in the control system to solve game challenges such as autonomous operation, improving mechanical systems with intelligent control, or using sensors to achieve better results on the field. The control component should work consistently on the field. The *Team's* Engineering Notebook must contain details about the implementation of the software, sensors, and mechanical control.

Required criteria for the Control Award:

- *Team* shows respect and **Gracious Professionalism®** to everyone they meet at a *FIRST* Tech Challenge event.
- *Team* must apply for the Control Award by filling out the Control Award Content Sheet, located in [Appendix D](#).
- The *Team* must submit an [Engineering Notebook](#). The Engineering Notebook must include an Engineering section that documents the control components.
- Control Components must enhance the functionality of the *Robot* on the *Playing Field*.

Strongly suggested criteria for the Control Award:

- Advanced software techniques and algorithms are encouraged.
- Control Components should work reliably.

The Control award is different from other Awards because *Teams* must apply for this Award. A *Team* applying

for this Award must turn in their Control Award Content Sheet to the Judges at the event. This Award focuses on a *Team's* ability to program a *Robot* that can reliably and efficiently carry out tasks during Match play, in a way that improves their ability to score during a Match. A *Team* can submit their code for Autonomous operation as well as their code for the Driver Controlled operation, if they choose.

The Judges are responsible for collecting the content sheet at the beginning of the *Teams'* Interview. After the *Team* Interview is complete, the Judges will reference the sections of the Engineering Notebook the *Team* has pointed out on the Control Award Content Sheet. The Judges should pay attention to look for:

- What sensors and hardware the *Team* has tried on the *Robot*; what worked, what didn't, and why.
- What algorithm or code the *Team* has programmed their *Robot* with; what worked, what didn't, and why.
- The Judges should pay attention to the program and design process. The design process is more critical than the code itself.

***Teams* are not required to include a printed copy of their code in the Control Award application or in the Engineering Notebook.**

Just like having Engineering Notebook reviewers, the Judge Advisor will assign a group of 2-3 Judges to review the Control Award Content Sheets, once Interviews are complete.

10.4.8 Promote Award (Optional)

This judged award is optional and may not be given at all Tournaments. Your Judge Advisor will have information about the Judging for this Award.

The Promote Award is given to the *Team* that is most successful in creating a compelling video message for the public designed to change our culture and celebrate science, technology, engineering and math. *Teams* must submit a one-minute long public service announcement (PSA) video based on the PSA subject for the season.

Teams may win the Promote Award only once at a Championship level event and only once at a qualifying level event.

PSA Subject for 2018-2019 Season:

“If every student participated in *FIRST*, the world would be...”

Required criteria for the Promote Award:

- **Video must meet the following criteria:**
 - **Video Must follow *FIRST* branding and design standards**
 - **Video cannot be longer than 60 seconds.**
 - **Video must be of a high quality, as submissions may be used at a later time to promote *FIRST*.**
 - ***Team* must have rights to music used in the video.**
 - **Music and permissions must be listed in video credits**
 - **Video must have strong production value.**
 - **Video must be submitted by the deadline given by the Event Organizer**
- ***Team* must present a thoughtful and impactful video which appeals to the public.**
- **Creativity in interpreting the yearly theme is required.**

- Follow [video award submission guidelines](#).

10.4.9 Compass Award (Optional)

A beacon and leader in the journey of the *FIRST* Tech Challenge.

This judged award is optional and may not be given at all tournaments. Your Judge Advisor will have information about the Judging for this Award.

The Compass Award recognizes an adult Coach or Mentor who has given outstanding guidance and support to a *Team* throughout the year and demonstrates to the *Team* what it means to be a Gracious Professional. The winner of the Compass Award will be determined from candidates nominated by *FIRST* Tech Challenge student *Team* members, via a 40-60 second video submission. The video must highlight how their Mentor has helped them become an inspirational *Team*. We want to hear what sets the Mentor apart.

Required criteria for the Compass Award:

- **Video must meet the following criteria:**
 - Video Must follow *FIRST* branding and design standards
 - Video cannot be longer than 60 seconds.
 - Video must be of a high quality, as submissions may be used at a later time to promote *FIRST*.
 - *Team* must have permission from the copyright owners for music used in the video.
 - Music and permissions must be listed in video credits
 - Video must be submitted by the deadline given by the Event Organizer.
- Video highlights the mentor's contribution to the *Team* and demonstrates what sets the mentor apart.
- Follow [video award submission guidelines](#).

10.4.10 Judges' Award

This award is optional and may not be given at all tournaments. Your Judge Advisor will have information about the Judging for this Award.

During the competition, the judging panel may meet a *Team* whose unique efforts, performance or dynamics merit recognition, but doesn't fit into any of the existing award categories. To recognize these unique *Teams*, *FIRST* offers a customizable Judges Award. The judging panel may select a *Team* to be honored, as well as the name of the Judges' Award. The Judges Award recognizes a *Team* for their outstanding efforts but does not factor into the Advancement Criteria.

10.4.11 Winning Alliance Award

This award will be given to the winning *Alliance* represented in the final match.

10.4.12 Finalist Alliance Award

This award will be given to the finalist *Alliance* represented in the final match.

11.0 FIRST® Tech Challenge Dean's List

In an effort to recognize the leadership and dedication of *FIRST*'s most outstanding *FIRST* Tech Challenge students, the Kamen family sponsors an Award for selected top students known as the *FIRST* Dean's List.

Since its introduction in 2010, the *FIRST* Dean's List Award has attracted the attention of prestigious colleges and universities who desire to recruit *FIRST* Dean's List students. Similar to the very prestigious National Merit Scholarship Award winners, there are three (3) "categories" of *FIRST* Dean's List Award students:

1. ***FIRST* Dean's List Semi-Finalists**

- *FIRST* Dean's List Semi-Finalists are the students nominated by each *Team* to compete for the *FIRST* Dean's List Finalist spots.

2. ***FIRST* Dean's List Finalists**

- The students selected to be recognized at each State/Regions Championship that are in the running for the *FIRST* Dean's List Winner spots.

3. ***FIRST* Dean's List Winners**

- The group of 10 students who are the final selection for the Dean's List Award at the *FIRST* World Championship.

Each *FIRST* Tech Challenge *Team* is invited to select up to two (2) students who are in the 10th or 11th grade (sophomores or juniors) as *FIRST* Dean's List Semi-Finalists. The students who earn *FIRST* Dean's List Award status as a Semi-Finalists, Finalist or Winner, are great examples of student leaders who have led their *Teams* and communities to increased awareness for *FIRST* and its mission. These students have also achieved personal technical expertise and accomplishment. It is the intention of *FIRST* that these individuals will continue, post-award, as great leaders, student alumni, and advocates of *FIRST*.

Prestigious colleges have expressed great interest in meeting *FIRST* Dean's List's Award winners and *FIRST* hopes that each *Team* will take advantage of the opportunity to nominate the most qualified students as *FIRST* Dean's List Nominees!

For more information on the Dean's List Award, and to see past *FIRST* Tech Challenge winners, please visit our website! <http://www.firstinspires.org/Robotics/ftc/deans-list>

11.1 Eligibility

Every registered *Team* in North America can submit up to two (2) students as *FIRST* Dean's List Award Semi-Finalists.

- Students must be a sophomore (grade 10) or junior (grade 11) to be eligible for this Award.
- The Coach or Mentor nominating the student(s) must submit an essay explaining why the student should receive this Award. The essay must be 4,000 characters or less.

11.2 Criteria

Criteria for selection of the *FIRST* Dean's List shall include, but not be limited to a student's:

- Demonstrated leadership and commitment to the ideals of *FIRST*;
- Interest in and passion for a long term commitment to *FIRST* and its ideals;
- Overall individual contribution to their *Team*;
- Technical expertise and passion;
- Entrepreneurship and creativity;
- Ability to motivate and lead fellow *Team* members; and
- Ability to effectively increase awareness of *FIRST* in their school and community.

The Mentor or Coach, who is not related to either of the students chosen as the *Team*'s Dean's List Semi-finalists, should gather the required information for the student *Team* member to interview for the *FIRST*

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

Dean's List Semi-Finalist designation at one (1) Qualifying Tournament, League Championship or Interview Only Event. Applications will require:

- Nominee name
- Nominee Grade
- Nominee GPA
- Qualifying Tournament for the Dean's List Interview to take place
- Nomination essay of no more than 4,000 characters
- Photo of Semi-Finalist (optional)

A photograph of the *FIRST* Dean's List Semi-Finalist is encouraged, but optional. Coaches can submit up to three photos of the student, and *FIRST* encourages at least one of the photos to be a head shot of the student. The essay submission and such photos may be used, in promotion of the recipient and/or the Award, at the discretion of *FIRST*.

11.3 Dean's List Nominations

There are specific instructions on how to submit Dean's List Nominations. The Dean's List Submission Guide has been created for Coaches and Mentors looking to submit a student for the Dean's List Award. Please visit our [website](#) for a copy of the Guide, which provides in depth information about the Dean's List, and step by step visual aids to complete the nominations.

Appendix A – Resources

Game Forum Q&A

<http://ftcforum.usfirst.org/forum.php>

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

Volunteers that apply for a specific volunteer role will receive an email from FTCTrainingSupport@firstinspires.org with their username and password to the forum. 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 – Robot Inspection Checklist

Team Number: _____

Robot Inspection Status (circle): **PASS / FAIL**

Team	Insp.	Robot Size & Weight Inspection	Rule #
		Robot is presented at inspection with all mechanisms (including all components of each mechanism), configurations, and decorations that will be used on the Robot during the competition.	<I7>
		Separately test the Robot in all of its unique starting (pre-match setup) configurations. The Robot fits within the Sizing Tool without exerting undue force on the Sizing Tool sides and top.	<I7>a <RG02>
		Robot Motion Warning Label is attached if servo motors move during the Robot initialization.	<RG02>b(i)
		Robot weighs no more than 42 pounds (19.05kg). + .5 pound overage allowance	<RG04>
✓	✓	General Robot Rules	Rule #
		Robot does not contain any components that could damage the Playing Field or other Robots.	<RG01>a&b
		Robot does not contain materials that are hazardous.	<RG01>c
		Robot poses no obvious unnecessary risk of entanglement.	<RG01>d
		Robot does not contain sharp edges or corners.	<RG01>e
		Robot does not contain animal-based, liquid, or gel materials.	<RG01>f&g
		Robot does not contain materials that would cause a delay of game if released.	<RG01>h
		Robot does not contain elements that electrically ground the Robot frame to the Playing Field.	<RG01>i
		Robot does not contain closed gas devices.	<RG01>j
		Robot does not contain hydraulic devices.	<RG01>k
		Alliance Flag Holder is present and adequately holds the Flag during normal Robot operation.	<RG05>
		Team number is visible from at least 2 sides (180 deg. apart). Numerals must be at least 2.5 inches (6.35 cm high), at least in 0.5 inches (1.27 cm) stroke width.	<RG06>
		Energy used by the Robot, (i.e., stored at the start of a Match), shall come only from approved sources.	<RG07>
		Robot is not capable of launching its own components.	<RG08>
✓	✓	Robot Mechanical Parts and Materials Rules	Rule #
		All components on the Robot are from allowable raw materials and Commercial Off The Shelf products.	<RM01> <RM02>
✓	✓	Robot Electrical Parts and Materials Rules	Rule #
		The Main Power Switch is installed properly, labeled, readily accessible, and visible to competition personnel. The TETRIX, REV, and MATRIX switches are the only allowed Main Power Switch.	<RE01>
		All batteries are securely attached to the Robot in a location where they will not make direct contact with other Robots or the Playing Field.	<RE02>
		Exactly one (1) Robot Main Battery Pack of an approved type is on the Robot and it is properly connected to the Main Power Switch and either the Core Power Distribution Module or REV Expansion Hub.	<RE03> <RE05>a(i)
		Where present, fuses must not be replaced with fuses of higher rating than originally installed or according to manufacturer's specifications.	<RE04>
		Allowed electronic devices are powered by power ports on the Core Power Distribution Module or REV Expansion Hub except as noted in <RE05>a&b, <RE12>, and <RE13>.	<RE05>a
		The Core Power Distribution Module or REV Expansion Hub is powered by the Robot main battery. If a hybrid of Modern Robotics modules is used with the REV Expansion Hub, the REV Expansion Hub must be powered from a power port on the Core Power Distribution Module.	<RE05>a(i)

		REV SPARK Mini Motor Controllers are powered by the Robot main battery.	<RE05>a(ii)
		Allowed sensors may only receive power from the Core Device Interface Module, and/or the REV Expansion Hub.	<RE05>a(iii)
		Light sources (including LEDs) are not focused or directed in any way, except for the REV Robotics 2m Distance Sensor. Light sources are powered by allowed methods.	<RE05>a(iv) <RE12>
		Video recording devices, if used, are powered by an internal battery and their wireless communication capability is turned off.	<RE05>a(v) <RE13>
		The Robot Controller is powered by its internal battery or by the built-in charging feature of the REV Expansion Hub.	<RE05>b
		Exactly one (1) Core Power Distribution Module is mounted on the Robot if any Modern Robotics Core Control Modules are used.	<RE07>a
		No more than two (2) REV Expansion Hubs are mounted on the Robot.	<RE07>e
		No more than two (2) Core Device Interface Modules are mounted on the Robot.	<RE07>b
		Robot contains no more than eight (8) DC motors of the allowed models.	<RE09>
		Robot contains no more than twelve (12) servos. They must be compatible with the attached REV Expansion Hub, REV Servo Power Module, or servo controller and not exceed the manufacturer specifications for the controller.	<RE10>
		Robot contains only allowed sensors and they are connected only to the REV Expansion Hub or the Core Device Interface Module.	<RE11>
		Power and motor control wires must use consistent color coding with different colors used for the positive (red, white, brown, or black with a stripe) and Negative/Common (black or blue) wires.	<RE14>h
		Power, motor control, servo and encoder wires are the correct size.	<RE14>k
		If electronics are grounded to the <i>Robot</i> frame, the only approved method is the REV Robotics Resistive Grounding Strap. If needed, the REV Robotics Anderson Powerpole to XT30 adapter may connect to the Resistive Grounding Strap. No other grounding straps or cables are allowed.	<RE14>l
		Approved electrical and electronic devices may be modified to make them more usable; they may not be modified internally or in any way that affects their safety.	<RE15>
✓	✓	Wheel/Tread Playing Field Damage Test - Optional	Rule #
		Robot did not damage the Playing Field tile. [This is an optional test that is performed only when an Inspector believes that the drivetrain tread may damage a Playing Field tile.]	<l8>
✓	✓	Team Marker Inspection	Rule #
		The <i>Team Marker</i> is subject to the <i>Robot</i> Mechanical Parts and Materials Rules in section 8.3.2.	<TM01>
		Maximum size of the Team Marker is 4 inches (10.16cm) by 4 inches (10.16cm) by 8 inches (20.32 cm). Minimum size of the <i>Team Marker</i> is 3 inches (7.62 cm) by 3 inches (7.62 cm) by 4 inches (10.16cm).	<TM02>
		Team Markers must be labeled with their Team number (numerals only, for example "12345").	<TM03>

General Comments or Reason(s) for Failure (if any):

I hereby state that all the above is true, and to the best of my knowledge all Robot construction rules and regulations of the FIRST® Tech Challenge have been abided by.

Robot Inspector

Team Student Representative

Appendix C – Field Inspection Checklist

Team Number: _____

Field Inspection Status (circle): **PASS / FAIL**

✓	Drive Team Members Present		Rule #
	Coach		<T8>
	Driver 1 (required); Driver 2 (optional)		<T8>
✓	Driver Station and Robot Controller Hardware Rules		Rule #
	Driver Station consists only of one Android device (Circle): ZTE Speed, Motorola Moto G 2 nd Generation, Motorola Moto G 3 rd Generation, Motorola Moto G4 Play, Motorola Moto G5, Motorola Moto E4, Google Nexus 5, or Samsung Galaxy S5.		<RE06> <RE16>a
	Robot Controller consists only of one Android device (Circle): ZTE Speed, Motorola Moto G 2 nd Generation, Motorola Moto G 3 rd Generation, Motorola Moto G4 Play, Motorola Moto G5, Motorola Moto E4, Google Nexus 5, or Samsung Galaxy S5. The Android device's USB interface only connects to the Core Power Distribution Module, a REV Expansion Hub, or a non-powered USB hub.		<RE06>
	Driver Station Android device USB interface is only connected to either a Mini USB to OTG cable or combination of cables connected to one non-powered USB Hub, or one gamepad.		<RE16>a&b
	No more than one (1) optional Commercial Off The Shelf USB external battery connected to the USB hub is allowed.		<RE16>c
	The Driver Station consists of no more than two of the allowed gamepads (Logitech F310 or Xbox 360 in any combination).		<RE16>a&d
	The touch display screen of the Driver Station must be accessible and visible to field personnel.		<RE16>e
DS	RC	Driver Station (DS) and Robot Controller (RC) Software Rules	Rule #
		Android operating system satisfies the requirements: ZTE Speed – version 4.4 or higher, Motorola Moto G4 Play 6.0.1 or higher, Motorola Moto G5 7.0 or higher, Motorola Moto E4 7.1 or higher, all other allowed Android devices – version 6.0 or higher.	<RS03>
		The Android device is set to airplane mode, and Bluetooth is turned off.	<RS07>
		Robot is not connected to any local networks.	
		Android device is named with the official team number followed by –DS or –RC as appropriate.	<RS01>
		Android Wi-Fi Direct device name does not include a newline character in the name.	
		All remembered Wi-Fi Direct Groups and Wi-Fi connections have been removed.	
		DS and RC apps are version 4.0 or higher and the DS and RC apps have the same version numbers.	<RS02>
		Communication between the Robot and Driver Station is only through the RC and DS applications. Out of band communication is not allowed.	<RS10>
	NA	Driver Station uses the official FTC Driver Station app to control the Robot.	<RS06>
NA		The FTC controller app is the default application, the application launches, and no other messages pop up.	<RS05>
NA		The FTC Wi-Fi Direct Channel Changing App is installed on the Robot Controller (for ZTE Speed devices only).	<RS08>
NA		Robot Controller is set to the correct Wi-Fi Direct channel (ZTE Speed, Motorola Moto G 2 nd Generation, Motorola Moto G 3 rd Generation, Motorola Moto G5, Motorola Moto G4 Play, and Motorola Moto E4 only).	<T6>
✓	Robot Operation Verified at the Playing Field		Rule #
	Robot Controller connects with the Driver Station.		
	Robot switches between autonomous and driver controlled operation correctly.		<RS04>
	Robot starts and stops when commanded by the Driver Station.		

✓	Queuing Process Information Provided at the Playing Field	Rule #
	Team understands that software changes are not allowed in the Queue Area.	
	Team understands that the match schedule is only an estimate. Matches may start prior to or after the scheduled time. It is the team's responsibility to monitor schedule changes and show up when required.	
	Team knows where to receive alliance flags and where to return them after the match.	
	The Stop Button, when pressed on the Driver Station, functions and stops the robot.	
	The team understands how to disable their Robot, if instructed to do so by a Referee.	

General Comments or Reason(s) for Failure (if any):

I hereby state that all the above is true, and to the best of my knowledge all software, Driver Station and Robot Controller rules of the *FIRST*® Tech Challenge have been abided by.

Field Inspector

Team Student Representative

Appendix D – Control Award Content Sheet & Instructions

To be considered for the Control Award, *Teams* must submit a Control Award Submission Form. On this form, *Teams* identify and summarize the key control elements that make their *Robot* unique. Included is a description of key observable actions for Judges to look for as well as the sensor and algorithm use that make it all possible. Judges will use this form for both evaluating control designs and when observing *Robots* on the competition field. Information on this form will typically fit on one page, with an additional page for each autonomous mode described. Optionally, additional summary pages may be added at the end to help the judges understand key developmental activity.

Autonomous Objectives

List the overall actions that the *Robot* is capable of completing. These should include scoring actions as well as other positioning and defensive operations. The *Robot* does not have to do accomplish all these in every program, but should be demonstrable in at least one autonomous program.

Sensors Used

List the sensors used to control the *Robot* and a brief description of how they are used.

Key Algorithms

List the key algorithms that make your *Robot* unique or are vital to its success on the field. Particularly complex or unique algorithms or those that integrate the use of multiple sensors are good candidates to highlight here.

Driver Controlled Enhancements

List any advanced control elements that are used during the driver controlled period to enhance performance. These may include signaling operations when a certain condition is detected on the field, auto-complete functions, fail-safe algorithms, or just any enhancements that make the control of the *Robot* easier or more efficient for the driver.

Engineering Notebook References

Judges also use the *Teams* Engineering Notebook to evaluate details of the Control elements. To help guide this effort, *Teams* should provide pointers to where in the Engineering Notebook control related information is located.

Some things to consider including as pointers are: *Team* goals for control activities, strategies for autonomous mode, *Robot* performance with and without added sensors, requirements for successful autonomous operation, performance improvements using algorithms and sensors, and testing results.

Autonomous Program Diagrams

For autonomous operations, *Teams* should draw and label a typical path the *Robot* takes. The labeled points identify key observable actions the *Robot* makes. For each labeled point, a brief description of what is taking place should be noted (see example below). Especially describe those key operations where adjustments are made to ensure accurate and repeatable performance.

For *Teams* with multiple autonomous programs, it is not necessary to document every program on a separate sheet. It is sufficient document the most commonly used or complex programs and note variances for the rest.

Additional Summary Information (optional)

For those *Teams* that have developed many different control features, they may want to provide additional information to assist the judges in understanding their work. This is a place where *Teams* can provide more detailed information about their designs. It should be organized such that separate topics are easily identified and can be quickly found.

Appendix E – Control Award Submission Form

****Please turn in this sheet during your Judge Interview along with your Engineering Notebook****

Team #	Team Name:
--------	------------

Autonomous objectives:

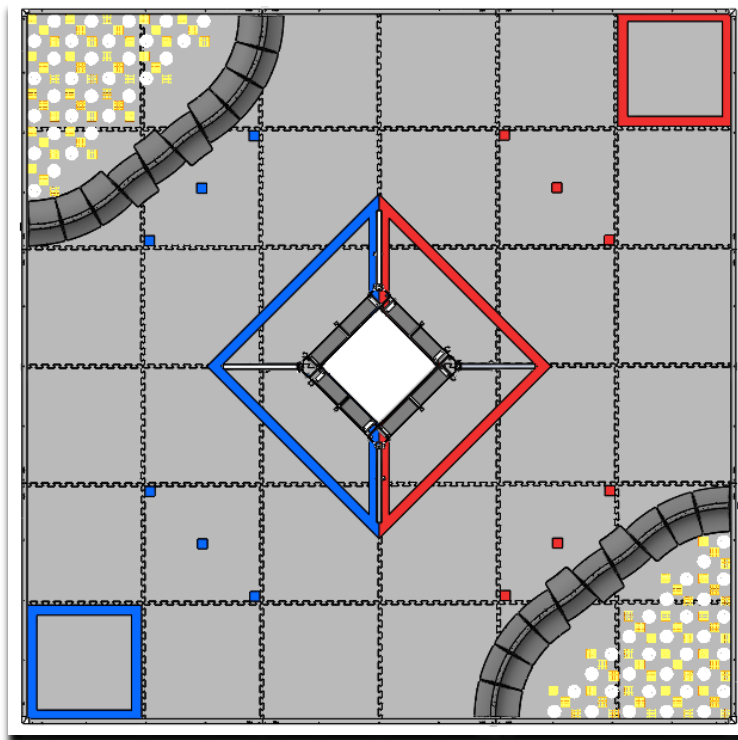
Sensors used:

Key algorithms:

Driver controlled enhancements:

Engineering notebook references:

Autonomous program diagrams:





Training and
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2018-2019 *FIRST*® Tech Challenge Game Manual Part 2

ROVER RUCKUS



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Volunteer Thank You

Thank you for taking the time to volunteer for a *FIRST*® Tech Challenge event. *FIRST*® and *FIRST*® Tech Challenge rely heavily on volunteers to ensure events run smoothly and are a fun experience for teams and their families, which could not happen without people like you. With over 5,500 teams competing yearly, your dedication and commitment are essential to the success of each event and the *FIRST* Tech Challenge program. Thank you for your time and effort in supporting the mission of *FIRST*!

Revision History		
Revision	Date	Description
1	8/21/2018	Limited Affiliate Partner Release
1.1	9/8/2018	<ul style="list-style-type: none"> Kickoff Release Section 1.5.1 Pre-Match – Updated text to match number of game elements in parentheses.

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

FIRST Core Values

We express the FIRST® philosophies of *Gracious Professionalism®* and *Coopertition®* through our Core Values:

- **Discovery:** *We explore new skills and ideas.*
- **Innovation:** *We use creativity and persistence to solve problems.*
- **Impact:** *We apply what we learn to improve our world.*
- **Inclusion:** *We respect each other and embrace our differences.*
- **Teamwork:** *We are stronger when we work together.*
- **Fun:** *We enjoy and celebrate what we do!*

Gracious Professionalism®

FIRST® uses this term to describe our programs' intent and *Gracious Professionalism®* is not clearly defined for a reason. It has different meanings to everyone. Some possible meanings of *Gracious Professionalism* include:

- Gracious attitudes and behaviors are win-win.
- Gracious folks respect others and let that respect show in their actions.
- Gracious Professionals make valued contributions in a way that is pleasing to others and to themselves.

In the end, *Gracious Professionalism®* is part of everyday life. When professionals use their knowledge graciously and individuals act with integrity and sensitivity, everyone wins, and society benefits.

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

Gracious Professionalism for Volunteers

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

Youth Protection Program

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

Youth Protection Expectations and Guidelines

Coaches and mentors should read and follow the [FIRST Youth Protection Program guide](#). Anything labeled as required is mandatory in the United States and Canada, and cannot be waived without approval from the FIRST Youth Protection Department. FIRST recommends that the standards set forth in the FIRST Youth

Protection Program guide be applied outside of the United States and Canada to the extent possible. At a minimum, local regulations regarding youth protection must be complied with.

Most up to date forms are available here: <http://firstinspires.org/resource-library/youth-protection-policy>

The US Screening process, the Canadian Screen process, Frequently Asked Questions (FAQ), and additional information are on the FIRST Youth Protection Program Website: <http://firstinspires.org/resource-library/youth-protection-policy>

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1.0 The Game

1.1 Introduction

This document describes ROVER RUCKUS™ presented by Qualcomm® Incorporated, the FIRST® Tech Challenge game for the 2018-2019 season. *Teams* must comply with all rules and requirements stated in this document and in the Game Manual Part 1. Clarifications to the game rules are issued on the Question & Answer section of the forum at ftcforum.usfirst.org. Forum rulings take precedence over information in the game manuals.

1.2 Game Description

Matches are played on a *Playing Field* initially set up as illustrated in Figure 1.3-1 below. Two *Alliances* – one “Red” and one “Blue,” composed of two *Teams* each – compete in each *Match*. The object of the game is to attain a higher *Score* than the opposing *Alliance* by descending from the *Lander*, collecting *Minerals* from the *Crater*, sorting and *Scoring Minerals* into the *Cargo Hold* of the *Lander*, performing *Autonomous* tasks, and navigating to specific parts of the *Playing Field*. The *Scoring Elements* for the game are 60 *Silver Minerals* and 90 *Gold Minerals*, and a *Team* supplied *Team Marker*. The game is played in two distinct periods: *Autonomous* and *Driver-Controlled*.

The *Match* starts with a 30-second *Autonomous Period* in which *Robots* operate using only pre-programmed instructions and sensor inputs. *Alliances* earn points by: (1) *Landing* – *Robots* lower themselves from the *Lander* onto the *Playing Field*; (2) *Sampling* – *Robots* identify the single *Gold Mineral* in each *Sample Field*; (3) *Claiming* – *Robots* place the *Team Marker* in their corresponding *Depot*; and (4) *Parking* – *Robots* that end the *Autonomous Period* in a *Crater* earn points.

The two-minute *Driver-Controlled Period* follows the *Autonomous Period*. During this period, *Teams* earn points for their *Alliance* by placing *Minerals* into their *Alliance’s Cargo Holds* and/or *Depot*. *Gold Minerals* must be placed in the *Gold Cargo Hold* and *Silver Minerals* into the *Silver Cargo Hold* to *Score*. Either *Mineral* in the *Depot* earns points for the *Alliance*.

The final 30 seconds of the *Driver-Controlled Period* is called the *End Game*. In addition to the previously listed *Driver-Controlled Period Scoring* activities, *Alliances* earn points by (1) *Latching* onto the *Lander* and (2) *Parking In* or *Completely In* any *Crater*.

1.3 Playing Field Illustration

The following illustrations identify the *Game Elements* and gives a general visual understanding of the *Playing Field*. 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://tinyurl.com/ftcgame>. Please note: *Playing Field Wall* heights may be different depending on the manufacturer. Wall height measurements are in the official Field Setup Guide. Across the season, *Teams* may attend events that use *Playing Field Walls* from different manufacturers, please incorporate that into the design of your *Robot*.

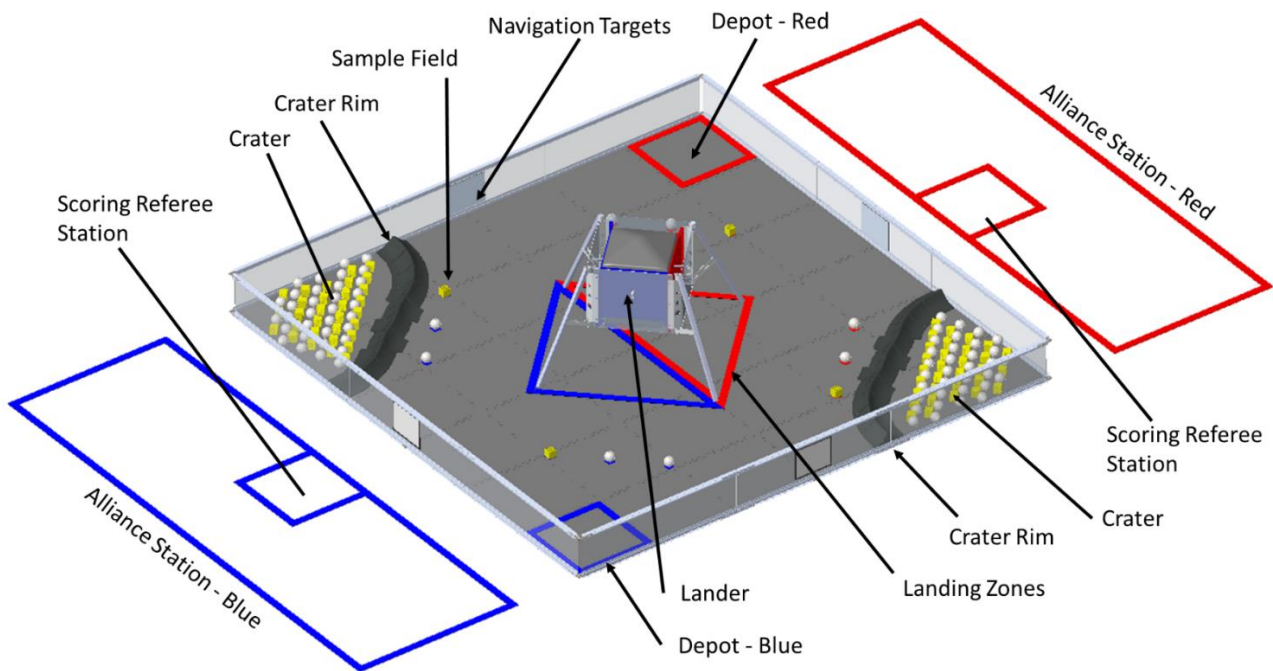


Figure 1.3-1 – Isometric view of the *Playing Field*

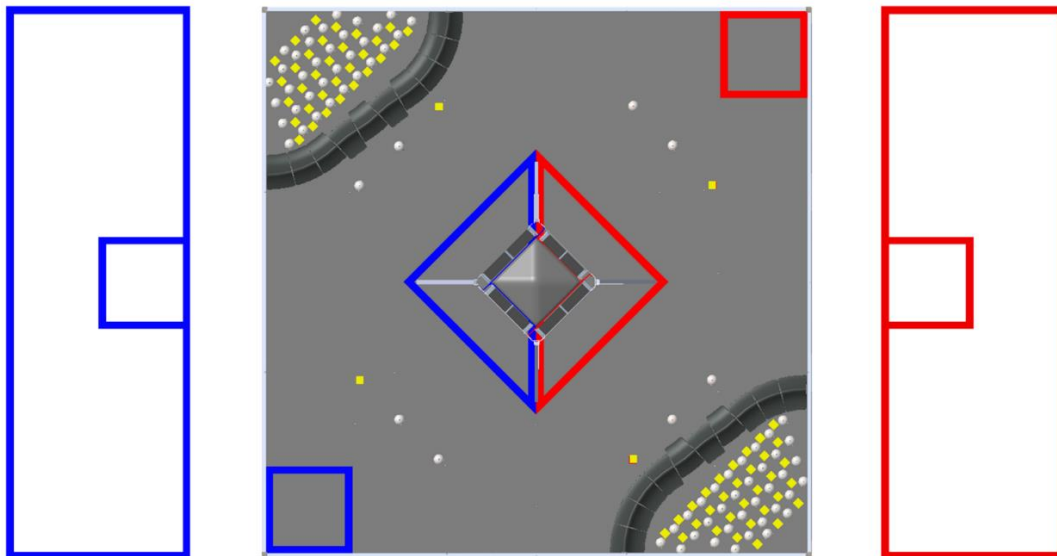


Figure 1.3-2 – Overhead view of the *Playing Field*

1.4 Game Definitions

The following definitions and terms are used in ROVER RUCKUSSM presented by Qualcomm® Incorporated:

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

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

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

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

Block / Blocking – Preventing an opposing *Alliance Robot* from accessing an *Area* or *Alliance-specific Game Element* or all remaining *Alliance-neutral Game Elements* for an extended period by obstructing ALL paths of travel to the object or *Area*. Active defense played by a *Robot* shadowing an opposing *Alliance Robot* that eliminates all paths of travel between the opposing *Alliance Robot* and an *Area* or *Alliance-specific Game Element* or all remaining *Alliance-neutral Game Elements* is considered *Blocking*, even though at any frozen point in time there is an open path. See also *Trap / Trapping* (which may be considered the same except it is from a *Game Element* or *Area* of the *Playing Field*).

Cargo Holds – Four *Areas* (two per *Alliance*) within the *Lander* where *Robots* deposit *Minerals* to *Score* points.

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

Competition Area – The *Area* where all the *Playing Fields*, *Alliance Stations*, scoring tables, on-deck queuing tables, event officials, and other tournament items relating to *Match* play are located. The *Team Pit Area* and practice *Playing Fields* are not part of the *Competition Area*.

Contaminant - A *Mineral In* an incompatible *Cargo Hold* (for example, *Silver In* a *Gold Cargo Hold*).

Control / Controlling – An object is considered to be *Controlled* by a *Robot* if the object is following the movement of the *Robot*. Objects that are *Controlled* by a *Robot* are considered to be part of the *Robot*. See *Possess / Possessing* to learn about a related term. Examples include, but are not limited to:

- Carrying – holding *Game Elements Inside* or *Outside* of a *Robot*.
- Herding – pushing or impelling *Game Elements* to a desired location or direction that gains a strategic advantage beyond moving the *Robot* around the *Playing Field*.
- Holding – *Trapping* one or more *Scoring Elements* against a *Game Element*, *Playing Field Wall*, or *Robot* in an attempt to shield or guard them.
- Launching – propelling *Game Elements* into the air.

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

- **Plowing** – *Inadvertent* contact with *Game Elements* while in the path of the *Robot* moving about the *Playing Field*.
- **Deflecting** – *Inadvertent* contact with a launched *Game Element* as it bounces off a *Robot*.

Crater – An Area surrounded by the *Playing Field Wall* and the Outer edge of the *Crater Rim* into which the *Minerals* are placed prior to the start of a *Match*. There are two (2) *Craters* located in opposite corners of the *Playing Field*. See Figure 1.3-1 for the location of the *Craters*.

Crater Rim – An assembly of wedge-shaped pieces on the *Playing Field* that forms the outside edge of a *Crater*. A single *Crater Rim* piece measures approximately 7.6 inches wide x 9 inches long x 3 inches tall (193 mm x 229 mm x 76 mm).

Deployed - *Robot* is not *Latched* to the *Lander*.

Depot – A segment of the *Playing Field* that is bounded by red or blue tape where *Game Elements* may be deposited. The *Depots* are *Alliance* specific, there is one (1) *Depot* per *Alliance*.

Disable / Disabled – A *Robot* that is no longer active for the remainder of the *Match* due to a *Robot* failure or by the request of a referee. *Drive Teams* may not *Disable* a *Robot* without the permission of a Field Technical Advisor or referee. If a referee *Disables* a *Robot* during a *Match*, he/she will ask the *Team* to drive their *Robot* to a neutral position on the *Playing Field*, issue a stop command with the *Driver Station*, and place their *Driver Station* in a hands-off location on a tournament-provided structure or the *Alliance Station* floor.

Disqualified / Disqualification / Disqualify – A *Team* that is *Disqualified* from a *Match* will not receive credit for the *Match* (that is, no Ranking or TieBreaker points).

Drive Team – Up to three 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 time period in which the *Drivers* operate the *Robots*.

Driver Station – Hardware and software used by a *Drive Team* to control their *Robot* during a *Match*. The *Driver Station* consists of an Android device, FIRST Tech Challenge supplied Android App, adapter cable(s), optional non-powered USB Hub (i.e., does not draw power from a DC power input port), an optional commercial off the shelf USB external battery connected to the USB Hub to charge the Android device at any time, and up to two controllers to drive the *Robot*. The only allowed controller models are the Logitech F310 Gamepad and the Xbox 360 Controller for Windows. The *Driver Station* also includes decorations and any components used to hold the above listed legal devices.

End Game – The *End Game* is a named period of time that is the last thirty seconds of the two-minute *Driver-Controlled Period*.

End of the Period/Match - The moment when the *Match* timer reaches 0:00.

Game Element – Any item *Robots* interact with to play the game. *Game Elements* for this year’s game include: *Minerals*, *Crater Rims*, *Team Markers* and the *Lander*.

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*.

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

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

Interference - Interaction between opposing *Alliance Robots* that amplifies the difficulty of a *Scoring* activity. Actions that constitute *Interference* should not be considered illegal except as specified by a *Game Rule*.

Lander – The structure on the *Playing Field Floor* where *Robots* may begin the *Match* and includes the *Cargo Hold Scoring Areas* where *Robots* deposit *Minerals*. See Figure 1.3-1 for the location of the *Lander*.

Lander Support Bracket – An attachment point on the *Lander* where *Robots* may start *Supported* at the beginning of the *Match* and may *Latch* onto during the *End Game*. There are four (4) *Alliance* specific *Lander Support Brackets*.

Landing Zone – A triangular *Area* underneath the *Lander* defined by the red or blue tape.

Latched – A *Robot* is considered *Latched* when it is *Completely Supported* by the *Lander Support Bracket* on the *Lander* and is not in contact with any other *Game Element*, *Robot*, or the *Playing Field Floor*. Incidental contact with *Scoring Elements*, the *Lander* sides or legs is allowed (for example, *Possession of Scoring Elements* is allowed). *Latching* is evaluated and *Scored* by earthlings. *Teams* are encouraged to make these actions obvious and unambiguous.

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

Minerals – *Scoring Elements* for this year's game. There are two kinds of *Minerals*:

- *Silver*: White, spherical shaped objects.
- *Gold*: Yellow, cube shaped objects.

Navigation Targets – Four unique images mounted on the *Playing Field Walls* (one image per wall) that *Robots* can use to navigate around the *Playing Field*. Images are printed on standard letter size paper for the tournament location, 8 1/2 inch x 11 inch (216 mm x 279 mm) or A4 (210 mm x 297 mm) paper.

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

Out / Outside – An object that has not crossed 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 awarded to the *Alliance* that did not incur the *Penalty*. *Penalties* are further

defined into *Minor Penalties* (ten points) and *Major Penalties* (forty points). *Penalties* may also escalate to issuing of a *Yellow Card* or *Red Card* as a result of a continued occurrence of a rule violation and upon discretion of the Referee.

Yellow Cards and Red Cards – In addition to rule violations explicitly listed in section 1.6, *Yellow Cards* and *Red Cards* are used in the *FIRST* Tech Challenge to manage *Team* and *Robot* behavior that does not align with the mission of *FIRST*. *Yellow* and *Red Cards* are not limited to just the *Competition Area*. *Teams* that display egregious behavior in the pit area, judging rooms, stands, or any other location of the tournament can be issued a yellow or red card for egregious behavior.

Egregious or repeated (3 or more) *Robot* or *Team* member behavior at the tournament can result in a *Yellow* and/or *Red Card*. *Yellow Cards* are additive, meaning that a second *Yellow Card* is automatically converted to a *Red Card*. A *Team* is issued a *Red Card* for any subsequent incident in which they receive an additional *Yellow Card*, for example, earning a second *Yellow Card* during a single *Match*.

Yellow and Red Cards at the Competition Field

The Head Referee may assign a *Yellow Card* as a warning, or a *Red Card* for *Disqualification* in a *Match*. A *Yellow Card* or *Red Card* is signaled by the Head Referee standing in front of the *Team's Alliance Station* and holding a yellow card and/or red card in the air.

To issue the second *Yellow Card*, the Head Referee will stand in front of the *Team's Alliance Station* and hold a yellow card and red card. The Head Referee will signal the second *Yellow Card* after the *Match* has ended.

A *Team* that has received either a *Yellow Card* or a *Red Card* carries a *Yellow Card* into following *Matches*, except as noted below. A *Red Card* results in *Match Disqualification*. Multiple *Red Cards* may lead to tournament *Disqualification*. Once a *Team* receives a *Yellow Card* or *Red Card*, the *Team* number is presented with a yellow background on the audience screen at the beginning of all following *Matches*. This is a reminder to the *Team*, referees, and audience the *Team* carries a *Yellow Card*.

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

Yellow and *Red Cards* may also be issued off the competition field. For details please make sure to read the Tournament Rules outlined in section 4.3 of the [Game Manual Part 1](#).

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

Playing Field – The part of the *Competition Area* that includes the 12 ft. x 12 ft. (3.66 m x 3.66 m) field and all the *Game Elements* described in the official field documents. From the audience viewpoint, the *Red Alliance Station* is on the right side of the *Playing Field*.

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

For Example: Black tire marks on a *Game Element* is not considered *Playing Field Damage*. However, digging a hole larger than 1 inch (2.54cm) diameter (approximately the size of a US quarter) or a series of smaller holes into the *Playing Field Floor* is considered *Damage*.

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

Playing Field Perimeter – The outside face of the *Playing Field Wall*.

Playing Field Wall – An approximate 12 inches (0.3 m) tall, 12 ft. (3.66 m) long by 12 ft. (3.66 m) wide wall surrounding the *Playing Field Floor*. The height of the *Wall* will vary depending on which *Playing Field Wall* is being used at the event. *Robots* should be built to interact with all legal perimeters.

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* of 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 is *Possessed* by a *Robot* at the start of the *Autonomous Period*.

Robot – A 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 Game Manual Part 1.

Sample Field – Three (3) positions on the *Playing Field Floor* that are in front of each *Robot* starting location onto which the *Samples* are placed prior to the start of a *Match*. Each position is defined by a red or blue taped Area.

Samples – Two (2) *Silver* and one (1) *Gold Minerals* that are randomly placed onto each *Sample Field* prior to the start of a *Match*.

Scoring / Score – *Robots* earn points for their *Alliance* by interacting with *Scoring Elements* and *Parking* in specific *Areas* of the *Playing Field*. *Scoring Elements* are considered to be *Scored* when they are placed in the appropriate location and are no longer in contact with a *Robot* from the corresponding *Alliance*. The *Scoring* achievements and their point values are described in section 1.5.

Scoring Elements – Objects that *Robots* manipulate to earn points for their *Alliance*. The *Scoring Elements* for ROVER RUCKUSSM are *Minerals* and *Team Markers*.

Scoring Referee Station – The designated “Red” or “Blue” *Area* Inside an *Alliance Station* where the *Scoring Referee* sits or stands during a *Match*.

Stop Playing The Game - A *Robot* that is *Parked* for the remainder of the *Match* period.

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

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

Team Marker – A *Team* provided *Scoring Element*. A detailed definition of *Team Marker* is in section 8.4 of the Game Manual Part 1. Compliance with construction rules will be verified during *Robot Inspection*.

Tile – The approximately 24 inch x 24 inch (0.61 m x 0.61 m) foam rubber mat, 36 of which make up the *Playing Field Floor*.

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

1.5 Game Play

Prior to the start of the *Match*, *Drive Teams* perform some basic *Robot* setup steps that are described in section 1.5.1. *Matches* are made up of several periods totaling two minutes and thirty seconds. There is a thirty-second *Autonomous Period*, followed by a two-minute *Driver-Controlled Period*. The last thirty seconds of the *Driver-Controlled Period* is called the *End Game*. When the *Match* is over and referees signal, *Drive Teams* collect their *Robots* and *Team Markers*, return *Game Elements* and *Flags*, and exit the *Competition Area*.

1.5.1 Pre-Match

Field personnel will place approximately half of the fifty-two (52) *Silver* and half of the eighty-six (86) *Gold Minerals* into each of the *Craters*. The *Silver* and *Gold* will be randomly mixed.

Drive Teams receive an *Alliance*-colored *Robot*-identification flag from field personnel. This flag must be securely mounted on the *Robot* as defined in the *Robot* rules.

Minerals are not *Pre-Loaded* onto the *Robot*. *Drive Teams* may *Pre-Load* one *Team Marker*.

The *Drive Team* must select one of the following starting locations for their *Robot*:

1. **Latched to the Lander** - *Robot* is *Completely Supported* by their *Alliance*-specific side of the *Lander* with the following constraints:
 - a. The *Robot* must be *Completely Supported* by the *Lander Support Bracket*. Incidental contact with the *Lander* walls or the legs is allowed.
 - b. The lowest point on a *Robot* and *Team Marker* can be no closer than four (4) inches (102 mm) from the *Playing Field Floor*.
 - c. When *Completely Supported* by the *Lander*, *Robots* must be within the 18 inch x 18 inch x 18 inch (45.7 cm x 45.7 cm x 45.7 cm) starting volume constraint.
2. **Deployed from the Lander** - *Robots* that start the *Match Deployed* are not eligible to earn the *Landing* achievement points. *Deployed Robots* are placed on the *Playing Field Floor* in any orientation with the following constraints:
 - a. The *Robot* must be *In* the *Landing Zone* within the vertical projection of the *Lander Support Bracket*. For example, a portion of the *Robot* must be directly beneath the *Lander Support Bracket*.
 - b. The *Robot* must start *Outside* the opposing *Alliance's Landing Zone*.

After the *Robots* are either *Latched* or *Deployed*, and *Autonomous* programs have been initialized, Referees will give a setup complete signal to the *Drive Team*, signifying the following:

1. *Drive Teams* may no longer touch their *Robots* until the conclusion of the *Match*, and
2. *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.
3. Prior to the start of the *Match*, *Referees* will place *Samples* in the *Sample Field*. *Referees* will randomly arrange two *Silver* and one *Gold* into a grouping. This grouping will be repeated in front of each *Robot* starting location.

1.5.2 Autonomous Period

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

The *Autonomous Score* is based on completing tasks during the *Period*. Points are awarded for the following achievements:

1. ***Landing*** – *Robots* lower themselves from the *Lander* onto the *Playing Field Floor*. Each *Robot* that is in contact with the *Playing Field Floor* and not in contact with the *Lander Support Bracket* will earn 30 points for their *Alliance*.
2. ***Claiming*** – Each *Robot* that successfully places their *Team Marker* In their *Alliance's Depot* will earn 15 points for their *Alliance*. The *Team Marker* may only be delivered by placing it into the *Depot*. Launching, shooting, throwing, etc. of a *Team Marker* is not allowed. If an *Alliance Completely Claims* their corresponding *Depot*, then descoring of *Minerals* by the *Opposing Alliance* will not be allowed from that *Depot* during the *Driver-Controlled Period*. *Completely Claimed Depots* are permanent for the *Match*.
3. ***Parking*** – Each *Robot* In a *Crater* at the *End of the Autonomous Period* will earn 10 points for their *Alliance*.
4. ***Sampling*** – Each *Sample Field* that has its *Gold Mineral Out* of the corresponding *taped Area* and the two (2) *Silver Minerals* remaining In their corresponding *taped Areas* will earn 25 points for the corresponding *Alliance*.

Minerals placed in the *Depot* or *Cargo Hold* during the *Autonomous Period* are *Scored* as described in section 1.5.3.

1.5.3 Driver-Controlled Period

Directly following the end of the *Autonomous Period*, *Drive Teams* have five (5) seconds plus a "3-2-1-go" countdown to prepare their *Driver Stations* for the start of the *Driver-Controlled Period*. On the countdown word "go," the *Driver-Controlled Period* starts and *Drive Teams* press their *Driver Station* start buttons to resume playing the *Match*.

The *Driver-Controlled Score* is based on completing tasks as outlined below. Points are awarded for the following achievements: *Minerals Scored* earn points as follows:

1. *Minerals Scored into the Depot* earn two (2) points each. *Minerals removed from the Depot* deduct two (2) points each.
2. *Gold Scored into the Gold Cargo Hold* on the *Lander* earns five (5) points.
3. *Silver Scored into the Silver Cargo Hold* on the *Lander* earns five (5) points.
4. *Minerals* placed into the wrong *Cargo Hold* (that is, *Gold* into *Silver* or *Silver* into *Gold*) on the *Lander* are considered *Contaminants* and *Score* zero (0) points.
5. To be considered *Scored* for either the *Depot* or a *Cargo Hold*, a *Mineral* must be *In* the volume defined by the *Scoring Area*. For the *Depots*, the volume is defined by the outer edge of the tape and extending infinitely upwards from the *Playing Field Floor*. For a *Cargo Hold*, the volume is defined by the 5 inner surfaces of the *Cargo Hold* and the horizontal extension of the upper edge of the clear panel on the outside of the *Cargo Hold*.

1.5.4 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*.

Points are awarded at the *End of the Match* for the following *End Game* achievements:

1. ***Robots Latched*** – Each *Robot* that *Deployed* during pre-*Match* setup or in the course of game play and is *Latched* onto either of their own *Alliance-specific Lander Support Brackets* at the *End of the Match* earns 50 points for their *Alliance*.
2. ***Robots Parked In any Crater*** – Each *Robot* that is *Parked In* any *Crater* at the *End of the Match* earns 15 points for their *Alliance*.
3. ***Robots Parked Completely In any Crater*** – Each *Robot* that is *Parked Completely In* any *Crater* at the *End of the Match* earns 25 points for their *Alliance*.

1.5.5 Post Match

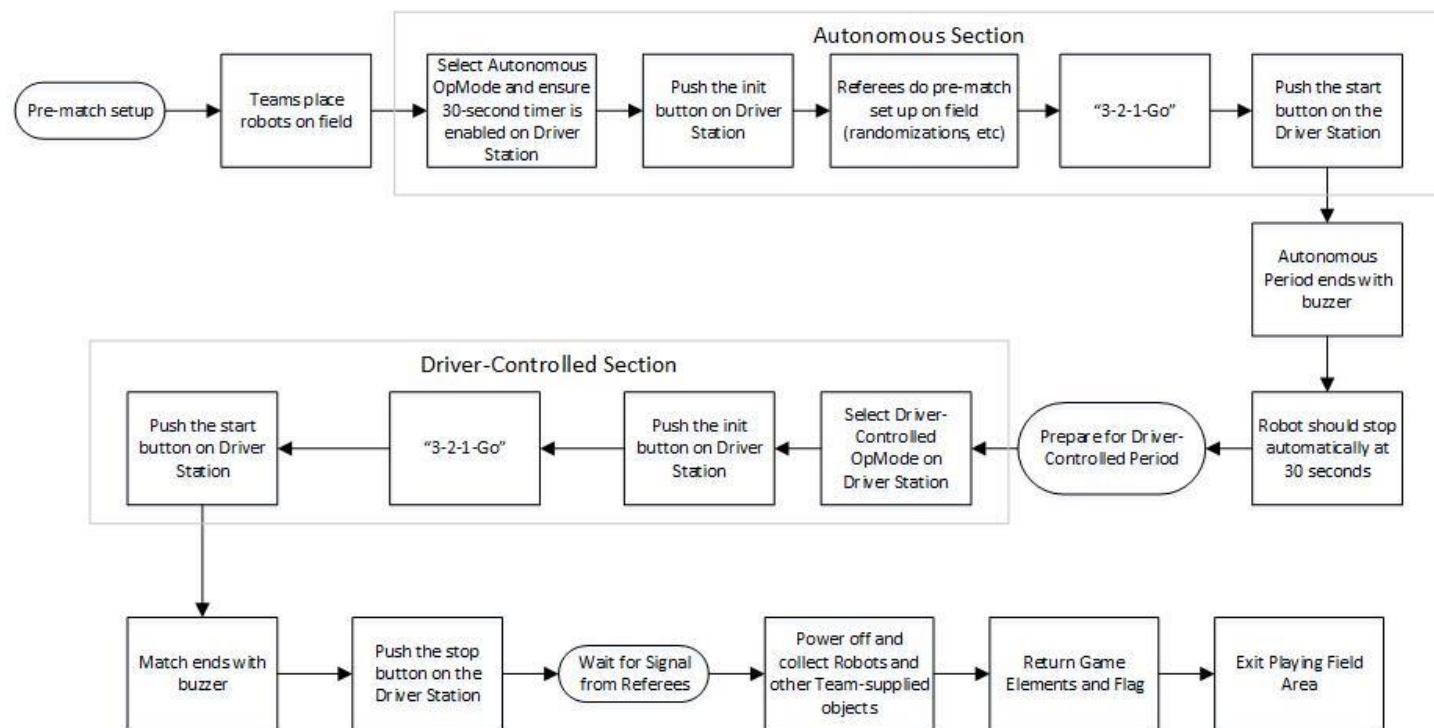
After the *Match* ends, field personnel will finalize the *Score*. Referees will signal for the *Drive Teams* to enter the *Playing Field* and retrieve their *Robots* and *Team Markers*. *Drive Teams* should not step on the *Crater Rim* when retrieving their *Robots* and *Team Markers*. The *Drive Teams* should return any *Minerals* that are *Possessed* by the *Robot* to the *Playing Field* and return the *Alliance-colored Robot* identification flag to the field personnel. The *Playing Field* reset crew will set up the *Playing Field* for the next *Match*.

1.5.6 Penalty Scoring

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

1.5.7 Flowchart of Match Play

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



1.6 Rules of Game Play

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

1.6.1 Safety Rules

<S1> Unsafe Robot and Playing Field Damage – If at any time the *Robot* operation is deemed unsafe or has damaged the *Playing Field* or another *Robot*, by the determination of the referees, the offending *Robot* may be *Disabled*, and the *Team* may be issued a *Yellow Card*. Re-inspection of the *Robot* is required before it may play another *Match*. Damage that requires significant repair and/or delays subsequent *Match* play is likely to escalate to a *Red Card*.

The intent of this rule is to immediately stop unsafe *Robot* actions or *Playing Field Damage* that is likely to persist with continued *Robot* operation. *Robots* that can continue safe operation without damaging the *Playing Field* will receive a warning and may continue to play the *Match*. *Robots* will be *Disabled* for unsafe operation or *Playing Field Damage* that occurs after the first warning for the tournament. Damage that affects game play is likely to escalate to a *Yellow Card*.

<S2> Robot Extension Outside the Playing Field Perimeter – If any portion of the *Robot* contacts anything *Outside* the *Playing Field Perimeter*, the *Team* will be issued a *Yellow Card* and it may be *Disabled* immediately for the remainder of the *Match*, unless allowed by Game-Specific rule(s) listed in Section 1.6.3. See the game definitions in section 1.4 for a complete description of the *Playing Field Perimeter*.

The intent of this rule is not to *Penalize* an *Alliance* for *Inadvertent*, safe *Robot* extension *Outside* the *Playing Field Perimeter*. Intentional *Robot* extension *Outside* the *Playing Field* is not permitted, except as allowed by game-specific rules listed in Section 1.6.3

<S3> Safety Gear – All members of the *Drive Team* are required to wear approved eye protection and shoes with closed-toes and a closed-back. If any member of the *Drive Team* is not wearing these safety items, the referee will issue a warning and if the situation is not remedied within thirty seconds, the offending member(s) of the *Drive Team* must leave the *Competition Area* for the remainder of the *Match* and may not be replaced by another *Team* member. Failure to comply with a request to leave the *Competition Area* violates rule <G28>.

1.6.2 General Game Rules

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

<G2> Pre-Match Robot Setup - *Team* members cannot enter the *Playing Field* for any reason other than to place/retrieve their *Robots*. *Teams* may not measure, test, or adjust field or game elements prior to the start of a *Match*. Inspection of the *Playing Field* elements by *Team* members to determine *Scoring* is not allowed. Individuals and *Teams* that violate this rule will be subject to possible penalties that could include *Match Disqualifications* or even removal from the tournament.

<G3> Pre-Match Robot Placement – At the beginning of a *Match*, each *Alliance Robot* must be set up on the *Playing Field* according to section 1.5.1 Pre- Match in the Game Manual Part 2. After *Robots* are set up on the *Playing Field*, *Drive Teams* must stand *Completely* inside the *Alliance Station* at the location (Station one or Station two) specified by the Qualification *Match* schedule.

- a. During the Qualification *Matches*, the blue *Alliance Robots* are set up on the *Playing Field* first, unless the red *Alliance* waives their right to set up on the *Playing Field* second.
- b. During the Elimination *Matches*, the 3rd and 4th seeded *Alliance Robots* are set up on the *Playing Field* first, unless the higher seeded *Alliance* waives their right to set up on the *Playing Field* second. *Alliance* color doesn't change the seeding of a *Team* during the Elimination *Matches*. If the 4th seed defeats the 1st seed in the Semi-Finals, they will still have to place their *Robot* on the field first in the Finals because their seeding will be lower than the 2nd or 3rd seed.
- c. During Elimination *Matches*, 3 *Team Alliances* may only place *Robots* that are intended to compete in that *Match*. Once two *Robots* are placed for the two *Teams* competing in a *Match*, the *Alliance* cannot swap in the 3rd *Alliance's Robot* for a *Robot* already placed.

- d. *Teams* may implicitly waive their right to place their *Robots* on the *Playing Field* last by placing their *Robots* on the *Playing Field* before or with the opposing *Alliance*. There is no need to tell the referees; *Teams* waive their right by the act of placing their *Robots* on the *Playing Field*.
- e. *Teams* that unnecessarily delay the beginning of a *Match* and/or field reset will incur a *Minor Penalty* for each offense.

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

- Late arrival to the *Playing Field*.
- *Robot* maintenance once on the *Playing Field*.

<G4> Robot Starting Volume – Before the start of a *Match*, each *Robot* in its starting location must not exceed a volume of 18 inches (45.7cm) by 18 inches (45.7cm) by 18 inches (45.7cm) unless otherwise allowed or restricted by Game Specific Rules detailed in Section 1.6.3. The *Alliance* identification flag and *Pre-Loaded Scoring Elements* may extend *Outside* the 18-inch (45.7cm) cube volume constraint. An offending *Robot* will be removed from the *Playing Field* for the length of the *Match*.

After the start of a *Match*, the *Robot* may extend in any dimension unless restricted by the Game-Specific rules detailed in Section 1.6.3.

<G5> Robot Setup/Alignment – *Teams* may align their *Robots* 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 (45.7cm) cube starting volume constraint. A single member of the *Drive Team* may also align the *Robot* by sight, assuming that he/she is next to the *Robot* and does not delay the start of a *Match*. A *Minor Penalty* will be assessed to the *Team* for violation of this rule.

<G6> Alliance Station – During a *Match*, the *Drivers* and *Coach* must remain *Completely Inside* their *Alliance Station*. The first instance of leaving the *Alliance Station* will result in a warning, with any following instances resulting in a *Minor Penalty*. Leaving the *Alliance Station* for safety reasons will not result in a warning or *Penalty*.

<G7> Starting Game Play Early – *Robots* that start play of the game (*Autonomous* or *Driver-Controlled Period*) prior to the start of a *Match Period* receive a *Minor Penalty*. Referees have the option of issuing a *Major Penalty* in place of the *Minor Penalty* if the early start results in a competitive advantage for the offending *Alliance*.

<G8> Late Start of the Autonomous Period – *Teams* participating in the *Autonomous Period* are expected to press the "start with 30-second" button on their *Driver Station* Android device and then place the *Driver Station* in a hands-off location without delay when field personnel signal the start of the *Autonomous Period*. A *Minor Penalty* is assessed for violating this rule. Referees have the option of issuing a *Major Penalty* in place of the *Minor Penalty* if the late start results in a competitive advantage for the offending *Alliance*.

<G9> Robot Control During Autonomous Period - During the *Autonomous Period*, *Drive Teams* may not directly or indirectly control or interact with *Robots* or *Driver Stations*. Early stopping of the *Robot* while running its *Autonomous* code is not allowed, except in cases of personal or equipment safety. A *Major Penalty* will be assessed for violating this rule.

<G10> Stopping Game Play Late – Robots that do not *Stop Playing The Game* at the end of the *Autonomous* or *Driver-Controlled Periods* when competition personnel or timer software announce the end of a *Match* period receive a *Minor Penalty* and the actions of the *Robot* occurring after the end of a *Match* period do not count towards their *Alliance's Score*. Referees have the option of issuing a *Major Penalty* in place of the *Minor Penalty* if the late stop results in a competitive advantage (other than *Scoring*) for the offending *Alliance*.

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

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

<G11> Drive Team Contact with the Playing Field or Robot – During a *Match*, the *Drivers* and *Coaches* are prohibited from making contact with the *Playing Field*, any *Game Element*, or any *Robot*. The first instance of contact will result in a warning, with any following instances resulting in a *Minor Penalty*. Contact that affects *Scoring* and/or game play will result in issuance of a *Yellow Card* at the discretion of the referees. Contact with the *Playing Field*, a *Game Element*, or a *Robot* for safety reasons will not result in a warning or *Penalty*.

For example, a *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 *Penalty* because the *Team* member was protecting him/herself (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 *Penalty*.

<G12> Autonomous to Driver-Controlled Period Transition – At the conclusion of the *Autonomous Period*, *Robots* will remain in a hands-off state. Field personnel will not enter the field and will not touch *Robots* on the field during the *Autonomous* to *Driver-Controlled* transition. *Drive Teams* will have 5 seconds to pick up their *Driver Station*. The scoring system display will provide visual and audio cues for *Drive Teams* to pick up their *Driver Stations*. After the 5 seconds, there will be a 3-2-1 countdown and the *Driver-Controlled Period* of the *Match* will begin.

<G13> Drive Team Coach Driver Station Control – During the *Driver-Controlled Period*, *Robots* must be remotely operated only by the *Drivers* using the Gamepads connected to the *Team's Driver Station* and/or by software running on the on-board *Robot* control system. The first instance of *Coach* controlling a *Robot* (for example, 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*.

<G14> Certifying the Score at Match End – Scores will be tracked by field personnel throughout the *Autonomous* and *Driver-Controlled Periods* of the *Match*. At the conclusion 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 at the end of the *Match*.

<G15> Robots Deliberately Detaching Parts – Parts may not be deliberately detached from *Robots* during a *Match* or leave mechanisms on the *Playing Field* unless permitted by a *Game Specific Rule*. The consequence of deliberately detaching a part is a *Minor Penalty* if it does not *Block* an opposing *Alliance Robot*, *Alliance-specific Scoring Element* or *Scoring Area*. If a deliberately-detached component or mechanism affects game play by any *Robot*, the offending *Robot* will receive a *Major Penalty* and will be issued a *Yellow Card*. *Robot* parts that are released but remain connected by a tether are considered detached for the purposes of this rule.

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

<G16> Robots Grasping Game Elements – *Robots* may not grab, grasp and/or attach to any *Game Element*, *Robot*, or structure other than *Scoring Elements*, unless specifically allowed by game-specific rule(s) listed in Section 1.6.3. The first instance will result in a warning with any following violations resulting in a *Major Penalty*.

<G17> Destruction, Damage, Tipping, etc. – Strategies and/or mechanisms aimed solely at the destruction, damage, tipping over, or entanglement of *Robots* or *Game Elements* are not in the spirit of the *FIRST* Tech Challenge and are not allowed. However, *FIRST* Tech Challenge games are highly interactive and *Robot-to-Robot* contact and defensive game play should be expected. Some tipping, entanglement, and damage may occur as a part of normal game play. If the tipping, entanglement, or damage is ruled to be deliberate or chronic, the offending *Team* will receive a *Major Penalty* and a *Yellow Card*.

<G18> Pinning, Trapping, or Blocking Robots – A *Robot* cannot cause an opposing *Alliance Robot* to become *Pinned*, *Trapped*, or *Blocked* for more than five seconds. If a referee determines this rule is violated, the offending *Alliance* will receive a *Minor Penalty* for every five seconds that they are in violation. If a referee declares a *Pinning*, *Trapping*, or *Blocking* warning during the *Match*, the offending *Robot* must immediately move away at least 3 feet (0.9 m), approximately 1.5 floor *Tiles*, from the *Pinned*, *Trapped*, or *Blocked Robot*.

The intent of this Rule is that *Drive Teams* begin to immediately move their *Robots* away and have a five second grace period to move the required distance, and not that they are permitted to intentionally *Block* for up to five seconds.

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

<G19> Forcing an Opponent to Break a Rule – The actions of an *Alliance* or their *Robots* shall not cause an opposing *Alliance* or *Robot* to break a rule and thus incur *Penalties*. Any forced rule violations committed by the affected *Alliance* shall be excused, and no *Penalties* will be assigned.

<G20> Removing Game Elements from the Playing Field – *Robots* 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

rule(s) listed in Section 1.6.3 that allow the removal of specified *Scoring Elements* from the *Playing Field* take precedence over this general game rule.

<G21> Scoring Elements in Contact with Robots – *Scoring Elements* in a *Scoring Area* that are in contact with or *Controlled* by a *Robot* on the corresponding *Alliance* for the *Scoring Area* have zero *Score* value. Game-specific rule(s) listed in Section 1.6.3 that allow *Robot* contact with *Scoring Elements* take precedence over this general game rule.

<G22> Post-Match Removal of Game Elements from Robots – *Robots* must be designed to permit easy removal of *Game Elements* from the *Robot* after the *Match*. *Robots* should also be able to be removed from the *Playing Field* without damaging the *Playing Field*. A *Minor Penalty* will be assessed for violations of this rule.

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

Drive Teams are expected to stage their *Robots* for a *Match*, and remove 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:

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

<G23> Robot Manipulation of Scoring Elements – *Scoring Elements* that are *Controlled* or *Possessed* by a *Robot* are considered to be part of the *Robot* except when determining the location of the *Robot*.

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*.

<G24> Robot or Scoring Elements In Two or More Scoring Areas – *Robots* or *Scoring Elements* that are *In* two or more *Scoring Areas* earn points only for the highest value achievement. If the achievement values are equal, only one achievement counts as *Scored*. Exceptions to this general rule may be specified in the Game Play section (1.5) or in the game-specific rules.

<G25> Disabled Robot Eligibility - If a referee *Disables* a *Robot*, it will not be eligible to *Score* or earn points for the remainder of the *Match*. A *Disabled Robot* (whether referee induced or failure) does not earn *Penalties* after becoming *Disabled*.

<G26> Playing Field Tolerances – Tournament provided *Playing Field* and *Game Elements* will start each *Match* with tolerances that may vary by as much as +/-1.0 inch (2.5 cm). *Teams* must design their *Robots* accordingly.

<G27> Match Replay – *Matches* are replayed at the discretion of the Head Referee only for a failure of a non-*Team* supplied *Game Element* or verified Wi-Fi interference that was likely to have impacted which *Alliance* won the *Match*.

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*.

<G28> Egregious Behavior – Egregious *Robot* or *Team* member behavior at the *Playing Field*, as determined by the referees, will result in a *Major Penalty* and issuance of a *Yellow Card* and/or *Red Card*. Subsequent violations will result in *Team Disqualification* from the tournament. Egregious behavior includes, but is not limited to, repeated and/or flagrant violation of game rules, unsafe behavior or actions, and uncivil behavior towards *Drivers*, *Coaches*, competition personnel, or event attendees.

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

<G30> Inadvertent and Inconsequential - *Robot* actions that violate a rule may be ruled at the referee's discretion to be *Inconsequential* and *Inadvertent* and will not be *Penalized*.

1.6.3 Game-Specific Rules

<GS1> Drive Teams Touching Robots or Driver Stations after Sample Randomization – *Drive Teams* are not allowed to touch or interact with their *Robots* or *Driver Stations* once field personnel have begun the randomization process. If this occurs, a *Minor Penalty* will be assessed, and the affected *Robot* is not eligible to *earn the Sample Score* in the *Autonomous Period*. This *Penalty* only affects the offending *Team*. The non-offending *Alliance Partner Robot* remains eligible for the *Sample Scoring* achievement.

<GS2> Autonomous Period Robot Interference – *Robots* may not *Interfere* with the opposing *Alliance's* *Scoring* attempts or *Sample Field* during the *Autonomous Period*. A *Major Penalty* will be assessed for violating this rule. *Robots* attempting to *Score* in a *Crater* are exempt from this rule.

The intent of this rule is to allow *Robots* to *Score* their *Autonomous points* without defensive play by the opposing *Alliance*. *Inadvertent* and *Inconsequential* actions will be treated per <G30>.

Since both *Craters* are *Alliance* neutral, *Inadvertent* and/or *Inconsequential* interaction between opposing *Alliance Robots* attempting to enter the *Craters* should not be considered illegal *Interference*. *Robot* actions that run an unnecessary risk of preventing opposing *Robot* access to the *Crater* is likely to be seen as illegal *Interference*. *Teams* should take this into consideration when designing their autonomous program.

<GS3> Control/Possession Limits of Minerals – A *Robot* may *Control* or *Possess* a maximum of *two (2)* *Minerals* at a time, however there is no *Control* or *Possession* limit on *Minerals* that are currently *In the Crater*. Plowing through any quantity of *Minerals* is allowed but herding or directing multiple *Minerals* beyond the allotted maximum to gain a strategic advantage (i.e., *Scoring*, accessibility, defense) is not allowed. The *Penalty* for *Controlling* or *Possessing* more than the allotted maximum is an immediate *Minor Penalty* for each *Mineral* above the limit plus an additional *Minor Penalty* per *Mineral* for each 5-second interval that this situation continues. A *Major Penalty* will be assessed for each *Mineral Scored* while a *Robot Controls* or *Possesses* more than the allotted maximum. Continued violation of this rule will escalate to *Yellow Cards* quickly.

Robot designs that obscure visibility of *Minerals* within a *Robot* may prevent referees from providing feedback to *Drive Teams* about violations of <GS3> and may lead to the *Robot* earning *Penalties*.

<GS4> De-scoring Minerals – Robots may not remove or re-position *Minerals* from the *Cargo Holds*. Robots may remove *Minerals* from their opposing *Alliance's Depot* if it was not *Completely Claimed* in the *Autonomous Period*. Robots may remove *Minerals* from their own *Alliance's Depot*. A *Minor Penalty* will be assessed for each *Mineral* illegally removed or re-positioned.

<GS5> Blocking Access to Scoring in the Lander - Robots may not *Block* access to an opposing *Alliance's Lander Cargo Hold* or *Lander Support Bracket*. The first instance will result in an immediate *Major Penalty* and an additional *Minor Penalty* assessed for every five-seconds that the rule violation persists. If the referee declares a *Blocking access Penalty*, the offending *Robot* must move away at least 3 ft. (0.9 m), approximately 1.5 floor *Tiles* from the opponent's *Landing Zone*. Additional occurrences of violations of this rule will escalate to *Yellow Cards* quickly.

<GS6> Interfering with Scoring at the Lander – Robots may not *Interfere* with the opposing *Alliance's Robot* while that *Robot* is *In* their *Alliance's Landing Zone* attempting to *Score Minerals* or *Latch* to the *Lander*. *Interference* results in an immediate *Major Penalty* and an additional *Minor Penalty* assessed for every five-seconds that the rule violation persists. The intent of this rule is to allow *Robots* to *Score Minerals* or *Latch* without *Interference*. Additional occurrences of violations of this rule will escalate to *Yellow Cards* quickly.

<GS7> Latching before the End Game - *Deployed Robots* are not allowed to intentionally *Support* any portion of their weight with the *Lander Support Bracket* prior to the start of the *End Game*. *Robots* that attempt to *Latch* to the *Lander Support Bracket* before the start of the *End Game* are not eligible to *Score* the *End Game Latching* achievement.

<GS8> Latching to the Lander - Robots may latch only onto either of their *Alliance* specific *Lander Support Brackets*. A *Major Penalty* is assessed for violating this rule.

<GS9> Launching Game Elements - Robots *In* the *Landing Zone* for their corresponding *Alliance* may *Launch Game Elements* in an attempt to *Score* in a *Cargo Hold*. Robots *Outside* their *Alliance's Landing Zone* may not *Launch Game Elements*. A *Minor Penalty* is assessed for each illegally *Launched Game Element*. Additional occurrences of violations of this rule will escalate to *Yellow Cards* quickly.

Illegally *Launched Scoring Elements* are eligible to be counted as *Scored* and a *Minor Penalty* is assessed for each illegally *Launched Game Element*.

1.7 Scoring Summary

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

Scoring Achievement	Autonomous Points	Driver-Controlled Points	End Game Points**	Reference
Robot				
- Landing	30	-	-	1.5.2 - 1
- Claiming	15	-	-	1.5.2 - 2
- Parking	10	-	-	1.5.2 - 3
- Sampling	25	-	-	1.5.2 - 4
- Latching	-	-	50	1.5.4 - 1
- Robot In Crater	-	-	15	1.5.4 - 2
- Robot Completely In Crater	-	-	25	1.5.4 - 3
Mineral				
- Any Mineral in Depot	2	2	2	1.5.3 - 1
- Gold in Gold Cargo Hold	5	5	5	1.5.3 - 2
- Silver in Silver Cargo Hold	5	5	5	1.5.3 - 3
- Gold in Silver Cargo Hold	0	0	0	1.5.3 - 4
- Silver in Gold Cargo Hold	0	0	0	1.5.3 - 4

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

1.8 Rule Summary

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

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
Safety Rules						
<S1>	Unsafe Robot.	Disable if unsafe operation is likely to persist. Optional <i>Yellow Card</i> .	D			YC*
	Damage to the <i>Playing Field</i> .	Warning escalating to <i>Disable</i> . Optional <i>Yellow Card</i> .	W D			YC*
<S2>	Contact Outside the <i>Playing Field</i> .	<i>Immediate Yellow Card</i> and Optional <i>Disable</i> unless allowed by rule.	D*			YC
<S3>	<i>Drive Team</i> missing safety gear.	Warning and if not resolved within 30 seconds, the offending member(s) of the <i>Drive Team</i> must leave the <i>Competition Area</i> and may not be replaced.	W+			
General Rules						
<G1>	<i>Drive Team</i> using disallowed electronic communication.	Warning followed by a <i>Minor Penalty</i> .	W	1x		
<G2>	<i>Pre-Match Robot</i> setup – Entering the <i>Playing Field</i> .	May lead to <i>Disqualification</i> from <i>Match</i> or <i>Tournament</i> .				DQ*

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
<G3>	Pre-Match Robot placement.	Minor Penalty if Teams delay start of Match.		1x		
<G4>	Robot starting volume.	Robot is Disabled, powered off, and removed from the <i>Playing Field</i> .	D			
<G5>	Robot setup alignment devices/Match Delay.	Minor Penalty for each offense.		1x		
<G6>	Drive Team member(s) leaving the <i>Alliance Station</i> .	Warning for the first instance with any following instances resulting in a <i>Minor Penalty</i> .	W	1x		
<G7>	Starting Game Play Early.	Minor Penalty with the option of a <i>Major Penalty</i> if the early start results in a competitive advantage for the offending <i>Alliance</i> .		1x	1x	
<G8>	Late Start of the <i>Autonomous Period</i> .	Minor Penalty with the option of a <i>Major Penalty</i> if the late start results in a competitive advantage for the offending <i>Alliance</i> .		1x	1x	
<G9>	Robot control during <i>Autonomous Period</i> / Early stopping of <i>Autonomous</i> code.	Major Penalty for each offense.			1x	
<G10>	Stopping Game Play Late.	Minor Penalty and the actions of the Robot that occur after the end of game play do not count towards their <i>Alliance's Score</i> . <i>Major Penalty</i> if the late stop results in a competitive advantage for the offending <i>Alliance</i> .		1x	1x	
<G11>	Drive Team contact with the <i>Playing Field</i> , <i>Game Element</i> , or <i>Robot</i> .	Warning for the first instance with any following instances resulting in a <i>Minor Penalty</i> . Optional <i>Yellow Card</i> if contact affects <i>Scoring</i> and/or game play. Contact for safety reasons will not result in a warning or <i>Penalty</i> .	W	1x		YC*
<G13>	Drive Team Coach Driver <i>Station Control</i> .	Warning for the first instance with any following instances resulting in a <i>Major Penalty</i> .	W		1x	
<G15>	Robots deliberately detaching parts.	Minor Penalty. <i>Major Penalty</i> and a <i>Yellow Card</i> if it affects gameplay.		1x	1x	YC
<G16>	Robots illegally grasping <i>Game Elements</i> .	Warning for the first instance with any following instances resulting in a <i>Major Penalty</i> .	W		1x	
<G17>	Destruction, damage, tipping, etc.	Deliberate or chronic violations of this rule will receive a <i>Major Penalty</i> and a <i>Yellow Card</i> .			1x	YC
<G18>	<i>Pinning</i> , <i>Trapping</i> , or <i>Blocking</i> for more than 5-seconds in the <i>Driver-Controlled Period</i> .	Minor Penalty for every five seconds the Robot violates this rule.		1x		

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
<G20>	Deliberately removing <i>Game Elements</i> from the <i>Playing Field</i> .	<i>Minor Penalty</i> per <i>Game Element</i> deliberately removed from the <i>Playing Field</i> .		1x		
<G21>	<i>Scoring Elements</i> in contact or <i>Controlled</i> with <i>Robots</i> of the corresponding <i>Alliance</i> .	Points are not earned for any <i>Scoring Elements</i> in contact with <i>Robots</i> of the corresponding <i>Alliance</i> .				
<G22>	Delay caused by removal of <i>Robots</i> from the <i>Playing Field</i> and <i>Game Elements</i> from <i>Robots</i> .	A <i>Minor Penalty</i> will be assessed.		1x		
<G28>	Egregious behavior.	<i>Major Penalty</i> plus a <i>Yellow</i> and/or <i>Red Card</i> . Possible <i>Match Disqualification</i> . Subsequent violations result in <i>Team Disqualification</i> for the tournament.			1x	YC RC
<G29>	Illegal Use of <i>Game Elements</i> to ease or amplify <i>Scoring</i> .	<i>Major Penalty</i> will be assessed with any following instances resulting in a <i>Yellow Card</i> .			1x	YC
Game-Specific Rules						
<GS1>	Touching <i>Robots</i> or <i>Driver Stations</i> after <i>Sample Randomization</i> .	<i>Minor Penalty</i> and <i>Robot</i> is not eligible to earn the <i>Sample Score</i> .		1x+		
<GS2>	<i>Interference</i> with opposing <i>Alliance Scoring</i> or <i>Sample Field</i> during <i>Autonomous</i> .	<i>Major Penalty</i> will be assessed.			1x	
<GS3>	<i>Control / Possession</i> limits of <i>Minerals</i> .	<i>Minor Penalty</i> per <i>Mineral</i> plus an additional <i>Minor Penalty</i> per five seconds. <i>Major Penalty</i> if <i>Mineral</i> is <i>Scored</i> . May escalate to <i>Yellow Card</i> .		1x+	1x+	YC
<GS4>	<i>De-scoring Minerals</i> from <i>Cargo Holds</i> or <i>Completely Claimed Depots</i> .	<i>Minor Penalty</i> per <i>Mineral</i> .		1x+		
<GS5>	<i>Blocking</i> access to <i>Scoring</i> in <i>Lander</i> .	<i>Major Penalty</i> is assessed plus an additional <i>Minor Penalty</i> per 5 seconds in violation. May escalate to <i>Yellow Card</i> .		1x+	1x	YC*
<GS6>	<i>Interfering</i> with <i>Scoring</i> in <i>Lander</i> .	<i>Major Penalty</i> is assessed plus an additional <i>Minor Penalty</i> per 5 seconds in violation. May escalate to <i>Yellow Card</i> .		1x+	1x	YC*
<GS7>	<i>Latching</i> before <i>End Game</i> begins.	<i>Robot</i> ineligible to <i>Score</i> the <i>Latching</i> achievement.				
<GS8>	<i>Latching</i> to opposing <i>Alliance's Lander Support Bracket</i> .	<i>Major Penalty</i> is assessed.			1x	

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
<GS9>	<i>Launching Game Elements illegally.</i>	<i>Minor Penalty per occurrence. May escalate to Yellow Card.</i>		1x		YC*

Column Key
1x: <i>Penalty at normal (single) cost</i>
2x: <i>Penalty at double cost</i>
D: <i>Robot Disabled</i>
D*: <i>Robot optionally Disabled</i>
DQ*: <i>Possible Disqualification</i>
RC: <i>Red Card issued</i>
W: <i>Warning</i>
YC: <i>Yellow Card issued</i>
YC*: <i>Yellow Card optionally issued</i>

Appendix A – Resources

Game Forum Q&A

<http://ftcforum.usfirst.org/forum.php>

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

Volunteers that apply for a specific volunteer role will receive an email from FTCTrainingSupport@firstinspires.org with their username and password to the forum. 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 Eastern Time

Email: firsttechchallengeteams@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 firsttechchallengeteams@firstinspires.org. Thank you!

Appendix B - Field Details

Sample Field

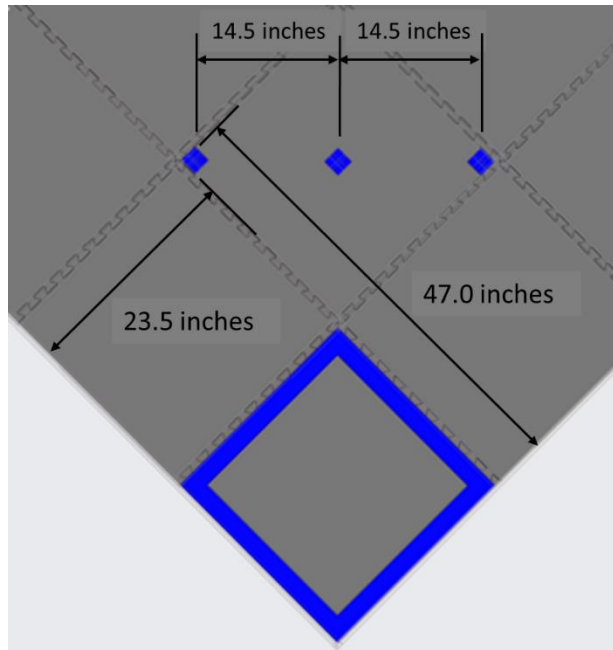


Figure B-1 Sample Field Locations

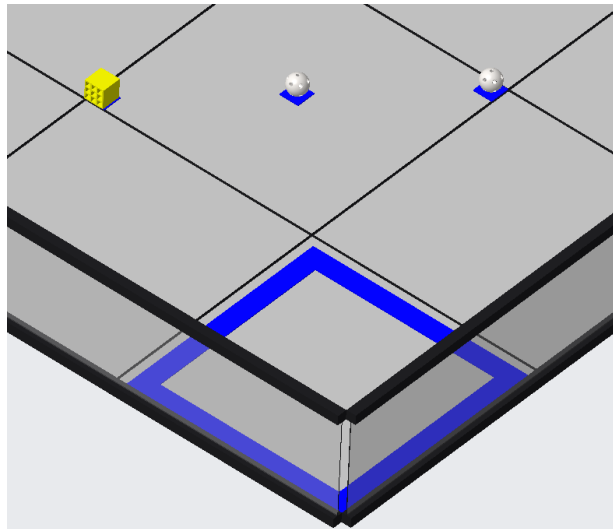


Figure B-2 Example of Samples positioned on Sample Field

The type of *Minerals* positioned at the three locations in the *Sample Field* will be randomized prior to each *Match*. There will always be one (1) *Gold* and two (2) *Silver Minerals*. The starting locations for the *Samples* are 2" x 2" strips of red or blue Gaffer tape located as shown in Figure B1-1. The two outside tape strips are positioned in the corners of the *Tile*, adjacent to the inside edge of the *Tile* tabs. The third tape strip is located midway between the two outside strips.

Lander

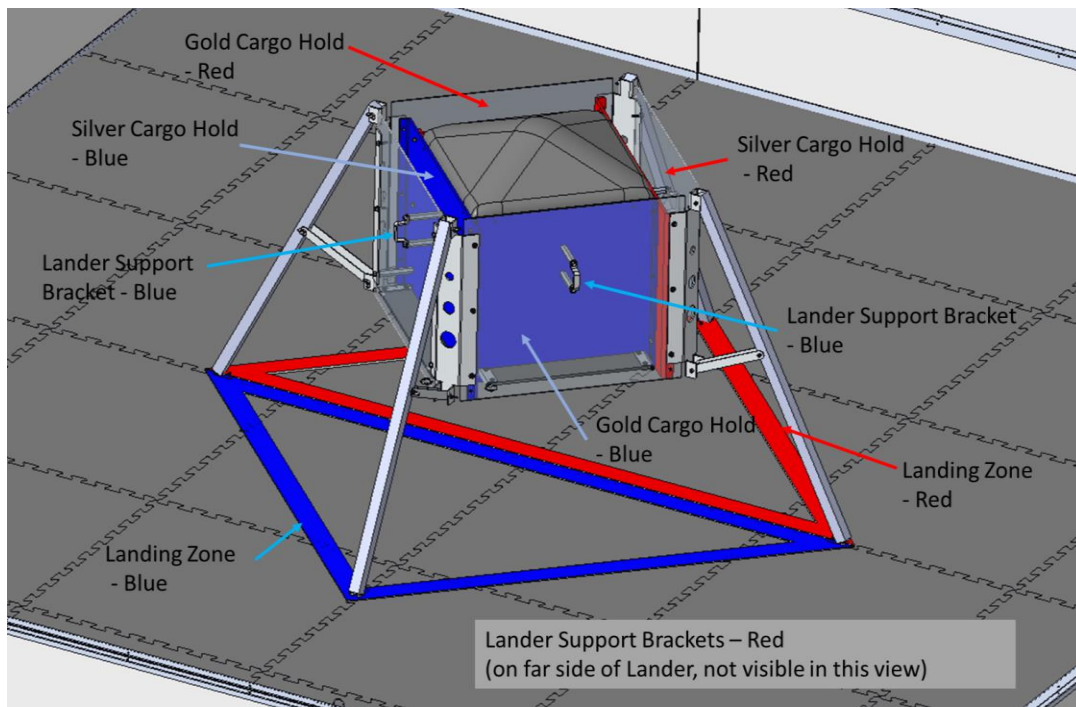


Figure B-3 Lander Detail

Lander Support Bracket

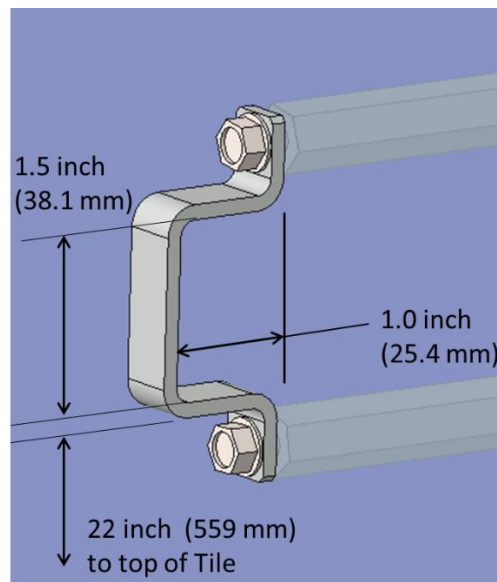


Figure B-4 Lander Support Bracket Detail

Navigation Target

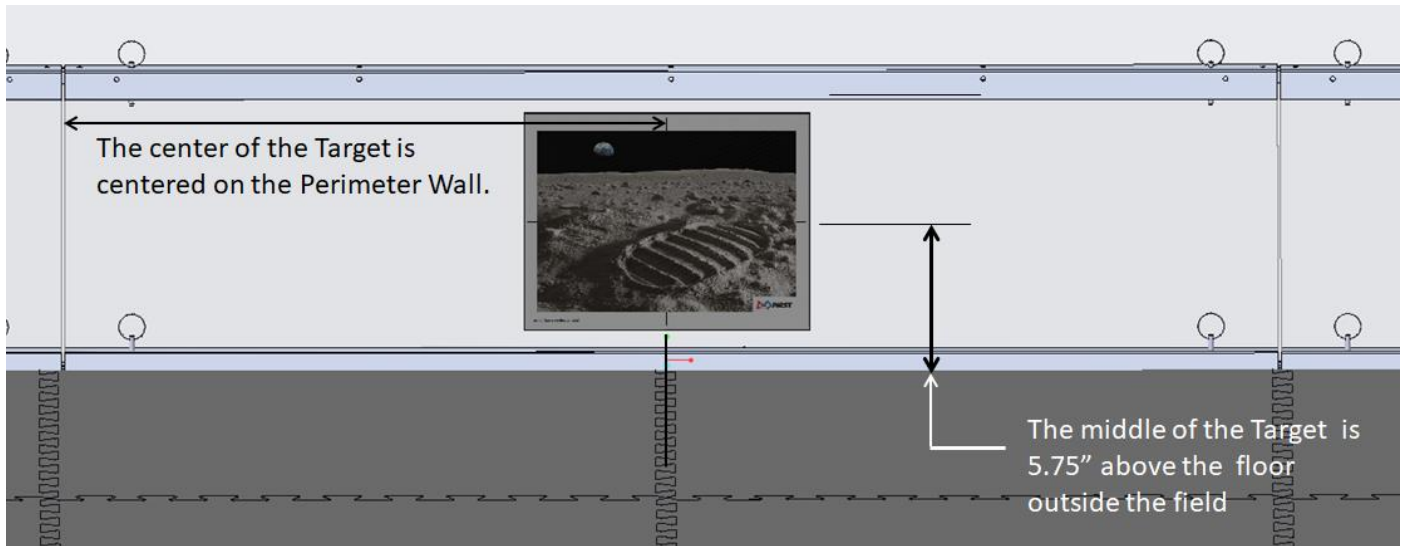
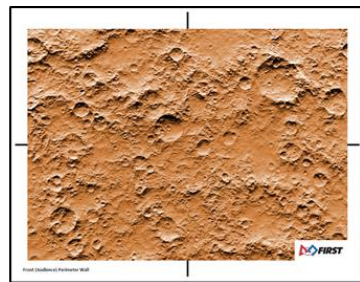


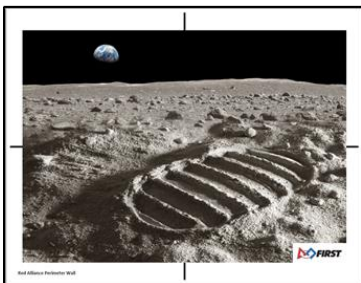
Figure B-5 Navigation Target Location



Target 1
Front Wall
(audience facing)



Target 3
Back Wall



Target 2
Red Alliance Wall



Target 4
Blue Alliance Wall

Figure B-6 Navigation Targets

Crater

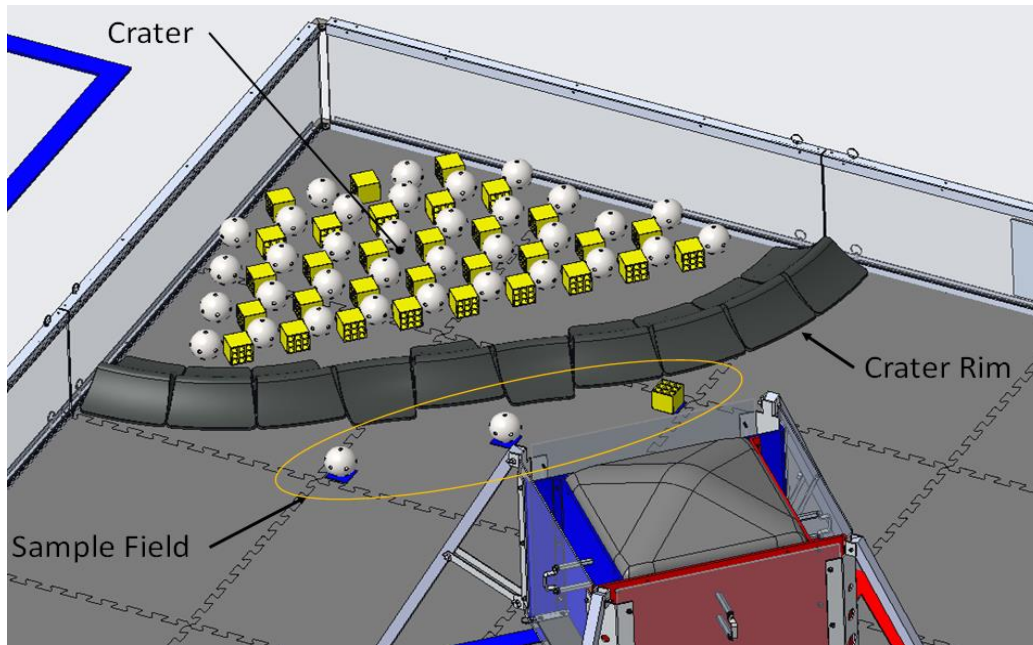


Figure B-7 Silver and Gold Minerals will be randomly mixed. Each Crater will contain approximately half the available Minerals.

Landing Zone

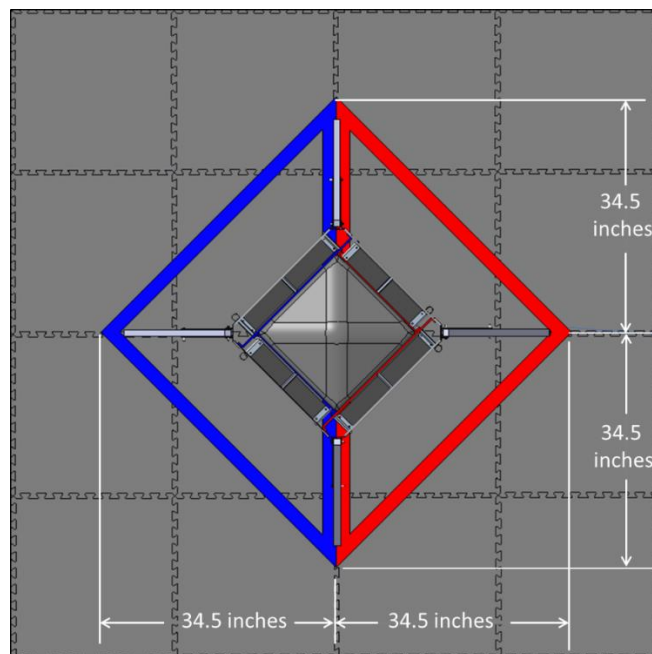


Figure B-8 Landing Zone Dimensions

Appendix C – Game Elements

Minerals

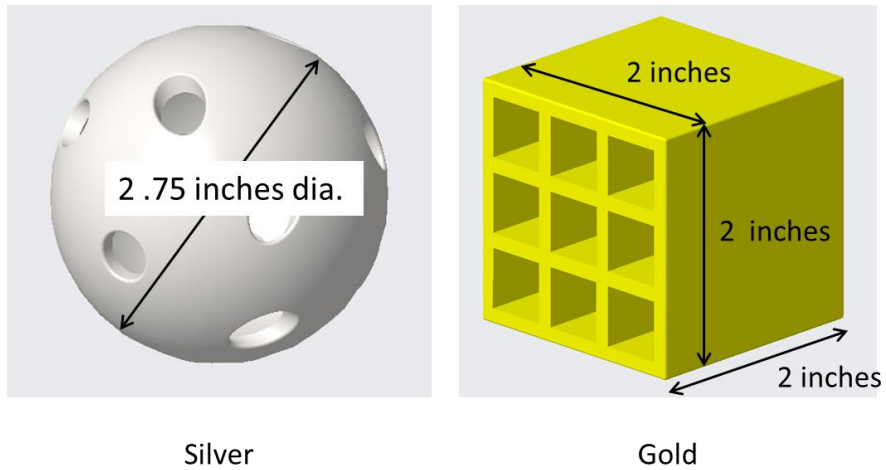


Figure C-1 There are sixty (60) Silver and ninety (90) Gold Minerals on the Playing Field.

Team Markers

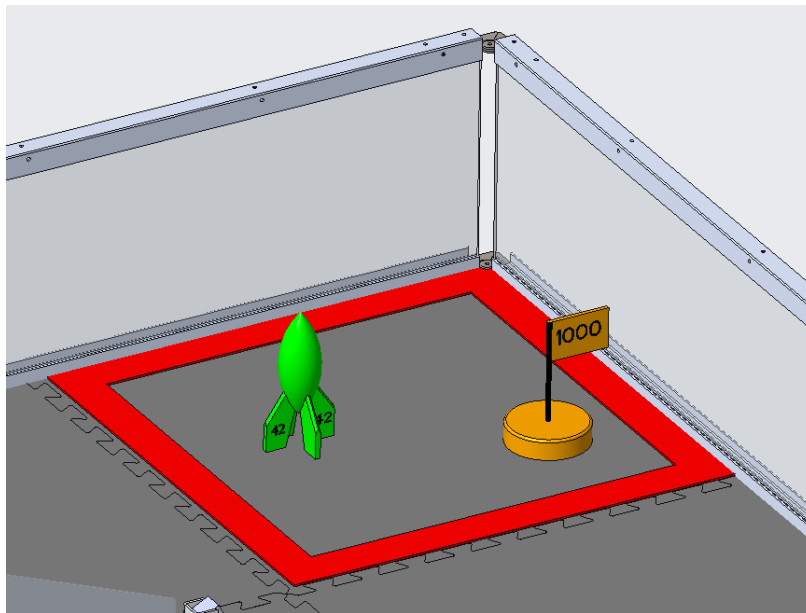
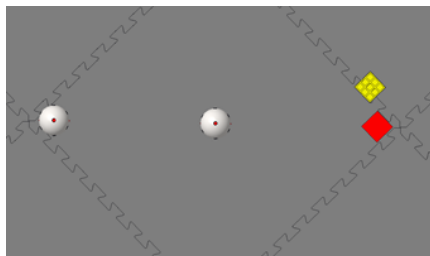


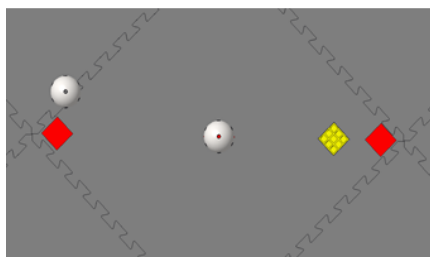
Figure C-2 A Team Marker is supplied by the Team and is constrained by the rules in section 8.4 in the Game Manual Part 1.

Appendix D – Sample Field



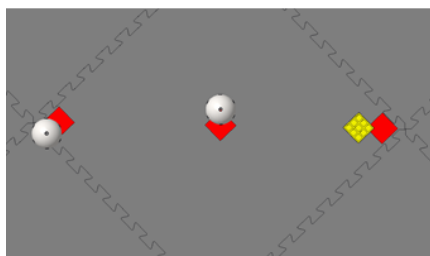
Example 1: Red earns the *Sampling* points.

The *Gold Sample* has been moved *Completely Off* the starting location and the *Silver Samples* are still *In* their starting locations.



Example 2: Red does not earn the *Sampling* points.

The *Gold Sample* has been moved *Completely Off* the starting location but one of the *Silver Samples* is *Outside* of its starting location.



Example 3: Red does not earn the *Sampling* points.

The *Gold Sample* has not been moved *Completely Off* the starting location.

Figure D-1 Sample Field Scoring Examples

Note: The Gold Sample will always be placed such that the hole pattern is facing up.

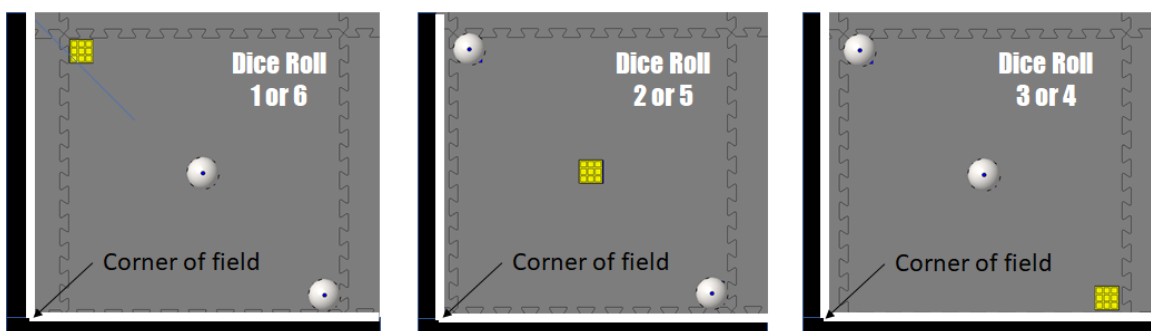


Figure D-2 Sample Field Pattern determined by die roll

Appendix E – Cargo Hold Scoring

Per section 1.5.3 – 5, the *Cargo Hold* volume is defined by the 5 inner surfaces of the *Cargo Hold* and the horizontal extension of the upper edge of the clear panel on the outside of the *Cargo Hold*.

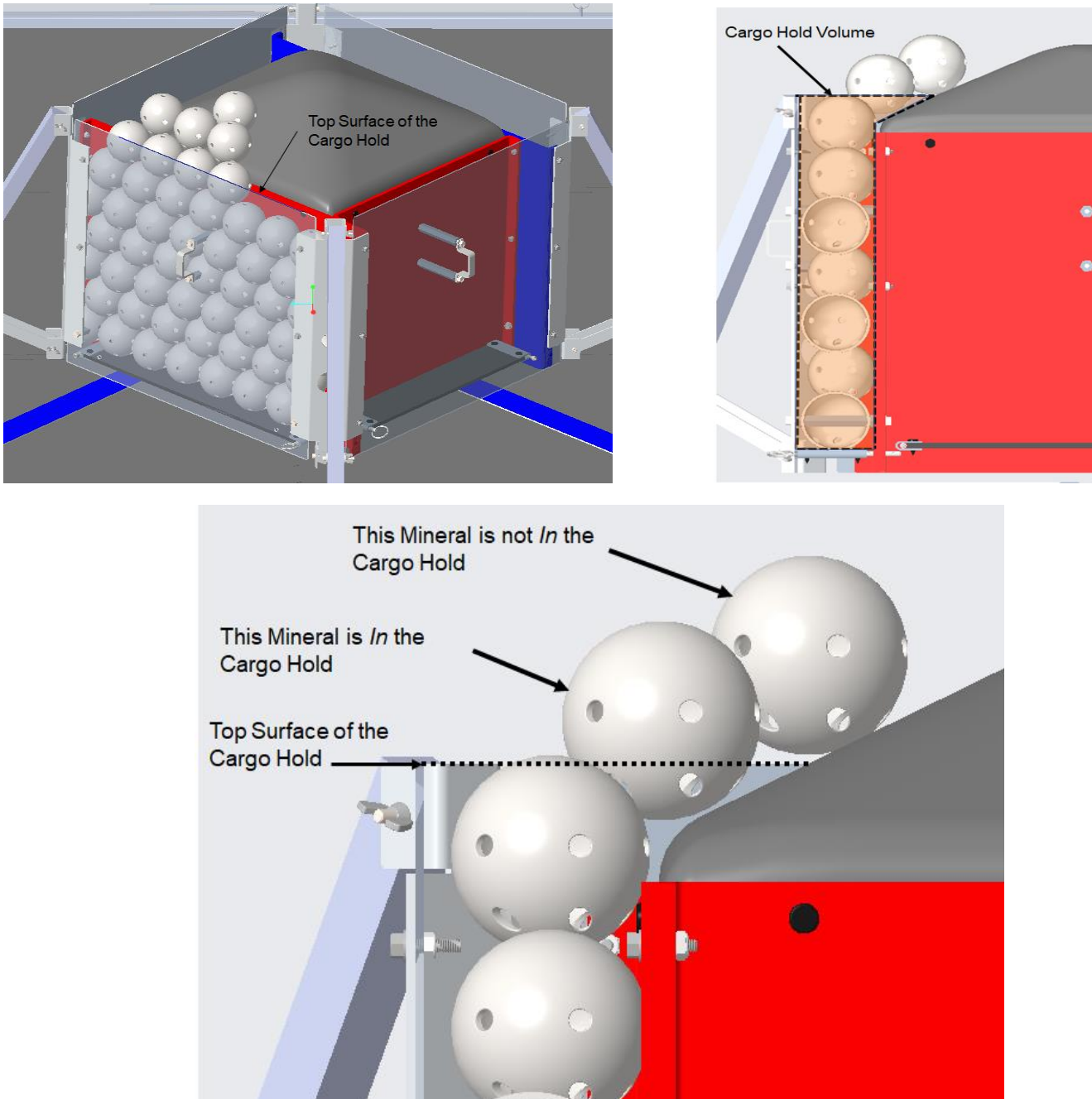


Figure E-1 Cargo Hold Scoring