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2019-2020 *FIRST®* Tech Challenge

Game Manual Part 1



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Contents

Contents	3
1.0 Introduction.....	6
1.1 What is <i>FIRST</i> ® Tech Challenge?	6
1.2 <i>FIRST</i> Core Values	6
2.0 <i>Gracious Professionalism</i> ®	6
3.0 The Tournament – Definitions and Rules.....	7
3.1 Overview.....	7
3.2 Tournament Definitions	7
3.3 Tournament Rules.....	8
4.0 Tournament Day Outline.....	15
4.1 Tournament Schedule	15
4.2 Team Check-In	15
4.2.1 Consent and Release Forms	15
4.2.2 Team Check-In Packets	15
4.3 Robot and Field Inspection.....	15
4.4 Judges' Interviews.....	16
4.5 Drivers' Meeting	16
4.6 Practice Time	16
4.7 Opening Ceremony	16
4.8 Qualification Matches.....	16
4.8.1 Calculating Ranking.....	17
4.9 Alliance Selection.....	18
4.10 Elimination Matches	18
4.11 Awards and Closing Ceremony	19
4.12 Team Spirit & Styling.....	19
4.13 Banners and Flags	20
4.14 Spectators and Etiquette	20
4.15 Scouting.....	20
5.0 Tournament Types.....	21
5.1 Scrimmage.....	21

5.2 Meets and League Play.....	21
5.3 Qualifying Tournaments and League Tournaments.....	21
5.4 Super-Qualifying Tournaments.....	21
5.5 Championship Tournaments	21
6.0 Eligibility and Advancement Criteria.....	22
6.1 Eligibility to Compete in Official <i>FIRST</i> Tech Challenge Tournaments:.....	22
6.1.1 North America Teams.....	22
6.1.2 Outside North America	22
6.2 Eligibility for Judged Awards	22
6.2.1 Inspire Award Eligibility	22
6.3 Eligibility for Advancement	22
6.4 Order of Advancement	23
7.0 The Robot.....	25
7.1 Overview.....	25
7.2 Robot Control System	25
7.2.1 Robot Technology Definitions	25
7.3 Robot Rules	26
7.3.1 General Robot Rules	26
7.3.2 Robot Mechanical Parts and Materials Rules.....	29
7.3.3 Robot Electrical Parts and Materials Rules	30
7.3.4 Robot Software Rules.....	37
7.4 Team Scoring Element.....	38
8.0 Robot Inspection.....	40
8.1 Overview	40
8.2 Description	40
8.3 Definitions	40
8.4 Inspection Rules.....	40
9.0 Judging and Award Criteria.....	42
10.0 <i>FIRST</i> ® Tech Challenge Dean’s List	43
10.1 Eligibility	43
10.2 Criteria	43
10.3 Dean’s List Nominations.....	44
Appendix A – Resources	45
Game Forum Q&A	45
<i>FIRST</i> Tech Challenge Game Manuals.....	45
<i>FIRST</i> Headquarters Pre-Event Support.....	45

<i>FIRST</i> Websites.....	45
<i>FIRST</i> Tech Challenge Social Media	45
Feedback.....	45
Appendix B – Robot Inspection Checklist	46
Appendix C – Field Inspection Checklist.....	48
Appendix D – Control Award Content Sheet & Instructions.....	50

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.

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

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

3.0 The Tournament – Definitions and Rules

3.1 Overview

Students that engage in the *FIRST* Tech Challenge program develop Science, Technology, Engineering, and Math (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.

3.2 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 semi-final and final *Elimination Matches*. The entire *Team* is also 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 four representatives two (2) *Drivers*, one (1) *Coach*, and one (1) *Human Player* from the same *Team*. Only one (1) *Human Player* represents an entire *Alliance* in a *Match*.

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.

Human Player – A student *Team* member that supplies *Scoring Elements* and is identified by wearing a tournament supplied “*Human Player*” badge or identifying marker. Only one *Human Player* represents the entire *Alliance*. For *Qualification Matches*, an *Alliance* must decide which *Team* will name the *Human Player*. If the *Alliance* cannot decide quickly, the *Team* listed in the *Match* list as “Red 1” or “Blue 1” for the *Alliance* has the responsibility for naming the *Human Player*. The *Human Player* must be from the *Teams* that are in the *Match*. For *Elimination Matches*, the captain of the *Alliance* has that responsibility.

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*.

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

Ranking Points – The first basis for ranking *Teams*. *Teams* earn *Ranking Points* for winning (two points), tying (one point), and losing or disqualification/no show (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 7 of this manual.

Sports Start – A model of competition where *Teams* start 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. A *Team* is made up of pre-college students and is designed for students in grades 7 -12. Students cannot be older than high school-aged if they are participating *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*.

3.3 Tournament Rules

<T1> Eggregious 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. Eggregious 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 eggregious behavior in the *Pit Area*, judging rooms, stands, or any other location of the tournament can be issued a yellow or red card for eggregious behavior.

Eggregious 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*. For regions that compete in League Meet formats which carry *Qualification Match* scores from Meet to Meet, Yellow and Red Cards do not carry from one Meet to the next Meet or to a League Tournament. 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 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 the announcement of the *Match* score.
 - ii. *Elimination 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 **Gracious Professionalism®** - "Doing your best work while treating others with respect and kindness - It's what makes FIRST, first."

official [FIRST Tech Challenge Forum](#). *Team* members must ask their questions in a gracious and respectful manner.

<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 *Driver 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*. Refusal to comply with this rule will result in a *Yellow Card*.

<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 four *Team* representatives are allowed in the *Competition Area*; two (2) student drivers, one (1) coach, and one *Human Player* who are identified by badges labeled 'driver', 'coach', or '*Human Player*'. 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, one coach, and one *Human Player* will be asked to leave the *Competition Area* immediately.

Only one *Human Player* represents the entire *Alliance*. For *Qualification Matches*, an *Alliance* must decide which *Team* will name the *Human Player*. If the *Alliance* cannot decide quickly, the *Team* listed in the *Match* list as "Red 1" or "Blue 1" for the *Alliance* has the responsibility for naming the *Human Player*. The *Human Player* must be from the *Teams* that are in the *Match*. For *Elimination Matches*, the captain of the *Alliance* has that responsibility.

<T9> *Playing Field Access* - *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*. Inspection of the *Playing Field* elements by *Team* members to determine scoring is not allowed. The consequences for violating this rule are:

- a) Minor Penalty for violation of this rule during *Match* setup or following the end of the *Match*.
- b) Major Penalty for violations of this rule that delay the start of the *Match*.
- c) Violations of this rule outside of normal *Match* play result in a yellow card.

If a *Team* feels the *Playing Field* is not set up currently, *Teams* should notify a *Referee* or *FTA* prior to the start of the *Match*.

<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 inside the *Alliance Station*. The *Human Player* for the *Alliance* must stand inside the designated *Human Player Station*.

- 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 Scoring Referees. 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 following the end of the *Match*.

<T12> There are no *Team* requested 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 *Qualification Matches*, and no more than 6 *Qualification Matches*.

<T31> A *Team* may not encourage another *Team* to throw a *Match* or to play beneath its ability. Likewise, a *Team* may not let another *Team* coerce them into throwing a *Match* or playing beneath their own ability. *FIRST* considers the action of a *Team* influencing another *Team* to throw a *Match*, to deliberately miss scoring objectives, etc. incompatible with *FIRST* values and not a strategy any *Team* should employ. Violations of this rule are likely to escalate rapidly to yellow or red cards and may lead to dismissal from the event. The following examples violate rule <T31>.

- Example 1: A *Match* is being played by *Alliance* partner *Teams* A and B in which *Team* B is encouraged by *Team* C to underperform/not score during a *Match*. *Team* C's motivation for this behavior is to negatively affect *Team* A's ranking.
- Example 2: A *Match* is being played by *Alliance* partner *Teams* A and B in which *Team* A is assigned to participate as a *Surrogate*. *Team* C encourages *Team* A to not fully participate in the *Match* so that *Team* C gains ranking position over *Team* B.

- Example 3: A *Match* is being played by *Alliance* partner *Teams* A and B in which *Team* A is assigned to participate as a *Surrogate*. *Team* A accepts *Team* C's request not to fully participate in the *Match* so that *Team* C gains ranking position over *Team* B.

NOTE: This rule is not intended to prevent an *Alliance* from planning and/or executing its own good faith strategy in a specific *Match* in which all the *Teams* are members of the same *Alliance*.

4.0 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*

4.1 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.

4.2 Team Check-In

4.2.1 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.

4.2.2 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.

4.3 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. *FIRST* encourages *Teams* to use the *Robot Inspection Sheet* as a guide to pre-inspect their *Robot* prior to attending a tournament.

4.4 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 *Team*’s 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.

4.5 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*.

4.6 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.

4.7 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 *Teams*, 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*.

4.8 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, *Match* pairings, and the *Alliance*’s color (red or blue). These *Matches* start immediately after the opening ceremonies and follow the *Qualification Match* schedule. The queue volunteer crew works *Teams* throughout the day maintain the *Qualification Match* 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.

4.8.1 Calculating Ranking

Teams at a Tournament are ranked as follows:

1. Average *Ranking Points*; highest to lowest
2. Average *TieBreaker Points*; highest to lowest
3. Highest *Match Score*
4. Random Electronic Draw

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

At the end of each *Match*, *Ranking Points* and *TieBreaker Points* are awarded:

- Average *Ranking Points* are calculated by adding the *Ranking Points* (2 for a win, 1 for a tie, 0 for a loss, disqualification, or no-show) for each *Match* and dividing by the total number of *Matches* played.
- Average *TieBreaker Points* are calculated by adding the *TieBreaker Points* for each *Match*, then subtracting the lowest scoring *Match* (5-6 *Matches*, one *Match* is subtracted; 7 or more, two are subtracted) and then dividing by the total number of *Matches* played minus the dropped *Match*.
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 or no-show, they receive zero (0) *TieBreaker Points*. This *Match* will not be subtracted as the lowest *Match* score and will count in the *Team's* rankings.
 - If both *Teams* on an *Alliance* are disqualified, the winning *Alliance Teams* are awarded their own pre-penalized score as their *TieBreaker Points* for that *Match*.

Example:

Match	Team	Ranking Points	TieBreaker Points
First Match Played	1111	2	15
Second Match Played	1111	2	65
Third Match Played	1111	0	125
Fourth Match Played	1111	1	200
Fifth Match Played	1111	2	78

In this example, the *Team* competed in five (5) *Matches*. The first *Match* had the lowest amount of *TieBreaker Points*, and therefore those points (15) will be dropped from the **Average Tiebreaker Point** calculation.

Therefore, this *Team* has an **Average Ranking Points** of 1.4 (2 + 2 + 0 + 1 + 2 divided by 5), and an **Average Tiebreaker Points** of 117 (65 + 125 + 200 + 78 divided by 4, since the first *Match* was dropped from the ranking).

4.9 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 decide the tournament's Winning *Alliance*. The *Alliance Selection* is as follows:

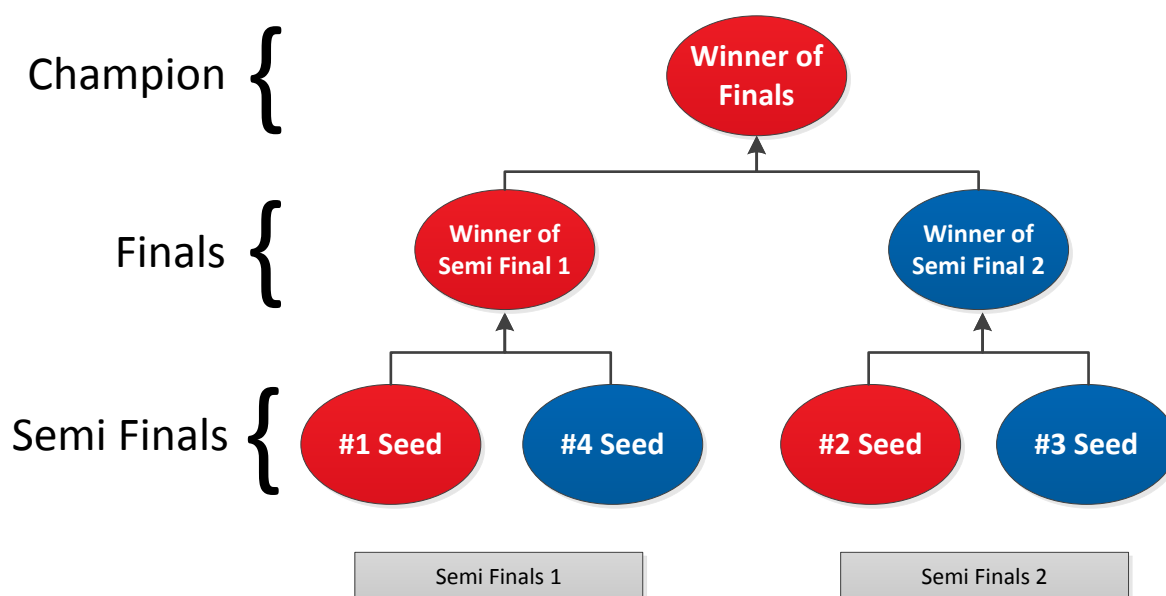
- Each *Team* chooses one student to act as the *Team's* representative. These representatives will continue to the *Competition Area* at the appointed time to represent their *Teams* in the *Alliance Selection*.
 - *Teams* can bring their scouting documents or communicate by phone with other teammates 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*.

4.10 Elimination Matches

The *Elimination Matches* are when the *Alliances* compete to decide 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 decide 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 compete in every *Match*. No special accommodations are made for *Robots* that fail during the Semi Final and Final *Matches*. *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. The *Match* is then 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* can 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.

4.11 Awards and Closing Ceremony

The awards and closing ceremony celebrate 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.

4.12 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>

4.13 Banners and Flags

Sponsors provide *FIRST* with banners to display 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.

4.14 Spectators and Etiquette

Teams are allowed to have 2 student drivers, 1 coach, and one *Human Player* (per *Alliance*) at the *Playing Field* during their scheduled *Matches*. Spectators are not allowed in the designated *Competition Area*. 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.

4.15 Scouting

During the *Qualification Matches*, the scoring system selects each *Team's* ally and opponents for each *Match*. In *Elimination Matches*, 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.

5.0 Tournament Types

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

5.1 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 tell 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.

5.2 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 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.

5.3 Qualifying Tournaments and League Tournaments

Hosted and managed by *FIRST* Tech Challenge Affiliate Partners or Affiliate Partner-appointed hosts. Qualifying tournaments follow the format outlined in sections 4.0. Qualifying Tournaments are 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 tournament level is detailed in section 6.0.

5.4 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.

5.5 Championship Tournaments

Hosted and managed by a *FIRST* Tech Challenge Affiliate Partner, Championship Tournaments uphold 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.

6.0 Eligibility and Advancement Criteria

6.1 Eligibility to Compete in Official FIRST Tech Challenge Tournaments:

6.1.1 North America Teams

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

1. The *Team* must complete the registration process through the [Team Registration System](#).
2. The *Team* registration fee must be paid.
3. Two adults must pass the [Youth Protection](#) screening process.

6.1.2 Outside North America

Teams outside of North America are encouraged, but not required, to register through the [Team Registration System](#). Fees will not be due to *FIRST* for the registration. Teams outside of North America should consult the Affiliate Partner in their region for program fees and product purchase.

6.2 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

6.2.1 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.

6.3 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	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.
League Tournament		A <i>Team</i> may participate in more than three Tournaments in the same competition tier, but are not eligible for consideration for advancement or Awards at Tournaments beyond their third.
Super-Qualifying Tournament		
State or Regional Championship Tournament	FIRST Tech Challenge World Championship	<i>Teams</i> advance from a State or Regional Championship Tournament to one of the FIRST Tech Challenge World Championships.

6.4 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 is offered. 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 Tournaments, 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. Collins Aerospace Innovate Award Winner
13. Finalist *Alliance*, 2nd *Team* selected
14. Design Award Winner
15. Motivate Award Winner
16. Control Award presented by ARM 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. Collins Aerospace 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 presented by ARM 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. Collins Aerospace 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 presented by ARM 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.

7.0 The Robot

7.1 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.

7.2 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 is mounted directly onto the *Robot* and acts as a *Robot Controller*. The other Android device is connected to a pair of gamepads and acts 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>

7.2.1 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 USB Hub; an optional, commercial, off the shelf, USB external battery connected to the USB Hub to charge the Android device; 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](#).

7.3 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 suppliers' 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](#).

7.3.1 General Robot Rules

It is the intent of *FIRST* to encourage creativity in design as long as 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 restricts this?
- If everybody did this, would the game play be impossible?

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

- 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).
- Those that could potentially damage or flip other competing *Robots*.
- 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).
- Those that pose an unnecessary risk of entanglement.
- Those that contain sharp edges or corners.
- Those that contain animal-based materials (because of health and safety concerns).
- Those that contain liquid or gel materials.
- Those that contain materials that would cause a delay of game if released (for example, loose ball bearings, coffee beans, etc.).
- Those that are designed to electrically ground the *Robot* frame to the *Playing Field*.
- Closed gas devices (for example, gas storage vessel, gas spring, compressors, etc.).
- 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*. Preloaded game elements may extend outside the starting volume constraint.

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

- 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*.
- A *Robot* Initialization Routine in the Autonomous *Op Mode* that may pre-position the servo motors, with the *Robot* powered on, to the desired stationary position.
 - If the *Robot* Initialization Routine moves the servos when a program is executed, there must be an indication label on the *Robot*. 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):

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<RG03> Robot Controller Mount – It is recommended the *Robot Controller* be accessible and visible by field personnel. If a *Team's Robot Controller* is not accessible or visible to field 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 (for example, batteries, motor and servo controllers, switches, sensors, wires) make poor bumpers and are unlikely to survive *Robot-to-Robot* contact during game play.

Important Note: The *Robot Controller* contains a built-in wireless radio that communicates with the Android device in the *Driver Station*. 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 includes one set of *Team* supplied *Alliance Marker* (either red or blue) and it does not include the *Team Scoring Element*. If a *Team* is using multiple mechanisms that will be swapped out between *Matches*, all parts and the *Robot* must be weighed together during weight inspection. The *Robot* and all mechanisms must not weigh more than 42 pounds.

<RG05> 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 in 0.5 inches (1.27 cm) stroke width, and in a contrasting color from their background. Minimum size requirements can be met with Arial Font, Bold, 250 point.
- d. *Team* numbers must be robust enough to withstand the rigors of *Match* play. Example robust materials include: 1) self-adhesive numbers (mailbox or vinyl numbers) mounted on polycarbonate sheet, wood panel, metal plate, etc. or 2) Ink jet or laser printed numbers on paper and laminated.

<RG06> Alliance Marker – *Robots* must include a *Team* supplied, *Alliance* specific marker on two opposite sides of the *Robot* to easily identify which *Alliance* a *Robot* is assigned to. The *Alliance Marker* must be displayed on the same side of the *Robot* as the *Team* number, within a 3” distance of the number. The *Alliance Marker* must be visible to the Referees during a *Match*.

- a. The Red *Alliance Marker* must be a solid red square, approximately 2.5 inches x 2.5 inches (6.35 cm x 6.35 cm).
- b. The Blue *Alliance Marker* must be a solid blue circle, approximately 2.5 inches (6.35 cm) in diameter.

- c. Both *Alliance Markers* must be removeable in order to swap them between *Matches*.
- d. The *Alliance Marker* must be robust enough to withstand the rigors of *Match* play. Example robust materials include: 1) *Alliance Marker* template printed and laminated; mounted on polycarbonate sheet, wood panel, metal plate, etc.

The intent of this rule is to allow easy identification of the *Robot* and their *Alliance* to field personnel. *Alliance* flags will no longer be provided by Tournament Directors.

<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* can launch scoring elements through the air unless limited by a game specific rule. *Teams* must only launch the elements with enough velocity to score. Launching elements with excessive velocity could create a safety hazard for other *Teams* and field personnel. If the referees feel that a *Robot* is launching scoring elements with excessive velocity, the *Robot* must be re-inspected. *Robots* must then show that a launched scoring element cannot travel in the air more than a 16 ft. (4.88 m) distance or more than 6 ft. (1.83 m) in elevation.

7.3.2 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 by

a single, independent, co-ordinate (or function)¹.

It is the intent of *FIRST* to encourage *Teams* to design their own mechanisms rather than buying 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.

Examples of allowed single degree of freedom parts:

- Linear Slide
- Single Speed (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 (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 COTS lubricant is allowed, if it doesn't contaminate the *Playing Field*, scoring elements or other *Robots*.

7.3.3 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 field personnel. A Main *Robot* Power label must be placed near the Main Power Switch of the *Robot*. Attach the

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

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 12V *Robot* main battery.

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

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

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

<RE04> 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. Replaceable 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* 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:

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- a. ZTE Speed
- b. Motorola Moto G 2nd Generation
- c. Motorola Moto G 3rd Generation
- d. Motorola Moto G4 Play
- e. Motorola Moto G5
- f. Motorola Moto G5 Plus
- g. Motorola Moto E4 (USA versions only, includes SKUs XT1765, XT1765PP, XT1766, and XT1767)
- h. Motorola Moto E5 (includes XT1920 and XT1925)
- i. Google Nexus 5*
- j. Samsung Galaxy S5*
 - i. 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.
 - ii. 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 USB hub.

Starting in the 2020-2021 season, the ZTE Speed, Google Nexus 5, and Samsung S5 will no longer be allowed for use at any FIRST Tech Challenge Tournament.

*Does not support Wi-Fi Direct channel changing through the *Robot Controller* app. Having the ability to switch to a different channel during an event is important if there is any wireless interference or bandwidth issues on a specific channel.

<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: *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 in any combination. 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.

<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 maximum, an overall total 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 (COTS) 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 battery (as supplied by the manufacturer).
- b. *UVC Compatible Cameras* are allowed for computer vision-related tasks. It is recommended that *UVC Compatible Cameras* be connected to the *Robot Controller* through a powered USB hub that is in turn 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 *USB hub*, and an *OTG Micro Adapter* may be used to connect the *Robot Controller* Android device to the *Robot* electronics. Note that the *OTG Micro Adapter* may be integrated into the USB hub. 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 USB hub that connects to the built-in USB input port of the *REV Expansion Hub*. If a powered hub is used, it must draw its energy from either
 - i. A commercial USB battery pack, or
 - ii. A 5V auxiliary power port on a *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 one (1) COTS USB external battery
 - v. No more than two (2) gamepads
 - vi. 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 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 field 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.

7.3.4 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 5.0. Programming must be done using one of the following applications:

- FTC Blocks Development tool – a visual, blocks-based programming tool hosted by the *Robot Controller*.
- Android Studio – a text-based integrated development environment.
- 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.
- 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:

- ZTE Speed: 4.4 or higher (Kit Kat)
- Motorola Moto E4, Motorola Moto E5, Motorola Moto G4 Play, Motorola Moto G5, Motorola Moto G5 Plus, 7.0 or higher (Nougat)
- Motorola Moto G 2nd Generation, Motorola Moto G 3rd Generation, Google Nexus 5, Samsung Galaxy

S5:
6.0
or

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>.

higher (Marshmallow)

<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*. The *Robot Controller* App must not be installed on the *Driver Station Android Device*.

<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. The *Driver Station* App must not be installed on the *Robot Controller Android Device*.

<RS07> Android Device Operating System Settings - The *Robot Controller* and *Driver Station* must be set to:

- a) Airplane mode must be turned on
- b) Bluetooth must be turned off
- c) Wi-Fi must be turned on.

<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).

<RS09> Software Modification - *Teams* are not allowed to modify the *FIRST* Tech Challenge *Driver Station* App in any fashion. When using the *Robot Controller* SDK, *Teams* are not allowed to replace or modify the portions of the SDK which are distributed as binary .AAR files.

<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.

7.4 Team Scoring Element

The *Team Scoring Element* is an object that *Teams* create and bring to a competition to be used in the current season’s game. The *Team Scoring Element* must pass *Inspection* before it can be used in a *Match*.

<TE01> Material Constraints - The *Team Scoring Element* is subject to the *Robot Mechanical Parts and Materials* Rules in section 7.3.2.

<TE02> Size Constraints - The maximum size of the *Team Scoring Element* is 4 inches (10.16 cm) by 4 inches (10.16 cm) by 8 inches (20.32 cm). The minimum size of the *TSE* is 3 inches (7.62 cm) by 3 inches (7.62 cm) by 4 inches (10.16cm).

<TE03> Team Number - The *Team Scoring Element* must be labeled with their *Team* number (numerals only, for example “12345”) The letters must be legible when viewed from 12 inches away. The *Team* number needs to appear only once on the *Team Scoring Element*.

<TE04> 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 7.3.

<TE05> Current season's *Scoring Elements* may not be used as the *Team Scoring Element*.

8.0 Robot Inspection

8.1 Overview

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

8.2 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.

8.2.1 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.

8.3 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 7.3.1.

8.4 Inspection Rules

<I1> Inspection - Every *Robot* is required to pass a full inspection before being cleared to compete. This inspection ensures that all *FIRST* Tech Challenge *Robot* rules are met.

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

- If significant changes are made to a *Robot* after passing initial inspection, it must be re-inspected before it can compete.
- Referees or inspectors may request the re-inspection of a *Robot*. The *Robot* cannot participate in a *Match* until it passes re-inspection. Refusal to submit to re-inspection will result in *Team* disqualification from the tournament.
- 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*. A *Robot* may be allowed to participate in *Practice Matches* before passing inspection if allowed by the Lead Robot Inspector.

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

<I4> Re-Inspection – Physical changes to a *Robot* that improve performance or add capability must pass re-inspection prior to being eligible to play in the next *Match*.

<I5> Safety - It is the Inspector's responsibility to evaluate *Robots* to ensure each *Robot* is designed to operate safely. Section 7 of this manual, and Game Manual Part 2, section 1.6.1 outline the safety rules and limits that apply to the design and construction of all *Robots*.

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

<I7> All Mechanisms are Inspected - For Inspection, the *Robot* must be presented with all mechanisms (including all parts of each, configurations, and decorations that will be used on the *Robot* during the competition. *Robots* are allowed 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 *Matches* 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* and inspection rules.
- c. The total of all electronics (motors, servos, *Core* modules, Android devices, etc.) used to build 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* rules.

<I8> Wheel or Tread *Playing Field* Damage Test - *Robot* Inspectors have the authority to ask that a *Team* test their wheels or treads that they feel might cause damage to the *Playing Field*. Not every tread or wheel can be evaluated and posted as a legal or illegal part. Therefore, the tread test is a quick way to find out if a *Team*'s wheels or 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 Supplied Scoring Element Inspection - *Team* Supplied Scoring Elements will be inspected before the start of the competition, when *Robot* inspection takes place. A *Team* Supplied Scoring Element must be re-inspected if it is changed after initial inspection.

9.0 Judging and Award Criteria

Will be released 9/7/2019

10.0 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>

10.1 Eligibility

Every registered *Team* 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.
 - Note for international nominations not using grade levels to identify years of schooling: This award is intended for students who are two (2) to three (3) years away from entering college or university.
- 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.

10.2 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.

10.3 Dean's List Nominations

There are specific instructions on how to submit Dean's List Nominations. There are two sets of instructions, The Dean's List Nomination Guide – US, and the Dean's List Nomination Guide – International. Please visit our [website](#) for a copy of the guides, 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.

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 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). + 0.5 pound (0.23 kg) 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 Markers are present and meet requirements.	<RG06>
		Team number is visible from at least 2 sides and meets requirements.	<RG05>
		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. Replaceable fuses are single use only.	<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>g
		Power, motor control, servo and encoder wires are the correct size.	<RE14>j
		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 Scoring Element Inspection	Rule #
		The Team Scoring Element is subject to the <i>Robot</i> Mechanical Parts and Materials Rules in section 8.3.2 and may not contain the current season's scoring elements.	<TE01> <TE05>
		Maximum size of the Team Scoring Element is 4 inches (10.16cm) by 4 inches (10.16cm) by 8 inches (20.32 cm). Minimum size of the Team Scoring Element is 3 inches (7.62 cm) by 3 inches (7.62 cm) by 4 inches (10.16cm).	<TE02>
		Team Scoring Element is properly labeled with the Team's number.	<TE03>

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); Human Player (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 G5 Plus, Motorola Moto E4, Motorola Moto E5, 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 G5 Plus, Motorola Moto E4, Motorola Moto E5, 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 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 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, Motorola Moto G5, Motorola Moto G5 Plus, Motorola Moto E4, Motorola Moto E5 - version 7.0 or higher; all other allowed Android devices – version 6.0 or higher.	<RS03>
		The Android device is set to airplane mode, Wi-Fi is turned on, and Bluetooth is turned off.	<RS07>
		Robot is not connected to any local networks.	<RS10>
		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 5.0 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 (Google Nexus 5 and Samsung Galaxy S5 do not support channel changing).	<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.		

	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.	
✓	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 that they are responsible for attaching their Team Supplied Alliance Marker on two sides of their robot before they approach the competition playing field.	<RG06>

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.