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2017-2018 *FIRST*® Tech Challenge
Game Manual Part 1

FIRST®

FOR INSPIRATION & RECOGNITION OF SCIENCE & TECHNOLOGY

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Thank you for taking the time to volunteer for a *FIRST®* Tech Challenge event. *FIRST®* and *FIRST®* Tech Challenge rely heavily on volunteers to ensure events run smoothly and are a fun experience for teams and their families, which could not happen without people like you. With over 4,600 teams competing yearly, your dedication and commitment are essential to the success of each event and the *FIRST* Tech Challenge program. Thank you for your time and effort in supporting the mission of *FIRST*!

Revision History		
Revision	**Date**	**Description**
1	7/10/2017	Initial Release
1.1	9/9/2017	• Updated cover page
		• Update to Sponsor and Volunteer Thank You
		• Changed section 4.4 to 4.3
		• Section 4.3 – Rule <T13> - updated timeframe between matches from 5 minutes to 7 minutes
		• Section 7.2 – clarification to Judged Award eligibility
		• Section 8.3.3 – Rule <RE14>j.ii.a) – Updated minimum requirement for power wires from 16 AWG or higher to 18 AWG or higher
		• Section 8.3.3 – Rule <RE14>j.ii.b) Updated recommendations for motor control wire size based on motor type.
		• Section 8.3.4 – Rule <RS02> - Added OnBot Java programming tool to the list of approved programming resources
		• Section 10.2.5 and 10.4.5 – Changed PTC Design Award to Design Award.
		• Appendix D – Added image to Control Award Content Sheet
1.2	10/3/2017	• Section 4.3 – Clarification to rule <T5> that allows in the Pit Area only, additional devices to connect with the Robot Controller using Wi-Fi Direct
		• Section 4.3 – Added rule <T28> defining the autonomous to driver controlled transition
		• Section 5.12 – Updated link to marketing resources
		• Section 7.4 - Changed PTC Design Award to Design Award
		• Section 8.2 – Updated link to Android technology resources
		• Section 8.3.3 – Rule <RE05>c. Removed last sentence of rule
		• Section 8.3.4 – Rule <RS02> - Changed minimum version of software required from 3.1 to 3.3
		• Section 10.4.7 – Deleted release date for Control Award Content Sheet

		• Appendix A – Removed volunteer on call support info • Appendix C – Changed minimum version of software required from 3.1 to 3.3 in Field Inspection Checklist
1.3	10/25/2017	• Section 4.3 – Rule <T13> - updated timeframe between matches back to 5 minutes • Section 4.3 – Rule <T28> - Scoring system will display both audio and visual cues for drivers to pick up driver stations, and 3-2-1 countdown

Contents

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.

They also cultivate life skills such as:

- Planning, brainstorming, and creative problem-solving.
- Research and technical skills.
- Collaboration and teamwork.
- Appreciating differences and respecting the ideas and contributions of others.

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

> **FIRST Tech Challenge is MORE THAN ROBOTS**SM**!** **While competing, students develop personal and professional skills they will be able to rely on throughout their life.**

1.2 FIRST Tech Challenge Core Values

FIRST asks everyone who takes part in *FIRST* Tech Challenge to uphold the following values:

- We display *Gracious Professionalism*® with everyone we engage with and in everything we do.
- We act with integrity.
- We have fun.
- We are a welcoming community of students, Mentors, and Volunteers.
- What we learn is more important than what we win.
- We respect each other and celebrate our diversity.
- Students and adults work together to find solutions to challenges.
- We honor the spirit of friendly competition.
- We behave with courtesy and compassion for others always.
- We act as ambassadors for *FIRST* and *FIRST* Tech Challenge.
- We inspire others to adopt these values.

2.0 Gracious Professionalism®

FIRST uses this term to describe our programs' intent and is shared with all young people engaging in *FIRST* programs. At *FIRST*, team members help other team members, but they also help other teams.

Gracious Professionalism® is not clearly defined for a reason. It has different meanings to everyone.

Some possible meanings of *Gracious Professionalism* include:

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

> **An example of *Gracious Professionalism* is patiently listening to a team's question and providing support despite having several pressing things to do on the day of the event.**

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

In *FIRST*, *Gracious Professionalism* teaches teams and student participants:

- Learn to be strong competitors, but also treat one another with respect and kindness in the process.
- Avoid leaving anyone feeling as if they are excluded or unappreciated.
- Knowledge, pride and empathy should be comfortably and genuinely blended.

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

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

2.1 Gracious Professionalism for Volunteers

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

3.0 Youth Protection Program

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

3.1 Youth Protection Expectations and Guidelines

Coaches and Mentors should read and follow the [*FIRST* Youth Protection Program guide.](#) Anything labeled as required is mandatory in the United States and Canada, and cannot be waived without approval from the *FIRST* Youth Protection Department. *FIRST* recommends that the standards set forth in the *FIRST* Youth Protection Program guide be applied outside of the United States and Canada to the extent possible. At a minimum, local regulations regarding youth protection must be complied with.

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

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

3.2 NOTICE OF NON-DISCRIMINATION

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

Keep updated at: http://www.firstinspires.org/about/legal-notices

4.0 The Tournament – Definitions and Rules

4.1 Overview

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

4.2 Tournament Definitions

Alliance – Each *FIRST* Tech Challenge match is made up 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 Events with more than 20 *Teams*, the semi-final and final round *Alliances* are made up of three *Teams* each. However, only two of those *Teams* compete during any one match.

Alliance Captain – The student representative from an *Alliance's* highest ranked *Team* chosen to represent an *Alliance* during *Alliance Selection* and for the final *Elimination Matches*. The entire *Team* is referred to as 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 Event officials and tables are located.

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

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

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

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

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

Ranking Points – The second basis of ranking *Teams*. *Ranking Points* are used as the tiebreakers when *Teams* have equal *Qualifying Points*. *Ranking 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 *Ranking Points*.

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

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

Surrogate Match – *Surrogate Matches* are scheduled into the Qualification rounds of an Event if the number of *Teams* at the Event 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 *Qualifying Points* or *Ranking Points*. These matches are important in the entire standings of the Event. These matches should be played as if they were regular *Qualification Matches*. *Surrogate Matches* will be marked on the official *Qualification Match* schedule.

Team – An official *FIRST* Tech Challenge *Team* consists of no more than 15 student *Team* members. All *Teams* in North America are required to register through the Team Registration System. Teams must have a minimum of TWO Lead Coach 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 Events.

4.3 Tournament Rules

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

<T2> Yellow Cards and Red Cards are used in the *FIRST* Tech Challenge to manage *Team* and *Robot* behavior that does not align with the mission of *FIRST*. Yellow and Red Cards are not limited to just the *Competition Area*. *Teams* that display egregious behavior in the *Pit Area*, Judging Rooms, stands, or any other location of the Event can be issued a Yellow or Red Card for egregious behavior.

Egregious or repeated (3 or more) *Robot* or *Team* member behavior at the Event can result in a Yellow and/or Red Card. 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.

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, including earning a second Yellow Card during a single match. To issue the second yellow card, the Head Referee will stand in front of the *Team's Alliance Station* and hold a Yellow Card and Red Card. The Head Referee will signal the second Yellow Card after the match has ended.

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

Yellow Cards do not carry over from the *Qualification Matches* to the *Elimination Matches*. During the *Elimination Matches*, Yellow and Red Cards count against the entire *Alliance,* not to a specific *Team.* If a

Team receives a Yellow Card or Red Card, it results in the entire *Alliance* receiving the Yellow Card or Red Card for that match. If two different *Teams* on the same *Alliance* are issued Yellow Cards, the entire *Alliance* is issued a Red Card. A Red Card results in zero (0) points for that match, and the *Alliance* loses the match. If both *Alliances* receive Red Cards, the *Alliance* which committed the action earning the Red Card first chronologically loses the match.

<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 the time period of three (3) matches following the disputed Match.

        ii. *Elimination Matches and Final Matches:* A *Team* must enter the Referee Question Box to dispute a match before the start of the next match played by the *Alliance*, regardless if the *Team* is playing in the next match. The next match played could involve different *Alliances*. Questions about the last match of the Finals must be brought to the question box no later than 5 minutes after the announcement of the score of the match.

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

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

<T4> No *Team*, *Team* Member, or Event 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 Event 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 Event 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-Event review and decide if any additional penalties are to be imposed on the offending *Team*.

Teams are encouraged to report wireless security vulnerabilities to the Field Technical Advisor (FTA) at an Event. *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 Direct® connectivity between the Android devices used as the Robot Controller and the Drivers Station is allowed. Additionally, in the Pits only, Wi-Fi Direct® connectivity between the same Android devices and an additional 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 Event 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-Event review and determine if any additional penalties are to be imposed on the offending *Team*.

<T6> *Team* members may be asked by the Event Director to use a specific Wi-Fi channel on the Event day. *Teams* must comply with the request of the Event 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 Event Director to switch their channel before playing in the next match.

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

   a. It is against this rule to compete with one *Robot* while a second is being adjusted or assembled at a Tournament.
   b. It is against this rule to switch back and forth between multiple *Robots* at a Tournament.
   c. It is against this rule to register and attend concurrent Events with a second *Robot*.

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

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

<T9> *Pre-Match Robot* Setup – At the beginning of a match, each *Alliance Robot* must be set up on the *Playing Field* in accordance with section 1.5.1 Pre-Match in the Game Manual Part 2. After *Robots* have been set up on the *Playing Field*, *Drive Teams* are required to stand Completely inside the *Alliance Station* at the location (Station one or Station two) specified by the *Qualification Match* schedule.

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

c. *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*.

d. *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*.

<T10> The state of the field (game and scoring elements) are recorded as the match is played by the Score Tracker. *Scores* may not be announced to the *Teams* until some amount of time after the match has completed. At some events, the use of live scoring software may be used to show the status of the match as it is played, with the final, official score being displayed at the end of the match.

<T11> There are no time-outs during the *Qualification Matches*.

<T12> 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.

<T13> *Teams* will receive a minimum of five minutes (5:00) between consecutive matches.

<T14> 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.

<T15> 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 as long as Event 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 Event environment are not acceptable.

<T16> 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 Event.

<T17> 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.

<T18> Batteries must be charged in an open, well-ventilated area.

<T19> 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.

<T20> *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 specified by the venue, whichever is shorter.

<T21> *Teams* are not allowed to use radios and walkie-talkies anywhere in the venue.

<T22> There is no running anywhere during the Event, as this is a safety hazard.

<T23> Sitting together in a group during Competition matches makes the game more exciting and fun. It allows *Team* members to show support for their *Team*. *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.

<T24> Soldering, gluing, brazing, or large power tools are not allowed in the *Pit* or Competitions *Areas* unless the Event Director specifically allows them.

<T25> Because of site rules or contracts, *FIRST* cannot allow *Teams* or individuals to sell items, such as T-shirts, pins, etc., at any Events. Fundraising for a cause is allowed with consent of the Tournament Director; fundraising for a *Team* is not allowed.

<T26> Check with the Tournament Director before bringing food to an Event, as some venues will not allow outside food on-site because of contracts and agreements.

<T27> Open-toed or open-backed shoes are not allowed in the *Pit Area* or in the *Competition Area*.

<T28> 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.

5.0 Tournament Day Overview

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

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

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

meet:

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

5.1 Tournament Event Schedule
Event schedules will be available through the Event Director before or at the Tournament. *Qualification Match* schedules are created on Tournament day after all *Teams* have checked-in and have passed all Inspections.

5.2 Team Check-In

5.2.1 Consent and Release Forms
Each student competing at a *FIRST* Tech Challenge Event 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 students 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 event.

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

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

5.4 Judges' Interviews
At *FIRST* Tech Challenge Events, 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. During the interview, students will get a minimum of 5 minutes to present to the Judges. After the Teams five-minute presentation, the Judges will have the opportunity to ask questions about the *Team*, the *Robot*, outreach efforts, etc.

The Judges' Interviews take place before any *Qualification Matches* so the entire *Team* may be interviewed. When *Teams* arrive at the Event, 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 Events, but should not take part in the interview.

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

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

5.6 Practice Time
At some Events, practice fields are set up so *Teams* can practice throughout the Event. Practice time is offered on a first-come, first-served basis. *Teams* should check with the Event Director if practice time will be allowed on Event day.

5.7 Opening Ceremony
The Opening Ceremony is the official kickoff of the Event for the *Teams*, Volunteers, and spectators. During the Opening Ceremony, an Event official or the Emcee will welcome the *Team*, introduce dignitaries and other special guests, and introduce the Judges and the Referees. Then the game will be described (usually with a video) and immediately after, the *Qualification Matches* take place.

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

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

All *Teams* are ranked based on the same number of *Qualification Matches*. Sometimes, a *Team* is asked to play a *Surrogate Match* which does not count towards their standings during the Event. This added match is marked by an asterisk on the match schedule or announced to the *Teams* before the start of the *Qualification Matches*.

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

- *Teams* receive *Qualifying Points* based on the following:
  - Winning *Teams* of a *Qualification Match* each receive two (2) *Qualifying Points*.
  - Losing *Teams* of a *Qualification Match* receive zero (0) *Qualifying Points*.
  - If a *Qualification Match* ends in a tie, all four *Teams* receive one (1) *Qualifying Point*.
  - If a *Team* is disqualified, they receive zero (0) *Qualifying Points*.
- *Ranking Points* are awarded based on the following:
  - The number of *Ranking 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 *Ranking Points*.

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

Example:

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

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

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

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

At the conclusion of all *Qualification Matches*, the *Teams* are ranked from first through last based on their total *Qualifying Points*. If multiple *Teams* have the same *Qualifying Points* total, these *Teams* are ranked based on their total *Ranking Points*. If multiple *Teams* have the same *Ranking Points* total as well, then these *Teams* are ranked based on their highest match score. If still tied, the next highest match score is used until the tie is broken. In the unlikely event there is still a tie based on identical match scores, then the *Teams* are ranked by a random electronic draw. These rankings are done automatically through the Scoring System software.

5.9 Alliance Selection

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

The *Alliance Selection* consists of several rounds of selections so all *Alliance Captains* form *Elimination Match Alliances*. These *Alliances* participate in a ladder-type Tournament to determine the Event'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*.
    - o   *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 the *Alliance Selection* process.
- In order of Tournament ranking, the student representative of the highest ranked *Team* not already in an *Alliance* is asked to step forward as the *Alliance Captain* to invite another available *Team* to join their *Alliance*.
- A *Team* is available if it is not already part of an *Alliance*, or has not already declined an *Alliance* invitation. If the *Team* accepts, it is moved into that *Alliance*. **If a *Team* declines, it CANNOT be invited into another *Alliance***, but it is still available to select their own *Alliance* if the opportunity arises. If a *Team* declines, the *Alliance Captain* from the inviting *Team* must then extend an invitation to another *Team*.
- The process continues until all *Alliance Captains* have been designated 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 the *Alliance*) from highest seed to lowest seed (i.e. 1 → 2 → 3 → 4). Any *Teams* remaining after the lowest seeded captain makes their choice do not compete in the *Elimination Matches*.

5.10 Elimination Matches

The *Elimination Matches* are when the *Alliances* determine who the Champion of the Event 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
    - o   Seed #1 and Seed #4 compete against one another in the Semi Finals 1; Seed #1 is assigned as the Red *Alliance* and Seed #4 is assigned as the Blue *Alliance*.
    - o   Seed #2 and Seed #3 compete against one another in the Semi Finals 2; Seed #2 is assigned as the Red *Alliance*, and Seed #3 is assigned as the Blue *Alliance*.
- Finals
    - o   The winner of Semi Finals 1 is assigned as the Red *Alliance*.
    - o   The winner of Semi Finals 2 is assigned as the Blue *Alliance*.

In the *Elimination Matches*, *Teams* do not get *Qualifying Points*; they get a win, loss or tie. Within each bracket (Semi-Finals or Finals) of the elimination, matches are played to determine which *Alliance* advances. The advancing *Alliance* is the first *Team* to win two matches. Any tied matches are replayed until one *Alliance* has two wins and advances. An example Tournament bracket appears here:
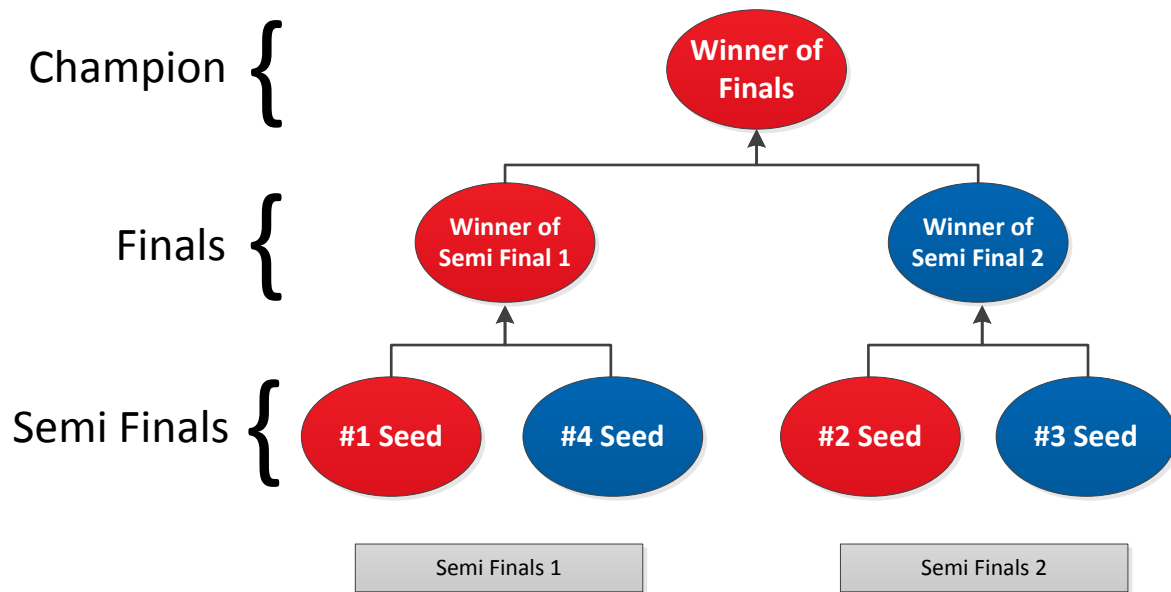
During the *Elimination Matches*, two *Teams* from an *Alliance* compete on the *Playing Field*. If the *Alliance* has three *Teams*, the *Team* that sits out the first match must play in the second match, with no exceptions. If the *Alliances* play more than two matches in any bracket, any combination of two *Alliance Robots* may be used. The Captain of the *Alliance* is not required to participate in every match. No special accommodations are made for *Robots* that fail during the Semi Final and Final Rounds. *Teams* should consider the robustness of the *Robots* when picking *Alliance* partners.

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

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

5.11 Awards and Closing Ceremony
The Awards and Closing Ceremony celebrates the *Teams* and their accomplishments throughout the Event, as well as the Volunteers who helped make the Event possible. At the Awards and Closing Ceremony, the finalists and winners of each award are announced. At most Events, the Judges will line up to high five each *Team* as they receive an Award.

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

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

5.13 Banners and Flags

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

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

5.14 Spectators and Etiquette

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

5.15 Scouting

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

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

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

Some possible areas to gather information include:

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

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

6.0 Tournament Types

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

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

6.2 Meets and League Play
A League Meet is a one-Field Competition that uses the same Field and Game as other Events. *Teams* may take part in as few or as many League Meets as they choose, but taking part in more improves their League Ranking. Some of the standard Tournament guidelines may be adapted for those regions that participate in the League format. *Teams* should contact their Affiliate Partner for more information about the scheduling, structure, advancement, and processes that are unique to the League/Meet in their region.

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

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

6.5 Championship Tournaments
Hosted and managed by a *FIRST* Tech Challenge Affiliate Partner, Championship Tournaments abide by certain standards in format, judging, awards, and overall quality. Some Championship Tournaments require that *Teams* advance from a Qualifying Tournament or League Tournament to advance to the State/Regional Championship. Championships 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.

6.6 Super-Regional Championship Tournaments
Teams in the United States have the opportunity to compete in an additional level of Championship Play. Four Super-Regional Championship Events will be held and run by a local Super-Regional Planning Committee. Super-Regional Championship Tournaments abide by certain standards in format, judging, awards, and overall quality. *Teams* advance from their State or Regional Championship to the Super-Regional Championship using the same advancement criteria described in section 7.0. *Teams* advance from the Super-Regional Championships to one of the *FIRST* Tech Challenge World Championships. *Teams* should expect a higher level of competition, both on the field and in the Judging room at Championship Tournaments.

7.0 Eligibility and Advancement Criteria

7.1 Eligibility to Compete in Official FIRST Tech Challenge Tournaments:

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

- ✓ The team has completed the registration process.
- ✓ The team registration fee is paid. *For North America Teams. Teams outside North America should consult the Affiliate Partner for their region.
- ✓ In North America, two adults must pass the <u>Youth Protection</u> screening process.

7.2 Eligibility for Judged Awards

Teams are eligible to be considered for all Judged Awards (except the Inspire Award, please see Inspire section for details) at any of the first three events 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 event is open to teams from other regions, or is only for teams within their region.

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

7.2.1 Inspire Award Eligibility

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

All teams are eligible to be considered for all Judged Awards at the following events:

- Super Regional Championship Tournament
- World Championship Tournament

7.3 Eligibility for Advancement

Teams are eligible for advancement at any one of the first three events 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
- Teams may advance to only 1 (one) Super Regional Championship Tournament.
  - o The team may only advance to the first Super Regional Championship Tournament that they are invited to.
  - o A team cannot decline their first invitation and accept an invitation to a different Super Regional Championship Tournament

A team who has earned their way directly to the World Championship cannot participate in a Super Regional Championship Tournament. For example, a team who won the Inspire Award in Mexico will advance directly to a World Championship event. If the same team is Captain of the Winning Alliance at a New Mexico event, they

are not eligible to advance to the South Super-Regional, because they have already earned a spot at a World Championship event.

Event Type	Advances To	Special Considerations
Qualifying Tournament League Tournament Super-Qualifying Tournament	State or Regional Championship Tournament	A *Team* is eligible to advance to the next competition tier from one of the first three Qualifying, League, or Super-Qualifying Tournaments they attend. A *Team* may participate in more than three Events in the same competition tier, but they are not eligible for consideration for advancement or Awards at Events beyond their third.
State or Regional Championship	Super-Regional Championship Tournament	A *Team* is eligible to advance to the next competition tier from one the first three Championship Tournaments they attend. A *Team* may only advance to the first Super-Regional Tournament they qualified for. A *Team* that has earned a spot at the World Championship outside of the Super-Regional system may not participate in a Super-Regional Event, even if they have earned a spot to the Event.
Super-Regional Championship Tournament	*FIRST* Tech Challenge World Championship	*Teams* advance from a Super Regional Championship Tournament to one of the *FIRST* Tech Challenge World Championships. Teams who participate in the West and South Super-Regional Championship Tournament will advance to the World Championship Event in Houston, Texas. Teams who participate in the East and North Super-Regional Championship Tournament will advance to the World Championship Event in Detroit, Michigan.

7.4 Order of Advancement

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

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

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

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

8.0 The *Robot*

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

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

For more information, tutorials, and to access our Android Technology forum, please visit:
https://www.firstinspires.org/resource-library/ftc/robot-building-resources

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

Core Legacy Module – The device that acts as a bridge between the Android *Robot Controller* and LEGO NXT compatible devices (motor controllers, servo controllers, and sensors).

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 Legacy Module, Core Motor Controller*, *Core Servo Controller*, and the *Core Device Interface Module*. The *Core Power Distribution Module* draws power from the

12V TETRIX battery, the 12V MATRIX battery, 12V REV Robotics, or the 9.6V MATRIX battery to power an internal USB Hub, DC motor controllers and servo controllers, and certain specified electronics.

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

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

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

Legacy TETRIX DC Motor Controller - TETRIX DC Motor Controller previously used with the legacy NXT/Samantha control system. This controller is used with the *Core Legacy Module*.

Legacy TETRIX Servo Controller - TETRIX Servo Controller previously used with the legacy NXT/Samantha control system. This controller is used with the *Core Legacy Module*.

Legacy MATRIX DC Motor/Servo Controller – MATRIX DC Motor/Servo Controller previously used with the legacy NXT/Samantha control system. This controller is used with the *Core Legacy Module*.

Legacy Sensors – *Legacy Sensors* are any LEGO approved NXT-compatible sensor including sensors from LEGO and HiTechnic.

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 *I^2C Sensor Adaptor Cable* to a 5V I^2C sensor.

I^2C Sensor Adapter Cable – An adapter to change the pin orientation of the REV Robotics *Logic Level Converter* to match a Modern Robotics compatible I^2C 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*, the *Core Device Interface Module*, and the *Core Legacy 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*.

OTG 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 I^2C buses. The *REV Expansion Hub* draws power from the 12V TETRIX battery, the 12V MATRIX battery, or the 12V REV Robotics battery to power these input/output channels. A *REV Expansion Hub* can be connected to a second *REV*

Expansion Hub using an RS-485 serial cable and an XT30 power cable.

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 Legacy, 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.

8.3 Robot Rules

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

8.3.1 General Robot Rules

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

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

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

a. Those that could potentially damage the *Playing Field* and/or Scoring Elements. For example, high traction wheels (for example, AM- 2256) and high grip tread (for example, Rough top) when used in a *Robot* drive system that may damage the *Playing Field* are not allowed.

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

b. Those that could potentially damage or flip other competing *Robot*s.

c.   Those that contain hazardous materials such as mercury switches, lead, or lead containing compounds, or lithium polymer batteries (except for the Android devices' internal battery).

d.   Those that pose an unnecessary risk of entanglement.

e.   Those that contain sharp edges or corners.

f.   Those that contain animal-based materials (because of health and safety concerns).

g.   Those that contain liquid or gel materials.

h.   Those that contain materials that would cause a delay of game if released (for example, loose ball bearings, coffee beans, etc.).

i.   Those that are designed to electrically ground the *Robot* frame to the *Playing Field*.

j.   Closed gas devices (for example, gas storage vessel, gas spring, compressors, etc.).

k.   Hydraulic devices.

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

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

a.   A mechanical means with the *Robot* in a power-OFF condition. Any restraints used to maintain starting size (that is, zip ties, rubber bands, string, etc.) MUST remain attached to the *Robot* for the entire match.

b.   A *Robot* Initialization Routine in the Autonomous operational mode (op mode) program that may pre-position the servo motors, with the *Robot* in a power-ON condition, to the desired stationary position. If the *Robot* Initialization Routine does move the servos when a program is executed, there must be an indicator on the *Robot* of this fact. A warning label placed near the *Robot*'s main power switch is required. Attach the image ("WARNING! - *Robot* moves on Initialization") to your *Robot* near the *Robot* main power switch if servos are commanded to move during the initialization routine. To be easily seen by field personnel the label should be at least 1 in x 2.63 in (2.54 cm x 6.68 cm, Avery Label # 5160) and placed on a flat surface (not wrapped around corners or cylinders).:

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

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

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

<RG04> *Alliance* **Flag Holder** - *Robot*s MUST include a mounting device to securely hold one Tournament supplied *FIRST* Tech Challenge *Robot Alliance* Identification Flag throughout an entire match. The flag MUST be mounted at the TOP of the *Robot* and be clearly visible throughout the match to clearly identify a *Robot*'s *Alliance*. Flag posts are typically a soda straw or wooden dowel. Dimensions of each are close to 0.25 inches (0.635 cm) outer diameter x 0.20 inches (0.5 cm) inner diameter x 8.25 inches (21 cm) length with a triangular flag 4.0 inches (10.16 cm) high x 6.0 inches (15.24 cm) wide. These may vary from Event to Event; *Alliance* Flag Holders should be able to securely hold both solid core dowels and open core straws. Mounting devices that damage the flag post are not acceptable.

<RG05> *Team* **Number Display** - *Robot*s 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 *Robot*s 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 <u>contrasting color</u> from their background. *Teams* can use Arial Font, Bold, 250 point to meet the minimum size requirements.

    d. *Team* numbers must be robust enough to withstand the rigors of match play. Example robust materials include: 1) self-adhesive numbers (that is, mailbox or vinyl numbers) mounted on polycarbonate sheet, wood panel, metal plate, etc.; 2) Ink jet or laser printed numbers on paper and laminated.

<RG06> Allowed Energy Sources - Energy used by *FIRST* Tech Challenge *Robot*s, (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.

<RG07> 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).

<RG08> Launching Game Scoring Elements – *Robot*s are allowed to launch game Scoring Elements through the air unless limited by a game specific rule. It is expected that *Teams* will launch the elements with just enough velocity to score. If the referees, feel that a *Robot* is launching Scoring Elements with excessive velocity that would cause a safety issue if they were to leave the field, the *Robot* will be required to be inspected. *Robot*s must then demonstrate that a launched Game Element cannot travel in the air more than a distance of 16 ft. (4.88 m) or more than 6 ft. (1.83 m) in elevation.

8.3.2 Robot Mechanical Parts and Materials Rules

<RM01> Allowed Materials - *Teams* may use raw and post-processed materials to build their *Robot*s, 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 <u>single degree of freedom</u>. A single degree of freedom is a system whose motion is defined just by a single independent co-ordinate (or function)[1].

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

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 mechanum) are allowed.

<RM04> 3D Printed Parts - 3D printed parts are allowed.

[1] See http://www.tech.plym.ac.uk/soe/james/my_papers/STRC201_SDOF_JMWB.pdf Accessed on 6/16/2016

<RM05> Modifying Materials and COTS Parts - Allowed materials and legal COTS parts may be modified (that is, drilled, cut, painted, etc.), as long as no other rules are violated.

<RM06> Allowed Assembly Methods - Welding, brazing, soldering, and fasteners of any type are legal methods for assembling a *Robot*.

<RM07> Lubricant - Any type of COTS lubricant is allowed, if it doesn't contaminate the *Playing Field*, game elements, other *Robot*s, etc.

8.3.3 Robot Electrical Parts and Materials Rules

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

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

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

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

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

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

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

a. *Core Motor Controller, Core Servo Controller, REV Expansion Hub, Legacy TETRIX DC Motor Controller,* and *Legacy TETRIX Servo Controller* based systems must use one (1) of the following:
   i. TETRIX (W39057, formally 739023) 12 VDC battery pack
   ii. Modern Robotics/MATRIX (14-0014) 12 VDC battery pack
   iii. REV Robotics (REV-31-1302) 12 VDC Slim Battery pack
b. *Legacy MATRIX DC Motor/Servo Controller* unified module (i.e., integrated Motor and Servo Controllers) based systems must use one (1) of the following:

    i.   Legacy Modern Robotics/MATRIX 9.6 VDC battery pack if the 9.6 VDC Legacy Modern Robotics/MATRIX DC Motors are used.

    ii.   MATRIX (14-0014) 12 VDC battery pack, TETRIX (W39057, formally 739023) 12 VDC battery pack, or REV Robotics (REV-31-1302) 12 VDC Slim Battery pack if TETRIX, AndyMark, REV Robotics, or MATRIX 12 VDC Motors are used

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

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

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

    a. Allowed electronic devices may only be powered by power ports on the *Core Power Distribution Module* or the *REV Expansion Hub* except as follows:
        i.   The *Core Power Distribution Module* or *REV Expansion Hub* is powered by the *Robot* main battery. 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.*
        ii.   Allowed sensors connected to the *Core Device Interface Module*, the *Core Legacy Module*, and the *REV Expansion Hub*.
        iii.   Light sources per <RE12>.
        iv.   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.
    c. A second *REV Expansion Hub* is allowed to be connected to and powered by the extra XT30 power port on a *Robot's* first *REV Expansion Hub*.

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

- ZTE Speed
- Motorola Moto G 2nd Generation
- Motorola Moto G 3rd Generation
- Motorola Moto G4 Play
- Google Nexus 5
- Samsung Galaxy S5

    a. No other devices may be used as *Robot Controllers* or in *Driver Stations.* See Rule <RS03> for the approved list of Android Operating System versions. 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* or a *REV Expansion Hub.*
    b. Exactly one (1) Android device must be used as a part of the *Driver Station*.
    c. The *Robot Controller* Android device must be powered by its own internal battery or by the built-in charging feature of the *REV Expansion Hub*; external power is not allowed.
    d. The *Driver Station* Android device must be powered by its own internal battery; external power is

allowed from a COTS USB external battery pack that is connected to the allowed USB hub.

<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* or *Legacy MATRIX DC Motor/Servo Controllers*.
b. No more than two (2) *Core Device Interface Modules* are allowed.
c. No more than two (2) *Core Legacy Modules* are allowed.
d. Any quantity of *Core Motor, Legacy TETRIX DC Motor, Core Servo, and Legacy TETRIX Servo Controllers* are allowed.
e. Any quantity of *REV Servo Power Modules* is allowed.
f. No more than two (2) *REV Expansion Hubs* are allowed.
g. The REV Control Hub is not allowed.
h. No more than two (2) *Legacy MATRIX DC Motor/Servo Controllers* (unified module) are allowed.

<RE08> Motor and Servo Controllers - Motor and Servo Controllers are allowed in only one of the following two configurations (cannot mix configurations).

a. *Core Motor Controllers, Core Servo Controllers*, *REV Expansion Hub*, *REV Servo Power Module*, *Legacy TETRIX DC Motor Controllers, and Legacy TETRIX Servo Controllers* in any combination.

b. *Legacy MATRIX DC Motor/Servo Controllers* (unified module).

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

a. *Core Motor Controller*, *REV Expansion Hub*, and *Legacy TETRIX DC Motor Controller* based systems must use the following 12 VDC motors in any combination.
   i. TETRIX 12V DC Motor
   ii. AndyMark NeveRest series 12V DC Motors
   iii. Modern Robotics/MATRIX 12V DC Motors
   iv. REV Robotics HD Hex 12V DC Motor
   v. REV Robotics Core Hex 12V DC Motor

b. *Legacy MATRIX DC Motor/Servo Controller* based systems powered by a 12 VDC Battery must use the following 12 VDC motors in any combination.
   i. TETRIX 12V DC Motor
   ii. AndyMark NeveRest series 12V DC Motors
   iii. Modern Robotics/MATRIX 12V DC Motors
   iv. REV Robotics HD Hex 12V DC Motor
   v. REV Robotics Core Hex 12V DC Motor

c. *Legacy MATRIX DC Motor/Servo Controller* based systems powered by a 9.6 VDC Battery must only use MATRIX 9.6 VDC motors in any combination. No other DC motors are allowed for use with the *Legacy MATRIX DC Motor/Servo Controller*.

d. No other DC motors are allowed.

The allowed battery, motor controller, and DC motor combinations are summarized in the following table. The check symbol (✓) indicates the DC motor is allowed with the controllers and batteries listed in the rows above it. The "X" symbol is present for DC motors that are not allowed for the listed controller and battery combination.

Controllers:	Core Motor Controller, REV Expansion Hub and/or *Legacy TETRIX DC Motor Controller*	Legacy MATRIX DC Motor/Servo Controller (Unified Module)	
Batteries:	**TETRIX 12 VDC, MATRIX 12 VDC, or REV *Robotics* 12 VDC**	**MATRIX 9.6 VDC**	**TETRIX 12 VDC, MATRIX 12 VDC, or REV *Robotics* 12 VDC**
TETRIX 12V	✓	X	✓
AndyMark NeveRest Series 12V	✓	X	✓
Modern Robotics/MATRIX 12V	✓	X	✓
REV HD Hex 12V	✓	X	✓
REV Core Hex 12V	✓	X	✓
MATRIX 9.6V	X	✓	X

<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.

Core Servo Controllers and *Legacy TETRIX 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*. The VEX EDR 393 motor is considered a servo and it is subject to the overall total maximum of twelve (12) servos.

<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 I^2C Sensor Adapter Cable.* Refer to Rule <RE14.k> for details on the use of *Logic Level Converter* and the I^2C *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 I^2C multiplexers are allowed and they may only be connected to and powered from the I^2C connections available on the *Core Device Interface Module* or the *REV Expansion Hub*.
g. *Legacy Sensors* are allowed and must be directly connected to the *Core Legacy Module*.

h. Voltage and/or current sensors are also allowed to connect between the battery pack and the *REV Expansion Hub* or *Core Power Distribution Module.*

i. The HiTechnic Touch Sensor Multiplexor (NTX1060) is allowed.

j. The HiTechnic Sensor Multiplexor (NSX2020) is **not** allowed.

<RE12> Light Sources - Light sources (including LEDs) are allowed; these may not be focused or directed in any way (for example: lasers and mirrors are not allowed). Approved power sources for lights are as follows:

a. Internal (as supplied by the manufacturer) battery pack or battery holder

b. Power ports on the *Core Power Distribution Module*

c. Motor-control port on the *Core Motor Controller Module*

d. Motor controller port on the *Legacy TETRIX DC Motor Controller*

e. REV Expansion Hub:
    i. Motor-control port
    ii. Spare XT30 port
    iii. 5V auxiliary power port

<RE13> Video Cameras - 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 video cameras must be powered by an internal (as supplied by the manufacturer) battery.

<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. Either A *Mini USB to OTG (On-The-Go) Micro Cable* or a *Mini USB adapter* and *OTG (On-The-Go) Micro Cable* is used to connect the *Robot Controller* Android device to the built-in USB input port of the *Core Power Distribution Module* or of the *REV Expansion Hub*.

d. Non-powered USB hubs connected to the *Core Power Distribution Module* are allowed.

e. Anderson PowerPole, and similar crimp or quick connect style connectors are required to connect downstream electronics with the *Core Power Distribution Module* and are recommended for joining electrical wires throughout the *Robot*. Power distribution splitters are recommended where appropriate to reduce wiring congestion. All connectors and distribution splitters should be appropriately insulated.

f. Installed connectors (such as battery-pack connectors, battery charger connectors, and *Core Power Distribution Module* power input connectors) may be replaced with Anderson PowerPole or any compatible connector.

g. Power and motor control wires must use consistent color coding with different colors used for the Positive (red, white, brown, or black with a stripe) and Negative/Common (black or blue) wires.

h. Wire and cable management products of any type are permitted (for example, cable ties, cord clips, sleeving, etc.).

i. Wire insulation materials of any type are permitted when used to insulate electrical wires or secure motor control wires to motors (for example, electrical tape, heat shrink, etc.).

j. Power, motor control, servo, encoder, and sensor wires and their connectors may be extended, modified, custom made, or COTS subject to the following constraints:
    i. Power wires are 18 AWG or larger.
    ii. Motor control wires as follows:
        a) 22 AWG or larger for TETRIX Max 12V DC motors and REV Robotics Core Hex (REV-41-1300) 12V DC motors
        b) 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 I^{2}C sensor or a 5V-compatible digital sensor are allowed. Exactly one *Logic Level Converter* per I^{2}C 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 electronics to the frame of the *Robot* is not allowed.

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

> Examples of modifications that are allowed:
> - Shortening or extending wires
> - Replacing or adding connectors on wires
> - Shortening motor shafts
> - Replacing gearboxes and/or changing gears
>
> Examples of modifications that are **not** allowed:
> - Replacing an H-Bridge in a motor controller
> - Rewinding a motor
> - Replacing a fuse with a higher value than specified by the manufacturer
> - Shorting out a fuse

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

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

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

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

8.3.4 Robot Software Rules

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

<RS02> Recommended Programming Language - *Java* is the recommended programming language for the *FIRST* Tech Challenge. The minimum allowed version number is 3.3. Programming must be done using one of the following applications:

a. FTC Blocks Programming development tool (built in to the FTC Robot Controller App version 2.2 and greater) – a visual, blocks-based programming tool hosted by the *Robot Controller*.
b. Android Studio – a text-based integrated development environment.
c. App Inventor – a visual blocks-based programming tool.
d. 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.
e. FTC OnBot Java Programming tool (built into the FTC Robot Controller App version 3.2 and greater) - a text-based integrated development environment hosted by the Robot Controller.

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

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

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

> **IMPORTANT:** Rules <RS02> or <RS03> do not require that *Teams* upgrade to the latest version of the software. A mandatory upgrade would only be required if *FIRST* determined there was a critical software fix that must be adopted by *Teams*. Mandatory upgrades will be communicated in the following ways:
> - Via [Team Blast](#) – The mandatory upgrade and version number will be communicated to *Teams* on the Team Blast, which will also show the date the required upgrade must be made.
> - Online – the minimally required software will be listed on our [Technology Resources](#) page, with the date *Teams* are required to make the mandatory software upgrade.
> - Forum – The minimally required software will be listed in the [Technology Forum](#) page, with the date *Teams* are required to make the mandatory software upgrade.
>
> Templates for all programming choices are available through the links located at http://www.firstinspires.org/node/5181.

<RS04> Motionless *Robot* at Start of Match Periods - Immediately before the start of the Autonomous Period and during the pause between the end of the Autonomous and the start of the Driver-Controlled periods, *Robot*s shall be motionless, with the exception of initialization of positioning for servos. Violations subject the *Robot* to random repositioning by the Head Referee. Repeated violations may be considered egregious behavior and be subject to penalties.

<RS05> 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.

<RS06> *Robot Controller* App - The *Robot Controller* must have a designated "FTC *Robot Controller"* app that is the default application for the *Core Robot modules (Legacy, Servo, Motor, and Device Interface)* or the *REV Expansion Hub.*

<RS07> *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.

<RS08> Android Device Operating System Settings - The *Robot Controller* and *Driver Station* must be set to airplane mode, and Bluetooth must be turned off.

<RS09> 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).

9.0 *Robot* Inspection

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

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

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

9.3 Definitions
Robot Initialization Routine – A set of programming instructions inserted immediately before the match control loop of the Autonomous or Driver-Controlled programs that serves to ready the *Robot* for a match.

Robot Sizing Box – A sturdily constructed cube 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 Box is used for *Robot* Inspection as outlined in section 8.3.1.

9.4 Inspection Rules

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

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

    a. If significant changes are made to a *Robot* after passing initial inspection, it must be re-inspected before it will be allowed to compete.

    b. Referees or inspectors may request the re-inspection of a *Robot*. The *Robot* is not allowed to participate in a match until it passes re-inspection. Refusal to submit to re-inspection will result in *Team* disqualification from the Tournament.

    c. Appendices B and C of this manual contain copies of the *Robot* and Field Inspection forms and provide additional information about the inspection process.

    d. A *Robot* may be rejected at inspection if the Lead Inspector considers it unsafe.

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

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

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

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

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

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

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

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

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

10.0 Judging & Award Criteria

10.1 Overview

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

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

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

FIRST Tech Challenge judging sessions do not include written or verbal feedback for students. The judging is a subjective process; and students are encouraged to learn the important life skill of self-evaluation. This helps students prepare for professional interviews while developing other real world life skills. For a copy of the *FIRST* Tech Challenge *Team* Judging Session Self-Reflection Sheet please visit the website: http://www.firstinspires.org/node/5226

10.2 Engineering Notebook

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

10.2.2 What is an Engineering Notebook?
One of the goals of *FIRST* and *FIRST* Tech Challenge is to recognize the engineering design process and "the journey" that a *Team* makes during the phases of the problem definition, concept design, system-level design, detailed design, test and verification, and production.

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

The Engineering Notebook is a complete documentation of the *Team*, outreach and fundraising efforts, business or strategic plans, and the *Robot* design. This documentation should include sketches, discussions

and *Team* meetings, design evolution, processes, obstacles, and each *Team* member's thoughts throughout the journey for the entire season. A new notebook should be created for each new season.

Please visit our website for a complete guide on writing and managing a Team Engineering Notebook. http://www.firstinspires.org/sites/default/files/uploads/resource_library/ftc/engineering-notebook-guidelines.pdf

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

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

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

1. *Teams* may not submit more than two notebooks at a competition.
2. The *Team* Number must appear on the outside front cover of the Engineering Notebook.
3. Attach a summary page to the front cover of the Engineering Notebook. This should include:
   a. The *Team* number.
   b. A brief, one-page narrative about the *Team*, the school or organization, and an overview of the highlights of the *Team*'s season.
   c. The summary page must point the Judges to pages in the Engineering Notebook that the *Team* would most like the Judges to consider.

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

4. The Engineering Notebook must be divided into multiple sections, including:
   a. An Engineering section that includes the *Robot* design processes.
   b. A *Team* section that includes information about the *Team* and outreach activities.
   c. A business plan, strategic plan or sustainability plan.

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

Engineering Notebook Requirements by Award	
Inspire Award	• *Team* must submit an Engineering Notebook. The Engineering notebook must include an Engineering section, a Team section and a Business or Strategic Plan. The entire Engineering Notebook must be high quality, thoughtful, thorough, detailed and well organized.
Think Award	• Engineering Notebook must have an Engineering section that includes entries describing underlying science, mathematics, and game strategies.

	• The Engineering Notebook must show that the Team has a clear understanding of the engineering design process, with pictures or drawings and details documenting all stages of Robot design. • Notebook must recount the Team's journey, experience and lessons learned throughout the season. • Engineering Notebook must be organized and follow the formatting guidelines provided by *FIRST* and include a Summary Page. Note: Teams should review the Engineering Notebook resources published in the Team Management section of the *FIRST* website.
Connect Award	• *Team* must submit an Engineering Notebook. The Engineering Notebook must include a Business or Strategic plan that identifies their future goals and the steps they will take to reach those goals. The plan could include fund-raising goals, sustainability goals, timelines, outreach, and community service goals.
Rockwell Collins Innovate Award	• *Team* must submit an Engineering Notebook. The Engineering Notebook must include an Engineering section that documents the design process and how the *Team* arrived at their design solution.
Design Award	• *Team* must submit an Engineering Notebook with an Engineering section that includes detailed *Robot* design drawings.
Motivate Award	• *Team* must submit an Engineering Notebook. The Engineering Notebook must include a Business or Strategic plan that identifies their future goals and the steps they will take to reach those goals. The plan could include fundraising goals, sustainability goals, timelines, outreach, and community service goals.
Control Award	• The *Team* must submit an Engineering Notebook. The Engineering Notebook must include an Engineering section that documents the control components.

10.2.6 Notebook Examples

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

10.3 Judging Process, Schedule, and Team Preparation

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

10.3.1 Judging Process

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

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

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

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

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

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

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

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

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

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

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

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

10.3.4 Video Award Submission Guidelines

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

- The video must be submitted at least one week prior to Tournament day. Instructions for submitting videos may vary from Tournament to Tournament. Please check with the Event Director for details.
- Videos must be submitted in AVI, WMV, MOV or better format. Submission through use of a streaming service such as YouTube is not acceptable. Remember the winning video may be shown on a large screen during the awards ceremony. *Teams* should use the best resolution available for the final version.
- Only one video submission per *Team* will be considered. *Teams* may submit new or updated videos at each Tournament.
- *Teams* must have permission from the copyright owners for music used in the video.

10.4 Award Categories

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

10.4.1 Inspire Award

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

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

Required criteria for the Inspire Award:

- *Team* **shows respect and** *Gracious Professionalism*® **to everyone they meet at a** *FIRST* **Tech Challenge event.**
- *Team* **is a strong contender for several other Judged awards. The Inspire Award celebrates the strongest qualities of all the Judged Awards.**
- **The** *Team* **is an ambassador for** *FIRST* **programs. They demonstrate and document their work in their community.**
- *Team* **is positive and inclusive, and each** *Team* **member contributes to the success of the** *Team***.**
- *Team* **must submit an** **Engineering Notebook**. **The Engineering notebook must include an Engineering section, a Team section and a Business or Strategic Plan. The entire Engineering Notebook must be high quality, thoughtful, thorough, detailed and well organized.**

- ***Robot* design is creative and innovative, and the *Robot* performs reliably on the field. *Team* communicates clearly about their *Robot* design and strategy to the judges.**
- ***Team* presentation is professional and engaging.**

10.4.2 Think Award

Removing engineering obstacles through creative thinking.

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

Required criteria for the Think Award:

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

Strongly suggested criteria for the Think Award:

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

10.4.3 Connect Award

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

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

Required criteria for the Connect Award:

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

10.4.4 Rockwell Collins Innovate Award

Bringing great ideas from concept to reality.

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

Required criteria for the Rockwell Collins Innovate Award:

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

10.4.5 Design Award

Industrial design at its best.

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

Required criteria for the Design Award:

- *Team* shows respect and *Gracious Professionalism®* to everyone they meet at a *FIRST* Tech Challenge event.

- *Team* must submit an **Engineering Notebook** with an Engineering section that includes detailed *Robot* design drawings.
- *Team* demonstrates industrial design principles, striking a balance between form, function, and aesthetics.
- *Robot* distinguishes itself from others by its aesthetic and functional design.
- Basis for the design is well considered (that is inspiration, function, etc.).

10.4.6 Motivate Award
Sparking others to embrace the culture of *FIRST*!

This *Team* embraces the culture of *FIRST* and clearly shows what it means to be a *Team*. This judged award celebrates the *Team* that represents the essence of the *FIRST* Tech Challenge competition through *Team* building, *Team* spirit and displayed enthusiasm. This is a *Team* who makes a collective effort to make *FIRST* known throughout their school and community, and sparks others to embrace the culture of *FIRST*.

Required criteria for the Motivate Award:

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

Strongly suggested criteria for the Motivate Award:

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

10.4.7 Control Award
Mastering *Robot* intelligence.

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

Required criteria for the Control Award:

- *Team* shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.
- *Team* must apply for the Control Award by filling out the Control Award Content Sheet, located

in **[Appendix D](#).**

- **The *Team* must submit an [Engineering Notebook.](#) The Engineering Notebook must include an Engineering section that documents the control components.**
- **Control Components must enhance the functionality of the *Robot* on the *Playing Field*.**

Strongly suggested criteria for the Control Award:

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

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

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

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

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

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

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

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

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

PSA Subject for 2017-2018 Season:

"What I would like the world to know about *FIRST*"

Required criteria for the Promote Award:

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

10.4.9 Compass Award (Optional)

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

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

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

Required criteria for the Compass Award:

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

10.4.10 Judges' Award

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

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

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

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

11.0 *FIRST®* Tech Challenge Dean's List

In an effort to recognize the leadership and dedication of *FIRST's* most outstanding *FIRST* Tech Challenge students, the Kamen family sponsors an Award for selected top students known as the *FIRST* Dean's List. Since its introduction in 2010, the *FIRST* Dean's List Award has attracted the attention of prestigious colleges and universities who desire to recruit *FIRST* Dean's List students. Similar to the very prestigious National Merit Scholarship Award winners, there are three (3) "categories" of *FIRST* Dean's List Award students:

1. *FIRST* **Dean's List Semi-Finalists**
    - *FIRST* Dean's List Semi-Finalists are the students nominated by each *Team* to compete for the *FIRST* Dean's List Finalist spots.
2. *FIRST* **Dean's List Finalists**
    - The students selected to be recognized at each State/Regions Championship that are in the running for the *FIRST* Dean's List Winner spots.
3. *FIRST* **Dean's List Winners**
    - The group of 10 students who are the final selection for the Dean's List Award at the *FIRST* World Championship.

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

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

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

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

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

11.2 Criteria

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

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

The Mentor or Coach, who is not related to either of the students chosen as the team's Dean's List Semi-finalists, should gather the required information in order for the student *Team* member to interview for the *FIRST* Dean's List Finalist designation at one (1) Qualifying Event, League Championship or Interview Only Event. Applications will require:

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

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

11.3 Dean's List Nominations

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

Appendix A – Resources

Game Forum Q&A

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

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

FIRST Tech Challenge Game Manuals

Part 1 and 2 - http://www.firstinspires.org/node/4271

FIRST Headquarters Pre-Event Support

Phone: 603-666-3906
Mon – Fri
8:30am – 5:00pm
Email: FTCTeams@firstinspires.org

FIRST Websites

FIRST homepage – www.firstinspires.org

FIRST Tech Challenge Page – For everything *FIRST* Tech Challenge.

FIRST Tech Challenge Volunteer Resources – To access public Volunteer Manuals.

FIRST Tech Challenge Event Schedule – Find *FIRST* Tech Challenge events in your area.

FIRST Tech Challenge Social Media

FIRST Tech Challenge Twitter Feed - If you are on Twitter, follow the *FIRST* Tech Challenge Twitter feed for news updates.

FIRST Tech Challenge Facebook page - If you are on Facebook, follow the *FIRST* Tech Challenge page for news updates.

FIRST Tech Challenge YouTube Channel – Contains training videos, Game animations, news clips, and more.

FIRST Tech Challenge Blog – Weekly articles for the *FIRST* Tech Challenge community, including Outstanding Volunteer Recognition!

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

FIRST Tech Challenge Google+ community - If you are on Google+, follow the *FIRST* Tech Challenge community for news updates.

Feedback

We strive to create support materials that are the best they can be. If you have feedback regarding this manual, please email ftcteams@firstinspires.org. Thank you!

Appendix B – Robot Inspection Checklist

Team Number: _____   Robot Inspection Status (circle): **PASS / FAIL**

✓	Robot Size 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 Box without exerting undue force on the Sizing Box sides and top.	\<I7\>a \<RG02\>
	Robot Motion Warning Label is attached if servo motors move during the Robot initialization.	\<RG02\>b
✓	**General Robot Rules**	**Rule #**
	Robot does not contain any components that could damage the Playing Field or other Robots.	\<RG01\>a&b
	Robot does not contain materials that are hazardous.	\<RG01\>c
	Robot poses no obvious unnecessary risk of entanglement.	\<RG01\>d
	Robot does not contain sharp edges or corners.	\<RG01\>e
	Robot does not contain animal-based, liquid, or gel materials.	\<RG01\>f&g
	Robot does not contain materials that would cause a delay of game if released.	\<RG01\>h
	Robot does not contain elements that electrically ground the Robot frame to the Playing Field.	\<RG01\>i
	Robot does not contain closed gas devices.	\<RG01\>j
	Robot does not contain hydraulic devices.	\<RG01\>k
	Alliance Flag Holder is present and adequately holds the Flag during normal Robot operation.	\<RG04\>
	Team number is visible from at least 2 sides (180 deg. apart). Numerals must be at least 2.5 inches (6.35 cm high), at least in 0.5 inches (1.27 cm) stroke width.	\<RG05\>
	Energy used by the Robot, (i.e., stored at the start of a Match), shall come only from approved sources.	\<RG06\>
	Robot is not capable of launching its own components.	\<RG07\>
✓	**Robot Mechanical Parts and Materials Rules**	**Rule #**
	All components on the Robot are from allowable raw materials and Commercial Off The Shelf products.	\<RM01\> \<RM02\>
✓	**Robot Electrical Parts and Materials Rules**	**Rule #**
	The Main Power Switch is installed properly, labeled, readily accessible, and visible to competition personnel. The TETRIX, REV, and MATRIX switches are the only allowed Main Power Switch.	\<RE01\>
	All batteries are securely attached to the Robot in a location where they will not make direct contact with other Robots or the Playing Field.	\<RE02\>
	Exactly one (1) Robot Main Battery Pack of an approved type is on the Robot and it is properly connected to the Main Power Switch and either the Core Power Distribution Module or REV Expansion Hub.	\<RE03\> \<RE05\>a(i)
	Where present, fuses must not be replaced with fuses of higher rating than originally installed or according to manufacturer's specifications.	\<RE04\>
	Allowed electronic devices are powered by power ports on the Core Power Distribution Module or REV Expansion Hub except as noted in \<RE05\>a, \<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)
	Allowed sensors may only receive power from the Core Device Interface Module, Core Legacy Module, or REV Expansion Hub,	\<RE05\>a(ii)
	Light sources (including LEDs) are not focused or directed in any way and they are powered by allowed methods.	\<RE05\>a(iii) \<RE12\>

	Video recording devices, if used, are powered by an internal battery and their wireless communication capability is turned off.	<RE05>a(iv) <RE13>
	The Robot Controller is powered by its internal battery or by the built-in charging feature of the REV Expansion Hub.	<RE05>b
	If present, a second REV Expansion Hub must be powered by the XT30 power port on the primary REV Expansion Hub.	<RE05>c
	Exactly one (1) Core Power Distribution Module is mounted on the Robot if any Modern Robotics Core Control Modules or Legacy MATRIX DC Motor/Servo Controllers are used.	<RE07>a
	No more than two (2) REV Expansion Hubs are mounted on the Robot.	<RE07>f
	No more than two (2) Core Device Interface Modules are mounted on the Robot.	<RE07>b
	No more than two (2) Core Legacy Modules are mounted on the Robot.	<RE07>c
	No more than two (2) Legacy MATRIX DC Motor/Servo Controllers (unified module) are allowed.	<RE07>h
	Motor and Servo Controllers are allowed in only one of the following configurations: i) REV Expansion Hub, Modern Robotics, and Legacy HiTechnic controllers in any combination OR; ii) Legacy MATRIX motor and servo controllers.	<RE08>
	Robot contains no more than eight (8) DC motors of the allowed models and they are compatible with the attached REV Expansion Hub or Motor Controller and the Robot Main Battery.	<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, Core Device Interface Module, or Core Legacy 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
	Robot does not contain elements that are electrically grounded to the Robot frame.	<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 Performed at the Discretion of the Inspector**	**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.]	<I8>

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 #
	✓	**Drive Team Members Present**	**Rule #**
		Coach	<T8>
		Driver 1 (required); Driver 2 (optional)	<T8>
	✓	**Driver Station and Robot Controller Hardware Rules**	**Rule #**
		Driver Station consists only of one Android device (Circle): ZTE Speed, Motorola Moto G 2nd Generation, Motorola Moto G 3rd Generation, Motorola Moto G4 Play, Google Nexus 5, or Samsung Galaxy S5.	<RE06> <RE16>a
		Robot Controller consists only of one Android device (Circle): ZTE Speed, Motorola Moto G 2nd Generation, Motorola Moto G 3rd Generation, Motorola Moto G4 Play, Google Nexus 5, or Samsung Galaxy S5. The Android device's USB interface only connects to the Core Power Distribution Module or the REV Expansion Hub.	<RE06>
		Driver Station Android device USB interface is only connected to either a Mini USB to OTG cable or combination of cables connected to one non-powered USB Hub, or one gamepad.	<RE16>a&b
		No more than one (1) optional Commercial Off The Shelf USB external battery connected to the USB hub is allowed.	<RE06>d <RE16>c
		The Driver Station consists of no more than two of the allowed gamepads (Logitech F310 or Xbox 360 in any combination).	<RE16>a&d
		The touch display screen of the Driver Station must be accessible and visible to field personnel.	<RE16>e
DS	**RC**	**Driver Station (DS) and Robot Controller (RC) Software Rules**	**Rule #**
		Android operating system satisfies the requirements: ZTE Speed – version 4.4 or higher, Motorola Moto G4 Play 6.0.1 or higher, all other allowed Android devices – version 6.0 or higher.	<RS03>
		The Android device is set to airplane mode, and Bluetooth is turned off.	<RS08>
		Robot is not connected to any local networks.	
		Android device is named with the official Team number followed by –DS or –RC as appropriate.	<RS01>
		Android Wi-Fi Direct device name does not include a newline character in the name.	
		All remembered Wi-Fi Direct Groups and Wi-Fi connections have been removed.	
	NA	Driver Station uses the official FTC Driver Station app to control the Robot.	<RS07>
		DS and RC apps are version 3.3 or higher and the DS and RC apps have the same version numbers.	<RS02> <RS07>
NA		The FTC controller app is the default application, the application launches, and no other messages pop up.	<RS06>
NA		The FTC Wi-Fi Direct Channel Changing App is installed on the Robot Controller (for ZTE Speed devices only).	<RS09>
NA		Robot Controller is set to the correct Wi-Fi Direct channel (ZTE Speed, Motorola Moto G 2nd Generation, Motorola Moto G 3rd Generation, and Motorola Moto G4 Play only).	<T6>
	✓	**Robot Operation Verified at the Playing Field**	**Rule #**
		Robot Controller connects with the Driver Station.	
		Robot is motionless prior to the start of the Autonomous and Driver-Controlled periods.	<RS04>
		Robot switches between Autonomous and Driver-Controlled operation correctly.	<RS05>
		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.	

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	Team understands that the Match schedule is only an estimate. Matches may start prior to or after the scheduled time. It is the Team's responsibility to monitor schedule changes and show up when required.	
	Team knows where to receive alliance flags and where to return them after the Match.	

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.

Control Award Submission Form

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

Team #	Team Name:

Autonomous objectives:

Sensors used:

Key algorithms:

Driver controlled enhancements:

Engineering notebook references:

Autonomous program diagrams: