



vex[®]
ROBOTICS
COMPETITION
TIPPING POINT

2021 - 2022
Game Manual
Version 1.0



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Appendix A - Field Specifications - link.vex.com/docs/21-22/vrc/tipping-point/Appendix-A

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Appendix E - Live Remote Tournaments - link.vex.com/docs/21-22/vrc/tipping-point/Appendix-E

Changelog

Version 1.0 - June 29, 2021

- Updated the definition of *Balanced* to fix a contradiction with <SG3>.
- Added a Note and Red Box to rule <G12> to clarify interaction with a *Robot* possessing a *Neutral Mobile Goal*.
- Added a Red Box to rule <G13> to clarify offensive / defensive roles of *Robots*.
- Added a graphic to <SG2> to further illustrate "point-to-point" expansion.
- Updated <SG3> to prevent *Scoring Objects* from causing interference with the opposing *Alliance Platform* during the last thirty (30) seconds of a *Match*.
- Changed bullet E of Rule <R8> to allow rope / string no thicker than 1/4" (6.35mm).
- Updated Appendix A to allow shorter standoffs for Platform construction.
- Updated Appendix B to introduce the recommendation, and eventual requirement of VEX GPS Code Strips for all *Programming Skills Matches*.
- Added a new definition of "Additional Electronics" in Appendix C.
- Updated rules <VUR1>, <VUR9> and <VUR10> in Appendix C to clarify use cases of *Additional Electronics*.
- Various minor typo corrections.

Version 0.2 - June 15, 2021

- Added two notes to <SG2>, clarifying "point-to-point" expansion.
- Updated <R18> to clarify that *Robots* must use VRC-legal pneumatic components.
- Updated the definition of *Mobile Goal Base*, and updated Figure 15 to include the lower, black part of the *Mobile Goal*.
- Updated the Scoring section of Appendix B to correct a contradicting rule.
- Various minor typo corrections.

Version 0.1 - May 22, 2021

- Initial Release

Section 1

Introduction

Overview

This section provides an introduction to the VEX Robotics Competition and VRC Tipping Point.

The VEX Robotics Competition

Our world faces a serious problem. It's a problem that, without explicit and intentional action, will eventually stagnate global progress and lead to a workforce that is unmotivated and ill-equipped to solve its future problems. As the world grows more technologically complex, the challenges we face every day will continue to escalate along with it. A cell phone has more failure modes than a landline. The internals of an electric car are more difficult to comprehend than a V8 combustion engine. Unmanned drone legislation is more nuanced than defining a maximum speed limit.

Dubbed "the STEM problem", the situation is equally simple to understand, yet difficult to solve. In many cases, the traditional methods of teaching science, technology, engineering, and math (STEM) will not be enough to adequately prepare students for this complex world. This is often coupled with the unfortunate reality that by the time they reach an age capable of grasping these critical topics, students may have already determined that they are "not cool" or "boring". Without the skills or passion necessary to approach these problems in an educated manner, you cannot possibly expect to be productive in making forward progress or even sustaining the status quo.

The VEX Robotics Competition exists to solve this problem. Through its uniquely engaging combination of teamwork, problem solving, and scientific discovery, the study of competitive robotics encompasses aspects of STEM. You're not building VEX robots because your future job will involve tightening shaft collars on a metal bar – you're executing an engineering design and problem-solving process that resembles the

same mindset used by rocket scientists, brain surgeons, and inventors around the world. VEX Robotics Competition Tipping Point is not just a game that we invented because it is fun to play – it is a vehicle for teaching (and testing) teamwork, perseverance in the face of hardship, and provides a methodology to approach and solve new challenges with confidence.

Contained in this manual are the rules that shape VRC Tipping Point. These rules are designed to simulate the constraints that will outline any real-world project. They are intended to promote creativity without punishing innovation. They are balanced to promote fair play while encouraging competition.

We encourage you to keep in mind that a VEX Robotics Competition game is more than just a set of game objects worth varying amounts of points. It is an opportunity to hone the life-long skills that will characterize the problem-solving leaders of tomorrow.

Good luck, and we'll see you on the playing field!

Sincerely,

The VEX Robotics Game Design Committee,
composed of members from the Robotics Education & Competition Foundation, DWAB Technology, and VEX Robotics.

VEX Robotics Competition Tipping Point: A Primer

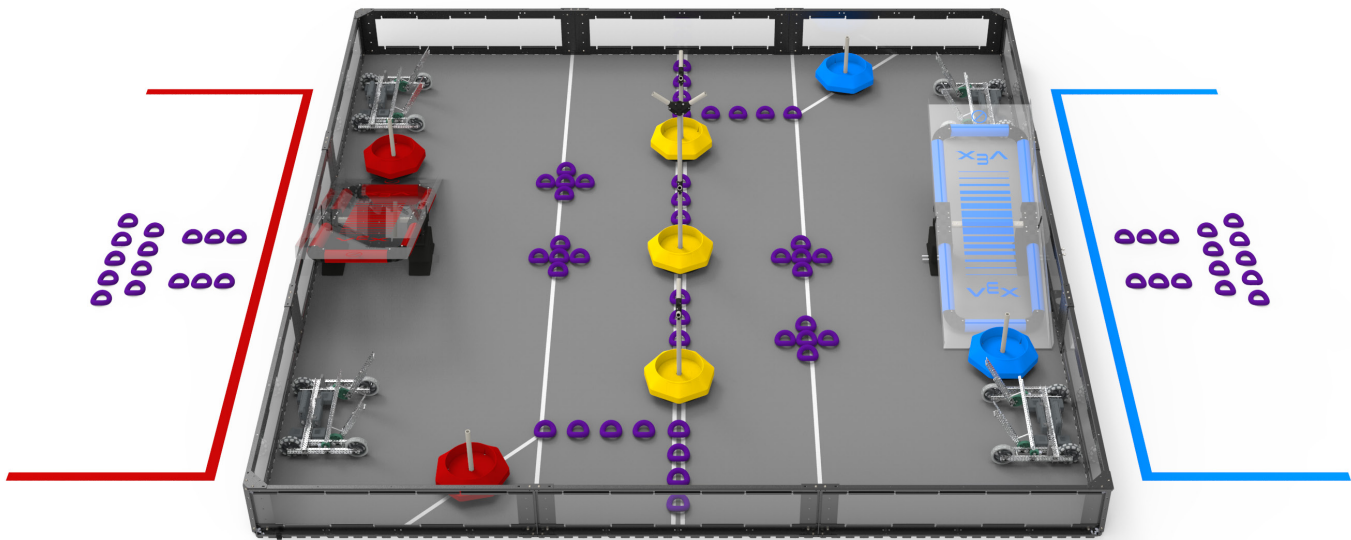
VEX Robotics Competition Tipping Point is played on a 12'x12' square field configured as seen below. Two (2) *Alliances* - one (1) "red" and one (1) "blue" - composed of two (2) *Teams* each, compete in *Matches* consisting of a fifteen (15) second *Autonomous Period*, followed by a one minute and forty-five second (1:45) *Driver Controlled Period*.

The object of the game is to attain a higher score than the opposing *Alliance* by Scoring *Rings*, moving *Mobile Goals* to *Alliance Home Zones*, and by *Elevating on Platforms* at the end of a *Match*. For more details and specific game-play rules, see "Section 2" – The Game.

For more information about VEX, visit www.vexrobotics.com. Follow us on Instagram & Twitter @vexrobotics. Like us on Facebook at www.facebook.com/vexrobotics.

For more information about the Robotics Education & Competition Foundation, visit www.roboticseducation.org. Follow us on Twitter @REC_Foundation. Like us on Facebook at www.facebook.com/RECFoundation.

Visit www.RobotEvents.com for more information about the VEX Robotics Competition, including team registration, event listings, and results.



Section 2

The Game

Overview

This section describes the 2021-22 VEX Robotics Competition game entitled VEX Robotics Competition Tipping Point. It also lists the game definitions and game rules.

Game Description

Matches are played on a field set up as illustrated in the figures throughout. Two *Alliances* – one “red” and one “blue” – composed of two *Teams* each, compete in each *Match*. The object of the game is to attain a higher score than the opposing *Alliance* by *Scoring Rings*, moving *Mobile Goals* to *Alliance Home Zones*, and by climbing *Platforms* at the end of a *Match*.

An *Autonomous Win Point* is awarded to any *Alliance* that has *Cleared* their *AWP Line* and *Scored* at least one *Ring* on each *Alliance Mobile Goal* at the end of the *Autonomous Period*.

An *Autonomous Bonus* is awarded to the *Alliance* that has the most points at the end of the *Autonomous Period*.

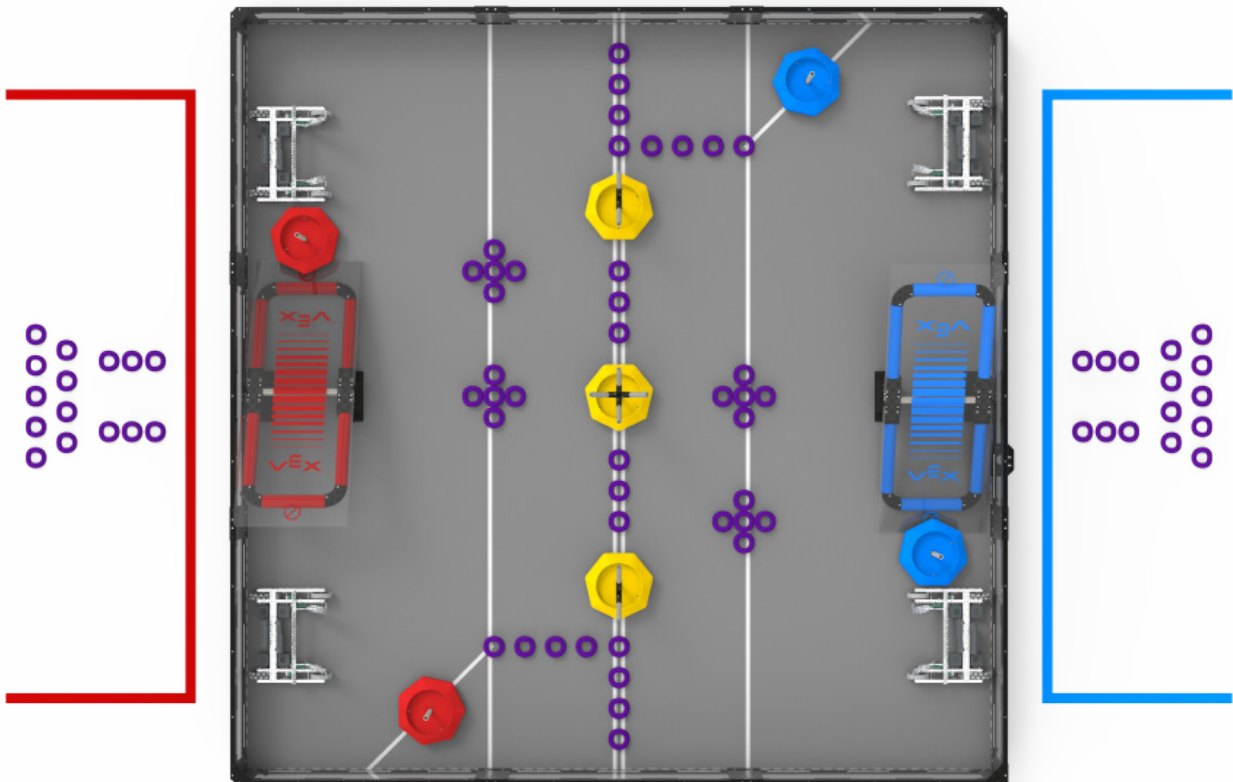


Figure 1: Top view of the field in its initial setup configuration.

Note: The illustrations in this section of the manual are intended to provide a general visual understanding of the game. Teams should refer to official field specifications, found in Appendix A, for exact field dimensions, a full field bill of materials, and exact details of field construction.

The VEX Robotics Competition Tipping Point field consists of the following:

- Seventy-two (72) *Rings*
 - Twelve (12) that begin as *Preloads*, six (6) per *Alliance*
 - Eighteen (18) that are used as *Match Loads*, nine (9) per *Alliance*
 - Forty-two (42) that begin on the field
- Four (4) *Alliance Mobile Goals*, two (2) per *Alliance*
- Three (3) *Neutral Mobile Goals*
- Two (2) *Platforms*, one per *Alliance*

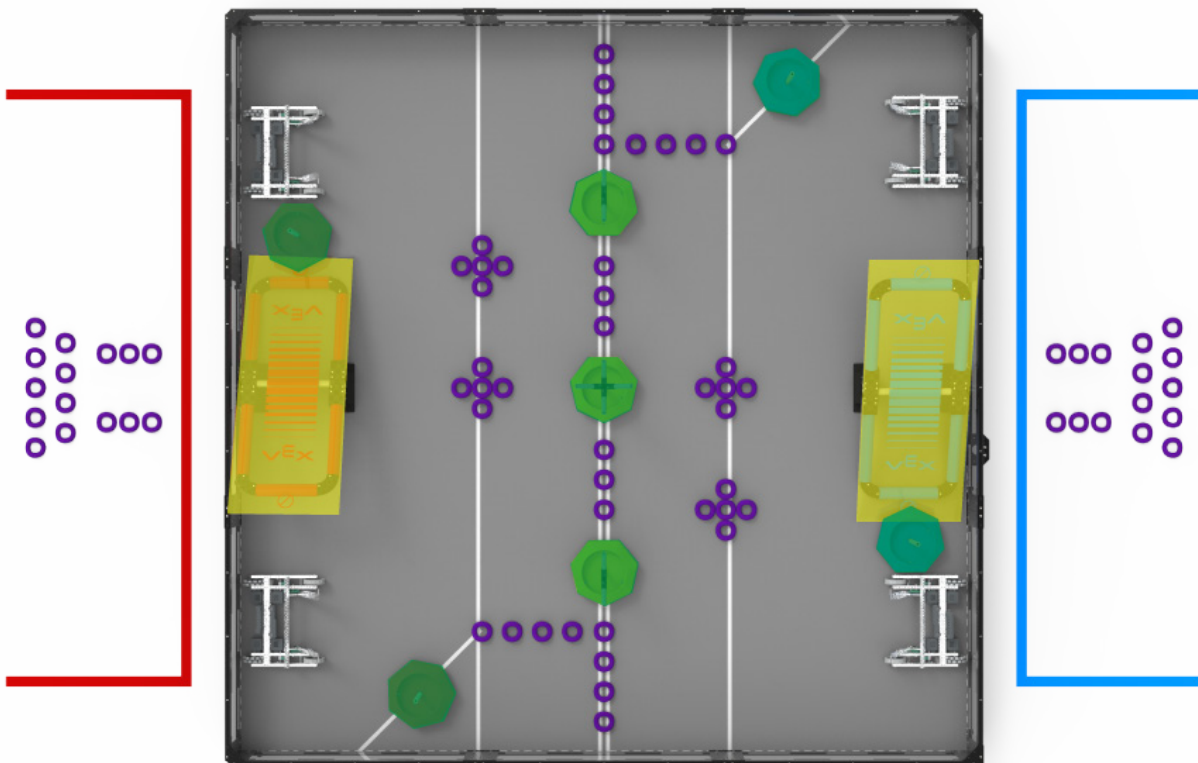


Figure 2: Top view of the field with Mobile Goals and Platforms highlighted.

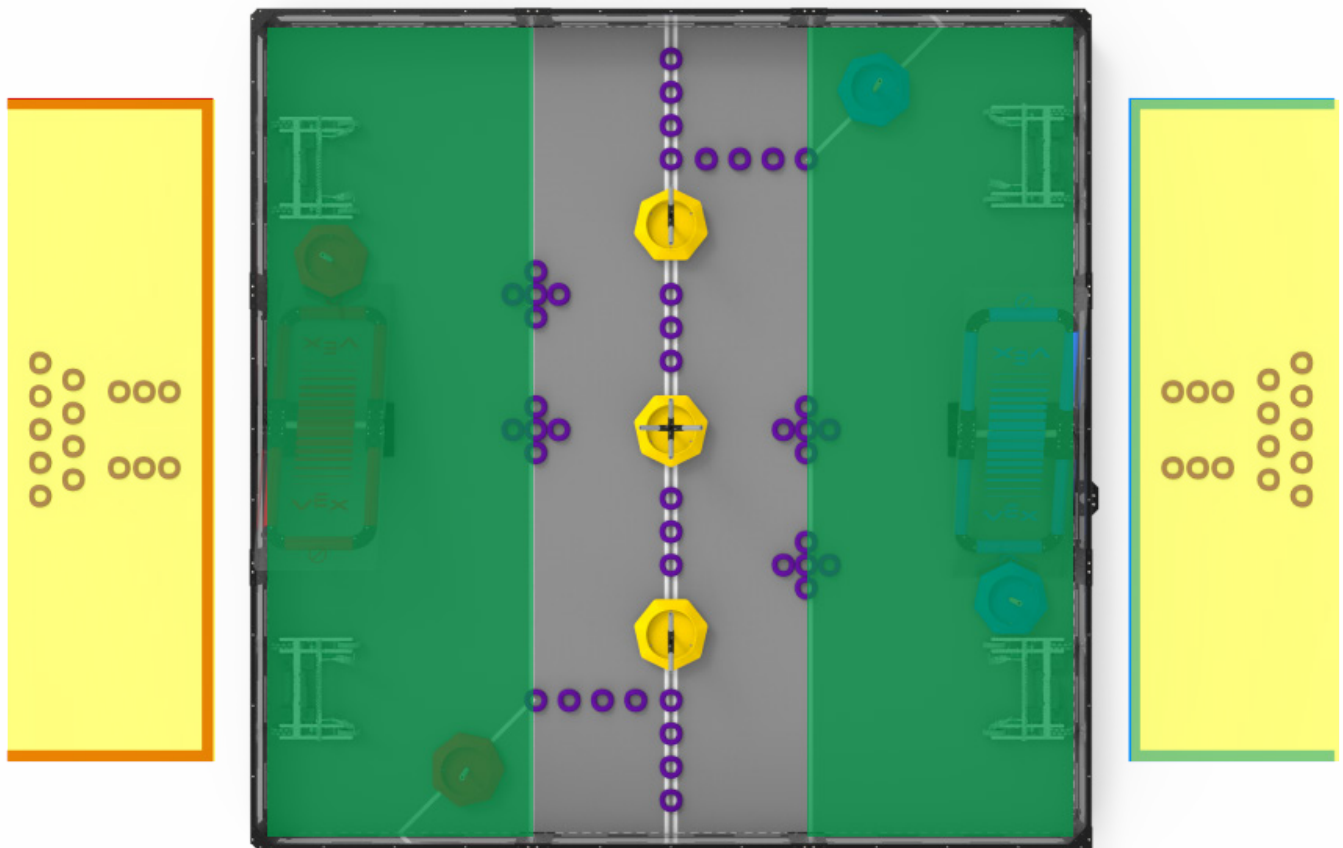


Figure 3: Top view of the field with the Alliance Stations and Alliance Home Zones highlighted.

Game Definitions

Adult – Anyone who is not a *Student*.

Alliance – A pre-assigned grouping of two (2) *Teams* that are paired together during a given *Match*.

Alliance Station – The designated regions where the *Drive Team Members* must remain for the duration of the *Match*.

Note: Either *Alliance Station* configuration shown in Figure 4 is permissible, and will be chosen at the *Event Partner's* discretion. The chosen configuration must be used for all *Matches* and / or fields within a given event.

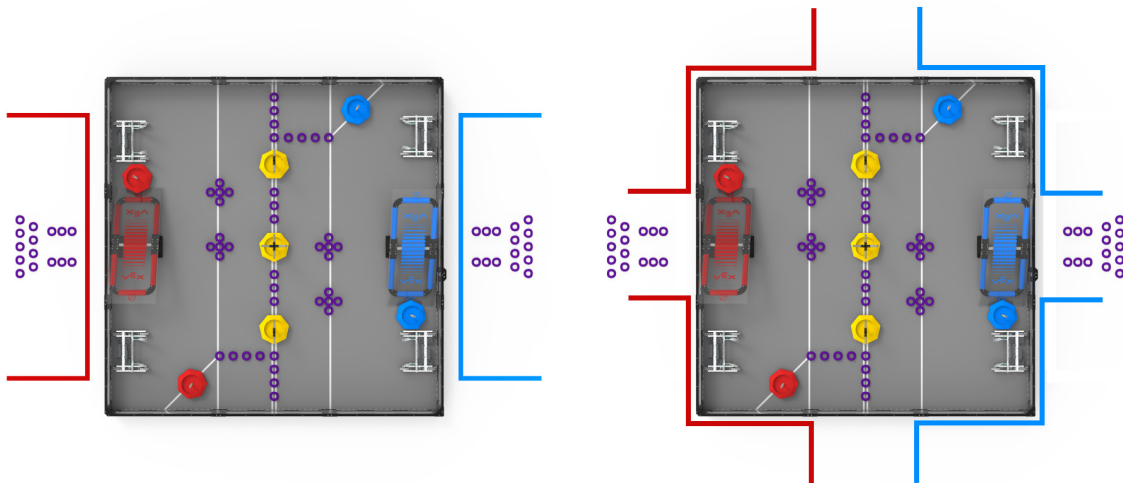


Figure 4: The two permissible Alliance Station configurations for VRC Tipping Point.

Autonomous Bonus - A point bonus of twenty (20) points awarded to the *Alliance* that has earned the most points at the end of the *Autonomous Period*.

Note: If the *Autonomous Period* ends in a tie, including a zero-to-zero tie, each *Alliance* will receive an *Autonomous Bonus* of ten (10) points.

Builder – The *Student(s)* on the *Team* who assemble(s) the *Robot*. An *Adult* cannot be the *Builder* on a *Team*. *Adults* are permitted to teach the *Builder(s)* associated concepts, but may never work on the *Robot* without the *Builder(s)* present and actively participating.

Designer – The *Student(s)* on the *Team* who design(s) the *Robot* to be built for competition. An *Adult* cannot be the *Designer* on a *Team*. *Adults* are permitted to teach the *Designer(s)* associated concepts, but may never work on the design of the *Robot* without the *Designer(s)* present and actively participating.

Disablement – A penalty applied to a *Team* for a rule violation. A *Team* that is Disabled is not allowed to operate their *Robot* for the remainder of the *Match*, and the *Drive Team Member(s)* will be asked to place their controller(s) on the ground.

Disqualification – A penalty applied to a *Team* for a rule violation. A *Team* that receives a *Disqualification* in a *Qualification Match* receives zero (0) *Win Points*, *Autonomous Win Points*, *Autonomous Points*, and *Strength of Schedule Points*. When a *Team* is *Disqualified* in an *Elimination Match*, the entire *Alliance* is *Disqualified* and they receive a loss for the *Match*. At the *Head Referee*'s discretion, repeated violations and *Disqualification* for a single *Team* may lead to its *Disqualification* for the entire tournament. (See <T11>)

Drive Team Member(s) – A *Student* who stands in the *Alliance Station* during a *Match* for each *Team* per <G7> . Only *Drive Team Members* are permitted to stand in the *Alliance Station* and touch the controls during the *Match* or interact with the *Robot* as per <G9>. *Adults* are not allowed to be *Drive Team Members*.

Entanglement – A *Robot* status. A *Robot* is *Entangled* if it has grabbed, hooked, or attached to an opposing *Robot* or a *Field Element*.

Field Element – The foam field tiles, field perimeter, white tape, *Platforms*, and all supporting structures or accessories (such as driver station posts, field monitors, etc).

Match – A *Match* consists of an *Autonomous Period* followed by a *Driver Controlled Period* for a total time of two minutes (2:00).

- **Autonomous Period** – A fifteen second (0:15) time period during which *Robots* operate and react only to sensor inputs and to commands pre-programmed by the *Students* into the *Robot* control system.
- **Driver Controlled Period** – The one minute and forty-five second (1:45) time period during which *Drive Team Members* operate their *Robot*.

Match Affecting – A rule violation status determined by the *Head Referee*. A rule violation is *Match Affecting* if it changes the winning and losing *Alliance* in the *Match*. Multiple rule violations within a *Match* can cumulatively become *Match Affecting*.

Programmer – The *Student(s)* on the *Team* who write(s) the computer code that is downloaded onto the *Robot*. An *Adult* cannot be the *Programmer* on a *Team*. *Adults* are permitted to teach the *Programmer(s)* associated concepts, but may never work on the code that goes on the *Robot* without the *Programmer(s)* present and actively participating.

Robot – A machine that has passed inspection, designed to execute one or more tasks autonomously and / or by remote control from a *Drive Team Member*.

Student - A person is considered a *Student* if he or she meets both of the following criteria:

1. Anyone who is earning or has earned credit toward a high school diploma, certificate or other equivalent during the six (6) months preceding the VEX Robotics World Championship. Courses earning credits leading up to high school would satisfy this requirement.
2. Anyone born after May 1, 2002 (i.e. who will be 19 or younger at VEX Worlds 2022). Eligibility may also be granted based on a disability that has delayed education by at least one year.
 - Middle School Student - A *Student* born after May 1, 2006 (i.e. who will be 15 or younger at VEX Worlds 2022). A Middle School *Student* may "play up" and compete as a High School *Student*.
 - High School Student - Any eligible *Student* that is not a Middle School *Student*.

Team - One or more *Students* make up a *Team*. A *Team* is classified as a *Middle School Team* if all members are *Middle School Students*. A *Team* is classified as a *High School Team* if any of its members are *High School Students*, or made up of *Middle School Students* who declare themselves “playing up” as *High School Students* by registering their *Team* as a *High School Team*.

Once declared and playing as a *High School Team*, that *Team* may not change back to a *Middle School Team* for the remainder of the season. *Teams* may be associated with schools, community / youth organizations, or groups of neighborhood *Students*.

Trapping – A *Robot* status. A *Robot* is *Trapping* if it has restricted an opposing *Robot* into a small, confined area of the field, approximately the size of one foam field tile or less, and has not provided an avenue for escape. *Trapping* can be direct (e.g. pinning an opponent to a field perimeter wall) or indirect (e.g. preventing a *Robot* from escaping from a corner of the field).

Note: If a *Robot* is not attempting to escape, then that *Robot* has not been Trapped.

Game Specific Definitions

AWP Line - The white tape line, one (1) per *Alliance Home Zone*, that starts the *Match* with one (1) *Alliance Mobile Goal* on it. See the Scoring Section for more details.

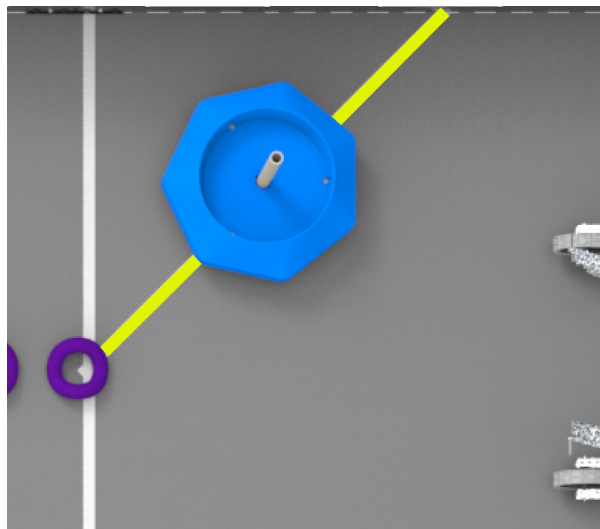


Figure 5: Top view of the field with an AWP Line highlighted.

Alliance Home Zone - One of two (2) areas of gray foam tiles, one (1) for each *Alliance*, where *Robots* begin the *Match* and defines the location where *Neutral Mobile Goals* can be Scored. See Figure 6.

- The *Alliance Home Zones* are defined by the inner edges of the playing field walls and the designated white tape lines.
- The tape is considered to be part of the *Alliance Home Zone*.
- The *Alliance Home Zones* are defined as the gray foam tiles themselves; it is not a 3-dimensional volume.
- The *Platforms* are considered part of their respective *Alliance Home Zone*.

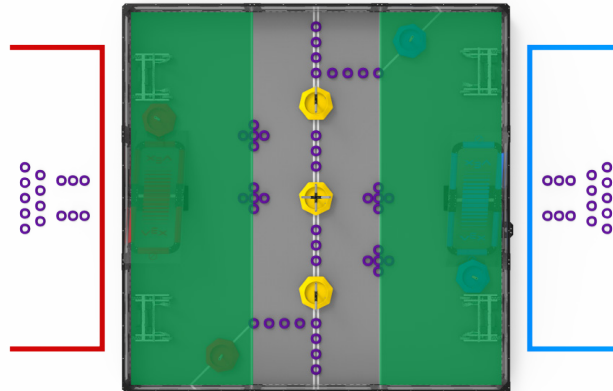


Figure 6: Top view of the field with the Alliance Home Zones highlighted.

Balanced - A Platform state. A Platform is considered *Balanced* if all of the following criteria are met at the end of a Match:

1. The Platform is roughly parallel to the field.
2. Both flat surfaces of the Platform hinges are contacting the Platform base, as shown in Figure 7.
3. Robots and / or Scoring Objects contacting the Platform in their Alliance Home Zone are not also contacting any other Field Elements, such as foam field tiles or the field perimeter.
 - a. For the purposes of this definition, contact is considered "transitive" through other Robots and Scoring Objects. For example, as shown in Figure 9, contact with a Mobile Goal that is resting on top of the field perimeter would not satisfy the definition of *Balanced*.

Note: As stated in rule <G18>, a Match ends once all Robots, Field Elements, and Scoring Objects have come to rest, including Platforms.

Note 2: As stated in rule <SG3>, a Platform which is being contacted by an opposing Alliance Robot at the end of a Match is automatically results in a Disqualification for the opposing Robot and / or Alliance, regardless of the above criteria.

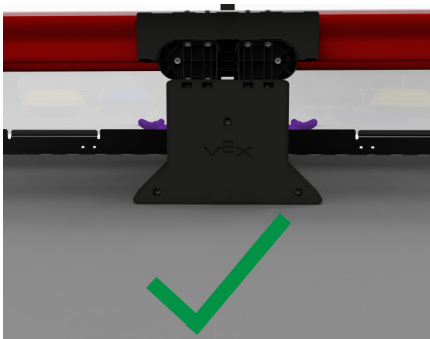


Figure 7: A Balanced Platform.

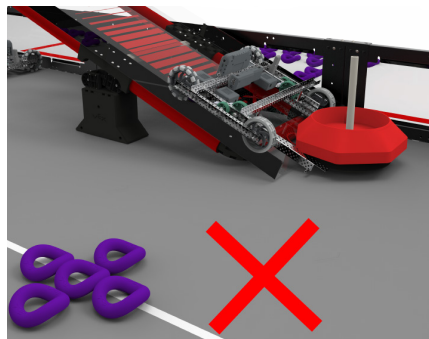


Figure 8: This Platform would not be considered *Balanced*, because the Platform is not level, and a Robot is in contact with a Mobile Goal that is not Elevated.

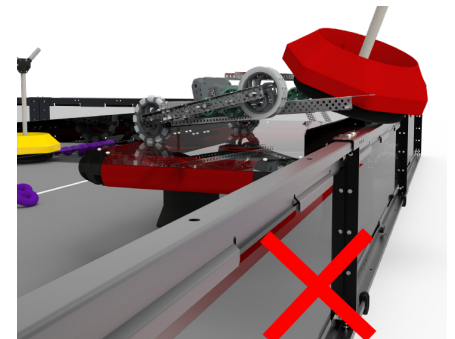


Figure 9: Even though it is level, this Platform would not be considered *Balanced*, because a Robot is in transitive contact with a Mobile Goal that is contacting the field perimeter.

Cleared - An *Alliance Mobile Goal* state. An *Alliance Mobile Goal* is considered "Cleared" if, at the end of the *Autonomous Period*, it is not contacting its *AWP Line* or the *Neutral Zone*. See the *Scoring Section* for more details.

Elevated - A *Robot* and / or *Mobile Goal* state. A *Robot* or *Mobile Goal* is considered *Elevated* if all of the following criteria are met at the end of a *Match*:

1. The *Robot* or *Mobile Goal* is contacting their *Alliance Platform*.
2. The *Platform* meets the definition of *Balanced*.
3. The *Robot* or *Mobile Goal* is not contacting any other *Field Element*, such as the foam field tiles or the field perimeter.
 - a. For the purposes of this definition, contact is considered "transitive" through other *Robots* and *Scoring Objects*. For example, as shown in Figure 10, contact with a *Mobile Goal* that is contacting a field tile would not satisfy the definition of *Elevated*.

Note: For the purposes of this definition, any *Mobile Goals* that are in *Possession* of an *Elevated Robot* are also considered *Elevated*. See Figure 11 for more information.

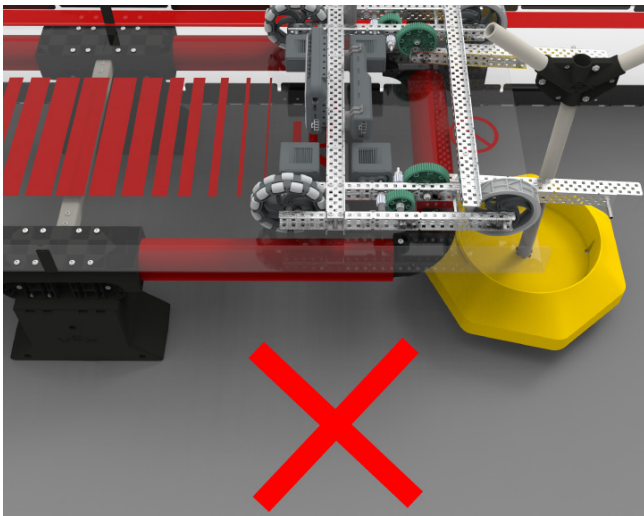


Figure 10: This *Robot* would not be considered *Elevated*, because the *Robot* is in contact with a *Mobile Goal* that is not *Elevated*.

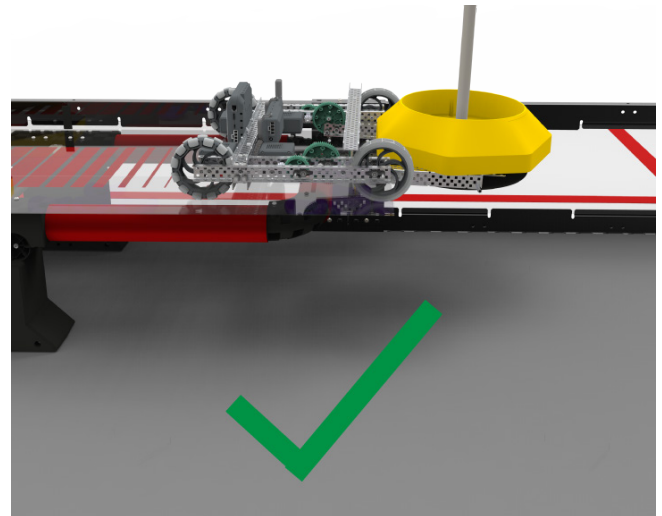


Figure 11: Both the *Mobile Goal*, and the *Robot*, are considered *Elevated*.

Hoarding – A form of *Possession*. A *Robot* is *Hoarding* if it is in *Possession* of any *Mobile Goal* in either of the two (2) corners of the field in their own *Alliance Home Zone* (i.e. positioned in the corner roughly the size of one foam field tile). See <SG7> for more information.

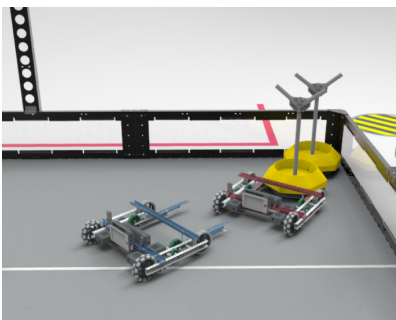


Figure 12: An example of a *Robot* *Hoarding* *Mobile Goals*.

Match Load Rings - The eighteen (18) *Rings*, nine (9) per *Alliance*, that begin the *Match* in an *Alliance Station* and may be introduced during the *Match*. See <SG8>.

Mobile Goal - One of the seven (7) large *Scoring Objects* made up of a *Mobile Goal Base* and *Mobile Goal Branch(es)*. All *Mobile Goals* have a maximal base diameter of 13" (330.2mm).

- **Alliance Mobile Goal** - The two (2) red and two (2) blue *Mobile Goals* which begin each *Match* in their respective *Alliance Home Zones*, and have only one *Mobile Goal Branch*. *Alliance Mobile Goals* weigh approximately 1,520 grams.
- **Neutral Mobile Goal** - The three (3) yellow *Mobile Goals* which begin each *Match* in the *Neutral Zone*, and have two (2) or four (4) *Mobile Goal Branches*. The 2-branch *Mobile Goal* weighs approximately 1,560 grams, and the 4-branch *Mobile Goal* weighs approximately 1,810 grams.

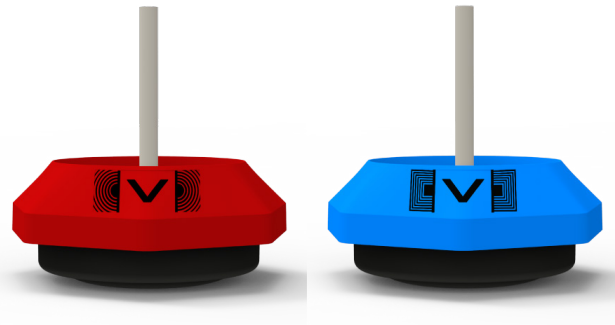


Figure 13: Alliance Mobile Goals



Figure 14: Neutral Mobile Goals

Mobile Goal Base - The 7-sided plastic bottom of a *Mobile Goal* with a maximal diameter of 13" (330.2mm). *Rings* may be *Scored* in the "bowl" of a *Mobile Goal Base* for points. Both the yellow, blue, or red "upper" portion, and the black "lower" portion, are considered parts of the *Mobile Goal Base*. See Figure 15.

Mobile Goal Branch - The gray PVC pipes, 0.84" (21.3mm) in diameter, that extend vertically out of a *Mobile Goal Base*. *Rings* may be *Scored* on *Mobile Goal Branches* for points. See Figure 15.

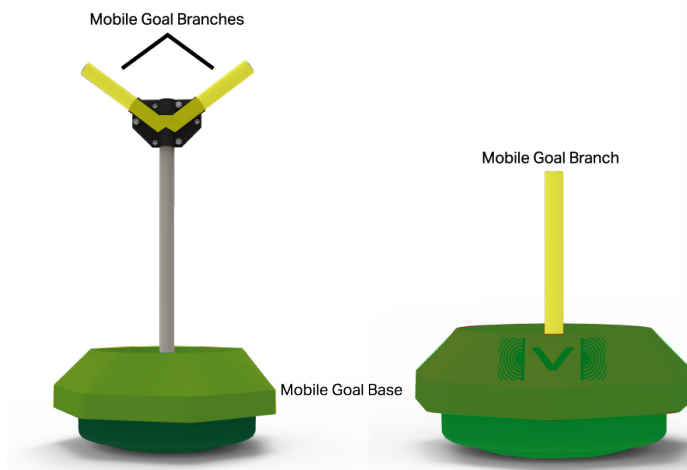


Figure 15: A Mobile Goal. The Base and Branches are highlighted.

Neutral Zone - The area of the field in which all three *Neutral Mobile Goals* begin. See rule <SG5>.

- The *Neutral Zone* is bounded by the inner edges of the playing field walls, and the single tape lines which run the length of the field.
- The *Neutral Zone* is defined as the gray foam tiles themselves; it is not a 3-dimensional volume.

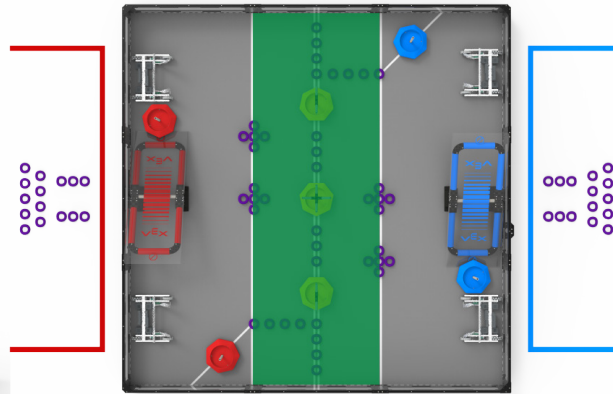


Figure 16: Top view of the field with the *Neutral Zone* highlighted.

Platform - The 53.0" x 20.1" (1,346.2mm x 511mm) structure, one per *Alliance Home Zone*, that sits 9.5" (241.5mm) high off of the ground when *Balanced*. The *Platform* is mounted on a double hinge that allows it to tip towards the field in either direction.

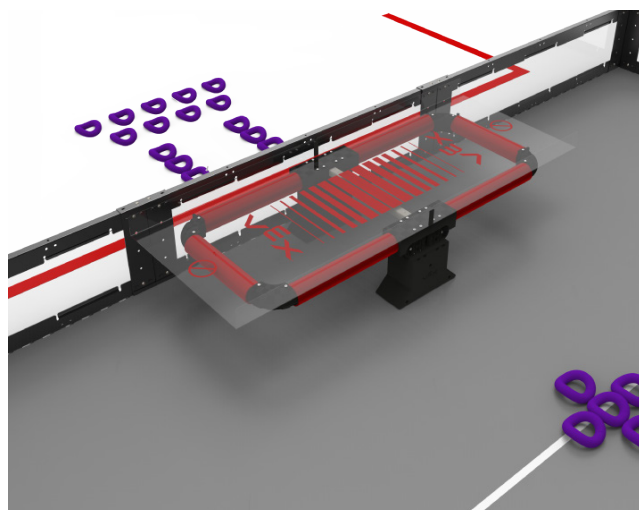


Figure 17: A *Platform*.

Possession – A *Robot* is considered to be in *Possession* of a *Mobile Goal* if any one of the following criteria are met:

1. The *Robot* is carrying, holding or controlling the movement of a *Mobile Goal* such that if the *Robot* changes direction, the *Mobile Goal* will move with the *Robot*. Therefore, pushing / plowing *Mobile Goals* is not considered *Possession*, however using concave portions of your *Robot* to control the movement of *Mobile Goals* is considered *Possession*. See Figure 18.

2. The *Robot* is actively blocking opposing *Robot's* access to *Mobile Goals*, such as by expanding horizontally and restricting access to a portion of the field. See Figure 19.
3. *Robots* on the same *Alliance* working in tandem to block access to *Mobile Goals* would share the *Possession* of said *Mobile Goal*. See Figure 20.

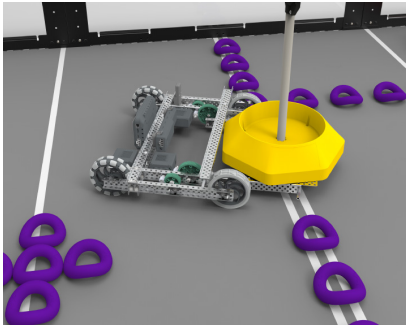


Figure 18: This Robot is in Possession of the Mobile Goal.

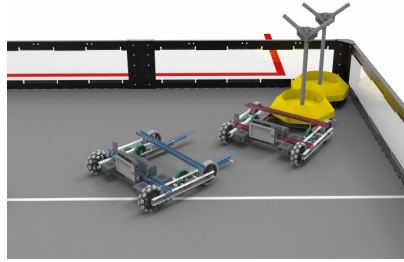


Figure 19: The Red Alliance Robot is in Possession of both Mobile Goals.

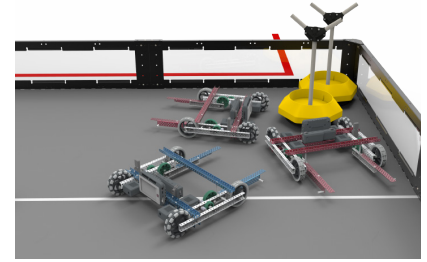


Figure 20: Both Red Alliance Robots are in Possession of both Mobile Goals.

Preload – The *Rings*, (3) per *Robot*, placed prior to the start of each *Match*. If used, these *Rings* must be placed such that they satisfy the conditions in <SG1>

Scored - A *Ring*, *Mobile Goal*, *Robot*, and *I* or *Platform* State. See the "Scoring" section for more details.

Scoring Object - A *Ring* or *Mobile Goal*.

Ring - One of seventy-two (72) small *Scoring Objects*. *Rings* have a maximal outer diameter of 4.125" (104.8mm) and a minimal inner diameter of 2" (50.8mm).

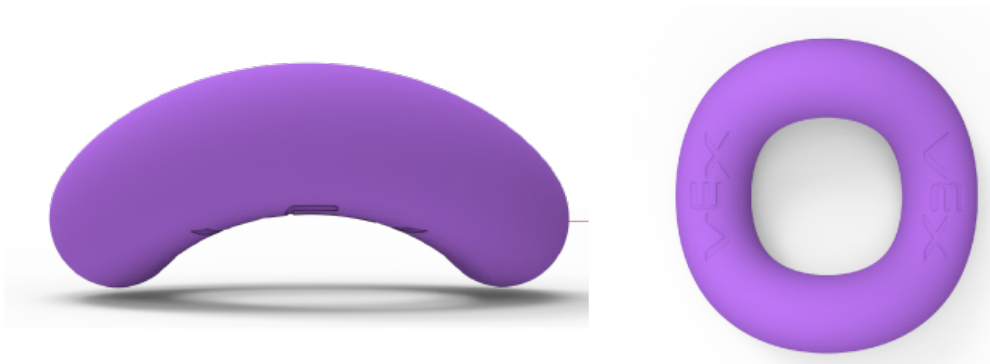


Figure 21: A Ring

Scoring

<i>Ring on / in a Scored Mobile Goal</i>	<i>Mobile Goal High Branch</i>	10 Points
	<i>Any other Mobile Goal Branch</i>	3 Points
	<i>Mobile Goal Base</i>	1 Point
<i>Neutral Mobile Goal</i>	<i>Either Alliance's Home Zone</i>	20 Points
	<i>Elevated on a Balanced Platform</i>	40 Points
<i>Alliance Mobile Goal</i>	<i>Correct Alliance's Home Zone</i>	20 Points
	<i>Elevated on correct Alliance's Balanced Platform</i>	40 Points
<i>Robot</i>	<i>Elevated on correct Alliance's Balanced Platform</i>	30 Points
<i>Alliance</i>	<i>Wins Autonomous Bonus</i>	20 Points

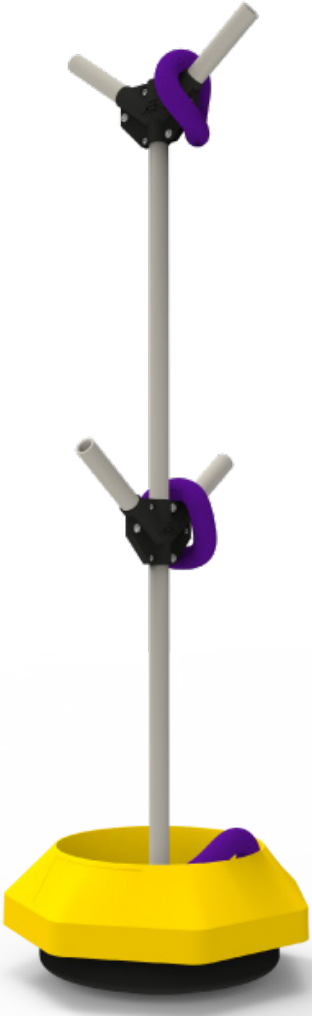
	<p>Each <i>Ring</i> which is Scored on a <i>Neutral Mobile Goal High Branch</i> is worth ten (10) points.</p>
	<p>Each <i>Ring</i> which is Scored on any other <i>Mobile Goal Branch</i> is worth three (3) points.</p>
	<p>Each <i>Ring</i> which is Scored in a <i>Mobile Goal Base</i> is worth one (1) point.</p>

Table 1: Point values for Scored Rings.

	<p>Each <i>Mobile Goal</i> that is <i>Scored</i> in an <i>Alliance Home Zone</i> is worth twenty (20) points for that <i>Alliance</i>.</p>
	<p>That <i>Alliance</i> also receives the points for any <i>Rings</i> which are <i>Scored</i> on or in that <i>Mobile Goal</i>.</p>
	<p>Each <i>Robot</i> which is <i>Elevated</i> on an <i>Alliance's Balanced Platform</i> is worth thirty (30) points for that <i>Alliance</i>.</p>
	<p>Each <i>Mobile Goal</i> which is <i>Elevated</i> on an <i>Alliance's Balanced Platform</i> is worth forty (40) points for that <i>Alliance</i>.</p>

Table 2: Point values for Scored Mobile Goals.

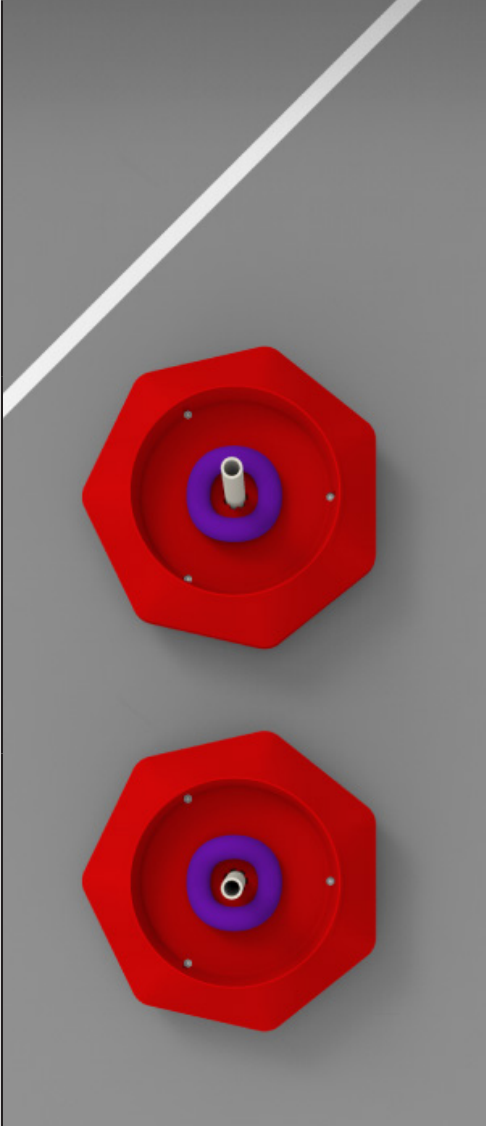
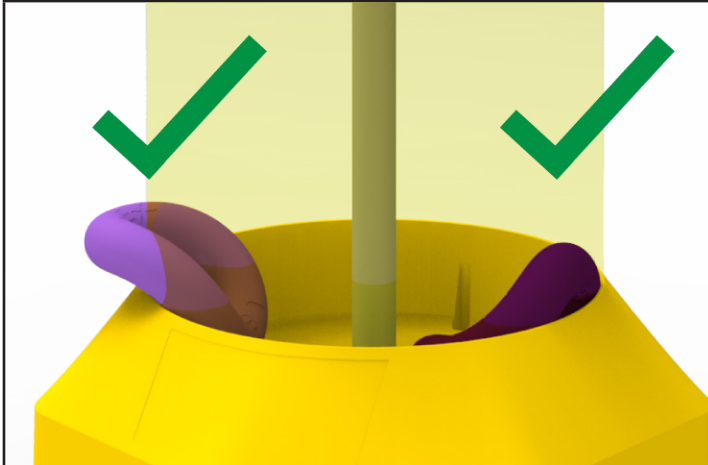
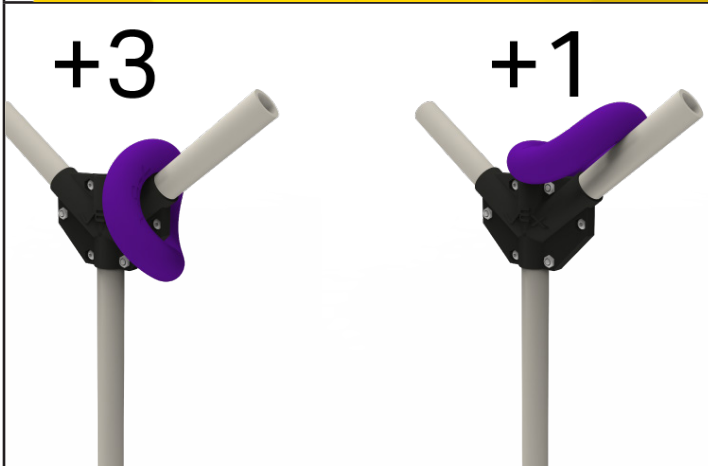
	<p>An <i>Autonomous Win Point</i> is awarded to any <i>Alliance</i> that has <i>Cleared</i> their <i>AWP Line</i>, and <i>Scored</i> at least one <i>Ring</i> on each <i>Alliance Mobile Goal</i>, at the end of the <i>Autonomous Period</i>.</p>
	<p>The winner of the <i>Autonomous Bonus</i> receives a twenty (20) point bonus. In the case of a tie, both <i>Alliances</i> receive a ten (10) point bonus.</p>
	<p>The <i>Autonomous Win Point</i> and the <i>Autonomous Bonus</i> are <i>Scored</i> independently of each other. For example, it is possible for both <i>Alliances</i> to receive the <i>Autonomous Win Point</i>, and it is possible for an <i>Alliance</i> to receive the <i>Autonomous Win Point</i> but not receive the <i>Autonomous Bonus</i>.</p>

Table 3: Autonomous Period scoring.

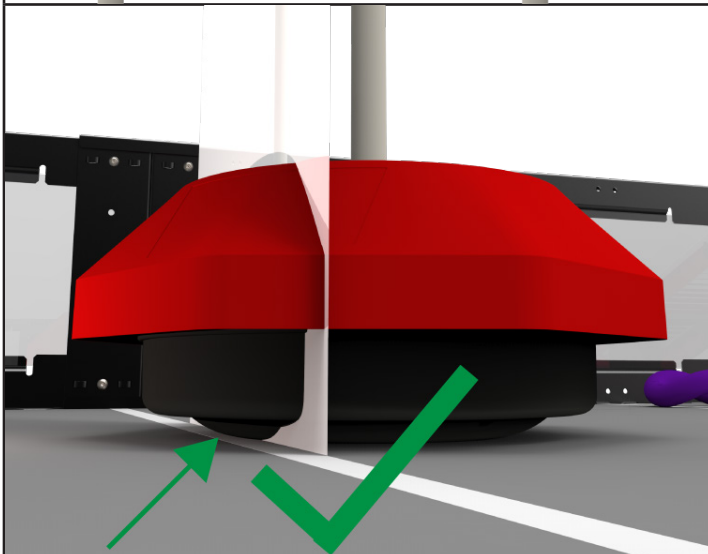
Scoring Notes



1. A *Ring* is considered *Scored* in a *Mobile Goal Base* if it is not contacting a *Robot* and is at least partially within the 3-dimensional vertical projection formed by the "bowl" of the *Mobile Goal Base*.



2. A *Ring* is considered *Scored* on a *Mobile Goal Branch* if it is not contacting a *Robot*, and any part of the *Branch* is within the volume defined by the outer edges of the *Ring* (i.e. part of the *Ring* is encircling or surrounding the *Branch*). A *Ring* supported by the *Mobile Goal Branch*, but not encircling it would still be considered *Scored* in the *Mobile Goal Base*, as it is within the 3D vertical projection.



3. A *Mobile Goal* is considered *Scored* in an *Alliance Home Zone* if, at the end of the *Match*, any part of the *Mobile Goal Base* is contacting the *Alliance Home Zone*.

	<p>4. Rings which are Scored on or in an Elevated Mobile Goal count for points for the Alliance who is Elevating the Mobile Goal.</p> <p>a. An Elevated Mobile Goal does not also receive points for being Scored in an Alliance Home Zone.</p> <p>The example shown here would be worth 51 points for the Red Alliance.</p> <ul style="list-style-type: none"> • Forty (40) points for the Elevated Mobile Goal • Two (2) points for the two (2) Scored Rings in the Mobile Goal Base • Nine (9) points for the three (3) Scored Rings on the Mobile Goal Branches
	<p>5. Alliance Mobile Goals only count for points when Scored in the same color Alliance Home Zone. Alliance Mobile Goals which end the Match anywhere other than their corresponding Alliance Home Zone or Platform are not worth any points for either Alliance.</p> <p>a. Rings which are Scored on / in an Alliance Mobile Goal are worth points for that color Alliance, regardless of where the Alliance Mobile Goal ends the Match.</p>

Table 4: Scoring notes and examples.

Safety Rules

<S1> Be safe out there. If at any time the *Robot* operation or *Team* actions are deemed unsafe or have damaged any *Field Elements* or *Scoring Objects*, the offending *Teams* may receive a *Disablement* and / or *Disqualification* at the discretion of the *Head Referee*. The *Robot* will require re-inspection before it may take the field again.

<S2> Stay inside the field. If a *Robot* is completely out-of-bounds (outside the playing field), it will be *Disabled* for the remainder of the *Match*.

Note: The intent of this rule is NOT to penalize *Robots* for having mechanisms that inadvertently cross the field perimeter during normal game play.

<S3> Wear safety glasses. All *Drive Team Members* must wear safety glasses or glasses with side shields while in the *Alliance Stations* during *Matches*. While in the pit area, it is highly recommended that all *Team* members wear safety glasses.

<S4> The Platform is for Robots strictly, not humans. Stepping on a *Platform* at any point, including in practice or pit areas, is explicitly prohibited. Violations could be considered a violation of the REC Foundation Code of Conduct due to both the safety risk, and the risk of unnecessary damage to *Field Elements*.

General Game Rules

<G1> Treat everyone with respect. All *Teams* are expected to conduct themselves in a respectful and professional manner while competing in VEX Robotics Competition events. If a *Team* or any of its members (*Students* or any *Adults* associated with the *Team*) are disrespectful or uncivil to event staff, volunteers, or fellow competitors, they may be *Disqualified* from a current or upcoming *Match*. Team conduct pertaining to <G1> may also impact a *Team's* eligibility for judged awards. Repeated or extreme violations of <G1> could result in a *Team* being *Disqualified* from an entire event, depending on the severity of the situation.

Robotics competitions often induce intense, high stress situations. These are good opportunities to model and / or gain experience in handling these situations in a positive and productive manner. It is important that we all exhibit maturity and class when dealing with any difficult situations that may present themselves in both the VEX Robotics Competition and our lives in general.

This rule exists alongside the REC Foundation Code of Conduct. Violation of the Code of Conduct can be considered a violation of <G1> and can result in *Disqualification* from a current *Match*, an upcoming *Match*, an entire event, or (in extreme cases) an entire competition season. The Code of Conduct can be found at <https://www.roboticseducation.org/competition-teams/vex-robotics-competition>

For the 2021-2022 season, some events may establish additional Health & Safety guidelines beyond the scope of this Game Manual. These guidelines will be communicated to all *Teams* in advance via Health & Safety notes associated with the event registration in RobotEvents. All *Teams* (including *Students* or any *Adults* associated with the *Team*) must abide by these guidelines as written. Violation of an event-specific Health & Safety rule may be considered a violation of <G1> and / or the REC Foundation Code of Conduct.

<G2> VRC is a student-centered program. *Adults* may assist *Students* in urgent situations, but *Adults* may never work on or program a *Robot* without *Students* on that *Team* being present and actively participating. *Students* must be prepared to demonstrate an active understanding of their *Robot's* construction and programming to judges or event staff.

Some amount of *Adult* mentorship, teaching, and / or guidance is an expected and encouraged facet of VEX competitions. No one is born an expert in robotics! However, obstacles should always be viewed as teaching opportunities, not tasks for an *Adult* to solve without *Students* present and actively participating.

When a mechanism falls off, it is...

...Okay for an *Adult* to help a *Student* investigate why it failed, so it can be improved.

...Not okay for an *Adult* to put the *Robot* back together.

When a *Team* encounters a complex programming concept, it is...

...Okay for an *Adult* to guide a *Student* through a flowchart to understand its logic.

...Not okay for an *Adult* to write a pre-made command for that *Student* to copy / paste.

During *Match* play, it is...

...Okay for an *Adult* to provide cheerful, positive encouragement as a spectator.

...Not okay for an *Adult* to explicitly shout step-by-step commands from the audience.

This rule operates in tandem with the REC Foundation Student Centered Policy, which is available on the REC Foundation website for *Teams* to reference throughout the season: <https://www.roboticseducation.org/documents/2019/08/student-centered-policy-rec-foundation.pdf/>

Violation of this rule could be considered a violation of <G1> and / or the REC Foundation Code of Conduct.

<G3> Use common sense. When reading and applying the various rules in this document, please remember that common sense always applies in the VEX Robotics Competition.

<G4> Robots begin the Match in the starting volume. At the beginning of a *Match*, each *Robot* must be smaller than a volume of 18" (457.2 mm) long by 18" (457.2 mm) wide by 18" (457.2 mm) tall. Using *Field Elements*, such as the field perimeter wall, to maintain starting size is only acceptable if the *Robot* would still satisfy the constraints of <R5> and pass inspection without the *Field Element*. *Robots* in violation of this limit will be removed from the field prior to the start of the *Match*, at the *Head Referee's* discretion.

<G5> Keep your Robots together. *Robots* may not intentionally detach parts during the *Match* or leave mechanisms on the field.

Minor violations of this rule that do not affect the *Match* will result in a warning. *Match Affecting* offenses will result in a *Disqualification*. *Teams* that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion. Multiple intentional infractions may result in *Disqualification* for the entire competition.

<G6> The Robot must represent the skill level of the Team. Each *Team* must include *Drive Team Members*, *Programmer(s)*, *Designer(s)*, and *Builder(s)*. No *Student* may fulfill any of these roles for more than one VEX Robotics Competition *Team* in a given competition season. *Students* may have more than one role on the *Team*, e.g. the *Designer* may also be the *Builder*, the *Programmer* and a *Drive Team Member*.

- a. *Team* members may move from one *Team* to another for non-strategic reasons outside of the *Team's* control.
 - i. Examples of permissible moves may include, but are not limited to, illness, changing schools, conflicts within a *Team*, or combining / splitting *Teams*.
 - ii. Examples of strategic moves in violation of this rule may include, but are not limited to, one *Programmer* "switching" *Teams* in order to write the same program for multiple *Robots*, or one *Student* writing the Engineering Notebook for multiple *Teams*.
 - iii. If a *Student* leaves a *Team* to join another *Team*, <G6> still applies to the *Students* remaining on the previous *Team*. For example, if a *Programmer* leaves a *Team*, then that *Team's Robot* must still represent the skill level of the *Team* without that *Programmer*. One way to accomplish this would be to ensure that the *Programmer* teaches or trains a "replacement" *Programmer* in their absence.
- b. When a *Team* qualifies for a Championship event (e.g., States, Nationals, Worlds, etc) the *Students* on the *Team* attending the Championship event are expected to be the same *Students* on the *Team* that was awarded the spot. *Students* can be added as support to the *Team*, but may not be added as *Drivers* or *Programmers* for the *Team*.
 - i. An exception is allowed if one (1) *Drive Team Member* and / or one (1) *Programmer* on the *Team* cannot attend the event. The *Team* can make a single substitution of a *Drive Team Member* or *Programmer* for the Championship event with another *Student*, even if that *Student* has competed on a different *Team*. This *Student* will now be on this new *Team* and may not substitute back to the original *Team*.

Violations of this rule will be evaluated on a case-by-case basis, in tandem with the REC Foundation Student Centered Policy as noted in <G2>, and the REC Foundation Code of Conduct as noted in <G1>

Event Partners should bear in mind <G3>, and use common sense when enforcing this rule. It is not the intent to punish a *Team* who may change *Team* members over the course of a season due to illness, changing schools, conflicts within a *Team*, etc. *Event Partners* and referees are not expected to keep a roster of any *Student* who has ever driven for a day. This rule is intended to block any instance of loaning or sharing *Team* members for the sole purpose of gaining a competitive advantage.

<G7> Only Drivers, and only in the Alliance Station. During a *Match*, each *Team* may have up to three (3) *Drive Team Members* in their *Alliance Station* and all *Drive Team Members* must remain in their *Alliance Station* for the duration of the *Match*. *Drive Team Members* are not allowed to use any sort of communication devices while in the *Alliance Station*. Devices with communication features turned off (e.g. a phone in airplane mode) are allowed.

Note: *Drive Team Members* are the only *Team* members that are allowed to be in the *Alliance Station* during a *Match*.

Note 2: During a *Match*, *Robots* may be operated only by the *Drive Team Members* and / or by software running on the *Robot's* control system, in accordance with <R27> and <G8>.

Violations or refusal to comply with this rule could be considered a violation of <G1> and is up to the discretion of the *Head Referee*.

<G8> Controllers must stay connected to the field towers. Prior to the beginning of each *Match*, *Drive Team Members* must plug their V5 Controller into the VEXnet Field Controller's Cat-5 cable via their controller's competition port. This cable must remain plugged in for the duration of the *Match*, and may not be removed until the "all-clear" has been given for *Drive Team Members* to retrieve their *Robots*.

Minor violations of these rules that do not affect the *Match* will result in a warning. *Match Affecting* offenses will result in a *Disqualification*. *Teams* that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

Note: The intent of this rule is to ensure that *Robots* abide by commands sent by the tournament software. Temporarily removing the cable to assist with mid-*Match* troubleshooting, with an *Event Partner* or other event technical staff present and assisting, would not be considered a violation.

<G9> Hands out of the field. *Drive Team Members* may only touch the *Team's* controls and *Robot* at specified times during a *Match* as per <G9a>. *Drive Team Members* are prohibited from making intentional contact with any *Scoring Objects*, *Field Elements*, or *Robots* during a *Match*, apart from the contact specified in <G9a>.

- a. During the *Driver Controlled Period*, *Drive Team Members* may only touch their own *Robot* if the *Robot* has not moved at all during the *Match*. Touching the *Robot* in this case is permitted only for the following reasons:
 - i. Turning the *Robot* on or off.
 - ii. Plugging in a battery.
 - iii. Plugging in a V5 Robot Radio.
 - iv. Touching the V5 Robot Brain screen, such as to start a program.
- b. *Drive Team Members* are not permitted to break the plane of the field perimeter at any time during the *Match*, apart from the actions described in <G9a>, and when introducing *Match Load Rings*, per <SG8>.
- c. Transitive contact, such as contact with the field perimeter that causes the field perimeter to contact *Field Elements* or *Scoring Objects* inside of the field, would be considered a violation of this rule.

Minor violations of these rules that do not affect the *Match* will result in a warning. *Match Affecting* offenses will result in a *Disqualification*. *Teams* that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

Note: Any concerns regarding *Field Element* or *Scoring Object* starting positions should be raised with the *Head Referee* prior to the *Match*; *Team* members may never adjust the *Scoring Objects* or *Field Elements* themselves.

<G10> Autonomous means "no humans". During the *Autonomous Period*, *Drive Team Members* are not permitted to interact with the *Robots* in any way, directly or indirectly. This could include, but is not limited to:

- Activating any controls on their V5 Controllers.
- Unplugging or otherwise manually interfering with the field connection in any way.
- Triggering sensors (including the Vision Sensor) in any way, even without touching them.

Minor violations of this rule will result in a Warning. Violations of this rule that affect the outcome of the *Autonomous Period* winner, or disrupt the autonomous routine of their opponent, will result in the *Autonomous Bonus* being awarded to the opposing *Alliance*. *Teams* that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

<G11> All rules still apply in the Autonomous Period. Any infractions committed during the *Autonomous Period* that are not *Match Affecting*, but do affect the outcome of the *Autonomous Bonus*, will result in the *Autonomous Bonus* being automatically awarded to the opposing *Alliance*.

- Teams* are responsible for the actions of their *Robots* at all times, including during the *Autonomous Period*. Any infractions committed during the *Autonomous Period* that are *Match Affecting* can result in a *Disqualification*, if warranted by the rule.
- If both *Alliances* cause infractions during the *Autonomous Period* that would have affected the outcome of the *Autonomous Bonus*, then no *Autonomous Bonus* will be awarded.

<G12> Don't destroy other Robots. But, be prepared to encounter defense. Strategies aimed solely at the destruction, damage, tipping over, or *Entanglement* of opposing *Robots* are not part of the ethos of the VEX Robotics Competition and are not allowed. If the tipping, *Entanglement*, or damage is ruled to be intentional or egregious, the offending *Team* may be *Disqualified* from that *Match*. Repeated offenses could result in *Disqualification* from the entirety of the competition.

- VRC Tipping Point is intended to be an offensive game. *Teams* that partake in solely defensive or destructive strategies will not have the protections implied by <G12> (see <G13>). However, defensive play which does not involve destructive or illegal strategies is still within the spirit of this rule.
- VRC Tipping Point is also intended to be an interactive game. Some incidental tipping, *Entanglement*, and damage may occur as a part of normal gameplay without violation. It will be up to the *Head Referee's* discretion whether the interaction was incidental or intentional.
- A *Team* is responsible for the actions of its *Robot* at all times, including the *Autonomous Period*. This applies both to *Teams* that are driving recklessly or potentially causing damage, and to *Teams* that drive around with a small wheel base. A *Team* should design its *Robot* such that it is not easily tipped over or damaged by minor contact.

Note: Incidental damage that occurs due to interaction with a *Robot* in *Possession* of a *Neutral Mobile Goal* will, in most cases, not be considered a violation of <G12>. Intentional damage, tipping, or dangerous mechanisms may still be considered a violation of <R3>, <S1>, or <G1> at the *Head Referee's* discretion.

VRC Tipping Point is intended to be an offensive, interactive game. *Robots* interacting with *Neutral Mobile Goals* should expect vigorous interactions from opponent *Robots*, especially if attempting to interact with multiple *Mobile Goals* at once.

<G13> Offensive Robots get the "benefit of the doubt". In the case where *Head Referees* are forced to make a judgment call regarding a destructive interaction between a defensive and offensive *Robot*, or an interaction which results in a questionable rules violation, the referees will err on the side of the offensive *Robot*.

The following “rules of thumb” apply when determining offensive / defensive roles in the context of rule <G13>:

- A *Robot* in Possession of its own *Alliance Mobile Goal* is generally playing an offensive role.
- A *Robot* in Possession of an opponent's *Alliance Mobile Goal* is generally playing a defensive role.
- A *Robot* in Possession of a *Neutral Mobile Goal* is generally neither playing a defensive or offensive role. In the case of a destructive interaction between two *Robots* competing for the same *Neutral Mobile Goal*, the Note from <G12> will apply.

<G14> You can't force an opponent into a penalty. Intentional strategies that cause an opponent to violate a rule are not permitted, and will not result in an infraction on the opposing *Alliance*.

Minor violations of this rule that do not affect the *Match* will result in a warning. *Match Affecting* offenses will result in a *Disqualification*. *Teams* that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

<G3> should be used when enforcing this rule. In most cases, if a *Team* causes their opponent to break a rule, the *Head Referee* will simply not enforce the penalty on that opponent. Only in extreme cases, where the act of forcing the opponent into breaking a rule changes the outcome of the *Match* for the benefit of the *Team*, should that *Team* who caused the opponent to break a rule receive a *Disqualification*.

<G15> No Trapping for more than 5 seconds. A *Robot* may not Trap an opposing *Robot* for more than five seconds (0:05) during the *Driver Controlled Period*. A Trap is officially over once the *Trapping Robot* has moved away and the *Robots* are separated by at least two (2) feet (approximately one [1] foam tile). After ending a Trap, a *Robot* may not Trap the same *Robot* again for a duration of five seconds (0:05). If a *Team* does Trap the same *Robot* again, the count will resume from where it left off when the *Trapping Robot* initially backed off.

Minor violations of this rule that do not affect the *Match* will result in a warning. *Match Affecting* offenses will result in a *Disqualification*. *Teams* that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

<G16> Don't clamp your Robot to the field. *Robots* may not intentionally grasp, grapple or attach to any *Field Elements*. Strategies with mechanisms that react against multiple sides of a *Field Element* in an effort to latch or clamp onto said *Field Element* are prohibited. The intent of this rule is to prevent *Teams* from both unintentionally damaging the field and / or from anchoring themselves to the field.

Minor violations of this rule that do not affect the *Match* will result in a warning. *Match Affecting* offenses will result in a *Disqualification*. *Teams* that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

<G17> Let go of Scoring Objects after the Match. *Robots* must be designed to permit easy removal of *Scoring Objects* from any mechanism without requiring the *Robot* to have power after a *Match*.

<G18> It's not over until it's over. Scores will be calculated for all *Matches* immediately after the *Match* ends, once all *Scoring Objects*, *Field Elements*, and *Robots* on the field come to rest.

- a. The determination of the *Autonomous Bonus* and *Autonomous Win Point(s)* will occur for all *Matches* immediately after the *Autonomous Period* ends, after all *Scoring Objects*, *Field Elements*, and *Robots* come to rest.

<G19> Be prepared for minor field variance. *Field Element* tolerances may vary from nominal by $\pm 1.0''$, unless otherwise specified. *Ring* weights may vary from nominal to ± 5 grams. *Mobile Goal* weights may vary from nominal to ± 65 grams respectively. *Teams* are encouraged to design their *Robots* accordingly. Please make sure to check Appendix A for more specific nominal dimensions and tolerances.

- a. *Scoring Object* placement at the beginning of *Matches* may vary from nominal to $\pm 1.5''$.
- b. The rotation of *Scoring Objects* may vary from nominal to $\pm 20^\circ$. *Rings* should always be oriented such that the "raised" portions are parallel to the *Platforms*. See Figure 22.

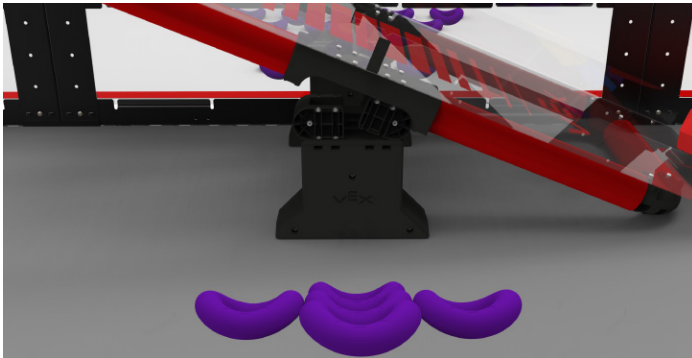


Figure 22: The proper starting configuration for Rings.

<G20> Match replays are allowed, but rare. *Match replays*, i.e. playing a *Match* over again from its start, are at the discretion of the *Event Partner* and *Head Referee*, and will only be issued in the most extreme circumstances. Some example situations that may warrant a *Match* replay are as follows:

- a. *Match Affecting* "field fault" issues.
 - i. *Game Elements* not starting in the correct positions
 - ii. Tape lines lifting
 - iii. *Field Elements* detaching or moving beyond normal tolerances (Not as a result of *Robot* interactions.
 - iv. The *Autonomous Period* or *Driver Controlled Period* ending early
 - v. Field control disconnecting or disabling *Robots*. Note that is sometimes confused with a *Robot* whose motors have overheated, or bent pins on a controller's competition port causing intermittent drop-outs. In general, any true field fault will impact both *Alliances* simultaneously, not one *Robot* at a time.
 - vi. A V5 Robot Brain lockup that is outside of the *Team's* control and results in a complete shutdown of the *Robot*. This condition can be identified by the V5 screen turning completely white, becoming unresponsive to any inputs from Controllers or sensors, and all connected devices blinking red at their Smart Port connections. The *Robot* must meet all of these criteria in order to qualify for a *Match* replay.
- b. *Match Affecting* game rule issues.
 - i. *Head Referee* disables a *Robot* for a misinterpretation of a rule violation.
 - ii. *Head Referee* starts the *Driver Controlled Period* of the *Match* without determining the outcome of the *Autonomous Period* winner.
 - iii. The field is reset before a score is determined.

<G21> This manual will have scheduled updates. This manual will have a series of “major” and “minor” updates. Each version is official and must be used in official VRC events until the release of the next version, when the previous version becomes void.

All updates may include clarifications that have been made in response to questions posted in the official Q&A system. Additionally, the three “major” updates, released in June, August, and April, may include gameplay or rule changes to resolve critical issues, if needed. *Teams* must be familiar with the information included in each major update, as there will be no “grace period” if a rule is changed that prohibits a previously-legal part, mechanism, or strategy.

Note: Multi-week league events that “cross over” a major update, and encounter a rule change that impacts their event, should contact their REC Foundation Regional Support Manager. Cases will be reviewed individually depending on the context of the event and the rule that has changed. This is the only possible “grace period” exception.

May 22, 2021	Version 0.1	Initial game release
June 7, 2021	(N/A)	Official Q&A system opens
June 15, 2021	Version 0.2	Minor typographical errors or formatting issues found in the initial release. There will be very few rule changes, if any.
June 29, 2021	Version 1.0	May include critical gameplay or rule changes inspired by input from the official Q&A system and the VEX community.
July 27, 2021	Version 1.1	“Q&A clarification update” only
August 31, 2021	Version 2.0	May include gameplay or rule changes inspired by early-season events.
December 7, 2021	Version 2.1	“Q&A clarification update” only
February 1, 2022	Version 2.2	“Q&A clarification update” only
April 5, 2022	Version 3.0	May include gameplay or rule changes pertaining specifically to the VEX Robotics World championship

<G22> The Q&A system is an extension of this Game Manual. All *Teams* must adhere to all VEX Robotics Competition rules as written in this Game Manual, and must abide by any stated intent of these rules. Officially registered *Teams* have the opportunity to ask for official rule interpretations in the VEX Robotics Competition Question & Answer system. All responses in this system must be treated as official rulings from the VEX Robotics Competition Game Design Committee (GDC), and they represent the correct and official interpretation of the VEX Robotics Competition Rules.

Previous Definitions, Rules and Rulings found in documents and Q&A’s from previous seasons do not apply to the current game. If clarification is needed, the question should be asked on the current Q&A.

The 2021-22 Q&A is the ONLY official source for rulings besides the Game Manual. If there are any conflicts between the Game Manual and other supplemental materials (e.g. Referee Training videos, VRC Hub app, etc), the most current version of the Game Manual takes precedent.

The VRC Q&A system can be found at <https://www.robotevents.com/VRC/2021-2022/QA>

Specific Game Rules

<SG1> **Starting a Match.** Prior to the start of each *Match*, the *Robot* must be placed such that it is:

- a. Contacting at least one (1) of the gray foam field tiles directly in front of their *Alliance Station*, i.e. the row of gray foam field tiles that contains their *Alliance's Platform*.
- b. Not contacting any other gray foam field tiles, i.e. those in contact with the white tape lines that define the *Alliance Home Zone*.
- c. Not contacting any *Scoring Objects* other than the *Preloads*.
- d. Not contacting another *Robot*.
- e. Not contacting the *Platform*.
- f. Contacting no more than three (3) *Preloads*.
 - i. No *Preloads* may be contacting more than one (1) *Robot*.
 - ii. All *Preloads* must be fully within the field perimeter.
 - iii. All *Preloads* must not be in any positions that would be considered *Scored* if the *Robot* were not present. See Figure 23 for examples of legal *Preloads*.
 - iv. If a *Team* does not wish to use their three (3) *Preloads* at the start of the *Match*, they may be used as *Match Load Rings* at any point during the *Match*, in accordance with <SG8>.

Note: If a *Robot* is not present for their *Match*, then their *Preloads* will be randomly placed in the corner foam tile that is on the opposite side of the *Platform* from the placed *Robot*. See Figure 23 for an example. In this scenario, point "iv" above would not apply, i.e. the *Team* who is present for the *Match* may not elect to use these *Preloads* as *Match Load Rings*.

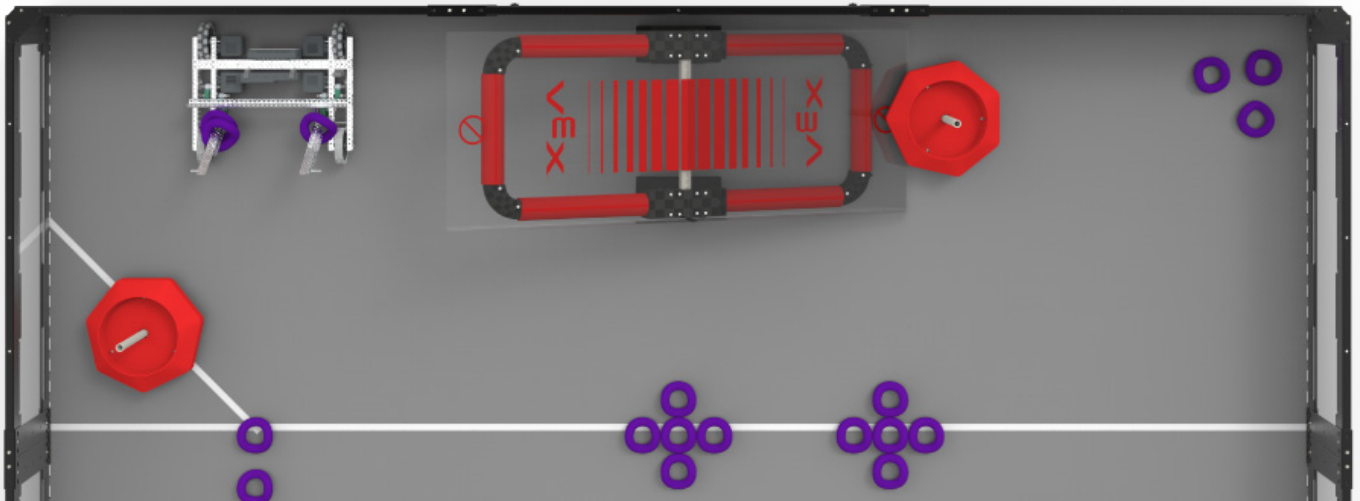


Figure 23: The proper starting configuration for *Preloads* in the event of a no-show.

<SG2> **Robot expansion is limited once the Match begins.** Per <G3>, at the beginning of a *Match*, each *Robot* must be smaller than a volume of 18" (457.2 mm) long by 18" (457.2 mm) wide by 18" (457.2 mm) tall. Once the *Match* begins, *Robots* may expand, but no horizontal dimension can exceed 36" (914.4 mm) at any point during the *Match*. See Figure 24.

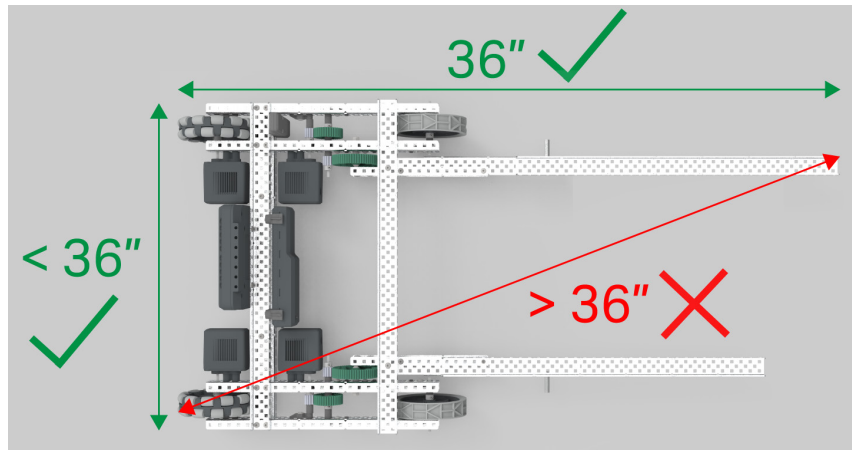


Figure 24: Examples of Legal and Illegal "point-to-point" expansions.

Note: This is intended to be a linear, horizontal, "point-to-point" limit, measured across an expanded *Robot*. It is not a 3D volume, and it does not "rotate" with the *Robot*.

Note 2: If a *Head Referee* is uncertain whether a *Robot* has momentarily expanded beyond this limit, they may ask the *Team* after the *Match* to replicate the *Robot's* state and check for compliance using a tape measure, VRC Expanded Sizing Tool, or other linear measuring device.

Minor violations of this rule that do not affect or interfere with the *Match* will result in a warning. *Match Affecting* offenses will result in a *Disqualification*. *Teams* that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

<SG3> Platforms are "safe" during the endgame. During the last thirty (30) seconds, *Robots* may not contact the opposing *Alliance's Platform*.

- For the purposes of this rule, contact is considered "transitive" through other *Robots* and *Scoring Objects*. For example, contacting an opposing *Robot* who is contacting their own *Platform* would be considered a violation of this rule.
- For the purposes of this rule, <G13> supersedes rule <G14>. Any *Robot* which is contacting its own *Platform* during the last thirty (30) seconds, provided that no other rules are being violated, will automatically receive the "benefit of the doubt". Therefore, any contact with this *Robot* will be considered a violation, regardless of intent.
- Per <SG10>, using a *Scoring Object* to cause interference with the opposing *Alliance's Platform* during the last thirty (30) seconds would be considered a violation of this rule.

A *Robot* which interferes with gameplay as a result of violating this rule, such as preventing a *Platform* from becoming *Balanced*, will result in a *Disqualification*, whether the interference was *Match Affecting* or not.

<SG4> Stay out of the opponent's Home Zone during Autonomous. During the *Autonomous Period*, *Robots* may not contact the foam tiles, *Mobile Goals*, *Robots*, or *Platform* which is / are in the opposing *Alliance Home Zone*.

Violations of this rule will result in the *Autonomous Bonus* being awarded to the opposing *Alliance*. The opposing *Alliance* will also receive an *Autonomous Win Point*, regardless of whether they completed the *Autonomous Win Point* tasks. Intentional, strategic, or egregious violations, such as intentional contact with an opposing *Robot* completely within their *Alliance Home Zone*, will result in a *Disqualification*.

<SG5> Enter the Neutral Zone during Autonomous at your own risk. Any *Robot* who engages with the *Neutral Zone* during the *Autonomous Period* should be aware that opponent *Robots* may also choose to do the same. Per <G11> and <G12>, *Teams* are responsible for the actions of their *Robots* at all times.

- a. For the purposes of this rule, "engages with" means any combination of:
 - i. Contacting foam tiles within the *Neutral Zone*
 - ii. Contacting *Neutral Mobile Goals*
 - iii. Contacting *Rings* that begin the *Match* on the double white tape line in the center of the *Neutral Zone*
- b. If opposing *Robots* contact one another while both engaging with the *Neutral Zone*, and a possible <G12> violation results (i.e. damage, *Entanglement*, or tipping over), then a judgment call will be made by the *Head Referee* within the context of <G12> just as it would if the interaction had occurred during the *Driver Controlled Period*.
- c. If opposing *Robots* contact one another while both engaging with the *Neutral Zone*, and an incidental violation of <SG4> occurs, no penalty will be assessed on either *Alliance*.
- d. <G15> does not apply during the *Autonomous Period*.
- e. Intentional, strategic, repeated, or egregious offenses of points "b" or "c" may still be deemed a violation of <SG4>, <G12>, <G13>, <G14>, <G1>, and / or <S1> at the *Head Referee's* discretion.

The *Neutral Zone* is intended to be a zone that *Robots* from both *Alliances* can utilize during the *Autonomous Period*. This will inevitably result in *Robot-on-Robot* interactions, both incidental and intentional. The overarching intent of <SG5> is for the vast majority of these interactions to result in **no rule violations and / or penalties** for either *Alliance*, just as no rules violations occur in 99% of *Driver Controlled* interactions.

Teams are responsible for the actions of their *Robots* at all times. A *Robot* with a small wheel base, who tips over every time they enter the *Neutral Zone* and contacts an opponent, should not attempt to claim a <G12> violation on their opponent.

With that being said, this is a *Neutral Zone*, not a "free-for-all" zone. The intent of point "e" is to provide *Head Referees* with the leeway to still make a judgment call, if needed, when a *Team* has chosen to exploit this rule beyond its intent. Reckless or unsafe strategies aimed solely at the destruction, damage, tipping over, *Entanglement*, *Trapping*, or forcing of an opponent into a penalty are still prohibited in the VEX Robotics Competition.

<SG6> Rings on the Alliance Mobile Goal are "safe". Strategies intended to remove *Rings* which are Scored on or in an opposing *Alliance Mobile Goal* are prohibited. Examples of "intentional strategies" could include, but are not limited to:

- *Robot* mechanisms or actions solely intended to "lift off" *Rings* from *Mobile Goal Branches*.
- *Robot* mechanisms or actions solely intended to "scoop out" *Rings* from *Mobile Goal Bases*.
- "Knocking over" or otherwise forcefully manipulating an *Alliance Mobile Goal* such that *Rings* become removed.

Minor violations of this rule that do not affect the *Match* will result in a warning. *Match Affecting* offenses will result in a *Disqualification*. *Teams* that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

<SG7> Hoarding of Mobile Goals is limited. Robots may not *Hoard* more than one (1) *Mobile Goal* at once.

Minor violations of this rule that do not affect the *Match* will result in a warning. *Match Affecting* offenses will result in a *Disqualification*. *Teams* that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

Note: *Hoarding* is not a time-based activity (i.e. a 5 second count, like *Trapping*). As soon as multiple *Mobile Goals* are placed in an *Alliance Home Zone* corner of the field, they are at risk of causing a *Hoarding* violation.

The intent of this rule is to prohibit one *Alliance* from actively stifling gameplay by "locking down" *Mobile Goals* in corners of the field. Its intent is not to make the corners of the field an area of edge-case accidental violations, just as it is not to prohibit *Robots* from *Possessing* multiple *Mobile Goals* while playing the game offensively. In general, unless a *Robot* or *Alliance* is intentionally and blatantly utilizing a *Hoarding* strategy, violations of this rule should be rare.

<SG8> Each Alliance may introduce their Match Load Rings at any point during the Match. This action must follow the following criteria:

- a. *Match Load Rings* must be gently placed onto one of the gray foam tiles directly in front of the *Alliance Station*, i.e. the tiles coincident with the field perimeter wall. See Figure 24.
- b. *Match Load Rings* may not be placed into a *Scored* position on a *Mobile Goal*.
- c. *Match Load Rings* may not be placed such that they are contacting a *Robot* (from either *Alliance*) while still in contact with a *Drive Team Member*.
- d. *Match Load Rings* must be gently placed directly onto the foam tile. "Throwing", "rolling", or otherwise imparting energy upon the *Rings* such that they leave the intended tile, or violate one of the other points in this rule, is not permitted.
- e. *Match Load Rings* may only be introduced during the *Autonomous Period* or the *Driver Controlled Period*, i.e. they may not be introduced during the pause between the two periods, or prior to the *Match*.
- f. It is expected that *Drive Team Members* may momentarily break the plane of the field perimeter while legally introducing *Match Load Rings*. This action should be kept as brief as possible, and *Teams* from both *Alliances* should be very mindful of <S1> when *Match Load Rings* are being entered into the field.
 - i. Any human contact with *Robots* from either *Alliance* during this interaction may be considered a violation of <G9> and / or <S1> at the *Head Referee's* discretion.

Note: There is no requirement for *Alliances* to introduce their *Match Load Rings*, if they do not wish to do so.

Minor violations of this rule that do not affect the *Match* will result in a warning. *Match Affecting* offenses, or violations of <S1>, will result in a *Disqualification* as applicable. *Teams* that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

The intent of this rule is to keep *Drive Team Member* hands away from any *Robots* during this interaction. There is no explicit requirement for an amount of time before a *Robot* may contact the *Ring*, or minimum distance away from other *Robots*; *Teams* are advised to bear <G3> in mind when introducing

Match Load Rings, and avoid scenarios that may require a *Head Referee* judgment call as to whether a portion of this rule, <G9>, or <S1> has been violated.

For example - if an opposing *Robot* is on a particular tile, try introducing *Match Load Rings* on a different tile.

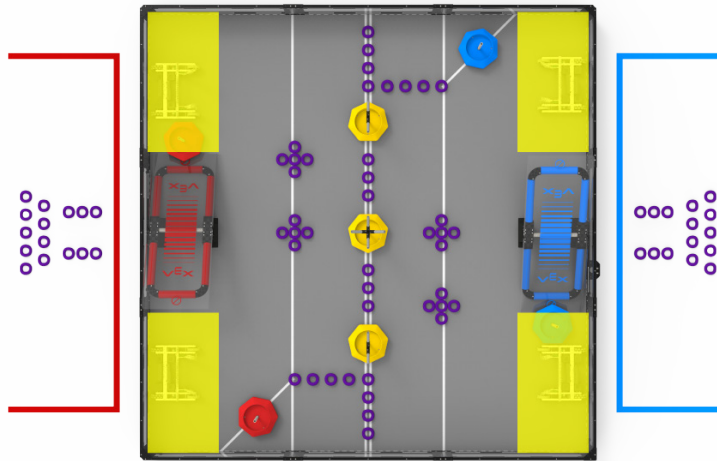


Figure 25: The tiles in which *Match Load Rings* can be introduced.

<SG9> Keep Scoring Objects in the field. Teams may not intentionally remove *Scoring Objects* from the field. While *Scoring Objects* may accidentally leave the field, doing so intentionally or repeatedly would be a violation of this rule. *Scoring Objects* that leave the field during *Match* play, intentionally or unintentionally, will be returned to the field at the location nearest the point at which they exited. Referees will return the *Scoring Object* to the field when it is deemed safe to do so, at the leisure of the referee.

Minor violations of this rule that do not affect the *Match* will result in a warning. *Match Affecting* offenses will result in a *Disqualification*. Teams that receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

If a *Mobile Goal* leaves the field, any *Rings* that were *Scored* in the *Mobile Goal Base*, or on *Mobile Goal Branches*, will be returned to the field in a non-*Scored* state, on the field tile closest to where they exited.

Note: During the last 30 seconds of the *Match*, any *Scoring Object* that leaves the field will not be returned.

<SG10> Use Scoring Objects to play the game. *Scoring Objects* may not be used to accomplish actions that would be otherwise illegal if they were attempted by *Robot* mechanisms (e.g., Interfering with an opponent's *Autonomous* routine per <SG4>.)

The intent of this rule is to prohibit teams from using game objects as "gloves" to loophole any rule that states "a *Robot* may not [do some action]". This rule is not intended to be taken in its most extreme literal interpretation, where any interaction between a *Scoring Object* and a *Robot* needs to be scrutinized with the same intensity as if it were a *Robot*.

Section 3

The Robot

Overview

This section provides rules and requirements for the design and construction of your *Robot*. A VEX Robotics Competition *Robot* is a remotely operated and / or autonomous vehicle designed and built by a registered VEX Robotics Competition *Team* to perform specific tasks when competing in VEX Robotics Competition Tipping Point. Prior to competing at each event, all *Robots* will have to pass an inspection.

There are specific rules and limitations that apply to the design and construction of your *Robot*. Please ensure that you are familiar with these *Robot* rules before beginning your *Robot* design.

Inspection Rules

<R1> One Robot per Team. Only one (1) *Robot* will be allowed to compete per *Team* in the VEX Robotics Competition. Though it is expected that *Teams* will make changes to their *Robot* at the competition, a *Team* is limited to only one (1) *Robot*. As such, a VEX *Robot*, for the purposes of the VEX Robotics Competition, has the following subsystems:

- Subsystem 1: Mobile robotic base including wheels, tracks, legs, or any other mechanism that allows the *Robot* to navigate the majority of the flat playing field surface. For a stationary *Robot*, the robotic base without wheels would be considered Subsystem 1.
- Subsystem 2: Power and control system that includes a legal VEX battery, a legal VEX control system, and associated motors for the mobile robotic base.
- Subsystem 3: Additional mechanisms (and associated motors) that allow manipulation of *Scoring Objects* or navigation of field obstacles.

Given the above definitions, a minimum *Robot* for use in any VEX Robotics Competition event (including Skills Challenges) must consist of 1 and 2 above. Thus, if you are swapping out an entire subsystem of either item 1 or 2, you have now created a second *Robot* and are no longer legal.

- a. *Teams* may not compete with one *Robot* while a second is being modified or assembled.
- b. *Teams* may not have an assembled second *Robot* to be used to repair or swap parts to the first *Robot*.
- c. *Teams* may not switch back and forth between multiple *Robots* during a competition. This includes using different *Robots* for Skills Challenge, Qualification and / or Elimination *Matches*.
- d. Multiple *Teams* may not use the same *Robot*. Once a *Robot* has competed under a given *Team* number at an event, it is "their" *Robot* - no other *Teams* may compete with it for the duration of the competition season.

The intent of <R1a>, <R1b>, and <R1c> are to ensure an unambiguous level playing field for all *Teams*. *Teams* are welcome (and encouraged) to improve or modify their *Robots* between events, or to collaborate with other *Teams* to develop the best possible game solution.

However, a *Team* who brings and / or competes with two separate *Robots* at the same tournament has diminished the efforts of a *Team* who spent extra design time making sure that their one *Robot* can

accomplish all of the game's tasks. A multi-*Team* organization that shares a single *Robot* has diminished the efforts of a multi-*Team* organization who puts in the time, effort, and resources to undergo separate individual design processes and develop their own *Robots*.

To help determine if a *Robot* is a "separate *Robot*" or not, use the Subsystem definitions found in <R1>. Above that, use common sense as referenced in <G3>. If you can place two *Robots* on a table next to each other, and they look like two separate legal / complete *Robots* (i.e. each have the 3 Subsystems defined by <R1>), then they are two *Robots*. Trying to decide if changing a screw, a wheel, or a micro-controller constitutes a separate *Robot* is missing the intent and spirit of this rule.

<R2> Robots must be a representation of the skill level of the team. The *Robot* must be designed, built and programmed by members of the *Team*. *Adults* are expected to mentor and teach design, building and programming skills to the *Students* on the *Team*, but may not design, build or program that *Team's Robot*.

In VRC, we expect *Adults* to teach different linkages, drive-trains, and manipulator applications to the *Students*, then allow the *Students* to determine which designs to implement and build on their *Robot*. *Adults* are encouraged to teach the *Students* how to code various functions involving applicable sensors, then have the *Students* program the *Robot* from what they have learned.

<R3> Robots must pass inspection. Every *Robot* will be required to pass a full inspection before being cleared to compete. This inspection will ensure that all *Robot* rules and regulations are met. Initial inspections will take place during team registration / practice time.

- a. Significant changes to a *Robot*, such as a partial or full swap of Subsystem 3, must be re-inspected before the *Robot* may compete again.
- b. All possible functional *Robot* configurations must be inspected before being used in competition.
- c. *Teams* may be requested to submit to random spot-inspections by event personnel. Refusal to submit will result in *Disqualification*.
- d. *Robots* which have not passed inspection (i.e. who are in violation of one or more *Robot* rules) will not be permitted to play in any *Matches* until they have done so. <T3> will apply to any *Matches* that occur until the *Robot* has passed inspection.
- e. If a *Robot* has passed inspection, but is later found to be in violation of a *Robot* rule during a *Match*, then they will be *Disqualified* from that *Match* and <R3d> will apply until the violation is remedied and the *Team* is re-inspected.

The intent of this rule is to ensure that *Teams* play *Matches* with legal *Robots*. If a *Robot* is determined to not be legal before the *Match* starts, the *Robot* will be removed from the field and a *Drive Team Member* must remain so that the *Team* does not get assessed a "no-show". If the *Match* is played with an illegal *Robot* on the Field, that *Team* will receive a *Disqualification* for the *Match* (see <T11>).

<R4> Robots must be safe. The following types of mechanisms and components are NOT allowed:

- a. Those that could potentially damage *Field Elements* or *Scoring Objects*.
- b. Those that could potentially damage other competing *Robots*.
- c. Those that pose an unnecessary risk of *Entanglement*.

<R5> Robots must fit in a sizing box. At the beginning of any *Match*, *Robots* must be smaller than 18" (457.2 mm) long by 18" (457.2 mm) wide by 18" (457.2 mm) tall.

- a. Per <SG2>, *Robots* may expand beyond their starting size constraints after the start of a *Match*.
- b. Any restraints used to maintain starting size (i.e. zip ties, rubber bands, etc.) MUST remain attached to the *Robot* for the duration of the *Match*.

It is at the *Event Partner's* discretion how size will be inspected at a given event. Possible methods may include the *Robot* being placed in a "sizing box" with interior dimensions matching the above size constraints, or by using the VEX Robotics Competition Robot Sizing Tool while the *Robot* is placed on a flat surface. A *Robot* may not touch the box walls or ceiling or the Robot Sizing Tool sides when being measured.

There are two VEX Robotics Competition Robot Sizing Tools that may be used: <https://www.vexrobotics.com/276-2086.html> and <https://www.vexrobotics.com/276-5942.html>

<R6> Robots are built from the VEX V5 system. *Robots* may be built ONLY using official VEX V5 components, unless otherwise specifically noted within these rules. Teams are responsible for providing documentation proving a part's legality in the event of a question. Examples of documentation include receipts, part numbers, official VEX websites, or other printed documentation.

- a. Products from the Cortex, VEXpro, VEX IQ, VEX GO, VEX 123 or VEX Robotics by HEXBUG product line cannot be used for *Robot* construction, unless specifically allowed by a clause of <R7> or cross-listed as part of the VEX V5 Product lines. For example, the Shaft Base Pack (228-3506) is a VEX IQ component that can be found on the VEX "Drive Shafts" page, and is thus legal: <https://www.vexrobotics.com/drive-shafts.html>
- b. VEX IQ pins used solely for the purpose of attaching VEX Team Identification Number Plates are permitted.
- c. Components obtained from the V5 beta program, including V5 beta firmware, are not legal for competition use.
 - i. All V5 beta hardware can be identified by its lighter gray pre-production color. Robot Brains, Robot Batteries, Controllers, and Vision Sensors from the V5 beta have a "BETA TEST" stamp on them. Smart Motors and Radios do not have this stamp, but can still be identified by color.
- d. Components from the VEXplorer kit that are not found in modern VEX V5 kits are not permitted. These include (but may not be limited to) electronics, wheels, non-standard gears, or plastic connectors.

Using VEX apparel, competition support materials, packaging, or other non-*Robot* products on a VEX Robotics Competition *Robot* goes against the spirit of this rule and is not permitted.

<R7> VEX products come from VEX Robotics or VEX Robotics Resellers. Official VEX products are ONLY available from VEX Robotics & official VEX Resellers. To determine whether a product is "official" or not, consult www.vexrobotics.com. A complete list of authorized VEX Resellers can be found at <https://www.vexrobotics.com/contact-us>.

<R8> Certain non-VEX components are allowed. Robots are allowed the following additional “non-VEX” components:

- Any material strictly used as a color filter or a color marker for a legal sensor, such as the VEX Light Sensor or the VEX V5 Vision Sensor.
- Any non-aerosol based grease or lubricating compound, when used in extreme moderation on surfaces and locations that do NOT contact the playing field walls, foam field surface, *Scoring Objects*, or other *Robots*.
- Anti-static compound, when used in extreme moderation (i.e. such that it does not leave residue on playing field walls, the foam field surface, *Scoring Objects*, or other *Robots*).
- Hot glue when used to secure cable connections.
- An unlimited amount of rope / string, no thicker than 1/4” (6.35mm).
- Commercially available items used solely for bundling or wrapping of 2-wire, 3-wire, 4-wire, or V5 Smart Cables, and pneumatic tubing are allowed. These items must solely be used for the purposes of cable protection, organization, or management. This includes but is not limited to electrical tape, cable carrier, cable track, etc. It is up to inspectors to determine whether a component is serving a function beyond protecting and managing cables.
- Non-functional 3D printed license plates, per <R13> and <R26>, are permitted. This includes any supporting structures whose sole purpose is to hold, mount, or display an official license plate.

<R9> Give the radio some space. The V5 Radio must be mounted such that no metal surrounds the radio symbol on the V5 Radio.

It is fine to loosely encapsulate the V5 Radio in *Robot* structure. The intent of this rule is to minimize radio connection issues by minimizing obstructions between VEXnet devices. If a radio is buried in a *Robot*, VEXnet is not able to connect as well and may result in *Robot* communication issues.



Figure 26: A V5 Robot Radio

<R10> A limited amount of custom plastic is allowed. Robots may use non-shattering plastic from the following list; polycarbonate (Lexan), acetal monopolymer (Delrin), acetal copolymer (Acetron GP), POM (acetal), ABS, PEEK, PET, HDPE, LDPE, Nylon (all grades), Polypropylene, FEP; as cut from a single 12” x 24” sheet up to 0.070” thick.

- Shattering plastic, such as PMMA (also called Plexiglass, Acrylic, or Perspex), is prohibited.
- Plastic may be mechanically altered by cutting, drilling, bending etc. It cannot be chemically treated, melted, or cast. Heating polycarbonate to aid in bending is acceptable.

<R11> A limited amount of tape is allowed. *Robots* may use a small amount of tape when used for the following purposes:

- a. For the sole purpose of securing any connection between the ends of two (2) VEX cables.
- b. For labeling wires and motors.
- c. For covering the back of License Plates (i.e. the “wrong color”).
- d. For the purposes of preventing leaks on the threaded portions of pneumatic fittings. This is the only acceptable use of Teflon tape.
- e. In any other application that would be considered a “non-functional decoration” per <R13>.

<R12> Certain non-VEX screws, nuts, and washers are allowed. *Robots* may use any commercially available #4, #6, #8, M3, M3.5, or M4 screw up to 2.5” (63.5mm) long (nominal), and any commercially available nut, washer, and / or non-threaded spacer (up to 2.5” (63.5mm) long) to fit these screws.

The intent of the rule is to allow *Teams* to purchase their own commodity hardware without introducing additional functionality not found in standard VEX equipment. It is up to inspectors to determine whether the non-VEX hardware has introduced additional functionality or not.

<R13> Decorations are allowed. *Teams* may add non-functional decorations, provided that they do not affect *Robot* performance in any significant way or affect the outcome of the *Match*. These decorations must be in the spirit of the competition. Inspectors will have final say in what is considered “non-functional”. Unless otherwise specified below, non-functional decorations are governed by all standard *Robot* rules.

In order to be “non-functional,” any guards, decals, or other decorations must be backed by legal materials that provide the same functionality. For example, if your *Robot* has a giant decal that prevents *Scoring Objects* from falling out of the *Robot*, the decal must be backed by VEX material that would also prevent the *Scoring Objects* from falling out.

- a. Anodizing and painting of parts is considered a legal nonfunctional decoration.
- b. Small cameras are permitted as non-functional decorations, provided that any transmitting functions or wireless communications are disabled. Unusually large cameras being used as ballast are not permitted.
- c. VEX electronics may not be used as non-functional decorations.
- d. Decorations that visually mimic field elements, or could otherwise interfere with an opponent’s Vision Sensor, are considered functional and are not permitted. This includes lights, such as the VEX Flashlight. The Inspector and *Head Referee* will make the final decision on whether a given decoration or mechanism violates this rule.
- e. Internal power sources (e.g. for a small blinking light) are permitted, provided that no other rules are violated and this source only provides power to the non-functional decoration (e.g. does not directly or indirectly influence any functional portions of the *Robot*).
- f. Decorations which provide feedback to the *Robot* (e.g. by influencing legal sensors) would be considered “functional”, and are not permitted.
- g. Decorations which provide visual feedback to *Drive Team Members* (e.g. decorative lighting) are permitted, provided that they do not violate any other rules and serve no other function (e.g. structural support).

<R14> No Wi-Fi. The Vision Sensor must have its wireless transmitting functionality disabled.

<R15> New VEX parts are legal. Additional VEX components released during the competition season on www.vexrobotics.com are considered legal for use.

Some “new” components may have certain restrictions placed on them upon their release. These restrictions will be documented in the official Q&A forums, in a Game Manual Update, or on their respective product web pages.

<R16> Robots have one microcontroller. Robots must ONLY use one (1) VEX V5 Robot Brain (276-4810).

- a. Any other microcontrollers or processing devices are not allowed, even as non-functional decorations. This includes microcontrollers that are part of other VEX product lines, such as Cortex, VEXpro, VEX RCR, VEX IQ, VEX GO, or VEX Robotics by HEXBUG; this also includes devices that are unrelated to VEX, such as Raspberry Pi or Arduino devices.

<R17> Robots use VEXnet. Robots must ONLY utilize the VEXnet system for all *Robot* communication.

- a. Electronics from the Cortex, VEXpro, VEX RCR, VEXplorer, VEX IQ, VEX GO, or VEX Robotics by HEXBUG product line are prohibited.
- b. A V5 Controller(s) may only be used in conjunction with a V5 Robot Brain.
- c. *Teams* are permitted to use the Bluetooth® capabilities of the V5 Robot Brain and / or V5 Controller in team pits or outside of *Matches*. However, VEXnet must be used for wireless communication during *Matches*.

<R18> Robots use one control system. Robots may use a V5 Robot Brain, up to eight (8) V5 Smart Motors, and a legal VRC pneumatic system.

- a. V5 Smart Motors, connected to Smart Ports, are the only motors that may be used with a V5 Robot Brain. The 3-wire ports may not be used to control motors of any kind.
- b. The 5.5W V5 Smart Motor, found in the V5 Workcell system, is not legal for use.

<R19> Electrical power comes from VEX batteries only. The only allowable source(s) of electrical power are as follows:

- a. Robots may use (1) V5 Robot Battery (276-4811).
 - i. There are no legal power expanders for the V5 Robot Battery.
 - ii. V5 Robot Batteries may only be charged by the V5 Robot Battery Charger (276-4812 or 276-4841).
 - iii. V5 Wireless Controllers may only be powered by their internal rechargeable battery.
 1. *Teams* are permitted to have an external power source (such as a rechargeable battery pack) plugged into their V5 Controller during a *Match*, provided that this power source is connected safely and does not violate any other rules, such as <G8> or <R22>.
 2. Some events may choose to provide field power for V5 Wireless Controllers. If this is provided for all *Teams* at the event, then this is a legal power source for the wireless remotes.

Component	V5 Robot Brain		
	Legal Parts	Legal Chargers	Maximum Quantity
Robot Battery	276-4811	276-4841	1
Power Expander	None	None	0
Controller Battery	276-4820 (internal)	Any safe Micro-USB cable	1 (per transmitter)

Table 5: The legal sources of electrical power for Robots.

<R20> One or two controllers per Robot. No more than two (2) VEX V5 Controllers may control a single Robot during the tournament.

- a. No modification of these transmitters is allowed under any circumstances.
- b. No other methods of controlling the Robot (light, sound, etc.) are permissible.
 - i. Using sensor feedback to augment driver control (such as motor encoders or the Vision Sensor) is acceptable.

Note: This rule does not prohibit objects that are attached to the controller to assist the *Drive Team Member* in holding the controller or manipulating buttons / joysticks on the V5 Controller.

<R21> No modifications to electronic components are allowed. Motors (including the internal PTC or Smart Motor firmware), microcontrollers (including V5 Robot Brain firmware), extension cords, sensors, controllers, battery packs, reservoirs, solenoids, pneumatic cylinders, and any other electrical component or pneumatics component of the VEX platform may NOT be altered from their original state in ANY way.

- a. External wires on VEX electrical components may be repaired by soldering, using twist / crimp connectors, electrical tape or shrink tubing such that the original functionality / length is not modified in any way. Wire used in repairs must be identical to VEX wire. Teams may make these repairs at their own risk; incorrect wiring may have undesired results.
- b. Teams must use the latest official VEXos firmware updates, found at www.vexrobotics.com. Custom firmware modifications are not permitted.
- c. Teams may make the following modifications to the V5 Smart Motor's user-serviceable features. No other modifications are permitted.
 - i. Changing or replacing the gear cartridge with other official replacement cartridges.
 - ii. Replacing the V5 Smart Motor Cap (276-6780).
 - iii. Replacing the threaded mounting inserts (276-6781).

<R22> Most modifications and repairs to non-electrical components are allowed. Physical modifications such as bending or cutting are permitted and may be done to legal VEX Robotics Competition metal structure or plastic components.

- a. Physical modifications to electrical components such as a legal microcontroller or radio is prohibited unless otherwise explicitly permitted, per <R21>.
- b. Internal or external mechanical repairs of VEX Limit and Bumper switches are permitted. Modifying the metal arm on the Limit Switch is permitted. Using components from these devices in other applications is prohibited.

- c. Metallurgical modifications that change fundamental material properties, such as heat treating, are not permitted.
- d. *Teams* may cut pneumatic tubing to a desired length.
- e. *Teams* are permitted to fuse / melt the end of the 1/8" nylon rope to prevent fraying.
- f. Welding, soldering, brazing, gluing, or attaching in any way that is not provided within the VEX platform is NOT permitted.

<R23> Custom V5 Smart Cables are allowed. *Teams* must use official V5 Smart Cable Stock but may use commodity 4P4C connectors and 4P4C crimping tools. *Teams* who create custom cables acknowledge that incorrect wiring may have undesired results.

<R24> Keep the power switch accessible. The *Robot* on / off switch or button must be accessible without moving or lifting the *Robot*. All microcontroller lights and / or screens must also be easily visible by competition personnel to assist in diagnosing *Robot* problems.

<R25> Pneumatics are limited. Pneumatic devices may only be charged to a maximum of 100 psi. *Teams* may only use a maximum of two (2) legal VEX pneumatic air reservoirs on a *Robot*.

The intent of this rule is to limit *Robots* to the air pressure stored in two reservoir tanks, as well as the normal working air pressure contained in their pneumatic cylinders and tubing on the *Robot*. *Teams* may not use other elements (e.g. surgical tubing) for the purposes of storing or generating air pressure. *Teams* who use cylinders and additional pneumatic tubing for no purpose other than additional storage are in violation of the spirit of this rule and will fail inspection.

<R26> Only registered Teams may compete in the VEX Robotics Competition. To participate in an official VEX Robotics Competition (VRC) event, a *Team* must first register on robotevents.com. Upon registering they will receive their VRC Team Number and four (4) VRC License Plates. *Teams* may choose to use the VRC License Plate Kit that comes in the VRC Team Welcome Kit, or may create their own, including one made from 3D printed parts. Plates must follow the following requirements:

- a. *Robots* must use the colored plates that match their *Alliance* color for each *Match* (i.e. red *Alliance Robots* must have their red plates on for the *Match*). It must be abundantly clear which color *Alliance* the *Robot* belongs to.

Note: If the plates are attached to opposite-color plates, then the incorrect color must be covered, taped over, or otherwise obscured to ensure that the correct *Alliance* color is abundantly clear to the *Head Referee* during a *Match*. Since License Plates are considered non-functional decorations, this is a legal non-functional use of tape.

- b. License Plates must fulfill all *Robot* rules (i.e. they must fit within the 18" cube per <R5>, they cannot functionally change the stability of rigidity of the *Robot*, cause entanglement, etc.)
- c. *Team* numbers must be in white font.
- d. Plates must be at least 2.48 inches (63.2mm) tall and 4.48 inches (114mm) wide, i.e. at least the size of the plates in the VRC License Plate Kit ignoring thickness.

The intent of this rule is to make it very easy for *Head Referees* to know which *Alliance* and which *Team* each *Robot* belongs to. Being able to "see through" a *Robot* arm to the wrong color License Plate on the opposite side of the *Robot* would be considered a violation of <R26a>.

It will be at the full discretion of the *Head Referee* and inspector at a given event to determine whether a given custom license plate satisfies the criteria listed in <R26>. *Teams* wishing to utilize custom plates should be prepared for the possibility of this judgment, and ensure that they are prepared to replace any custom parts with official VEX License Plates if requested. Not bringing official replacement plates to an event will not be an acceptable reason for overlooking a violation of one or more points in <R26>.

<R27> Use the "Competition Template" for programming. The *Robot* must be programmed to follow control directions provided by the VEXnet Field Controllers.

During the *Autonomous Period*, *Drive Team Members* will not be allowed to use their hand-held controllers. As such, *Teams* are responsible for programming their *Robot* with custom software if they want to perform in the *Autonomous Period*. *Robots* must be programmed to follow control directions provided by the VEXnet Field Controllers (i.e. ignore wireless input during the *Autonomous Period*, disable at the end of the *Driver Controlled Period*, etc).

Teams must use a provided "competition template", or functional equivalent, to accomplish this. All *Robots* will be required to pass a functional enable / disable test as part of inspection. For more information on this, *Teams* should consult the help guides produced by the developers of their chosen programming software.

<R28> There is a difference between accidentally and willfully violating a Robot rule. Any violation of *Robot* rules will result in a *Team* being unable to play until they pass inspection (per <R3d>). In addition, *Teams* who intentionally or knowingly circumvent or violate rules to gain an advantage over their fellow competitors are in violation of the spirit and ethos of the competition. Any violation of this sort may be considered a violation of <G1> and / or the REC Foundation Code of Conduct.

Section 4

The Tournament

Overview

The main challenge of the VEX Robotics Competition will be played in a tournament format. Each tournament consists of *Qualification Matches* and *Elimination Matches* and may also include *Practice Matches*. After the *Qualification Matches*, *Teams* are ranked based on their WP, AP, and SP. The top ranked *Teams* will then participate in *Elimination Matches* to determine the tournament champions.

Tournament Definitions

Alliance Captain - The *Team Representative* of the highest ranked *Team* in an *Alliance* during *Elimination Matches*. The *Alliance Captain* invites available *Teams* to join his or her *Alliance* until the *Alliance* is formed.

Alliance Selection - The process of choosing the permanent *Alliances* for the *Elimination Matches*. *Alliance Selection* proceeds as follows:

1. The highest ranked *Team* at the end of *Qualification Matches* becomes the first *Alliance Captain*
2. The *Alliance Captain* invites another *Team* to join their *Alliance*
3. The invited *Team Representative* either accepts or declines as outlined in <T13>
4. The next highest ranked *Team* at the end of *Qualification Matches* becomes the next *Alliance Captain*

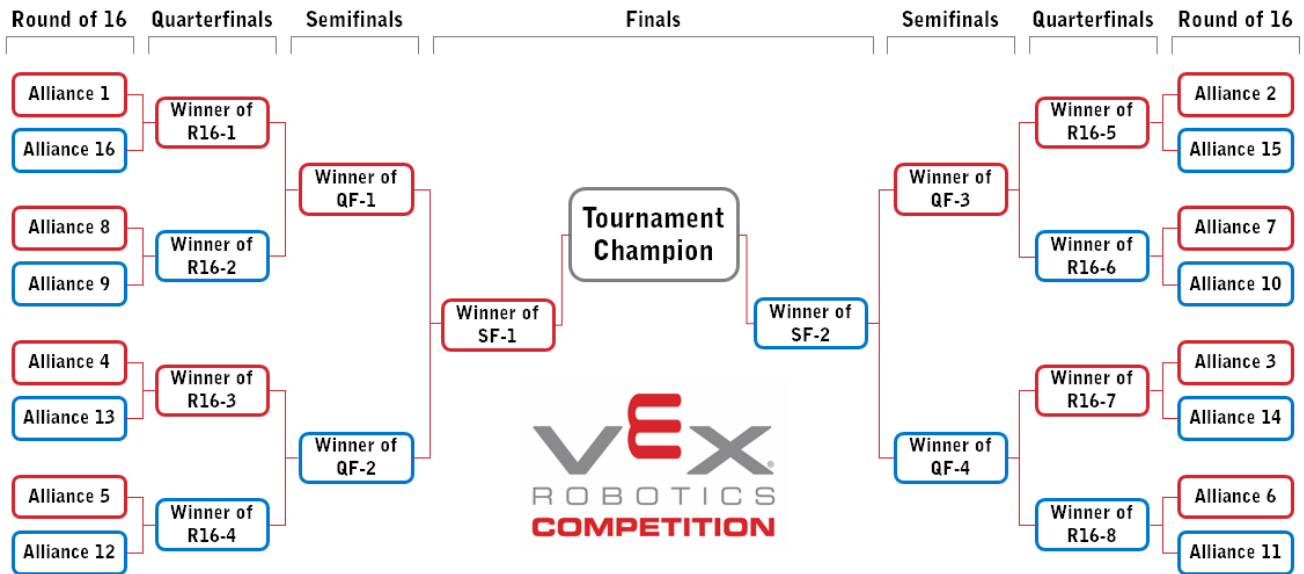
Alliance Captains continue to select their *Alliances* in this order until all *Alliances* are formed for the *Elimination Matches*

Autonomous Points (AP) - The second basis of ranking *Teams*. An *Alliance* who wins the *Autonomous Bonus* during a *Qualification Match* earns twenty (20) *Autonomous Points*. In the event of a tie, both *Alliances* will receive ten (10) *Autonomous Points*.

Autonomous Win Point - One (1) *Win Point (WP)* given to an *Alliance* that has *Cleared* their *AWP Line*, and *Scored* at least one *Ring* on each *Alliance Mobile Goal*, at the end of the *Autonomous Period*. Both *Alliances* can earn this WP if both *Alliances* accomplish this task.

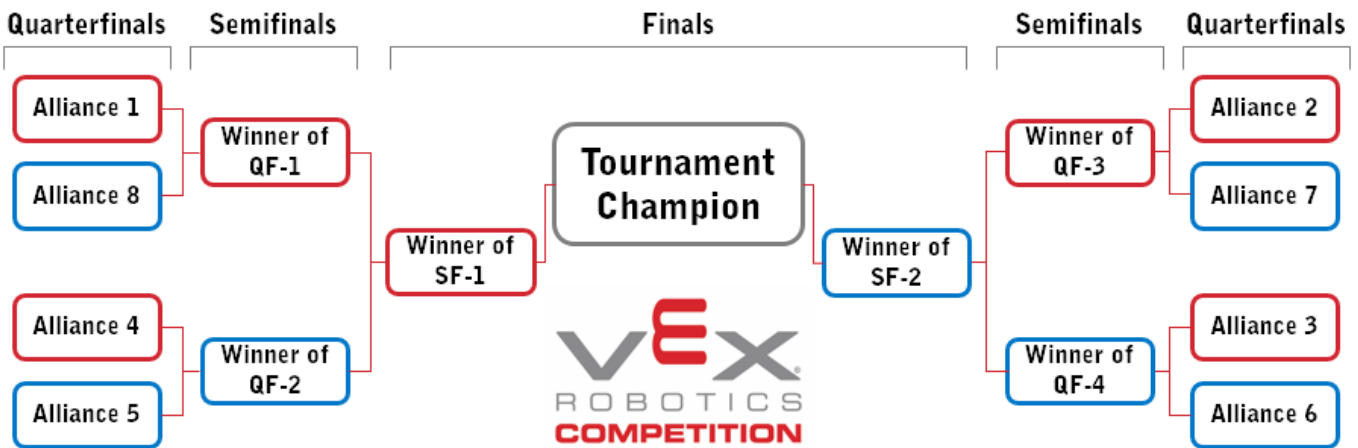
Elimination Bracket - A schedule of *Elimination Matches*. Between eight (8) and sixteen (16) *Alliances* are used to fill the *Elimination Bracket*. The exact quantity of *Alliances* in an *Elimination Bracket* is determined by the *Event Partner* per <T16>.

A sixteen (16) *Alliance* bracket would play as follows:



If an event is run with fewer than sixteen (16) *Alliances*, then they will use the bracket shown above, with byes awarded when there is no applicable *Alliance*. For example, in a tournament with fourteen (14) *Alliances*, *Alliances* 1 and 2 would automatically advance.

Thus, an eight (8) *Alliance* bracket would run as follows:



Elimination Match - A *Match* used in the process of determining the champion *Alliance*. *Alliances* of two (2) *Teams* face off according to the *Elimination Bracket*; the winning *Alliance* moves on to the next round.

Event Partner - The VEX Robotics Competition tournament coordinator who serves as an overall manager for the volunteers, venue, event materials, and all other event considerations. *Event Partners* serve as the official liaison between the REC Foundation, the event volunteers, and event attendees.

Head Referee - An impartial volunteer responsible for enforcing the rules in this manual as written, and has completed the REC Foundation *Head Referee* certification course. *Head Referees* are the only individuals who may discuss ruling interpretations or scoring questions with *Teams* at an event.

Practice Match - A *Match* used to provide time for *Teams* and volunteers to get acquainted with the official playing field. *Practice Matches* earn *Teams* zero (0) WP, AP, SP.

Qualification Match - A *Match* used to determine the rankings for the *Alliance Selection*. *Alliances* compete to earn *Win Points*, *Autonomous Points*, and *Strength of Schedule Points*.

Strength of Schedule Points (SP) - The third basis of ranking *Teams*. *Strength of Schedule Points* are equivalent to the score of the losing *Alliance* in a *Qualification Match*. In the event of a tie, both *Alliances* receive SP's equal to the tie score. If both *Teams* on an *Alliance* are Disqualified, the *Teams* on the not Disqualified *Alliance* will receive their own score as SP's for that *Match*.

Time Out - A single break period no greater than three minutes (3:00) allotted for each *Alliance* during *Elimination Matches*. See <T14>.

Team Representative - A *Student* chosen to represent his or her *Team* during *Alliance Selection* for *Elimination Matches*.

Win Points (WP) - The first basis of ranking *Teams*. *Teams* will receive zero (0), one (1), two (2) or three (3) *Win Points* for each *Qualification Match*.

- One (1) WP is awarded at the end of the *Autonomous Period* for any *Team* in an *Alliance* earning the *Autonomous Win Point*.
- Two (2) WP's are awarded for winning a *Qualification Match*.
- One (1) WP is awarded for tying a *Qualification Match*.
- Zero (0) WP are awarded for losing a *Qualification Match*.

Win Percentage (WP) - Replaces *Win Points* in a league event. *Win Percentage* is calculated by the number of wins divided by the number of *Qualification Matches* the team plays. In cases of a tie, the *Team* is given a 0.5 number of wins for that match. Also, in Leagues only, the *Autonomous Win Point* is given a value of 0.5 and is added to the total number of wins.

Tournament Rules

<T1> The Head Referee has ultimate authority on ruling decisions during the competition.

- a. *Head Referees* must have the following qualifications.
 - i. Be at least 20 years of age.
 - ii. Be approved by the *Event Partner*.
 - iii. Contain the following attributes
 1. Thorough knowledge of the current game and rules of play.
 2. Effective decision making.
 3. Attention to detail.
 4. Ability to work effectively as a member of a team.
 5. Ability to be confident and assertive when necessary.
 6. Strong communication and diplomacy skills.
 - iv. The *Head Referee* must be an REC Foundation Certified VRC Head Referee for the current season.
- b. *Head Referees* may not review any photo or video *Match* recordings to determine a score or ruling.
- c. *Head Referees* are the only individuals permitted to explain a rule, *Disqualification* or warning to the *Teams*.
- d. The *Head Referee* must give the rule number of the rule violated when issuing a *Disqualification* or *Warning* to a *Team*.

Violations of the REC Foundation Code of Conduct may involve additional escalation beyond the *Head Referee's* initial ruling, including (but not limited to) investigation by an REC Foundation representative. Rules <S1>, <G1>, and <G2> are the only rules for which this escalation may be required.

Note: Scorekeeper Referees score the *Match*, serve as observers for the *Head Referees* and advise the *Head Referee*, but may not communicate any rules or infractions directly to the teams. Scorekeeper Referees must be at least 15 years of age.

<T2> The Drive Team is permitted to immediately appeal the Head Referee's ruling. If *Drive Team Members* wish to dispute a score or ruling, they must stay in the *Alliance Station* until the *Head Referee* talks with them. Time permitting, the *Head Referee* may choose to meet with the *Drive Team Members* at another location and / or at a later time so that the *Head Referee* has time to reference materials or resources to help with the decision. Once the *Head Referee* announces that his or her decision has been made final, the issue is over and no more appeals may be made. The *Event Partner* may not overrule the *Head Referee's* decision.

Violations of this rule may result in the team being disqualified from the match in question and / or the event and is up to the discretion of the *Head Referee*.

Communication and conflict resolution skills are an important life skill for *Students* to practice and learn. In VEX Robotics Competitions, we expect *Students* to practice proper conflict resolution using the proper chain of command. See <G1>.

<T3> The Team's Robot or a Drive Team Member should attend every Match. A *Robot* or a *Student* member of the *Team* must report to the field for the *Team's* assigned *Match*. If no *Student Team* members report to the field, the *Team* will be considered a "no-show" and receive zero (0) WP's, AP's, and SP's.

<T4> Robots at the field must be ready to play. Teams must bring their *Robots* to the field prepared to play. Teams who use VEX pneumatics must have their systems charged before they place the *Robot* on the field.

- a. *Robots* must be placed on the field promptly. Repeated failure to do so could result in a violation of <G1>.

The exact definition of the term “promptly” is at the discretion of the *Head Referee* and the *Event Partner*, who will consider event schedule, previous warnings or delays, etc.

<T5> Practice Matches may be run at some events. If *Practice Matches* are run, they will be conducted on a first-come, first-served basis with every effort made to equalize *Practice Match* time for all *Teams*.

<T6> The red Alliance, or the highest seed, places last. The red *Alliance* has the right to place its *Robots* on the field last in both *Qualification Matches* and *Elimination Matches*. Once a *Team* has placed its *Robot* on the field, its position cannot be readjusted prior to the *Match*. If a *Team* violates this rule, the opposing *Alliance* will be given the opportunity to reposition their *Robots* promptly.

<T7> Qualification Matches follow the Qualification Match schedule. A *Qualification Match* schedule will be available on the day of competition. The *Qualification Match* schedule will indicate *Alliance* partners, *Match* pairings, and *Alliance* color. For tournaments with multiple fields, the schedule will indicate which field the *Match* will take place on.

- a. *Alliances* are randomly assigned during *Qualification Matches*

Note: The official *Match* schedule is subject to changes at the *Event Partner’s* discretion.

<T8> Each Team will be scheduled Qualification Matches as follows.

- a. When in a tournament, the tournament must have a minimum of four (4) *Qualification Matches* per *Team*. The suggested amount of *Qualification Matches* per *Team* for a standard tournament is six (6) and up to ten (10) for a championship event.
- b. When in a league, there must be at least three (3) league ranking sessions and each session must have a minimum of two (2) *Qualification Matches* per *Team*. The suggested amount of *Qualification Matches* per *Team* for a standard league ranking session is four (4). Leagues will have a championship session where elimination rounds will be played. *Event Partners* may choose to have *Qualification Matches* as part of their championship session.

<T9> Team rankings are determined during Qualification Matches as outlined below.

- a. When in a tournament, every *Team* will be ranked based on the same number of *Qualification Matches*.
- b. When in a league, every *Team* will be ranked based on the number of *Matches* played. *Teams* that participate at least 60% of the total *Matches* available will be ranked above *Teams* that participate in less than 60% of the total *Matches* available, e.g. if the league offers 3 ranking sessions with 4 *Qualification Matches* per *Team*, teams that participate in 8 or more matches will be ranked higher than *Teams* who participate in 7 or fewer *Matches*. Being a no-show to a *Match* that a *Team* is scheduled in still constitutes participation for these calculations.

- c. In some cases, a *Team* will be asked to play an additional *Qualification Match*. The extra *Match* will be identified on the Match Schedule with an asterisk and will not impact the *Team's* ranking, WP's AP's or SP's for that *Qualification Match* (and will not affect participation percentage for leagues). *Teams* are reminded that <G1> is always in effect and *Teams* are expected to behave as if the additional *Qualification Match* counted. In Leagues, *Teams* may have a different number of *Qualification Matches* and the WP is calculated by the *Win Percentage*, which is the number of wins divided by the number of *Qualification Matches* that *Team* has played.

<T10> Qualification Match tiebreakers. *Team* rankings are determined throughout *Qualification Matches* as follows:

- a. Average *Win Points* (WP / Number of *Matches* played)
- b. Average *Autonomous Points* (AP / Number of *Matches* played)
- c. Average *Strength of Schedule Points* (SP / Number of *Matches* played)
- d. Highest *Match* score
- e. Second highest *Match* score
- f. Random electronic draw

<T11> Disqualifications.

- a. When a *Team* receives a *Disqualification* in a *Qualification Match*, they receive zero (0) *Win Points*, *Autonomous Win Points*, *Autonomous Points*, and *Strength of Schedule Points*.
 - i. If the *Team* receiving the *Disqualification* is on the winning *Alliance*, then *Teams* on the opposing *Alliance* who are not also *Disqualified* will receive the win for the *Match* and two (2) WP.
 - ii. If the *Match* was a tie, then each *Team* on the opposing *Alliance* (the *Alliance* that did not receive the *Disqualification*) will receive the win for the *Match* and two (2) WP.
 - iii. If both *Alliances* have a *Team* receiving a *Disqualification*, then all non-*Disqualified Teams* will receive a tie for the *Match* and one (1) WP.

Note: *Autonomous Win Points* are not given to *Teams* that receive a *Disqualification*, and are not automatically awarded to the opposing *Alliance*.

When a *Team* is *Disqualified* in an *Elimination Match*, the entire *Alliance* is *Disqualified* and they receive a loss for the *Match* and the opposing *Alliance* is awarded the win. If both *Alliances* receive a *Disqualification* in an *Elimination Match*, both *Alliances* receive a loss and will play another *Match* to determine a winner.

<T12> Send a Team Representative to Alliance Selection. Each *Team* must send one (1) *Team Representative* to the playing field for *Alliance Selection*. If the *Team Representative* fails to report to the playing field for *Alliance Selection*, their *Team* will be ineligible for participation in the *Alliance Selection* process.

<T13> Each Team may only be invited once to join an Alliance. If a *Team Representative* declines an *Alliance Captain's* invitation during *Alliance Selection*, that *Team* is no longer eligible to be selected by another *Alliance Captain*. However, they are still eligible to play *Elimination Matches* as an *Alliance Captain*.

For example:

- *Alliance Captain 1* invites Team ABC to join their *Alliance*.
- Team ABC declines the invitation.
- No other *Alliance Captains* may invite Team ABC to join their *Alliance*.
- However, Team ABC may still form their own *Alliance*, if Team ABC ranked high enough after *Qualification Matches* to become an *Alliance Captain*.

<T14> Each Alliance gets one Time Out. Each *Alliance* may request one (1) *Time Out* during the *Elimination Bracket* between *Elimination Matches*, as permitted by the *Head Referee* and *Event Partner*. *Alliances* may not use their *Time Out* during a *Match*.

<T15> Elimination Matches are a blend of "Best of 1" and "Best of 3".

- a. In Tournaments that do not directly qualify teams to the VEX Robotics World Championship,
 - i. In Tournaments that only have one division - The first *Alliance* to win a *Match* advances to the next round of the *Elimination Bracket*. Any ties will result in additional *Matches* until one *Alliance* wins and advances or wins and receives the title of "Tournament Champion." i.e. *Elimination Matches* are all Best of 1.
 - ii. In Tournaments that have multiple divisions -
 1. In the Division *Elimination Matches* - *Elimination Matches* are all Best of 1 and the *Alliance* that wins the Division Finals will be declared the "Division Champion."
 2. When the Division Champions play each other – The Finals Matches are played as a "Best of 3" where an *Alliance* needs two wins to receive the title of "Tournament Champion."
- b. In Tournaments that qualify teams to the VEX Robotics World Championship,
 - i. In Tournaments that only have one division - *Elimination Matches* are "Best of 1" from Round-of-16 up through the Semi-Finals Matches. The Finals Matches are played as a "Best of 3" where an *Alliance* needs two wins to receive the title of "Tournament Champion."
 - ii. In Tournaments that have multiple divisions -
 1. In the Division Elimination Matches - *Elimination Matches* are "Best of 1" from Round-of-16 up through the Semi-Finals Matches. The Division Finals Matches are played as a "Best of 3" where an *Alliance* needs two wins to receive the title of "Division Champion."
 2. When the Division Champions play each other – The Finals Matches are played as a "Best of 3" where an *Alliance* needs two wins to receive the title of "Tournament Champion."

<T16> Small tournaments may have fewer Alliances. Events or divisions within an event with 32 or more *Teams* must use 16-team *Alliances* when starting *Elimination Matches*. Events with fewer than 32 *Teams* (i.e. the requisite amount for sixteen full *Alliances*) must limit the number of *Alliances* by dividing the number of *Teams* by two, less any remainder.

<T17> Fields may be raised or on the floor. Some tournaments may choose to place the playing field on the floor, or elevated off the floor (common heights are 12" to 24" [30.5cm to 61cm]). No *Drive Team Members* may stand on any sort of object during a *Match*, regardless of whether the field is on the floor or elevated.

The 2022 VEX Robotics World Championship field will be elevated 24" (61cm) from the floor.

<T18> Students must be accompanied by an Adult. No *Student* may attend a VRC event without a responsible *Adult* supervising them. The *Adult* must obey all rules and be careful to not violate student-centered policies, but must be present at the event in the case of an emergency.