Mobile Robotics Technology

2022-23 Game Manual for Middle School Teams

Presented by: The Robotics Education & Competition Foundation

Adapted from: VEX IQ Competition Full Volume

In Partnership with: VEX Robotics and REC Foundation

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OVERVIEW

Students who participate in Mobile Robotics Technology engage in the Engineering Process and demonstrate their ability to keep and maintain an engineering notebook. Students will be judged based on their robot in design, construction, and programming, along with the quality of their notebook, and their ability to communicate their design process to the judges. Students will show the result of their preparation by performing tasks in both autonomous and driver control functions. The game that will be played is an adaptation of the VEX IQ Challenge (VIQC) Full Volume Robot Skills Challenge. Students can participate in both VIQC and SkillsUSA using the same robot and engineering notebook. The key difference is that SkillsUSA focuses on the ability of students to create a robot that performs exceptionally at a given task, whereas VIQC is a teamwork-based program that focuses on collaborating with other teams along with game strategy in a tournament structure of competition. Students in SkillsUSA should focus on designing, building and programming a robot to perform well, knowing that there are no other robots on the field that may help their robot or might get in the way.

ELIGIBILITY

Eligibility (Team of Two)
Open to a team of two active SkillsUSA members. Each state may send one middle school, one high school, and one college/postsecondary team.
Middle School: Students who may be interested in pursuing coursework in a career and technical education engineering program or a program that integrates robotics, engineering, or pre-engineering techniques as an integral component of the instructional program.

CLOTHING REQUIREMENT

Class E: Competition Specific — Business Casual
- Official SkillsUSA white polo shirt
- Black dress slacks or black dress skirt (knee-length minimum)
- Black closed-toe dress shoes

Note: Wearing socks or hose is no longer required. If worn, socks must be black dress socks and hose must be either black or skin-tone and seamless/nonpattern.
These regulations refer to clothing items that are pictured and described at www.skillsusastore.org. If you have questions about clothing or other logo items, call
1-888-501-2183.
Note: Competitors must wear their official competition clothing to the competition orientation meeting.

THE GAME

VEX IQ Competition (VIQC) Full Volume is played on a 6' x 8' rectangular Field, set up as illustrated in the figures throughout this manual.

The object of the game is to score points by Removing Discs from Dispensers, by placing Discs into Goal Zones, and by getting Contact Bonuses at the end of the Match.

Teams compete in Robot Skills Challenge Matches, where one (1) Robot tries to score as many points as possible.

General Definitions

Adult – Anyone who is not a *Student*

Autonomous Coding Skills Match – An *Autonomous Coding Skills Match* consists of a sixty-second (1:00) *Autonomous Period*. There is no *Driver Controlled Period*. *Teams* can elect to end an *Autonomous Coding Skills Match* early if they wish to record a *Skills Stop Time*.

Disablement – A penalty applied to a *Team* for a rule *Violation*. During *Disablement*, a *Team* is no longer allowed to operate their *Robot*, and the *Drivers* will be asked to place their Controller on the ground. A *Disablement* is not the same as a *Disqualification*.

Disqualification – A penalty applied to a *Team* for a rule violation (see <T8> for more details). If a *Team* is Disqualified in a *Match*, the *Head Referee* will notify the *Team* of their *Violation* at the end of the *Match*. At the *Head Referee's* discretion, repeated violations and/or *Disqualifications* for a single *Team* may lead to its *Disqualification* for the entire event.

Driver – A *Student Team* member who stands in the *Driver Station* and is responsible for operating and controlling that *Team's Robot*. Up to two *Team* members may fulfill this role in a given *Match* (see <G8>).

Driving Skills Match – A *Driving Skills Match* consists of a sixty-second (1:00) *Driver Controlled Period*.

There is no *Autonomous Period*. *Teams* can elect to end a *Driving Skills Match* early if they wish to record a *Skills Stop Time*.

Driver Station – The region behind the *Field* where the *Drivers* must remain during their *Match* unless legally interacting with their *Robot*.

Field – The entire playing *Field*, being six (6) field tiles wide by eight (8) field tiles long (totaling forty-eight (48) field tiles), including the *Field Perimeter*.

Field Element – The *Field Perimeter*, *Floor*, PVC pipes, and VEX IQ elements which are attached to the *Field*.

Field Perimeter – The outer part of the *Field*, made up of four (4) outside corners and twenty-four (24) straight sections.

Floor – The interior flat part of the playing Field, made up of the forty-eight (48) field tiles that are within the *Field Perimeter*.

Game Design Committee (GDC) - The creators of VIQRC Full Volume, and authors of this Game Manual.

License Plate – A physical component on the *Robot* that displays the *Team's* VEX IQ Robotics Competition number. The *License Plate* must have a length and height of 3.5" x 1.5" (88.9mm x 38.1mm) and must not exceed a width of 0.25" (6.35mm) per <R9>.

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

Robot Skills Match – A *Driving Skills Match* or *Autonomous Coding Skills Match*.

Student – Anyone born after May 1, 2008 (i.e. who will be 15 or younger at VEX Worlds 2024). Eligibility may also be granted based on a disability that has delayed education by at least one year. *Students* are the individuals who design, build, repair, and program the *Robot* with minimal *Adult* assistance.

- **Elementary School Student** - Any *Student* born after May 1, 2011 (i.e. who will be 12 or younger at VEX Worlds 2024). Elementary School *Students* may "play up" and compete as *Middle School Students*.
- **Middle School Student** – Any eligible *Student* that is not an *Elementary School Student*.

Team – Two or more *Students* make up a *Team*. A *Team* is classified as an Elementary School *Team* if all members are *Elementary School Students*. A *Team* is classified as a Middle School *Team* if any member is a *Middle School Student*, or if the *Team* is made up of *Elementary School Students* who declare themselves as "Playing Up" as *Middle School Students* by registering their *Team* as a Middle School *Team*.

Once a *Team* has competed in an event as a Middle School *Team*, that *Team* may not change back to a Elementary School *Team* for the remainder of the season. *Teams* may be associated with schools, community/youth organizations, or a group of neighborhood *Students*.

- **Builder** – The *Student*(s) on the team who assemble(s) the *Robot*. An *Adult* cannot be a *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 a *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.

- **Programmer** – The *Student*(s) on the *Team* who write(s) the computer code that is downloaded onto the *Robot*. An *Adult* cannot be a *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.

Violation – The act of breaking a rule in the Game Manual.

- **Minor Violation** – A *Violation* which does not result in a *Disqualification*.
  - Accidental, momentary, or otherwise non-*Score Affecting Violations* are usually *Minor Violations*.
  - *Minor Violations* usually result in a verbal warning from the *Head Referee* during the *Match*, which should serve to inform the *Team* that a rule is being Violated before it escalates to a *Major Violation*.
- **Major Violation** – A *Violation* which results in a *Disqualification*.
  - Unless otherwise noted in a rule, all *Score Affecting Violations* are *Major Violations*.
  - If noted in the rule, egregious or intentional *Violations* may also be *Major Violations*.
  - Multiple *Minor Violations* within a *Match* or tournament may escalate to a *Major Violation* at the *Head Referee's* discretion.
- **Score Affecting** – A *Violation* which improves an *Alliance's* score at the end of a *Match*.
  - Multiple *Violations* within a *Match* can cumulatively become *Score Affecting*.
  - When evaluating whether a *Violation* was *Score Affecting*, *Head Referees* will focus primarily on any *Robot* actions that were directly related to the *Violation*.
  - Determining whether a *Violation* was *Score Affecting* can only be done once the *Match* is complete and the scores have been calculated.

Some rules include *Violation* Notes in *red italicized text* to denote special circumstances or provide additional clarifications. If no *Violation* Notes are found in a given rule, then it should be assumed that the above "default" definitions apply.

To determine whether a *Violation* may have been *Score Affecting*, check whether the *Violation* directly contributed to increasing the score of the *Match*. If it did not increase the *Alliance's* score, then the *Violation* was not *Score Affecting*, and it was very likely a *Minor Violation*.

See the following flowchart for more information.
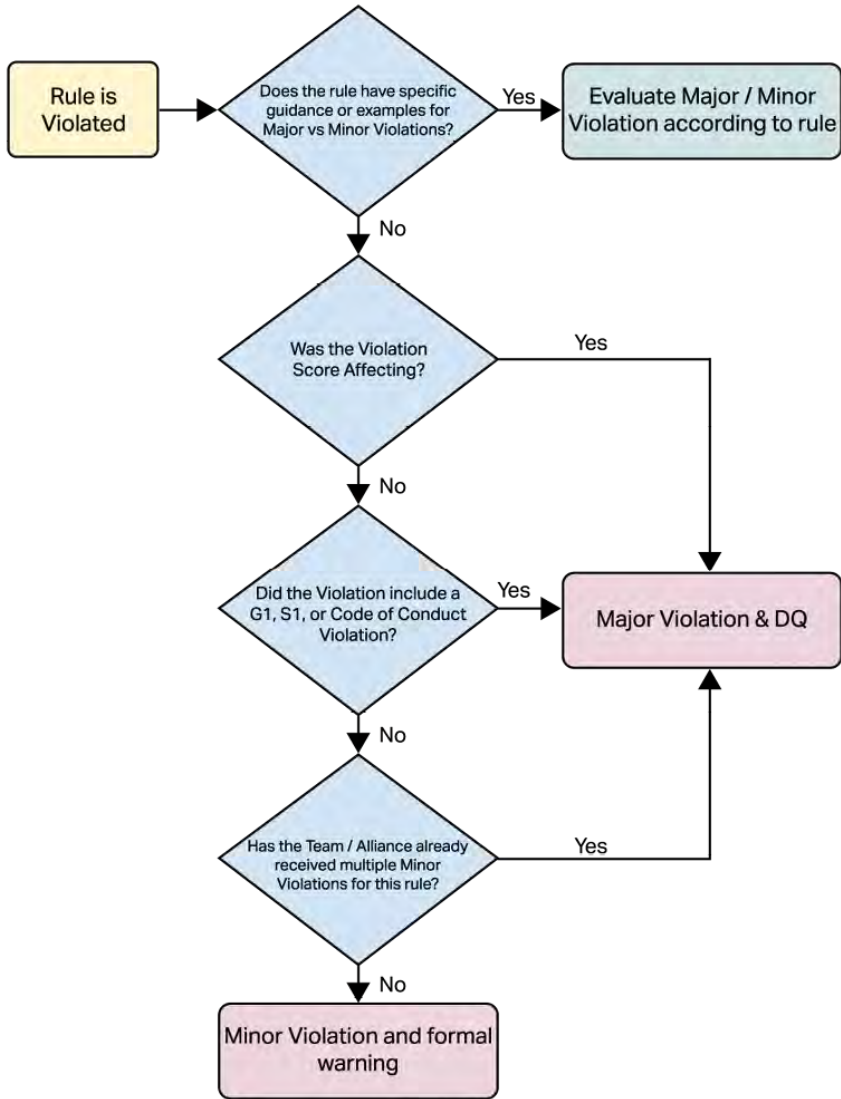
Game-Specific Definitions

Block – A green, purple, or red plastic scoring object.

- Each green *Block* consists of six sides, is approximately 2" (51mm) to a side, and weighs approximately 1.1 oz (30g). There are fifty four (54) green *Blocks* on the *Field*.
- Each purple *Block* consists of six sides, is approximately 3" (76mm) to a side, and weighs approximately 1.6oz (45g). There are sixteen (16) purple *Blocks* on the *Field*.
- Each red *Block* is a partially-rounded octagonal shape, has a major diameter of approximately 5.8" (147mm), and weighs approximately 6.3 oz (180g). There are three (3) red *Blocks* on the *Field*.

Cleared – A *Supply Zone* status. The *Supply Zone* is considered *Cleared* if no *Blocks* are fully within the 3D volume of the *Supply Zone* at the end of the *Match*.
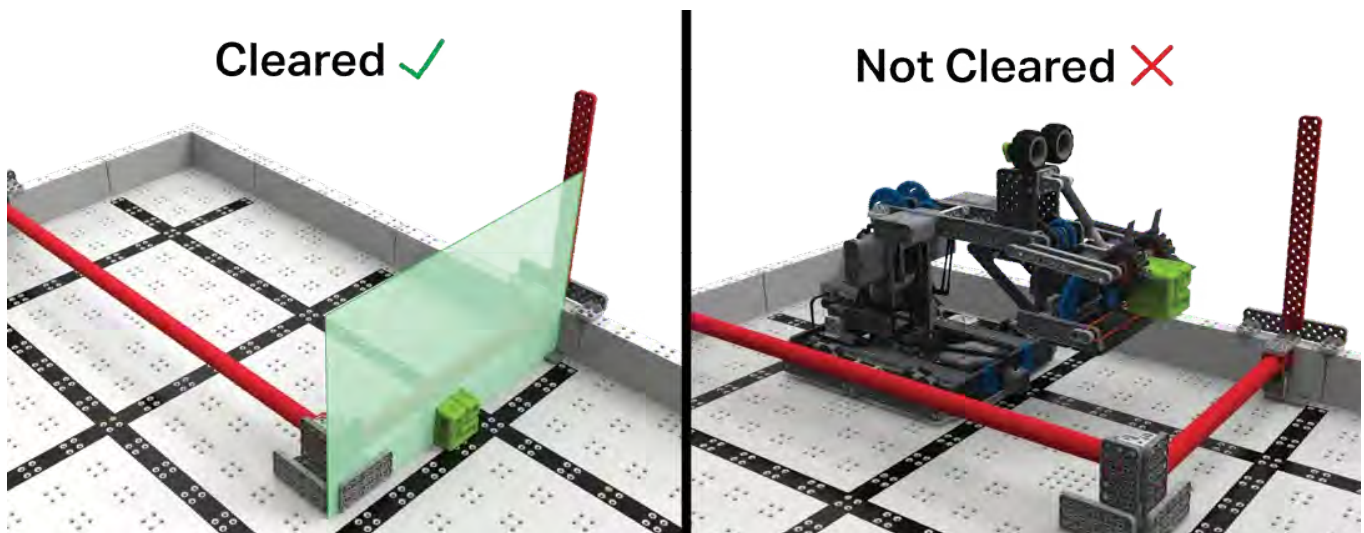

Figure 4: Two example** Supply Zone **states. The example on the left is considered** Cleared **because even though a** Block **is still partially within the** Supply Zone**, it is no longer fully within the** Supply Zone**. The example on the right would not be considered** Cleared**, because the** Block **is still within the boundaries of the** Supply Zone**.

Fill Level – A *Goal* attribute that corresponds to the "highest" *Block*(s) *Scored* in a given *Goal*. A *Goal* can have one of three possible *Fill Levels* as described below; if a *Goal* meets the requirements for multiple *Fill Levels*, it should be assigned the highest of those *Fill Levels*. *Fill Levels* are used to determine the overall *Height Bonus* at the end of the *Match*.
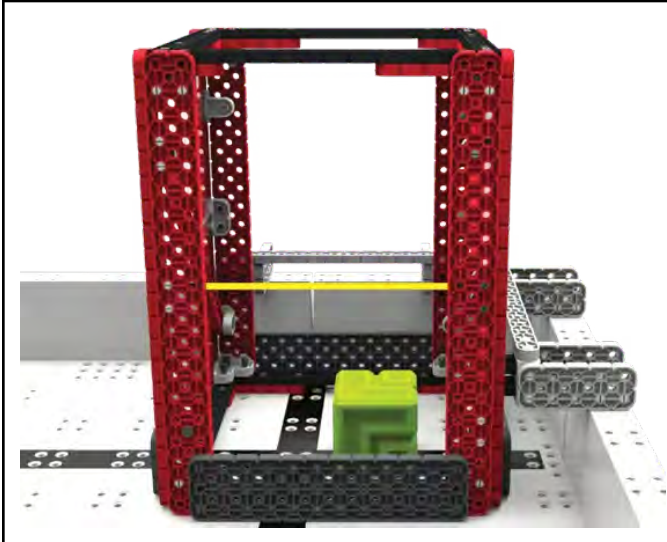
Fill Level 1: At least one *Block* is contacting the *Floor* within the *Goal*.
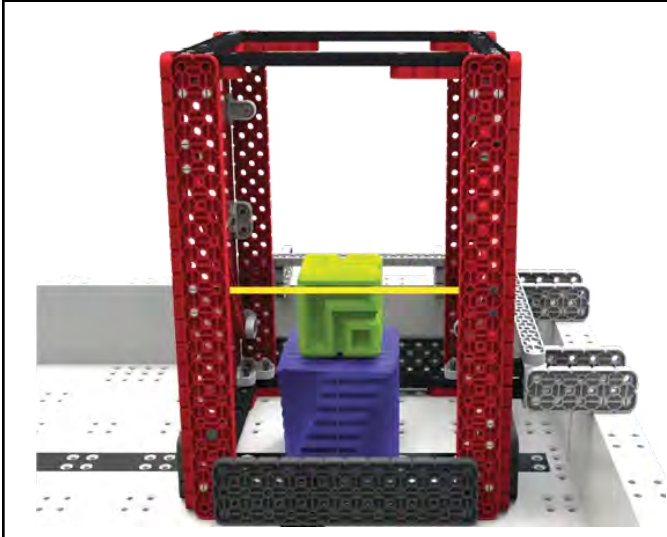
Fill Level 2: At least one *Block* is at least partially above the horizontal line printed on the outside of the *Goal*.
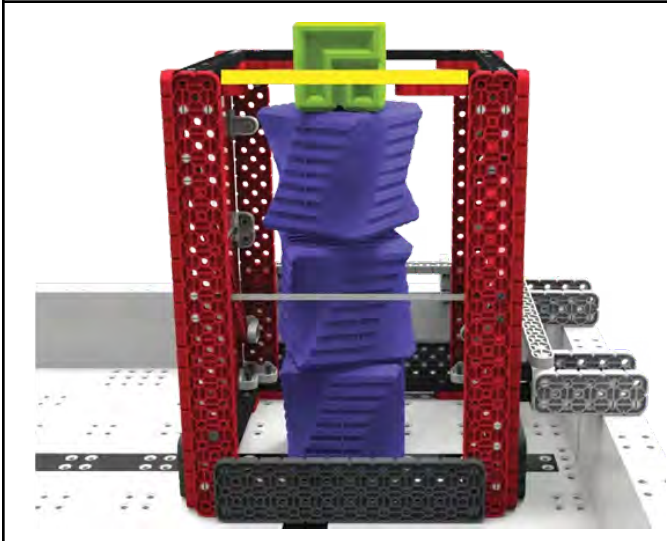
Fill Level 3: At least one *Block* is at least partially above the top of the *Goal*.

Goal – A rectangular-shaped structure built out of VEX IQ parts and clear plastic sheets and connected to a corner of the *Field*. The VEX IQ parts used to connect a *Goal* to the *Field* are not considered part of the *Goal*.

Note: The "I", "II", and "III" labels on each Goal are intended to be common identifiers for Teams and Referees to use instead of referring to them in other ways (e.g. "top-left Goal"). They have no relation to scoring, Fill Levels, Blocks, etc.

Height Bonus – A point bonus awarded at the end of the *Match*. See rule <SC5>.

Parked – A *Robot* status at the end of the *Match*.

- **Partially Parked** – A *Robot* is *Partially Parked* if it is partially within the *Supply Zone*.
- **Fully Parked** – A *Robot* is *Fully Parked* if it is fully within the *Supply Zone*.

Scored – A *Block* status. A *Block* is considered to be *Scored* in a *Goal* if it meets the criteria set forth in rule <SC3>.

Removed – A red *Block* status. A red *Block* is considered *Removed* if it is no longer fully supported by a *Starting Peg* at the end of the *Match*.

Starting Peg – One of three (3) *Field Elements* used for setting up red *Blocks* at the beginning of a *Match*.
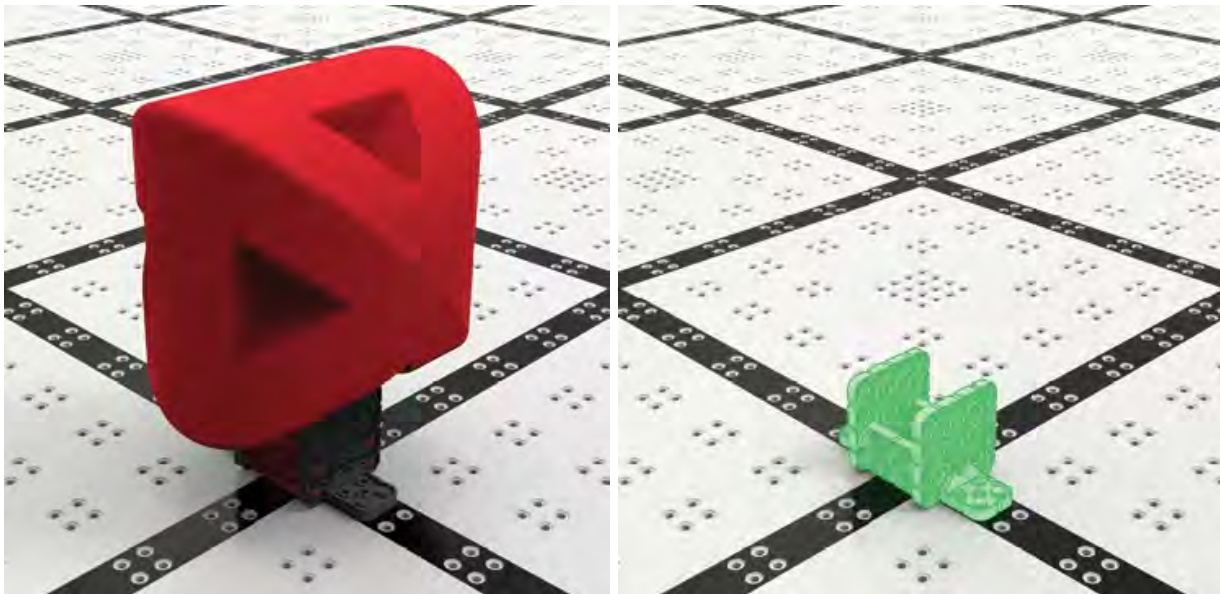

Figure 7: A Starting Peg.

Supply Zone - An infinitely tall three-dimensional volume of the *Field* bordered by the outer edges of the red PVC pipe and the outer edges of the *Field Perimeter* (which coincides with the outer edges of the vertical red VEX IQ beams in 2 of the corners). A predefined number of *Blocks* begin the *Match* within the *Supply Zone* (see rule <SG4>). *Teams* can receive points for *Clearing* the *Supply Zone*, and for using it to *Park Robots*.
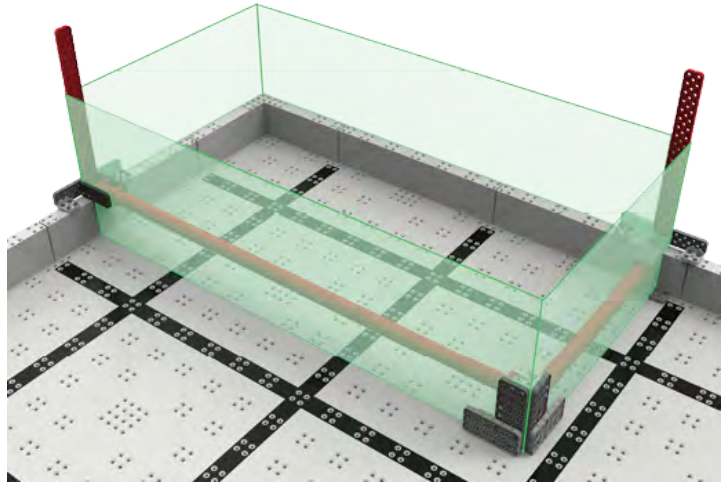

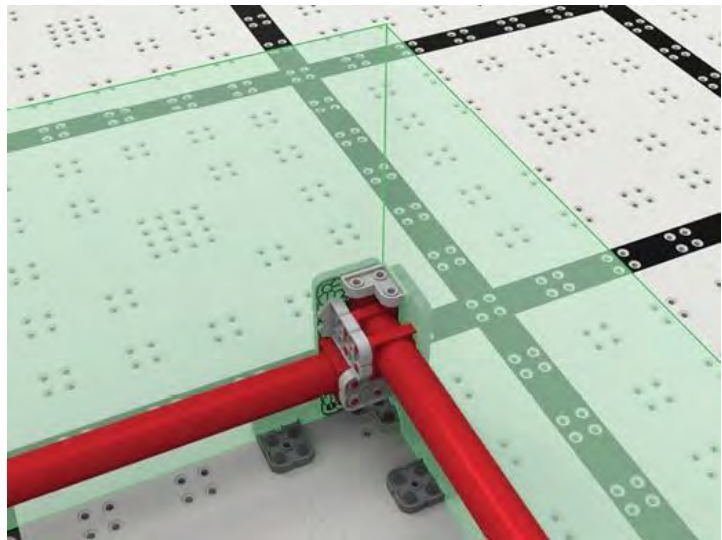*Figure 8: The boundaries of the Supply Zone.*

Figure 9: The boundaries of the Supply Zone.
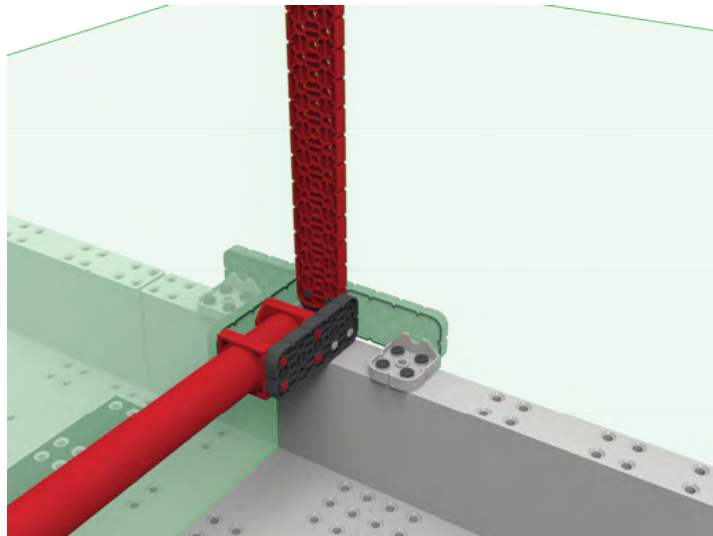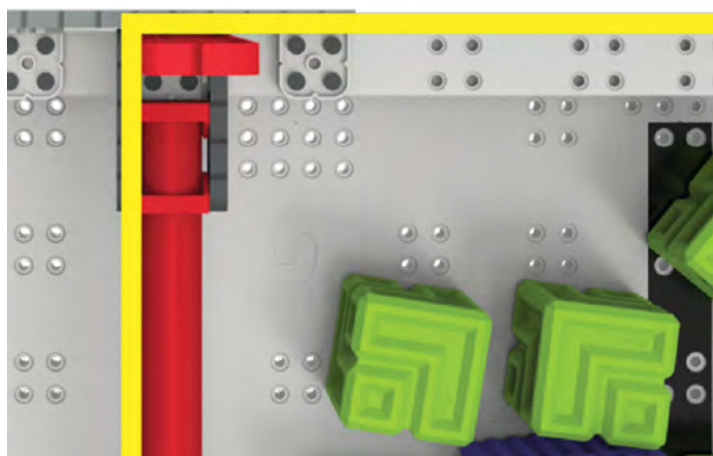
Figure 10: The boundaries of the Supply Zone.

Figure 11: The boundaries of the Supply Zone.

Uniform - A *Goal* status. A *Goal* is considered *Uniform* if it meets the criteria set forth in rule <SC4>.

Scoring

Each Block Scored in a Goal	1 Point
Each Uniform Goal	10 Points
Height Bonus	10 Points per Fill Level (see <SC5>)
Cleared Supply Zone	20 Points
Each Red Block Removed from Starting Peg	5 Points
Partially Parked Robot	5 Points
Fully Parked Robot	10 Points

<SC1> All Scoring statuses are evaluated **after the Match ends**, once all *Scored Blocks*, *Field Elements*, and *Robots* on the *Field* come to rest.

    a. This rule's intent is for *Driver* inputs and *Robot* motion to cease at the end of the *Match*, when the *Match* timer reaches 0:00. A pre-programmed routine which causes *Robot* motion to continue after the end of the *Match* would violate the spirit of this rule. Any Scoring which takes place after the *Match* due to *Robots* continuing to move will not count.

<SC2> All Scoring statuses are evaluated **visually by a Head Referee**, to the best of their ability within the context of a given *Match* / event.

    a. Referees and other event staff are not allowed to review any videos or pictures from the *Match*. See <T3>.

    b. If there is a concern regarding the score of a *Match*, only the *Drivers* from that *Match*, not an *Adult*, may share their questions with the *Head Referee*. See <T3>.

Note: In cases where a Scoring status is "too close to call," Teams will be given the "benefit of the doubt," and the higher of the two possible Scoring statuses should be assigned. Head Referees will not be expected or required to define a perfect horizontal plane or check imperceptibly small measurements. **alliance**

<SC3> A **Block is considered Scored in a Goal** if it meets the following criteria:

a. The *Block* is not contacting any *Robots*.

b. The *Block* is at least partially contained within the infinite vertical projection of the outside surfaces of a *Goal*.

c. The *Block* is either contacting the *Floor* within the *Goal* (i.e., at *Fill Level* 1), or transitively contacting the *Floor* via other *Scored Blocks*.

Yes, all *Scored*
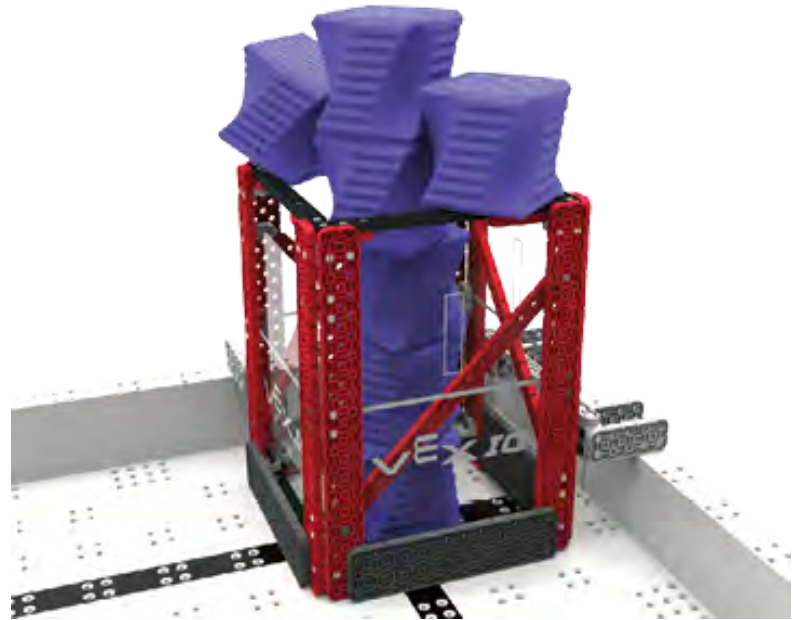
Yes, all *Scored*
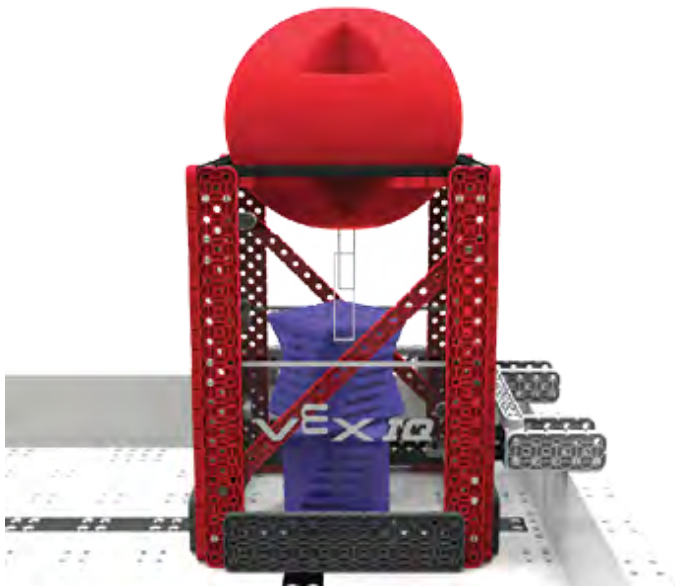
The red *Block* is not *Scored*, because it is not transitively contacting the *Floor* within the *Goal*.

<SC4> A **Goal is considered Uniform** if it meets the following criteria:

a. At least two (2) *Blocks* are *Scored* in the *Goal*.

b. All *Blocks* which are *Scored* in the *Goal* are of the same type.

Figure 12: This Goal would be considered Uniform, because it contains at least 2 Blocks, all of which are the same type.

Figure 13: This Goal would not be considered Uniform, because not all of the Blocks Scored inside it are the same type.

<SC5> A Height Bonus is awarded for the highest *Fill Level* shared by all three *Goals*. If the *Fill Levels* meet the criteria for multiple *Height Bonuses*, only the highest of those Bonuses will be awarded.

| If all Goals have a Fill Level of...	...then the Height Bonus is
1 or higher	10 points
2 or higher	20 points
3	30 points

In cases where a *Fill Level* is "too close to call," *Teams* will be given the "benefit of the doubt," and the higher of the two possible *Fill Levels* should be assigned. *Head Referees* will not be expected or required to define a perfect horizontal plane within a *Goal* or check imperceptibly small measurements.

Example 1

| Fill Level: 2 Uniform: Yes | Fill Level: 2 Uniform: Yes | Fill Level: 2 Uniform: Yes |

Highest common Fill Level: 2

All three *Goals* reached *Fill Level* 2, and all three *Goals* are considered *Uniform*.

Total # *Blocks*: 6

Height Bonus: 20

Total *Uniform* Bonus: 30

Total: 56

Example 2

| Fill Level: 1 Uniform: No | Fill Level: 2 Uniform: Yes | Fill Level: 3 Uniform: Yes |

Highest common Fill Level: 1

Even though *Goals* II and III reached higher *Fill Levels*, the overall *Height Bonus* is still only 10 points because of *Goal* I's *Fill Level*. *Goal* I is not considered *Uniform* because it only contains one *Block*.

Total # *Blocks*: 7

Height Bonus: 10

Total *Uniform* Bonus: 20

Total: 37

<SC7> Referees will verify if a **Robot is Fully or Partially Parked** by sliding a right-angle tool (such as a VEX IQ beam/plate) along the outside edge of the red PVC pipe or the *Field Perimeter*.

Note: Parking is evaluated independently of all other scoring statuses. For example, the Supply Zone does not need to be Cleared in order for Robots to be considered Parked.
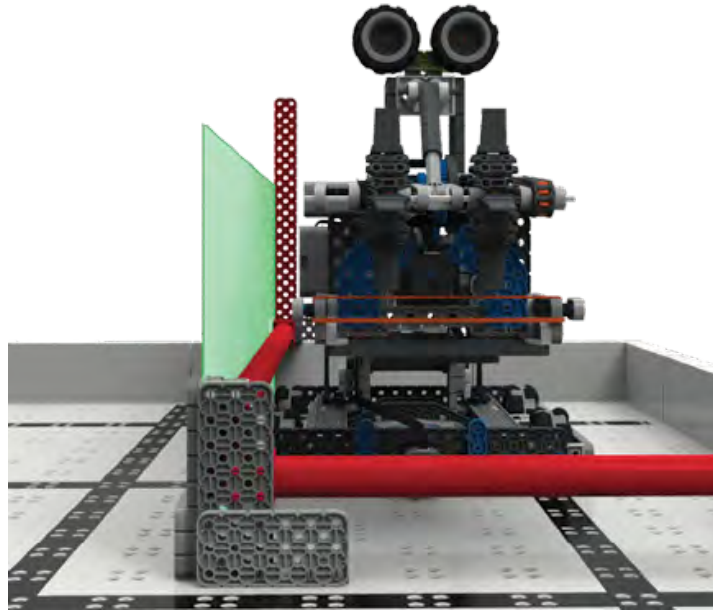
Figure 14: This Robot would be considered as Parked, because it is completely within the boundaries of the Supply Zone.
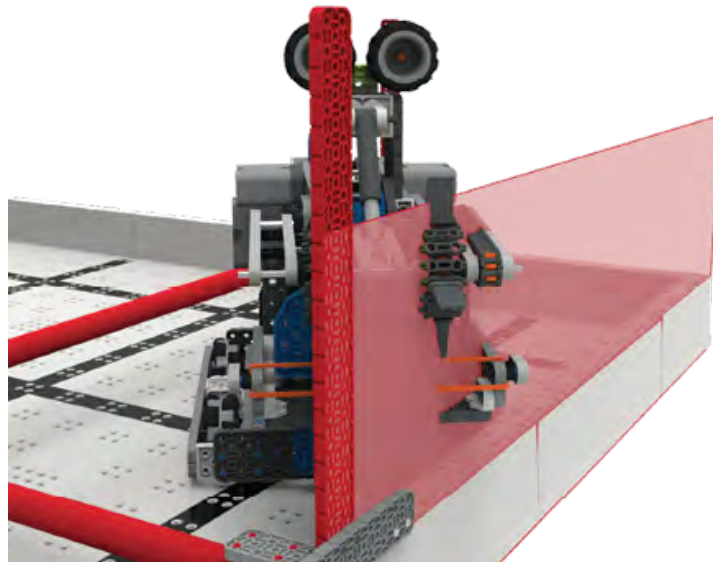
Figure 15: This Robot would be considered as Partially Parked, because it is not completely within the boundaries of the Supply Zone.
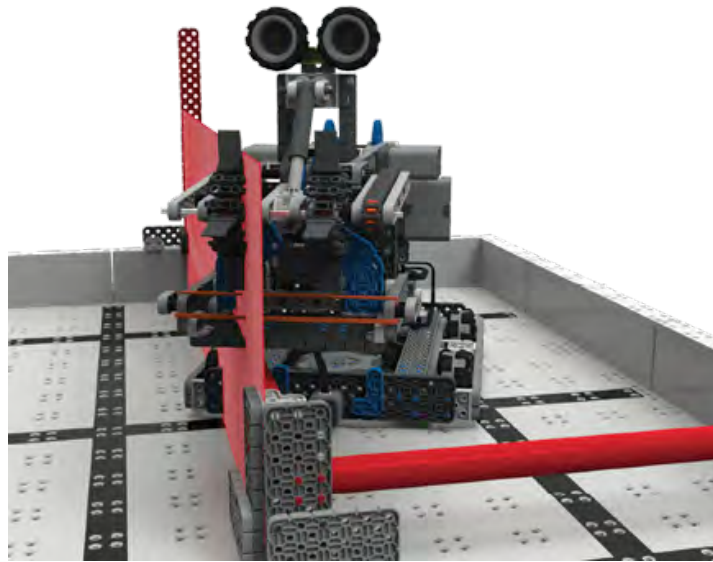
Figure 16: This Robot would be considered as Partially Parked, because it is not completely within the boundaries of the Supply Zone.

Safety Rules

<S1> Stay safe, don't damage the Field. If, at any time, the *Robot* operation or *Team* actions are deemed unsafe or have damaged any *Field Elements* or *Blocks*, the offending *Team* may be *Disabled* and/or Disqualified at the *Head Referee's* discretion. The *Robot* will require re-inspection before it may again take the *Field*.

<S2> Students must be accompanied by an Adult. No *Student* may attend a VEX IQ Robotics Competition 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. *Violations* of this rule may result in removal from the event.

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 IQ 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.

This rule exists alongside the REC Foundation Code of Conduct. Violation of the Code of Conduct can be considered a *Major 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://viqc-kb.recf.org/hc/en-us/articles/9778593540247-Code-of-Conduct.

More information regarding the event Code of Conduct process can be found at:
https://vrc-kb.recf.org/hc/en-us/articles/16943747839383-Event-Code-of-Conduct-Process

> **We all can contribute to creating a fun and inclusive event experience for all event attendees. Some examples include:**
>
> **When dealing with difficult and stressful situations, it is…**

- **Okay for _Teams_ to be gracious and supportive when your _Alliance_ partner makes a mistake.**
- **Not okay for _Teams_ to harass, tease, or be disrespectful to your _Alliance_ partner when a _Match_ does not go your way.**

> **When a _Team_ does not understand a _Match_ ruling or score, it is…**

- **Okay for _Drivers_ to consult with a _Head Referee_ to discuss a ruling per the process outlined in _<T3>_ in a calm and respectful manner.**
- **Not okay for _Drivers_ to continue arguing with the _Head Referee_ after a decision has been finalized, or for _Adults_ to approach a _Head Referee_ with ruling/scoring concerns.**

> **When _Teams_ are getting ready for an upcoming _Match_, it is…**

- **Okay for _Teams_ in an _Alliance_ to develop a game strategy that utilizes the strengths of both _Robots_ to cooperatively solve the game.**
- **Not okay for one _Team_ in an _Alliance_ to ask another _Team_ to sit in a corner during the _Match_ or to intentionally play beneath their abilities.**

Violation Notes: All Violations of <G1> are considered Major Violations and should be addressed on a case-by-case basis. Teams at risk of a <G1> Violation due to multiple disrespectful or uncivil behaviors will usually receive a "final warning", although the Head Referee is not required to provide one.

<G2> VIQRC 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 premade 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://viqc-kb.recf.org/hc/en-us/articles/9778591033879-Student-Centered-Policy

Violation Notes: Potential Violations of this rule will be reviewed on a case-by-case basis. By definition, all Violations of this rule become Score Affecting as soon as a Robot which was built by an Adult scores points in a Match.

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

Some examples may include:

- If there is an obvious typographical error (such as "per **<T5>**" instead of "per **<G5>**"), this does not mean that the error should be taken literally until corrected in a future update.
- Understand the realities of the VEX IQ **_Robot_** construction system. For example, if a **_Robot_** could hover above the **_Field_** for a whole **_Match_**, that would create loopholes in many of the rules. But… they can't. So… don't worry about it.
- When in doubt, if there is no rule prohibiting an action, it is generally legal. However, if you have to ask whether a given action would violate **<S1>**, **<G1>**, or **<T1>**, then that's probably a good indication that it is outside the spirit of the competition.
- In general, **_Teams_** will be given the "benefit of the doubt" in the case of accidental or edge-case rules infractions. However, there is a limit to this allowance, and repeated or strategic infractions will still be penalized.

<G4> The Robot must represent the skill level of the Team. Each *Team* must include *Drivers*, *Programmer*(s), *Designer*(s), and *Builder*(s). No *Student* may fulfill any of these roles for more than one VEX IQ 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 *Driver*.

    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*, <G4> 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) *Driver* and/or one (1) *Programmer* on the *Team* cannot attend the event. The *Team* can make a single substitution of a *Driver* 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*.

Violation Notes: 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 been a *Driver* for one day. This rule is intended to block any instance of loaning or sharing *Team* members for the sole purpose of gaining a competitive advantage.

<G5> Robots begin the Match in the starting size. At the beginning of a *Match*, each *Robot* must fit within an 11" wide x 20" long x 15" high (279mm x 508mm x 381mm) volume, as checked during inspection per <R4>.

Violation Notes: Any Violation of this rule will result in the Robot being removed from the Field prior to the start of the Match; rules <R3d> and <T6> will apply until the situation is corrected. They will not receive a Disqualification, but they will not be permitted to play in the Match.

<G6> Keep your Robot together. *Robots* may not intentionally detach parts or leave mechanisms on the *Field* during any *Match*. Parts that become unintentionally detached from the *Robot* are no longer considered to be part of the *Robot* and can be either left on the *Field* or collected by a *Driver* (utilizing <G10>).

Note: Adding or replacing mechanisms on a Robot mid-Match (e.g. during a <G10> interaction) is considered a Violation of the intent and spirit of this rule.

<G7> Don't damage the Field. *Robot* interactions which damage the *Field* or any *Field Elements* are prohibited. For the purpose of this rule, "damage" is defined as anything which requires repair in order to begin the next *Match*, such as causing part of a *Goal* to detach from the *Field*.

Teams **are responsible for the actions of their** *Robots* **at all times, especially when interacting with** *Goals* **and the** *Supply Zone***. If a** *Team* **chooses to repeatedly ram full-speed into a** *Goal***, it will be hard to convince a** *Head Referee* **that any damage caused was "accidental."**

Violation Notes:

- *In most cases, accidental Field damage should only be considered a Minor Violation / formal warning*
- *Accidentally dislodging a Starting Peg is not considered a Major Violation*
- *Egregious, intentional, or repeated accidental / Minor Violations may escalate to a Major Violation at the Head Referee's discretion*

<G8> Drivers drive your Robot, and stay in the Driver Station. During a *Match*, *Robots* may only be operated by that *Team's Drivers* and/or software running on the *Robot's* control system. *Drivers* must remain in their *Driver Station*, except when legally interacting with their *Robot* as per <G10>.

Drivers are prohibited from any of the following actions during a *Match*:

    a. Bringing/using any sort of communication devices into the *Driver Station*. Devices with communication features turned off (e.g., a phone in airplane mode) are allowed.

    b. Standing or sitting on any sort of object during a *Match*, regardless of whether the *Field* is on the floor or elevated.

    c. Materials used outside of the 1:00 *Match* time are permitted, provided that no other rules are violated. Examples could include a bin to help carry the *Robot* to the *Field*, or VEX IQ parts used to help align the *Robot* at the start of the *Match*.

Note: Drivers are the only Team members that are allowed to be in the Driver Station during a Match. Adults (other than event staff) are not permitted to be in the Driver Station during a Match.

Violation Notes: Major Violations of this rule are not required to be Score Affecting, and could invoke Violations of other rules, such as <G1>, <G2>, or <G11>.

<G9> Hands out of the Field. *Drivers* are prohibited from making intentional contact with any *Field Element*, *Block*, or *Robot* during a *Match*, except for the allowances in <G10>, <RSC5> and/or <SG3>.

<G10> Handling the Robot mid-match is allowed under certain circumstances. If a *Robot* goes completely outside the playing *Field*, gets stuck, tips over, or otherwise requires assistance, the *Team's Drivers* may retrieve & reset the *Robot*. To do so, they must do the following:

1. Signal the Referee by placing their VEX IQ Controller on the ground.
2. Any *Blocks* being controlled by the *Robot* while being handled must be removed from the *Field*.

    a. In the context of this rule, "controlled" implies that the *Robot* was manipulating the *Block*, and not simply touching it. For example, if the *Block* moves with the *Robot* either vertically or while turning, then the *Robot* is "controlling" the *Block*.

3. The *Robot* must be placed back into a legal position that meets the criteria listed in <SG1> (i.e., contacting the *Field Perimeter*, not contacting any *Blocks*, etc).

If the *Drivers* cannot reach the *Robot* due to the *Robot* being in the center of the *Field*, the *Drivers* may ask the *Head Referee* to pick up the *Robot* and hand it to the *Drivers* for placement according to the conditions above.

Violation Notes: This rule is intended to allow Teams to fix damaged Robots or help get their Robots "out of trouble." Strategically exploiting this rule may be considered a Minor Violation or Major Violation at the Head Referee's discretion.

<G11> A Team's two Drivers switch Controllers midway through the Match. In a given *Match*, up to two (2) *Drivers* may be in the *Driver Station* per *Team*. The two *Drivers* must switch their controller between twenty-five seconds (0:25) and thirty-five seconds (0:35) remaining in the *Match*.

   a. No *Driver* shall operate a *Robot* for more than thirty-five seconds (0:35).
   b. The second *Driver* may not touch their *Team's* controls until the controller is passed to him/her.
   c. Once the controller is passed, the first *Driver* may no longer touch their *Team's* controls.

Note: If only one Driver is present (i.e., the Team has not exercised the allowance in <G4>), this rule still applies, and they must cease Robot operation after the first thirty-five (0:35) seconds of the Match.

Violation Notes: At a minimum, any Violation of this rule is considered a Minor Violation. Whether it escalates to a Major Violation or not is dependent upon the Head Referee's judgment regarding:

- *Prior warnings or Violations*
- *Any Score Affecting actions that were a direct result of the Violation, such as the first Driver scoring additional points after 35 seconds of driving*

Specific Game Rules

<SG1> Pre-match setup. At the beginning of a *Match*, *Robot*s must meet the following criteria:

   1. Not contacting any *Blocks*, *Goals* or their supporting structure, *Starting Pegs*, or other *Robots*.
   2. Fit within an 11" wide x 20" long x 15" high (279mm x 508mm x 381mm) volume, as checked during inspection per <R3>.
   3. Contacting the inside and/or top face of the *Field Perimeter* wall that is between *Goals* I and II. See Figure 18.
   4. Have no motors or other mechanisms in motion or "running" until the *Match* begins. Pre-charging a pneumatic system (i.e., having the Pneumatic Pump running prior to the Match) is the only permitted exception to this rule.
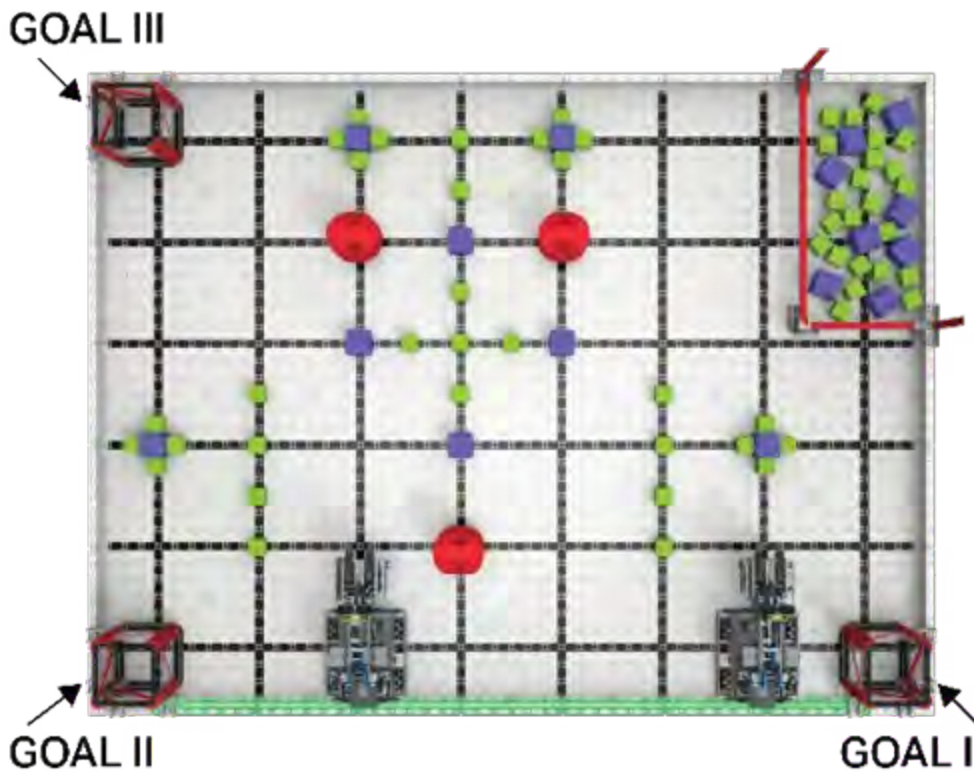
Violation Notes: Any Violation of this rule will result in the Robot being removed from the Field prior to the start of the Match; rules <R3d> and <T6> will apply until the situation is corrected. They will not receive a Disqualification, but they will not be permitted to play in the Match.

Note: There are no specific starting positions, as long as the above criteria are met. Head Referees may ask Teams to temporarily move their Robot between two of the black lines on the Field for a size check, but there is no requirement for them to start the Match in that location once the size has been verified.

<SG2> Horizontal expansion is limited during a Match. *Robots* may not expand horizontally beyond the 11" x 20" starting dimension limit at any time during a *Match*.

Note: There are no restrictions on vertical expansion.
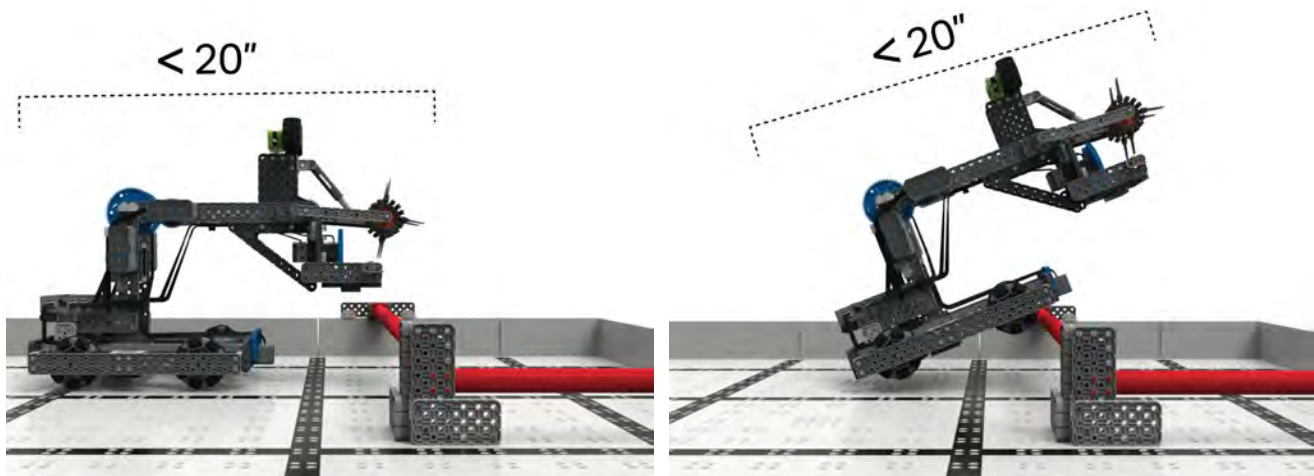
<SG3> Keep Blocks in the Field. *Blocks* that leave the *Field* during a *Match* may be returned to the *Supply Zone* by a *Driver* or *Referee*

    a. "Leaving the *Field*" means that a *Block* is outside of the *Field Perimeter* and no longer in contact with the *Field*, *Field Elements*, other *Blocks*, or *Robots*. If *Blocks* are removed from a *Robot* during a *<G10>* interaction, these *Blocks* are considered "out of the *Field*" as soon as they are no longer in contact with a *Robot*.

    b. *Blocks* may not be placed in contact with a *Robot*

    c. Moving or disturbing other *Blocks* during this action may be considered a *Violation* of rule *<G9>*. If a *Block* is unable to be returned without disturbing other *Blocks*, it should remain outside of the *Field* until it can be legally placed.

    d. Any *Blocks* which remain outside of the *Field* at the end of a *Match* will be considered "in" the *Supply Zone* (i.e., the *Supply Zone* will not be eligible to be *Cleared*).

Note: If a Block is unable to be returned to the Supply Zone without disturbing or moving other Blocks, it may remain outside of the Field.

> **If a _Block_ is on its way out of the _Field_ (as determined by the _Head Referee_), but is deflected back into the field by a _Driver_, field monitor, ceiling/wall, or other external factor, <SG3> would still apply. This _Block_ should be considered "out of the _Field_" and removed or returned to the _Supply Zone_ by a _Head Referee_. If the redirection occurred due to contact with a _Driver_, it will be at the _Head Referee's_ discretion whether <G9> or <SG3> should apply.**

<SG4> Blocks are randomly loaded in the Supply Zone. Prior to each *Match*, the *Supply Zone* will be filled randomly with eight (8) Purple *Blocks* and twenty-three (23) Green *Blocks*.

    a. *Blocks* will be randomly mixed by a field reset volunteer and/or the *Head Referee*.

b. *Blocks* must be placed such that one face of each *Block* is "flat" on the *Floor* (i.e. not "stacked" or "tilted'). See images throughout this Game Manual for examples.

c. *Team* members may not touch *Blocks* in the *Supply Zone* during pre-*Match* setup. Any contact will result in a re-randomization of the *Supply Zone* by the *Head Referee*.

Robot Skills Challenge Rules

<RSC1> Standard rules apply in most cases. All rules and scoring from previous sections apply to the *Robot Skills Matches*, unless otherwise specified.

a. There is no *Double Parked* bonus for *Robot Skills Matches*.

<RSC2> Skills Scoring and Ranking at events. For each *Robot Skills Match*, *Teams* are awarded a score based on the standard rules and scoring rules. *Teams* will be ranked based on the following scores and tiebreakers:

1. Sum of highest *Autonomous Coding Skills Match* score and highest *Driving Skills Match* Score.
2. Highest *Autonomous Coding Skills Match* score.
3. Second-highest *Autonomous Coding Skills Match* score.
4. Second-highest *Driving Skills Match* score.
5. Highest sum of *Skills Stop Times* from a *Team's* highest *Autonomous Coding Skills Match* and highest *Driving Skills Match* (i.e., the *Matches* in point 1).
6. Highest *Skills Stop Time* from a *Team's* highest *Autonomous Coding Skills Match* (i.e., the *Match* in point 2).
7. Third-highest *Autonomous Coding Skills Match* score
8. Third-highest *Driving Skills Match* score.
9. If the tie cannot be broken after all above criteria (i.e., both *Teams* have the exact same scores and *Skills Stop Times* for each *Autonomous Coding Skills Match* and *Driving Skills Match*), then the following ordered criteria will be used to determine which team had the "best" *Autonomous Coding Skills Match*:
   a. Points for *Blocks* Scored in *Goals*
   b. Points for *Height Bonus*
   c. Points for *Uniform Goals*
10. If the tie still cannot be broken, the same process in the step above will be applied to the *Teams'* highest *Driving Skills Matches*.
11. If the tie still isn't broken, the *Event Partner* may choose to allow *Teams* to have one more deciding *Match*, or both *Teams* may be declared the winner.

<RSC3> Handling Robots during an Autonomous Coding Skills Match. A *Team* may handle their *Robot* as many times as desired during an *Autonomous Coding Skills Match*.

    a. Upon handling the *Robot*, it must be immediately brought back to any legal Starting Position.

        i. *Drivers* may reset or adjust the *Robot* as desired from this position, including pressing buttons on the Robot Brain or activating sensors.

    b. Any *Blocks* being controlled by the *Robot* while being handled must be removed from the *Field*, and can be returned to the *Supply Zone* by a referee or *Driver*. "Controlled" requires that the *Robot* was manipulating the *Block* and not simply touching it (e.g., if the *Block* moves with the *Robot* either vertically or while turning, the *Robot* is controlling the *Block*).

    c. Any *Blocks* within the chosen Starting Position for a reset must be removed from the *Field* and can be returned to the *Supply Zone* by a referee or *Driver*.

    d. During an *Autonomous Coding Skills Match*, *Drivers* may move freely around the *Field*, and are not restricted to the *Driver Station* when not handling their *Robot*.

        i. The rest of <G8>, which states that *Drivers* are not allowed to use any communication devices during their *Match*, still applies.

        ii. An intent of this exception is to permit *Drivers* who wish to "stage" *Robot* handling during an *Autonomous Coding Skills Match* to do so without excessive running back and forth to the *Driver Station*.

Note: This rule only applies to Autonomous Coding Skills Matches. Driving Skills Matches are still governed by <G9> & <G10>, especially for strategic violations.

Note 2: Any Blocks which remain outside of the Field at the end of a Match will be considered "in" the Supply Zone (i.e., the Supply Zone will not be eligible to be Cleared).

<RSC4> Starting an Autonomous Coding Skills Match. *Drivers* must start a *Robot's Autonomous Coding Skills Match* routine by pressing a button on the Robot Brain or manually activating a sensor. Because there is no VEX IQ Controller hand-off, only one (1) *Driver* is required for an *Autonomous Coding Skills Match* (though *Teams* may still have two (2) if desired).

    a. Pre-match sensor calibration is considered part of the standard pre-*Match* setup time (i.e., the time when the *Team* would typically be turning on the *Robot*, moving any mechanisms to their desired legal start position, etc.).

    b. Pressing a button on the VEX IQ Controller to begin the routine is not permitted. To avoid any confusion, *Teams* are advised not to bring controllers to *Autonomous Coding Skills Match*.

<RSC5> Skills Stop Time. If a *Team* wishes to end their *Robot Skills Match* early, they may elect to record a *Skills Stop Time*. This is used as a tiebreaker for *Robot Skills Challenge* rankings. A *Skills Stop Time* does not affect a *Team's* score for a given *Robot Skills Match*. *Drivers* and field staff must agree prior to the *Match* on the signal that will be used to end the *Match* early.

a. As noted in the definition of *Skills Stop Time*, the moment when the *Match* ends early is defined as the moment when the *Robot* and *Blocks* have come to a rest and the *Driver* provides the agreed upon visual and audio signal to the *Scorekeeper Referee*.

b. *Teams* who intend to attempt a *Skills Stop Time* must "opt-in" by verbally confirming with the *Scorekeeper Referee* prior to the *Robot Skills Match*. If no notification is given prior to the start of the *Match*, then the *Team* forfeits their option to record a *Skills Stop Time* for that *Match*.

c. This conversation should include informing the *Scorekeeper Referee* which *Driver* will signal the stop. The *Match* may only be ended early by a *Driver* for that *Match*.

d. The agreed-upon signal to stop the match must be both verbal and visual, such as *Drivers* crossing their arms in an "X" or placing their VEX IQ Controller on the ground.

e. It is recommended that the *Driver* also provides a verbal notice that they are approaching their *Skills Stop Time*, such as counting out "3-2-1-stop."

f. If a *Team* runs multiple *Robot Skills Matches* in a row, they must reconfirm their *Skills Stop Time* choice with the *Scorekeeper Referee* prior to each *Match*.

g. Any questions regarding a *Skills Stop Time* should be reviewed and settled immediately following the *Match*. <T1> and <T3> apply to *Robot Skills Matches*.

ROBOT EQUIPMENT

The Robot

<R1> One Robot per Team. Only one (1) *Robot* will be allowed to participate per *Team* at a given event. Though it is expected that *Teams* will make changes to their *Robots* at the event, a *Team* is limited to only one (1) *Robot*, and a given *Robot* may only be used by (1) *Team*. The VEX IQ system is intended to be a mobile robotics design platform. As such, a VEX IQ Robotics Competition *Robot*, for the purposes of the VEX IQ Robotics Competition, has the following subsystems:

- Subsystem 1: Mobile robotic base including wheels, tracks, 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 VEX IQ legal battery, a VEX IQ control system, and associated Smart Motors for the mobile robotic base.
- Subsystem 3: Additional mechanisms (and associated Smart Motors) that allow manipulation of *Blocks* or navigation/manipulation of *Field Elements*.

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

- *Teams* may not compete with one *Robot* while a second is being modified or assembled at a competition.
- *Teams* may not have an assembled second *Robot* on hand at a competition that is used to repair or swap parts with the first *Robot*.
- *Teams* may not switch back and forth between multiple *Robots* during a competition. This includes using different *Robots* for Skills Challenge, *Qualification Matches*, and/or *Finals Matches*.
- 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> is 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 that puts in the time, effort, and resources to undergo separate individual design processes and develop their own *Robots*.

To help determine whether 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 complete and legal *Robots* on a table next to each other, then they are two separate *Robots*. Trying to decide if changing a pin, a wheel, or a motor constitutes a separate *Robot* is missing the intent and spirit of this rule.

<R2> Robots must represent the Team's skill level. The *Robot* must be designed, built, and programmed by members of the *Team*. *Adults* are permitted 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 VIQRC, we expect _Adults_ to teach fundamental _Robot_ principles like linkages, drivetrains, and manipulators, then allow the _Students_ to determine which designs to implement and build on their _Robot_.

Similarly, _Adults_ are encouraged to teach the _Students_ how to code various functions involving applicable sensors and mechanisms, then have the _Students_ program the _Robot_ from what they have learned.

<R3> Robots must pass inspection. The _Team's Robot_ must pass inspection before being allowed to participate in any _Matches_. Noncompliance with any _Robot_ design or construction rule will result in removal from _Matches_ or _Disqualification_ of the _Robot_ at an event until the _Robot_ is brought back into compliance, as described in the following subclauses.

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 asked to submit to random spot inspections by _Head Referees_. Refusal to submit will result in _Disqualification_.

    i. If a _Robot_ is determined to not be legal before a _Match_ begins, the _Robot_ will be removed from the _Field_. A _Driver_ may remain so that the _Team_ does not get assessed a "no-show" (per <T5>).

d. _Robots_ which have not passed inspection (i.e., that are in _Violation_ of one or more _Robot_ rules) will not be permitted to play in any _Matches_ until they have done so. <T6> 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 or immediately following a _Match_, then they will be Disqualified from that _Match_ and <R3d> / <T6> will apply until the _Violation_ is remedied and the _Team_ is re-inspected.

f. All inspection rules are to be enforced at the discretion of the _Head Referee_ within a given event. _Robot_ legality at one event does not automatically imply legality at future events. _Robots_ which rely on "edge-case" interpretations of subjective rules, such as whether a decoration is "non-functional" or not, should expect additional scrutiny during inspection.

<R4> Starting configuration. At the start of each _Match_, the _Robot_ must be able to satisfy the following constraints:

a. Only be contacting the _Floor_ and the _Field Perimeter_.

b. Fit within an 11" x 20" x 15" (279.4mm x 508mm x 381.0mm) volume.

c. The starting configuration of the *Robot* at the beginning of a *Match* must be the same as a *Robot* configuration inspected for compliance, and within the maximum allowed size.

   i. *Teams* using more than one possible *Robot* configuration at the beginning of *Matches* must tell the Inspector(s) and have the *Robot* inspected in its largest configuration(s).

   ii. A *Team* may NOT have its *Robot* inspected in one configuration and then place it in an uninspected configuration at the start of a *Match*.
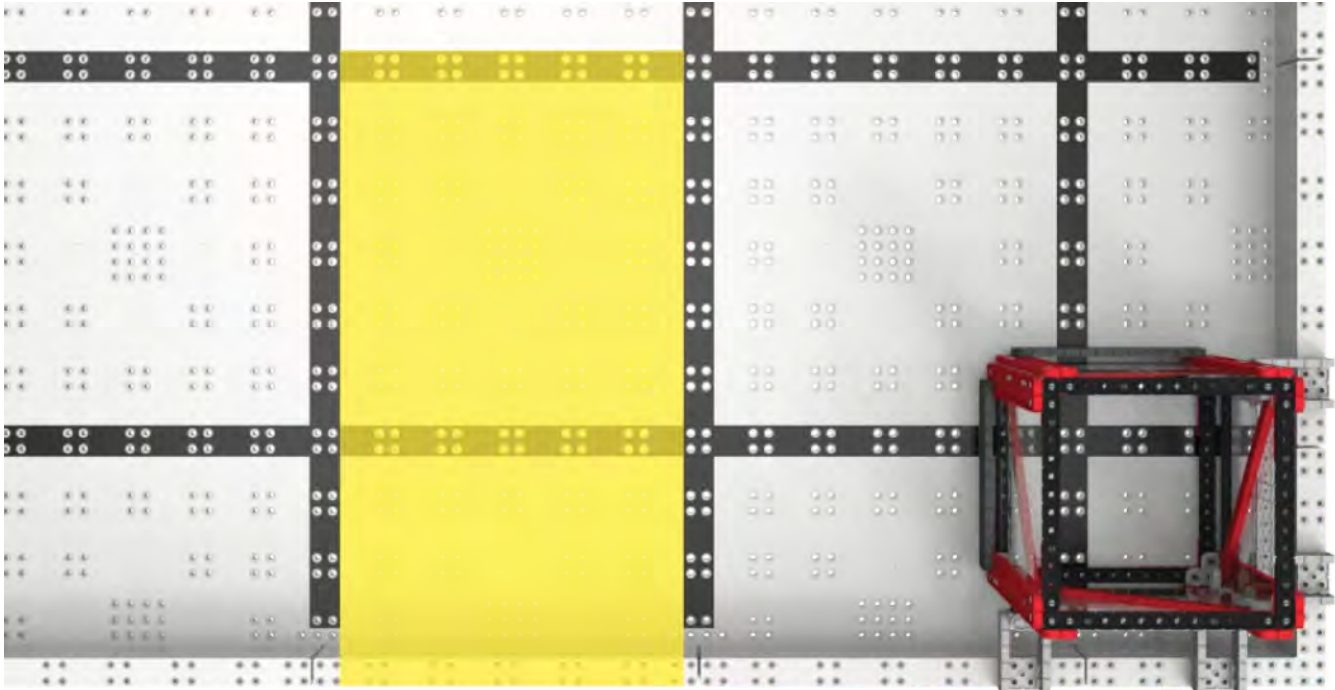
Figure 20: The approximate starting size that a Robot should start the Match in.

<R5> Prohibited items. The following types of mechanisms and components are NOT allowed:

a. Those that could potentially damage *Field Elements* or *Blocks*.

b. Those that could potentially damage or entangle other *Robots*.

<R6> VEX IQ product line. *Robots* may be built ONLY from official *Robot* components from the VEX IQ product line, unless otherwise specifically noted within these rules.

a. Official VEX IQ products are ONLY available from VEX Robotics. To determine whether a product is "official" or not, consult www.vexiq.com.

b. If an Inspector or event official questions whether something is an official VEX IQ component, the *Team* will be required to provide documentation to an inspector that proves the

component's source. Such documentation may include receipts, part numbers, or other printed documentation.

c. Only VEX IQ components specifically designed for use in *Robot* construction are allowed. Using additional components outside their typical purpose is against the intent of the rule (i.e., please don't try using VEX IQ apparel, *Team* or event support materials, packaging, *Field Elements*, or other non-*Robot* products on a VEX IQ Robotics Competition *Robot*).

d. Products from the VEX V5, VEX CTE, VEX EXP, Cortex, or VEXpro product lines cannot be used for *Robot* construction. However, products from the VEX V5 product line that are also cross-listed as part of the VEX IQ product line are legal. A "cross-listed" product is one which can be found in both the VEX IQ and VEX V5 sections of the VEX Robotics website.

e. Mechanical/structural components from the VEX Robotics by HEXBUG* product line are legal for *Robot* construction. However, electrical components from the VEX Robotics by HEXBUG product line are illegal for *Robot* construction.

f. Mechanical/structural components from the VEX GO product line are legal for *Robot* construction. However, electrical components from the VEX GO product line are illegal for *Robot* construction.

g. Official Robotics components from the VEX IQ product line that have been discontinued are still legal for *Robot* use. However, *Teams* must be aware of <R6b>.

h. Functional 3D printed components, such as replicas of legal VEX IQ parts or custom designs, are not legal for *Robot* use.

i. Additional VEX IQ products that are released during the season are legal for use, unless otherwise noted on their product pages and/or in the VEX IQ Robotics Competition Legal Parts Appendix.

j. VEX IQ Smart Cables may only be used for connecting legal electronic devices to the VEX IQ Robot Brain.

Note: A comprehensive list of legal parts can be found in the VEX IQ Robotics Competition Legal Parts Appendix, at https://www.vexrobotics.com/iq/competition/viqc-current-game. This Appendix is updated as needed if/when new VEX IQ parts are released, and may not coincide with scheduled Game Manual updates.

* The HEXBUG brand is a registered trademark belonging to Spin Master Corp

<R7> Non-VEX IQ components. *Robots* are allowed to use the following additional "non-VEX IQ" components:

> a. Rubber bands that are identical in length and thickness to those included in the VEX IQ product line (#32, #64 & #117B).
>
> b. ⅛" metal shafts from the VEX V5 product line.

<R8> 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.

> a. Decorations must be in the spirit of an educational competition.
>
> b. To be considered "non-functional," any decorations must be backed by legal materials that provide the same functionality. For example, a giant decal cannot be used to prevent *Blocks* from falling out of the *Robot* unless it is backed by VEX IQ material. A simple way to check this is to determine if removing the decoration would impact the performance of the *Robot* in any way.
>
> c. The use of non-toxic paint is considered a legal non-functional decoration. However, any paint being used as an adhesive or to impact how tightly parts fit together would be classified as functional.

Teams should be mindful of any non-functional decorations which could risk "distracting" *Alliance* partner *Robots*' Vision Sensor or other sensors.

<R9> Officially registered Team numbers must be displayed on Robot License Plates. To participate in an official VEX IQ Robotics Competition Event, a *Team* must first register on robotevents.com and receive a VEX IQ Robotics Competition Team Number.

This *Team* number must be legibly displayed on at least one (1) VEX IQ Robotics Competition *License Plate*. *Teams* may choose to use the official VEX IQ Robotics Competition *License Plate* (VEX Part Number 228-7401), or may create their own custom *License Plates*.

> a. *License Plates* must fulfill all inspection rules.
>
> b. *License Plates* must be clearly visible at all times. For example, *License Plates* must not be in a position that would be easily obstructed by a *Robot* mechanism during standard *Match* play.
>
> c. Any custom-made *License Plates* used must be the same length and height as the official *License Plate* (3.5" x 1.5" [88.9mm x 38.1mm]). They must not exceed the width of the official *License Plate* (0.25" [6.35mm]).

d. Custom-made *License Plates* are considered non-functional decorations, and must therefore meet all of the criteria listed in <R8>. Therefore, 3D printed *License Plates* are permitted within these rules.
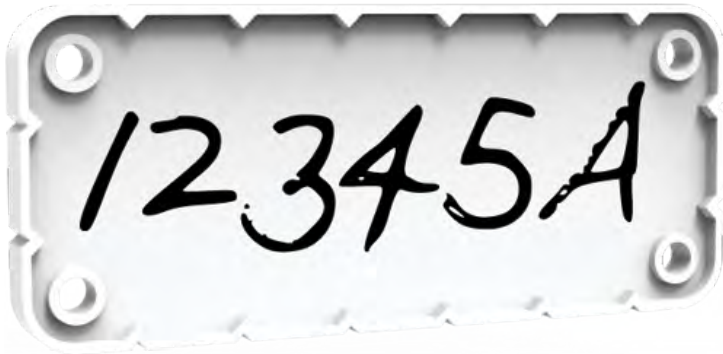

Figure 21: A VEX IQ Robotics Competition License Plate with a VEX IQ Robotics Competition Team Number written upon it.

Figure 22: An example of a legal custom License Plate.

<R10> Let it go after the Match is over. *Robots* must be designed to permit easy removal of *Blocks* from their *Robot* without requiring that the *Robot* have power or remote control after the *Match* is over.

<R11> Robot Brain. *Robots* are limited to one (1) VEX IQ Robot Brain.

a. Robot Brains, microcontrollers, and other electronic components that are part of the VEX Robotics by HEXBUG, VEX GO, VEX EXP, VEX V5, VEX 123, or VEXpro product lines are not allowed.

    i. The Robot AA Battery Holder (228-3493) is the only exception to this rule, per <R13>.

b. If using a first generation VEX IQ Brain, Robots must use one (1) VEX IQ 900 MHz radio, VEX IQ 2.4 GHz radio, or VEX IQ Smart Radio in conjunction with their VEX IQ Robot Brain.

c. The only legal method of driving the *Robot* during *Teamwork Challenge* Matches and *Driving Skills Matches* is the VEX IQ Controller.

d. See <RSC5> and <RSC6> for more information about operating the *Robot* during *Autonomous Coding Skills Matches*.

<R12> Motors. *Robots* may use up to six (6) VEX IQ Smart Motors.

    a. Additional motors cannot be used on the *Robot* (even motors that aren't connected).

<R13> Batteries. The only allowable sources of electrical power for a VEX IQ Robotics Competition *Robot* are one (1) VEX IQ Robot Battery (first or second generation) or six (6) AA batteries via the Robot AA Battery Holder (228-3493).

    a. Additional batteries cannot be used on the *Robot* (even batteries that aren't connected).

    b. *Teams* are permitted to have an external power source (such as a rechargeable battery pack) plugged into their VEX IQ Controller during a *Match*, provided that this power source is connected safely and does not violate any other rules (such as <G8>).

Note: Although it is legal, the Robot AA Battery Holder (228-3493) is not recommended for use in the VEX IQ Robotics Competition.

<R14> Firmware. *Teams* must have their VEX IQ firmware (VEXos) up to date. *Teams* can download the latest version of VEXos at www.vexiq.com/vexos.

<R15> Modifications of parts. Parts may NOT be modified unless specifically listed as an exception in this rule. Examples of modifications include, but are not limited to, bending, cutting, sanding, gluing, or melting. The following exceptions are legal:

    a. Cutting metal VEX IQ or VEX V5 shafts to custom lengths.

    b. Bending parts which are intended to be flexible, such as string, rubber bands, or thin plastic sheets.

    c. Cutting VEX IQ pneumatic tubing to custom lengths.

<R16> Pneumatics. *Robots* using parts from the VEX IQ Pneumatics Kit (228-8795) must satisfy the following criteria:

    a. No more than two (2) Air Tanks, including any that aren't connected.

    b. No more than (1) Pneumatic Pump, including any that aren't connected.

    c. No additional parts that are not included in the VEX IQ Pneumatics Kit (e.g., unofficial tubing or fittings).

Note: There is no limit on the number of Pneumatic Cylinders or Pneumatic Control Units that may be used, provided that no other rules are violated. There are no restrictions on running the Pneumatic Pump prior to (or during) Matches.

The intent of <R16a> is to limit *Robots* to the air pressure stored in two Air Tanks, as well as the normal working air pressure contained in any Pneumatic Cylinders and tubing on the *Robot*. *Teams* may not use other elements for the purposes of storing or generating air pressure. allianceUsing Pneumatic Cylinders or additional tubing solely for additional air storage is in *Violation* of the spirit of this rule. Similarly, using Pneumatic Cylinders and/or tubing without an actual pneumatic system (e.g., Air Tanks and/or a Pneumatic Pump) is also in *Violation* of the spirit of this rule.

SkillsUSA NLSC Robot Rules

<NLSC-R1> Building Robots during the Competition at SkillsUSA NLSC.

Teams will be required to fully disassemble their robot at the start of the competition or bring a fully disassembled robot to the competition. All Robot Rules must be adhered to, but teams will not be limited to use the quantity of parts in those specific kits. All applicable limitations are listed in the Robot Equipment section of this game manual. You must provide your own robot parts.

<NLSC-R2> Teams may use any programming language. Teams must come to competition with a laptop for programming their Robot. The laptop must have the programming software already installed and licensed. Some programming software options can be found here.
https://www.vexrobotics.com/vexiq/resources/programming

DESIGN PROCESS

Judges must use the Design Rubric to evaluate the teams' design process. A record of all teams submitting notebooks shall be kept by the Judge Advisor. Notebooks shall be collected during the orientation meeting and brought to the Judges' room for evaluation. The Rubric comes in two (2) pages. The first page is for the Engineering Notebook, and the second page is for the Design Interview.

Engineering Notebooks

The Engineering Notebook is a way for teams to document how the VEX Robotics Competition experience has helped them to better understand the engineering design process while also practicing a

variety of critical life skills including project management, time management, brainstorming, and teamwork. Bound notebooks are preferred by Judges and are given a 3-point bonus on the Design Rubric.

Each notebook is created through a concerted effort by a team to document their design decisions.

Engineering is an iterative process whereby students recognize and define a problem, brainstorm and work through various stages of the design process, test their designs, continue to improve their designs, and continue the process until a solution has been identified. During this process, students will come across obstacles, encounter instances of success and failure, and learn many lessons. It is this iterative process that students should document in their Engineering Notebook.

The Engineering Notebook is an opportunity to document everything a team does throughout the design process. Students should include a number of items in their Engineering Notebook including:

- A table of contents
- Team meeting notes as they relate to the design process
- Design concepts, sketches and pictures
- Notes from competitions regarding observations that should be considered in the next iteration of their design
- Programming improvements or significant modifications
- CAD drawings of their Robot and/or specific elements of their Robot.
- Team members' observations and thoughts on their design
- Team organization practices as they relate to their design process
- Other documentation that a team finds useful as related to their robot's design

The team should also document their project management practices including their use of personnel, financial, and time resources.

A bound quad-ruled notebook is the preferred format. The team number should be on the cover. The notebook should never be edited. Pages should never be removed from the notebook even if they contain errors. The notebook should be written in ink with errors crossed out using a single line. Pages should be numbered, and entries should be dated in chronological order with each page signed or initialed by the students. Additional materials such as examples of computer code or CAD drawings should be glued or taped into the notebook.

The question of what is a 'bound' Engineering Notebook often arises. To be considered bound, a notebook must have been bound prior to any entries being made in it. Teams should not be able to insert entries between other entries. Leaving blank pages between entries defeats the purpose of being bound.

Judges will not accept electronic notebooks on laptops, thumb drives, or cloud-based servers.

Design Interview

All teams will be interviewed by Judges who will ask them questions about their robot and design process. Teams should bring their robot with them to the interview. Judges will fill out page 2 of the Design Rubric and give teams a score based on the responses of the team members. Teams are not to prepare a slide presentation such as Power Point for this interview and should be prepared to talk about their robot without any written notes such as cards or written outlines.

Appendix A contains the Design Award Rubric and Design Interview Rubric.

Programming Interview

All teams will be interviewed by Judges who will ask questions about the coding and programming process. Teams should bring their robot, laptop and programming cable with them to the interview. Judges will use the following interview process rubric to determine the knowledge of the programmer and quality of the written code.

Appendix B contains the Programming Interview questions.

Appendix C contains the Programming Interview Scorecard.

SAFETY POINTS

All teams are expected to be safe in the competition area. Students will start with 90-points in Safety and will be deducted 10-points for every instance of a safety violation. The minimum score is zero.

Students will be notified immediately upon each instance of a safety violation. Examples of Safety violations are as follows.

- General horseplay (running, throwing objects, pushing others)
- Not wearing shoes (except when walking on foam tiles)
- Using teeth as a tool (other than eating)
- Leaving equipment in aisles (creating trip hazards)

Note: Eye protection is not required in Junior Mobile Robotics Technology unless cutting metal shafts.

TEAM RANKING

Teams will be given a total score based on the Professional Development Test, Engineering Notebook (Page 1 of the Design Rubric), CAD drawings, the Design Interview (Page 2 of the Design Rubric), the Programming Interview, the team's highest Programming Skills Score, the team's highest Driving Skills Score, and the Team's Safety Score. Teams are ranked by the sum of their weighted scores in these categories.

All teams will be given the same number of Robot Skills Matches to be determined by the Competition Organizer. At SkillsUSA NLSC, each team will get three (3) chances for Programming Skills and three (3) chances for Driving Skills. Only the highest Programming Skills score and the highest Driving Skills score will be used to determine rankings.

In the case of ties, the tie will be broken by looking at the following in order.

1. Engineering Notebook Score
2. Team's highest Programming Skills Score
3. Team's highest Driving Skills Score

Appendix F contains the Mobile Robotics Technology Overall Scorecard.

MOBILE ROBOTICS TECHNOLOGY Jr. APPENDIX

Engineering Notebook Rubric

Team # _____   Grade Level □ ES | □ MS | □ HS | □ VEX U   Judge Name: _____

CRITERIA	PROFICIENCY LEVEL			
ENGINEERING DESIGN PROCESS	**EXPERT** (4-5 POINTS)	**PROFICIENT** (2-3 POINTS)	**EMERGING** (0-1 POINTS)	**POINTS**
IDENTIFY THE PROBLEM	Identifies the game and robot design challenges in detail at the start of each design process cycle with words and pictures. States the goals for accomplishing the challenge.	Identifies the challenge at the start of each design cycle. Lacking details in words, pictures, or goals.	Does not identify the challenge at the start of each design cycle.	
BRAINSTORM, DIAGRAM, OR PROTOTYPE SOLUTIONS	Lists three or more possible solutions to the challenge with labeled diagrams. Citations provided for ideas that came from outside sources such as online videos or other teams.	Lists one or two possible solutions to the challenge. Citations provided for ideas that came from outside sources.	Does not list any solutions to the challenge.	
SELECT BEST SOLUTION AND PLAN	Explains why the solution was selected through testing and/or a decision matrix. Fully describes the plan to implement the solution.	Explains why the solution was selected. Mentions the plan.	Does not explain any plan or why the solution or plan was selected.	
BUILD AND PROGRAM THE SOLUTION	Records the steps to build and program the solution. Includes enough detail that the reader can follow the logic used by the team to develop their robot design, as well as recreate the robot design from the documentation.	Records the key steps to build and program the solution. Lacks sufficient detail for the reader to follow the design process.	Does not record the key steps to build and program the solution.	
TEST SOLUTION	Records all the steps to test the solution, including test results.	Records the key steps to test the solution.	Does not record steps to test the solution.	
REPEAT DESIGN PROCESS	Shows that the design process is repeated multiple times to improve performance on a design goal, or robot/game performance.	Design process is not often repeated for design goals or robot/game performance.	Does not show that the design process is repeated.	
INNOVATION/ ORIGINALITY	Team shows evidence of independent inquiry from the beginning stages of their design process	Team shows evidence of independent inquiry for some elements of their design process	Team shows little to no evidence of independent inquiry in their design process	
USEABILITY AND COMPLETENESS	Records the entire design and development process in such clarity and detail that the reader could recreate the project's history.	Records the design and development process completely but lacks sufficient detail	Lacks sufficient detail to understand the design process.	
RECORD OF TEAM AND PROJECT MANAGEMENT	Provides a complete record of team and project assignments; team meeting notes including goals, decisions, and building/programming accomplishments; Design cycles are easily identified. Resource constraints including time and materials are noted throughout.	Records most of the information listed at the left. Level of detail is inconsistent, or some aspects are missing.	Does not record most of the information listed at the left. Not organized.	
NOTEBOOK FORMAT	Five (5) points if the notebook has evidence that documentation was done in sequence with the design process. This can take the form of dated entries with the names of contributing students included and an overall system of organization. For example, numbered pages and a table of contents with entries organized for future reference.		**ZERO POINTS** (DOES NOT MEET CRITERIA) If awarding zero points, please include details in the "NOTES" area below.	
NOTES: ✏️			**TOTAL POINTS**	

CAD Drawings

(Keep separate from Engineering Notebook Score)

1 point = Made an attempt to have a CAD drawing, but it is not accurate

2-3 points = Have basic elements of CAD drawings

4-5 points = Have detailed CAD drawings for entire Robot including some early iterations of design

CAD Score_____

Team Interview Rubric

Team # _____   Grade Level ☐ ES | ☐ MS | ☐ HS | ☐ VEX U   Judge Name: _____

Directions: Determine a point value that best characterizes the content of the Team Interview for that criterion. Write that value in the column to the right.

CRITERIA	PROFICIENCY LEVEL			POINTS
	EXPERT (4-5 POINTS)	**PROFICIENT** (2-3 POINTS)	**EMERGING** (0-1 POINTS)	
ENGINEERING DESIGN PROCESS *All Awards*	Team shows evidence of independent inquiry from the beginning stages of their design process. This includes brainstorming, testing, and exploring alternative solutions	Team shows evidence of independent inquiry for some elements of their design process	Team shows little to no evidence of independent inquiry in their design process	
GAME STRATEGIES *Design, Innovate, Create*	Team can fully explain their entire game strategy including game analysis	Team can explain their current strategy with limited evidence of game analysis	Team did not explain game strategy/strategy is not student-directed	
ROBOT DESIGN *Design, Innovate, Create, Amaze*	Team can fully explain the evolution of their robot design to the current design	Team can provide a limited description of why the current robot design was chosen, but shows limited evolution	Team did not explain robot design /design is not student-directed	
ROBOT BUILD *Build, Create, Amaze*	Team can fully explain their robot construction. Ownership of the robot build is evident	Team can describe why the current robot design was chosen, but with limited explanation	Team did not explain robot build/build is not student-directed	
ROBOT PROGRAMMING *Think, Amaze*	Team can fully explain the evolution of their programming	Team can describe how the current programs work, but with limited evolution	Team did not explain programming or programming is not student-directed	
TEAM AND PROJECT MANAGEMENT *All Awards*	Team can explain how team progress was tracked against an overall project timeline. Team can explain management of material and personnel resources	Team can explain how team progress was monitored, and some degree of management of material and personnel resources	Team cannot explain how team progress was monitored or how resources were managed.	
TEAMWORK, COMMUNICATION, PROFESSIONALISM *All Awards*	Most or all team members contribute to explanations of the design process, game strategy, and other work done by the team.	Some team members contribute to explanations of the design process, game strategy, and other work done by the team.	Few team members contribute to explanations of the design process, game strategy, and other work done by the team.	
RESPECT, COURTESY, POSITIVITY *All Awards*	Team consistently interacts respectfully, courteously, and positively in their interview	Team interactions show signs of respect and courtesy, but there is room for improvement	Team interactions lack respectful and courteous behavior	
SPECIAL ATTRIBUTES AND OVERALL IMPRESSIONS *Judges, Inspire*	Does the team have any special attributes, accomplishments, or exemplary effort in overcoming challenges at this event? Did anything stand out about this team in their interview? Please describe:			TOTAL POINTS

NOTES:

Professional Dress

(Add this to the Design Interview Score)

As the students walk into the interview, check to see if their shirts are fully tucked in.

Add 5 points if BOTH students have their shirts fully tucked in.

Professional Dress Score_____

(5 or 0)

Mobile Robotics Programming Interview Questions

This interview is comprised of 3 sections. For each section please read all instructions and questions before assessing the team.

Please pay attention to the students' Professional Dress as they walk into the interview. There is a point value evaluation on the Programming Interview Scorecard for this category.

Section 1: General Programming Information (Maximum 15 pts)

For this section you will be asking the team general information about their program. This section will make sure teams have come prepared for their interview.

1. Did the team bring a laptop with their code?

No (0 pts)		Yes (5 pts)	

2. Did the team bring their robot?

No (0 pts)		Yes (5 pts)	

3. Ask the team, what programming software are they using. Does it match the code that was brought to the interview?

No (0 pts)		Yes (5 pts)	

Section 2: Program Design and Fluency (Maximum 60 pts)

In this section you will ask the team to walk you through their code. Ask the team to start at the very beginning and explain the program until the robot stops. Read all questions beforehand because you will need to assess the program after the walk through is complete. The following questions are for the judge and should not be asked to the team.

4. Did the program include comments?

1 pt	2 pt	5 pt	9 pt	10 pt
Program did not contain comments.	Program contained comments but lacked in depth. The comments were only useful for the programmer.			Program contained in depth comments for their entire code base. Comments were articulate and meaningful.

5. Did the program use variables instead of hard coding numbers? (eg. when they set the speed of the motor, is it a number or a variable)?

1 pt	2 pt	5 pt	9 pt	10 pt
Program did not include any variables.	Program contained a mix of variables and hard coded values. Variable may not be organized.			The program used variables for all or most opportunities. Variables were organized and named in a meaningful way.

6. Did the program contain advanced programing structures like loops and if else statements?

1 pt	2 pt	5 pt	9 pt	10 pt
Program did not contain any loops or if else statements.	The program only had a few loops or if/else structure. Some parts of the code were reused in loops but others were programed linearly.			The program contained many loops and if/else structures.

7. Did the program contain functions that were used throughout their code?

1 pt	2 pt	5 pt	9 pt	10 pt
Program did not contain any functions.	The program used some functions but missed opportunities to make a function.			The program had multiple functions and was used to reuse code wherever possible in their program.

8. Is the code formatted in an organized manner?

1 pt	2 pt	5 pt	9 pt	10 pt
Program did not follow any kind of format. Code was not properly indented or spaced in a neat fashion.	Most or some of the code was formatted. There are areas where code could have been formatted a little better.			The entire code base is formatted and spaced.

9. How did the team conduct the walkthrough of their code?

1 pt	2 pt	5 pt	9 pt	10 pt

The team showed zero or minimal knowledge of their program. They were not able to articulate what their program does or where it starts.	Team was able to walk you through the program. Students read the comments verbatim and were not able to explain more than what was already written in the program. The team was unsure about how some of the code worked in some sections.	The team was able to explain all parts of their program. The team used proper terminology when talking about their program. The team was able to explain their code without having to read the comments verbatim.

Section 3: Smart Programming (Maximum 15 pts)

In this section you will be asking the team specific questions about their program. The judge will assess the team on how well they answer each question.

10. Ask the team how many sensors are on their robot that they programed.

1 pt	2 pt	3 pt	4 pt	5 pt
Team uses one or less sensors on their robot.	The team uses a moderate amount of sensors (2 - 3).			Team used a large amount of sensors (4+).

11. Find a sensor on the team's robot or one they mentioned in the question above. An example could be an Encoder in the Smart Motor. Ask the team to show you where in their code that they use this sensor. Is the team able to explain and show you how they used the sensor?

1 pt	2 pt	5 pt	9 pt	10 pt
Team did not use any sensors or could not find how they used the sensor in their code.	The team struggled to find where they used the sensor in their code, and/or was only able to explain how they used the sensor by reading comments in that section. The team did not fully understand what data was being collected by the sensor and how it was used by the program.			Teams were able to quickly find the sensor in their program. They were able to explain in great detail how the program uses the data from the sensor.

SCORECARD

Programming Interview

Team Number _____

Total Score _____

_____ 1. Laptop (5)

_____ 2. Robot (5)

_____ 3. Software Match (5)

_____ 4. Comments (10)

_____ 5. Variables (10)

_____ 6. Programming Structure (10)

_____ 7. Functions (10)

_____ 8. Format (10)

_____ 9. Walkthrough (10)

_____ 10. Number of Sensors (5)

_____ 11. Code for Sensor (10)

_____ Subtotal (90)

_____ Professional Dress: 5 points per student if shirt is fully tucked in as they walk into interview. (10)

_____ Total Score: Copy this number to the top of sheet (100)

Programming Skills Matches

Team Number _____

(2-minute matches)

Highest Score _____

Trial 1

Total: _____

Trial 2

Total: _____

Trial 3

Total: _____

Driving Skills Matches   **Team Number _____**

(2-minute matches)   **Highest Score _____**

Trial 1
Total: _____

Trial 2
Total: _____

Trial 3
Total: _____

Team Number _____

Mobile Robotics Technology Overall Scorecard

Scoring Category	Max Score (Raw x Weight)	Raw Score	Weight	Total Score
Professional Development Test	25 x 1 = 25		1	
Engineering Notebook	45 x 4 = 180		4	
CAD Drawings	5 x 5 = 25		5	
Design Interview	30 x 6 = 180		6	
Programming Interview	100 x 2 = 200		2	
Highest Programming Skills Score	150 x 1 = 150		1	
Highest Driving Skills Score	150 x 1 = 150		1	
Safety Points	90 x 1 = 90		1	
Total Points	**1000**	**N/A**	**N/A**	

Used for tiebreaking purposes only:

_____ Engineering Notebook Score

_____ Team's highest Programming Skills Score

_____ Team's highest Driving Skills Score

Robot Inspection Checklist

Team Number: _____   Division: _____

Inspection Item	Rule #
☐ Team is only competing with ONE robot. They have no spare or replacement robots. Multiples of subsystem 3 are permitted.	**<R1>**
☐ Team testifies that the designing, building, and programming of the robot was done only by the students on the team.	**<R2>**
☐ Robot displays at least one (1) easily visible VEX IQ Competition license plate (or a custom plate of similar size) with a clearly visible and legible team number.	**<R9>**
☐ The Robot fits within the starting size of 11" x 20" x 15" **in all potential starting configurations** and does not expand beyond 11" x 20" during the match.	**<R4>, <SG2>**
☐ Robot is constructed ONLY from official **robot** components from the VEX IQ product line and the mechanical/structural components from the VEX Robotics by HEXBUG product line. All rubber bands must be identical in length and thickness to those included in the VEX IQ product line. 1/8th metal shafts from the VEX V5 product line are legal.	**<R6> <R7>**
☐ Any robot decorations are nonfunctional and do not affect performance.	**<R8>**
☐ Robot uses no more than six (6) VEX IQ Smart Motors. Additional motors cannot be used on the robot, even motors that are not connected.	**<R12>**
☐ Robot uses no more than one (1) VEX IQ battery pack or six (6) AA batteries. Additional batteries cannot be used, even batteries that are not connected.	**<R13>**
☐ No Robot parts have been modified with the exception of cutting **metal** VEX IQ, metal VEX V5 shafts, or VEX IQ pneumatic tubing to any custom length.	**<R15>**
☐ Robot does not have components that are intentionally detachable, pose an unnecessary risk of entanglement, or pose a risk of potential damage to the field elements or other robots.	**<R5> <G6> <G7>**
☐ Robot installed VEX IQ Brain can communicate with the VEX IQ Controller and is properly paired using VEX IQ 900 MHz radio, VEX IQ 2.4 GHz radio, or VEX IQ Smart Radio.	**<R11>**
☐ VEX IQ firmware (VEXos) is up to date. www.vexiq.com/vexos	**<R14>**
☐ Robot uses a maximum of two (2) VEX IQ pneumatic air tanks, one (1) VEX IQ Pneumatic Pump, and no additional pneumatic parts that are not included in the VEX IQ Pneumatics Kit. No other elements are used for the purposes of storing or generating air pressure, and pneumatic cylinders and tubing are only used as part of a pneumatic system.	**<R16>**

Team Verification

	Initial
☐ Team has fully read and understands the game manual and Q&As, including but not limited to G1, G2, G3, G4, G11, R1, R2, and T1.	
☐ Team and coach have fully read and understand the Code of Conduct and Student-Centered Policy.	

Final Inspection   Pass

Inspector Signature: _____

(Circle when passed)

Student team member accepts these Inspection results and certifies that this robot was designed, built, and programmed by qualified students on this team with little to no assistance from the adult mentor(s):

Team Member Signature: _____   **Coach Signature:** _____