Mobile Robotics Technology

Purpose: To evaluate each contestant's preparation for employment in the field of robotics with emphasis on the team approach to problem solving in a work environment. To recognize outstanding students for their excellence and professionalism in the emerging field of mobile robotics.

Contest Location	▪April 22, 2023 ▪**In-Person** at **2600 Corporate Exchange Dr., Suite 175A**. ▪Registration starts at 8AM. ▪Contest will be held from 9AM – 12PM.
Eligibility	▪Please refer to the National Technical Standards for this contest. ▪**Team of 2 (two)*
Clothing	Business Dress Casual: Polo or other collared shirt and khakis or dress pants. Closed toe dress shoes. NO jeans or athletic shoes. School logo, contestant name or other identifiers on shirt must be covered. OR Work /School Attire: Field specific work clothing required for the work environment or that matches the service conditions for the contest. This may include jeans if they are clean and professional looking and are accepted in the respective field (no holes or overly soiled pants). Work shoes or boots with a hard sole or anti-slip properties (steel toes may be required – refer to **Provided by Contestant** section below). Clothing should be as such that it will not get caught in moving equipment or power tools. School uniforms may be worn if they meet the above requirements with all identifiers covered.
Testing	▪Students should be prepared to take a written SkillsUSA knowledge test. (Required for all contestants prior to contest day).

Provided by Contestant **(Tool List)**	<u>Documentation</u> ▪ One hard copy of a 1-page personal resume <u>Personal Tools</u> ▪ Teams need to bring a competition ready robot for this contest. • They must use the parts from Appendix A plus they can also include One 12″ x 24″ piece of polycarbonate. 1/16″ thick. ▪ Engineering Notebook ▪ Safety glasses and work gloves ▪ Dremel (or similar) rotary tool with appropriate attachments .4 ▪ Drill and drill bits ▪ Allen wrench set (Imperial)

	▪ Aircraft metal snippers for cutting VEX metal ▪ A Wi-Fi enabled laptop equipped with licensed VEX programming software (for the Cortex microcontroller) and suitable presentation software (such as Microsoft's PowerPoint) An additional tablet device is allowed for presentations.8. ▪ Power strip and extension cord ▪ Calculator (standard, scientific or graphing) ▪ Tape measure and/or ruler ▪ Phillips and slotted screwdrivers ▪ Metal file ▪ Pliers ▪ Graph paper, pens, pencils, tape, electrical tape, markers, and scissors ▪ Multi-meter ▪ Replacement batteries and chargers-All 7.2V robot batteries must be made by VEX Robotics.9V and AAA can be manufactured by any vendor ▪ Grease or graphite(non-aerosol) ▪ VEX competition switch simulator and VEX programming cable ▪ Empty small parts bin or storage container ▪ Tap set ▪ Small toolbox (optional)
Special Notes	▪ Exhibit Halls do not open to observers until 12:00 pm. ▪ No smart watches, phones, or earbuds are permitted during the contest and/or in contest. ▪ No contact with anyone outside of the contest area once the contest begins ▪ No inappropriate communication between contestants such as verbally degrading another contestant ▪ No cheating on any portion of the contest such as informing another contestant of the skills/test prior to competing. ▪ A contest debriefing will be held directly after close of contest, advisor may attend. **Note: State contest presentation time is 3-5 minutes, which differs from the National Technical standards. Contestants should be prepared to adhere to this change as deductions will occur for presentations under 3 minutes or over 5 minutes.
National Technical Standards	▪ Please refer to the 2022-2023 National Technical Standards for all contests. Any and all standards included may be tested in any competition. ▪ In conjunction with National Standards, violations may result in student loss of contest.

Resume	▪ All SkillsUSA Ohio State Championship Contest will require a short interview component. Students should be prepared with basic job interview skills. ▪ All contestants must have a hard copy of a one (1) page personal resume.

Mobile Robotics Technology

2022-23 Game Manual for Secondary & Post-Secondary Teams

Presented by: Competition Pros Inc.

Adapted from: VEX Robotics Competition Spin Up

In Partnership with: VEX Robotics & REC Foundation

Table of Contents

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 VRC Spin Up Robot Skills Challenge. Students can participate in both VRC 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 VRC 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

Open to a team of two active SkillsUSA members who are enrolled in a career and technical education engineering program or a program that integrates robotics, engineering or preengineering techniques as an integral component of the instructional program.

CLOTHING REQUIREMENT

Class E: Contest Specific – Business Casual

Official SkillsUSA white polo shirt
Black dress slacks or black dress skirt (knee-length minimum)
Black closed-toe dress shoes

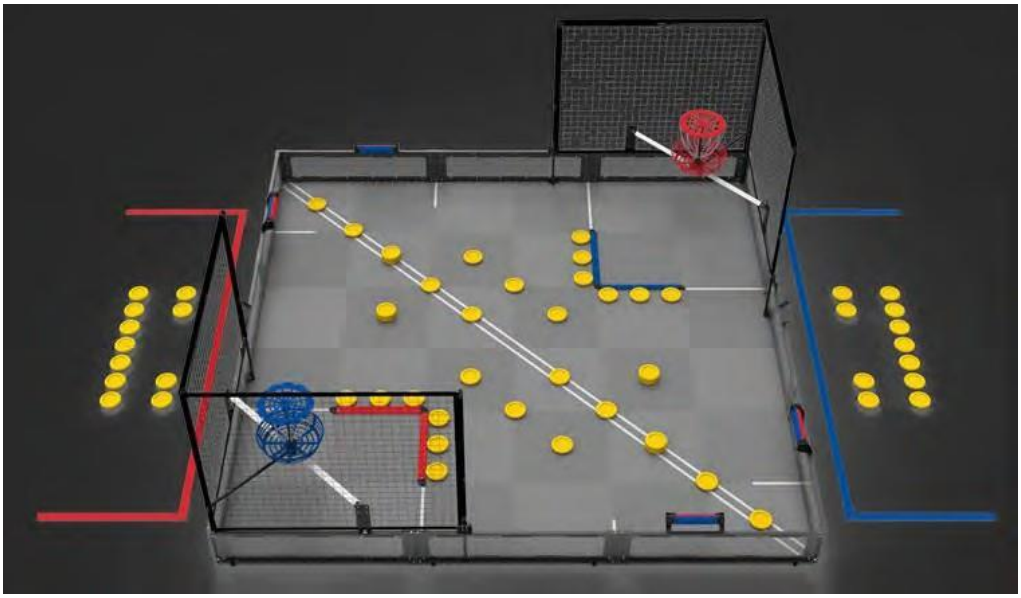
Note: Wearing socks or hose is no longer required. If worn, socks must be black dress socks and hose must be either black or skin-tone and seamless/nonpattern.

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 (800) 501-2183.

THE GAME

A Primer

VEX Robotics Competition Spin Up is played on a 12’x12’ square field, set up as illustrated below and in figures throughout this game manual.



Teams compete in one-minute (1:00) Robot Skills Matches, where one (1) Robot tries to score as many points as possible for Secondary Teams and two (2) Robots driven by the same team for Post-Secondary Teams. There are two types of matches, Driving Skills and Programming Skills Matches. In Driving Skills, teams use the remote control operate the robot, and in Programming Skills, no input from the remote control is permitted. The VEX GPS code strip will be installed on the field for both types of matches.

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.

Autonomous Bonus - A point bonus awarded to the Alliance that has earned the most points at the end of the Autonomous Period. See <SC6> for more information.

Autonomous Win Point - A bonus awarded to any Alliance that has completed a defined set of tasks at the end of the Autonomous Period of a Qualification Match. See <SC6> for more information.

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 / or Disqualifications for a single Team may lead to its Disqualification for the entire tournament. (See <T13>)

Drive Team Member - A Student who stands in the Alliance Station during a Match. Adults are not allowed to be Drive Team Members. See rules <G7>, <G8>, and <G9>.

Entanglement - A Robot status. A Robot is Entangled if it has grabbed, hooked, or attached to an opposing Robot or a Field Element. See rules <G12> and <SG3>.

Field Element - All elements that make up the field, including the foam field tiles, field perimeter, white tape, High Goals, Nets, Rollers, Barriers, and all supporting structures and accessories (such as Alliance Station posts, field monitors, etc.).

Match - A set time period, consisting of Autonomous and / or Driver Controlled Periods, during which Teams play a defined version of Spin Up to earn points. See Section 4.

- **Autonomous Period** - A time period during which Robots operate and react only to sensor inputs and commands pre-programmed by the Students into the Robot control system.
- **Driver Controlled Period** - A time period during which Drive Team Members operate their Robot via remote control.

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. Secondary Teams utilize 1 Robot and Post-Secondary Teams utilize 2 Robots.

Student – An eligible SkillsUSA member.

Team - One or more Students make up a Team.

- In the context of this Game Manual, Teams include three Student roles related to Robot assembly, design, and programming. See <G2> and <G6> for more information. Adults may not fulfill any of these roles. Each student may fill one or multiple student roles.

    - Builder - The Student(s) on the Team who assemble(s) the Robot. Adults are permitted to teach the Builder(s) how to use concepts or tools associated with Robot construction, 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. Adults are permitted to teach the Designer(s) how to use concepts or tools associated with design, 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. Adults are permitted to teach the Programmer(s) how to use concepts or tools associated with programming, but may never work on the code that goes on the Robot without the Programmer(s) present and actively participating.

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). See rule <G15>.

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

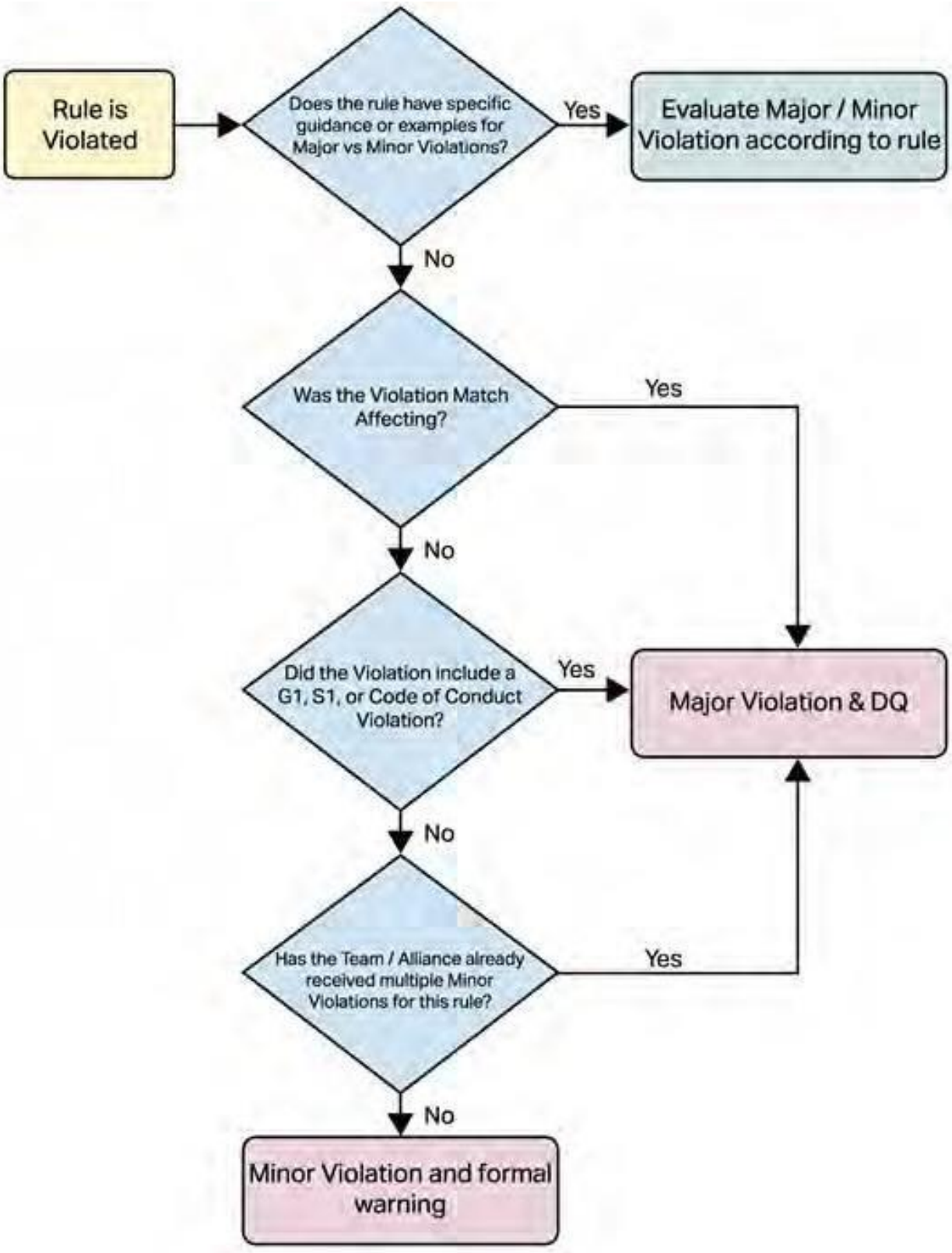
Violation - The act of breaking a rule in the Game Manual.

- Minor Violation - A Violation which does not result in a Disqualification.
  - Accidental, momentary, or otherwise non-Match 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 Match 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.
- Match Affecting - A Violation which changes the winning and losing Alliance in the Match.
  - Multiple Violations within a Match can cumulatively become Match Affecting.
  - When evaluating if a Violation was Match Affecting, Head Referees will focus primarily on any Robot actions that were directly related to the Violation.
  - Determining whether a Violation was Match Affecting can only be done once the Match is complete and the scores have been calculated.

Some rules include Violation Notes in a *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 Match Affecting, check whether the Team who committed the Violation won or lost the Match. If they did not win the Match, then the Violation could not have been Match Affecting, and it was very likely a Minor Violation.

See the flowchart below for more information.


Rule is Violated
Does the rule have specific guidance or examples for Major vs Minor Violations?
Yes
Evaluate Major / Minor Violation according to rule
No
Was the Violation Match Affecting?
Yes
No
Did the Violation include a G1, S1, or Code of Conduct Violation?
Yes
Major Violation & DQ
No
Has the Team / Alliance already received multiple Minor Violations for this rule?
Yes
No
Minor Violation and formal warning

Game Specific Definitions

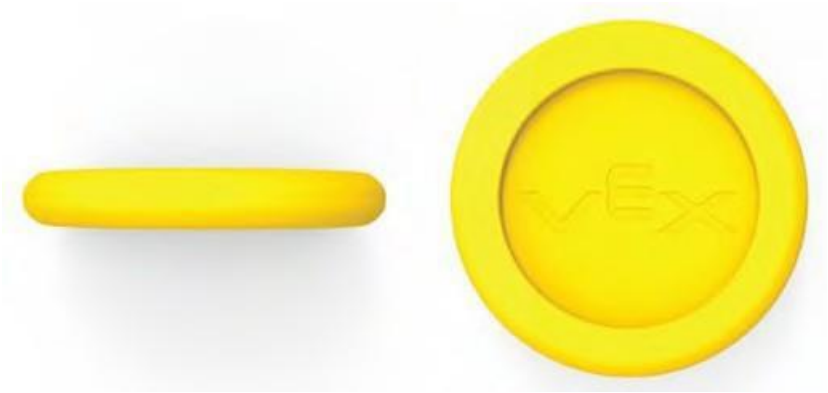
Autonomous Line - The pair of white tape lines that runs diagonally across the field. See <SG8> for more information.

Barrier - A Field Element that marks an edge of each Low Goal. Barriers are made of red or blue plastic extrusions and black plastic connectors.

Covered - A field tile status. See <SC5> for more information.

Disc - A yellow foam object that can be manipulated by Robots. Discs have the following overall dimensions, with an expected tolerance of 0.02”:

- Diameter: 5.512” (140mm)”
- Thickness: 0.787” (20mm)”
- Weight: 65g ± 20g



Endgame - The final 10 seconds of the Match.

Goal - A place where Robots can Score Discs.

- **High Goal** - A basket-shaped Field Element where Robots can Score Discs. The High Goal is defined as the top & bottom colored plastic pieces, the chains, and the vertical pipe assembly connecting the top and bottom together. The horizontal supporting structures and brackets used

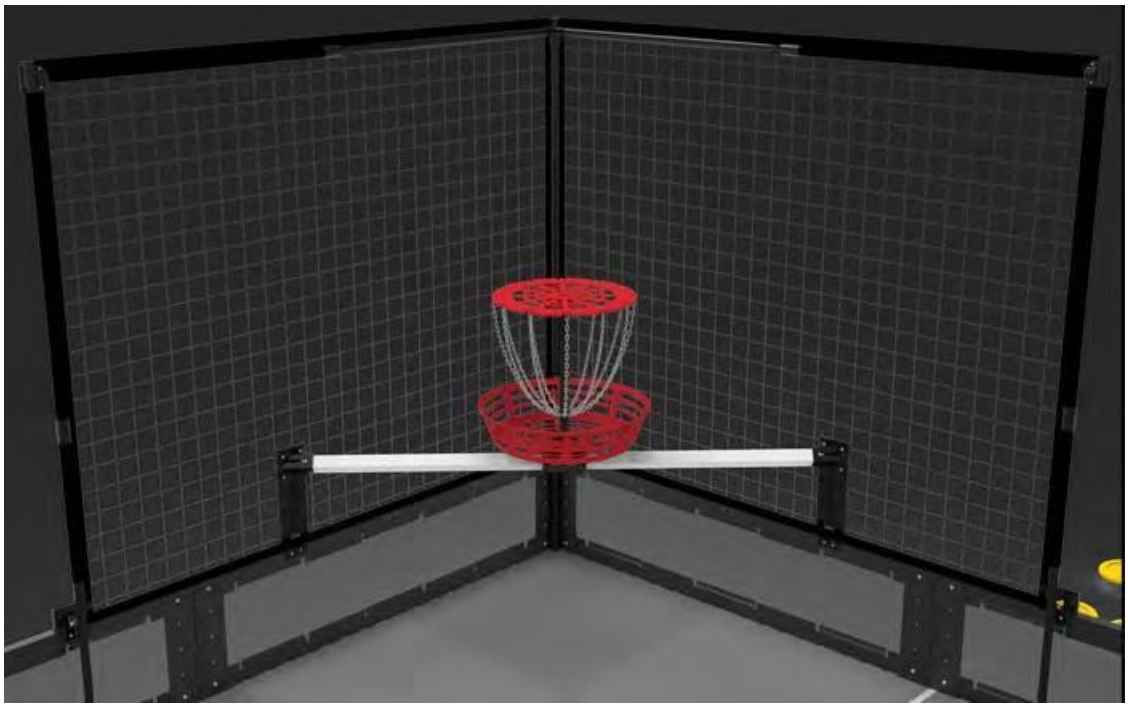
to attach this basket assembly to the field are not considered part of the High Goal. The color of the High Goal indicates which Alliance receives points for Discs Scored in that High Goal.

- **Low Goal** - A region of the field where Robots can Score Discs. The Low Goal is defined as the space in each corner of the field directly beneath each High Goal, bordered by white tape lines, the field perimeter, and the Barrier. The white tape lines and Barrier are considered part of the Low Goal, and the color of the Barrier indicates which Alliance receives points for Discs Scored in that Low Goal.

Loader - A metal ramp, one per Alliance, that can be used to introduce Match Load Discs. See rule <SG6> for more information.

Match Load Discs - One of the fourteen (14) Discs, seven (7) per Alliance, that begin the Match in an Alliance Station and may be introduced during the Match. See <SG6> for more information.

Net - One of two woven, nylon, mesh structures located behind the High Goals.



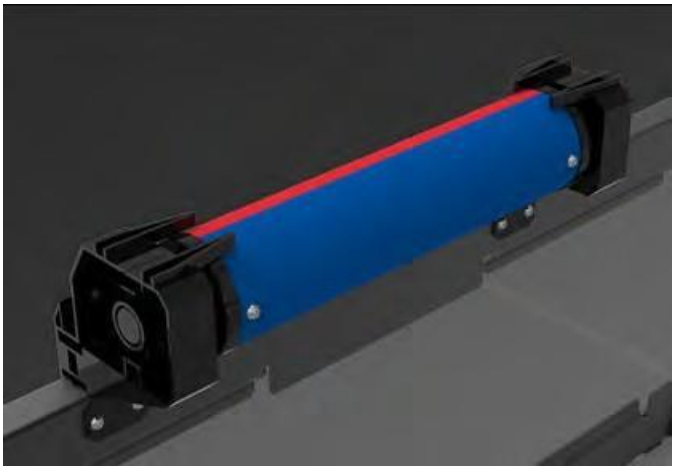
Owned - A Roller status that can be used to score points. See <SC4> for more information.

Preload - The Discs, two (2) per Robot, placed prior to the start of each Match. If used, Preloads must be placed such that they satisfy the conditions in <SG1> and <SG2>. If they are not used, they may be used as additional Match Load Discs.

Possession - A Robot / Disc status. A Robot is considered to be in Possession of a Disc if the Robot is carrying, holding, or controlling the movement of a Disc such that if the Robot changes direction, the Disc will move with the Robot. Therefore, pushing / plowing Discs is not considered Possession; however, using concave portions of a Robot to control the movement of Discs is considered Possession.

Roller - One of four (4) Field Elements mounted to the field perimeter that can be Owned to score points. Each Roller has two pairs of pointers that, when viewed from above, indicate which Alliance

Owns the Roller. In Head-to-Head Matches, Rollers begin in a neutral position. Rollers are made of 2” nominal Schedule 40 PVC pipe, and are 9.843” (250mm) long and 2.375” (60.3mm) in diameter. See <SC4> for more information.



Scored - A Disc status. See the Scoring section for more details.

Starting Line - One of four (4) white tape lines placed perpendicular to the field wall and used to determine Robot starting locations. See <SG1> for more information.

Scoring

Each Disc Scored in a High Goal	5 Points
Each Disc Scored in a Low Goal	1 Point
Each Owned Roller	10 Points
Each Covered Field Tile	3 Points

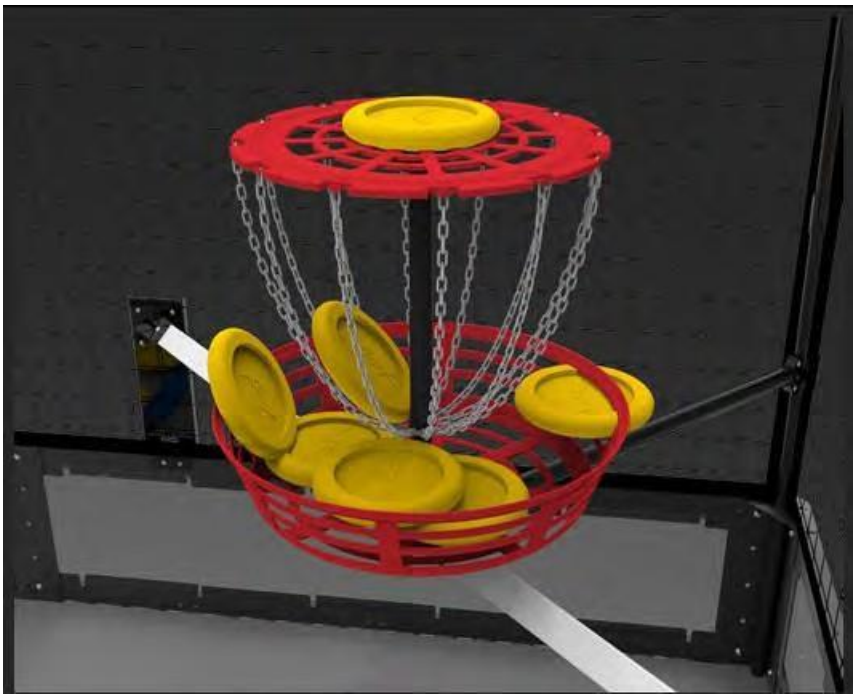
<SC1> All Scoring statuses are evaluated immediately after the Match ends. For determination of the Autonomous Bonus and Autonomous Win Point, all Scoring statuses are evaluated immediately after the Autonomous Period ends, unless otherwise noted.

a. For the purposes of this rule, “immediately after” means when all Discs, Field Elements, and Robots on the field come to rest.

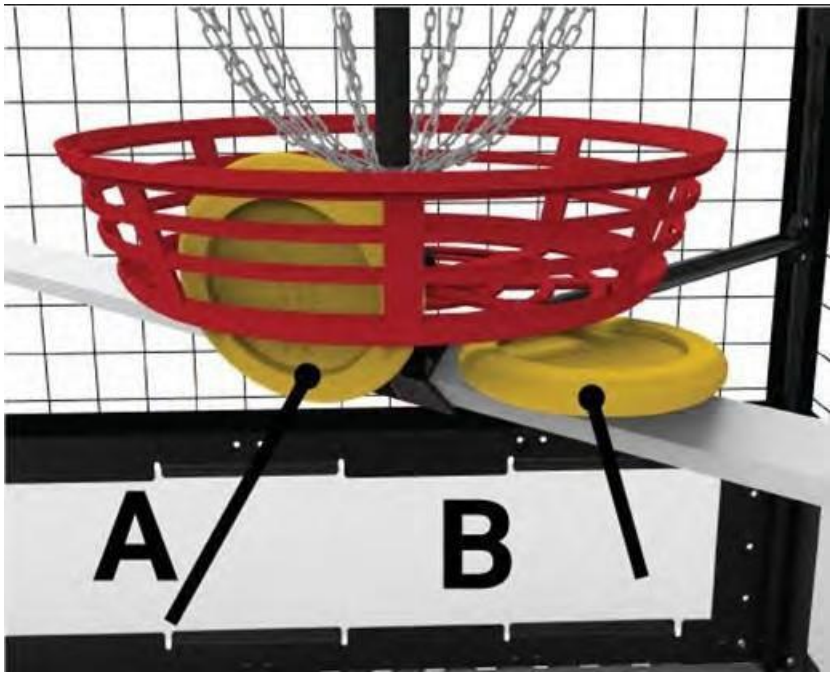
<SC2> A Disc is considered Scored in the High Goal for the corresponding Alliance color if it meets the following criteria:

a. Not contacting a Robot of the same color Alliance as the High Goal.
b. Not contacting the gray or black supporting structures underneath the High Goal.
c. At least partially contained within the vertical projection of the widest portion of the bottom “basket” of the High Goal.

In the figure below, all discs are scored.



In the figure below, Disc A is scored, Disc B is NOT scored



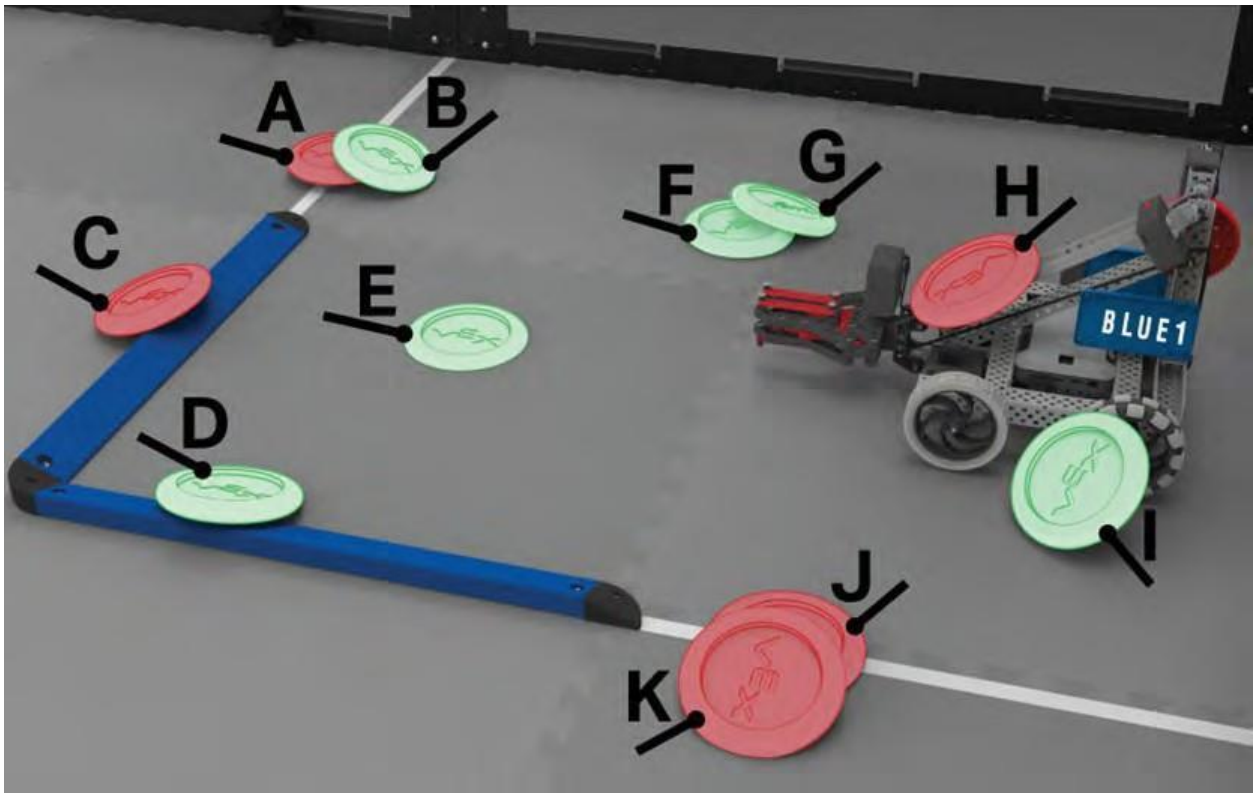
<SC3> A Disc is considered Scored in the Low Goal for the Alliance corresponding to the color of the adjacent Barrier if it meets the following criteria:

a. Not fully supported by a Robot of the same color Alliance as the Low Goal.
b. At least partially contained within the vertical projection of the Low Goal (i.e., “breaking the plane” of the Low Goal).
c. Not contacting any field tiles outside of the Low Goal.
d. Not contacting the Net.

e. Not contacting the High Goal, or any of the supporting structures underneath the High Goal. Note: Discs which are Scored in a High Goal may not also count as being Scored in a LowGoal.

In the figure below,

- Discs B, D, E, F, G, and I are all considered Scored in the Low Goal.
- Disc H is not considered Scored, as it is being fully supported by a Robot of the same color Alliance as the Low Goal.
- Discs A, C, J, and K are not considered Scored, as they are contacting the gray foam tiles outside of the Low Goal.



<SC4> A Roller is Owned by an Alliance if the area between the Roller's pointers is entirely that Alliance's color, when viewed from above.

<SC5> A field tile is considered Covered if it is being contacted by a Robot at the end of a Match.

Safety Rules

<S1> Be safe out there. If at any time the Robot operation or Team actions are deemed unsafe or have damaged a Field Element or Disc, the offending Team may receive a Disablement and / or Disqualification at the discretion of the Head Referee. The Robot will require re-inspection as described in rule <R3e> before it may take the field again.

Note: Teams should exercise caution when interacting with the Net, per <SG3>.

<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. However, mechanisms which cross the field

perimeter intentionally and / or repeatedly while interacting with the Loader and / or during the Endgame may be considered a Violation of <S1> at the Head Referee's discretion.

<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, all Team members who are working on the robot must wear safety glasses.

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.

<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.

<G3> Use common sense. When reading and applying the 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 Elements.

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

> Note: Parts which become detached unintentionally and therefore a Minor Violation are no longer considered "part of a Robot," and should be ignored for the purposes of any rules which involve Robot contact (e.g., Covering field tiles, contacting a Low Goal, horizontal expansion, etc.) or Robot size.

<G6> N/A

<G7> N/A

<G8> N/A

<G9> Hands out of the field. Drive Team Members are prohibited from making intentional contact with any Discs, Field Elements, or Robots during a Match

<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 Controller(s)
- 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

<G11> N/A

<G12> N/A

<G13> N/A

<G14> N/A

<G15> N/A

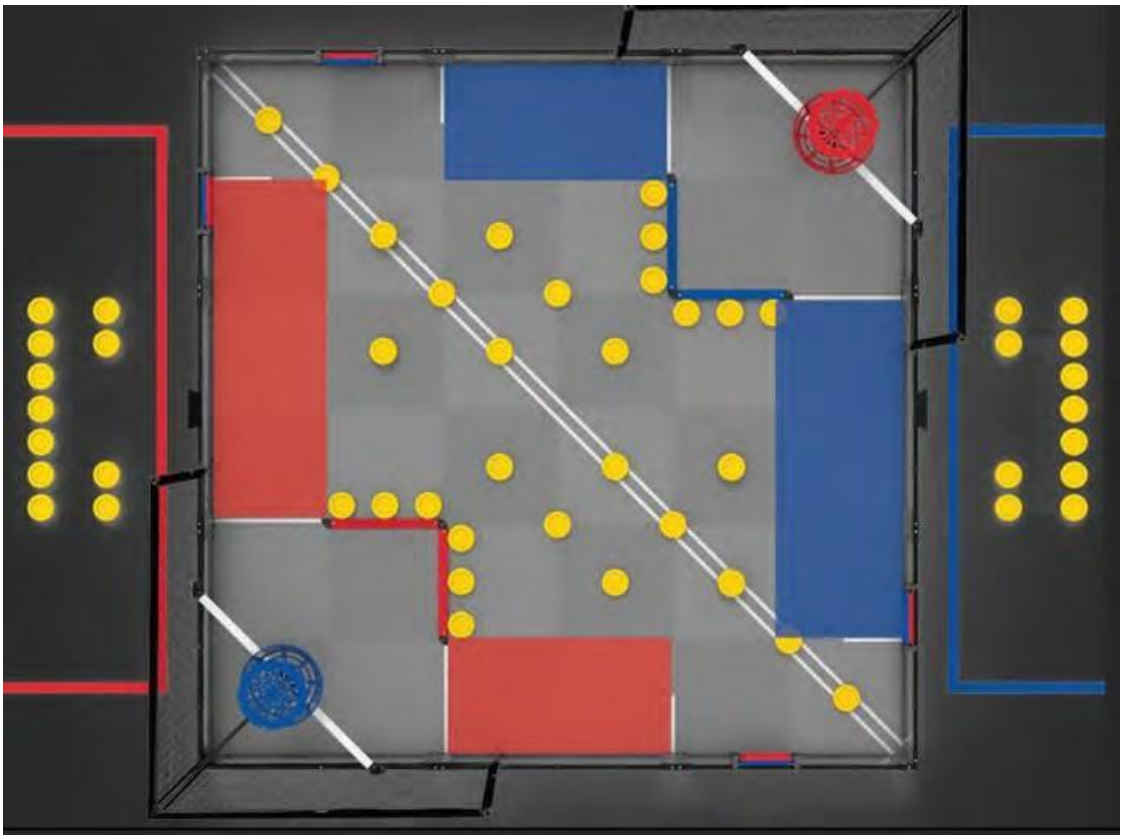
<G16> Don't clamp your Robot to the field. Robots may not intentionally grasp, grapple or attach to any Field Elements. Strategies with mechanisms that react against multiple sides of a Field Element in an effort to latch or clamp onto said Field Element are prohibited. The intent of this rule is to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

<G17> Use Discs to play the game. Discs 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 <SG8>).

VRC Spin Up Specific 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 adjacent to the field perimeter that are between a pair of Starting Lines on their Alliance's side of the Autonomous Line.
    i. Secondary Teams can choose which Alliance color to be for each match.
    j. Post-Secondary Teams must place one robot in each Alliance color.
b. Not contacting any other gray foam field tiles.
c. Not contacting any Discs other than the Preloads.
d. Not contacting another Robot.
e. Not contacting any Field Elements, such as the Barrier or the Net.
    i. Contact with the field perimeter is permitted, but not required.
f. Contacting no more than two (2) Preloads. See rule <SG2>.
g. Not contacting any gray foam tiles inside the Low Goal.
h. Within the required starting volume. See rule <G4>.



<SG2> Robots get two Preloads. Prior to the start of each Match, each Preload must be placed such that it is:

a. Contacting no more than one Robot.
b. Fully within the field perimeter.
c. Not in any position that would be considered Scored (such as Disc I in Figure 15).

If a Team does not wish to use one or more of their Preloads, or if a Robot is not present for their Match, then the Preloads may be used as Match Load Discs in accordance with <SG6>.

<SG3> Stay away from the Net. Becoming Entangled with the Net is considered a Violation of <S1> and / or <G16>, and will result in a Disablement. Causing an opponent to become Entangled with the Net is considered a Violation of <G14> and, at a minimum, will result in a Disablement for both Teams.

Violation Notes:

- *Momentary or incidental contact that does not result in Entanglement, such as while aligning with a Loader, is expected and is not considered a Violation.*
- *The Disablement associated with this rule is not considered a Major Violation. It is intended to be an avenue for the Head Referee to prevent any potential safety concerns and / or damage to the Net.*
- *Intentional, strategic, or repeated Minor Violations and / or Disablements may escalate to a Major Violation at the Head Referee's discretion.*

<SG4> Horizontal expansion is limited until the Endgame. Robots may not expand beyond a horizontal area of 18" x 18" at any point during the Match prior to the Endgame.

There are no horizontal expansion limits during the Endgame.

Violation Notes:

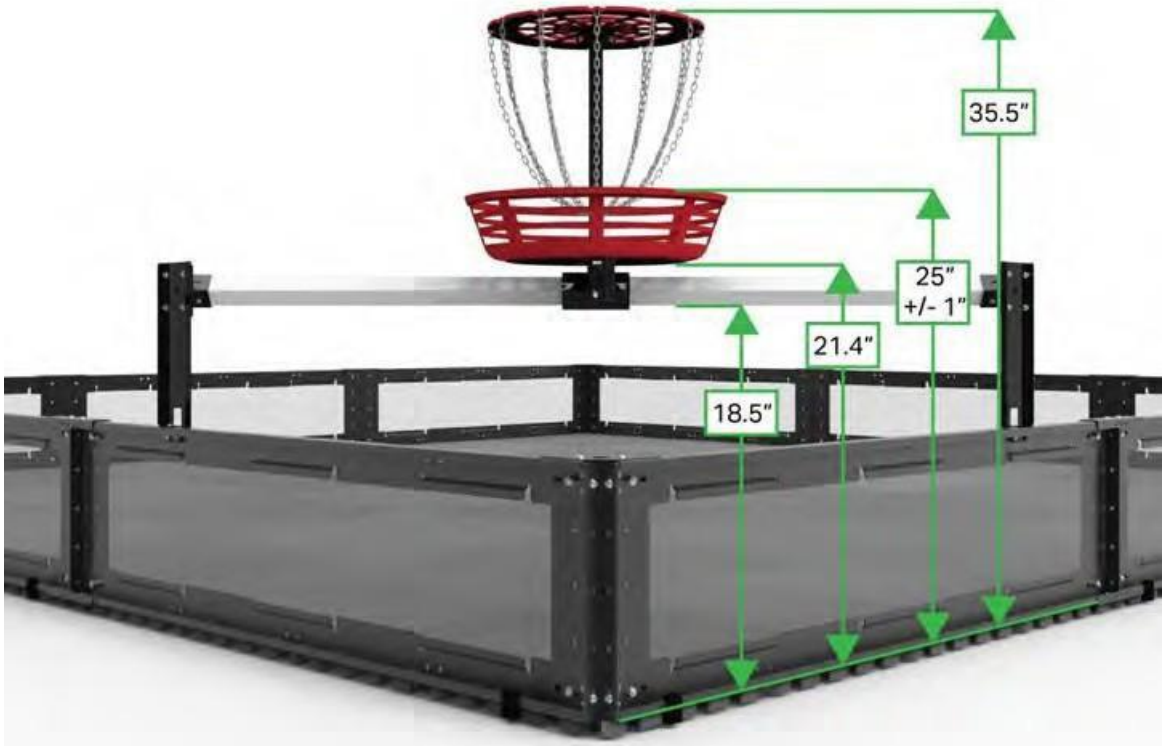
- *Teams can prevent an accidental or momentary expansion from becoming a Major Violation by immediately moving to rectify the Violation, and / or removing themselves from gameplay (e.g., parking in a corner of the field without impacting gameplay for other Robots).*
- *Even if an expansion was accidental, it can still be considered a Major Violation if the Head Referee judges that the expansion was intentional, strategic, and / or Match Affecting.*

Examples of Major Violations could include, but are not limited to:

- *A Robot utilizing an expanded mechanism to manipulate Discs*
- *A tipped Robot blocking access to an opponent's Low Goal*
- *A Robot forfeiting Driver Controlled gameplay (i.e., "accidentally" expanding early) in order to get a head-start on the Endgame*

<SG5> Vertical expansion is limited. Robots may expand vertically within the following conditions:

a. The Robot must not be contacting the gray field tiles in either Low Goal.
b. No part of the Robot may exceed an overall height of 24". This height limit is a "virtual ceiling," meaning that no part of any Robot may ever exceed 24" above the foam tiles, regardless of Robot orientation.
c. Any extensions or combinations of extensions above 18" must fit within a vertical cylinder 2" in diameter.
d. There are no vertical expansion limits during the Endgame.
e. Robots may not contact the High Goal, Discs which are Scored in the High Goal, or the horizontal supporting structures directly underneath the High Goal. This rule applies at all times, regardless of Alliance / High Goal color.



<SG6> Match Load Discs may be safely introduced during the Match under certain conditions. For the purpose of this rule, "introduce" refers to the moment when Match Load Discs are no longer in contact with a human, have crossed the plane of the field perimeter, and are no longer in contact with the Loader.

a. Match Load Discs may only be introduced once the Driver Controlled Period has begun.
    a. During the Autonomous Period, and during the time between the Autonomous and Driver Controlled Period, Match Load Discs may not cross the plane of the field perimeter.
b. Match Load Discs must be introduced by a Drive Team Member placing them gently onto a Loader. They may then be retrieved from the Loader by a Robot, or gently pushed into the field by a Drive Team Member. See Figure 22 for examples of how Match Load Discs should be introduced.
    a. The intent of this rule is to permit Teams to impart enough energy on Match Load Discs such that they slide onto the tile (or a Robot) directly in front of the Loader. "Throwing," "rolling," or otherwise imparting enough energy onto the Discs such that they leave the intended tile, or violate one of the other points in this rule, is not permitted.
c. Match Load Discs may never be contacted by a Robot while still being contacted by a Drive Team Member.
d. When utilizing the Loader correctly, a Drive Team Member's hands should never break the plane of the field perimeter. Therefore, rule <G9> still applies to this interaction.
e. When utilizing the Loader correctly, a Robot should never break the plane of the field perimeter. Therefore, rules <S1> and <S2> still apply to this interaction.

<SG7> Possession is limited to three (3) Discs. Robots may not have greater-than-momentary Possession of more than three (3) Discs at once. Robots in Violation of this rule must immediately stop all Robot actions except for attempting to remove the excess Disc(s).

Note: This rule applies to both intentional and accidental Possession.

<SG8> N/A

<SG9> Keep Discs in the field. Teams may not intentionally remove Discs from the field.

a. Although Discs may accidentally leave the field, doing so intentionally or repeatedly would be a Violation of this rule.
b. Discs that leave the field during Match play, whether intentionally or unintentionally, will be returned to the field at a location nearest the point at which they exited. Referees will return the Discs to the field when it is deemed safe to do so, at the leisure of the referee.

Rules Specific to SkillsUSA

<SkillsUSA1> This manual will be updated for NLSC. Rules in this manual are subject to change for NLSC and will be announced when teams arrive at the Championship for the Orientation Meeting. Teams should be prepared for the following changes which may or may not occur. No other rules will be changed.

a. The starting position of all Game Objects.
b. The starting position of the Robot.
c. Which high goals count for points.
d. Values for scoring.

<SkillsUSA2> No Power Tools. Teams may not use power tools in the competition or pit areas. Hand tools are the only acceptable means of cutting and bending materials.

<SkillsUSA3> Matches will be 1:00 in length for both Programming Skills and Driving Skills Matches.

Robot Inspection

All Robot Equipment rules are identical to the VRC Spin Up Game Manual.

- See Section 3 of the Game Manual using the above link for specific robot rules.
- Secondary Teams utilize 1 18x18x18 inch maximum size robot.
- Post-Secondary Teams utilize 2 18x18x18 inch maximum size robots.

In addition to these rules, SkillsUSA teams may have 3D printed parts.

- An unlimited amount of plastic 3D printed parts may be used on the Robot using PLA, PETG and/or ABS. These parts must be documented in the Engineering Notebook and explained why they are chosen including how they were printed.

  Note: Using a 3D printer to make molds for casting or injection molding is not legal and not within the spirit of this rule.

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.

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.

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 65-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)
- Not wearing safety glasses while working on Robot
- Not wearing safety glasses while standing in the Alliance Station
- Using teeth as a tool (other than eating)
- Leaving equipment in aisles (creating trip hazards)

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 APPENDIX

Design Award Rubric – Page 1 *Engineering Notebook Review*

Directions: Write the points in each row for the criterion that best describes the performance of the Engineering Notebook on each topic. Total the points.

Team Number _____

	Topic	Criteria			Points
		Expert (4-5 points)	Proficient (2-3 points)	Emerging (0-1 points)	
Engineering Design Process	Identify game and robot design challenges and goals	Identifies the game challenge or robot design challenge 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 and 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. No citations provided for ideas that came from outside sources.	Does not list any solutions to the challenge.	
	Select the 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 why the solution was selected or does not mention the plan.	
	Build and program the solution	Records the steps to build and program the solution. Includes enough detail that the reader could recreate the solution following the steps in the Notebook.	Records the key steps to build and program the solution. Lacks sufficient detail to recreate the solution.	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 the steps to test the solution.	
	Repeat design process	Shows that the design process is repeated multiple times to improve performance on an individual design goal or overall robot or game performance.	Shows that the design process is not often repeated for individual design goals or overall robot or game performance.	Does not show that the design process is repeated.	
Usefulness and repeatability		Records the entire design and development process in such great clarity and detail that the reader could recreate the project's history and build the current robot from the notebook.	Records the design and development process completely but lacks sufficient detail to fully recreate the entire project or robot.	Does not record the design and development process or lacks sufficient detail to understand the design process.	
Record of team and project management		Provides a complete record of team and project assignments; notes from team meetings including goals, decisions, and accomplishments; name or initials of author; each page numbered and dated. Design cycles are easily identified. Includes Table of Contents and/or Index so anyone can easily locate needed information.	Records most of the information listed at the left. Organized so that team members can locate most of the needed information.	Does not record most of the information listed at the left. Not organized; needed information difficult to locate.	
Notebook construction		Five (5) points if notebook is bound. Notebook must have been bound before any entries were made in it.	Zero points for any other notebook construction.	Zero points for any other notebook construction.	
Describe a few of the best features of the Engineering Notebook:				**Total points for Engineering Notebook:**	

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

Design Award Rubric – Page 2 *Team Interview with Judges*

Team Number _____

Directions: Write the points in each row for the criterion that best describes the team's performance on each topic during interview. Total the points below.

Topic	Criteria			Points
	Expert (4-5 points)	Proficient (2-3 points)	Emerging (0-1 points)	
Design process and Engineering Notebook	Students clearly explain all aspects of the design process and how they recorded their use of the design process in the Notebook.	Students can explain most aspects of the design process and how they recorded their use of the process.	Students can explain only limited aspects of the design process and how they recorded their use of the process.	
Game strategies and robot designs	Students can describe three or more game strategies and robot designs that were considered; students can fully explain how and why the current game strategy and robot design were chosen.	Students can describe two game strategies and robot designs that were considered; students can explain how and why the current game strategy or robot design were chosen.	Students can describe only their current game strategy and design, or they cannot explain how and why the current game strategy or robot design were chosen.	
Project and team management	Students can explain how team progress was tracked against an overall project timeline, and how students were assigned to tasks based on their skills and availability; students can explain management of material resources.	Students can explain how team progress was monitored, or how students were assigned to tasks, or management of material resources.	Students cannot explain how team progress was monitored or how students were assigned to tasks or how material resources were managed.	
Teamwork and communication	Students can explain how multiple team members contributed to the robot design and game strategy. All students answer questions independently.	Students can explain how most team members contributed to the robot design and game strategy. Students support each other as needed to answer questions.	Only one team member answered questions or contributed to the robot design process.	
Respect and courtesy	Students answer respectfully and courteously. Students make sure each team member contributes. Students wait to speak until others have finished.	Students answer respectfully and courteously. Some students attempt to contribute but are interrupted by other students.	Students do not answer respectfully and courteously. Students interrupt each other or the Judges.	
			Total points for Design Interview (30 Max):	

Describe a few of the best features of the team interview:

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? (e.g., 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

(1-minute matches)

Team Number _____

Highest Score _____

Trial 1

High Goals Scored_____x 5 = _____ **Low Goals Scored_____x 1 = _____**

Owned Rollers _____x 10 =_____ **Covered Field Tiles_____x 3 = _____**

Trial 1 Score:

Trial 2

High Goals Scored_____x 5 = _____ **Low Goals Scored_____x 1 = _____**

Owned Rollers _____x 10 = _____ **Covered Field Tiles_____x 3 = _____**

Trial 2 Score:

Trial 3

High Goals Scored_____x 5 = _____ **Low Goals Scored_____x 1 = _____**

Owned Rollers _____x 10 = _____ **Covered Field Tiles_____x 3 = _____**

Trial 3 Score:

Driving Skills Matches

Team Number _____

(1-minute matches)

Highest Score _____

Trial 1

High Goals Scored_____x 5 = _____ **Low Goals Scored_____x 1 = _____**

Owned Rollers _____x 10 =_____ **Covered Field Tiles_____x 3 = _____**

Trial 1 Score:

Trial 2

High Goals Scored_____x 5 = _____ **Low Goals Scored_____x 1 = _____**

Owned Rollers _____x 10 = _____ **Covered Field Tiles_____x 3 = _____**

Trial 2 Score:

Trial 3

High Goals Scored_____x 5 = _____ **Low Goals Scored_____x 1 = _____**

Owned Rollers _____x 10 = _____ **Covered Field Tiles_____x 3 = _____**

Trial 3 Score:

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	100 x 1.5 = 150		1.5	
Highest Driving Skills Score	200 x 0.75 = 150		0.75	
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