Team Update 08

GENERAL

- **VR Assets**
  - From AutomationDirect: You asked for it ... You got it ... A number of teams have requested the source files for the AutomationDirect VR Simulation so they can see how it was built and use it in their own projects. A link is now available at [here](#). Beware – it is HUGE - just under 6GB! Let us know if you do anything fun with it! FYI: It was built in UNREAL Engine using the Blueprint node-based programming. All assets were created in Blender.

- **Drawing Updates**: The Team Version drawing packages have been updated to correct a discrepancy between the Team Version LOADING STATION and the LOADING STATION on the official FIELD. The discrepancy leads to the HATCH PANEL being more difficult to remove from the Team Version than intended. See the drawing for TE-19108 for the corrected geometry of the part and an alternative fix that doesn't require the part to be recut.

- **Q&A Update**: [Q257](#) has been updated to reflect the change made to R12 below.

MANUAL

SECTION 4.8.1

Figure 4-25 has been updated to correct the orientation of the vision target tape on the left side LOADING STATION.

![Figure 4-25 ALLIANCE WALL](image)

SECTION 7

C2. **Be a good person.** All teams must be civil toward their team members, other team members, competition personnel, FIELD STAFF, and event attendees while at a FIRST® Robotics Competition event.

Violation: Behavior will be discussed with team or individual. Violations of this rule are likely to escalate to YELLOW or RED CARDS rapidly (i.e. the threshold for egregious or repeated violations is relatively low.)

Examples of inappropriate behavior include, but are not limited to, use of offensive language or other uncivil conduct.

We’ve learned that, although intended with no ill will, “clothes pinning” (a game played by some event participants where they try to clip a clothespin to an unsuspecting person) can and does make people uncomfortable. Understandable; it’s unwelcome contact that may or may not have been from someone you know and trust. As a result, this is considered an example of uncivil conduct.

The activity known as ‘the circle game’ uses hand signals that can be negatively interpreted. As such, this game is considered an example of uncivil conduct.
**SECTION 10.4**

**R12.** The total cost of all items on the ROBOT shall not exceed $5500 USD. All costs are to be determined as explained in the Budget Constraints & Fabrication Schedule section. Exceptions are as follows:

A. individual items that are less than $5 USD each, as purchasable from a VENDOR, and

B. items from the current year’s KOP, up to the KOP quantity (including the rookie KOP items). Identical functional replacements may be used to meet this criterion.

Teams should be prepared to disclose to Inspectors the cost of any non-KOP item and the total cost of the ROBOT. Teams should also be prepared to show that a particular item was received from FIRST Choice or a voucher in the current season if necessary.

Per I5, teams must be prepared to display a Bill of Material (BOM) to Inspectors during Inspection. The BOM may be displayed in either printed or electronic form.

Individual COMPONENTS or MECHANISMS, not excluded in R12, that are retrieved from previous ROBOTS and used on 2019 ROBOTS must have their un-depreciated cost included in the 2019 BOM and applied to the overall cost assessment.

Example 1: The Kickoff KOP checklist lists two (2) of motor controller XYZ in the Gray Tote distributed to rookie teams. Any team, including a veteran team that did not receive these items, can account for up to two (2) of them on the KOP checklist at a $0 cost. Additional quantity of the same item would have to be accounted at the Fair Market Value.

Example 2: A team uses FIRST Choice credits, or a voucher, to acquire part ABC. This part, in the quantity obtained by the team via the KOP may be accounted at $0. Additional quantity of the same item would have to be accounted at the Fair Market Value.

Example 3: Part ABC is available in FIRST Choice, but a team decides they have enough already on hand and does not acquire any through FIRST Choice. All of these items used on the ROBOT need to be accounted for at Fair Market Value as they did not come from the current year’s KOP.

An "identical functional replacement" is an item which, to any reasonably astute observer, has the same form, fit, feature set, and function as the original component.

For example, any CIM motor can replace a CIM motor or a sheet of polycarbonate paid for completely by a voucher can be replaced with a sheet of polycarbonate of the same parameters (thickness, color, size, etc.). As another example, a motor controller that has the same form, fit, and function (i.e. controlling motors) as the original motor controller, but a different feature set (i.e. can communicate over CAN vs. the original controller which was PWM only) is not an identical functional replacement because the controllers’ feature sets differ.
Each FIELD for DESTINATION: DEEP SPACE is a 27 ft. (~823 cm) by 54 ft. (~1646 cm) carpeted area bound by and including the inward-facing surfaces of the guardrails, inward-facing surfaces of the ALLIANCE WALLS (except Chute surfaces).

SECTION 10.5

R28. Each ROBOT must be able to display Red or Blue BUMPERS to MATCH their ALLIANCE color, as assigned in the MATCH schedule distributed at the event (as described in the MATCH Schedules section). BUMPER Markings visible when installed on the ROBOT, other than the following, are prohibited:

A. those required per R29,
B. hook-and-loop fastener or snap fasteners backed by the hard parts of the BUMPER, and
C. solid white FIRST logos between 4½ in. (~12 cm) and 5¼ in. wide (~13 cm) (i.e. comparable to those available in the 2019 Virtual Kit).

The FRAME PERIMETER facing surfaces of BUMPERS are not “displayed” and thus R28 does not apply.
Team Update 06

GENERAL

- CAD/Drawing Package: The Official Field Models and the Official Field Drawings (specifically GE-19150, GE-19153, and GE-19244) have been updated to show the correct shape of the loop tape on HATCH PANELS.
- Bill of Material (BOM) Template: published!
- Robot Lockup Form: published!
- Radio Configuration Tool Update: An updated version of the FRC Radio Configuration Utility (19.1.1) has been posted (Israel version) in the Screensteps Programming your radio article. This version corrects an issue with applying the Bandwidth Limit. Teams testing camera streams are advised to update and re-program their radios (there is no need to re-flash firmware).
- VR Updates:
  - AutomationDirect HTC Vive/Oculus Rift has updated their VR application (link to info on FIRST’s site, link to AutomationDirect's page which includes a video describing updates). In addition to fixing bugs, the new version allows users to drive a blue lift bot, press buttons to load GAME PIECES in the LOADING STATIONS, and preset the FIELD with GAME PIECES (“Start” doesn’t reset the FIELD anymore).
  - NASA released a new version of their Android viewer, the RAP FRC Field Viewer. The update adds a “Non-VR” mode. This update accommodates users that don’t have gyroscopes in their devices (which prevented them from being able to run the program previously) and use without a cardboard viewer. The user can use their left thumb on the corner of the screen to pan/tilt the camera and their right thumb to navigate forward/backward.

MANUAL

SECTION 4.10

Strips are angled toward each other at ~14.5 degrees with a tolerance of approximately ±1 degree in respect to the part to which it’s adhered (but please note, as stated earlier in this manual that “every effort is made to ensure that ARENAS are consistent from event to event. However, ARENAS are assembled in different venues by different event staff and some small variations occur”) and such that there’s an 8-in. (~20 cm) gap at their closest points.

SECTION 10.7

R60. All circuits shall be wired with appropriately sized insulated copper wire (SIGNAL LEVEL cables don’t have to be copper):

<table>
<thead>
<tr>
<th>Application</th>
<th>Minimum Wire Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 – 40A protected circuit</td>
<td>12 AWG (13 SWG or 4 mm²)</td>
</tr>
<tr>
<td>21 – 30A protected circuit</td>
<td>14 AWG (16 SWG or 2.5 mm²)</td>
</tr>
<tr>
<td>6 – 20A protected circuit Between the PDP dedicated terminals</td>
<td>18 AWG (19 SWG or 1 mm²)</td>
</tr>
<tr>
<td>and the VRM or PCM Compressor outputs from the PCM</td>
<td></td>
</tr>
<tr>
<td>Between the PDP and the roboRIO ≤5A protected circuit</td>
<td>22 AWG (22 SWG or 0.5 mm²)</td>
</tr>
<tr>
<td>VRM 2A circuits</td>
<td>24 AWG (24 SWG or .25 mm²)</td>
</tr>
<tr>
<td>roboRIO PWM port outputs</td>
<td>26 AWG (27 SWG or 0.14 mm²)</td>
</tr>
</tbody>
</table>
### SECTION 13

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROBOT</td>
<td>an electromechanical assembly built by the FIRST Robotics Competition team to perform specific tasks when competing in DESTINATION: DEEP SPACE Presented By The Boeing Company. The ROBOT must include all of the basic systems required to be an active participant in the game – power, communications, control, BUMPERS, and movement. The ROBOT implementation must obviously follow a design approach intended to play DESTINATION: DEEP SPACE (e.g. a box of unassembled parts placed on the FIELD, or a ROBOT designed to play a different game, does not satisfy this definition).</td>
</tr>
</tbody>
</table>

**SIGNAL LEVEL circuits** (i.e. circuits which draw ≤1A continuous and have a source incapable of delivering >1A, including but not limited to roboRIO non-PWM outputs, CAN signals, PCM Solenoid outputs, VRM 500mA outputs and Arduino outputs)  

28 AWG  
(29 SWG or .08 mm2)
Team Update 05

GENERAL
No updates

MANUAL
No updates
Team Update 04

GENERAL

- **Control System Update:** An optional NI Update Suite update (2019.1.0) has been released. This update:
  - contains a new roboRIO image (v13) that repairs an issue in interfacing with the Analog Devices IMU and Gyro boards in all languages (so, updating to this new image is needed for teams working with these sensors)
  - fixes a Driver Station issue with launching Smartdashboard and Shuffleboard automatically.
- **Q&A Updates:** Q101 and Q146 have been revised to reflect the revision to G4 described below. Please accept our apologies for any confusion.

MANUAL

SECTION 5.4

Table 5.2 DESTINATION: DEEP SPACE rule violations

<table>
<thead>
<tr>
<th>Penalty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOUL</td>
<td>a credit of three (3) points towards the opponent’s total score</td>
</tr>
<tr>
<td>TECH FOUL</td>
<td>a credit of ten (10) points toward the opponent’s total score</td>
</tr>
<tr>
<td>YELLOW CARD</td>
<td>a warning issued by the Head REFEREE for egregious ROBOT or team member behavior or rule violations. A subsequent YELLOW CARD within the same tournament phase will lead to a RED CARD.</td>
</tr>
<tr>
<td>RED CARD</td>
<td>a penalty assessed for egregious ROBOT or team member behavior or rule violations which results in a team being DISQUALIFIED for the MATCH.</td>
</tr>
<tr>
<td>DISABLED</td>
<td>ROBOT is commanded to deactivate all outputs, rendering the ROBOT inoperable for the remainder of the MATCH.</td>
</tr>
<tr>
<td>DISQUALIFIED</td>
<td>the state of a team in which they receive zero (0) MATCH points and zero (0) Ranking Points in a Qualification MATCH or causes their ALLIANCE to receive zero (0) MATCH points in a Playoff MATCH</td>
</tr>
</tbody>
</table>

SECTION 8.2.2

G4. **One GAME PIECE at a time.** ROBOTS may not have extended or repeated control, i.e. exercise extended or repeated influence, of more than one (1) GAME PIECE at a time, either directly or transitively through other objects. A GAME PIECE that is at least partially supported by a ROCKET or CARGO SHIP is not considered controlled by the ROBOT.

Violation: FOUL per additional GAME PIECE. If greater than two (2) at a time, YELLOW CARD. If ROBOT releases all GAME PIECES, YELLOW CARD. If strategic, YELLOW CARD.

If a GAME PIECE becomes lodged in or on a ROBOT, it is considered controlled by the ROBOT. It is important to design your ROBOT so that it is impossible to inadvertently or unintentionally control more than the allowed maximum.

For Example, 1: if a ROBOT controls three (3) two (2) GAME PIECES and then releases them all in a way that both GAME PIECES are in scoring position, the team is issued two (2) FOULS (per part 1 of the violation), a YELLOW CARD for controlling more than two (2) GAME PIECES (per part 2 of the violation), and a second YELLOW CARD for releasing them all during the MATCH (per part 3 of the violation), thus earning a RED YELLOW CARD.

Example 2: If a CARGO is stuck on a ROBOT and that ROBOT picks up a HATCH PANEL, they are issued a FOUL per G4. If they place that HATCH PANEL and then pick up another HATCH PANEL, they are issued another FOUL. Continuing game play in this manner (i.e. not taking advantage of carrying more than one (1) GAME PIECE) would generally not be considered a strategic violation.
Example 3: A ROBOT controlling one (1) GAME PIECE that briefly contacts several CARGO in close proximity causing them to scatter would generally not be considered in violation of G4.

SECTION 10.5

R31.

C. use a stacked pair of approximately 2½ in. (nominal) round, petal, or hex "pool noodles" (solid or hollow) as the BUMPER cushion material (see Figure 10-6). All pool noodles used in a BUMPER set (e.g. Red set of BUMPERS) may not be modified (with the exception of cutting to length or beveling ends) or deformed and must be the same diameter, cross-section, and density (e.g. all round hollow or all hex solid). Cushion material may extend up to 2½ in. (~63 mm) beyond the end of the plywood (see Figure 10-7). To assist in applying the fabric covering, soft fasteners may be used to attach the pool noodles to the wood backing, so long as the cross section in Figure 10-6 is not significantly altered (e.g. tape compressing the pool noodles).
Team Update 03

GENERAL

- **Control System**: An optional update has been released for WPILib for C++\Java, fixing a number of minor bugs discovered by teams in the first week of the season. Upgrade instructions and release notes detailing the changes can be found on the release page.

- **VR Assets**: A new version of the AutomationDirect HTC Vive/Oculus Rift application has been posted. The new version allows users to control the CARGO SHIP to hold or eject CARGO, drive a ROBOT around the FIELD, and run a simulated MATCH. The SANDSTORM PERIOD has an active ROBOT camera view in the Driver Station computer.

- **Q&A**: Q25 and Q60 have been revised to reflect the clarification on SANDSTORM and HAB Climb Bonus assessments. Please accept our apologies for any confusion.

MANUAL

SECTION 5.1.1

Twenty-four (24) of each GAME PIECE are staged on each side of the FIELD ARENA for each MATCH as follows:

SECTION 5.3

For the purposes of assessing SANDSTORM and HAB Climb Bonuses described in Table 5-1, a ROBOT is considered to have started from, or climbed to, a HAB Level if:

1. the ROBOT'S BUMPERS are fully above the Level’s platform,
2. the ROBOT is only supported by:
   - surfaces of the HAB PLATFORM at or above that Level,
   - ALLIANCE WALL, and/or
   - another ROBOT which has climbed to that HAB Level or higher

SANDSTORM and HAB Climb Bonuses are evaluated and scored by human REFEREES. Teams are encouraged to make sure that it’s obvious and unambiguous that a ROBOT is not being supported by anything below that Level.

SECTION 8.2.2

G4. **One GAME PIECE at a time.** ROBOTS may not have extended or repeated control, i.e. exercise extended or repeated influence, of more than one (1) GAME PIECE at a time, either directly or transitively through other objects.

Violation: FOUL per additional GAME PIECE. If greater than two (2) at a time or second GAME PIECE leaves ROBOT, YELLOW CARD. If ROBOT releases all GAME PIECES, YELLOW CARD.

If a GAME PIECE becomes lodged in or on a ROBOT, it is considered controlled by the ROBOT. It is important to design your ROBOT so that it is impossible to inadvertently or unintentionally control more than the allowed maximum.

For example, if a ROBOT controls three (3) GAME PIECES and then releases them all, the team is issued two (2) FOULS (per part 1 of the violation), a YELLOW CARD for controlling more than two (2) GAME PIECES (per part 2 of the violation), and a second YELLOW CARD for releasing them all during the MATCH (per part 3 of the violation), thus earning a RED CARD.

G6. **No throwing HATCH PANELS.** ROBOTS may not shoot HATCH PANELS into the air in a way that’s prohibited in R6, kick them across the floor using an active MECHANISM, or eject them across the floor in a forceful way (i.e. HATCH PANEL is propelled caused to move a significant distance).
SECTION 8.2.6

**G24. Don’t overextend yourself.** ROBOTS may not extend more than 30 in (~76 cm) beyond their FRAME PERIMETER (see Figure 8-2).

*Violation: FOUL. If strategic (e.g. expansion results in scoring a GAME PIECE), RED CARD.*

Examples of compliance and non-compliance of G24 are shown in Figure 8-2.

Yellow bars represent the limits of the FRAME PERIMETER and are drawn in the same orientation of the ROBOT’S FRAME PERIMETER. Green bars represent a measured extension from the FRAME PERIMETER that has not been exceeded. Red bars represent a measured extension from the FRAME PERIMETER that has exceeded the limit in G24). ROBOTS A and C违olate G24, whereas ROBOT B does not.

![Figure 8-2 Examples of G24 compliance and non-compliance](image)

SECTION 10.2

**R3.** (Blue Box)

Expect to have to demonstrate a ROBOT’S ability to constrain itself per above during Inspection. Constraints may be implemented with either hardware or software.

Be sure to consider the size of the ROBOT on its cart to make sure it will fit through doors. Also consider the size of the ROBOT to ensure that it will fit into a shipping crate, bag, vehicle, etc.

Note that the BUMPER Rules contained in the BUMPER Rules section may impose additional restrictions on ROBOT design.

**R4.** (Blue Box)

Expect to have to demonstrate a ROBOT’S ability to constrain itself per above during Inspection. Constraints may be implemented with either hardware or software.

See the Game Rules: ROBOTS section for height and extension restrictions for various areas of the FIELD.

SECTION 10.3

**R6.** A ROBOT may not be designed to shoot a HATCH PANEL such that it travels more than 3 horizontal ft. (~91 cm) beyond its FRAME PERIMETER (reference G6).

The distance is measured with a stationary ROBOT relative to the ground and from the ROBOT’S FRAME PERIMETER to where the HATCH PANEL first contacts the ground. At Inspection,
Inspectors will expect teams to demonstrate compliance with R6 using the configuration and operation of the ROBOT that results in the farthest shot of a HATCH PANEL, i.e. the greatest distance of which the ROBOT is capable.

**SECTION 10.4**

**R13.** No individual, non-KOP item shall have a value Fair Market Value that exceeds $500 USD. The total cost of COMPONENTS purchased in bulk may exceed $500 USD as long as the cost of an individual COMPONENT does not exceed $500 USD.

**R14.** The BOM cost of each non-KOP item must be calculated based on the unit Fair Market Value for the material and/or labor, except for labor provided by team members (including sponsor employees who are members of the team), members of other teams, event provided Machine Shops and shipping.

The Fair Market Value of a COTS part is its price defined by a VENDOR.

Example 1: A team orders a custom bracket made by a company to the team's specification. The company's material cost and normally charged labor rate apply.

Example 2: A team receives a donated sensor. The company would normally sell this item for $52 USD, which is therefore its Fair Market Value.

Example 3: Special price discounts from National Instruments and other FIRST Suppliers are being offered to teams. The discounted purchase price of items from these sources may be used in the additional parts accounting calculations.

Example 4: A team purchases steel bar stock for $10 USD and has it machined by a local machine shop. The machine shop is not considered a team Sponsor but donates two (2) hours of expended labor anyway. The team must include the estimated normal cost of the labor as if it were paid to the machine shop and add it to the $10 USD.

Example 5: A team purchases steel bar stock for $10 USD and has it machined by a local machine shop that is a recognized Sponsor of the team. If the machinists are considered members of the team, their labor costs do not apply. The total applicable cost for the part would be $10 USD.

It is in the best interests of the teams and FIRST to form relationships with as many organizations as possible. Teams are encouraged to be expansive in recruiting and including organizations in their team, as that exposes more people and organizations to FIRST. Recognizing supporting companies as Sponsors of, and members in, the team is encouraged, even if the involvement of the Sponsor is solely through the donation of fabrication labor.

Example 6: A team purchases steel bar stock for $10 USD and has it machined by another team. The total applicable cost for the part would be $10 USD.

Example 7: A team purchases a 4 ft. by 4 ft. (~122 cm by 122 cm) sheet of aluminum, but only uses a piece 10 in. by 10 in. (~25 cm by 25 cm) on their ROBOT. The team identifies a source that sells aluminum sheet in 1 by 1 ft. (~30 cm by 30 cm) pieces. The team may cost their part based on a 1 by 1 ft. (~30 cm by 30 cm) piece, even though they cut the piece from a larger bulk purchase. They do not have to account for the entire 4 by 4 ft. (~122 cm by 122 cm) bulk purchase item.

Example 8: A team purchases a widget at a garage sale or online auction for $3, but it’s available for sale from a VENDOR for $13. The Fair Market Value that gets reported on the BOM is $13.

**SECTION 10.5**

**R25.**

Example 2: A ROBOT outside its HAB ZONE deploys a MECHANISM which lifts the BUMPERS outside the BUMPER ZONE (when virtually transposed onto a flat floor). This violates R25.

**R31.**
B. hard BUMPER parts allowed per R31-A, -E, -F, and -G must not extend more than 1 in. (~25 mm) beyond the FRAME PERIMETER (measured as shown in Figure 10-4).

R31. (Blue Box 2)

All pool noodles used on a ROBOT must be the same in order to maintain the desired interaction between ROBOTS in the cases of BUMPER-to-BUMPER contact. BUMPERS containing pool noodles of vastly different construction may cause a “ramp” effect when interacting with other BUMPERS.

Noodle compression as a result of smoothing BUMPER fabric or rounding a FRAME PERIMETER corner is not considered deformed. Any compression beyond that, e.g. for the purposes of flattening the noodle, is deformation and a violation of R31-C.

R31. (Figure 10-6, change is “optional aluminum metal angle attached with wood screws to clamp fabric” in callout)

R32. (Figure 10-7, modified to better represent that the bottom right example is a noodle wrapped around the corner.)
SECTION 10.9

R92.

C. The two wires from the pressure switch must be connected directly to the pressure switch input of the PCM controlling the compressor or, if controlled using the roboRIO and a Spike relay, to the roboRIO.
Team Update 02

GENERAL

- A link to the soft copy of the 2019 Virtual Kit Catalog (printed copies were distributed in the Kickoff Kit) is posted in the Virtual Kit section of the Kit of Parts page.
- GE-19126, GE-19127, GE-19165, GE-19166, and GE-19217 have been updated to include the information added to the game manual’s Section 4.3, detailed below, and added to the Field Drawings – season specific drawing package.

MANUAL

SECTION 4.3

Each ROCKET HATCH is flanked by two (2) 10 in. (~25 cm) tall, 2 in. (~5 cm) wide pieces of black hook tape (3M part number SJ3572), positioned as shown below.

SECTION 5.1.1

Twenty-four (24) of each GAME PIECES are staged on each side of the FIELD for each MATCH as follows:

SECTION 7

C8.

C8 does not apply for strategies consistent with standard gameplay, for example:

a. causing an opponent ROBOT to contact your ROCKET during the last few seconds of a MATCH while in the process of trying to place a HATCH PANEL.
b. contacting an opponent ROBOT while in your HAB ZONE while trying to retrieve CARGO from your DEPOT.

C8 requires an intentional act with limited or no opportunity for the TEAM being acted on to avoid the penalty, such as:

c. placing a HATCH PANEL on/in an opponent who’s already controlling a GAME PIECE such that they cannot help but violate G4.
d. pushing an opponent ROBOT against your ROCKET during the final twenty (20) seconds of the MATCH for the sole purpose of making them violate G9 G16.

SECTION 8.2.2

G6. No throwing HATCH PANELS. ROBOTS may not shoot HATCH PANELS into the air in a way that's prohibited in R6, kick them across the floor using an active MECHANISM, or eject them across the floor in a forceful way (i.e. HATCH PANEL is propelled a significant distance).

Violation: RED CARD.

SECTION 8.2.3

G14. Don’t climb on each other unless in the HAB ZONE. A ROBOT may not be fully supported by a partner ROBOT unless the supporting ROBOT is at least partially in contact with its HAB ZONE.

SECTION 8.2.4

G15. Be careful about what you interact with. DRIVE TEAMS, ROBOTS, and OPERATOR CONSOLES are prohibited from the following actions with regards to interaction with ARENA elements. Items A-D exclude GAME PIECES and the HAB PLATFORM.

A. Grabbing (excluding DRIVE TEAM interaction with FIELD elements in their areas)
B. Grasping (excluding DRIVE TEAM interaction with FIELD elements in their areas)
C. Attaching (including the use of hook tape to anchor to the FIELD carpet and excluding use of the PLAYER STATION hook-and-loop tape, plugging in to the provided power outlet, and plugging the provided Ethernet cable in to the OPERATOR CONSOLE)

D. Hanging

E. Deforming

F. Becoming entangled

G. Damaging

Violation: If prior to MATCH, and situation can be corrected quickly, it must be remedied before the MATCH will start. If during a MATCH, FOUL. If during a MATCH and extended or repeated, YELLOW CARD. If offense is via a ROBOT and the Head REFEREE determines that further damage is likely to occur, offending ROBOT will be DISABLED. Corrective action (such as eliminating sharp edges, removing the damaging MECHANISM, and/or re-Inspection) may be required before the ROBOT will be allowed to compete in subsequent MATCHES.

GAME PIECES are expected to undergo a reasonable amount of wear and tear as they are handled by ROBOTS, such as scratching or marking. Gouging, tearing off pieces, popping, or routinely marking GAME PIECES are violations of this rule. Materials that aggressively wear or leave behind residue or debris on the HATCH PANEL’S loop tape may hinder the natural behavior of the loop tape and thus violate G15. Humans causing GAME PIECE wear and tear, e.g. deforming a CARGO, are subject to a CARD per C1.

There are no rules that prohibit contact with the SANDSTORM’S black out material, however contact that prevents the SANDSTORM from working properly (e.g. retracting at T-minus 135s) is considered damaging and a violation of G15.

SECTION 10.2

R1. The ROBOT (excluding BUMPERS) must have a FRAME PERIMETER, contained within the BUMPER ZONE and established in the ROBOT’S STARTING CONFIGURATION, that is comprised of fixed, non-articulated structural elements of the ROBOT. Minor protrusions no greater than ¼ in. (~6 mm) such as bolt heads, fastener ends, weld beads, and rivets are not considered part of the FRAME PERIMETER.

SECTION 10.3

R6. A ROBOT may not be designed to launch shoot a HATCH PANEL such that it travels more than 2 3 horizontal ft. (~60 91 cm) beyond its FRAME PERIMETER (reference G6).

The distance is measured with a stationary ROBOT relative to the ground and from the ROBOT’S FRAME PERIMETER to where the HATCH PANEL first contacts the ground.
SECTION 10.6

R34. The only motors and actuators permitted on 2019 ROBOTS include the following (in any quantity):

<table>
<thead>
<tr>
<th>Motor Name</th>
<th>Part Numbers Available</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CIM</strong></td>
<td>FR801-001</td>
</tr>
<tr>
<td></td>
<td>M4-R0062-12</td>
</tr>
<tr>
<td></td>
<td>AM802-001A</td>
</tr>
<tr>
<td></td>
<td>217-2000</td>
</tr>
<tr>
<td></td>
<td>PM25R-44F-1005</td>
</tr>
<tr>
<td>West Coast Products RS775 Pro</td>
<td>217-4347</td>
</tr>
<tr>
<td><strong>Banebots</strong></td>
<td>am-3830</td>
</tr>
<tr>
<td></td>
<td>M7-RS775-18</td>
</tr>
<tr>
<td></td>
<td>RS775WC-8514</td>
</tr>
<tr>
<td><strong>AndyMark 9015</strong></td>
<td>am-0912</td>
</tr>
<tr>
<td><strong>VEX BAG</strong></td>
<td>217-3351</td>
</tr>
<tr>
<td><strong>VEX mini-CIM</strong></td>
<td>217-3371</td>
</tr>
<tr>
<td><strong>AndyMark PG</strong></td>
<td>am-2161 (alt. PN am-2765)</td>
</tr>
<tr>
<td><strong>KOP Automotive motors</strong></td>
<td>Denso AE235100-0160</td>
</tr>
<tr>
<td></td>
<td>Denso 5-163800-RC1</td>
</tr>
<tr>
<td></td>
<td>Denso 262100-3030</td>
</tr>
<tr>
<td><strong>Snow Blower Motor</strong></td>
<td>am-2235</td>
</tr>
<tr>
<td><strong>AndyMark NeveRest</strong></td>
<td>am-3104</td>
</tr>
<tr>
<td><strong>AndyMark RedLine Motor</strong></td>
<td>am-3775</td>
</tr>
<tr>
<td><strong>Nidec Dynamo BLDC Motor</strong></td>
<td>am-3740</td>
</tr>
<tr>
<td><strong>REV Robotics NEO Brushless</strong></td>
<td>REV-21-1650</td>
</tr>
</tbody>
</table>

- Electrical solenoid actuators, no greater than 1 in. (nominal) stroke and rated electrical input power no greater than 10 watts (W) continuous duty at 12 volts (VDC)
- Hard drive motors or fans that are: included in any Kickoff Kit, distributed via FIRST Choice, part of a legal motor controller (including manufacturer provided accessories), or part of a legal COTS computing device
- Factory installed vibration and autofocus motors resident in COTS computing devices (e.g. rumble motor in a smartphone).
- PWM COTS servos with a retail cost < $75.
- Motors integral to a COTS sensor (e.g. LIDAR, scanning sonar, etc.), provided the device is not modified except to facilitate mounting
- One (1) compressor compliant with R86 and used to compress air for the ROBOT'S pneumatic system

SECTION 10.9

R84. The only pneumatic system items permitted on ROBOTS include the items listed below.

A. Pneumatic pressure vent plug valves functionally equivalent to those provided in the KOP,

Parker valves PV609-2 or MV709-2 are recommended.

B. Pressure relief valves functionally equivalent to those provided in the KOP,

Norgren 16-004-011, 16-004-003 or McMaster-Carr 48435K714 recommended.

To be considered functionally equivalent the valve must be preset or adjustable to 125 psi (~862 kPA) and capable of relieving at least 1 scfm (~472 cm3/s).

C. Solenoid valves with a maximum ¼ in. (nominal, ~3 mm) NPT, BSPP, or BSPT port diameter or integrated quick connect ¼ in. (nominal, ~6mm) outside diameter tubing connection,

D. Additional pneumatic tubing, with a maximum ¼ in. (nominal, ~6 mm) outside diameter,
E. Pressure transducers, pressure gauges, passive flow control valves (specifically “needle valve”), manifolds, and connecting fittings (including COTS pneumatic U-tubes),
F. Check and quick exhaust valves, provided that the requirements of Error! Reference source not found. are still met.
G. Shutoff valves which relieve downstream pressure to atmosphere when closed (may also be known as 3-way or 3-way exhausting valves).
H. Pressure regulators with the maximum outlet pressure adjusted to no more than 60 psi (~413 kPa),
I. Pneumatic cylinders, pneumatic linear actuators, and rotary actuators,
J. Pneumatic storage tanks (with the exception of White Clippard tanks P/N: AVT-PP-41),
K. One (1) compressor that is compliant with R86, and
L. Debris or coalescing (water) filters, and
M. Venturi valves (note: the high-pressure side of a Venturi valve is considered a pneumatic device and must follow all pneumatic rules. The vacuum side of a Venturi valve is exempt from the pneumatic rules per “a” in the Blue Box below).

The following devices are not considered pneumatic devices and are not subject to pneumatic rules (though they must satisfy all other rules):

- a. a device that creates a vacuum
- b. closed-loop COTS pneumatic (gas) shocks
- c. air-filled (pneumatic) wheels
- d. pneumatic devices not used as part of a pneumatic system (i.e. used in a way that does not allow them to contain pressurized air)

SECTION 12.2.1

During the Playoff MATCHES, if a team receives a YELLOW or RED CARD, it results in for the entire ALLIANCE receiving the YELLOW or RED CARD for that MATCH. If different teams on the same Alliance are issued YELLOW CARDS, the entire Alliance is issued a RED CARD.
GENERAL

- **CAD Models:** The official CAD models have been updated per the changes described in this document and also to correct errors users may have experienced in accessing files for parts that get a vinyl overlay.
- **Control System:** As you dive into programming your robot, we want to point out two pages of the Screensteps documentation you may want to pay particularly close attention to. The New for 2019! page outlines major software changes for the 2019 season, including information about 2019 Game Specifics such as how the Sandstorm is handled in robot code. The Known Issues page documents major issues we are currently aware of along with workarounds or solutions where available.

KICKOFF KIT CHECKLIST: BLACK TOTE

V1 of the [Black Tote Checklist](#) has been updated to include the following edit:

| Seat Motor | Bosch | 6004 RA3 194-06 | 1 | www.andyark.com |

2019 VIRTUAL KIT CATALOG

Consider marking up your 2019 Virtual Kit Catalog packed in your Black Tote with the following edits:

- **Inventables:** Use the voucher code as a gift certificate code in the "Enter Promotion" field on the shopping cart page.
- **Next Gen Robots:** Voucher Detail: CIM Cooler 180 or 775 Cooler 360
- **Wolfram:** Access Codes: Visit Team Registration Account (Lead Mentor 1 or 2) sent via email after completing webform

VIRTUAL REALITY (VR) ASSETS

VR assets have been updated as follows:

- **AutomationDirect HTC Vive/Oculus Rift Asset:** The color of cargo ships has been corrected.
- **PTC:** The VuMark pdf (for use with the Scaled VR model) has been updated to remove unnecessary “with ThingMark” language.

MANUAL

SECTION 4.1

A run of steel, black powder coated cable protectors (VEX part number 217-6294) extends from the center of the guardrail on the scoring table side of the FIELD to the center of the FIELD, between the CARGO SHIPS. A cable protector run is made up of three (3) long segments (P/N) and an exit segment (P/N note, the exit segments are not available for purchase).
- Figure 4-16 has been added (please note, this addition renumbers all subsequent images in Section 4).

*Figure 4-16 Overall CARGO SHIP length and width.*
- Figure 4-17 (formerly Figure 4-16) has been updated to correct the length and width of the CARGO SHIP base.

Figure 4-17 Major CARGO SHIP dimensions.

- Figure 4-18 (formerly Figure 4-17) has been updated as follows:

Figure 4-18 CARGO SHIP HATCH geometry and dimensions.
SECTION 4.5

Figure 4-21 (formerly Figure 4-20) has been updated to correct the width and depth of the lowest deck and ramps.

![Figure 4-21 Blue HAB PLATFORM with major dimensions.](image)

SECTION 4.6

Figure 4-23 (formerly Figure 4-22) has been updated to correct the width and depth of the DEPOT.

![Figure 4-23 Blue DEPOTS](image)

SECTION 4.8.1.1

Three (3) in. (~7.6 cm) of black tape is applied to the left and right edges of the PLAYER STATION polycarbonate window, on the FIELD side.

Figure 4-26 (formerly Figure 4-25) has been updated to show the wider taped area (as have other affected images in the manual, CAD models, and the Layout and Marking Diagram):
SECTION 4.8.1.2

Figure 4-28 (formerly Figure 4-27) has been updated to correct the width of the LOADING STATION.

SECTION 4.9.1

Each CARGO is an orange 13-in. (~33 cm) \( \pm \frac{1}{2} \text{ in.} \) (~1.2 cm) diameter rubber playground ball with a FIRST logo as shown in Figure 4-29 Figure 4-30.

SECTION 5.5

While the TECHNICIAN may be the primary technical member of the DRIVE TEAM, all members of the DRIVE TEAM are encouraged to have knowledge of the basic functionality of the ROBOT, such as the location and operation of the main circuit breaker, connecting and resetting joysticks or gamepads from the OPERATOR CONSOLE, and releasing removing the ROBOT from the SCALE HAB PLATFORM.
SECTION 6

S2.  **Wait for the green lights.** Team members may only enter the FIELD if the ROCKET’S nosecone LEDs are green, unless explicitly instructed by a REFEREE or an FTA.

SECTION 8.2.2

G5.  **Don’t mess with opponents’ scored GAME PIECES.** A ROBOT may not remove a GAME PIECE from an opponents’ ROCKET/CARGO SHIP. GAME PIECES which become dislodged because of incidental contact with the ROCKET/CARGO SHIP are not considered a violation of this rule.

Violation: FOUL per GAME PIECE de-scored and opponents are awarded one (1) Complete ROCKET Ranking Point if neither of their ROCKETS are completed at T-minus 0s.

SECTION 8.2.4

G16.  **Don’t touch opponents’ ROCKETS at the end of the MATCH.** During Qualification MATCHES, ROBOTS may not contact opponents’ ROCKETS starting at T-minus 20s. Incidental contact, i.e. unintentional contact where opponents’ actions are not impeded (e.g. minor contact while driving by the ROCKET), is an exception to this rule.

Violation: FOUL and opponents are awarded one (1) Complete ROCKET Ranking Point if neither of their ROCKETS are completed at T-minus 0s.

SECTION 10.4

A note about the change to R12: We regret the oversight of not informing teams of the changes to the cost limit and KIT OF PARTS definition before the Drive Base Opt Out window and FIRST Choice Round 1.

We’re sorry.

As a result, we’re modifying R12 to compensate, if only partially, for the fact that teams may have made different decisions in the fall given the change to the rules.

R12.  The total cost of all items on the ROBOT shall not exceed $5000 $5500 USD. All costs are to be determined as explained in the Budget Constraints & Fabrication Schedule section. Exceptions are as follows:

A.  individual items that are less than $5 USD each, as purchasable from a VENDOR, and
B.  items from the current year’s KOP, up to the KOP quantity (including the rookie KOP items). Identical replacements may be used to meet this criterion.

SECTION 10.9

R86.  Throughout an event, compressed air on the ROBOT must be provided by its one onboard compressor only. Compressor specifications must not exceed nominal 1.10 cfm (~519 cm3/s) flow rate @ 12VDC.

SECTION 12.7

Table 12-3 was updated as follows:

<table>
<thead>
<tr>
<th>Order Sort</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>Cumulative FOUL and TECH FOUL points due to opponent rule violations</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>Cumulative CARGO points</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>Cumulative HATCH PANEL points</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Cumulative HAB CLIMB points</td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Cumulative SANDSTORM BONUS points</td>
</tr>
<tr>
<td>6&lt;sup&gt;th&lt;/sup&gt;</td>
<td>MATCH is replayed</td>
</tr>
</tbody>
</table>

SECTION 12.8.3

Some District Championships have a sufficient number of teams to justify using more than one division. Teams are assigned divisions by event organizers FIRST using a process developed by FIRST in Michigan.

The process employs a “brute force iterative randomizer” and is executed as follows:
1. The district team list is sorted in order of cumulative district points earned as described in the District Events section.
2. The list is divided into quartiles based on rank (e.g. the 1st quartile has the top 25% ranked teams).
3. Division assignments are randomly generated using equal contribution from each quartile.
4. Three (3) criteria are calculated for each division:
   a. Average strength: The arithmetic mean of the district point values of teams in a division.
   b. Distribution of strength: The Signal to Noise Ratio (SNR) of the district point values of teams in a division.
      SNR is calculated as follows:
      \[
      SNR = 10 \left( \log \frac{\bar{x}^2}{\sigma^2} \right)
      \]
      \(\bar{x}\) = arithmetic mean of the district points in a division
      \(\sigma\) = standard deviation of the district points in a division
   c. Distribution of strength for “top” teams: The SNR of the district point values of teams in the 1st quartile of a division.
5. The three (3) criteria for each division are compared to the other division(s). If the difference between the division’s value and any other division’s value exceeds the limits in Table 0-1, the criteria is not met.

<table>
<thead>
<tr>
<th></th>
<th>Two (2) Divisions</th>
<th>Four (4) Divisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average strength</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Distribution of strength</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>Distribution of strength for “top” teams</td>
<td>1.5</td>
<td>2</td>
</tr>
</tbody>
</table>

6. If all three (3) criteria met, event organizers publish the assignments. If any of the three (3) criteria are not met, assignments are rejected, and the process returns to Step 3.

   In these cases:
   - Division winning ALLIANCES play each other in District Championship Playoffs, employing the bracket below that corresponds to their District, until a winning ALLIANCE for the event is determined.