# 4 ARENA

The ARENA includes all elements of the game infrastructure that are required to play DESTINATION: DEEP SPACE Presented By The Boeing Company: the FIELD, GAME PIECES, and all equipment needed for FIELD control, ROBOT control, and scorekeeping.

The ARENA is modular and assembled, used, disassembled, and shipped many times during the competition season. It will undergo wear and tear. The ARENA is designed to withstand rigorous play and frequent shipping. 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. For details regarding assembly tolerances, please refer to the 2019 ARENA Layout and Marking Diagram. Successful teams will design ROBOTS that are insensitive to these variations.

Illustrations included in this section are for a general visual understanding of the DESTINATION: DEEP SPACE ARENA, and dimensions included in the manual are nominal. Please refer to the official drawings for exact dimensions, tolerances, and construction details. The official drawings, CAD models, and drawings for low-cost versions of important elements of the DESTINATION: DEEP SPACE FIELD are posted on the <u>2019 DESTINATION: DEEP SPACE Game & Season Materials page</u> on the *FIRST*<sup>®</sup> website.

### 4.1 FIELD



#### Figure 4-1: DESTINATION: DEEP SPACE

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- and upward-facing surfaces of the guardrails, inward-facing surfaces of the ALLIANCE WALLS (except Chute surfaces). It is populated with ROCKETS, CARGO SHIPS, HAB PLATFORMS, DEPOTS, and LOADING STATIONS. Two (2) Red ROCKETS and two (2) Blue ROCKETS are on their respective ALLIANCE'S side of the FIELD, positioned against each guardrail.

One (1) Red CARGO SHIP and one (1) Blue CARGO SHIP are centered on the CENTER LINE and face their respective ALLIANCE STATIONS. Each CARGO SHIP is on its ALLIANCE'S side of the FIELD. The small space between the sterns of the CARGO SHIPS is sealed with clear plastic.

Each ROCKET has six (6) BAYS and each CARGO SHIP has eight (8) BAYS. A BAY is a container used to hold one (1) CARGO and can be sealed with one (1) HATCH PANEL. Each BAY has a HATCH which must be covered by a HATCH PANEL for the BAY to retain CARGO.

One (1) Red HAB PLATFORM and one (1) Blue HAB PLATFORM abut the corresponding ALLIANCE WALL and are centered on the MIDLINE. Each HAB PLATFORM is a 12 ft. 6½ in. (~382 cm) by 7 ft. 11½ in. (~243 cm) assembly that consists of Level 1, 2, and 3 platforms, their supporting structures, and the ramp.

Two (2) Red LOADING STATIONS and two (2) Blue LOADING STATIONS are located on their ALLIANCE'S side of the FIELD and intersect perpendicularly with the guardrails.

The surface of the FIELD is low pile carpet, Shaw Floors, Philadelphia Commercial, Neyland II 20, "66561 Medallion" (please note that Neyland II carpet is obsolete and the closest equivalent is Neyland III). The edge of the carpet is secured to the venue floor using 3M<sup>™</sup> Premium Matte Cloth Tape GT2 or comparable gaffers tape.

Guardrails form the long edges of the FIELD and are a 1 ft. 7 in. (~48 cm) tall system of transparent polycarbonate supported on the top and bottom by aluminum extrusion. Guardrails, along with the ALLIANCE WALLS, prevent ROBOTS from inadvertently exiting the FIELD during a MATCH. There are four (4) gates in the guardrail that allow access to the FIELD for placement and removal of ROBOTS. The gate passthrough, when open, is 3 ft. 2 in. (~97 cm) wide. Gates are closed and shielded during the MATCH.



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#### Figure 4-2 Gate locations

There are two versions of guardrails and PLAYER STATIONS used for competitions. One design has been used at *FIRST* Robotics Competitions for several years and matches the <u>2019 Official *FIRST* FIELD</u> <u>Drawings & Models</u>. The other is designed and sold by AndyMark. While the designs are slightly different, the critical dimensions, performance, and expected user experience between the two are the same. Detailed drawings for the AndyMark design are posted on the <u>AndyMark website</u>. All illustrations in this manual show the traditional FIELD design.



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 and an exit segment (note, the exit segments are not available for purchase). The total length of the cable protector run is 11 ft.  $11^{3}_{4}$  in (~365 cm). The long cable protector segment is a custom steel channel that is  $7_{6}$  in. tall, 8 in. wide, and 3 ft.  $11^{1}_{6}$  in. long (~2 cm tall, ~20 cm wide, and ~120 cm long). It is secured to the carpet using hook fastener which increases the height to approximately  $^{15}/_{16}$  in. (~2 cm). Exit segments are attached to the guardrail with hook fastener and are 6 in. tall, 8 in. wide and  $2^{3}_{4}$  in. deep (~15 cm tall, ~20 cm wide and ~7 cm deep).



Figure 4-3 Cable Protector

## 4.2 ZONES AND MARKINGS

FIELD Zones and markings of consequence are described below. Unless otherwise specified, the tape used to mark lines and zones throughout the FIELD is 2-in. (~5cm)  $\underline{3M^{TM} \text{ Premium Matte Cloth (Gaffers)}}{Tape (GT2)}$ .



#### Figure 4-4 DESTINATION: DEEP SPACE FIELD

ALIGNMENT LINE: one of thirty-two (32) white gaffers tape marks adhered to the carpet that start 1 ft. 6 in. (~46 cm) from the outermost face of the assembly and extend to the point where the carpet meets the assembly and centered at GAME PIECE placement/retrieval points.



- one (1) ALIGNMENT LINE for each of the three (3) faces of each ROCKET
- one (1) ALIGNMENT LINE for each CARGO SHIP BAY
- one (1) ALIGNMENT LINE for each LOADING STATION





Figure 4-5 ALIGNMENT LINES (three (3) places per ROCKET, eight (8) places per CARGO SHIP, and one (1) place per LOADING STATION)



ALLIANCE STATION: a 30-ft. (~914 cm) wide by 10-ft. (~305 cm) deep infinitely tall volume formed by, and including the ALLIANCE WALL, the edge of the carpet, and ALLIANCE colored tape.



Figure 4-6 Blue ALLIANCE STATION

CARGO SHIP LINE: one of two (2) tape lines that extend the width of the FIELD and are colinear with the stern of each CARGO SHIP. The tape color matches the color of the closest ALLIANCE WALL.



Figure 4-7 CARGO SHIP LINES



CENTER LINE: an unmarked reference line that bisects the length of the FIELD.



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Figure 4-8 CENTER LINE

HAB LINE: one (1) of two (2) tape lines that extend the width of the FIELD and are colinear with and overlap the bottom of the HAB ramp by 1 in. The tape color matches the color of the closest ALLIANCE STATION.



Figure 4-9 Blue HAB LINE

HAB ZONE: an infinitely tall volume defined by the guardrail, ALLIANCE WALL, and the HAB LINE. The HAB ZONE includes the HAB LINE.



MIDLINE: a reference line that bisects the width of the FIELD and is marked by black tape that covers the mating seam of the two strips of carpet.



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#### Figure 4-10 MIDLINE

STARTING LINE: one (1) of two (2) lines in an ALLIANCE STATION, marked by white tape, that extends from the back of the outermost Driver Station Support assembly to the back of the ALLIANCE STATION.



Figure 4-11 Red ALLIANCE STARTING LINES

### 4.3 ROCKET



Figure 4-12 Red ROCKET

A ROCKET is a 10 ft. 4 in. (~315 cm) tall assembly placed such that its centerline is 8 ft. (~244 cm) from the CENTER LINE, and its "front" face is parallel to the guardrail, faces its CARGO SHIP, and 2 ft.  $3\frac{1}{2}$  in. (~70 cm) from the guardrail. The distance from the front of the "front" face to the back of the "back" face is 1 ft. 7% in. (~50 cm). The angle of its sides is  $61\frac{1}{4}$  degrees. Each ROCKET sits on top of a base; the base is not part of the ROCKET.

Each ROCKET has three (3) levels that collectively reach 7 ft. 10 in. tall (~239 cm) and are topped by one (1) nosecone. A nosecone is a FIELD assembly that caps each ROCKET and is lit per the <u>Scoring</u> section. Each level has two (2) BAYS. Note per the <u>Scoring</u> section only one (1) CARGO per BAY contributes to the ALLIANCE'S MATCH score.

A PORT is one of three (3) 1 ft. 4 in. (~41 cm) diameter holes in the "front" face of each ROCKET. The center of the lowest PORT is 2 ft. 3<sup>1</sup>/<sub>2</sub> in. (~70 cm) from the carpet, and the distance between the centers of each PORT is 2 ft. 4 in. (~71 cm).

A HATCH is an opening on a ROCKET or CARGO SHIP on which HATCH PANELS must be placed to retain CARGO. There are two types of HATCHES: a ROCKET HATCH and a CARGO SHIP HATCH.

A ROCKET HATCH is one (1) of three (3) 2 ft. 1 in. ( $\sim$ 64 cm) tall by 1 ft. 4½ in. ( $\sim$ 42 cm) wide cutouts on each side of a ROCKET. The center of the lowest cutout is 1 ft. 7 in. ( $\sim$ 48 cm) from the carpet. The vertical distance between the centers of each ROCKET HATCH is 2 ft. by 4 in. ( $\sim$ 71 cm).





Figure 4-13 ROCKET HATCHES and dimensions

The HATCH PANEL placement height at the bottom of a ROCKET equals the HATCH PANEL placement height on the CARGO SHIP (per the <u>CARGO SHIP</u> section), which equals the HATCH PANEL retrieval height from the LOADING STATION (per the <u>LOADING STATION</u> section).

The top of each ROCKET HATCH is backed by a cavity that includes an arched backstop that is  $7\frac{3}{4}$  in. (~20 cm) wide with a minimum height of 3 in. (~8 cm). It limits the depth of the HATCH to  $3\frac{1}{4}$  in (~8 cm).



Figure 4-14 ROCKET HATCH backstop, one (1) per ROCKET HATCH

The backstop reduces the likelihood that HATCH PANELS enter and get stuck in BAYS.



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.



Figure 4-15 ROCKET hook tape locations, two (2)/BAY.

The inside of each ROCKET BAY has an angled ramp which directs CARGO out the HATCH.

Note that two (2) ROCKET BAYS at the same height as each other can, together, physically accommodate more than two (2) CARGO, however CARGO in excess of two (2) per level will not be counted per the <u>Scoring</u> section.

Each ROCKET is flanked by two (2) wings. A wing is a sheet of bent plastic that is 6 ft. 2 in. (~188 cm) tall, 2 ft.  $5\frac{1}{4}$  in. (~74 cm) long, and  $7\frac{5}{4}$  in. (~19 cm) deep. The backs of the wings are tacked to the GUARDRAIL polycarbonate with double-sided polyethylene plastic mounting tape (<u>McMaster part number</u> <u>77185A23</u>).

## 4.4 CARGO SHIP

Each CARGO SHIP is a 7-ft. 11<sup>3</sup>/<sub>4</sub>-in. (~243 cm) long, 4-ft. 7<sup>3</sup>/<sub>4</sub> in. (~142 cm) wide, and 4 ft. (~122 cm) tall (excluding its fin) assembly with eight (8) BAYS, three (3) on each side and two (2) on the front (the front faces its ALLIANCE WALL). CARGO SHIPS are placed back-to-back, 9 in. (~23 cm) from the middle of the FIELD and centered on the MIDLINE.





Figure 4-16 Overall CARGO SHIP length and width.



Figure 4-17 Major CARGO SHIP dimensions.

Each BAY has a CARGO SHIP HATCH for one (1) HATCH PANEL. CARGO SHIP HATCH geometry is similar, but not identical, to ROCKET HATCH geometry and is detailed below in Figure 4-18.





Figure 4-18 CARGO SHIP HATCH geometry and dimensions.

Each CARGO SHIP HATCH is backed by a cavity that includes two (2) backstops. The backstops each have an inner width of  $7\frac{3}{4}$  in. (~20 cm) and a depth of  $3\frac{1}{4}$  in. (~8 cm). The top backstop has a minimum height of 3 in. (~8 cm), and the bottom backstop has a minimum height of  $3\frac{1}{4}$  in. (~8 cm).

The backstop prevents HATCH PANELS from entering and getting stuck in BAYS.

Each BAY capacity is approximately three (3) CARGO but note per the <u>Scoring</u> section only one (1) CARGO per BAY contributes to the ALLIANCE'S MATCH score. The back of each BAY is a cargo net (for side BAYS, the net is <u>Hall-Master, item no. 69618</u>, square or diamond pattern, and for front BAYS, the net is <u>PowerTye, Part #50362</u>). Nets are used to retain GAME PIECES in the CARGO SHIP and are not intended to behave consistently.

BAY floors are initially sloped to retain CARGO. At the end of the SANDSTORM PERIOD, T-minus135s, they tilt (magnets holding the back of the floor down disengage) causing CARGO to roll out of the CARGO SHIP if no HATCH PANEL has been attached to the corresponding HATCH.

There are three (3) posts on each side of each HATCH. Each post is  $\frac{5}{10}$  in. (~2 cm) in diameter and extends  $\frac{3}{10}$  in. (~2 cm) from the face of the CARGO SHIP. Posts are aligned vertically and positioned such that the center of the lower post is 1 ft. 1 in. (~33 cm) from the floor and their centers are  $5\frac{1}{2}$  in. (~14 cm) apart.





Figure 4-19 Posts

Each CARGO SHIP has an 8 in. (~20 cm) tall recess around the bottom. The recess is  $5^{3/_{16}}$  in. (~13 cm) deep on each side of the CARGO SHIP and  $7_{36}^{3}$  in. (~19 cm) deep on the front of the CARGO SHIP (relative to the face to which the HATCH PANELS are mounted). There is a  $\frac{1}{6}$  in. thick piece of polycarbonate that spans the back of the recess.

The recess around the bottom of the CARGO SHIP gives BUMPER clearance and allows ROBOTS to interact with the CARGO SHIP using ROBOT parts inside the FRAME PERIMETER.

Each CARGO SHIP has a yellow light suspended inside the aft part of the ship which, if on, indicates that a MATCH is not in progress and the magnets securing the BAY floors are energized.



Figure 4-20 CARGO SHIP light location

### 4.5 HAB PLATFORM

The HAB PLATFORM consists of a ramp, four (4) decks at three levels, the ALLIANCE colored tape that traces the intersection of the ramp and the carpet, and all relevant supporting structure. Major HAB PLATFORM dimensions are as shown in Figure 4-21.



Figure 4-21 Blue HAB PLATFORM with major dimensions.

The deck surfaces are ½-in. (~1 cm) textured HDPE sheets.

The decks define the levels for scoring purposes as follows.

- The lowest deck, the ramps, and the strips of ALLIANCE colored tape that trace the intersections of the ramps and the carpet form Level 1. The Level 1 deck is 3 in. (~8 cm) high by 10 ft. 8 in. (~325 cm) long by 3 ft. (~91 cm) deep. The ramps are 11<sup>1</sup>/<sub>2</sub> in. (~29 cm) long with a 15-degree angle.
- The middle two (2) decks form Level 2. Each Level 2 deck is 3 ft. 4 in. (~102 cm) wide by 4 ft. (~122 cm) deep. Level 2 is 6 in. (~15 cm) higher than the deck of Level 1.
- The highest deck forms Level 3. The Level 3 deck is 4 ft. (~122 cm) wide by 4 ft. (~122 cm) deep. Level 3 is 1 ft. 1 in. (~33 cm) higher than Level 2.





Figure 4-22 HAB PLATFORM Levels

### 4.6 DEPOT

A DEPOT is an area used to stage CARGO at the start of the MATCH per the <u>Setup</u> section. Each DEPOT is bounded by, but does not include, its ALLIANCE'S HAB PLATFORM, ALLIANCE WALL, and rails and its inside dimensions are 1 ft. 9¾ in. (~55 cm) wide by 3 ft. 7½ in. (~111 cm) deep. A rail is a 1½-in. (~3 cm) tall and 3-in. (~8 cm) wide steel barrier that is attached to the ARENA carpet using 2-in. (~5 cm) wide 3M<sup>™</sup> Hook Fastener SJ3572.



#### Figure 4-23 Blue DEPOTS

### 4.7 SANDSTORM

The SANDSTORM is installed above each ALLIANCE WALL. The SANDSTORM is an assembly that features three (3) shutters, each directly above a PLAYER STATION. Each shutter consists of a 4 ft. 6 in. (~137 cm) tall by 5 ft. 8 in. (~173 cm) wide black out material (<u>IFR Rip Stop Nylon</u> from Rose Brand in



Black). Just before the MATCH, shutters are lowered on the HAB ZONE side of the PLAYER STATION transparent plastic panels. At the end of the SANDSTORM PERIOD, the shutters retract over a period of ~2 seconds to reveal the FIELD to DRIVE TEAMS. The shutters remain retracted for the remainder of the MATCH.



Figure 4-24 SANDSTORM

# 4.8 ALLIANCE STATION

## 4.8.1 ALLIANCE WALL

The ALLIANCE WALL is a 6-ft. 6-in. (~198 cm) tall structure that separates ROBOTS from DRIVE TEAMS (except the TECHNICIAN) and consists of three (3) PLAYER STATIONS, and two (2) LOADING STATIONS. ALLIANCE WALLS define the short edges of the FIELD and, along with the guardrails, prevent ROBOTS from inadvertently exiting the FIELD during the MATCH.



Figure 4-25 ALLIANCE WALL

# 4.8.1.1 PLAYER STATION



Figure 4-26 Blue PLAYER STATIONS

A PLAYER STATION is one (1) of three (3) assigned positions in an ALLIANCE WALL from where a DRIVE TEAM operates their ROBOT. Each PLAYER STATION is made from a 3 ft. (~91 cm) tall diamond plate base topped with a 3 ft. 6 in. (~107 cm) tall transparent plastic sheet and a top rail. An aluminum shelf is attached to each PLAYER STATION to support the DRIVE TEAM'S OPERATOR CONSOLE. The shelf is 5 ft. 9 in. (~175 cm) wide and 1 ft. ¼ in. (~31 cm) deep. There is a 4 ft. 6 in. (~137 cm) long by 2 in. (nominal) wide strip of hook-and-loop tape ("loop" side) along the center of the support shelf that may be used to secure the OPERATOR CONSOLE to the shelf.

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 4-27 Tape on PLAYER STATION window

Each PLAYER STATION contains the following COMPONENTS for teams:

- One Ethernet Cable: attaches to the Ethernet port of the OPERATOR CONSOLE and provides connectivity to the Field Management System.
- One 120VAC NEMA 5-15R power outlet: located on each PLAYER STATION shelf and protected by its own 2-Amp circuit breaker. It can be used to power the OPERATOR CONSOLE. DRIVE TEAMS are responsible for monitoring their power consumption as a tripped breaker in the outlet does not constitute an ARENA FAULT. For some events in regions that don't use NEMA 5-15 shaped outlets, event organizers may install appropriate plug adapters to be used throughout the event.
- One Emergency Stop (E-Stop) button: located on the left side of the PLAYER STATION shelf and is used to deactivate a ROBOT in an emergency.
- One Team sign: displays the team number and located at the top of each PLAYER STATION.
- One Team LED: indicates ALLIANCE color, ROBOT status, and E-Stop status and centered at the top of each PLAYER STATION. Team LED states include:
  - Solid: indicates that the ROBOT is connected and enabled. This will only happen during a MATCH.
  - Blinking: indicates that either the Field Management System is preset for the MATCH or it's during a MATCH and the corresponding ROBOT has lost connectivity.
  - Off: indicates that the MATCH has not started yet, but the ROBOT is linked and DISABLED.
  - $\circ$   $\:$  If the amber LED is on, the E-stop button has been pressed.
- One Timer (in PLAYER STATION 2): displays the official time remaining in the MATCH and TIMEOUTS and is marked with white tape along the bottom edge.
- Field Management System hardware and wiring: mostly located below the center PLAYER STATION shelf.



# 4.8.1.2 LOADING STATION



Figure 4-28 LOADING STATION

A LOADING STATION is a FIELD assembly that allows HUMAN PLAYERS to feed GAME PIECES to ROBOTS. One LOADING STATION is located at either end of the ALLIANCE WALL (i.e. in each of the four corners of the FIELD). A LOADING STATION consists of a vertical wall and supporting elements which allow a Drive team member to deliver a GAME PIECE to a ROBOT.

HATCH PANELS placed from the ALLIANCE STATION in the round hole drop down onto pins on the FIELD-side of the wall, and rest vertically such that the center of the HATCH PANEL is 1 ft. 7 in. (~48 cm) above the carpet. HATCH PANELS are retained by brushes (Frost King Model #C35PH, available at Home Depot, SKU #291722) until retrieved from their position by a ROBOT. The LOADING STATION HATCH is similar, but not identical, to the ROCKET and CARGO SHIP HATCHES and is detailed in Figure 4-28.

Like the CARGO SHIP HATCH, the LOADING STATION HATCH is backed by two (2) backstops. The backstops each have an inner width of  $7\frac{3}{4}$  in. (~20 cm) and a depth of  $3\frac{1}{4}$  in. (~8 cm). The top backstop has a minimum height of 3 in. (~8 cm), and the bottom backstop has a minimum height of  $3\frac{1}{4}$  in. (~8 cm).

A CARGO dropped in to the chute falls out the FIELD side of the LOADING STATION through a 1 ft. 2<sup>1</sup>/<sub>4</sub> in. (~36 cm) long square hole 3 ft. 1 in. (~94 cm) from the carpet.

Each station has an 8 in. (~20 cm) tall by 3 ft.  $9\frac{1}{2}$  in. (~116 cm) wide by  $5\frac{1}{6}$  in. (~13 cm) deep recess at the bottom to accommodate ROBOT BUMPERS. There is a plastic and metal guard behind the station to isolate humans from ROBOTS.

#### 4.8.2 GAME PIECE HOLDERS

Each ALLIANCE STATION has two (2) Panel hold assemblies. A HATCH PANEL Holder is a 1 ft 10 in. (~56 cm) long by 1 ft 7 in. (~48 cm) wide by 10 in. (~25 cm) tall HDPE rack positioned such that one is in each of the back corners of the ALLIANCE STATION. Each HATCH PANEL Holder can hold up to eleven (11) HATCH PANELS in their vertical orientation.



Each ALLIANCE STATION also has two (2) CARGO Holders. A CARGO Holder is a 6 ft 8 in. (~203 cm) long by 1 ft (~30 cm) wide by 2 in. (~5 cm) tall PVC rectangle positioned next to the PANEL Holder and against the back of the ALLIANCE STATION. Each CARGO Holder can hold up to six (6) CARGO.



Figure 4-29 GAME PIECE Holders

### 4.9 GAME PIECES

There are two types of GAME PIECES: CARGO and HATCH PANELS.

## 4.9.1 CARGO

Each CARGO is an orange 13-in. (~33 cm)  $\pm \frac{1}{2}$  in. (~1.2 cm) diameter rubber playground ball with a *FIRST* logo as shown in Figure 4-30. The ball is made by Sportime (PN 1623139E) and sold by AndyMark (<u>PN am-4000 cargo</u>). The closest commercially available substitute, a red ball with no *FIRST* logo (same size and material), is available at School Specialty (Sportime PN <u>1293618</u>).

These playground balls used as CARGO are not manufactured with any tight tolerance. They're not balanced all the way around and wall thickness varies so they may not always roll straight or bounce as expected.







Figure 4-30 CARGO

# 4.9.2 HATCH PANEL

Each HATCH PANEL is a circular <sup>3</sup>/<sub>16</sub>-in. (~5 mm) thick polycarbonate toroid. The outside diameter of the toroid is 19 in. (~48 cm) and the diameter of the hole centered in the toroid is 6 in. (~15 cm). The edge and outside ~1 in. (~3 cm) of both sides of the toroid are covered with white 3M<sup>™</sup> Fastener SJ3571 loop tape (PN 70070457349).

The HATCH PANELS that shipped in the Kickoff Kits and that will be used in official DESTINATION: DEEP SPACE competitions are <u>VEXpro part number 217-6562</u>. Due to sourcing complexities, most panel inventory available for purchase uses a different, but functionally equivalent, loop tape.



Figure 4-31 HATCH PANEL

## 4.10 VISION TARGETS

Vision targets are located on the ROCKETS, CARGO SHIPS, and LOADING STATIONS and highlight the locations of the HATCHES, PORTS, and HATCH PANEL retrieval locations. A vision target is a pair of 5½ in. (~14 cm) long by 2 in. (~5 cm) wide strips of 3M 8830 Scotchlite Reflective Material. 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.

Vision targets on the "front" face of the ROCKET highlight the top of the lowest PORT and are 3 ft 3<sup>1</sup>/<sub>8</sub> in. (~99 cm) above the carpet at their highest point.

Vision targets on the "side" faces of the ROCKET highlight the location of the top of the lowest HATCH and are 2 ft  $7\frac{1}{2}$  in. (~80 cm) above the carpet at their highest point (the same height as the top of the HATCH opening).

Vision targets also highlight the locations of the tops of each CARGO SHIP HATCH and the tops of each LOADING STATION HATCH (at the same height as the ROCKET HATCH targets).





#### 4.11 THE FIELD MANAGEMENT SYSTEM

The Field Management System (FMS) is the electronics core responsible for controlling the *FIRST* Robotics Competition playing FIELD. The FMS encompasses all FIELD electronics, including the computers, REFEREE touchscreens, wireless access point, sensors, stack lights, E-Stops, etc.

When a DRIVE TEAM connects the Ethernet cable from their assigned PLAYER STATION to their OPERATOR CONSOLE, the DRIVER Station software on the OPERATOR CONSOLE computer will begin to communicate with the Field Management System (FMS). Once connected to FMS, the only open ports available are described in Table 4-1.



Table 4-1 FMS Ports

Port	Designation	<b>Bi-directional?</b>
UDP/TCP 1180-1190	Camera data from the roboRIO to the Driver Station when the camera is connected the roboRIO via USB	Yes
TCP 1735	SmartDashboard	Yes
UDP 1130	Dashboard-to-ROBOT control data	Yes
UDP 1140	ROBOT-to-Dashboard status data	Yes
HTTP 80	Camera connected via switch on the ROBOT	Yes
HTTP 443	Camera connected via switch on the ROBOT	Yes
UDP/TCP 554	Real-Time Streaming Protocol for h.264 camera streaming	Yes
<b>UDP/TCP 1250</b>	CTRE Diagnostics Server	Yes
UDP/TCP 5800-5810	Team Use	Yes

Teams may use these ports as they wish if they do not employ them as outlined above (e.g. TCP 1180 can be used to pass data back and forth between the ROBOT and the Driver Station software if the team chooses not to use the camera on USB). Note that ROBOT code cannot be deployed while connected to the FMS. Additional information about the FMS may be found in the <u>FMS Whitepaper</u>.

FMS alerts participants to milestones in the MATCH using audio cues. Please note that audio cues are intended to be a courtesy to participants and not intended as official MATCH markers. If there is a discrepancy between an audio cue and the FIELD timers, the FIELD timers are the authority.

- MATCH start (T-minus 150s)
  - SANDSTORMS lowered just prior to MATCH start
    - "Cavalry Charge" audio cue
- SANDSTORM PERIOD ends (T-minus 135s)
  - SANDSTORMS retract
  - "Three Bells" audio cue
- End game warning (T-minus 30s)
  - "Space Station Alert" audio cue
- End game (T-minus 20s)
  - o "Train Whistle" audio cue
- MATCH End (T-minus 0s)
  - o "Buzzer" audio cue
- MATCH stopped
  - "Foghorn" audio cue

FMS also alerts participants about the state of MATCH progress or FIELD safety with lighting. ROCKETS have red or blue lights in their nosecones which illuminate during a MATCH if that ROCKET has six (6) CARGO and six (6) HATCH PANELS. Once the MATCH is over, and if the Head REFEREE has determined the FIELD is safe for humans, the nosecone lights all turn green.







Figure 4-33 Complete Red ROCKET nosecone lit.

