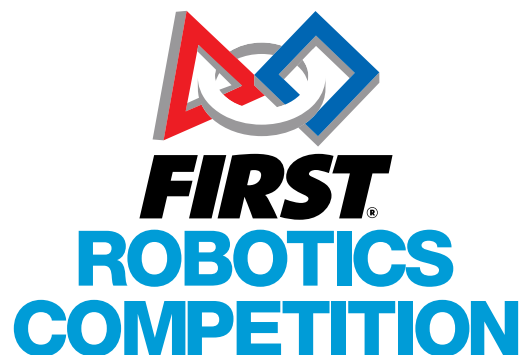


# 2

## Arena

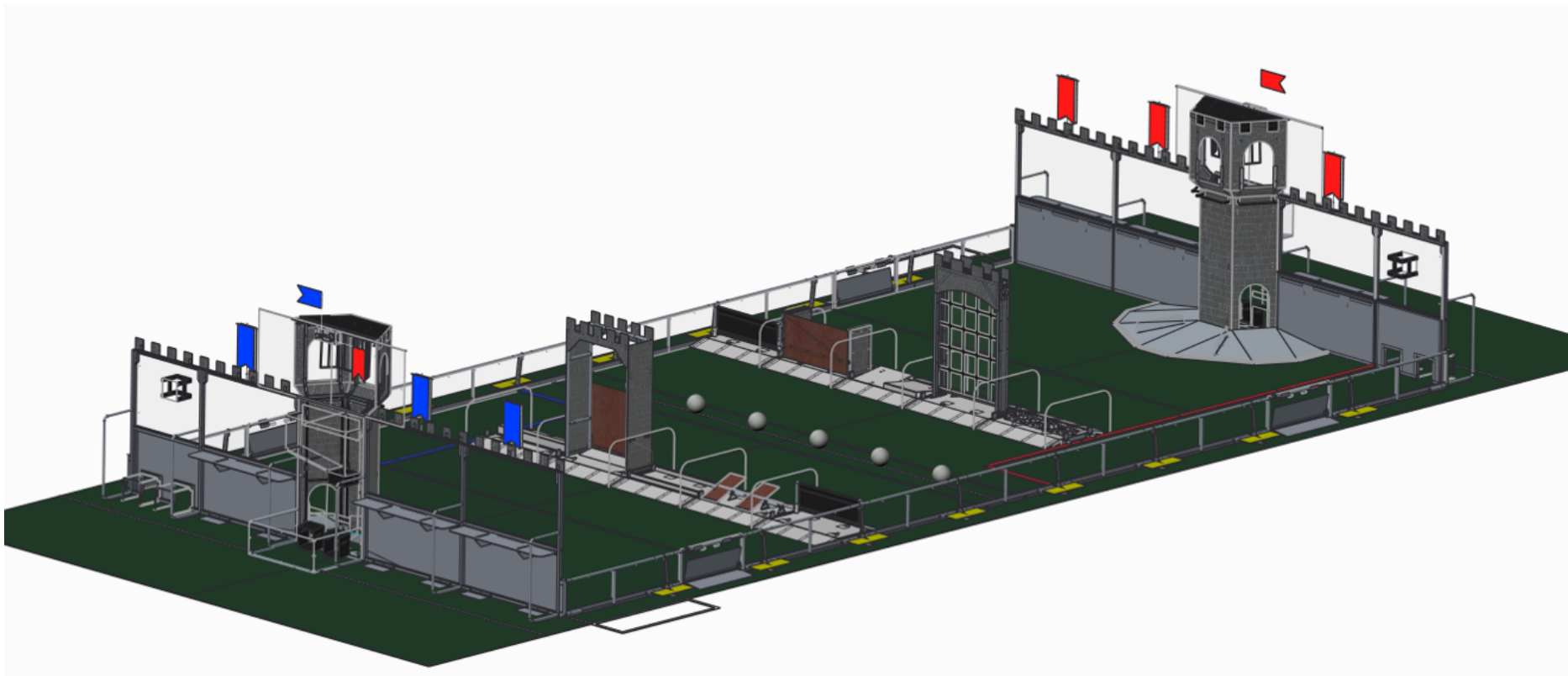
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Figure 2-1: FIRST STRONGHOLD Arena



*FIRST STRONGHOLD*<sup>SM</sup> is a medieval tower defender game in which two (2) ALLIANCES of three (3) Teams each select DEFENSES to fortify their OUTER WORKS before competing simultaneously to score points while BREACHING the opponent's OUTER WORKS and CAPTURING the opponent's TOWER.

The ARENA includes all elements of the game infrastructure that are required to play *FIRST STRONGHOLD*: the FIELD, the CASTLES, the scoring elements, and all equipment needed for FIELD control, ROBOT control, and scorekeeping.

The competition 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 [2016 ARENA Layout and Marking Drawing](#). Successful Teams will design ROBOTS that are insensitive to these variations.

Illustrations included in this section are for a general visual understanding of the *FIRST STRONGHOLD* 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 *FIRST STRONGHOLD* FIELD are posted on the [2016 Official FIRST Field Drawings & Models](#) web page.

## 2.1 Zones & Markings

The *FIRST STRONGHOLD* ARENA contains the following areas and volumes relevant to game play. Each element is identified in [Figure 2-2](#).

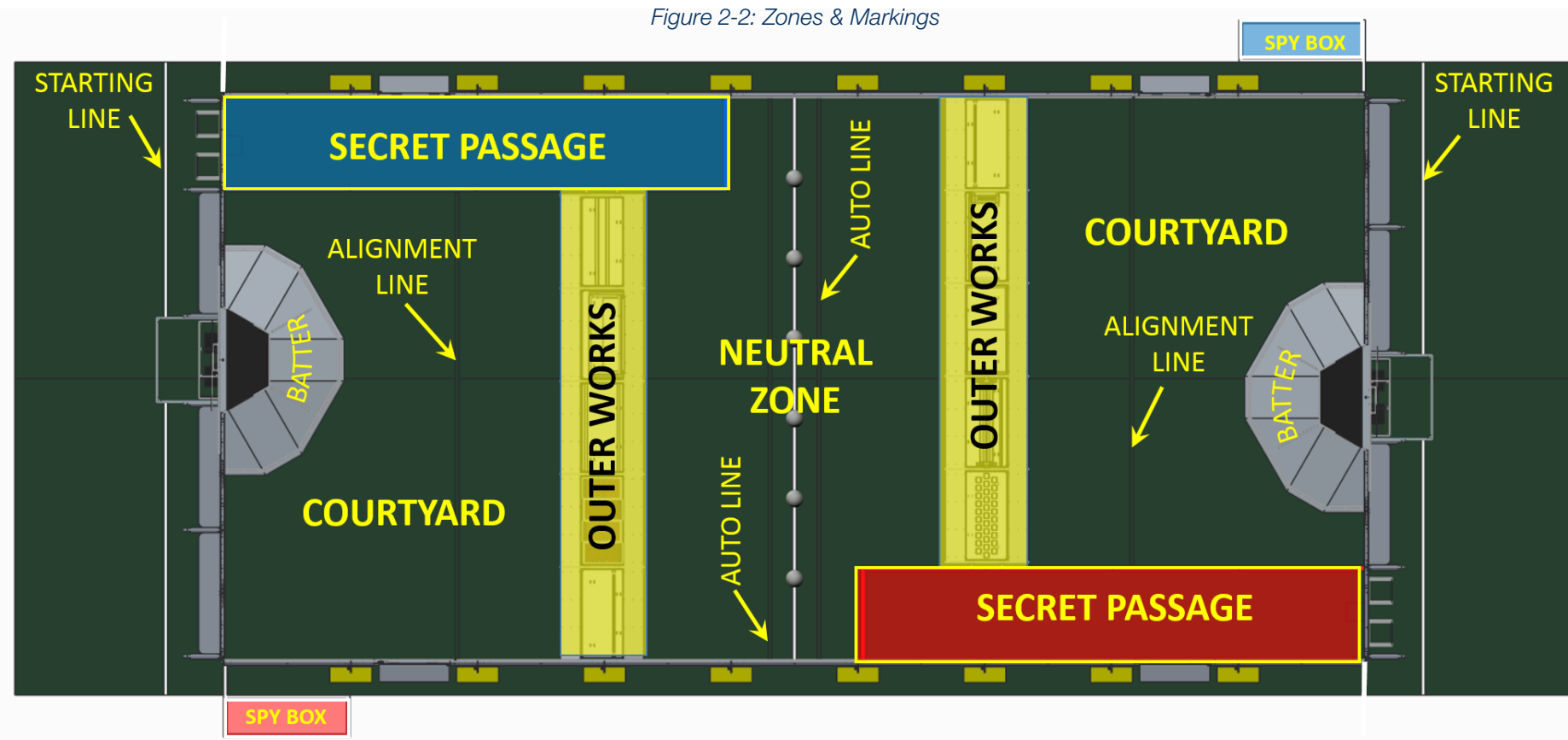
- COURTYARD: an infinitely tall volume bordered by, but excluding, the CASTLE WALL, the GUARDRAIL, the SECRET PASSAGE and the OUTER WORKS.
- NEUTRAL ZONE: an infinitely tall volume formed by, but not including, the BERMS, the GUARDRAILS and OUTER WORKS.

- **OUTER WORKS:** an infinitely tall volume bordered by, but not including, the GUARDRAIL, the SECRET PASSAGE, and the bottom edges of the PLATFORM ramps. The OUTER WORKS is positioned 7 ft. 2 in. from the MIDLINE.
- **SECRET PASSAGE:** an infinitely tall, 4 ft. 5-1/2 in. wide, 23 ft. 11-1/2 in. deep volume defined by the BERMS, the GUARDRAIL and the CASTLE WALL. The SECRET PASSAGE includes the BERMS, but does not include the GUARDRAILS or CASTLE WALL.
- **SPY BOX:** a 6 ft. wide by 2 ft. deep, infinitely tall volume, bounded by and including 2 in. white gaffers tape, located adjacent to the edge of the opposing CASTLE and the 18 in. from the GUARDRAIL.

The ARENA contains the following additional markings:

- **MIDLINE:** a line of 2 in. white gaffers tape that bisects the length of the FIELD.
- **AUTO LINE:** a 2 in. wide line of green gaffers tape that is 12 in. from the edge of the Midline.
- **STARTING LINE:** a 2 in. white gaffers tape line that is the width of the CASTLE and is 2 ft. 6 in. from the CASTLE WALL
- **ALIGNMENT LINE:** A 2 in. wide line of green gaffers tape that is 11 ft. from the CASTLE WALL.

Figure 2-2: Zones & Markings



## 2.2 FIELD

The FIELD for *FIRST STRONGHOLD* is a 26 ft. 7 in. by 54 ft. 1 in. carpeted area, bound by and including the inward-facing surfaces of the GUARDRAILS and two (2) CASTLES. The carpet used for the FIELD is green in color (Shaw Floors, Philadelphia Commercial, Neyland II 20, 30352, "Scotch Pine").

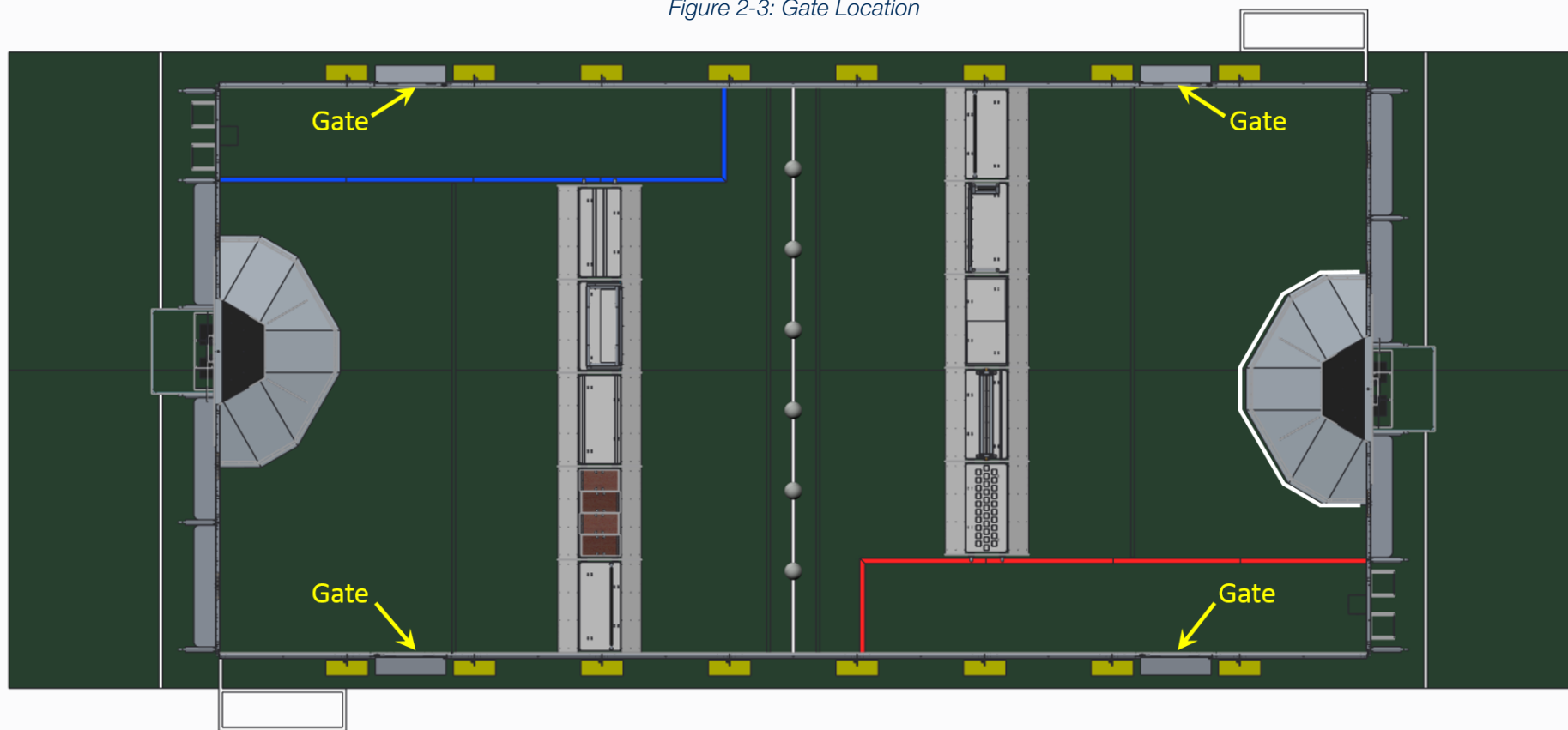
There are two versions of GUARDRAILS and CASTLE WALLS used for competitions. One design has been used at FRC competitions for several years and matches the [2016 Official FIRST Field Drawings & Models](#). The other was designed and is sold by AndyMark. While the designs are slightly different, the critical dimensions, performance, and expected user experience between the two is the same. All Regional and Championship assemblies will use the traditional *FIRST* design. Teams may contact their local District leadership for details on which assembly is used by their District. Detailed drawings for the AndyMark design are posted on the [AndyMark](#) website. All illustrations in the Game Manual show the traditional FIELD design.

## 2.2.1 GUARDRAIL

The GUARDRAIL is a system that consists of transparent polycarbonate supported on the top and bottom by aluminum extrusion. The GUARDRAIL prevents 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 gates are 3 ft. 2 in. wide and closed and shielded during the MATCH.

Figure 2-3: Gate Location



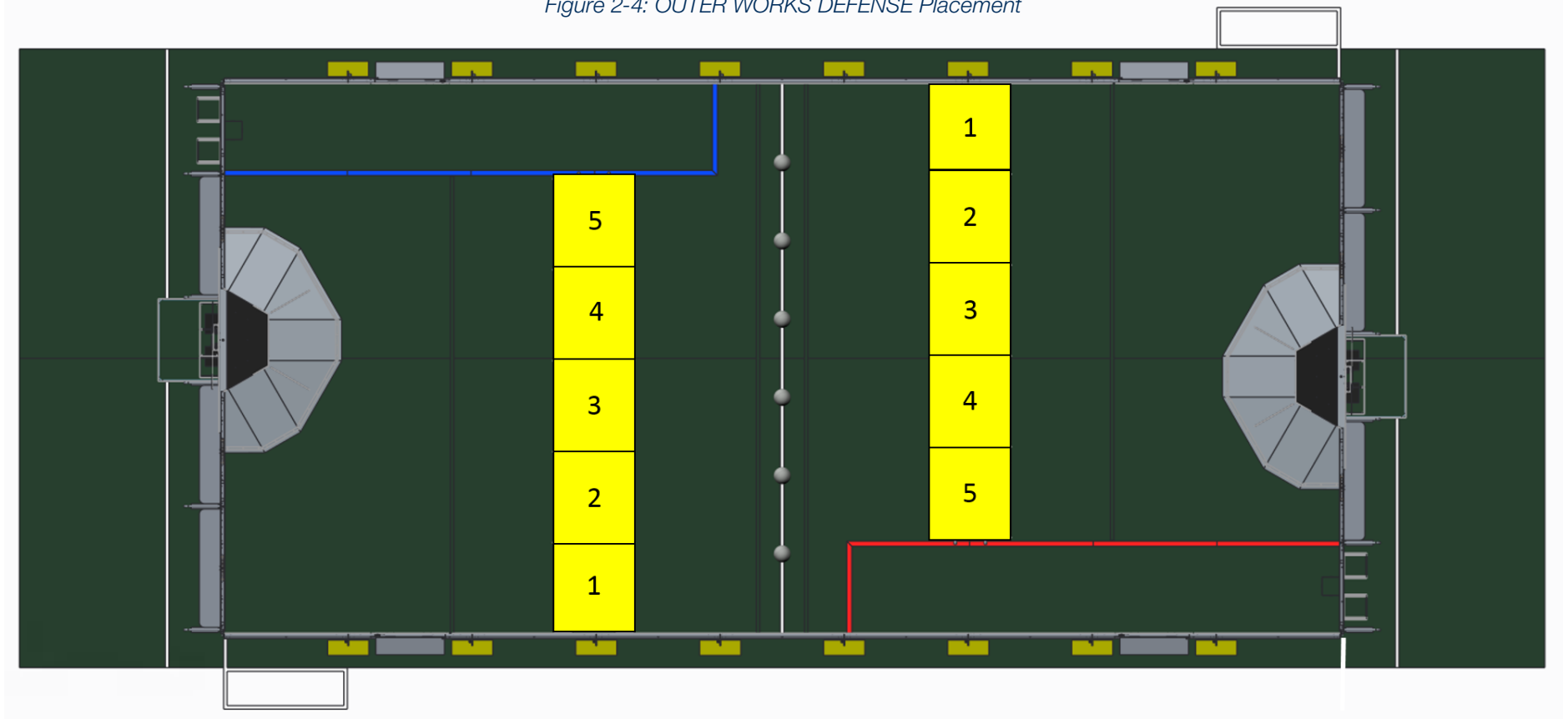
## 2.2.2 OUTER WORKS

The OUTER WORKS is an infinitely tall volume bordered by, but not including, the GUARDRAIL, the SECRET PASSAGE, and the bottom edges of the PLATFORM ramps. The OUTER WORKS is positioned 7 ft. 2 in. from the MIDLINE. It consists of a series of five (5) DEFENSES, five (5) PLATFORMS, and five (5) Shields arranged in a line across the FIELD and is designed to impede the passage of ROBOTS and BOULDERS in to the COURTYARD. Three (3) of the DEFENSES are selected by the ALLIANCE, one (1) is selected by the audience, and the one (1) is a permanently mounted Low Bar. ([Figure 2-4](#) shows the locations of the Low Bar, ALLIANCE, and audience selected DEFENSES.)

1. Low Bar
2. ALLIANCE selected
3. Audience selected
4. ALLIANCE selected
5. ALLIANCE selected



Figure 2-4: OUTER WORKS DEFENSE Placement

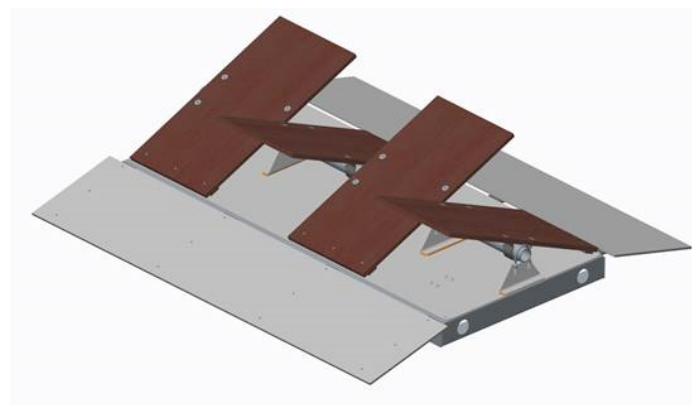
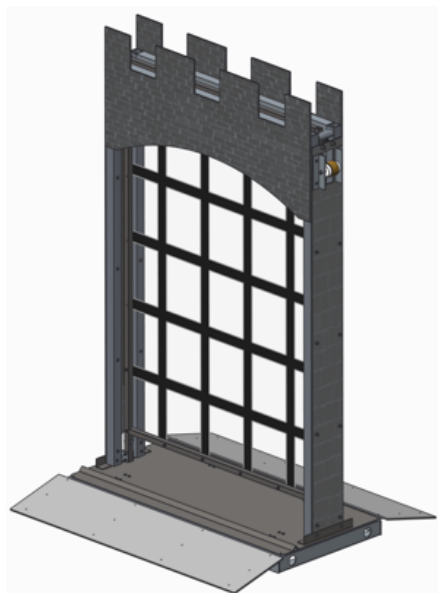


### 2.2.2.1 DEFENSES

A DEFENSE is one (1) of five (5) obstacles in the OUTER WORKS and on a PLATFORM. There are a total of eight (8) unique, selectable DEFENSES. These DEFENSES are arranged into four different categories. Each ALLIANCE selects one (1) DEFENSE from each category per [Section 5 \(5.5.10 Selecting Defenses\)](#).

#### Category A

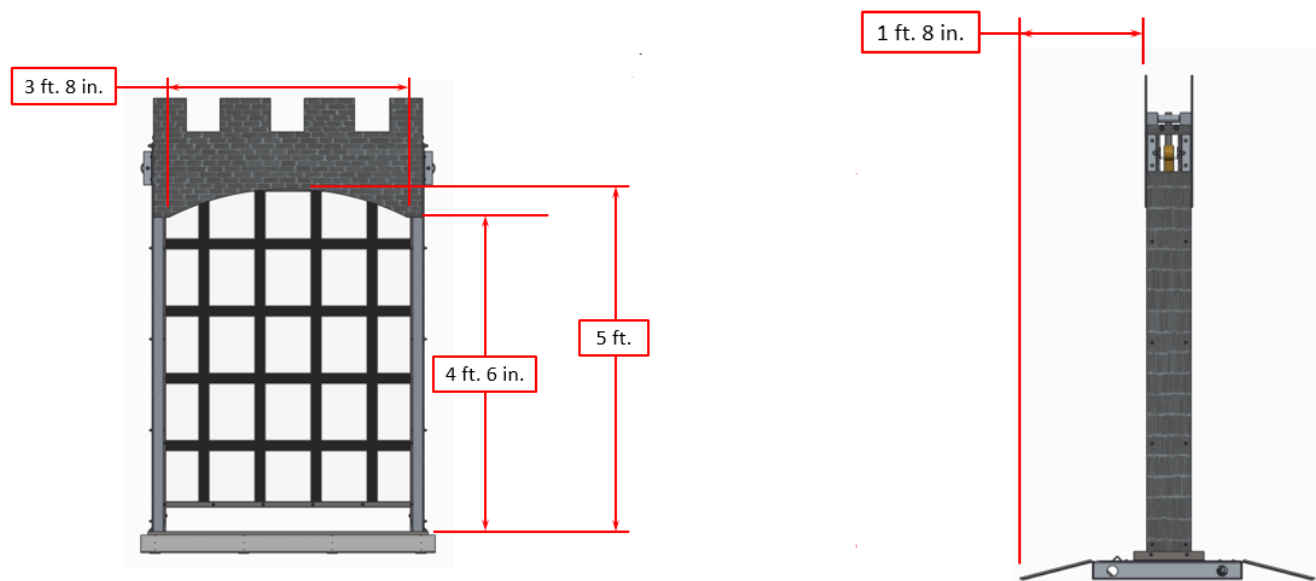
Figure 2-5: Category A Selections



## Portcullis

The Portcullis is an arched gateway with a door that opens when lifted up. The gateway is 3 ft. 8 in. wide and 5 ft. 2 in. tall. The door is constructed of a steel frame with a 1/8 in. thick polycarbonate sheet covering the opening in the frame. The door requires approximately 5 lbs. to lift from the bottom edge. When it is resting in its natural position there is a 5 in. gap below the door.

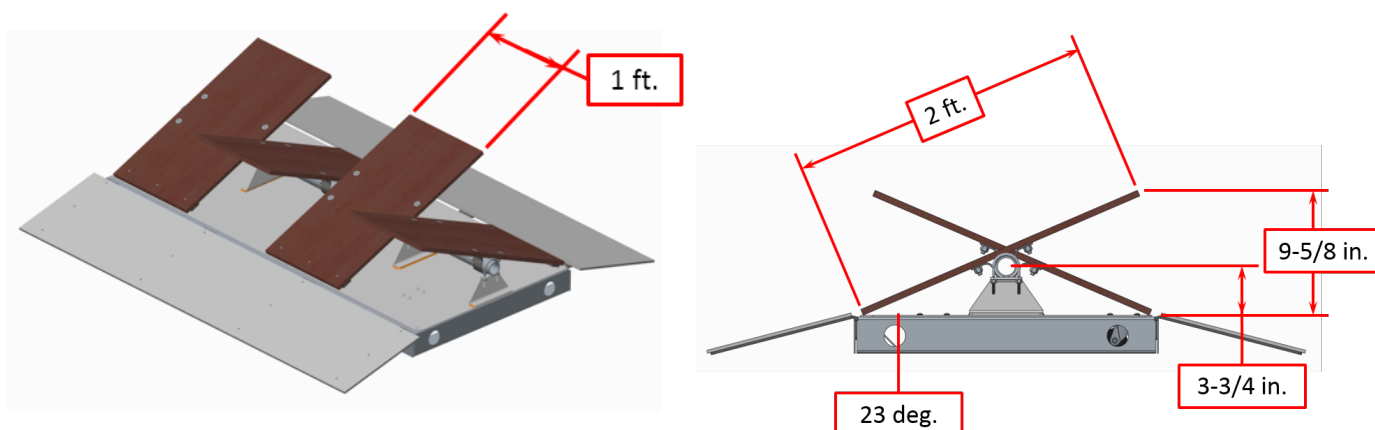
Figure 2-6: Portcullis Dimensions



## Cheval de Frise

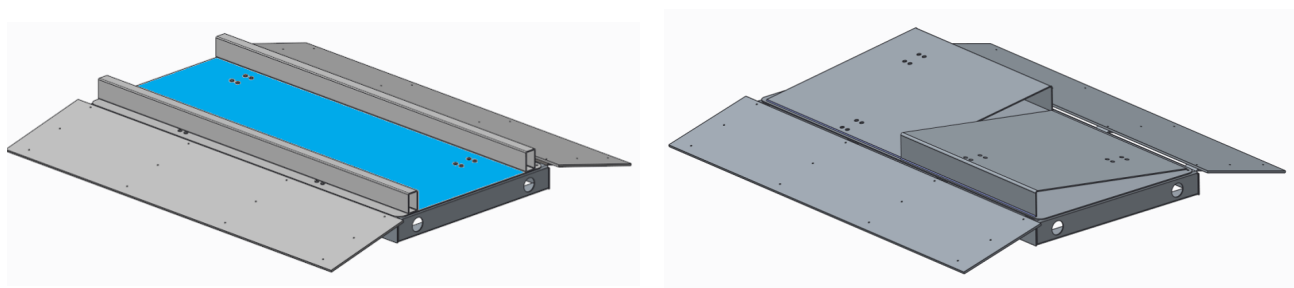
The Cheval de Frise is a series of four (4) independently tilting, weighted polycarbonate platforms. The platforms rotate about a pipe in the middle and are weighted so that they rest on alternate sides. Platforms are 1 ft. wide and 2 ft. long and 1/2 in. thick. The axis of the pipe is 3-3/4 in. from the surface of the platform. The top edge of the platform is 9-5/8 in. from the DEFENSE platform. In order to tilt a platform, approximately 1 lbs. of force must be applied at the edge of the platform.

Figure 2-7: Cheval de Frise Dimensions



## Category B

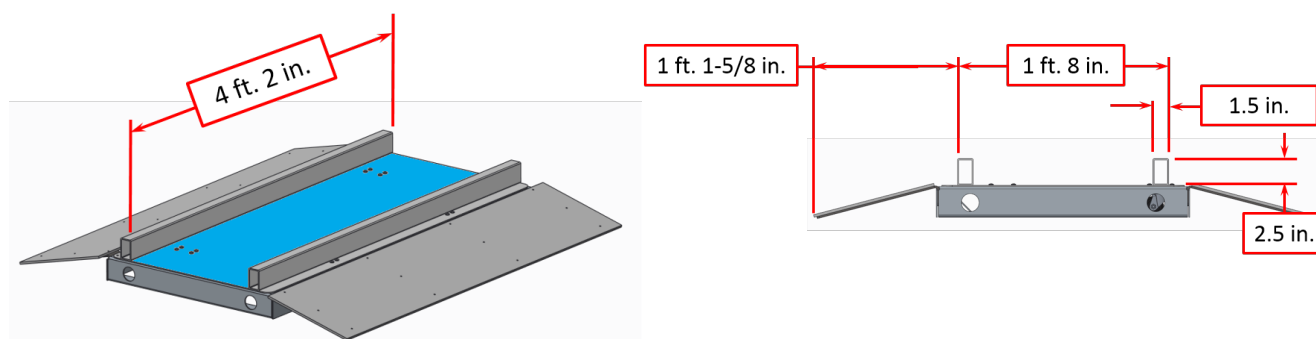
Figure 2-8: Category B Selections



## Moat

The Moat is a 2-1/2 in. high, 4 ft. 2 in. wide, and 1 ft. 8 in. deep u-shaped channel, formed by vertical rectangular steel tubes.

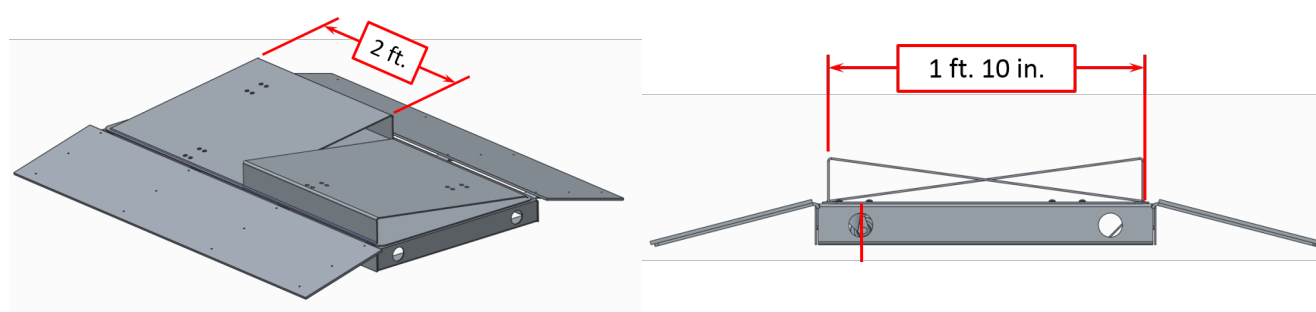
Figure 2-9: Moat Dimensions



## Ramparts

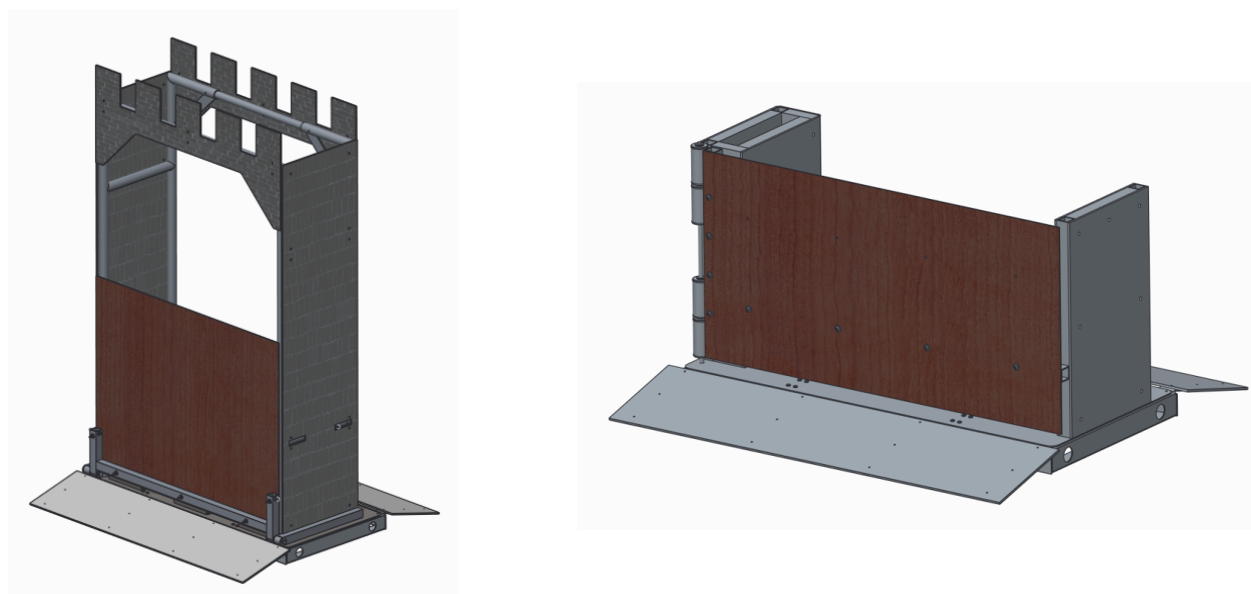
The Ramparts are two static, steel ramps, side by side, facing opposite directions. Each ramp is 2 ft. wide and 1 ft. 10 in. deep, set at an 8 deg. angle.

Figure 2-10: Ramparts Dimensions



## Category C

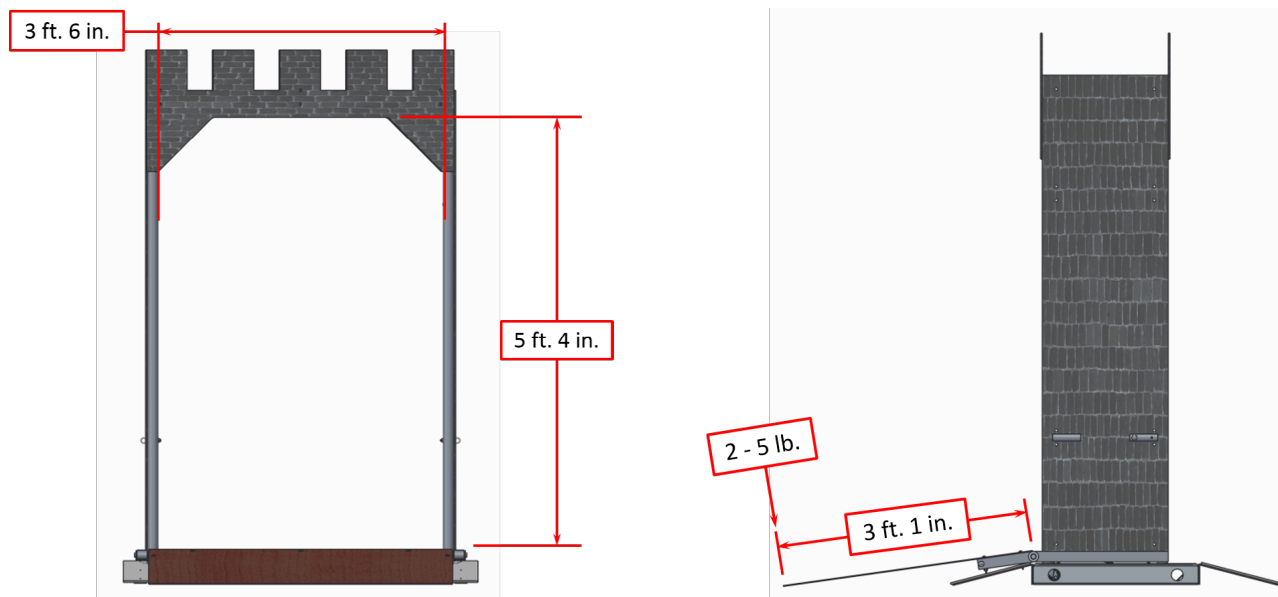
Figure 2-11: Category C Selections



## Drawbridge

The Drawbridge is an arched gateway with a door that lowers toward the NEUTRAL ZONE. The door is made from polycarbonate and is 37 in. tall and 1/4 in. thick. When the door is fully down, the opening is 3 ft. 6 in. wide and 5 ft. 5-3/4 in. tall (to the top of the center of the arch). The door is sprung so that it will return to a closed position when there is no weight on it. The door can be manipulated at any point, but for reference, it takes approximately 2 lbs. of force applied at the top edge of the door for it to begin to move. Once moving, the required force increases to a maximum of 5 lbs.

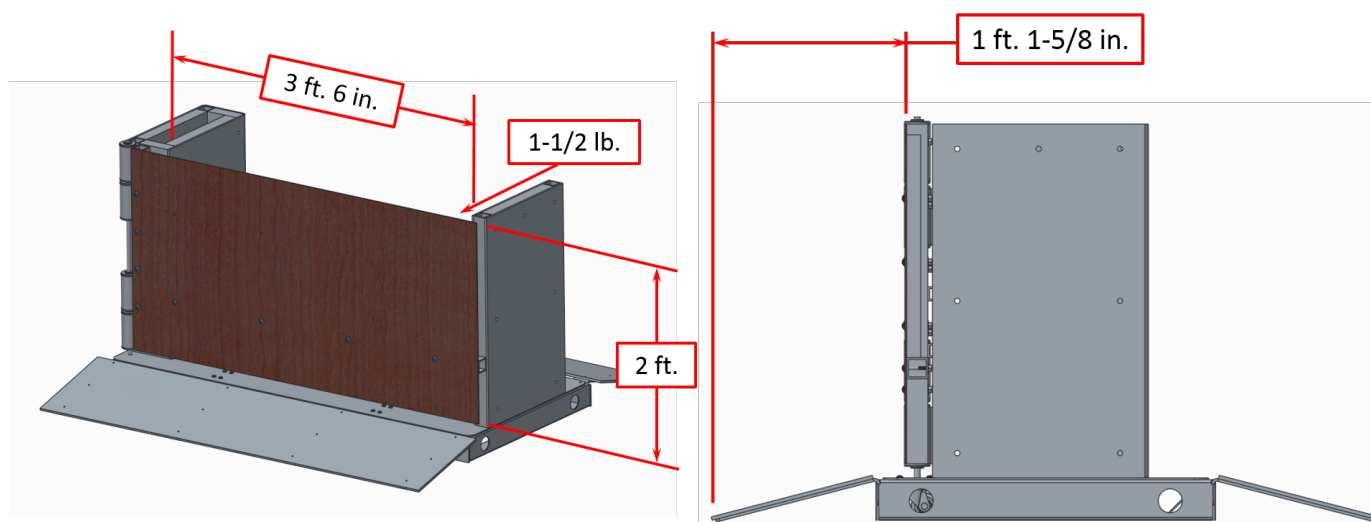
Figure 2-12: Drawbridge Dimensions



## Sally Port

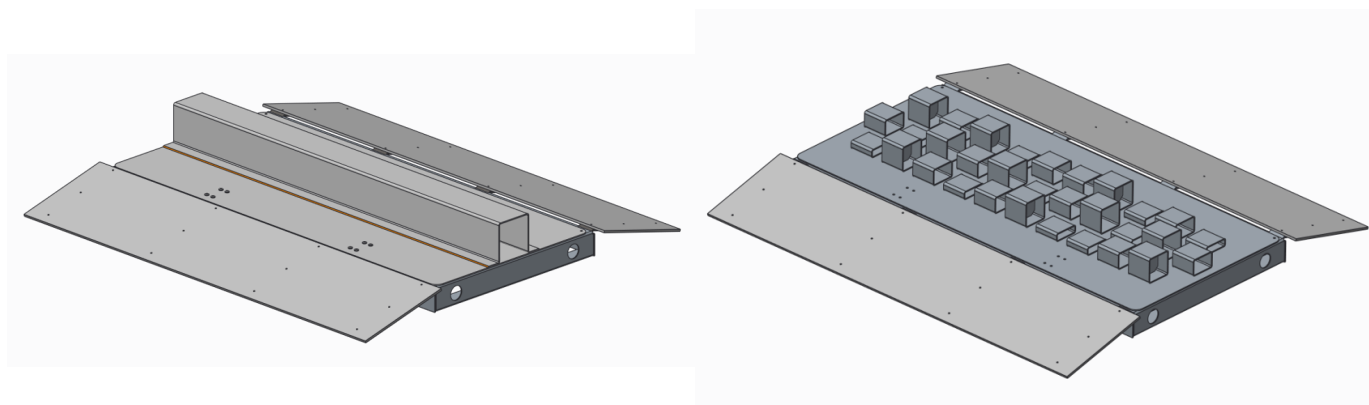
The Sally Port is a door  $\frac{1}{4}$ " thick, 4 ft. wide, 2 ft. tall that can only swing toward the NEUTRAL ZONE. The opening is 3 ft. 6 in. wide. The top of the door is 2 ft. 1 in. from the surface of the platform. The door is sprung so that it will return to a closed position when it is not being held open. A force of approximately 1.5 lbs. must be applied to the outer edge of the door in order for it to open.

Figure 2-13: Sally Port Dimensions



## Category D

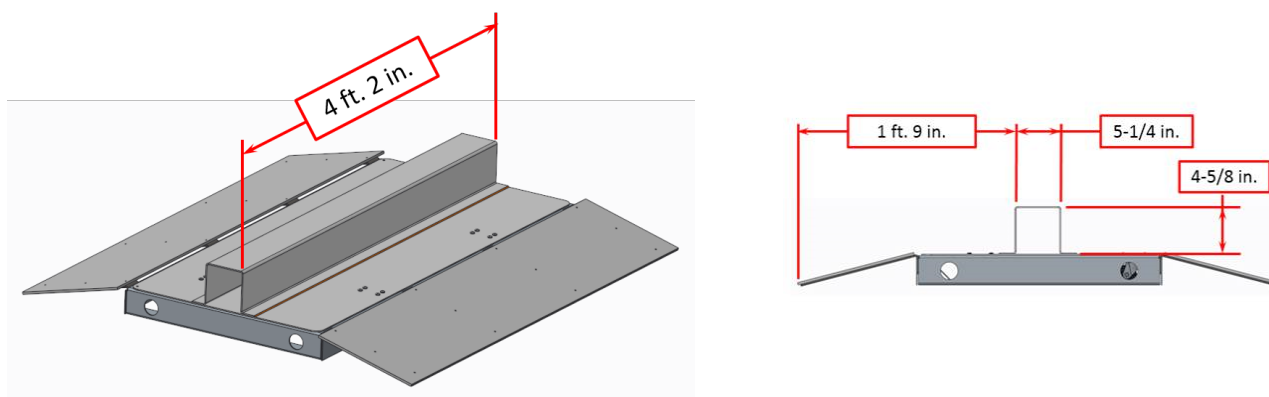
Figure 2-14: Category D Selections



## Rock Wall

The Rock Wall is a steel block that is 4 ft. 2 in. wide, 5- $\frac{1}{4}$  in. deep, and 4- $\frac{5}{8}$  in. tall.

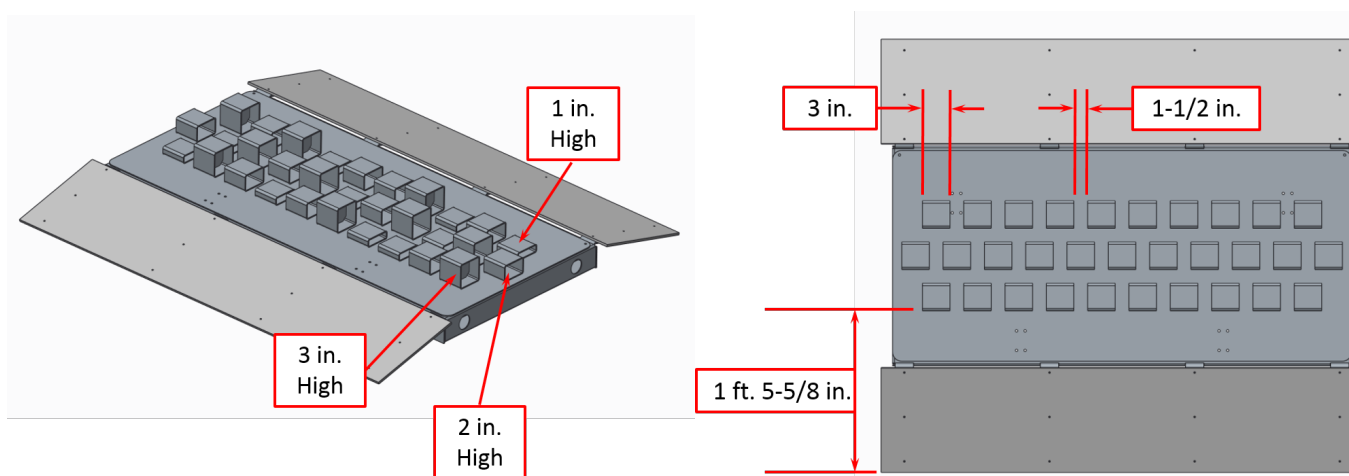
Figure 2-15: Rock Wall Dimensions



## Rough Terrain

The Rough Terrain is constructed from thirty-one (31) pieces of square or rectangular steel tubing. There are three different sizes of steel tubing: 1 in. by 3 in., 2 in. by 3 in., and 3 in. by 3 in. All of the tubing is cut into 3 in. lengths. The tubing is then welded on to a steel plate to form a “random” series of bumps spaced 1- $\frac{1}{2}$  in. from each other. Please refer to the [2016 Official FIRST Field Drawings & Models](#) for complete information. The tubing is arranged in three rows. The first and third row have ten (10) pieces of tubing, while the second row has eleven (11). The tubing is spaced 1- $\frac{1}{2}$  in. apart.

Figure 2-16: Rough Terrain Dimensions



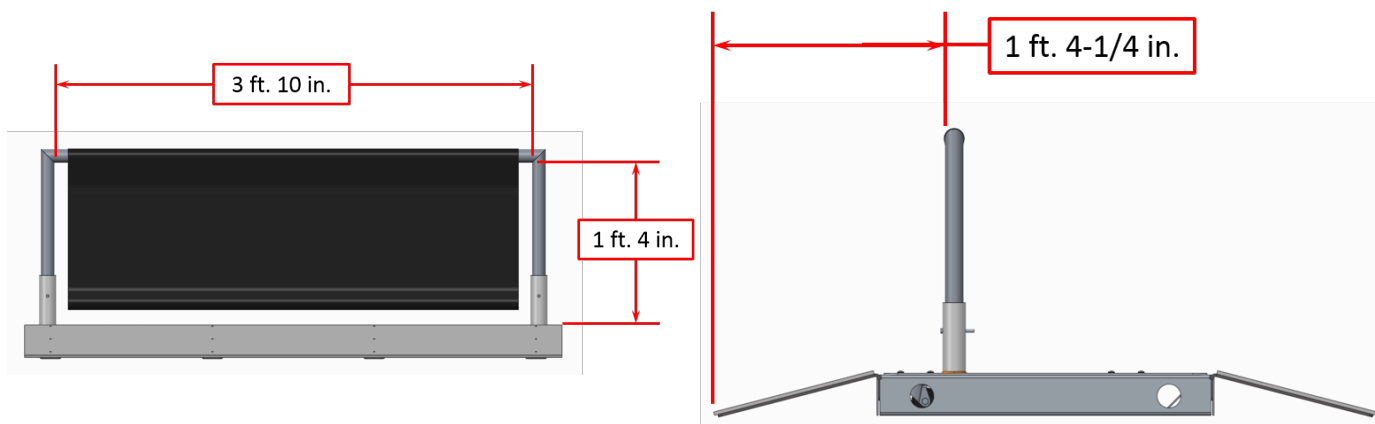
There is one (1) non-selectable DEFENSE.

## Low Bar

The Low Bar is constructed from 1" 6061 Aluminum Schedule 40 pipe. The pipe creates an opening that is 1 ft. 4 in. tall and 3 ft. 10- $\frac{1}{2}$  in. wide. It features opaque walk-in freezer door flaps, designed to keep BOULDERS from passing through on their own. The material is McMaster-Carr part number 1894A214, opaque black. 33 $\frac{1}{2}$ -in. long strips are draped over the Low Bar at regular intervals and in such a way that the front and back flaps are of equal length with an approximate 1 in. gap between the base and the bottom of the flaps. The vinyl is secured to itself using cable ties just below the bar to allow free, independent rotation of individual strips. Additional cable ties are used to maintain spacing between the strips. The Low Bar is mounted 1 ft. 4- $\frac{1}{2}$  in. from edge of the PLATFORM on the NEUTRAL ZONE side of the OUTER WORKS.



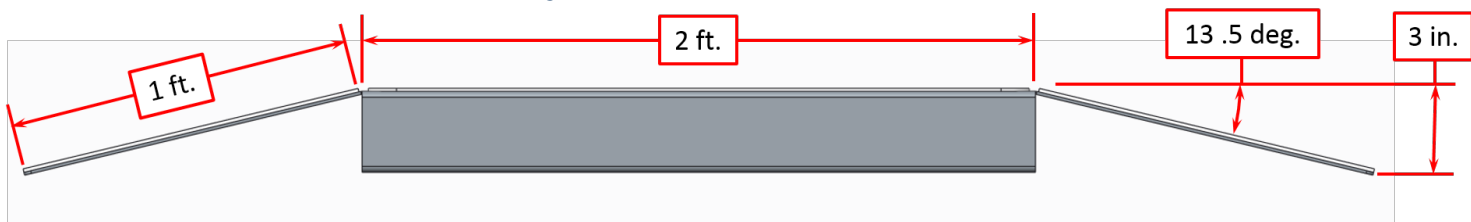
Figure 2-17: Low Bar Dimensions



## PLATFORMS

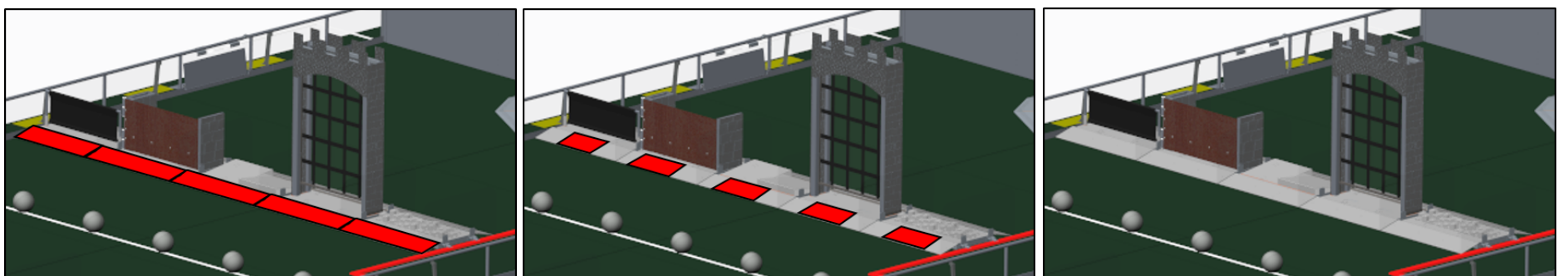
PLATFORMS are a 4 ft. 2 in. wide, 2 ft. deep and 3 in. tall base for a DEFENSE and associated ramps. Each PLATFORM is permanently installed on the FIELD and is abutted by translucent polycarbonate ramps on each long edge. Ramps are 4 ft. 2 in. wide, 1 ft. deep, resulting in a 13.5 deg. angle.

Figure 2-18: PLATFORM Dimensions



Each PLATFORM has indicator lights beneath the ramps to indicate that DEFENSE'S STRENGTH. Once a DEFENSE'S STRENGTH has been reduced to half STRENGTH (1), the outer lights will turn off, leaving the center third on. Once the DEFENSE'S STRENGTH is reduced to zero (0) all lights for that DEFENSE will turn off as indicated in [Figure 2-19](#).

Figure 2-19: DEFENSE lighting



Full Strength

Half Strength

Zero Strength

These lights are used for other situations as well, as described in [Table 2-1](#).

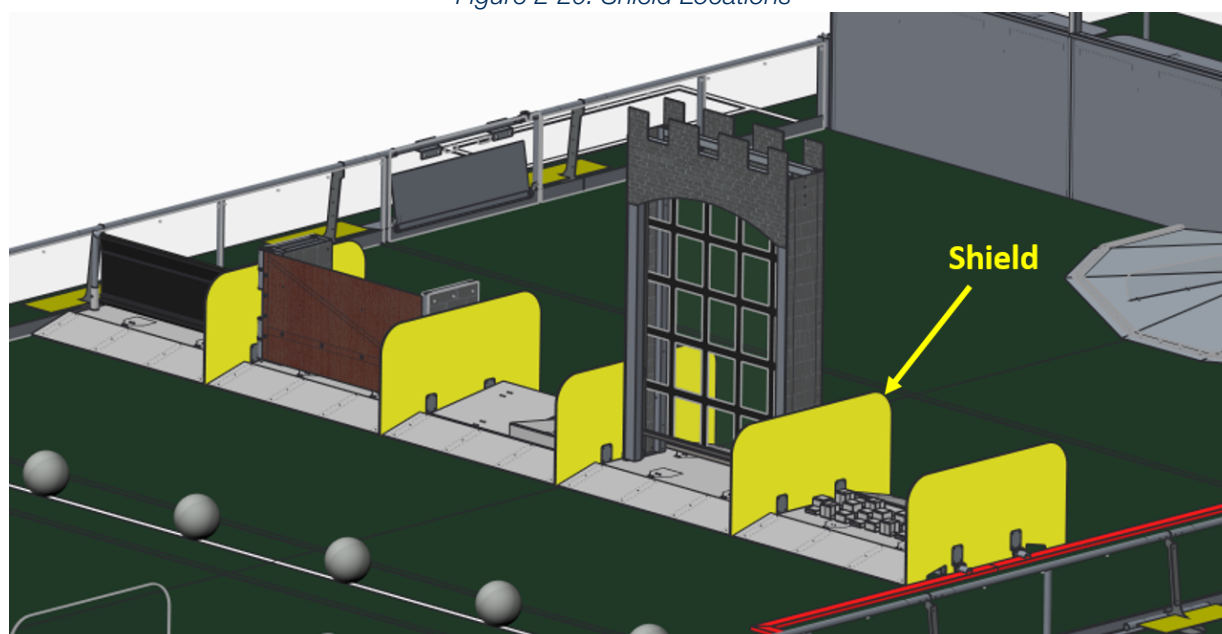
*Table 2-1: DEFENSE lighting states and meanings*

Light State	Meaning
Off	Prior to start of MATCH: FIELD is ready for the MATCH to begin, all personnel should be off the FIELD at this time.  During MATCH: DEFENSE with no (0) STRENGTH.
Alliance Color (all)	DEFENSE with full (2) STRENGTH
Alliance Color (half)	DEFENSE with half (1) STRENGTH

## Shields

Separating each DEFENSE/PLATFORM pair, and the OUTER WORKS from the SECRET PASSAGE BERM, is a 3/8" thick polycarbonate Shield, 4 ft. deep and 2 ft. tall. Shields are highlighted in yellow in [Figure 2-20](#).

*Figure 2-20: Shield Locations*

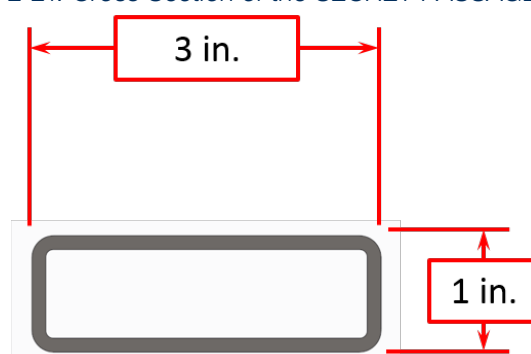


### 2.2.2.2 SECRET PASSAGE

A SECRET PASSAGE is a rectangular lane in front of each HUMAN PLAYER STATION. As introduced in [Section 2.1 Zones & Markings](#), each ALLIANCE has a SECRET PASSAGE; an infinitely tall, 4 ft. 5-1/2 in. wide, 23 ft. 11-1/2 in. deep volume defined by BERMS, the GUARDRAIL and the CASTLE WALL.

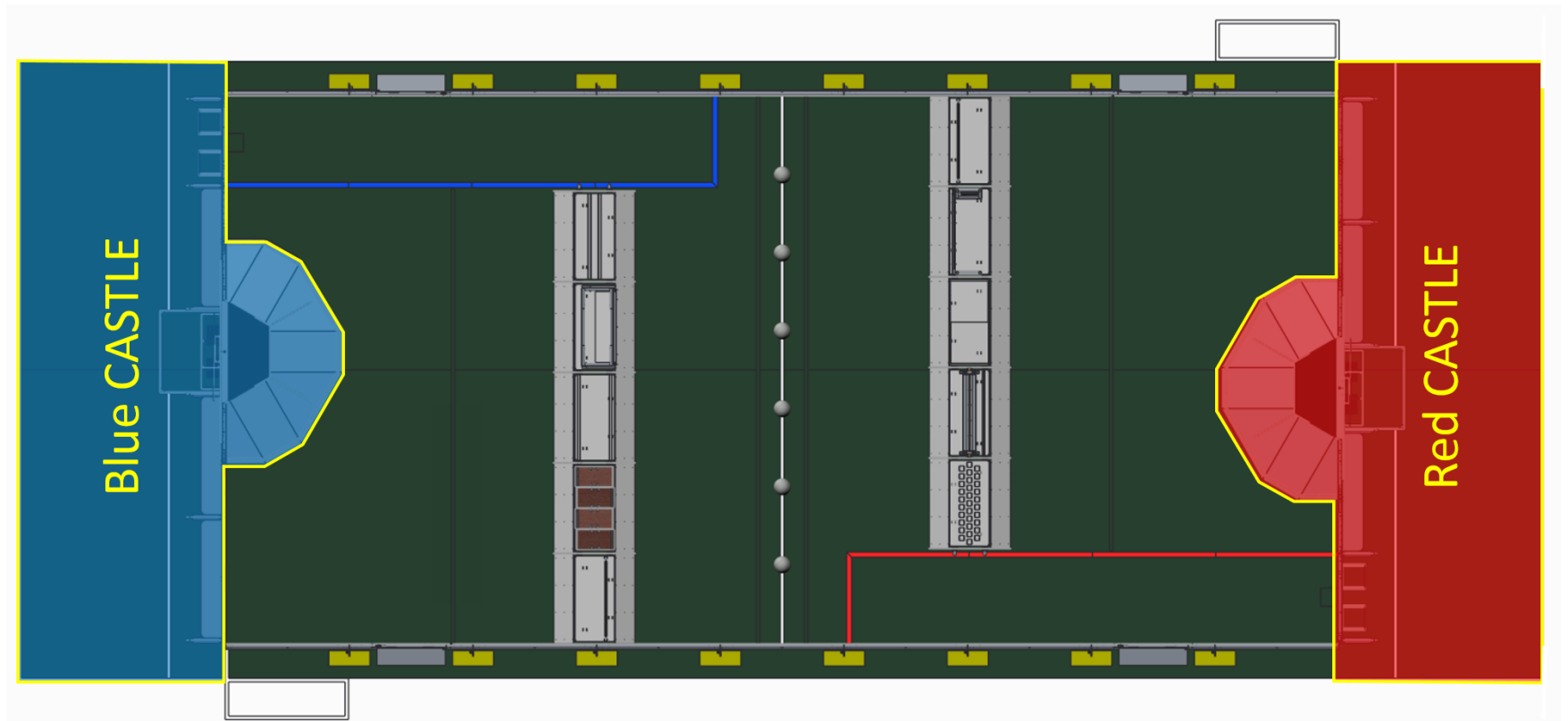
The SECRET PASSAGE includes the BERMS, but does not include the GUARDRAIL or CASTLE WALL. BERMS consist of a steel barrier, 1 in. tall and 3 in. wide that defines the border of the SECRET PASSAGE.

*Figure 2-21: Cross Section of the SECRET PASSAGE BERM*



## 2.2.3 CASTLES

Figure 2-22: Red and Blue CASTLES

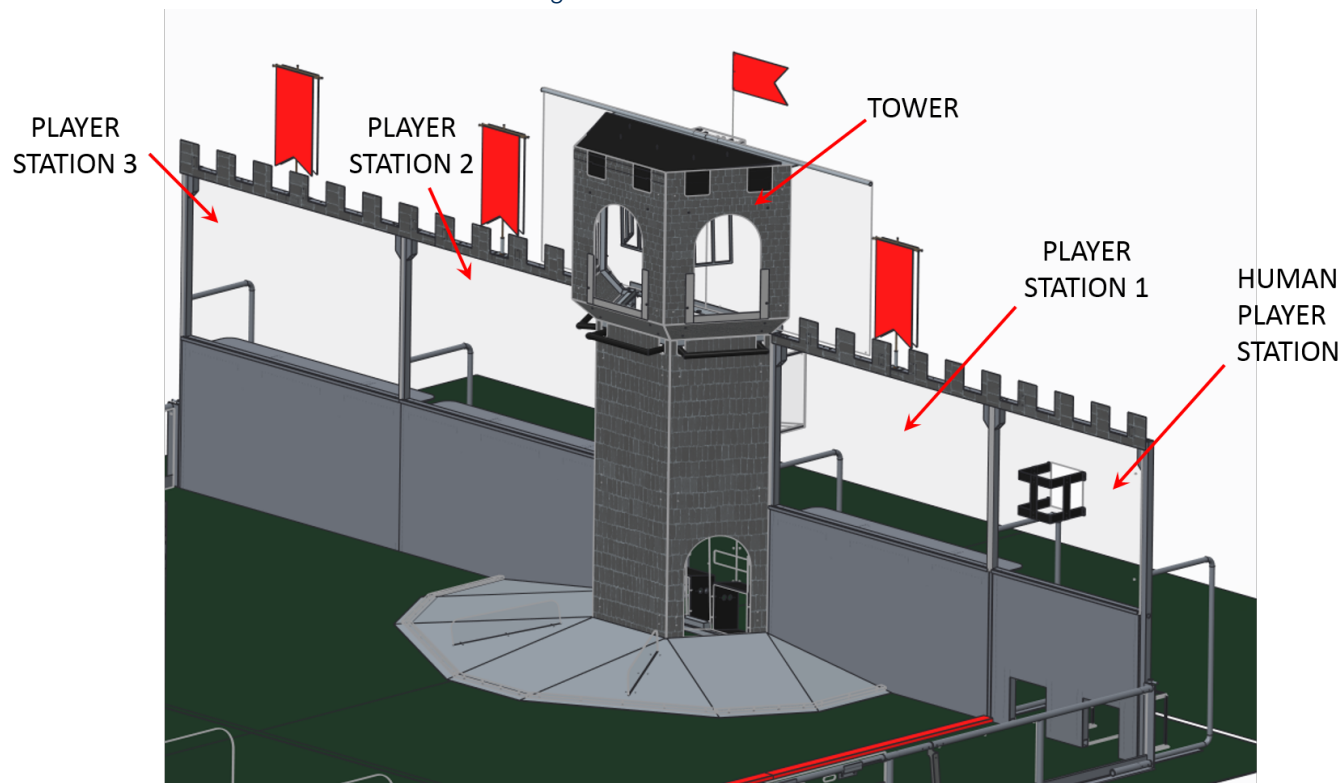


A CASTLE is located on each end of the FIELD. Each CASTLE is bounded by and includes the edges of the carpet, the CASTLE WALL, and white gaffers tape.

### 2.2.3.1 CASTLE WALL

The CASTLE WALL is the barrier between ROBOTS and DRIVE TEAMS (with the exception of a SPY in the SPY BOX) that consists of three (3) PLAYER STATIONS, a HUMAN PLAYER STATION, and a TOWER.

Figure 2-23: Red CASTLE WALL

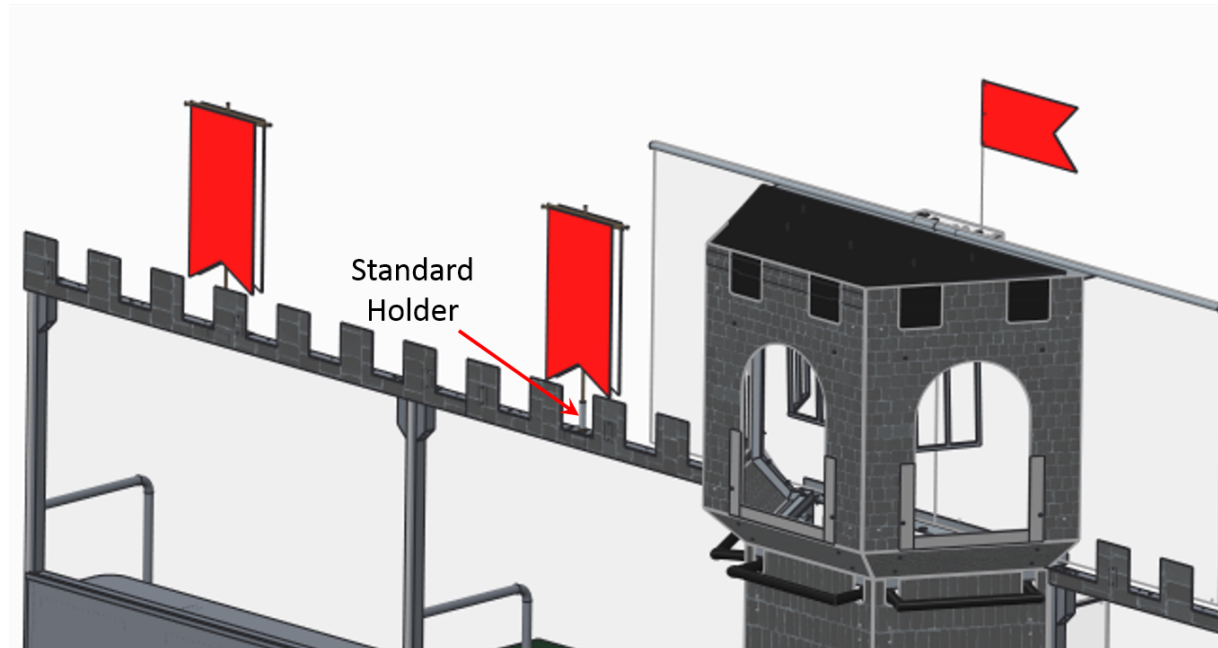


## PLAYER STATION

A PLAYER STATION is one (1) of three (3) assigned positions behind a CASTLE WALL from where a DRIVE TEAM operates their ROBOT. Each PLAYER STATION is made from a 3 ft. tall diamond plate panel base topped with a 3 ft. 6 in. tall transparent plastic panel. An aluminum shelf is attached to each PLAYER STATION to support the DRIVE TEAM'S OPERATOR CONSOLE. The shelf is 5 ft. 9 in. wide and 1 ft. deep. There is a 4 ft. 6 in. long by 2 in. 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.

Each Player Station supports one (1) Standard Holder. The Standard Holder features a receptacle designed to hold a 1/2 in. diameter rod and is mounted above the team sign.

Figure 2-24: Standard Holder



Each PLAYER STATION contains the following electronic components for Teams:

- One Ethernet Cable. This cable attaches to the Ethernet port of the OPERATOR CONSOLE and provides connectivity to the ARENA network.
- One 120VAC NEMA 5-15R power outlet. It is located on the right side of each PLAYER STATION shelf. The outlet is protected by a 3-Amp circuit breaker and 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.
- One Emergency Stop (E-Stop) button. It is located on the left side of the PLAYER STATION shelf and should be used to deactivate a ROBOT if necessary.
- One Team sign. This displays the Team number and is located at the top of each PLAYER STATION.
- One Team LED. This indicates ALLIANCE color, ROBOT status, and E-Stop status and is 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 (FMS) 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 in a disabled state.

When the amber colored LED is lit, it means that the E-stop button has been pressed.

- One Timer (in the middle PLAYER STATION only). This displays the official time remaining in AUTO, TELEOP, and TIMEOUTS and is marked with white tape along the bottom edge.
- Competition ARENA hardware and wiring. Mostly located below the center PLAYER STATION shelf and TOWER.

### **HUMAN PLAYER STATION**

The HUMAN PLAYER STATION is an area on the side of each CASTLE through which HUMAN PLAYERS feed BOULDERS on to the FIELD. The HUMAN PLAYER STATION connects the PLAYER STATION #1 to the GUARDRAIL. Each HUMAN PLAYER STATION is constructed of a 3 ft. tall diamond plate panel base topped with a 3 ft. 6 in. tall transparent plastic panel.

The BRATTICE is the hole in the HUMAN PLAYER STATION plastic and its protective aluminum cage, which can be used by an ALLIANCE to introduce BOULDERS to the FIELD. The hole is 10-1/2" square, and the bottom edge of the hole is 4 ft. 8 in. from the FIELD carpet. There is a protective aluminum cage that mounts to the polycarbonate on the FIELD side of the CASTLE WALL.

An EMBRASURE is a hole at the bottom of the HUMAN PLAYER STATION wall diamond plate which can be used by an ALLIANCE to introduce BOULDERS to the FIELD. Each HUMAN PLAYER STATION hole has two EMBRASURES, each with an opening of 1 ft. by 1 ft. and a polycarbonate tunnel on the player station side of the hole. These tunnels are 1 ft. 3 in. long, and are designed to help prevent ROBOT to HUMAN PLAYER contact.

For *FIRST* Championship Playoff MATCHES, a 4<sup>th</sup> Standard Holder will be installed above the Human Player Station, centered over the BRATTICE, to hold the Standard for the ALLIANCE member not listed on the LINEUP for that MATCH.

Figure 2-25: Red HUMAN PLAYER STATION

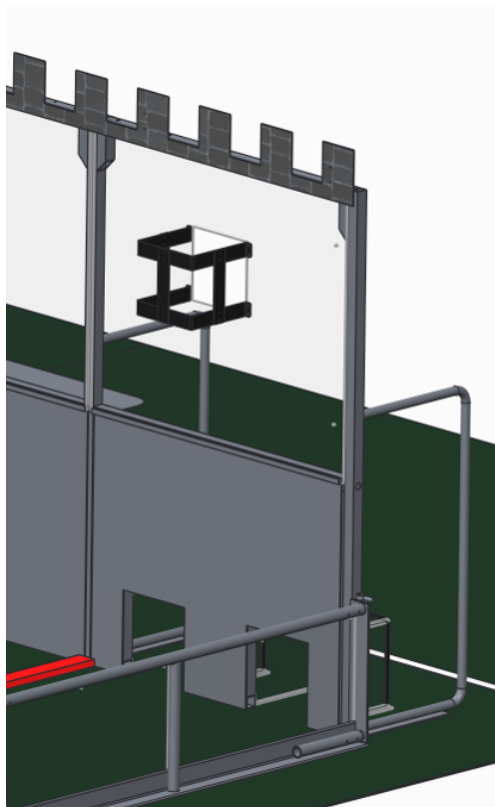
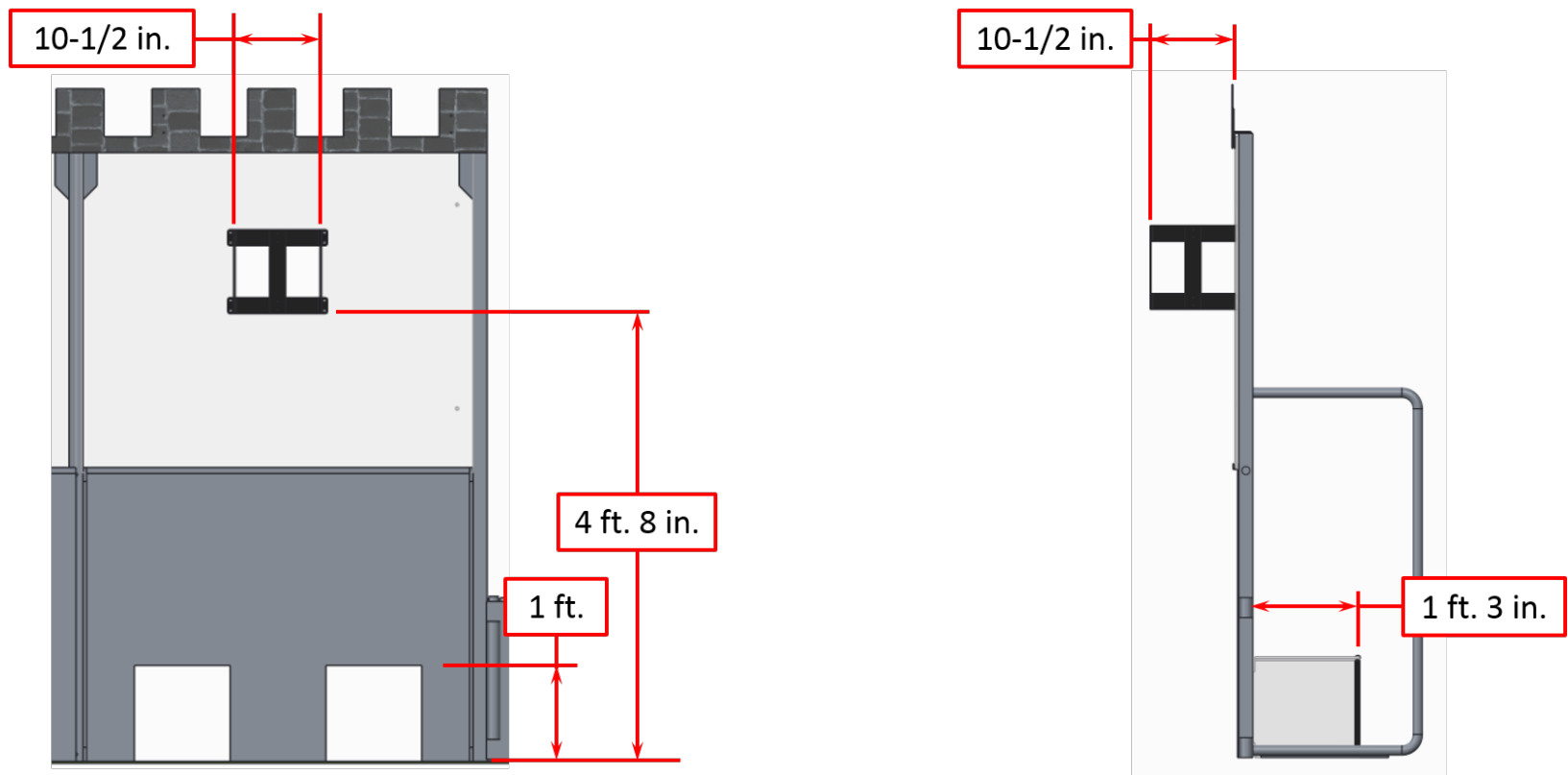




Figure 2-26: HUMAN PLAYER STATION Dimensions

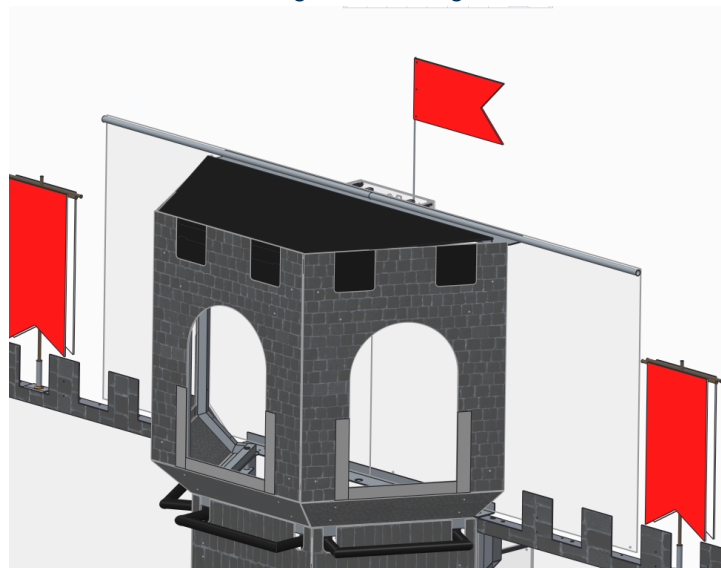


## TOWER

Each CASTLE has a TOWER between PLAYER STATIONS one (1) and two (2). Each TOWER has three faces with RUNGS, five GOALS, a BATTER, and a CORRAL.

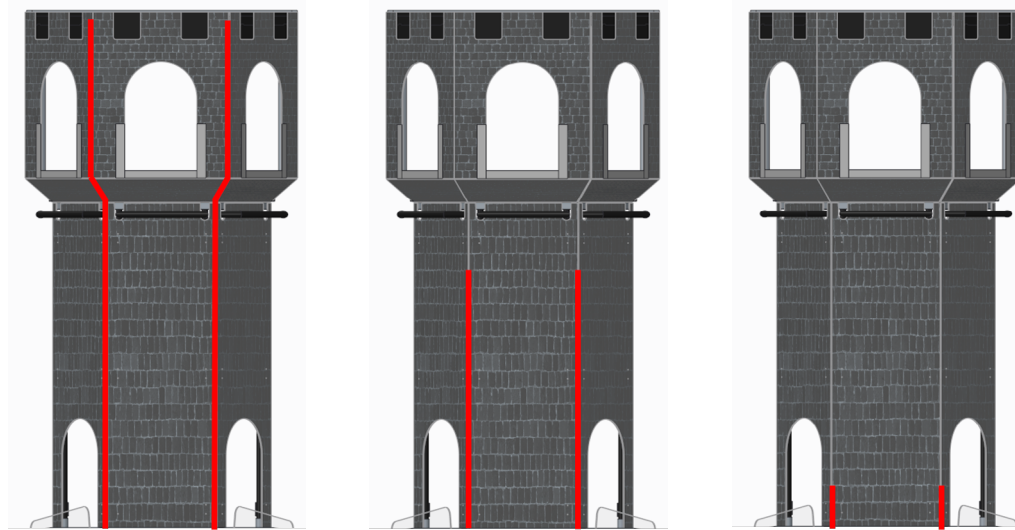
A set of flags is on top of each TOWER: one red, one blue. Only one flag will be visible at a time. The color of the displayed flag indicates ownership of the TOWER. When a TOWER has been WEAKENED, the flag matching the defending ALLIANCE will be lowered. If at the conclusion of the MATCH a TOWER has been CAPTURED, as described in [Section 3 \(3.1.4 The TOWER\)](#), the flag matching the CAPTURING ALLIANCE color will be raised

Figure 2-27: Flag



Each TOWER has two (2) Phillips Color Kinetics iColor Flex LMX LED light strings mounted to both vertical edges of the front face of the TOWER. During the MATCH they indicate TOWER STRENGTH. As opponents score BOULDERS in the TOWER, the STRENGTH of the TOWER is reduced and the lights begin to turn off, from the top to the bottom. The lights decrement eight (8) times until the entire strand is off.

Figure 2-28: TOWER STRENGTH Light Location



The light strings in the TOWER are used to indicate other situations as well, as shown in [Table 2-2](#).

Table 2-2: TOWER STRENGTH Light States and Meanings

Light State	Meaning
Off	FIELD is ready for the MATCH to begin, all personnel should be off the FIELD at this time.  Or  Tower has been WEAKENED during a MATCH.
Bottom two-thirds Green	FIELD is safe to enter
Pulsing at 1 Hz for three (3) seconds	The final twenty (20) seconds of the MATCH has begun
Top one-third in opposing ALLIANCE color (Red or Blue)	TOWER has been CAPTURED.

## GOALS

Each TOWER has five (5) GOALS; two (2) low and three (3) high. Each GOAL is an opening in the TOWER in which BOULDERS may be scored. Each GOAL is 1 ft. 4 in. wide by 2 ft. tall. The bottoms of the High GOALS are 7 ft. 1 in. from the carpet. The bottoms of the low GOALS are 6 in. from the flat FIELD surface, at the same height as the top of the BATTER.

Each of the high GOALS is marked with two (2) vertical strips of 2 in. retro-reflective material (3M 8830 Silver Marking Film) and one (1) horizontal strip of 2 in. retro-reflective material (with the unsupported .25 in. folded over the bottom edge of the GOAL opening such that 1.75 in. is visible) to form a u-shaped target. The targets are 1 ft. tall and 1 ft. 8 in. wide.

Figure 4-29: High TOWER GOAL Dimensions

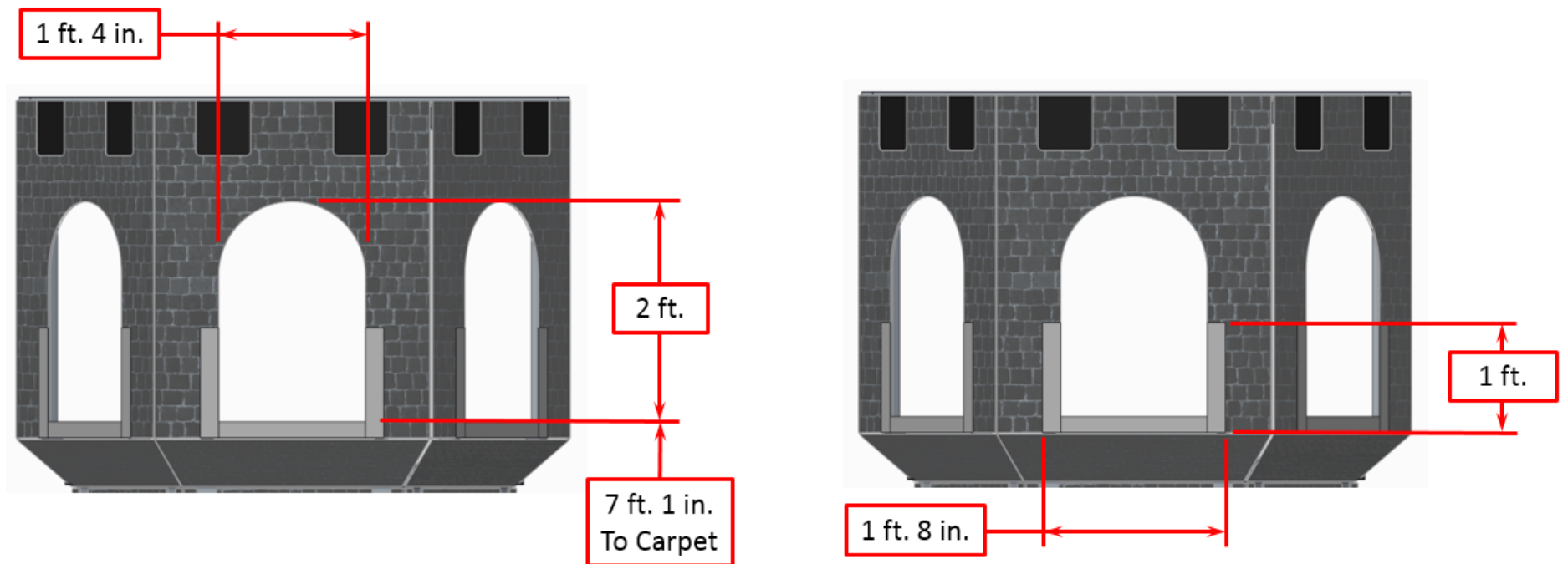
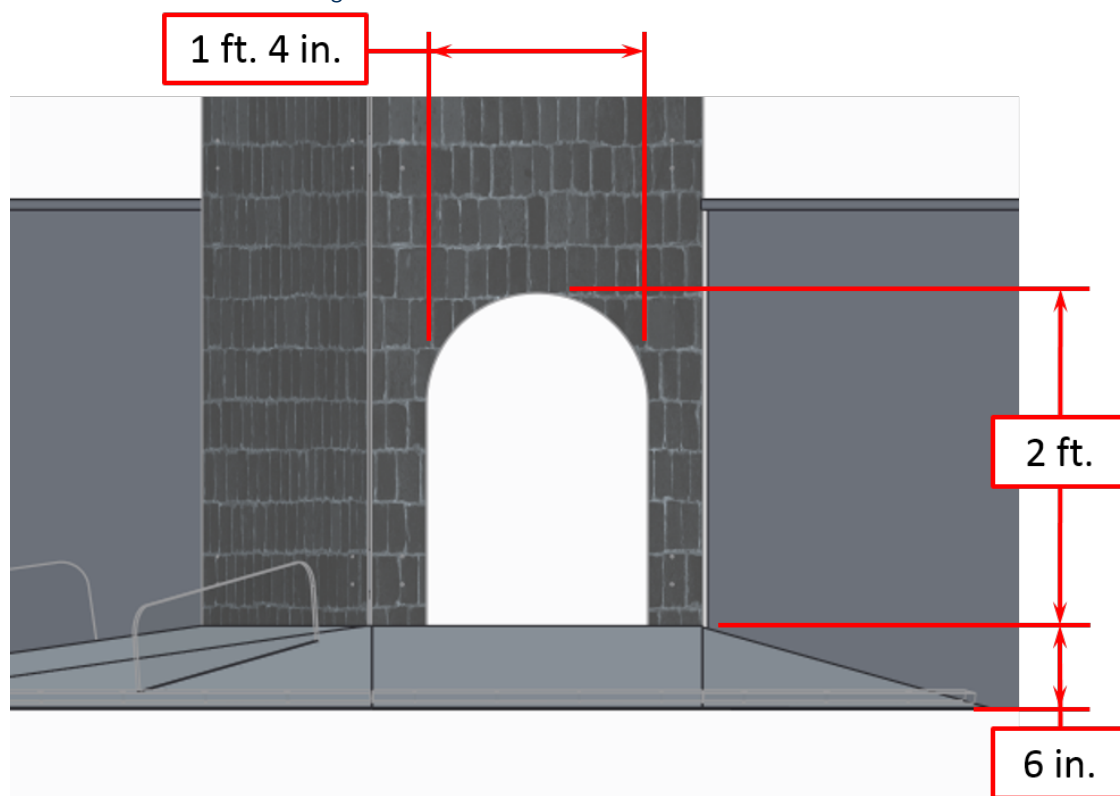
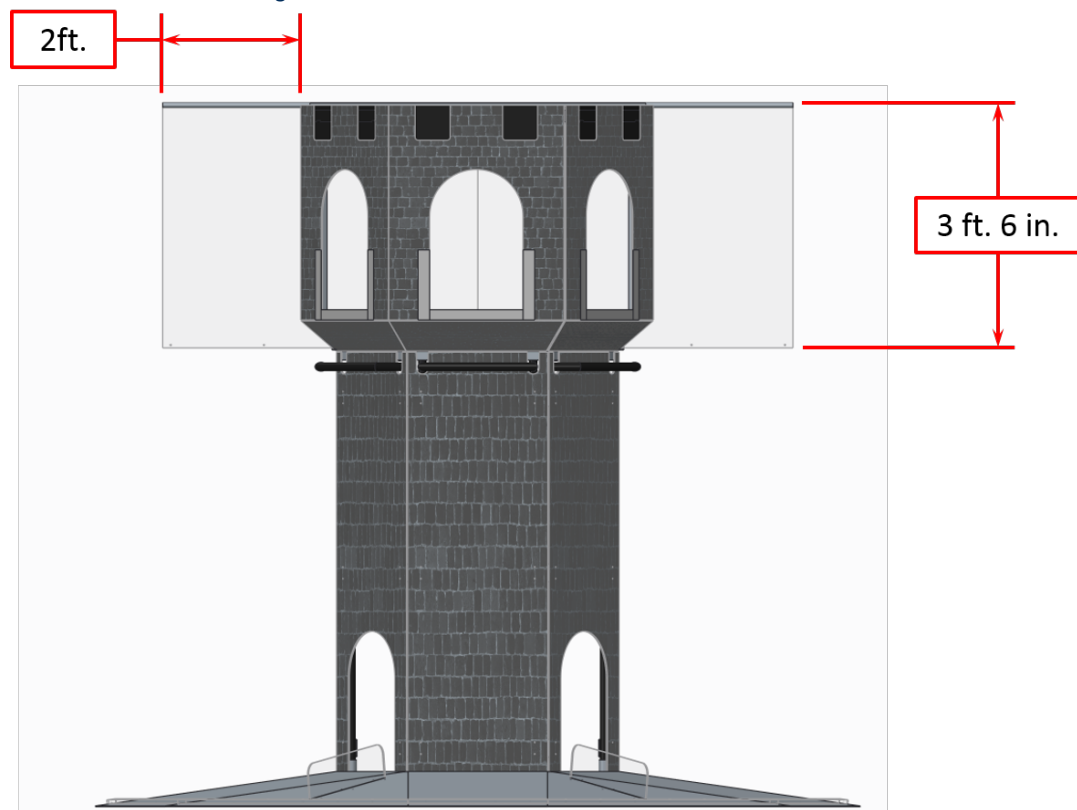


Figure 2-30: Low TOWER GOAL Dimensions



Goals have a series of chains and plastic dividers inside the TOWER to help mitigate shots bouncing out. Details can be found in the [2016 Official FIRST Field Drawings & Models](#). Additionally, each TOWER will have two (2) polycarbonate backboards, hung on either side of the TOWER, to help prevent shots from leaving the FIELD. These backboards are 2 ft. wide and 3 ft. 6 in. tall.

Figure 2-31: TOWER Backboard Size and Location

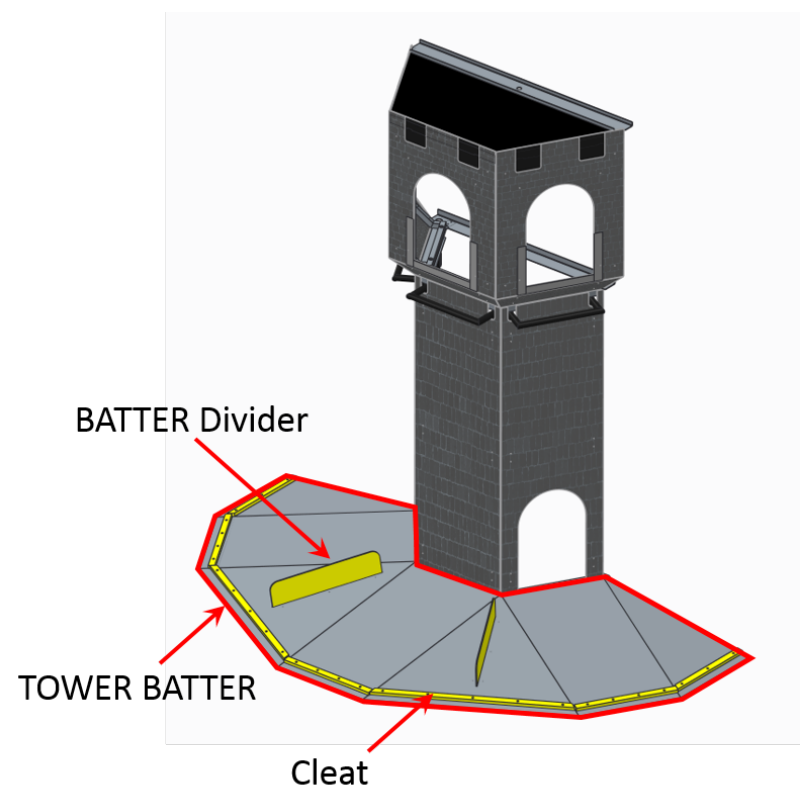
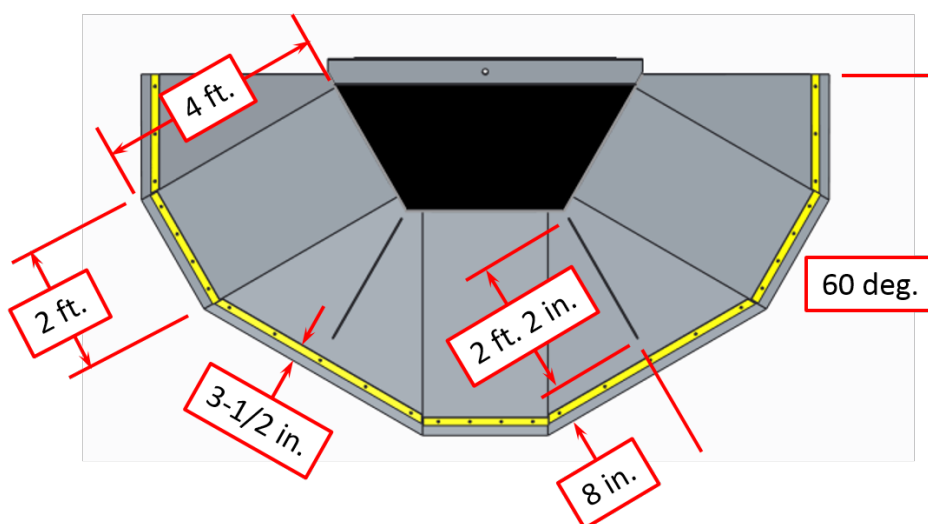


## BATTER

The BATTER is a series of seven (7) ramps with two (2) dividers that create the base of the TOWER. Ramps are 6-8 deg. inclines. The ramps directly in front of the low GOALS are 2 ft. wide and 4 ft. deep. The dividers are clear polycarbonate, 6 in. tall by 26 in. long, located 60 deg. from the face of the CASTLE WALL, and 8 in. from the leading edge of the ramp.

Cleats are attached to the bottoms of the BATTER ramps to help prevent ROBOTS from rolling off the BATTER at the conclusion of the MATCH. They are parallel to and 3-1/2 in. from the bottom edge of each ramp. Cleats are plastic and 3/4 in. tall and 1-1/2 in. deep.

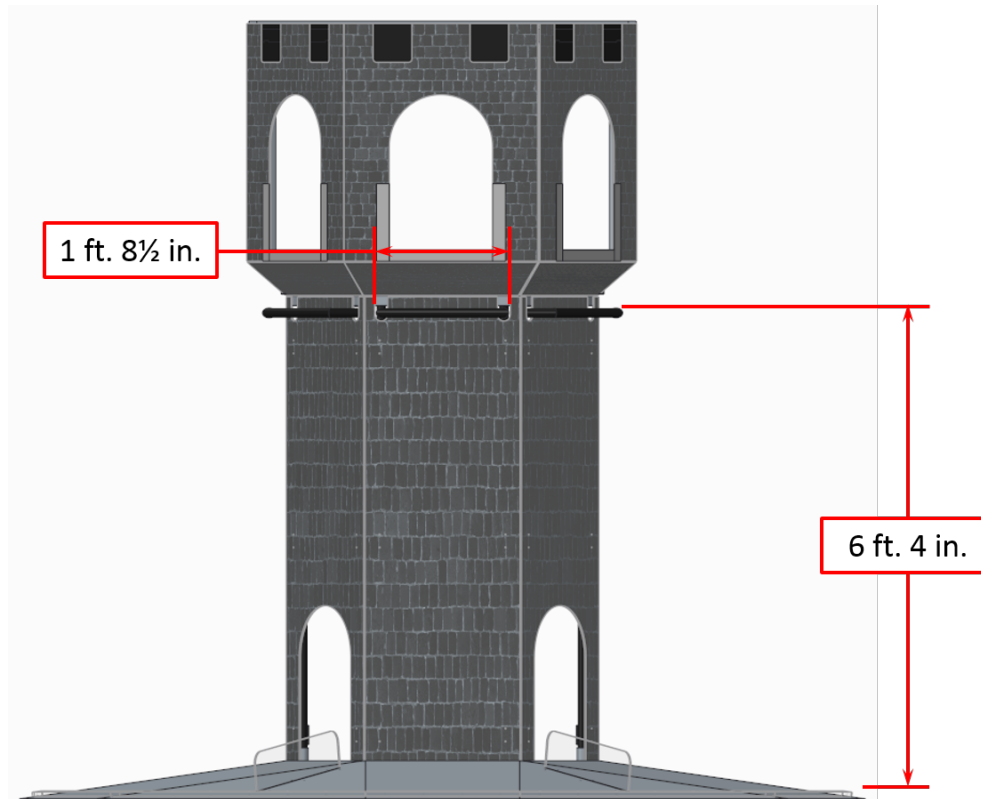
Figure 2-32: BATTER Dimensions and Location



## SCALING RUNGS

A RUNG is a bar mounted on a TOWER face that is 1 ft. 9 in. wide and constructed of 1-1/2" Steel DOM Tubing. Each TOWER has three (3) RUNGS, one on each face of the TOWER, designed to support SCALING robots. The top of the rung is 6 ft. 4in. from the FIELD carpet. The RUNGS protrude 5-1/4 in. from the face of the TOWER.

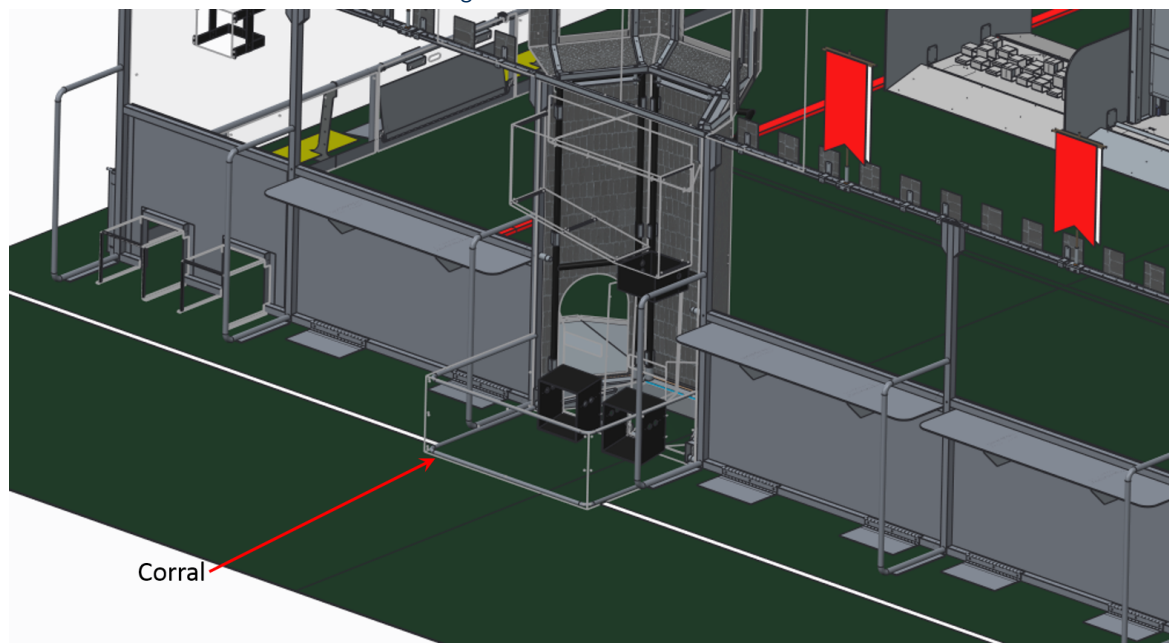
Figure 2-33: TOWER Rung Height and Dimensions



## CORRAL

Once a BOULDER passes through the TOWER and is scored, it falls into the CORRAL. The CORRAL is the collection area for scored BOULDERS located at the rear base of the TOWER. The CORRAL is 4 ft. wide, 1 ft. 6 in. tall and extends 2 ft. 11-1/2 in. from the CASTLE WALL.

Figure 2-34: Red CORRAL





## 2.3 BOULDERS

Scoring elements are called BOULDERS. BOULDERS are a 10 in. diameter, gray, Gopher SoftiBall™ coated foam ball used by ALLIANCES to score points in *FIRST STRONGHOLD*. BOULDERS may be purchased from [AndyMark](http://AndyMark.com) (AM-3276). Single balls and six (6) packs of rainbow colored balls may be purchased at [gophersport.com](http://gophersport.com) (6-pack Item Number: 47-121, Single ball Item Number: 99-634).

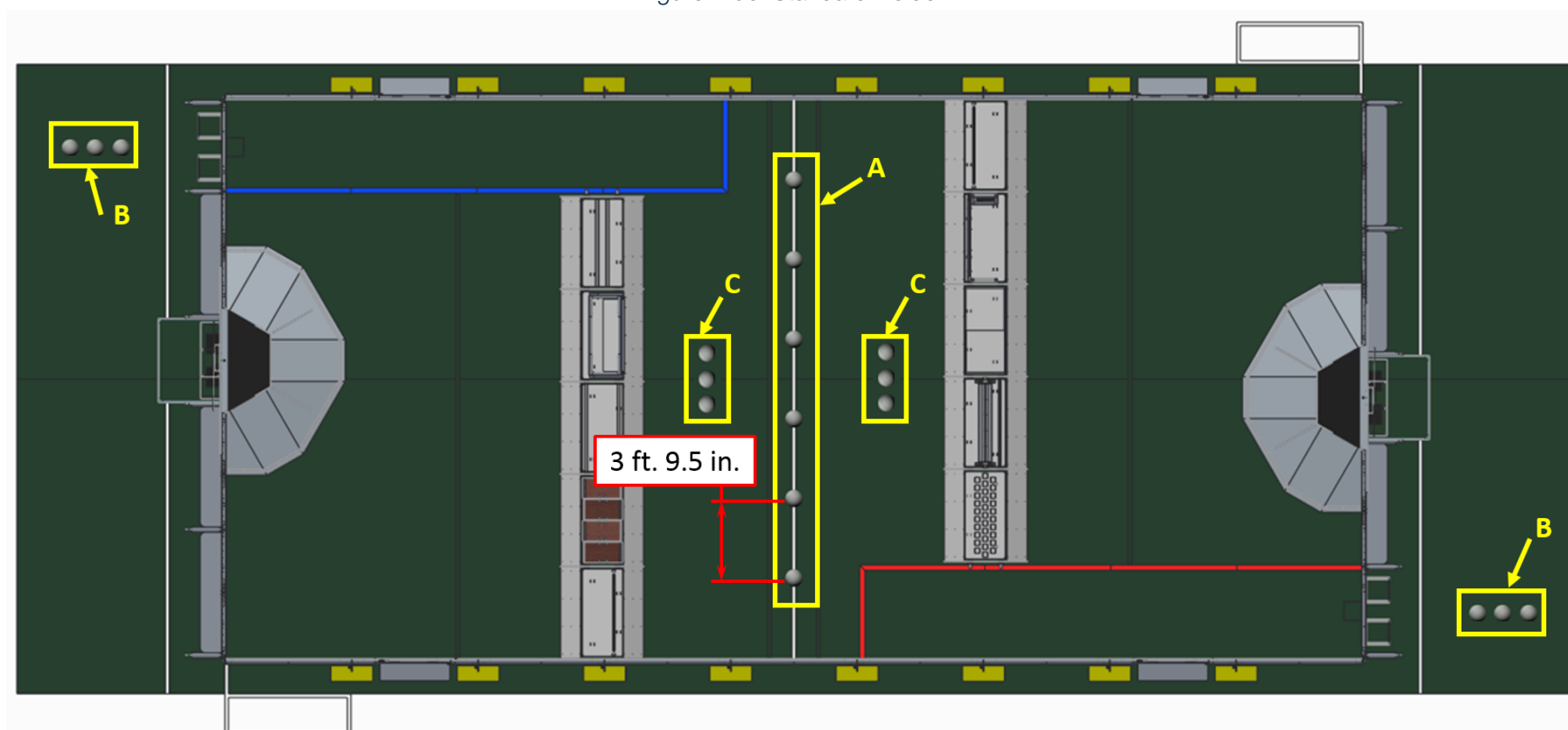
Figure 2-35: BOULDER



Each MATCH begins with eighteen (18) BOULDERS in the ARENA. BOULDERS are staged before the MATCH in the following manner:

- A. Six (6) BOULDERS are staged evenly along the length of the Midline, 3 ft. 9-1/2 in. apart as shown in Figure 2-35. Small rings are used to keep them in place prior to the start of a MATCH. Rings are O-rings, Dash 222, Buna N, 1.762 in. outer diameter, .13 in thick (Grainger Item#: 1KLE7). Rings will be secured to the carpet by the MIDLINE tape.
- B. Three (3) BOULDERS are staged in each CASTLE
- C. Three (3) BOULDERS per ALLIANCE are staged on or in each ROBOT or in the CASTLE. See [Section 3 \(3.2 MATCH Logistics\)](#) for more detail.

Figure 2-36: Standard Holder



## 2.4 The FIELD Management System

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, ports are available are as follows:

- A. TCP 1180: Camera data from the roboRIO to the Driver Station (DS) when the camera is connected the roboRIO via USB, bi-directional.
- B. TCP 1735: SmartDashboard, bi-directional
- C. UDP 1130: Dashboard-to-ROBOT control data, uni-directional
- D. UDP 1140: ROBOT-to-Dashboard status data, uni-directional
- E. HTTP 80: Camera connected via switch on the ROBOT, bi-directional
- F. HTTP 443: Camera connected via switch on the ROBOT, bi-directional
- G. UDP/TCP 554: Real-Time Streaming Protocol for h.264 camera streaming, bi-directional
- H. UDP/TCP 5800-5810: Team Use, bi-directional

Teams may use these ports as they wish if they do not employ them as outlined above (i.e. TCP 1180 can be used to pass data back and forth between the ROBOT and the Driver Station if the Team chooses not to use the camera on USB). Additional information about the FMS may be found on the *FIRST* website in the FMS Whitepaper.

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