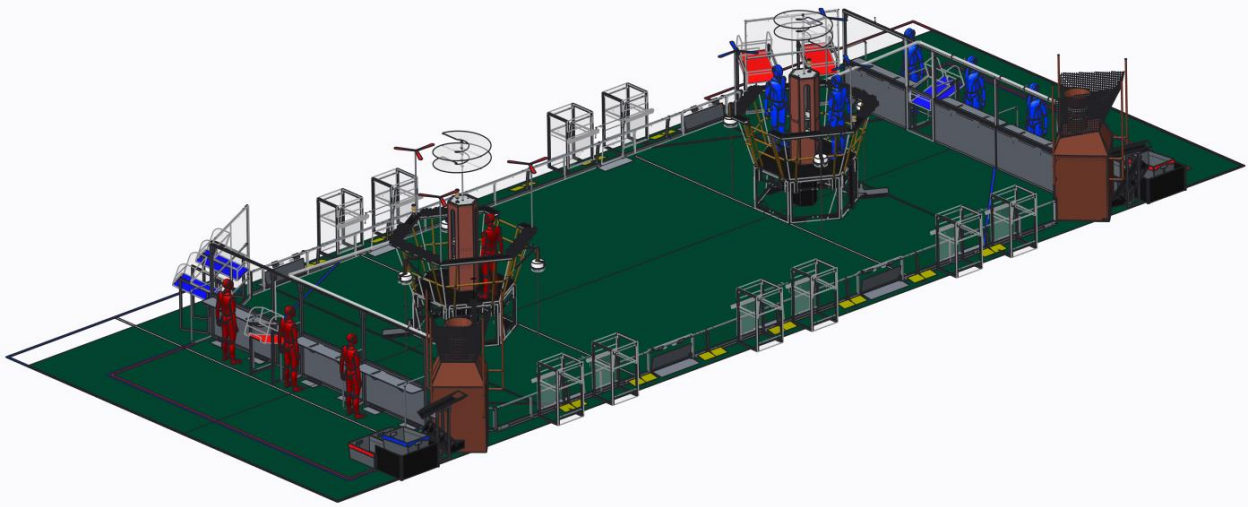
3 ARENA

The ARENA includes all elements and areas of the game infrastructure that are required to play *FIRST* STEAMWORKS[SM]: the FIELD, AIRSHIPS, carpet, scoring elements, and all equipment and areas needed for FIELD control, ROBOT control, and scorekeeping.

Figure 3-1: FIRST STEAMWORKS playing area



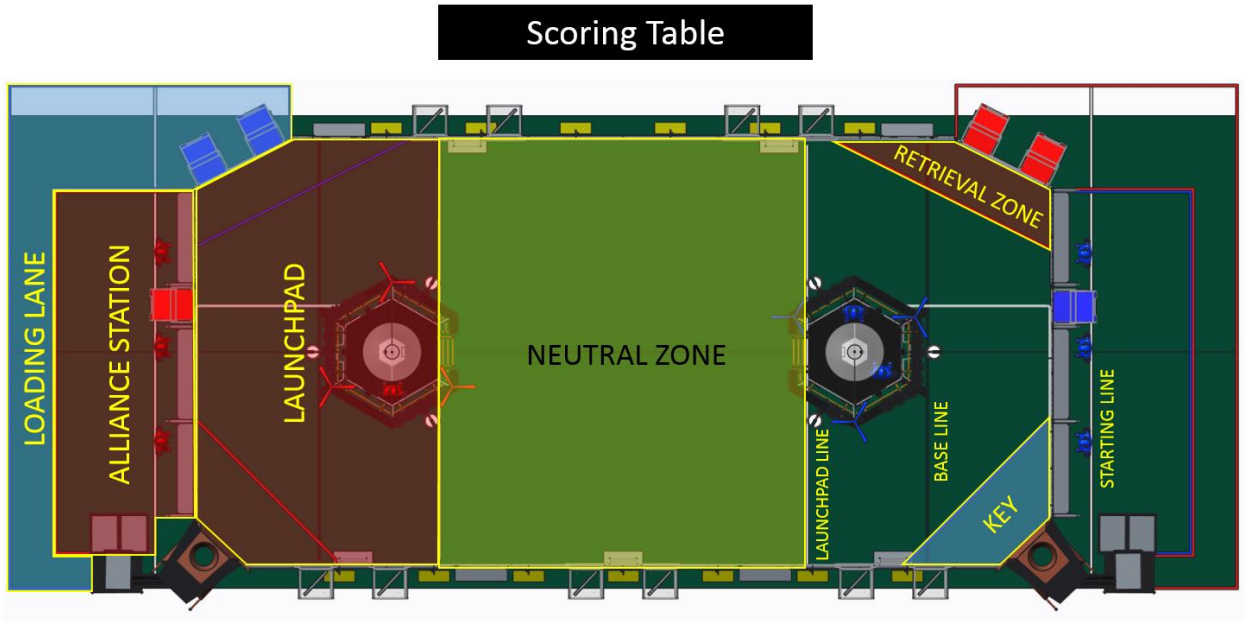
The competition ARENA is modular and assembled, used, disassembled, and shipped many times during the competition season. It will undergo wear and tear. The ARENA is designed to withstand rigorous play and frequent shipping. Every effort is made to ensure that ARENAS are consistent from event to event. 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 2017 FRC Field Assembly 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* STEAMWORKS 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* STEAMWORKS FIELD are posted in the "Playing Field Details" section of the *FIRST* STEAMWORKS Game & Season Materials web page.

3.1 Zones and Markings

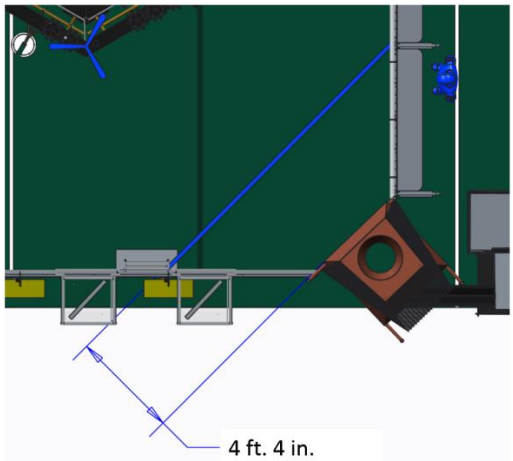
There are several areas on the FIELD relevant to game play and rules. Such spaces are described below. All lines are marked using 2-in. (nominal) gaffers tape.

Figure 3-2: Zones and Markings



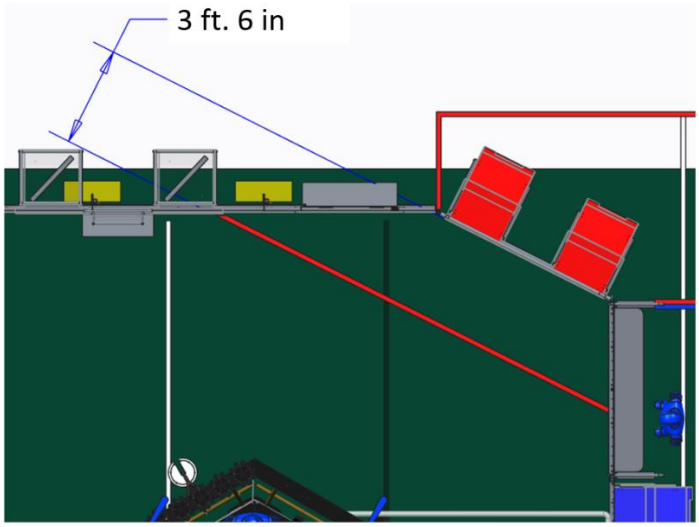
- ALLIANCE STATION: an 8 ft. 9¾ in. (~269 cm) by 23 ft. 1½ in. (~705 cm) infinitely tall volume bounded by the ALLIANCE WALL and ALLIANCE colored tape. The volume above the tape is part of the ALLIANCE STATION.
- BASE LINE: a green line that spans the width of the FIELD and is 7 ft. 9¼ in. (~237 cm) from the ALLIANCE WALL diamond plate.
- KEY: an infinitely tall volume in the ALLIANCE'S LAUNCHPAD bounded by the ALLIANCE WALL, GUARDRAIL, and ALLIANCE colored tape. The KEY includes the volume above the tape. The far edge of the tape is parallel to and 4 ft. 4 in. (~132 cm) from the front face of the BOILER.

Figure 3-3: KEY



- LAUNCHPAD: an infinitely tall volume in the FIELD bounded by the GUARDRAILS, the ALLIANCE WALL, and the LAUNCHPAD LINE. The volume above the LAUNCHPAD LINE is part of the LAUNCHPAD.
- LAUNCHPAD LINE: a tape line that is the width of the FIELD and collinear with the edge of the AIRSHIP deck that is closest to the center of the FIELD.
- LOADING LANE: an area bounded by and including ALLIANCE colored tape, edge of the carpet, the RETURN BIN Table, and the opponent's ALLIANCE WALL.
- NEUTRAL ZONE: an infinitely tall volume on the FIELD bounded by the GUARDRAILS and the LAUNCHPAD LINES. The volume above the LAUNCHPAD LINES is not part of the NEUTRAL ZONE.
- RETRIEVAL ZONE: an infinitely tall volume inside the FIELD bounded by the ALLIANCE WALL, GUARDRAIL and ALLIANCE colored tape. The RETRIEVAL ZONE includes the volume above the tape. The far edge of the tape is parallel to and 3 ft. 6 in. (~107 cm) from the front face of the LOADING STATION.

Figure 3-4: RETRIEVAL ZONE

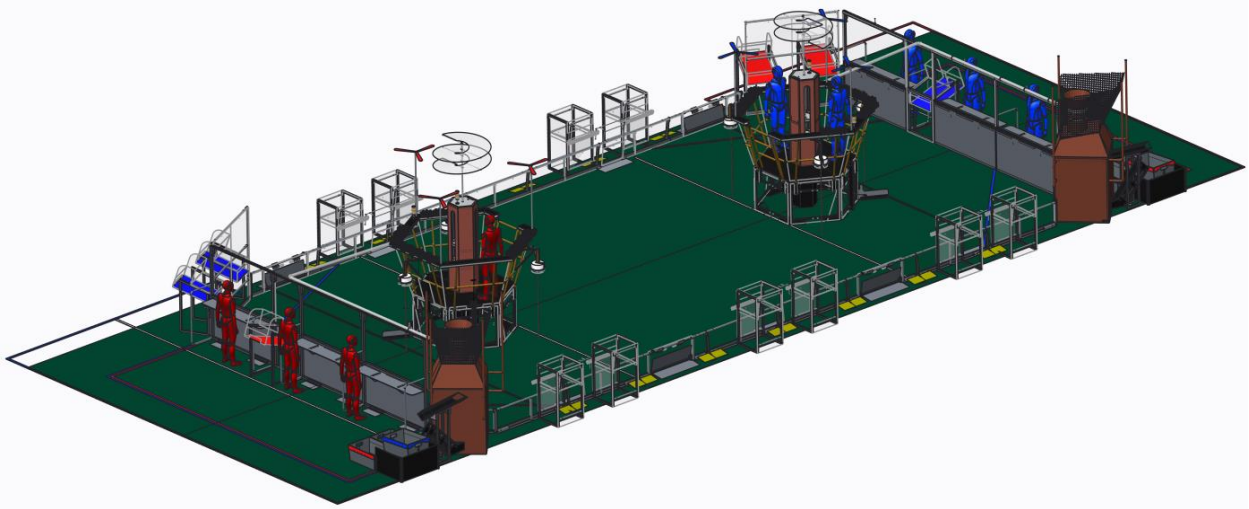


- STARTING LINE: a white tape line that runs the width of the carpet and is 2 ft. 6 in. (~76 cm) behind the ALLIANCE WALL diamond plate.

3.2 FIELD

The FIELD for *FIRST* STEAMWORKS is a 27 ft. by 54 ft. 4 in. (~823 cm by ~1656 cm) area, bounded by and including the upward- and inward-facing surfaces of the GUARDRAILS and ALLIANCE WALLS. The carpet used for the FIELD is green (Shaw Floors, Philadelphia Commercial, Neyland II 20, 30352, "Scotch Pine").

Figure 3-5: FIRST STEAMWORKS playing area



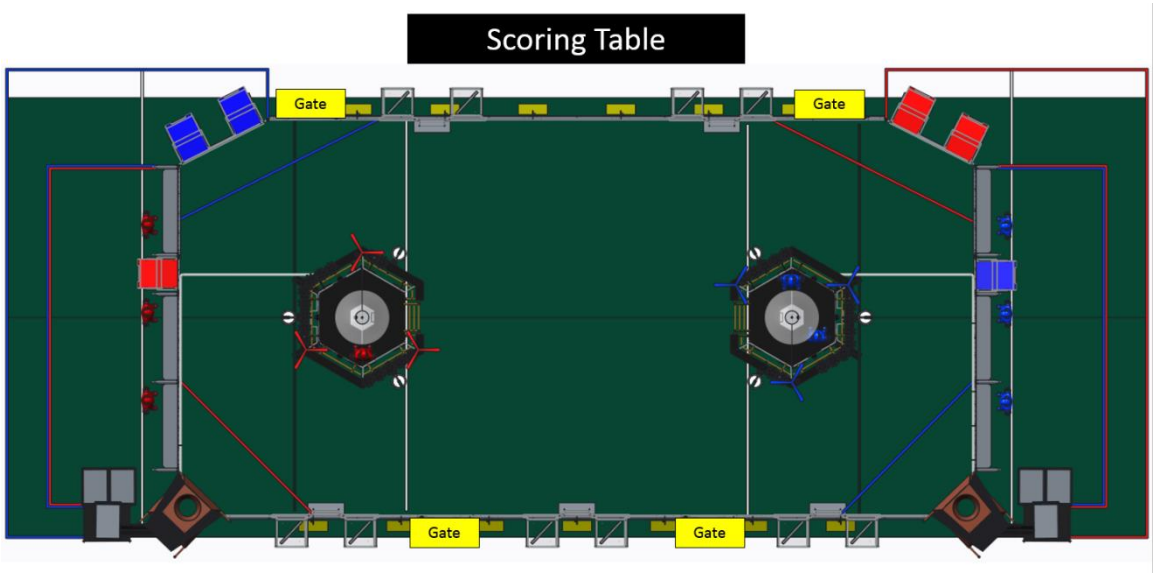
There are two versions of GUARDRAILS and PLAYER STATIONS (i.e. the FIELD perimeter) used for competitions. One design has been used at *FIRST* Robotics Competition events for several years and is depicted in the 2017 Basic Field Drawings and *FIRST* provided CAD models. The other is designed and sold by AndyMark. While the designs are slightly different, the critical dimensions, performance, and expected user experience between the two is the same. All Regional and Championship assemblies will use the traditional *FIRST* design (except for Shenzhen Regional and all *FIRST* Championship practice fields). 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 this document depict the traditional FIELD design.

3.3 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. (~97 cm) wide and closed and shielded during the MATCH.

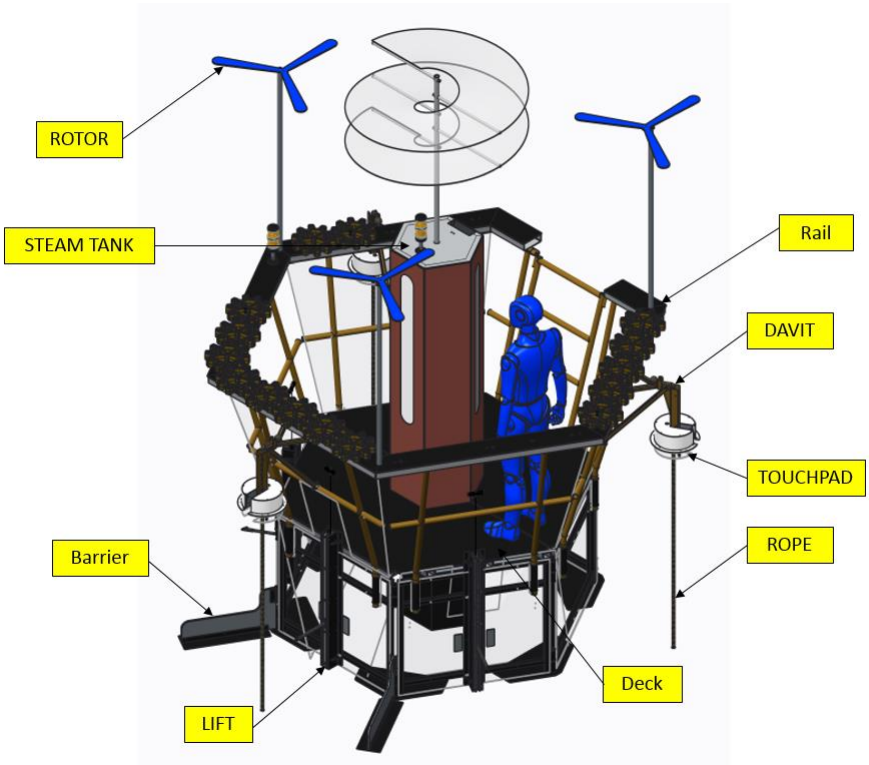
Figure 3-6: Gate locations



3.4 AIRSHIP

The AIRSHIP is a structure that features an elevated hexagonal deck, slanted walls, rails with AXLES to mount GEARS, four (4) ROTORS, three (3) LIFTS, a STEAM TANK, and three (3) ROPES attached to DAVITS. There is one AIRSHIP at the edge of each LAUNCHPAD. The AIRSHIP is positioned such that the three (3) LIFTS face the ALLIANCE wall. The maximum capacity of the AIRSHIP is two (2) people.

Figure 3-7: AIRSHIP elements



The hexagonal deck is 5 ft. 10½ in. (~179 cm) wide and 3 ft. ½ in. (~93 cm) above the FIELD carpet. The rail forms an 8 ft. 5 in. (~257 cm) wide hexagon that is 3 ft. 6½ in. (~108 cm) above the deck. Polycarbonate walls connect the deck and rail and angle out from the deck at a 75 deg. angle. PORTS, 13 in. (~33 cm) wide by 19½ in. (~50 cm) holes next to each LIFT, are cut in the three walls facing the ALLIANCE WALL.

Figure 3-8: PORT

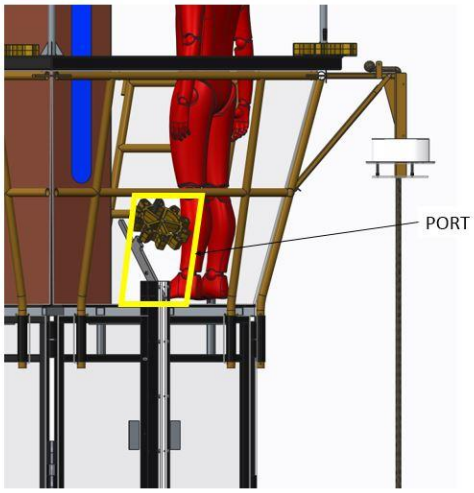
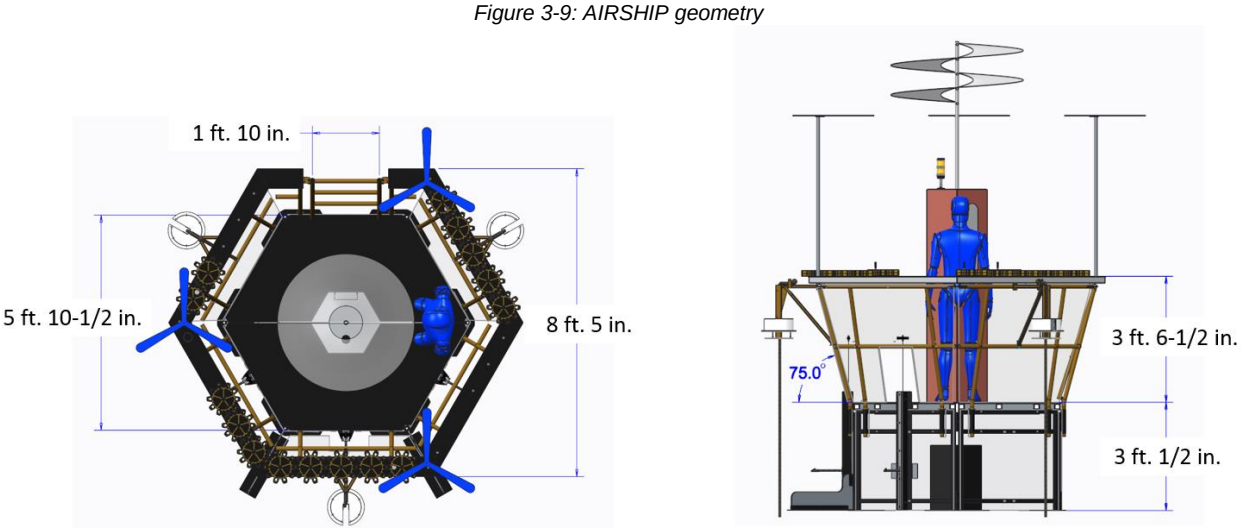


Figure 3-9: AIRSHIP geometry

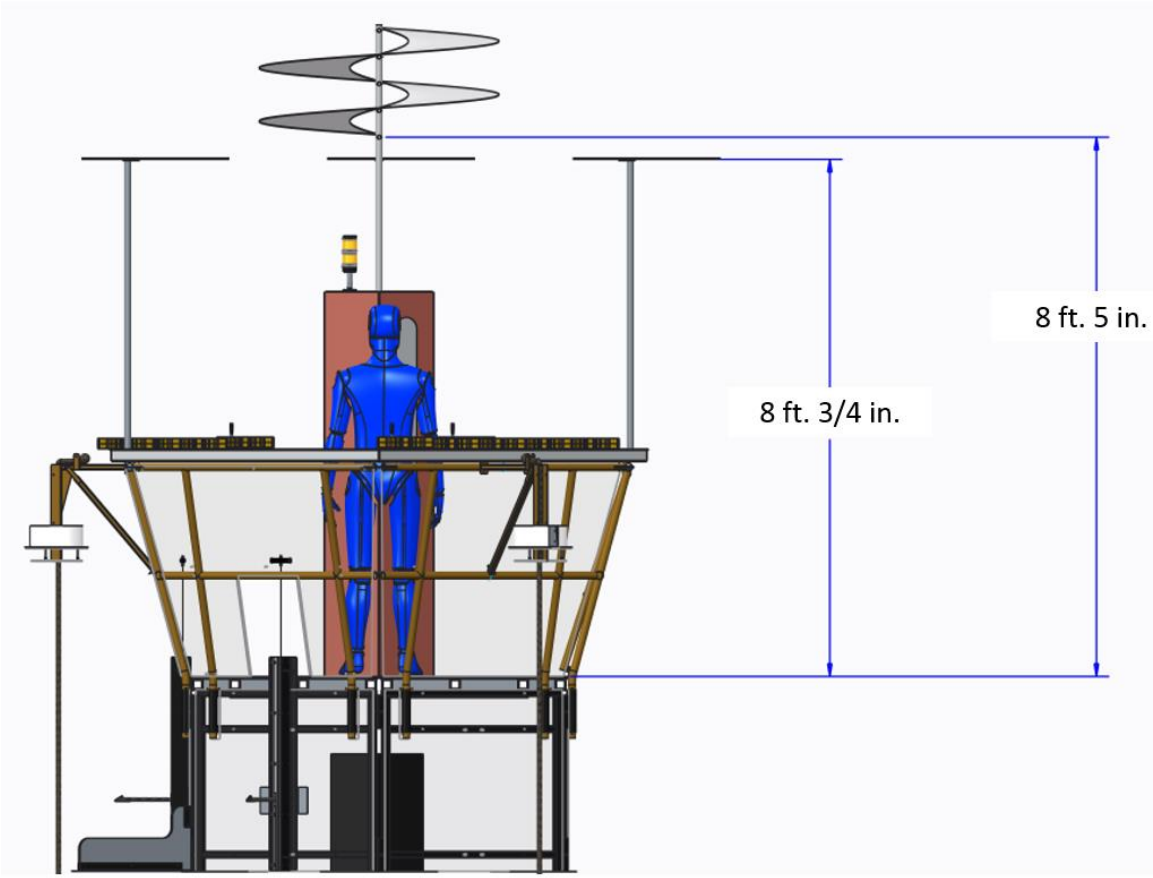


The deck is accessed by a step ladder. The step ladder is 1 ft. 10 in. (~56 cm) wide. Before MATCH play, it is rotated upward and latched to the rail.

3.4.1 ROTORS

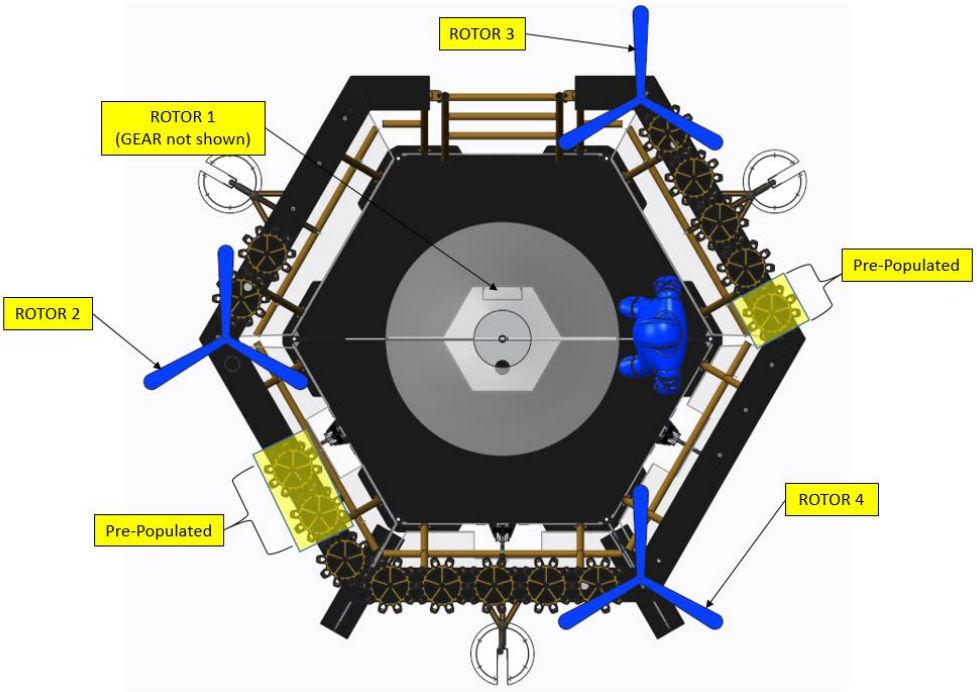
A ROTOR is one of four (4) rotating airfoils mounted to each AIRSHIP. There is one (1) central ROTOR (modeled after the Da Vinci Aerial Screw) that protrudes from the center of the STEAM TANK. It starts 8 ft. 5 in. (~257 cm) above the deck. Three (3) smaller ROTORS are mounted to the rail, 8 ft. ¾ in. (~246 cm) above the deck, and evenly spaced around the rail.

Figure 3-10: ROTOR heights



3.4.2 GEAR Sets

Figure 3-11: GEAR placement



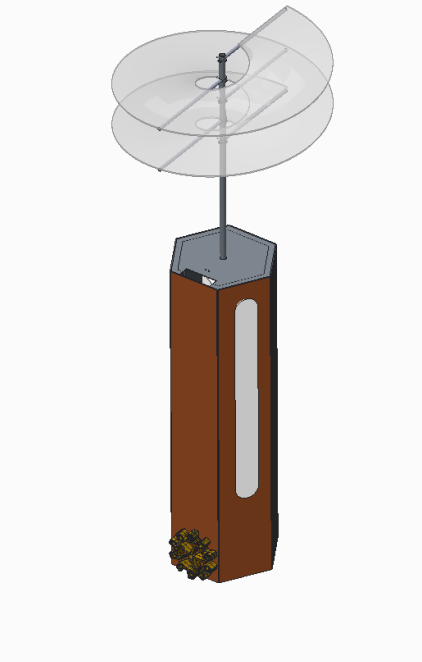
A GEAR set is a series of meshed GEARS that correspond to a specific ROTOR. GEAR sets are installed on AXLES mounted to the rail. An AXLE is a ⅞-in. diameter (~2 cm), 2-in. (~5 cm) long shaft which fits the central hub of a GEAR. The number of AXLES for each GEAR set depends on the ROTOR. Some AXLES are prepopulated with GEARS and indicated in Table 3-1. Prepopulated GEARS are marked with ALLIANCE color gaff tape. The number of pre-populated GEARS may change for District Championships or the *FIRST* Championship.

Table 3-1: GEAR set population.

	ROTOR 1	ROTOR 2	ROTOR 3	ROTOR 4
Pre-populated GEARS	0	0	1	2
PILOT placed GEARS	1	2	4	6

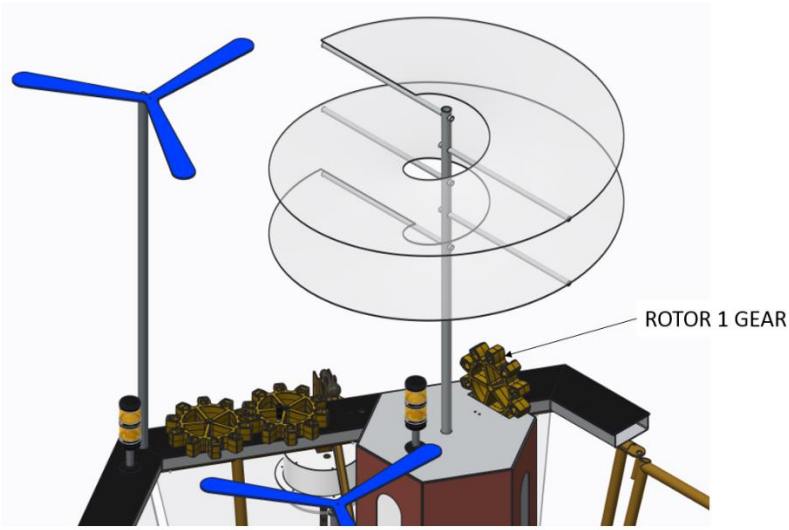
One GEAR, the Reserve GEAR, is staged on the AIRSHIP at the start of the MATCH at the base of the STEAM TANK, as shown in Figure 3-12.

Figure 3-12: Reserve GEAR location



Once a ROTOR is started, it remains turning for the duration of the MATCH. ROTORS only start in order: 1, 2, 3, and then 4. The order of GEAR placement within a GEAR set is not important. To start ROTOR 1, the PILOT places the GEAR in the GEAR slot at the top of the STEAM TANK, opposite the stack light for ROTOR 1.

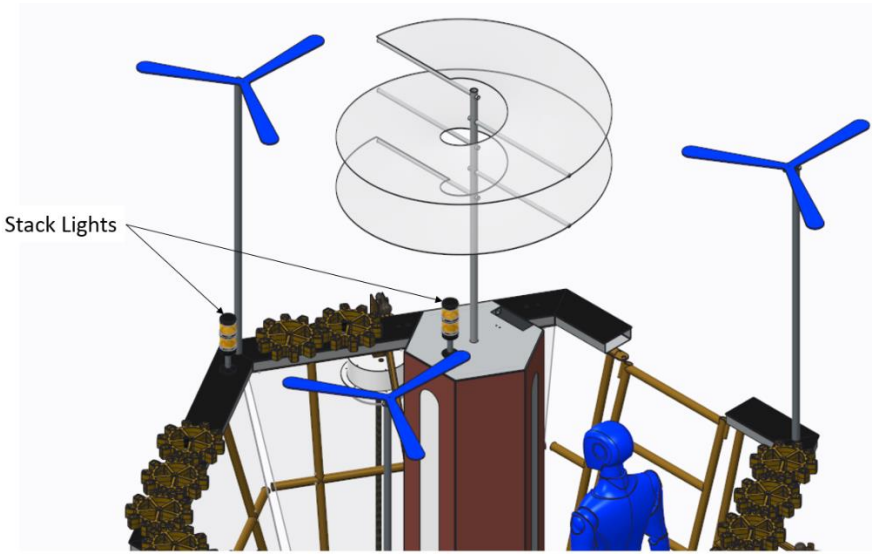
Figure 3-13: GEAR placement to start ROTOR 1



When a GEAR set for ROTORS 2, 3, or 4 is complete, a CRANK, a handle located with the first GEAR in the set, can be turned which engages the corresponding ROTOR. It takes three (3) full rotations to engage the ROTOR. If a GEAR set corresponding to the next sequential unengaged ROTOR remains idle for more than ten (10) seconds, the rotation count resets to zero (0).

A yellow stack light is installed next to ROTORS 1 and 2 and illuminates if its corresponding ROTOR is engaged during AUTO.

Figure 3-14: AUTO stack light indicators



3.5 LIFTS

LIFTS are used to transfer GEARS from the ROBOTS to the PILOTS. One (1) LIFT is mounted to each of the three (3) sides of the deck that face the PLAYER STATIONS. Each LIFT consists of a peg, steel guide frame, carriage assembly, and cable. The cable is pulled by the PILOT to raise the carriage to a PORT where the GEAR can be safely accessed. Each carriage has a peg designed to hold the GEAR during the transition. The peg is 1 ft. 1 in. (~33 cm) from the FIELD carpet when the carriage is all the way down, protrudes 10½ in. (~27 cm) from the carriage and is 1⅜ in. (~3 cm) wide. It is constructed from ⅞-in. (nominal) diameter extension spring (McMaster P/N: 9664K68 or Century Spring P/N: E-41). A PVC ring, centered on and mounted to the lower rung of the AIRSHIP rail as show in Figure 3-15, loosely holds the pull cord and prevents the LIFT handle from falling out the PORT.

Figure 3-15: Reserve GEAR location

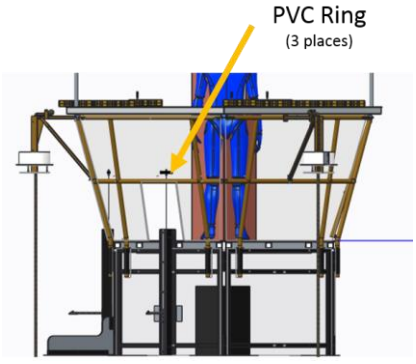
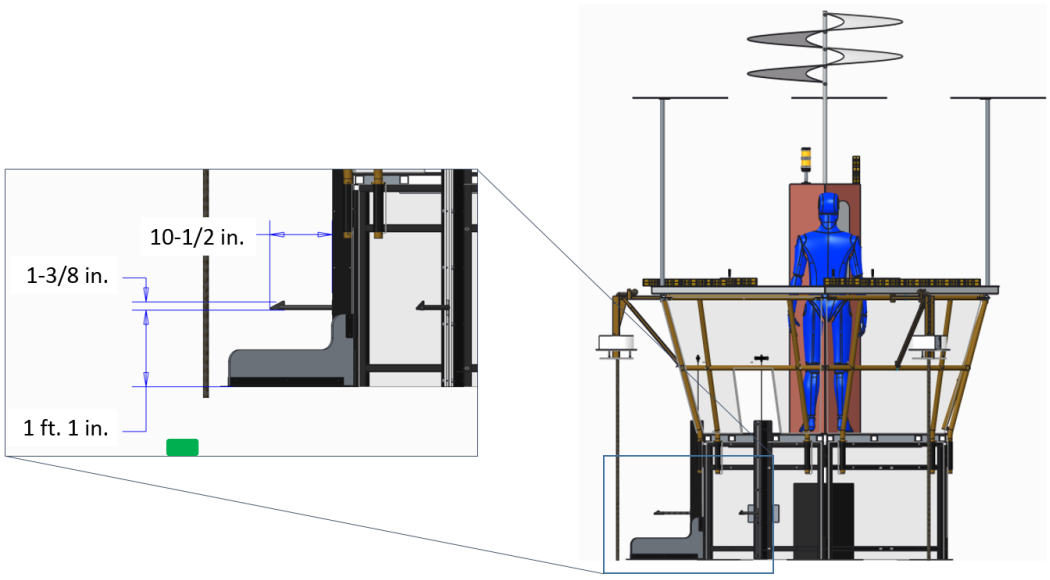
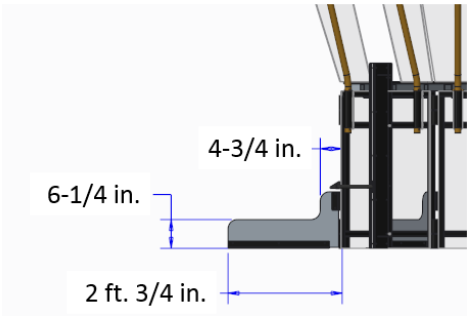


Figure 3-16: LIFT geometry



The center LIFT is flanked by two ½-in. (nominal) thick HDPE barriers that radiate out from the adjacent AIRSHIP corners. Barriers are 6¼ in. (~16 cm) tall and extend 2 ft. ¾ in. (~63 cm) out from the leg of the AIRSHIP.

Figure 3-17: Barrier geometry

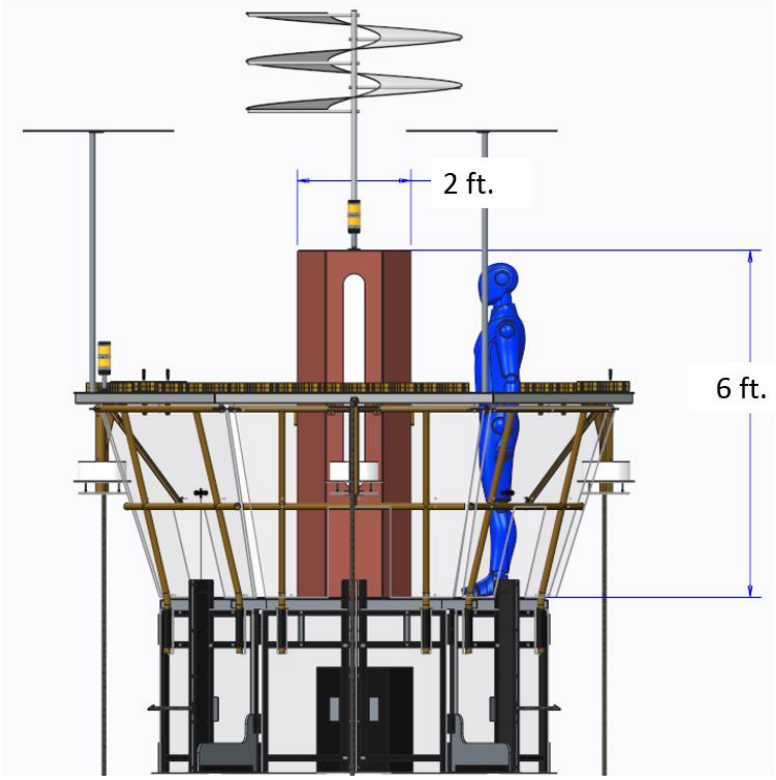


3.6 STEAM TANK

The STEAM TANK is a 6-ft. (~183 cm) tall hexagonal container with a diagonal dimension of 2 ft. (~61 cm) centrally mounted on the deck. It is "filled" via a STEAM PIPE that originates at the BOILERS. Lights indicate the pressure, in kiloPascals (kPa), that's been generated by the ALLIANCE and stored in the STEAM TANK.

Three windows in the STEAM TANK contain Philips Color Kinetics LED Light Strips used to indicate the amount of steam pressure generated by the BOILER and transmitted to the AIRSHIP. Each window displays the same information. For every five (5) kPa of pressure generated, a row of LEDs illuminates in the ALLIANCE'S color. For example, if the Red ALLIANCE has generated forty (40) kPa, the bottom eight (8) rows of LEDs are red. If the Blue ALLIANCE generates ten (10) kPa, the bottom two (2) rows are blue.

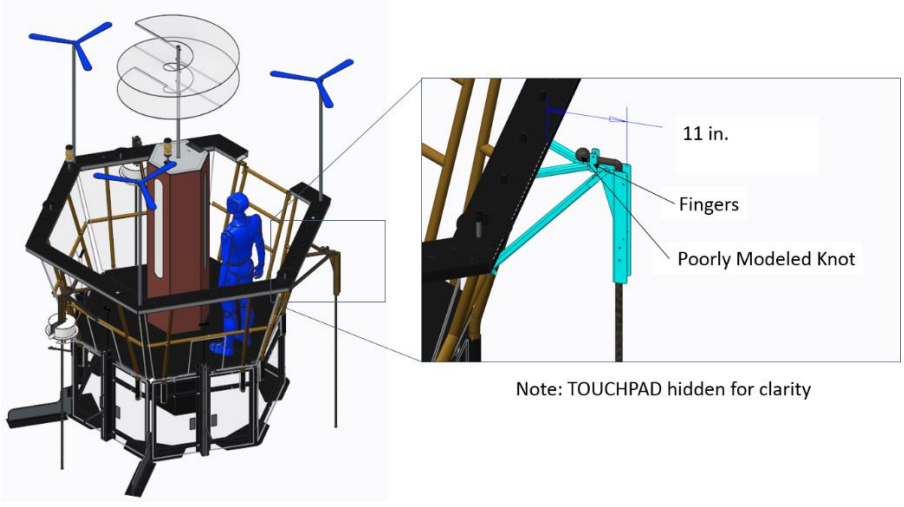
Figure 3-18: STEAM TANK geometry



3.7 DAVIT

A DAVIT is one of three steel frames that attaches a ROPE to the AIRSHIP. Each DAVIT extends 11 in. (~28 cm) from the railing of the AIRSHIP. Each DAVIT has a 2-in. (~5 cm) wide by 2-in. (~5 cm) deep vertical steel channel used to cradle the ROPE and to mount the TOUCHPAD. There are two (2) steel fingers at the top of each DAVIT used to secure the ROPE. These fingers are 1 in. (~3 cm) apart and have a hole for a wire locking retaining pin (McMaster P/N: 98416A009 or similar). The ROPE passes through the fingers with the top knot on the AIRSHIP side of the fingers.

Figure 3-19: DAVIT location and geometry



3.8 ROPE

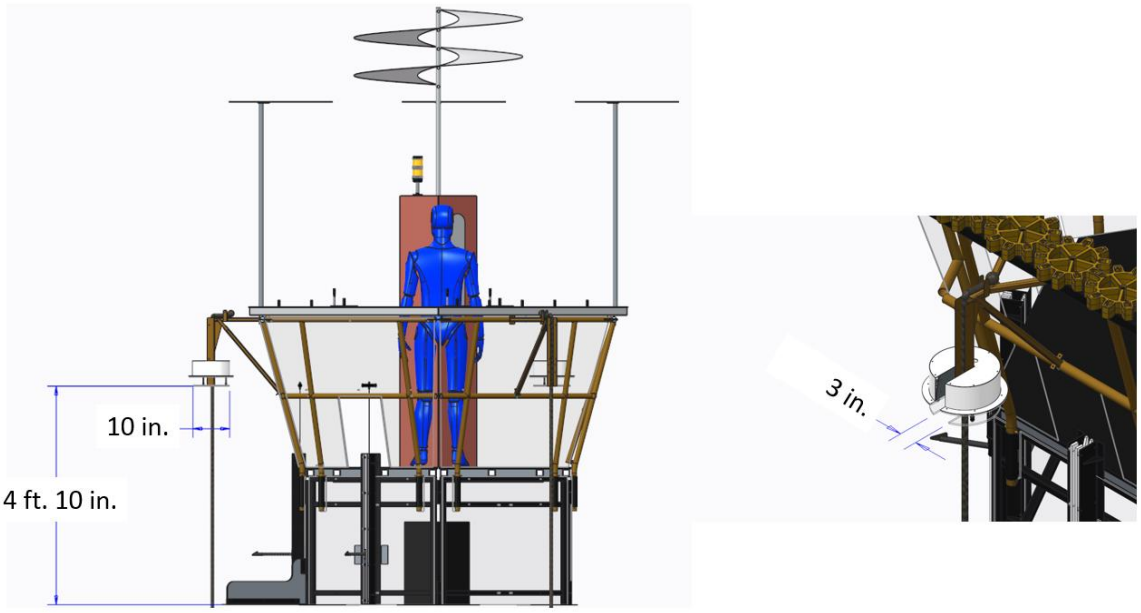
A ROPE is a strong, thick string composed of twisted or braided strands of manila, hemp, flax, or the like, secured to the AIRSHIP, and used to secure ROBOTS for flight at the end of the MATCH. As described in Section 4.2 Match Setup, Teams are invited to bring and install their own ROPE. If they don't, they can expect default FIELD ROPES installed. These default ROPES are three (3), 1 in. (nominal) thick by 7 ft. 2 in. (~218 cm) long polypropylene "Manila" style ROPES from Knot and Rope Supply, SKU 0162. Each default ROPE is knotted at the top, such that there's at least 7 ft. 2 in. (~218 cm) below the knot (see Figure 3-19), fused at the bottom, suspended from a notch at the end of each DAVIT, and stowed using the ROPE retention strap and loop pad (as described in GE-17025) on the outside of the AIRSHIP. The ROPE passes through the center of the TOUCHPAD and hangs down to the FIELD carpet. The PILOT pulls the ROPE'S retention strap to deploy the ROPE.

Figure 3-20: FIELD ROPE Anatomy

3.9 TOUCHPAD

Each TOUCHPAD is a 10 in. (~25 cm) polycarbonate plate mounted 4 ft. 10 in. (~147 cm) above the carpet and used to determine if a ROBOT has successfully latched on to the AIRSHIP (i.e. ready for takeoff) at the end of the MATCH. The plate has a 3 in. (~8 cm) wide by 6 in. (~15 cm) deep rectangular cut-out to aid in assembly and ROPE mounting.

Figure 3-21: TOUCHPAD geometry



The TOUCHPAD plate must be pressed such that the following conditions are met for the ROBOT to be credited with being ready for takeoff at the end of the MATCH:

A. it's minimally displaced by ½ in. (~1 cm),

B. it's pressed for a duration of at least one (1) sec, and

C. it's pressed when the Teleop Period ends at T = 0

The force required to activate the TOUCHPAD (i.e. push the TOUCHPAD plate up by approximately ½ in. (~1.3 cm), causing activation of one or more of its microswitches) is no more than 1 lb. (~½ kg).

The force required to move the TOUCHPAD throughout its full range of travel (i.e. cause the TOUCHPAD plate to travel the full 1½ in. (~4 cm)) is no more than 2 lbs. (~1 kg).

While a force less than 75 lbs (~34 kg) applied to the TOUCHPAD plate once it's fully pressed is not likely to damage the TOUCHPAD, be aware that any damage, even if a result of less than 75 lbs of force, is a violation of G15.

> Teams may wish to consider a reasonable "safety factor" for TOUCHPAD activation and assume that no more than 3 lbs. (~1.4 kg) of vertical force is required to guarantee activation to account for tolerances, assembly variations, temperature/humidity differences, and other variances.

Figure 3-22 shows the two extreme states of the TOUCHPAD plate. The image on the left shows the TOUCHPAD unactuated and the figure on the right shows one example of an actuated TOUCHPAD (with the plate pressed all the way up). The DAVIT'S steel channel does not move with the TOUCHPAD plate.

Figure 3-22 Unactuated TOUCHPAD (left) and fully displaced TOUCHPAD plate (right)

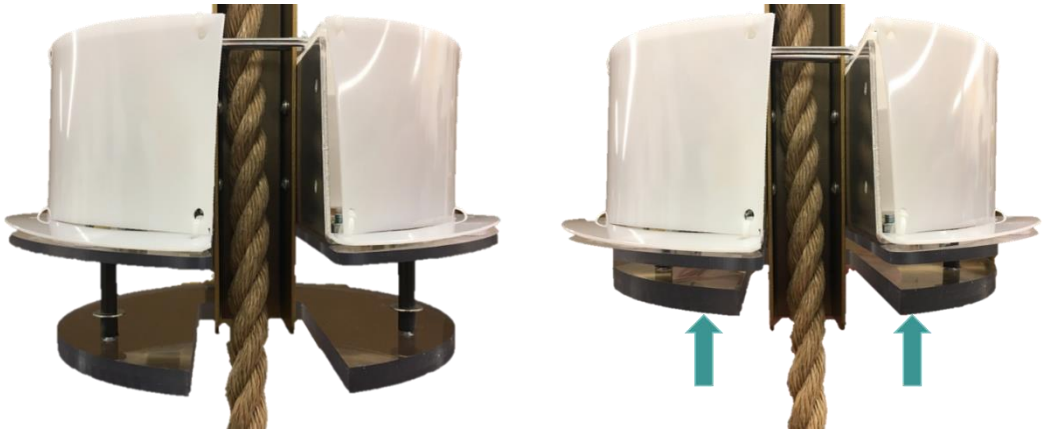
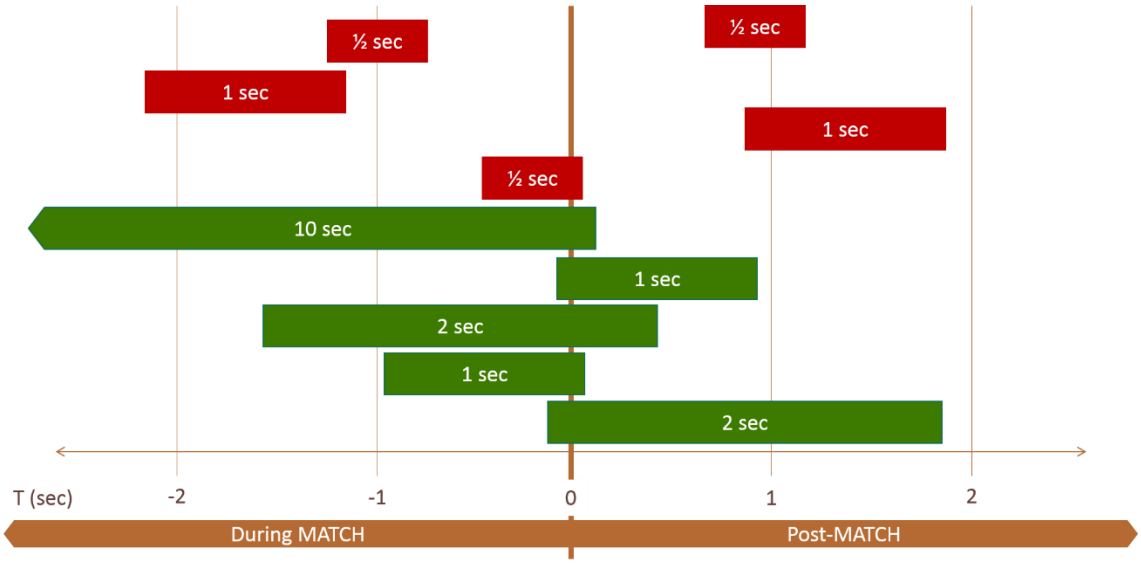


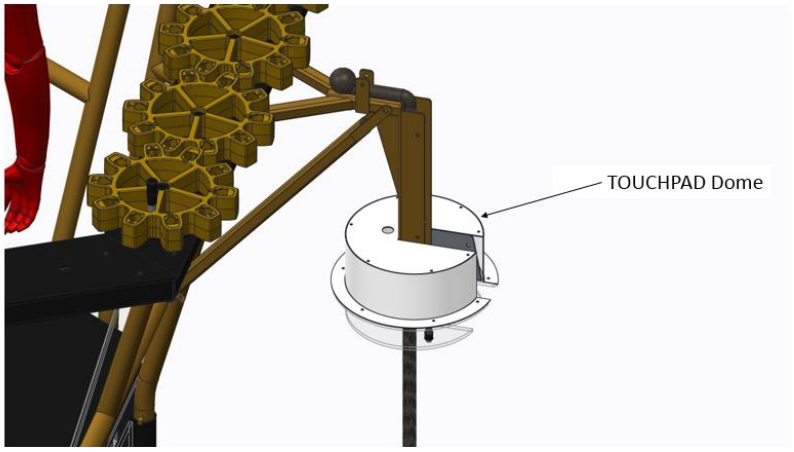
Figure 3-23 shows examples where the TOUCHPAD has been sufficiently displaced, but timing varies. Activations in red indicate that the requirements were not met, and the ROBOT was not credited with "ready for takeoff" points defined in Table 4-1. Activations in green meet all criteria and credit the ALLIANCE with associated points.

Figure 3-23: TOUCHPAD activation examples.



A plastic dome is mounted above each TOUCHPAD and indicates if the associated ROBOT is ready for takeoff. When thirty (30) seconds remain in TELEOP, all six (6) domes briefly animate to indicate that they are active. If a TOUCHPAD is pressed by a ROBOT prior to this, the dome remains off. If a TOUCHPAD is pressed during the final thirty (30) seconds of the MATCH and for the minimal duration described in part B above, the dome illuminates in the ALLIANCE'S color and the associated points are added to the real-time score. If a ROBOT causes a dome to illuminate, but disengages from the TOUCHPAD, the dome turns off and the associated points are removed from the real-time score.

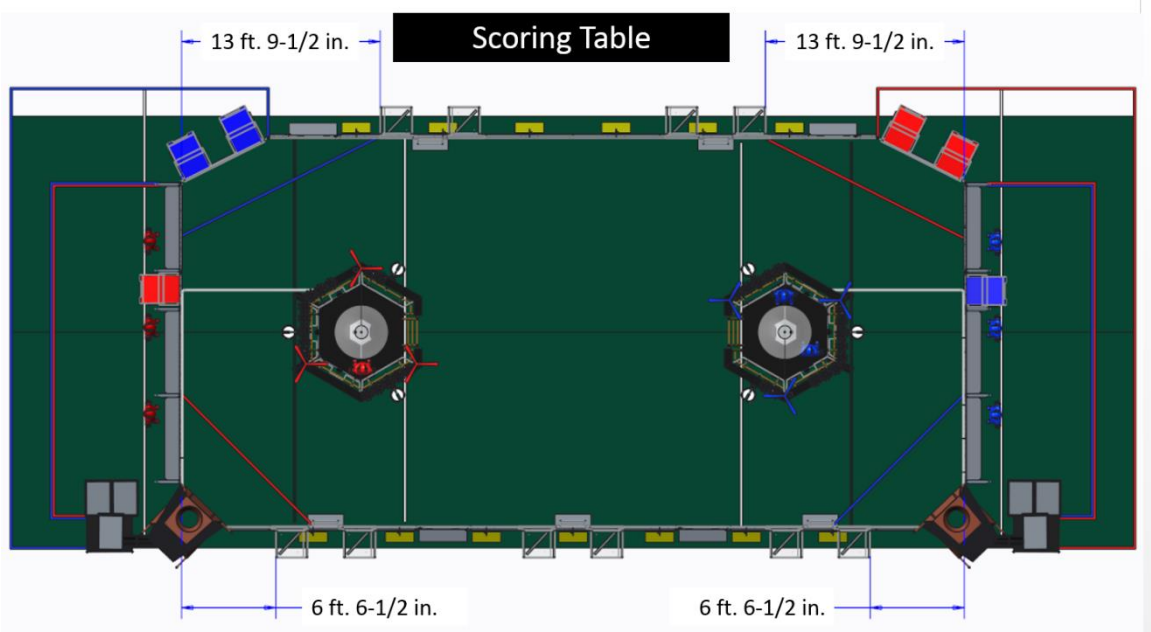
Figure 3-24: TOUCHPAD dome



3.10 HOPPERS

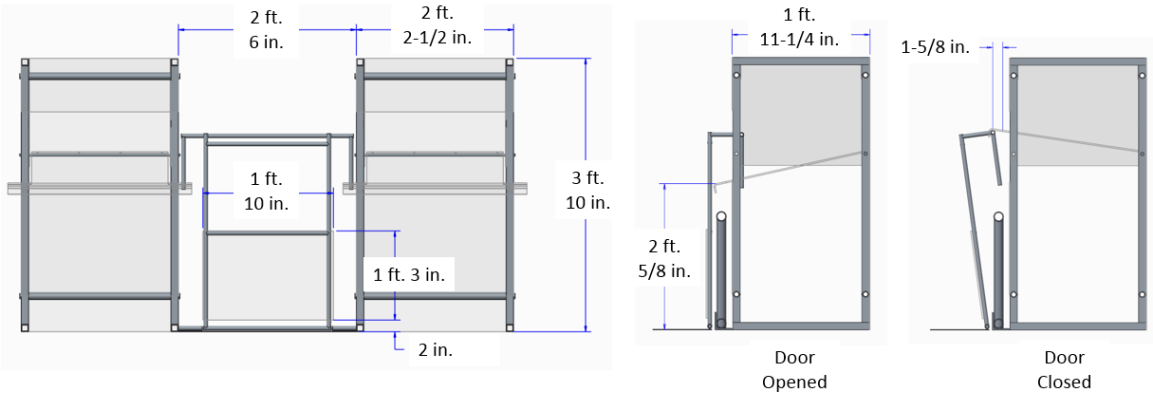
A HOPPER is a pair of containers located just outside the FIELD and used to store FUEL at the start of the MATCH. There are five (5) HOPPERS located alongside and outside the GUARDRAIL. Two (2) are positioned on the scoring table side of the FIELD and are each 13 ft. 9½ in. (~420 cm) from the ALLIANCE WALLS. Two (2) are positioned opposite the scoring table side of the FIELD and are each 6 ft. 6½ in. (~199 cm) from the ALLIANCE WALLS. The fifth HOPPER is positioned opposite the scoring table side of the FIELD and centered on the GUARDRAIL.

Figure 3-25: HOPPER locations



Each HOPPER container is an aluminum framed polycarbonate box that is 2 ft. 2½ in. (~67 cm) wide by 1 ft. 11¼ in. (~59 cm) deep by 3 ft. 10 in. (~117 cm) high. There is an opening that faces the FIELD at the top of each HOPPER container. Once a polycarbonate panel is pushed, the floor of the box pivots down, causing FUEL to roll onto the FIELD. When depositing FUEL onto the FIELD, the floor of the HOPPER is 2 ft. ⅝ in. (~63 cm) from the carpet. The polycarbonate panel is 1 ft. 3 in. (~38 cm) high, 1 ft. 10 in. (~56 cm) long and 2 in. (~5 cm) above the FIELD carpet, and requires approximately 25 lbs. (~11 kg) applied 6 in. from the carpet over 1⅝ in. (~4 cm) toward the HOPPER (until flush with the guardrail) to fully engage.

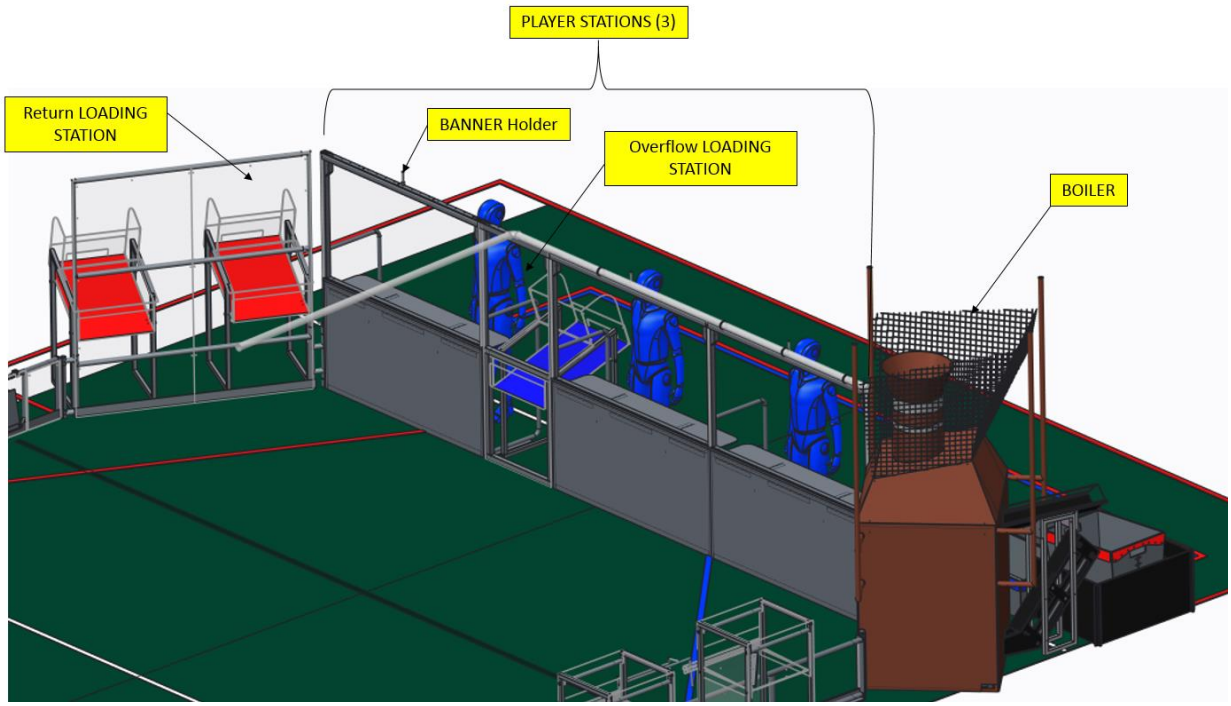
Figure 3-26: HOPPER geometry



3.11 ALLIANCE WALL

The ALLIANCE WALL is the physical structure that separates ROBOTS from DRIVE TEAMS (except the PILOT) and consists of a BOILER, three (3) PLAYER STATIONS, an Overflow LOADING STATION and a Return LOADING STATION.

Figure 3-27: ALLIANCE WALL COMPONENTS

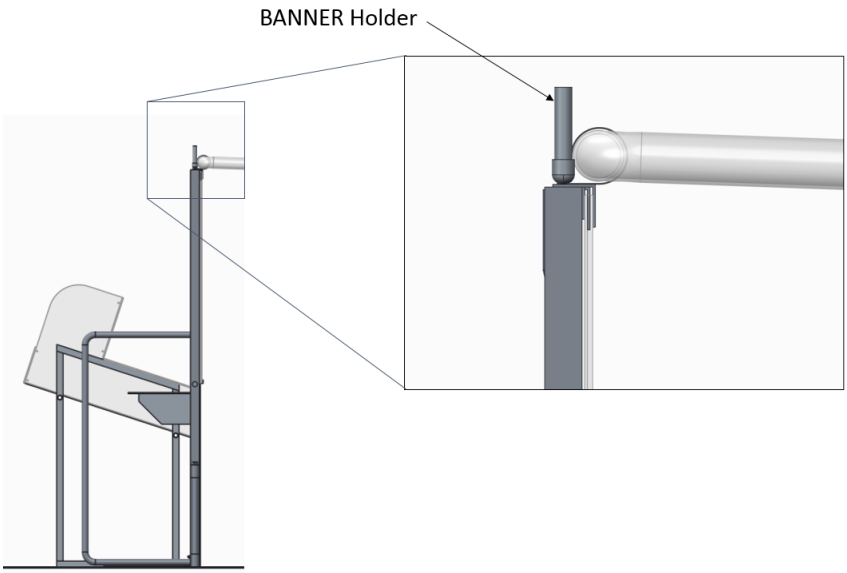


3.11.1 PLAYER STATION

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 panel base topped with a 3 ft. 6 in. (~107 cm) 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. (~175 cm) wide and 1 ft. (~30 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.

Each PLAYER STATION supports one (1) BANNER Holder. The BANNER Holder features a receptacle designed to hold a ½-in. (nominal) diameter rod and is mounted above the team sign and behind the STEAM PIPE.

Figure 3-28: BANNER holder



Each PLAYER STATION contains the following electronic components for Teams:

- One Ethernet Cable: attaches to the Ethernet port of the OPERATOR CONSOLE and provides connectivity to the ARENA network.
- One 120VAC NEMA 5-15R power outlet: located on the right side of 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.

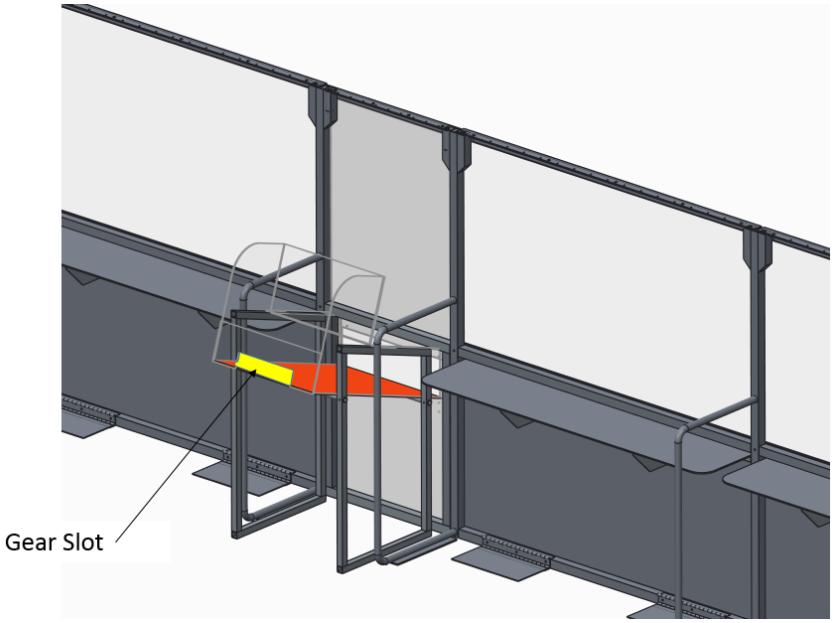
> Note: The power outlet circuit breaker has been reduced from a 3A breaker to a 2A breaker (used in 2015 and 2016).

- One Emergency Stop (E-Stop) button: located on the left side of the PLAYER STATION shelf and should be 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 (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 disabled.
  - If the amber LED is on, the E-stop button has been pressed.
- One Timer: displays the official time remaining in AUTO, TELEOP, and TIMEOUTS and marked with white tape along the bottom edge. A Timer is positioned at the top of each Return LOADING STATION.
- Competition ARENA hardware and wiring: mostly located below the center PLAYER STATION shelf.

3.11.2 Overflow LOADING STATION

An Overflow LOADING STATION is located two (2) PLAYER STATIONS away from each BOILER.

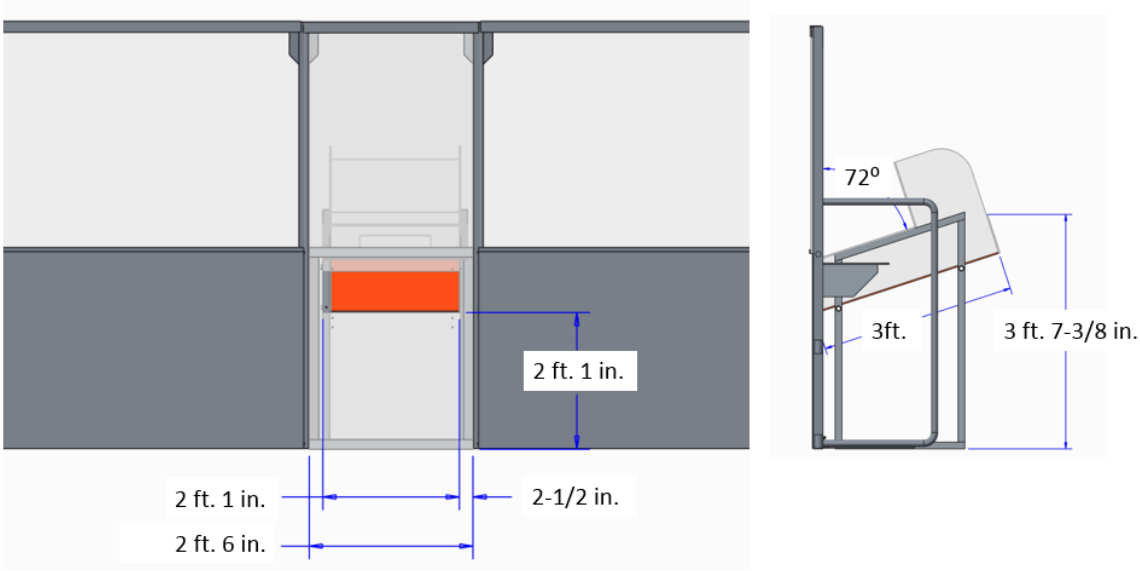
Figure 3-29: Overflow LOADING STATION



An Overflow LOADING STATION is used to feed FUEL from the OVERFLOW BIN on to the FIELD. Each Overflow LOADING STATION includes a 6 ft. 6 in. (~198 cm) in. tall and 2 ft. 6 in. (~76 cm) wide polycarbonate panel with an opening, aluminum frame, and shelf with backboard. The opening is 2½ in. (~6 cm) from each edge of the loading station, 2 ft. 1 in. (~64 cm) wide, 7½ in. tall (~19 cm), and 2 ft. 1 in. (~64 cm) above the carpet.

The Overflow LOADING STATION shelf is 2 ft. (~61 cm) wide, 3 ft. (~91 cm) long, and mounted at a 72 deg. angle. The top of the shelf is 3 ft. 7⅜ in. (~110 cm) from the carpet.

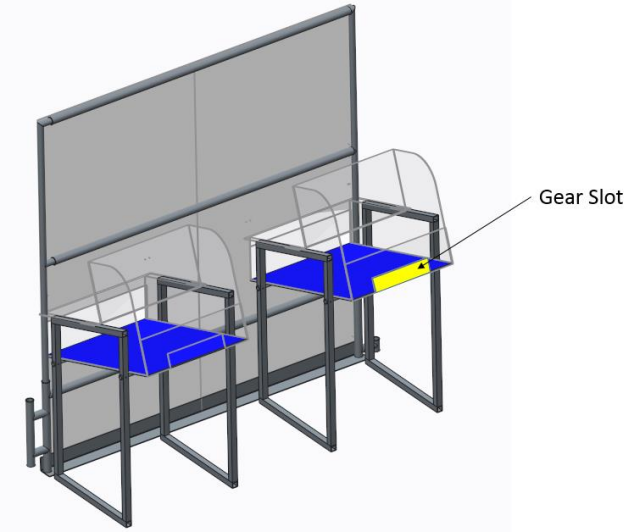
Figure 3-30: Overflow LOADING STATION geometry



3.11.3 Return LOADING STATIONS

Return LOADING STATIONS are located in each of the two (2) corners of the FIELD opposite the BOILERS.

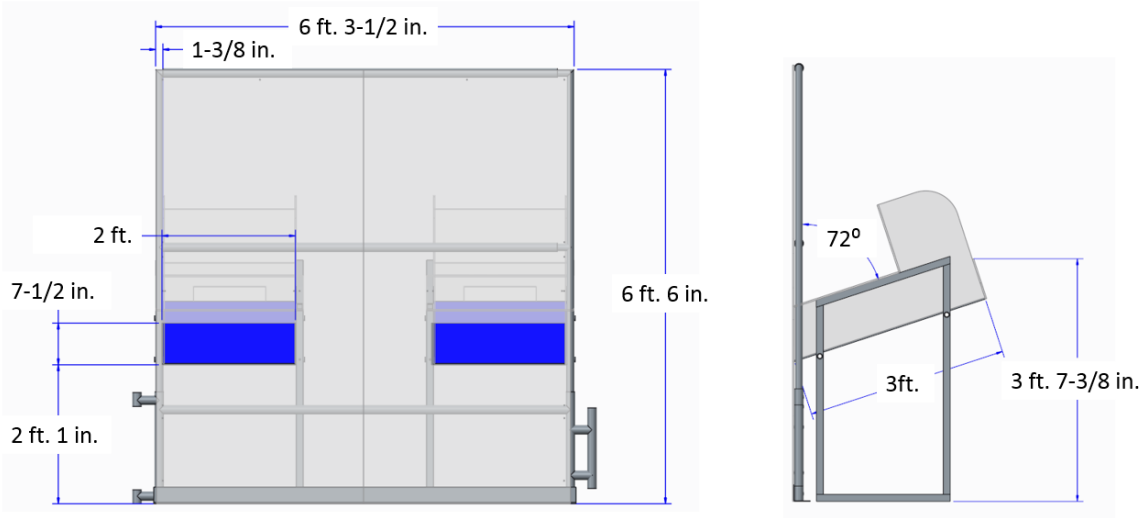
Figure 3-31: Return LOADING STATIONS



A Return LOADING STATION is used to feed FUEL and GEARS on to the FIELD. Each Return LOADING STATION includes a 6 ft. 6 in. (~198 cm) in. tall and 6 ft. 3½ in. (~192 cm) wide polycarbonate panel with two (2) openings, aluminum frame, and shelves with backboards. The openings are side by side, 1⅜ in. (~3 cm) from each edge of the loading station, 2 ft. (~61 cm) wide, 7½ in. tall (~19 cm), and 2 ft. 1 in. (~64 cm) above the carpet.

There are two (2) shelves, 2 ft. (~61 cm) wide by 3 ft. (~91 cm) long, mounted at a 72 deg. angle. The tops of the shelves are 3 ft. 7⅜ in. (~110 cm) from the carpet. Each shelf has a slot through which to pass GEARS.

Figure 3-32: Return LOADING STATION geometry



3.11.4 BOILER

A BOILER is a FIELD element which converts FUEL to steam. There is a BOILER on each corner of the FIELD opposite the scoring table. The base of each BOILER is 3 ft. 6 in. wide (~107 cm) by 3 ft. 6 in. (~107 cm) deep by 8 ft. 1 in. (~246 cm) tall. There are two (2) openings, or GOALS, for loading FUEL into the BOILER: the High Efficiency GOAL and the Low Efficiency GOAL.

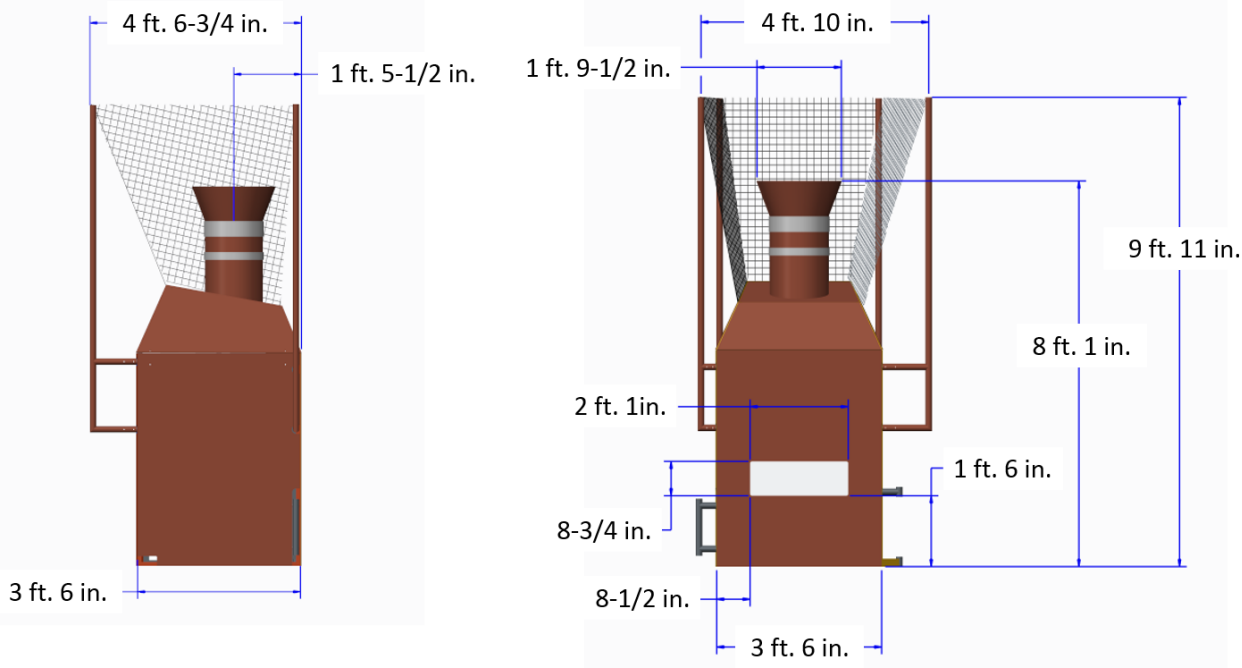
The High Efficiency GOAL is a 1 ft. 9½ in. (~55 cm) diameter vertical cylinder. The opening is 8 ft. 1in. (~246 cm) from the carpet. The horizontal offset between the face of the BOILER and the center of the High Efficiency Goal opening is 1 ft. 5½ in. (~44 cm).

> The High Efficiency GOAL geometry can be simulated using six (6) 2015 Recycle Rush™ totes and one (1) 2015 Recycle Rush recycling container.

The Low Efficiency GOAL is 2 ft. 1 in. (~64 cm) wide by 8¾ in. (~22 cm) tall. The bottom edge of the GOAL is 1 ft. 6 in. (46 cm) above the carpet.

A series of nets is installed behind the BOILER which redirects missed shots back in to the FIELD. The net is approximately 4 ft.10 in. (147 cm) wide by 9 ft. 11 in. (302 cm) tall and is set 4 ft. 6¾ in. (139 cm) behind the GOAL opening. Nets are used to retain GAME PIECES in the FIELD and not intended to behave consistently.

Figure 3-33: BOILER geometry



The capacity of the Low Efficiency GOAL is seventy (70) FUEL. The capacity of the High Efficiency GOAL is one-hundred and fifty (150) FUEL. FUEL that exceeds GOAL capacities will fall back on to the FIELD.

A BOILER processes FUEL in to steam at an average rate of five (5) FUEL per second per GOAL, but actual rate is dependent on the amount and packing of FUEL in the GOALS (i.e. the tighter the packing in a GOAL, the faster the FUEL processing rate).

> *FIRST* instructs FTAs to test BOILER counting by dumping forty (40) FUEL into each High and Low Efficiency GOAL and noting the count

logged by the FMS three times before MATCHES begin each day. The BOILER is operating as expected if the counts in each batch are 40 +/-1.

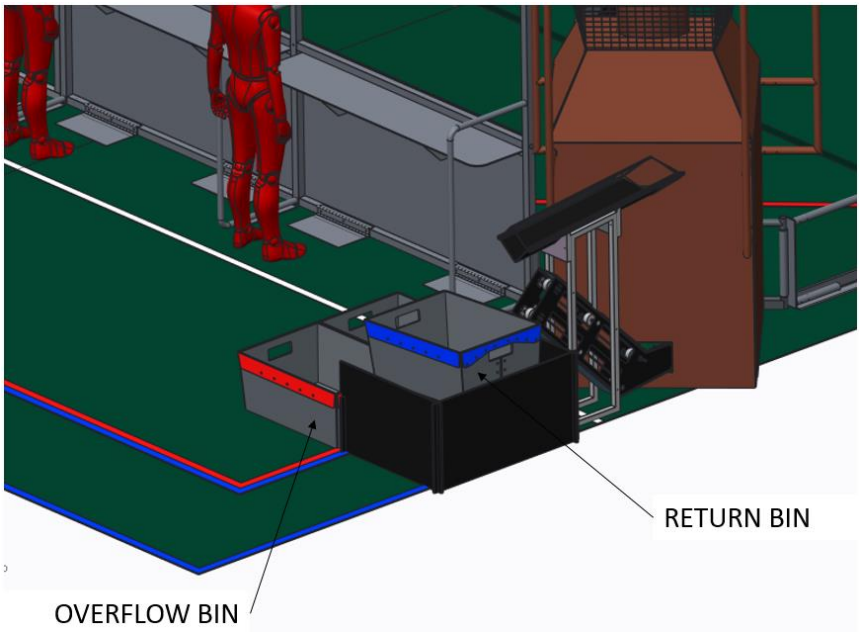
3.11.5 RETURN & OVERFLOW BINS

RETURN and OVERFLOW BINS are used to store and transport FUEL that has exited a BOILER. They are plastic open-topped containers, 2 ft. 9½ in. (~85 cm) wide by 1 ft. 6 in. (~46 cm) deep by 1 ft. 1 in. (~33 cm) tall, and each has a capacity of approximately fifty to sixty (50-60) FUEL.

Once FUEL is processed, it exits the BOILER into a RETURN BIN. Each LOADING LANE has three (3) RETURN BINS. To prevent a RETURN BIN from overflowing, HUMAN PLAYERS may replace it with an empty RETURN BIN.

Should a RETURN BIN overflow, the FUEL collects in either of the (2) OVERFLOW BINS.

Figure 3-34: RETURN and OVERFLOW BINS

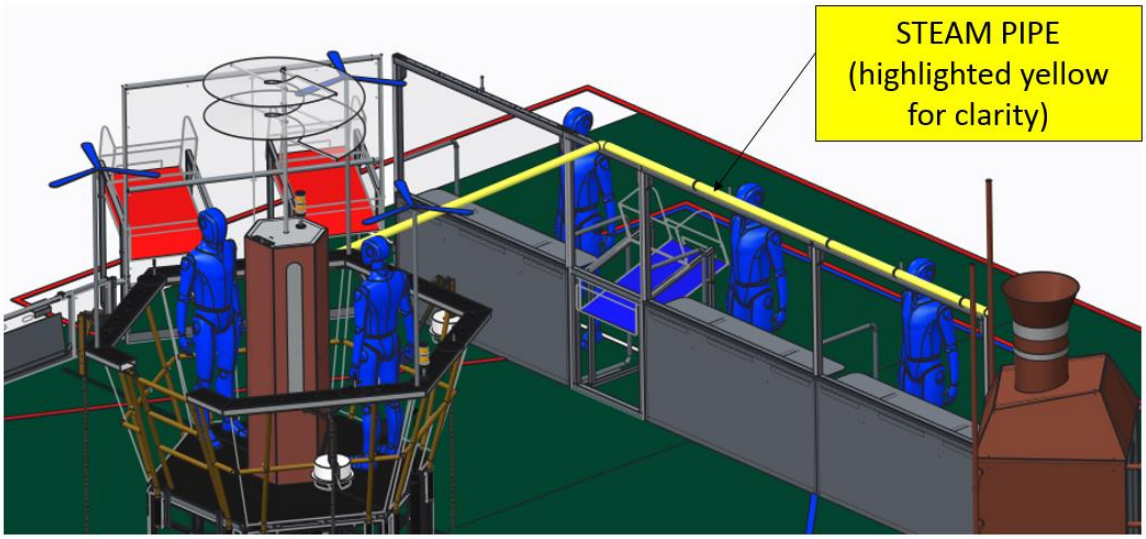


3.11.6 STEAM PIPE

The STEAM PIPE is a clear PVC pipe that transfers steam from the BOILER to the STEAM TANK on the AIRSHIP. It is constructed from 2⅜ in. (nominal) diameter clear plastic pipe and exits out the side of the BOILER net support pipe closest to the PLAYER STATION. It is mounted flush to the top of the ALLIANCE WALL and when it reaches the middle of the Overflow LOADING STATION, it turns and extends to the AIRSHIP.

The pipe contains strips of Philips Color Kinetics Lights which display the transfer of steam. A pattern of colored LEDs flow from the BOILER to the AIRSHIP as FUEL is scored by the BOILER. As the rate of FUEL being scored inside the BOILER increases, the animation become faster. If the scoring rate decreases, the animation slows down. If an ALLIANCE stops scoring FUEL in their BOILER, the lights will come to a stop at their current position, indicating that FUEL is not being scored.

Figure 3-35: STEAM PIPE



3.12 GAME PIECES

3.12.1 FUEL

FUEL is used to generate steam for the AIRSHIP and is represented by "Screamin' Yellow," 5 in. (nominal) diameter Gopher ResisDent™ polyethylene balls (Item Number 42-555). Each FUEL weighs 2.6 oz. (~74 g.). FUEL may be purchased from AndyMark (am-3376), and a six (6) pack of balls may be purchased directly from Gopher Sports.

Figure 3-36: FUEL

3.12.2 GEARS

A GEAR is a toothed wheel used to start ROTORS on the AIRSHIP. Each GEAR is made from gold (Pantone PMC 124C) polypropylene, has 10 teeth, an 11 in. (~28 cm) diameter, 10 in. (~25 cm) pitch diameter, and is 2 in. (~5 cm) thick. Each GEAR weighs 18.4 oz. (~0.5 kg.) GEARS may be purchased from AndyMark (am-3302).

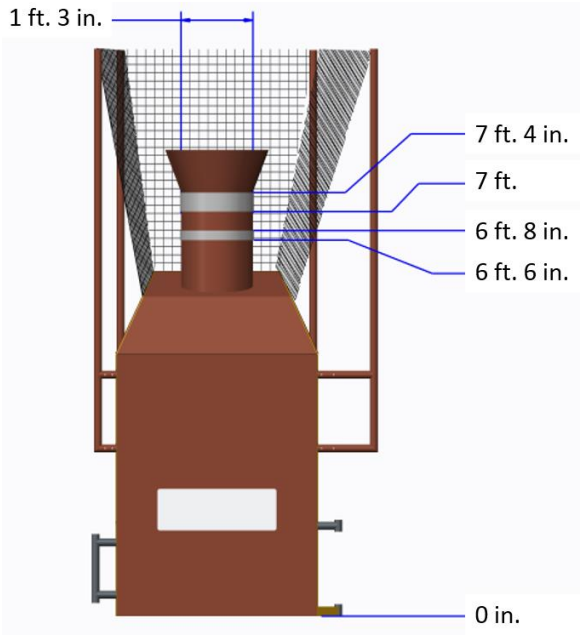
Figure 3-37: GEAR

3.13 Vision Targets

Vision targets are marked using 3M 8830 Scotchlite Reflective Material and highlight the locations of High GOALS and LIFT pegs.

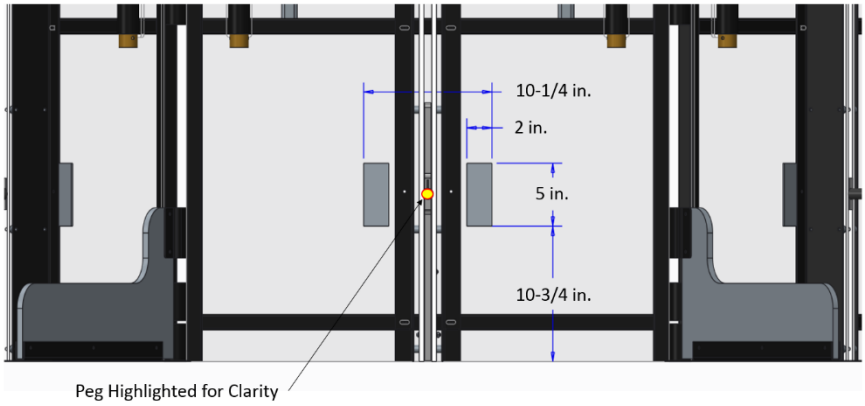
The vision target on the High GOAL consists of two horizontal rings. The first ring is 4 in. (~10 cm) wide, with the upper edge located 7 ft. 4 in. (~224 cm) from the carpet. The second ring is 2 in. (~5 cm) wide with the upper edge 6 ft. 8 in. (~203 cm) off the carpet.

Figure 3-38: BOILER vision target measurements



There are also vision targets on both sides of each LIFT peg. The peg targets are 2 in. (~5 cm) wide by 5 in. (~13 cm) tall rectangles located 10¾ in. (~27 cm) from the carpet and spaced 10¼ in. (~26 cm) apart (outside dimensions).

Figure 3-39: LIFT peg vision target dimensions



3.14 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, the only open ports available are described in Table 3-2.

Table 3-2: Open FMS Ports

Port	Designation	Bi-directional?
UDP/TCP 1180-1190	Camera data from the roboRIO to the Driver Station (DS) 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
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 FMS Whitepaper.