3 ARENA

The ARENA includes all elements of the game infrastructure that are required to play INFINITE RECHARGE®: the FIELD, POWER CELLS, 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 2021 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 INFINITE RECHARGE 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 INFINITE RECHARGE FIELD are posted on the 2021 INFINITE RECHARGE Playing Field Page on the FIRST website.

3.1 FIELD

Each FIELD for INFINITE RECHARGE is 26 ft. 11¼ in. (~821 cm) by 52 ft. 5¼ in. (~1598 cm) carpeted area bound by and including the inward- and upward-facing surfaces of the guardrails and inward-facing surfaces of the ALLIANCE WALLS (except Chute surfaces and any surface beyond the face of the POWER PORT). It is populated with a SHIELD GENERATOR, TRENCHES, LOADING BAYS, and POWER PORTS.

The SHIELD GENERATOR is located in the center of the FIELD. The SHIELD GENERATOR consists of the structure, the GENERATOR SWITCHES, the BOUNDARIES, and the RENDEZVOUS POINTS.
3.2 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) 3M™ Premium Matte Cloth (Gaffers) Tape (GT2) or comparable gaffers tape.

![Figure 3-3 INFINITE RECHARGE FIELD](image)

ALLIANCE STATION: a 30-ft. (~914 cm) wide by 10 ft. 9¼ in. (~328 cm) to 12 ft. 10¼ in. (~393 cm) deep infinitely tall volume formed by, and including the ALLIANCE WALL, the edge of the carpet, and ALLIANCE colored tape.

INITIATION LINE: a white tape line spanning the width of the FIELD and located 10 ft. (~305 cm) from the face of PLAYER STATION 2 to the near edge of the tape. An ALLIANCE’S INITIATION LINE is located in the opponent’s SECTOR.

LOADING ZONE: a 5 ft. (~152 cm) wide, 2 ft. 6 in. (~76 cm) deep infinitely tall volume with a triangular base bounded by the LOADING BAY and ALLIANCE colored tape. The LOADING ZONE includes the ALLIANCE colored tape.
The SHIELD GENERATOR is a 14 ft. 1½ in. (~431 cm) wide, 15 ft. ¾ in. (~459 cm) deep, and 9 ft. 6½ in. (~291 cm) tall structure located in the center of the FIELD, oriented at a 22.5 degree angle relative to the guardrails. The SHIELD GENERATOR has one (1) GENERATOR SWITCH per ALLIANCE. Black BOUNDARIES divide the floor of the SHIELD GENERATOR into two sections. Spaces between BOUNDARIES include flooring protection to prevent floor damage. The RENDEZVOUS POINTS
(including ALLIANCE colored BOUNDARIES, ALLIANCE colored tape, and floor protection) are part of the SHIELD GENERATOR.

### 3.3.1 SHIELD GENERATOR Structure

The SHIELD GENERATOR structure consists of 1 ft. x 1 ft. (~30 cm x ~30 cm) square truss. The truss structure is 13 ft. 1½ in. (~400 cm) wide, 14 ft. ¾ in. (~429 cm) deep, and 9 ft. 2¼ in. (~280 cm) tall. Each of the four vertical truss legs sits on a base. The baseplate extends 6 in. (~15 cm) from each square face and is ⅛ in. (~3 mm) thick.

![Figure 3-7 SHIELD GENERATOR structure](image)

### 3.3.2 GENERATOR SWITCH

Each SHIELD GENERATOR has one (1) GENERATOR SWITCH per ALLIANCE. A GENERATOR SWITCH is a 7 ft. 6 in. (~229 cm) wide, 10 ft. 1½ in. deep (~309 cm), and 4 ft. 6 in. (~137 cm) tall assembly that swings from the top of the SHIELD GENERATOR. Each GENERATOR SWITCH has a HANDLE. The HANDLE is a structure that consists of a RUNG and the supporting structure below the horizontal beam of the GENERATOR SWITCH. A RUNG is a 1¼ in. schedule 40 aluminum pipe (1.66 in. (~4 cm) outer diameter) with two (2) exposed 4 ft. 7⅝ in. (~141 cm) long sections. The amount of clearance above the RUNG varies from a minimum of 3½ in. (~9 cm) to a maximum of 12 in. (~30 cm). For safety, foam corner cushions line the lowest edges of the HANDLE. The HANDLE (green and yellow) and RUNG (yellow) are highlighted in Figure 3-8 for clarity.

![Figure 3-8 GENERATOR SWITCH](image)
ALLIANCE colored stack lights on the SHIELD GENERATOR display information about the status of the ALLIANCE’S GENERATOR SWITCH. See SHIELD GENERATOR Lighting for more information.

### 3.3.3 BOUNDARIES

BOUNDARIES are 3 in. (~8 cm) wide, 1 in. (~3 cm) tall steel barriers that divide the area inside the SHIELD GENERATOR into two (2) equal sized areas that are 6 ft. 9¼ in. (~208 cm) wide by 12 ft. ¾ in. (~368 cm) deep. BOUNDARIES are secured to the carpet using hook fastener which increases the height to approximately 1¹⁄₁₆ in. (~3 cm). The Red and Blue BOUNDARIES feature 1-in. (~3 cm) diameter holes spaced every 1 ft. 4½ in. (~42 cm). A pair of black BOUNDARIES divide the Red and Blue RENDEZVOUS POINTS. Each truss base has two shorter steel barriers, black with ALLIANCE colored tape, mounted to it. These barriers are ALLIANCE colored BOUNDARIES.

![Figure 3-10 BOUNDARY dimensions](image)

A layer of ⅛ in. (~3 mm) thick hardboard is installed on top of the FIELD carpet and covered with another layer of carpet to protect venue flooring. This flooring protection adds approximately ¾ in. (~10 mm) of height to the area between the BOUNDARIES. The floor protection features 1-in. (~3 cm) diameter holes used for staging of POWER CELLS. Holes are placed in a rectangular pattern with 2 ft. 7¾ in. (~81 cm) wide by 1 ft. 8 in. (~51 cm) deep spacing, as shown in Figure 4-2.
3.3.4 SHIELD GENERATOR Lighting

The SHIELD GENERATOR has a set of stack lights for each ALLIANCE which are enabled from the start of the END GAME until five (5) seconds after the MATCH. These lights illuminate when the corresponding GENERATOR SWITCH is LEVEL.

Each half of the SHIELD GENERATOR features three (3) ALLIANCE colored light bars inside of the truss structure.

- The first light bar, inside the vertical truss section adjacent to the ALLIANCE’S TRENCH, turns on once Stage 1 is ACTIVATED.
- The second light bar, inside the vertical truss section closest to the ALLIANCE’S POWER PORT, turns on once Stage 2 is ACTIVATED.
- The third light bar, inside the horizontal truss connecting the two (2) previous truss sections, turns on once Stage 3 is ACTIVATED.
3.4 ALLIANCE STATION

3.4.1 ALLIANCE WALL

The ALLIANCE WALL is the structure that separates ROBOTS from DRIVERS, COACHES, and HUMAN PLAYERS. It consists of three (3) PLAYER STATIONS, the LOADING BAY, and the POWER PORT. ALLIANCE WALLS define the short edges of the FIELD and, along with the guardrails, prevent ROBOTS from exiting the FIELD during the MATCH.

![Figure 3-12 ALLIANCE WALL](image)

3.4.1.1 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 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 an 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. PLAYER STATION 1 and PLAYER STATION 3 intersect the guardrail at a 110 degree angle.

Each PLAYER STATION contains the following components for teams:

A. one (1) Ethernet cable: attaches to the Ethernet port of the OPERATOR CONSOLE and provides connectivity to the Field Management System (FMS)
B. one (1) 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.
C. one (1) 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.

D. one (1) team sign: displays the team number and is located at the top of each PLAYER STATION.

E. one (1) team LED: indicates ALLIANCE color, ROBOT status, E-Stop status, and is centered at the top of each PLAYER STATION. Team LED states include:

F. Solid: indicates that the ROBOT is connected and enabled. This only happens during a MATCH.

G. Blinking: indicates that either the FMS is preset for the MATCH and the ROBOT is not connected yet, or it’s during a MATCH and the corresponding ROBOT, is BYPASSED, has lost connectivity or the E-stop was pressed.

H. Off: indicates that the ROBOT is linked and DISABLED prior to the start of the MATCH. This light is also off, regardless of ROBOT connection status, after the MATCH has concluded.

I. Amber LED Solid: the PLAYER STATION or FIELD E-stop button has been pressed.

J. one (1) timer (in PLAYER STATION 2): displays the official time remaining in the MATCH and TIMEOUTS. It is marked with white tape along the bottom edge.

- FMS hardware and wiring: mostly located below the PLAYER STATION 2 shelf.

3.4.1.2 LOADING BAY

The LOADING BAY is a 6 ft. 6 in. (~198 cm) tall by 5 ft. (~152 cm) wide structure located between PLAYER STATIONS 2 and 3. HUMAN PLAYERS deliver POWER CELLS through one (1) of the five (5) Chutes in the LOADING BAY.

There are two (2) low Chutes and three (3) high Chutes. Low Chute openings are 3 in. (~8 cm) above the carpet, and high Chute openings are 2 ft. (~61 cm) above the carpet. The high Chutes are adjacent to each other and have a combined width of 2 ft. ¼ in. (~62 cm).

The LOADING BAY also includes two (2) racks for POWER CELL storage. Each rack contains openings for seven (7) POWER CELLS. The racks are 4 ft. 11⅞ in. (~152 cm) and 5 ft. 9⅞ in. (~177 cm) above the carpet.
3.4.1.3 POWER PORT

There are two (2) POWER PORTS on the FIELD. The Red POWER PORT is part of the Blue ALLIANCE WALL and the Blue POWER PORT is part of the Red ALLIANCE WALL. Each POWER PORT is a 10 ft. 2¼ in. (~310 cm) tall by 4 ft. (~122 cm) wide (excluding backboards) structure and is located between PLAYER STATIONS 1 and 2. POWER PORTS process POWER CELLS scored in its BOTTOM PORT, OUTER PORT, and INNER PORT.

The BOTTOM PORT is a 10 in. (~25 cm) tall, 2 ft. 10 in. (~86 cm) wide rectangle. The bottom edge is 1 ft. 6 in. (~46 cm) above the carpet.

The OUTER PORT is a regular hexagon that measures 2 ft. 6 in. (~76 cm) in height. The center of the OUTER PORT is 8 ft. 2¼ in. (~249 cm) above the carpet.

The INNER PORT is a 1 ft. 1 in. (~33 cm) diameter circle concentric with and 2 ft. 5¼ in. (~74 cm) behind (i.e. on the ALLIANCE STATION side of) the OUTER PORT. The center is 8 ft. 2¼ in. (~249 cm) above the carpet.
3.5 TRENCH

Each ALLIANCE has a TRENCH in their TRENCH RUN that spans the gap between the guardrail and SHIELD GENERATOR. On the top of each TRENCH is an ALLIANCE specific CONTROL PANEL and a yellow stack light.

![Figure 3-20 TRENCH](image)

Each TRENCH is a 3 ft. ½ in. (~93 cm) tall, 4 ft. 8 in. (~142 cm) wide, and 3 ft. 5½ in. (~105 cm) deep structure that forms a 4 ft. 4 in. (~132 cm) wide, 2 ft. 4 in. (~71 cm) tall, and 2 ft. 6 in. (~76 cm) deep tunnel. Each TRENCH has two (2) ⅛ in. (~3 mm) thick baseplates. Each baseplate has two (2) 1-in. (~3 cm) diameter holes used to stage POWER CELLS. Holes are 1 ft. 6½ in. (~47 cm) apart.

![Figure 3-21 TRENCH dimensions](image)
3.5.1 CONTROL PANEL

A CONTROL PANEL is centered on the top of each TRENCH. The CONTROL PANEL is a 2 in. (~5 cm) tall, 2 ft. 8 in. (~81 cm) diameter disk constructed of two pieces of ¼ in. (~6 mm) thick polycarbonate, spaced apart by ten ½ in. (~13 mm) diameter metal spacers at regular intervals. The centers of the spacers are located 1 in. (~3 cm) in from the outer perimeter of the CONTROL PANEL. The bottom edge of the CONTROL PANEL is located 2 ft. 6¼ in. (~77 cm) above the carpet.

![Figure 3-22 TRENCH and CONTROL PANEL dimensions](image)

The CONTROL PANEL is divided into eight (8) equal size wedges. Wedges are red, green, blue, and yellow (see Table 3-3 for CMYK values) and visible from above and below the CONTROL PANEL. Colors are arranged as shown in Figure 3-23 and line up top and bottom. The arc length of each wedge is 1 ft. ½ in. (~32 cm). Fasteners in the CONTROL PANEL create holes in the colored wedges.

<table>
<thead>
<tr>
<th>CONTROL PANEL color</th>
<th>Cyan</th>
<th>Magenta</th>
<th>Yellow</th>
<th>Black</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Green</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Red</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Yellow</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>
Each TRENCH has a yellow stack light to indicate CONTROL PANEL status.

Table 3-4 TRENCH light status

<table>
<thead>
<tr>
<th>Light State</th>
<th>SHIELD GENERATOR Stage</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>1, 2, or 3</td>
<td>Stage not at CAPACITY or Stage 3 ACTIVATED</td>
</tr>
<tr>
<td>Solid</td>
<td>2 or 3</td>
<td>The POWER PORT is at CAPACITY, the CONTROL PANEL is ready for use</td>
</tr>
<tr>
<td>Flashing</td>
<td>2</td>
<td>The CONTROL PANEL has rotated the required number for ROTATION CONTROL, but has not yet continuously read a single color for two (2) seconds</td>
</tr>
</tbody>
</table>
|             | 3                       | The CONTROL PANEL has read the required color for POSITION CONTROL for at least three (3) seconds and less than five (5) seconds |\(^1\)  

\(^1\) If a color change is detected during the two (2) second period when the stack light is flashing, the light returns to solid and the color detection timer resets to zero (0).

### 3.6 POWER CELL

![POWER CELL](image)

INFINITE RECHARGE is played with POWER CELLS. A POWER CELL is a yellow 7 in. (~18 cm) diameter Medium Bounce Dino-Skin foam ball. The FIRST logo may be printed on each ball in black ink. The ball is made by Flaghouse (PN 1892 YEL) and sold by AndyMark (PN AM-4200a) without a FIRST logo. Three (3) POWER CELLS are in each Black Tote of the 2021 Kickoff Kit.

### 3.7 Vision Targets

Vision targets made from 2 in. (~5 cm) wide strips of 3M 8830 Scotchlite™ Reflective Material are located on the POWER PORTS and LOADING BAYS. On the POWER PORT, they target the location of the INNER and OUTER PORTS and trace the bottom perimeter of the OUTER PORT. The target has an overall height of 1 ft. 5 in. (~43 cm), and a width of 3 ft. 3¼ in. (~100 cm). The bottom of the target is 6 ft. 9¼ in. (~206 cm) above the carpet. An 8 ft. (~243 cm) strip of 3M 8830 Scotchlite™ Reflective Material is in each Kickoff Kit.
The LOADING BAY target is a 7 in. (~18 cm) wide by 11 in. (~28 cm) tall rectangle. The target is centered on the width of the LOADING BAY and located 11 in. (~28 cm) above the carpet.

### 3.8 The FIELD Management System

The Field Management System (FMS) is the electronics core responsible for sensing and controlling the FIRST Robotics Competition FIELD. The FMS encompasses all FIELD electronics, including 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 communicate with FMS. Once connected, the open ports available are described in Table 3-5.