FROM

RUNWAY TO ROOTS

ADVANCED VERTICAL ROBOTICS

OFFICIAL GAME MANUAL

2026 SEASON

THEAVR.ORG

1 – Introduction

The **2026 From Runway to Roots Challenge** provides students with an exciting opportunity to apply engineering, teamwork, creativity, and strategic thinking to solve a real-world problem using autonomous aerial and ground robotic systems. This year's challenge focuses on the reclamation and repurposing of a historic airfield, transforming land that has served aviation for decades into productive farmland that can once again benefit the surrounding community.

The AVR Competition continues to challenge students to design, build, program, and operate increasingly capable robotic systems while developing skills in computer vision, object detection, autonomous GPS-denied navigation, multi-agent coordination, perception, decision making, and systems integration. Success requires careful planning, communication, and collaboration as each Aircraft and Vehicle contributes unique capabilities toward accomplishing the overall mission. Although every robot has a primary role, teams are encouraged to develop contingency strategies that leverage the capabilities of the other Aircraft and Vehicles when unexpected failures occur—just as engineers do when operating real-world autonomous systems.

The AVR Competition is committed to carrying on good sportsmanship resulting from a disciplined effort to respect yourself, your opponents, and the officials. With that in mind, remember our standing mission statement:

"We will be gracious in both victory and defeat. We will uphold the responsibility of sportsmanship by lifting others up, demonstrating leadership and showing respect. We will pursue excellence with passion, integrity, and honor."

Team Spirit continues to be one of the most powerful aspects of this competition. With seven to twelve students participating in each Match, extensive collaboration is required both during preparation and throughout competition day.

One important aspect of competing is showing your unified camaraderie through what you wear to the competition. Teams are encouraged to create coordinated outfits, shirts, accessories, or other team apparel that represent your school, your Team, and your innovative AVR design. Team appearance, spirit, and coordinated presentation are one factor of scoring the Presentation Award (Appendix B).

This manual outlines all rules, regulations, and restrictions for this year's competition. Rulings of referees and judges will be based on this manual, but all rulings defer to the final decisions of the Head Referee and their interpretation of both the language and spirit of these rules.

Changelog

Version 1.0 – August 25, 2026

Initial release of the 2026 Game Manual. Sections featuring new content as compared to previous seasons are denoted with 'NEW' after the section label. Sections 2, 3, 5, and Appendix A should be considered fundamentally new content.

Version 2.0 – September 30, 2026

Pg 60, 62, 64 additions for Pallet Pull/Push, Sphero Row Verification, Barn Top Opening scoring. Section 5 rule updates. Appendix A court element information.

Version 3.0 – October 10, 2026

Important Update to Seed Design rules, Appendix A Court Element weights, Section 8.2 update to allow Raspberry Pi Compute Module 5 as well as the currently allowed CM4.

2 – Competition Overview

The AVR Competition consists of two components. During a one-day Event, a Team will participate in the 2026 From Runway to Roots Challenge (4 Matches) and a Judged Presentation to determine a combined overall score.

2.1 – From Runway to Roots Challenge - Summary

After decades of service, a historic airfield has reached the end of its operational life. Rather than allowing the property to remain unused, engineers have begun reclaiming and repurposing the site into productive agricultural land. Before crops can be planted, the former airfield must be surveyed, remaining supplies relocated, environmentally hazardous materials safely removed, farmland prepared, and planting operations completed.

The **Airfield Reclamation Team** consists of autonomous aerial and ground robotic systems working together to complete this transformation. **DEXI-5** serves as the Team's primary reconnaissance and coordination aircraft, identifying April Tags and mission images while communicating critical information through LED Signaling. **DEXI-10** serves as the primary logistics aircraft, transporting materials throughout the Field while supporting the final stages of crop establishment. Supporting the aerial systems are the **RVR**, responsible for autonomous navigation and ground support operations, along with three **Sphero Minis** that inspect worksites, verify mission completion, and support operations throughout the Match.

Using autonomous aerial and ground systems, computer vision, object detection, April Tags, GPS-denied navigation, multi-agent coordination, and strategic decision making, Teams must determine the most effective order to complete the required missions while maximizing their score before the Match expires. Throughout the competition, the DEXI LED Signaling system serves as the primary method of communicating mission information to the remainder of the Airfield Reclamation Team, while also allowing Teams to develop alternative strategies should unexpected equipment failures occur.

Each Match is divided into three phases:

> **PHASE 1: AUTONOMOUS CHALLENGE** → At the start of each Match, DEXI-5, DEXI-10, the RVR, and all three Spheros begin by attempting their assigned Phase 1 routes. Phase 1 officially lasts thirty (30) seconds, after which Phase 2 begins. DEXI-5 and DEXI-10 complete their GPS-denied routes using April Tags, student-developed software, and assigned LED Signals. The RVR completes its route using color-based navigation, and the Spheros complete their routes using movement, acceleration sensors, and time calculations. Although this phase emphasizes autonomous operation, Teams may also complete route actions manually for reduced points. Autonomous Phase 1 route scoring may continue after the first thirty (30) seconds if the Team clearly notifies a referee before the attempt continues or begins.
>
> **PHASE 2: AIRFIELD RECLAMATION** → Beginning at the thirty-second mark, Teams may complete the four Airfield Reclamation missions in any order. Working together, the Airfield Reclamation Team transforms the former airfield one step at a time through Hangar Hustle, Seeding Sprint, Barn Blitz, and Toxic Transfer.

PHASE 3: MISSION WRAP-UP → Phase 3 begins at the four-minute mark, with one minute remaining in the Match. During this final phase, Teams have the opportunity to complete any remaining objectives before returning Aircraft and Vehicles to their designated ending locations for additional points.

2.2 – Airfield Reclamation Missions

During Phase 2, Teams may complete the following four missions in any order:

MISSION 1: HANGAR HUSTLE → DEXI-5 surveys the Hangars to identify the two active April Tags and communicates the correct Hangars using LED Signaling. The matching Spheros travel to and verify those Hangars before the RVR pulls the selected Pallets into the open for inspection. DEXI-5 then scans the Barrel Images and activates the correct LED Signal to identify Wheat, Water, Gasoline, and Toxic Fluid Barrels. Hay Bales are also present on the Pallets but do not have an image or LED Signal associated for this mission. The Barrels and Hay Bales are offloaded from the Pallets to make the deliveries required in Mission 3 and Mission 4.

MISSION 2: SEEDING SPRINT → The RVR clears the Bridge Coasters to expose four Bridge Image Locations while DEXI-5 identifies the three active Cultivated Rows using computer vision. The corresponding Spheros travel down the identified active rows, to verify they are ready for planting. DEXI-10 then performs aerial seeding by dropping colored Seeds into the matching active Cultivated Rows and attempting to spread Seeds individually across the correct row sections for bonus points.

MISSION 3: BARN BLITZ → DEXI-5 identifies the Wheat Barn and Water Barn by scanning the Barn Images and communicating the required deliveries using LED Signaling. The Barn with no image or LED Signal is the Hay Bale Barn. The corresponding Spheros travel to the Wheat and Water Barns to verify the unloading locations before Wheat Barrels and Water Barrels are delivered. Hay Bales are delivered to the Hay Bale Barn. Teams delivering Barrels and Hay Bales through the Top Opening of the Barns will receive more points than those that deliver through the front entrance of the Barns.

MISSION 4: TOXIC TRANSFER → DEXI-5 identifies the Freight Cars designated to receive Gasoline Barrels and Toxic Fluid Barrels, then communicates the correct destinations through LED Signaling. Any two Spheros may verify the active Freight Cars before the hazardous Barrels are delivered. Teams may place Barrels alongside the correct Freight Cars for lower points or deliver Barrels inside the correct Freight Cars for higher points. The connected Freight Cars and hazardous Barrels must then be moved fully into Toxic Storage. Bonus points are available if the Freight Cars hitch is used to connect to the Freight Cars and move them fully into Toxic Storage. Bonus points are also available for Gasoline Barrels and Toxic Fluid Barrels that remain inside the correct Freight Cars while transported to Toxic Storage and for those that remain inside while fully inside Toxic Storage.

2.3 – Callouts and/or Signaling for Mission Tasks

Volunteer referees are essential to ensuring our qualifiers and competitions run smoothly and fairly. To assist referees (who may have limited time to learn every task and scoring detail) and to help maintain fairness across all Teams, competitors are asked to signal when they are beginning a task and upon completion.

For example, during this year's competition, a Team might call out **"DEXI-5 scanning Hangar," "DEXI-10 transporting Water Barrel," "RVR clearing Bridge," "Sphero verifying Crop Row," or "RVR moving Freight Cars to Toxic Storage"** so the referee knows which robot and task to observe.

To ensure inclusivity, Teams with communication impairments or other limitations may establish an alternative signaling method (such as hand signals) with the Head Referee prior to their Matches.

If a Team attempts or restarts Autonomous Phase 1 route scoring after the first thirty (30) seconds of the Match, a Drive Team Member must clearly notify a referee before the attempt begins or continues. Autonomous Phase 1 route actions completed after the first 30 seconds without referee observation may not receive points.

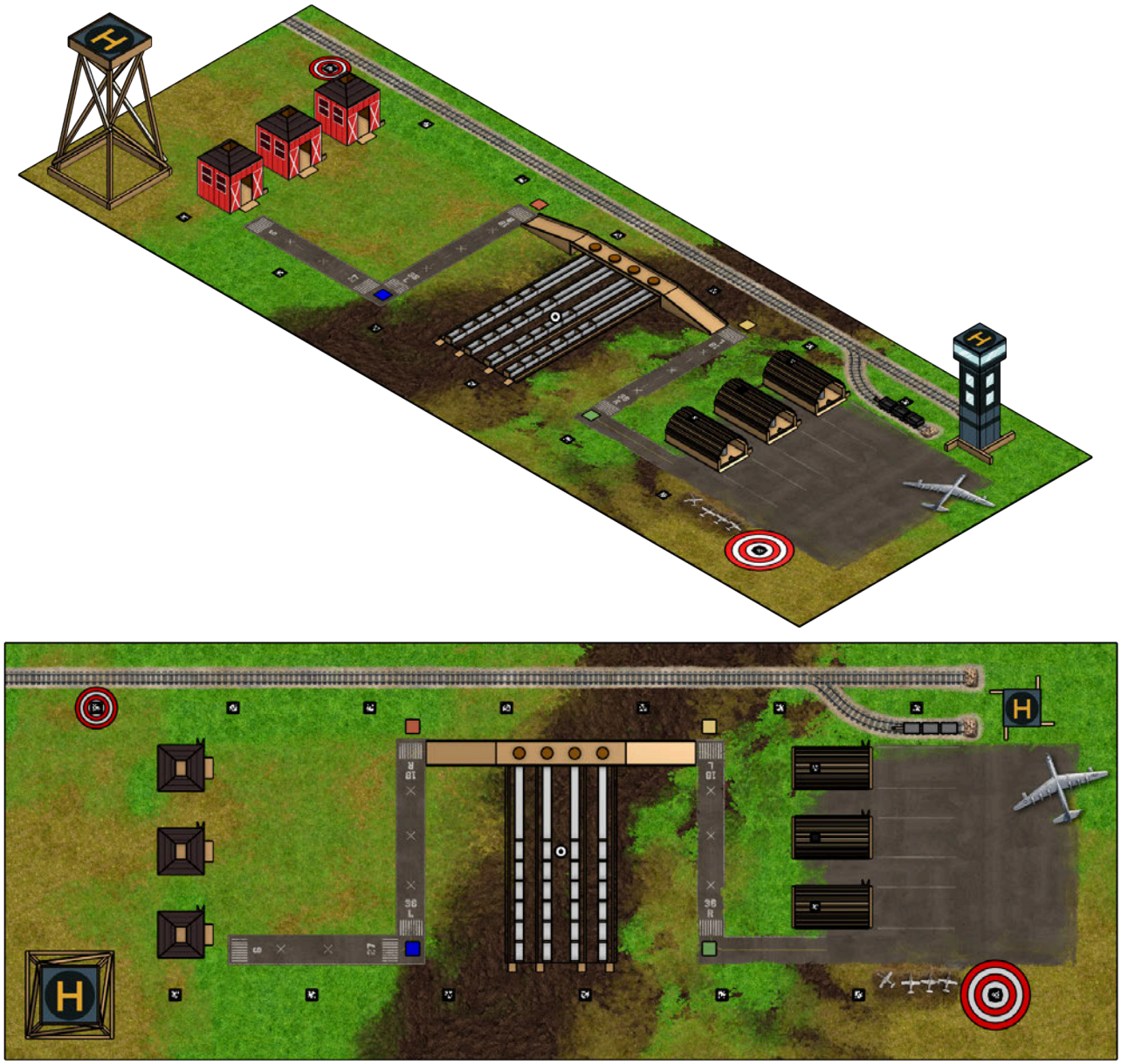
2.4 – Judged Presentation

Throughout the day of the competition, each Team will have a scheduled time to deliver a presentation to the judges. Presentations will be limited to 12 minutes and consist of two parts,

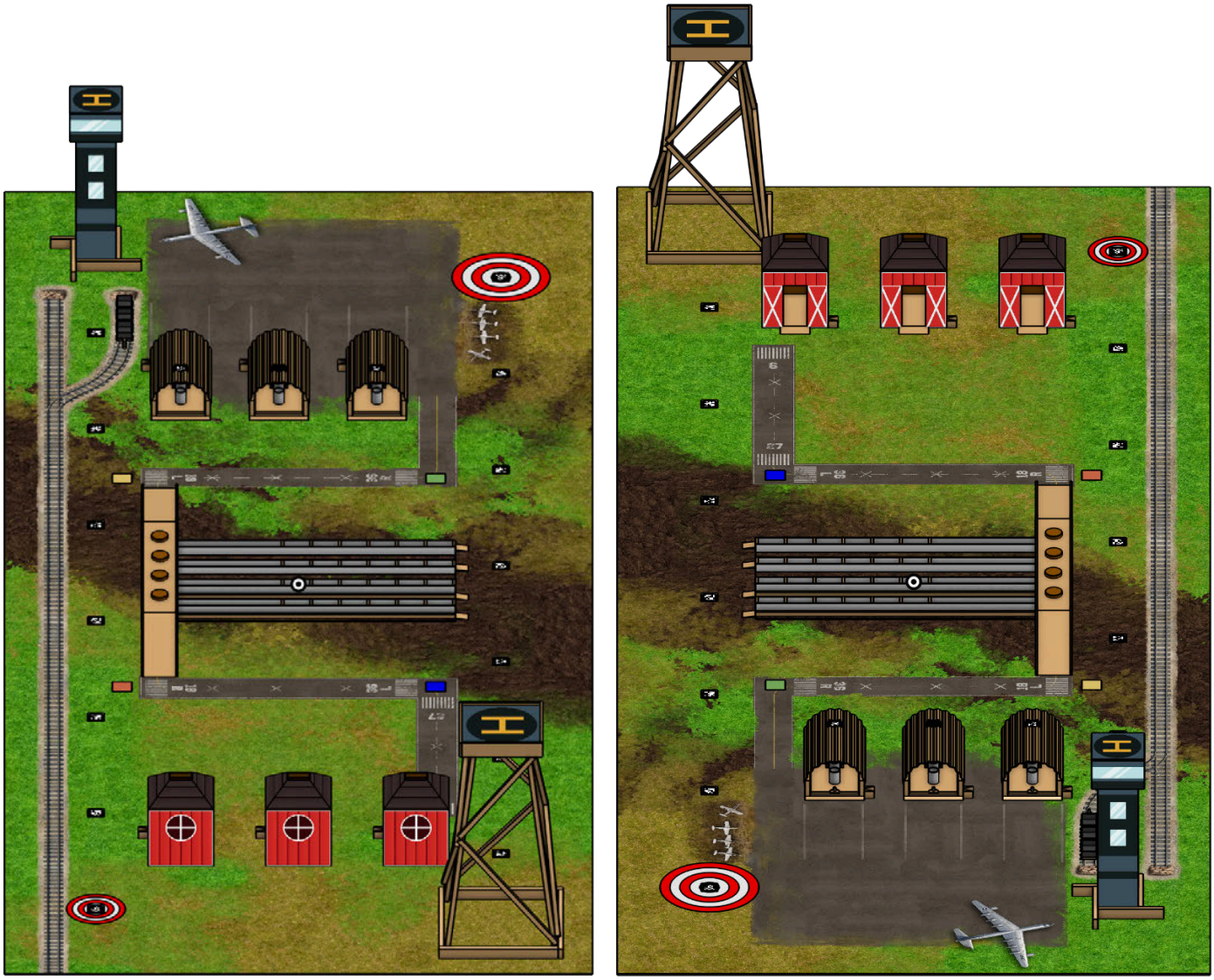
as described in Section 6.

3 – Field Overview

The From Runway to Roots Challenge is played on a 15’ wide x 14’ tall x 40’ long netted Field as depicted in the figures below and throughout this Game Manual.



Figures 1 and 2: Isometric and top-down views of the Field.



Figures 3 and 4: Left and Right View of the Field.

4 – Definitions

4.1 – General Definitions

NEW April Tag – A visual fiducial system popular in robotics. April Tags are images that can be recognized by DEXI-5 and DEXI-10 using onboard cameras and student-developed code. April Tags are used during the competition for the DEXI Phase 1 Autonomous Challenge routes and mission identification. Hangar April Tag assignments will be randomized between Matches by the referees. The Phase 1 Autonomy Challenge April Tags for DEXI routes will always remain in the same position and order.

The black-and-white recognition portion of each April Tag measures six inches by six inches (6" × 6"). Each April Tag is printed within a seven-inch by seven-inch (7" × 7") square target with a thin black outer border. The area between the 6" × 6" April Tag pattern and the outer border is white and includes small text identifying the April Tag ID. See Figure 5 for dimensions and Figures 6–12 for examples of how the April Tags will appear on the Field.

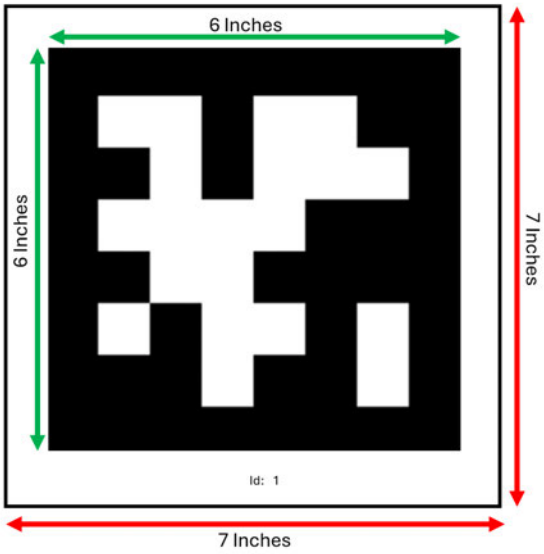
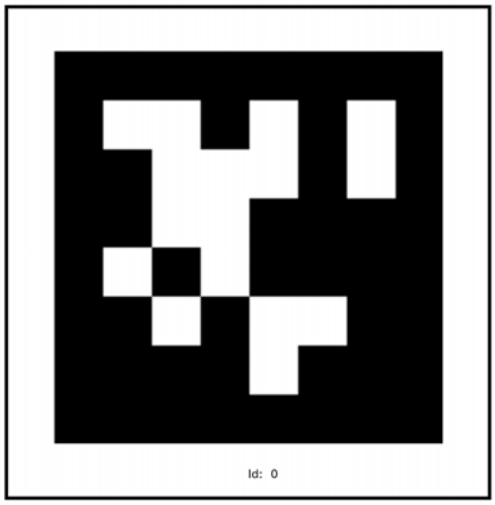
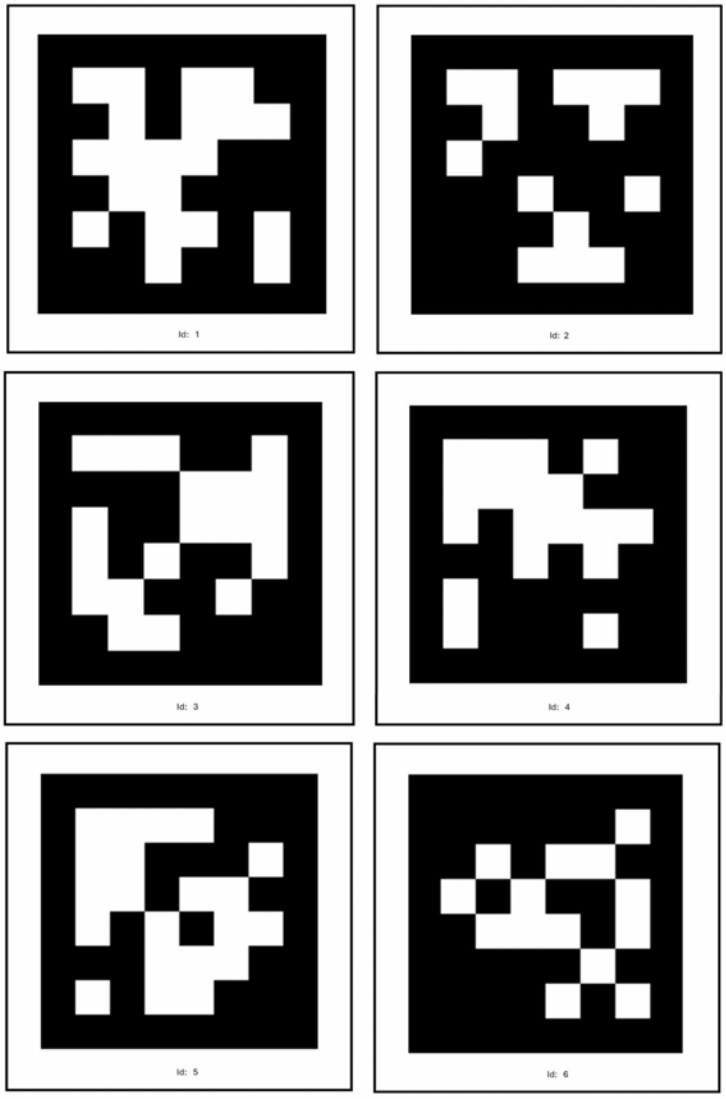


Figure 5: April Tags Dimensions

Figures 6-12 below and on the following page: April Tags roughly as they will appear on the court





The use of April Tags for this year's competition includes:

1. During **Phase 1 – Autonomous Challenge**, DEXI-5 and DEXI-10 each use a seven (7) checkpoint April Tag Route. Both DEXI routes use the following April Tag ID and corresponding LED Color Sequence:

    1. ID 0 - Yellow
    2. ID 1 - Red
    3. ID 2 - Green
    4. ID 3 - Blue
    5. ID 4 - Purple
    6. ID 5 - Orange
    7. ID 6 - Magenta

2. During **Mission 1 – Hangar Hustle,** April Tags are also used to identify the active Hangars. DEXI-5 is the primary aircraft intended to scan the active Hangar April Tags and activate the correct LED Signal, but DEXI-10 may complete this task if necessary and if the Team has developed that capability. The three possible Hangar April Tags are ID 1, ID 2, and ID 3. ID 1 corresponds to the Red Sphero, ID 2 corresponds to the Green Sphero, and ID 3 corresponds to the Blue Sphero. During each Match, two of these three April Tags are in use at the active Hangars. The inactive Hangar uses a solid black sticker in place of an April Tag. Active April Tag locations will be randomized between Matches by the referees.

April Tag ID Reference

ID	April Tag	Color
0		Yellow
1		Red
2		Green
3		Blue
4		Purple
5		Orange
6		Magenta

Figure 13: April Tags used for DEXI Phase 1 route scoring and Hangar Hustle active-Hangar identification.

Armed – The state of a DEXI-5 or DEXI-10 flight controller being in the "Armed" mode, which allows motors to begin spinning. See Section 9.2.2.

NEW DEXI – In scoring tables, "DEXI" refers to either DEXI-5 or DEXI-10. DEXI-5 is the primary aircraft intended for scanning, image recognition, and LED Signaling, but DEXI-10 may complete those tasks if necessary and if the Team has developed that capability.

NEW DEXI-5 – The smaller unmanned aircraft which is built and operated by the Team. DEXI-5 serves as the primary reconnaissance and coordination aircraft for the Airfield Reclamation Team.

To achieve this year's challenge, Teams will need to add or integrate capabilities allowing DEXI-5 to:

a. GPS-denied autonomous navigation and manual route following and scoring using April Tags.

b. Activate LED Signals to communicate mission information.

c. Identify correct Hangars, Barrel Images, Bridge Images, Barn Images, and Freight Car Images.

d. Support contingency strategies if another Aircraft or Vehicle becomes unavailable.

DEXI-5 is primarily used for detection, recognition, and communication. However, Teams are encouraged to consider backup strategies that use DEXI-5 in additional ways when appropriate, such as supporting Barrel or Hay Bale transport if the Team develops a safe and effective mechanism.

See Section 8 and the Assembly Guide at **theavr.org/resources** for details on assembling, coding, and operating DEXI-5.

NEW DEXI-10 – The larger unmanned aircraft which is built and operated by the Team. DEXI-10 serves as the primary logistics aircraft for the Airfield Reclamation Team. Returning Teams may be utilizing an updated version of the AVR Drone (2025 & earlier). For the purpose of the 2026 game, all versions of the AVR Drone will be referred to as DEXI-10.

To achieve this year's challenge, Teams will need to add or integrate capabilities allowing DEXI-10 to:

a. GPS-denied autonomous navigation and manual route following and scoring using April Tags.

b. Transport and deliver Barrels and Hay Bales to Barns and Freight Cars and transport Seeds to perform aerial seeding of correct Cultivated Rows.

c. Activate LED Signals to communicate mission information.

d. Support contingency strategies if another Aircraft or Vehicle becomes unavailable.

DEXI-10 is primarily used for transport, delivery, and seeding. DEXI-10 is also equipped with onboard vision and computing systems capable of recognizing April Tags and mission images, allowing it to support recognition and LED Signaling tasks if necessary.

See Section 8 and the Assembly Guide at **theavr.org/resources** for details on assembling, coding, and operating DEXI-10.

Disqualification – A penalty applied to a Team for a rule violation. A Team that receives a Disqualification receives zero points for the Match in question. At the Head Referee's discretion, repeated violations and/or Disqualifications for a single Team may lead to its Disqualification for the entire tournament.

NEW Drive Team Member – A Student who is allowed to stand in the Driver Station during a Match. They must be operating a robot, holding/operating critical equipment like laptops, or directly responsible for observation and callouts. Exceptions may be made for

photographers/videographers or others on a case by case basis under direction of the Head Referee. Refer to Section 5.3 rules for more information.

NEW Driver Station – The area next to the Field where only Drive Team Members may stand during a Match. Other Team members that are not Drive Team Members may not stand in this area during a Match. This does not apply to AVR game officials or required personnel (including but not limited to referees, judges, and photographers/videographers). See Figure 14.

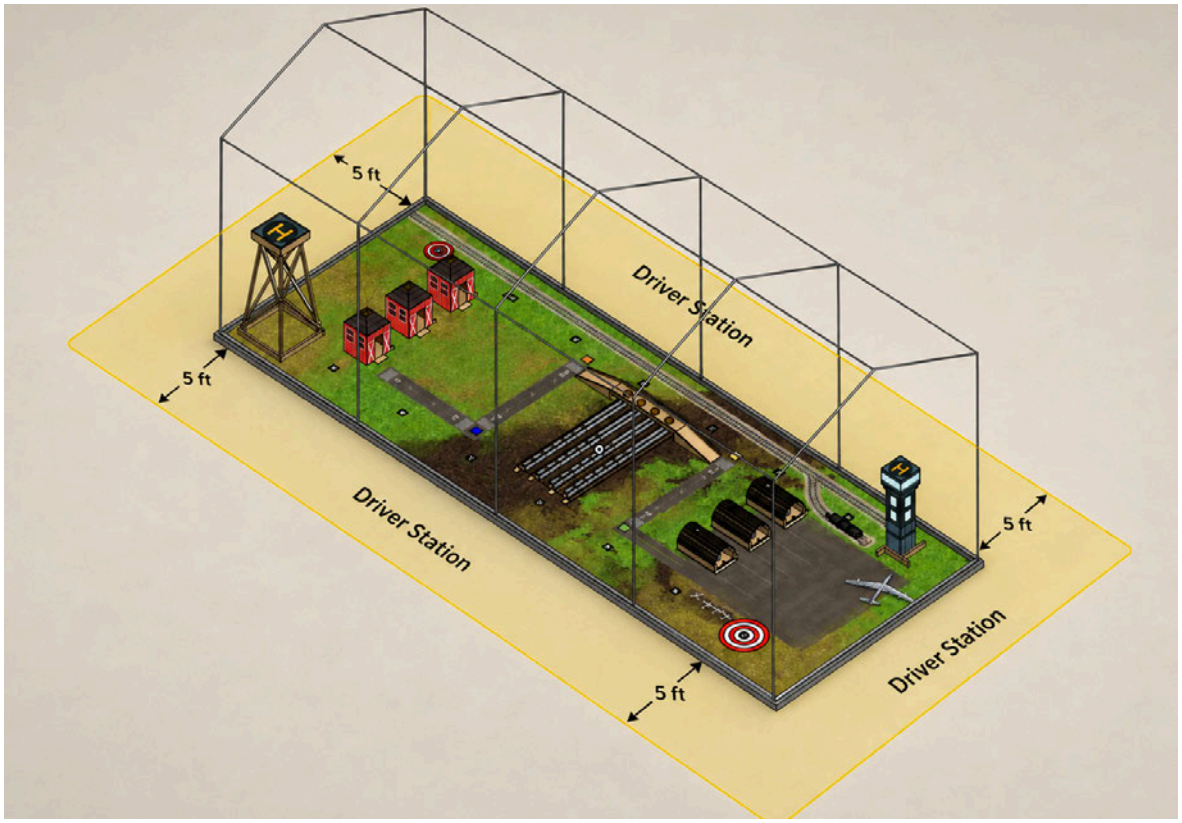


Figure 14: A top-down view of the Field, with the highlighted area showing where Drive Team Members are allowed during a Match.

Event – A one-day competition, consisting of Matches and judged Presentations.

Event Coordinator – The overall manager for the volunteers, venue, event management, and other event considerations. The Event Coordinator does not interpret rules for the Teams, but may be consulted by the Head Referee at the Head Referee's discretion.

Field – The entire 15' wide x 14' tall x 40' long netted space in which Teams play Matches.

Field Elements – All elements that make up the Field, including the flooring, netting, game structures, and all supporting structures and accessories.

Flight Controller – The flight controller that includes onboard sensors to report movement of the aircraft to the Raspberry Pi Companion Computer, interfaces with the Drive Team Member's transmitter via the aircraft receiver, and controls the motor speeds via the Electronic Speed Controller (ESC). See the Assembly Guide for more information.

Head Referee – The impartial volunteer responsible for enforcing the rules in this manual as written. Head Referees are the only individuals who may discuss ruling interpretations or scoring questions with Teams at an Event.

NEW LED Signal – A programmable light displayed by DEXI-5 or DEXI-10 to communicate mission information to the remainder of the Airfield Reclamation Team.

a. During Phase 1, DEXI-5 and DEXI-10 use assigned LED colors to communicate April Tag checkpoint progress. For both manual and autonomous DEXI checkpoint scoring, the correct LED Signal must be displayed before the aircraft reaches the next April Tag/checkpoint. DEXI does not need to stop over each April Tag, but the LED Signal must clearly correspond to the April Tag/checkpoint being scored. At April Tag ID 6, whether manual or autonomous, the DEXI must show the correct LED Signal before it fully lands on the ground. If manual, a manual landing can be performed, however if autonomous the landing must remain hands-off.

b. During Phase 2, LED Signals are used to identify correct Hangars, Barrel Images, active Cultivated Rows, Barns, and Freight Cars. The primary image and LED color mappings are:

    i. Wheat Image - Green LED Signal

    ii. Water Image - Blue LED Signal

    iii. Gasoline Image - Red LED Signal

    iv. Toxic Fluid Image - Yellow LED Signal

    v. Hay Bales do not have an image or LED Signal

c. If LED Signals are not functioning during Phase 2, Teams may still use live camera views or student callouts to continue completing mission actions, but LED Signal points may not be awarded unless the correct LED Signal is displayed as required by the scoring rules.

NEW Match – A set time period during which Teams play a single round consisting of three (3) Phases for the From Runway to Roots Challenge during a Match Cycle.

Match Cycle – The entire time spent by a Team at the Field for a given Match. Match Cycles are ten (10) minutes long and consist of three periods:

1. Setup – 3:00 minutes
2. Match – 5:00 minutes
3. Reset – 2:00 minutes

NEW Object Recognition – A computer vision technique used to identify known images throughout the competition. The images used in this year's competition include:

a. Wheat Image

b. Water Image

c. Gasoline Image

d. Toxic Fluid Image

e. Bridge Images used to identify active Cultivated Rows

f. April Tags

These images are printed targets used for recognition by DEXI-5 and/or DEXI-10. The onboard cameras are detecting the printed images, not the three-dimensional physical objects themselves.

Hay Bales are not recognized through Object Recognition and do not have a Hay Bale Image or LED Signal.

The inactive Hangar, Hay Bale Barn, Seed Row, and Freight Car in each Match use solid black where an image or April Tag would normally be to represent the inactive location. These do not require an LED Signal.

One of the programming tasks for Teams is to recognize these known images and activate the appropriate LED Signal to communicate mission information to the rest of the Airfield Reclamation Team.

Object Recognition Images

Name	Recognition Image	LED Signal
Wheat		Green
Water		Blue
Gasoline		Red
Toxic Fluid		Yellow
Red Bridge Image		Red
Green Bridge Image		Green
Blue Bridge Image		Blue
No Image (Blackout)		No LED Signal

Figure 15: Images used for Object Recognition, including Wheat, Water, Gasoline, Toxic Fluid, and Bridge Images (see Figure 13 for April Tags on pg 11).

NEW Parking – The return locations for the Airfield Reclamation Team to receive Phase 3 points. To be considered Parked, the DEXIs, RVR, and Spheros must meet the following criteria:

Aircraft/Vehicle	Parking Criteria
DEXI-5 and DEXI-10	Landed on the designated Tower Helipad. DEXI should be landed on top of the Tower Helipad, but imperfect landings may still score at referee discretion. To receive parking points, the aircraft may be partially on the Tower Helipad, but it may not be tilted more than approximately forty-five (45) degrees from a normal level takeoff/landing position. No measurement device will be used. Final determination is made by the referee and may be escalated to the Head Referee if needed. “Dangling DEXIs” do not receive parking points.
RVR	Fully under the roof of any Hangar. The RVR may use any Hangar, including a Hangar where a Pallet remains, but it must be completely under the Hangar roof to receive parking points.
Spheros	Each Sphero must be parked separately inside a Barn. No more than one Sphero may receive parking points in the same Barn. To receive parking points, the Sphero must have completely crossed the Barn Entrance ramp drop-off and be inside the Barn. If Barrels or Hay Bales prevent a Sphero from fitting completely inside the Barn, the Sphero must be as far into the Barn as possible, as determined by the referee.

Raspberry Pi Companion Computer – The companion computer used to interface with external sensors, connect to the Ground Control Operator laptop, and run Team code.

Raspberry Pi Hat – The Pi Hat developed by the DroneBlocks team enables communication with the flight controller, LED control, servo control, and interfacing with GPIO. The hat also includes an M.2 connector, which allows for AI acceleration.

NEW RVR – The Sphero RVR or RVR+ tracked vehicle which serves as a ground support vehicle for the Airfield Reclamation Team. The RVR completes a Phase 1 autonomous or manual route, pulls Pallets out of the Hangars during Hangar Hustle, clears Bridge Coasters during Seeding Sprint, may support Barrel and Hay Bale movement during Barn Blitz and Toxic Transfer, and may move the connected Freight Cars into Toxic Storage.

Teams may design, fabricate, and integrate mechanisms onto the RVR to support Pallet movement, Bridge Coaster clearing, Barrel pushing, Freight Car hitching, and other legal mission tasks.

NEW RVR Color Squares – The color squares the RVR will use during the autonomous portion are Blue, Red, Yellow, and Green and will be 8 inches wide by 8 inches tall. See Figure 16 on the following page.

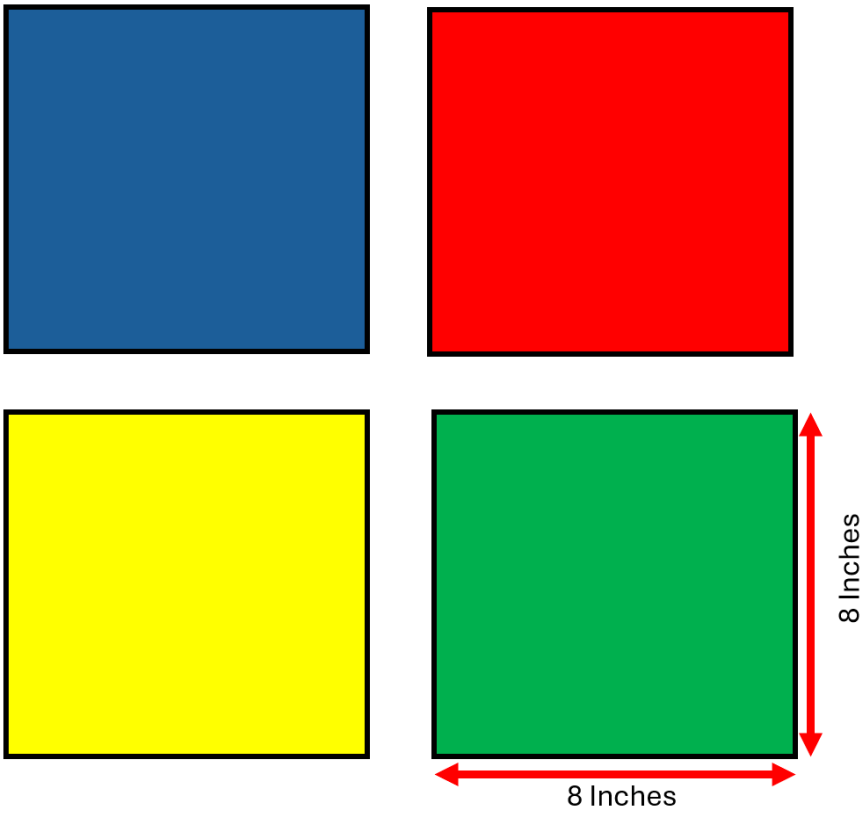


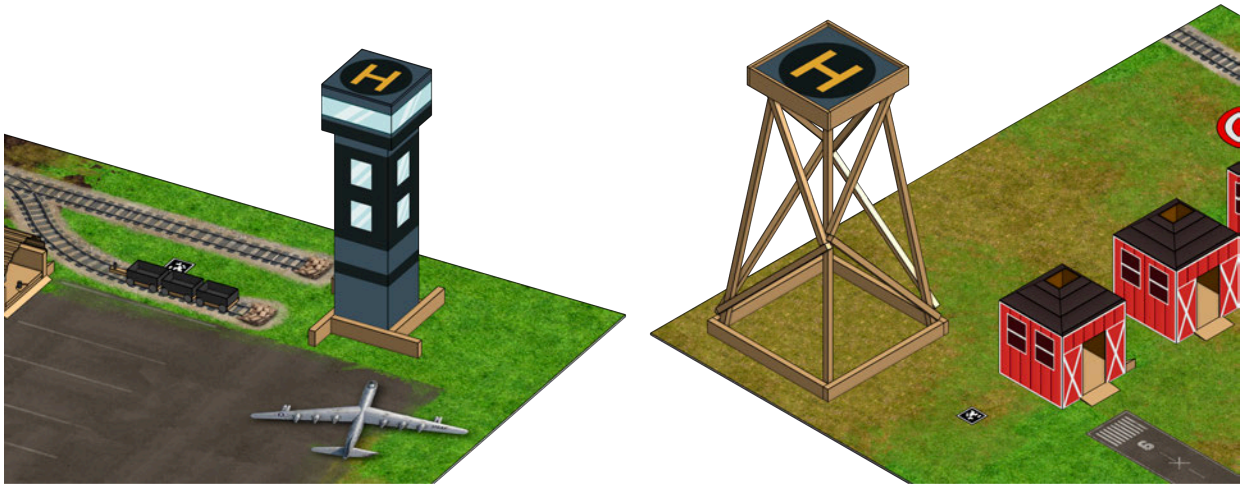
Figure 16: RVR Color Squares and Dimensions

NEW Sphero – A Sphero Mini robot used as a ground support and verification robot during the From Runway to Roots Challenge. Three (3) Spheros are used by each Team, and should be distinguishable by color: Red, Blue, and Green. During Phase 1, each Sphero completes its own autonomous or manual route. During Phase 2, the Spheros travel to and verify active Hangars, Cultivated Rows, Barns, and Freight Cars for points.

Sphero verification points are separate from delivery, seeding, Pallet movement, and Freight Car movement points. A failed, late, or incorrect Sphero verification action does not prevent a Team from earning other mission points (like delivery) unless a scoring rule specifically states otherwise.

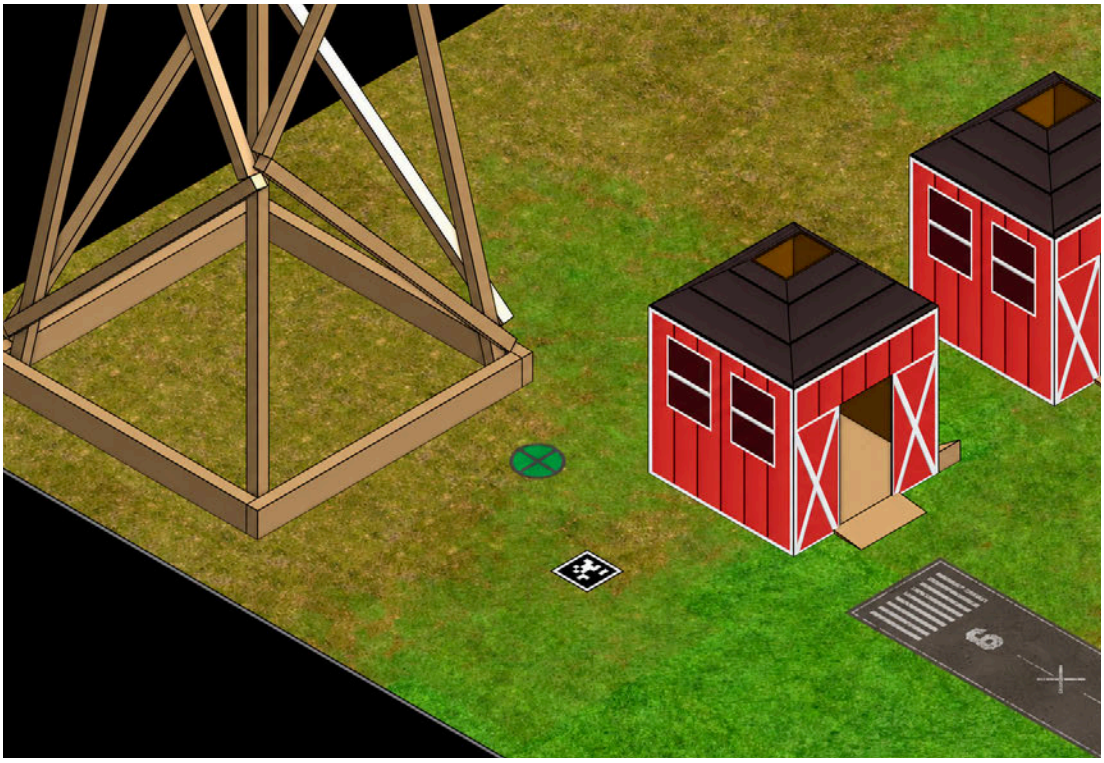
NEW Starting and Ending Locations – The designated locations on the Field where each Aircraft and Vehicle begins the Match and where they return at the end of the Match in Phase 3 for points. See the Figures on the following pages.

Figures 17-24: A view of the designated Starting and Ending Locations for DEXI-5, DEXI-10, RVR, and the Spheros.

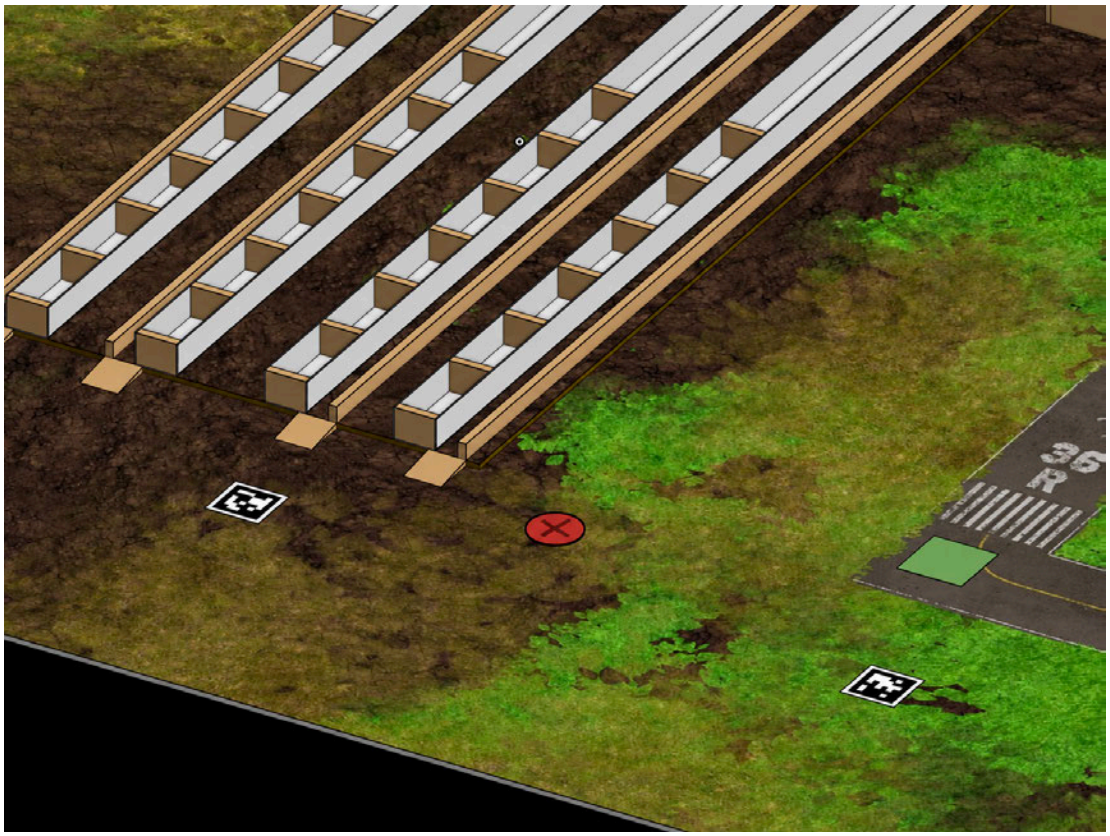


DEXI-5 (left) and DEXI-10 (right) Starting Location and Return Location (Top of Tower Helipad)

RVR Start Location



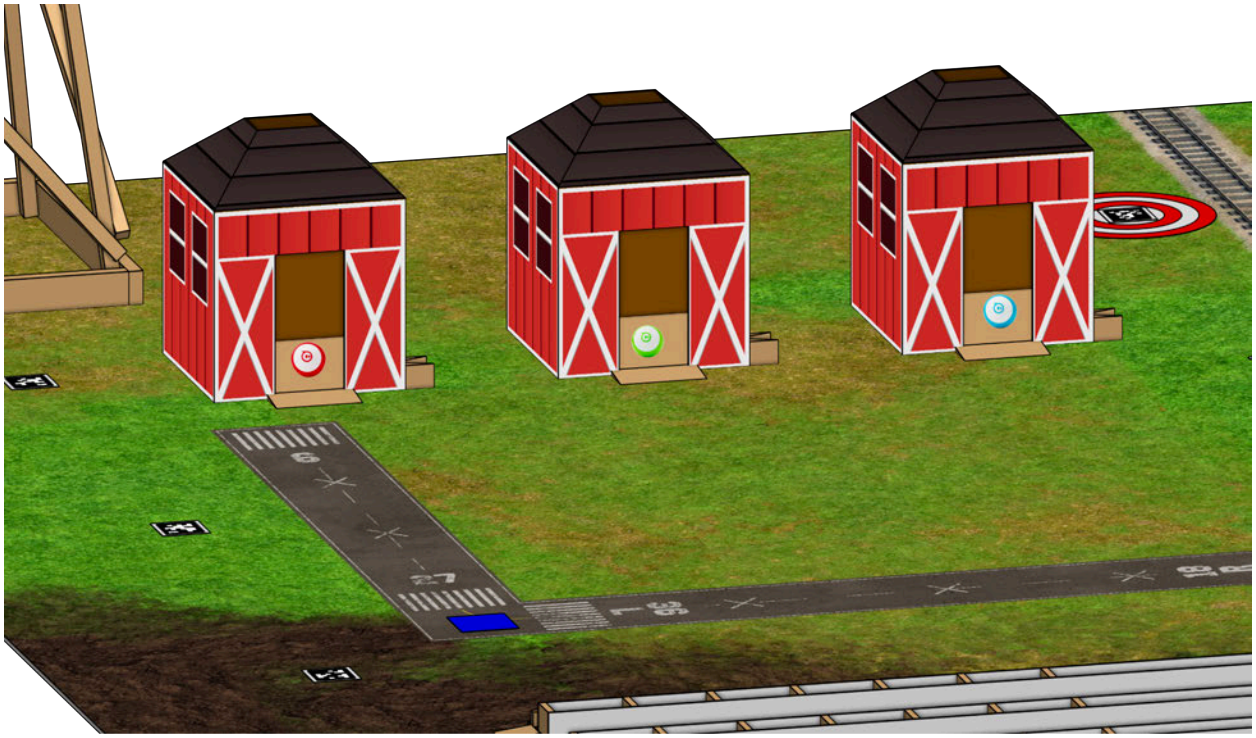
Green Sphero Start Location



Red Sphero Start Location

Blue Sphero Start Location

RVR Return Location - Fully Under the Roof of Any Hangar



Sphero Return Locations - One per Barn, Color does not matter per Barn

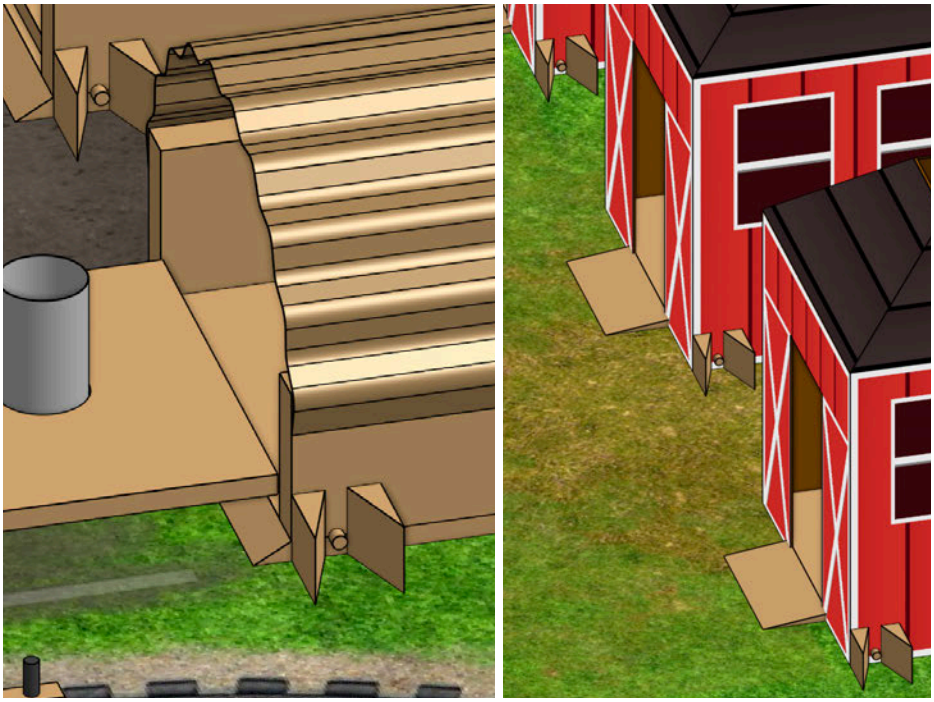
NEW Switch Button – A Field element used for Sphero verification points during Hangar Hustle and Barn Blitz. Switch Buttons are located on all three Hangars and all three Barns. Switch Buttons are not used for any other Field Elements.

Each Switch Button includes a small LED indicator that turns on when the button is activated. To receive Sphero verification points for Hangars or Barns, the correct Sphero must activate the appropriate Switch Button. It is highly recommended for the Sphero to remain at that verification location through the scoring window/delivery window to act as a reminder to your Team.

For Hangars and Barns, the Switch Button is located on the right side of the wall facing the train track, as shown in Figure 25. Figure 26 shows an actual Switch Button.

The Hay Bale Barn Switch Button does not provide scoring points, as no Sphero verification is required for Hay Bale delivery.

See Appendix A for more information.



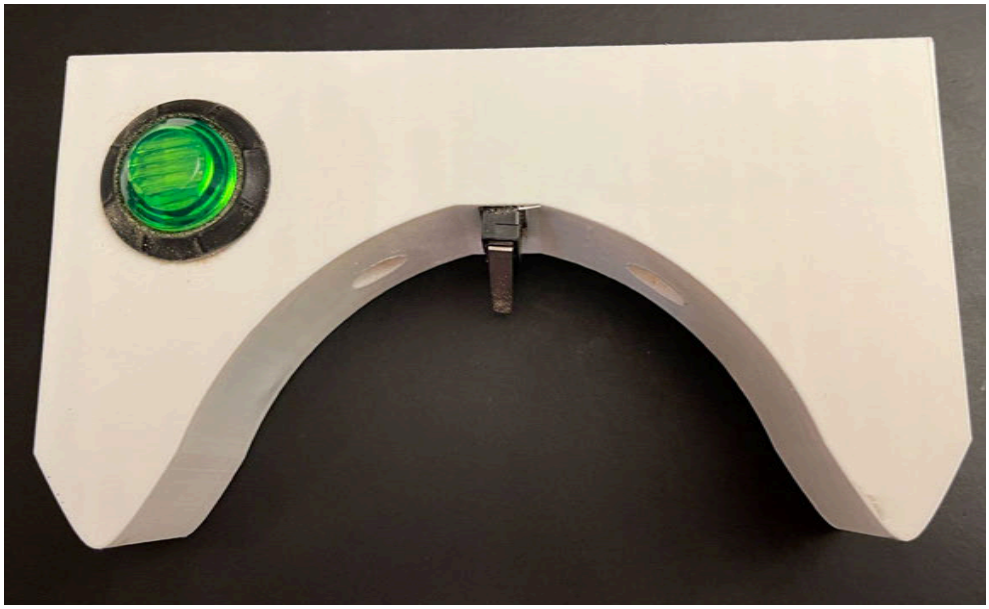


Figure 25 (top): Example Switch Button used for Sphero interaction on both Hangars and Barns.
Figure 26 (bottom): Actual Switch Button used in physical assembly of the Field.

Team – A group of students representing a single high school or club, who coordinate efforts to prepare for and participate in Matches.

Taxiing – DEXI-5 or DEXI-10 moving on the ground under its own power while not actively flying. Taxiing is permitted except where specifically prohibited by Rule 5.3.15.

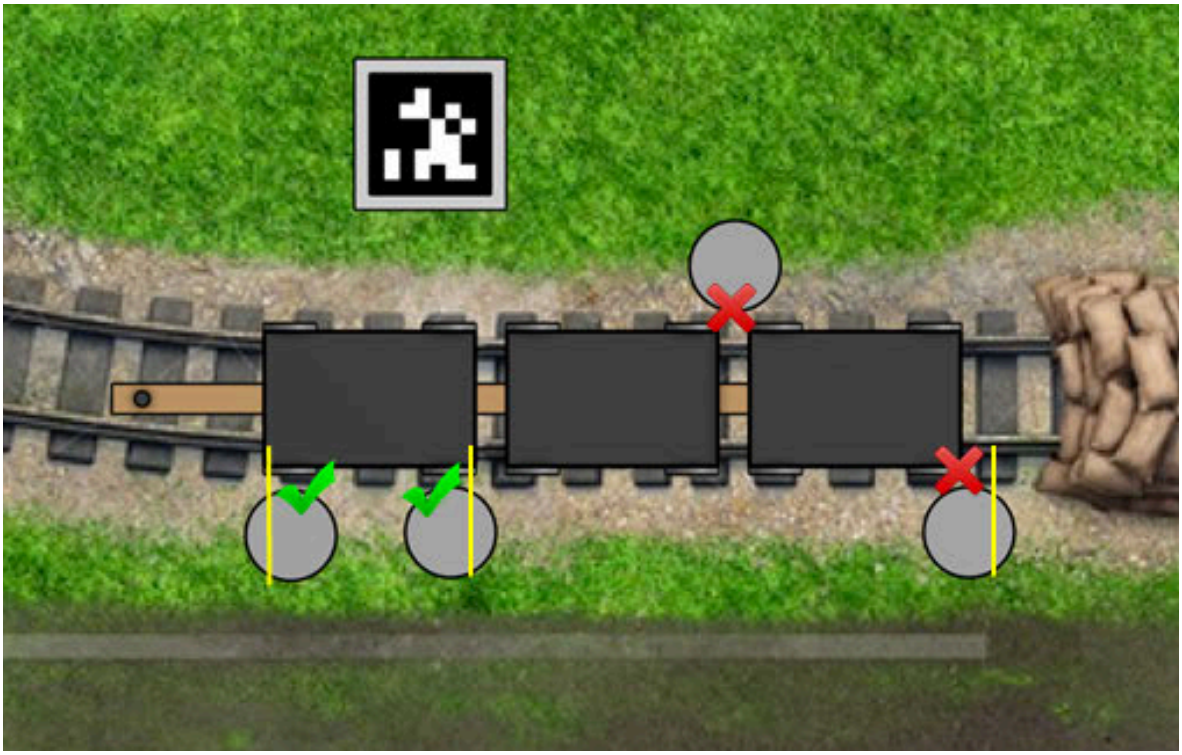
4.2 – **NEW** Game Specific Definitions

Aircraft – DEXI-5 or DEXI-10.

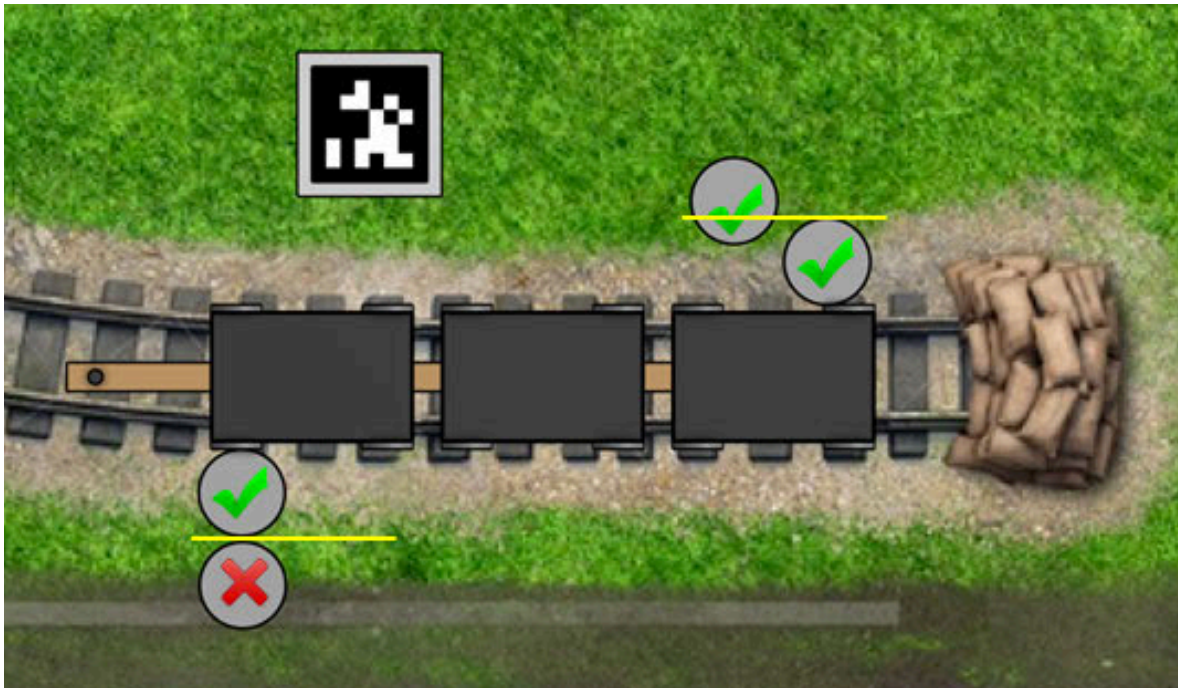
Airfield Reclamation Team – The group of Aircraft and Vehicles used by each Team to complete the From Runway to Roots Challenge. The Airfield Reclamation Team consists of one (1) DEXI-10, one (1) DEXI-5, one (1) RVR, and three (3) Spheros.

Alongside Freight Car Delivery – During Toxic Transfer, this definition is used for lower-value Barrel placement in both the initial Freight Car Delivery portion and the Toxic Storage portion of the mission. As the Freight Cars may get slightly moved or bumped during the Match, it is not realistic to define a fixed area on the ground to meet this definition. Instead, referees will use their best judgement and operate under the following guidelines to best determine what does and does not meet this definition.

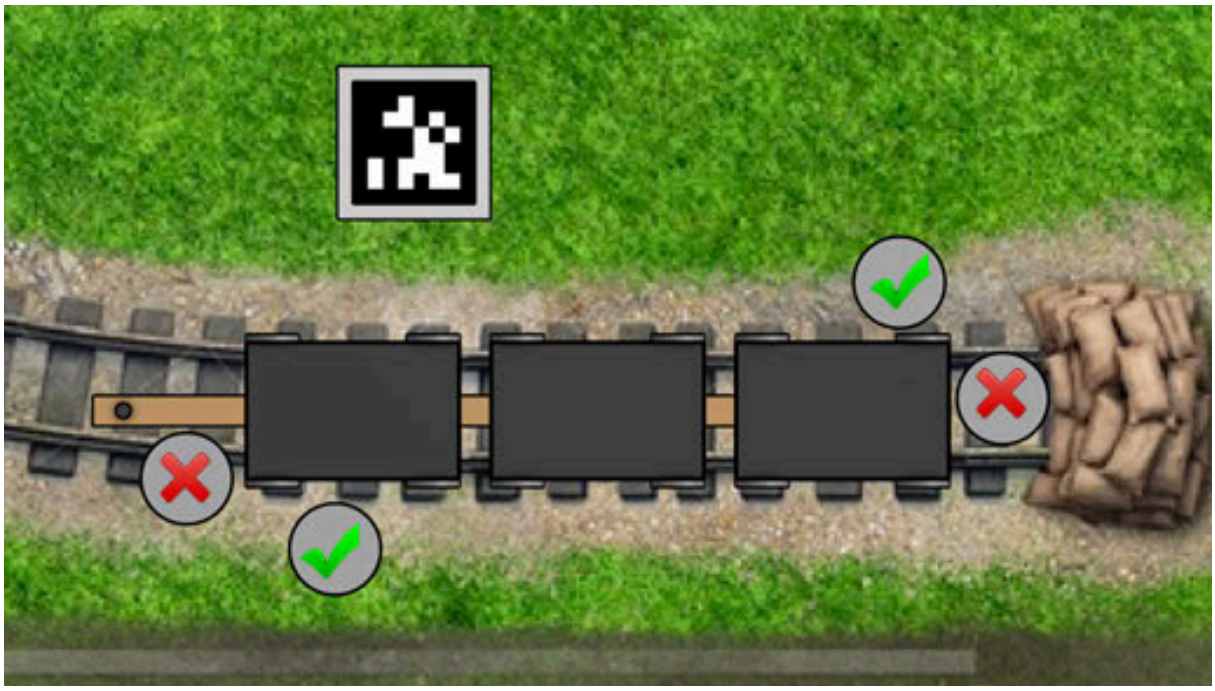
- A Barrel should be adjacent to the Freight Car matching the Barrel Image and it can be adjacent on either side of the Freight Car
    - A Barrel that is adjacent may not be in between two Freight Cars - the Barrel must have more than ⅔ of its diameter within the area directly adjacent to the correct Freight Car. See Figure 27 below - yellow highlight represents ⅔ of the diameter of the Barrel in relation to the Freight Car.



- A Barrel should be no further than its own diameter away from the side of a Freight Car
    - See Figure 28 on the following page.



- A Barrel cannot be in front of or behind the row of Freight Cars to receive points - Barrels should only be placed alongside the Freight Cars
    - See Figure 29 below.



- A Barrel must remain upright to receive Alongside Freight Car Delivery points - in real life, a barrel full of supply unintentionally spilled everywhere is not good!

It is absolutely crucial that, if Teams are unsure whether they meet this definition, they immediately get the attention of a referee during the Match so a determination can be made and the Team can adjust as necessary.

Barrel – A game object located on a Pallet inside a Hangar. Each Pallet contains four (4) Barrels. Barrels represent materials left at the former airfield which must be identified and transported to the correct destination. Depending on the image associated with the Barrel, it may be delivered to a Barn or Freight Car. See Figure 30 below. See Appendix A for more information. The Barrels have images that sit roughly ½" below the top.

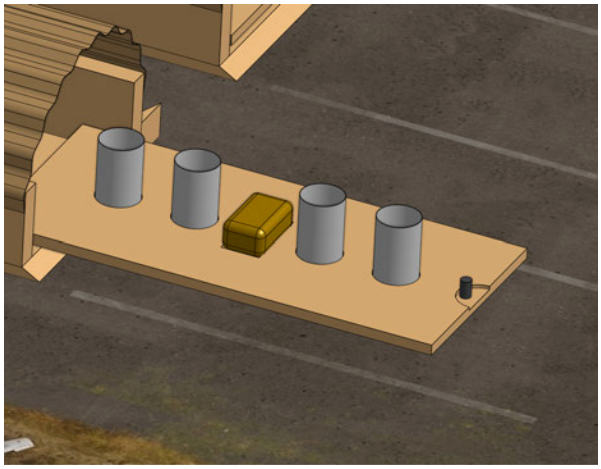


Figure 30 (left): Actual Barrel with Wheat Image sitting ½" below top of Barrel.
Figure 31 (right): OnShape Barrel game objects located on a Pallet.

Barrel Images – Printed images associated with the Barrels on each Pallet. DEXI-5 scans these images to identify what type of material each Barrel represents and communicates the result using LED Signals.

Each active Pallet contains four (4) Barrels with the following images:

1. Wheat Image - Green LED Signal
2. Water Image - Blue LED Signal
3. Gasoline Image - Red LED Signal
4. Toxic Fluid Image - Yellow LED Signal

Barrel positions will be randomized between Matches by the referees.

The Wheat, Water, Gasoline, and Toxic Fluid Images inside the Barrels will be two and five-eighths inches (2 ⅝") in diameter.

See Figure 32 on the following page.

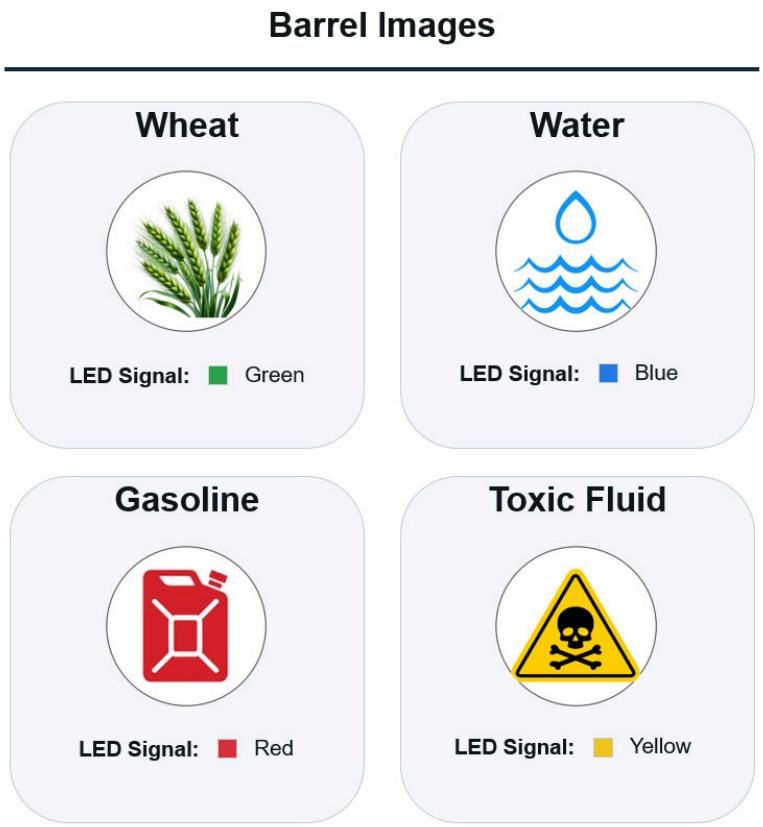


Figure 32: Barrel Images used to identify Wheat, Water, Gasoline, and Toxic Fluid Barrels.

Barn – A Field Element representing part of the agricultural infrastructure being created as the historic airfield is repurposed into farmland. Barns are used as destinations for Wheat Barrels, Water Barrels, and Hay Bales.

Two Barns will have Barn Images: one Wheat Image and one Water Image. The remaining Barn will not have an image and is the Hay Bale Barn. Correct Barrels or Hay Bales may be delivered completely through the Barn Entrance for lower points or deposited through the Top Opening of the Barn for the highest points possible. Barns also include Switch Buttons used for Sphero verification points during Barn Blitz, except that the Hay Bale Barn Switch Button does not provide scoring points.

See Figure 33 on the following page.

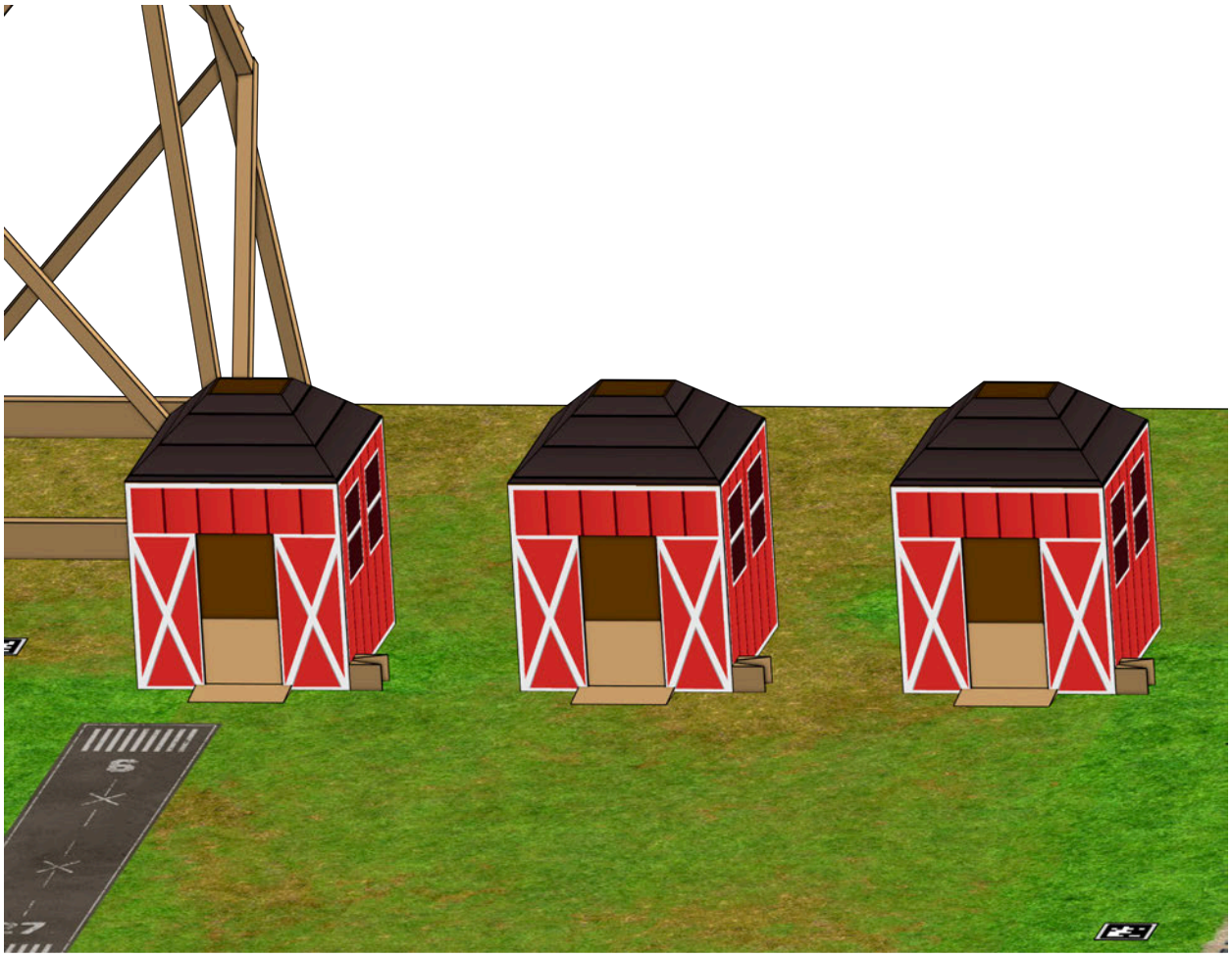


Figure 33: Barn Field Elements used as destinations for agricultural materials.

Barn Entrance – The opening in the front of each Barn which is cut out for deliveries to happen. It is 7 inches wide and 15 inches tall from floor to the top of the opening. The Barn Entrance includes a small ramp which is 7 inches wide, 4” deep, and 1” tall at the high end. The Barn floor sits ½” above the floor. The high end of the ramp sits ½” above the Barn floor which creates a dropoff. See Appendix A for the latest information. See Figure 34 on the following page.

Figure 34: The entrance dimensions of the Barns.

Barn Images – Printed images located on a block roughly 3 ¼” below the Top Opening of the Barns that identify which agricultural material should be delivered to those Barns. DEXI-5 scans the Barn Images and activates the correct LED Signal to communicate where each Barrel should be delivered.

Barn Images include:

1. Wheat Image - Green LED Signal
2. Water Image - Blue LED Signal

The Barn without a Water or Wheat Image which instead will have a solid black sticker, is the Hay Bale Barn. The location of the Wheat Barn, Water Barn, and Hay Bale Barn may change between Matches.

The Wheat and Water Images inside the Barn roof will be 4 inches wide and 4 inches tall.

See Figure 35 on the following page.

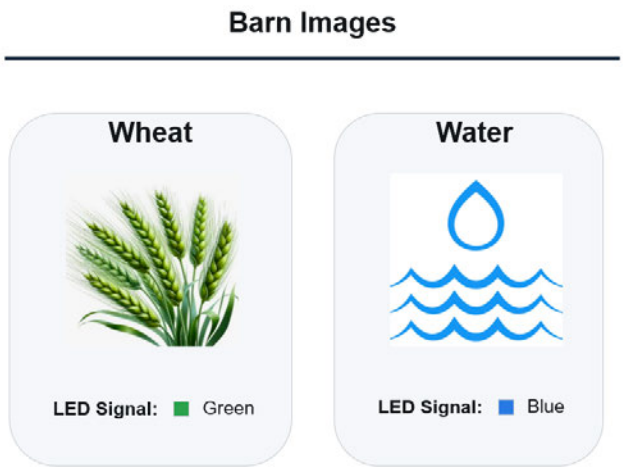


Figure 35: Barn Images used to identify Wheat and Water destinations.

Barn Top Opening – The open area at the top of each Barn through which Barrels and Hay Bales may be deposited for the higher-value Barn Blitz placement score. The dimensions of the Barn Top Opening are roughly 5 inches by 7 inches. See Figure 36 below.

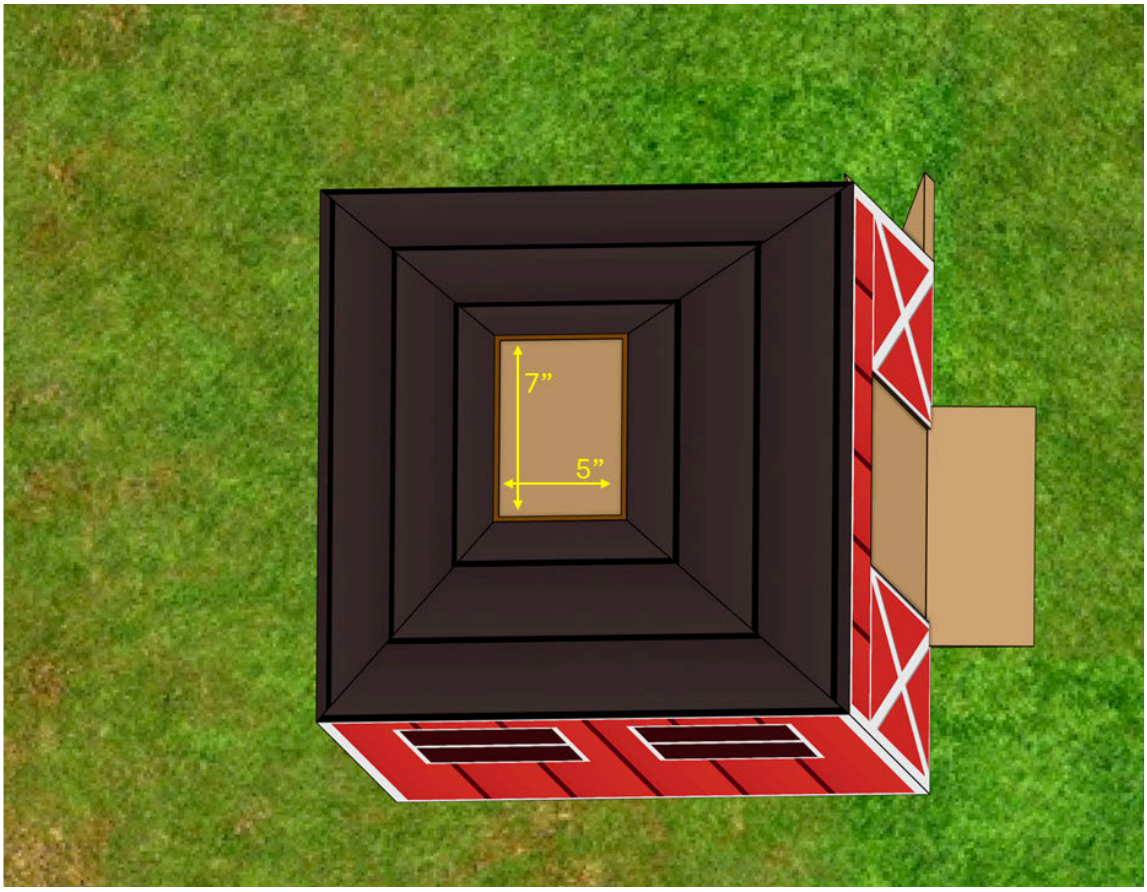


Figure 36: The dimensions of the Barn Top Openings.

Bridge – A Field Element used during Seeding Sprint. The RVR travels over the Bridge to remove four (4) Bridge Coasters covering the Bridge Image Locations. Once the images are uncovered, DEXI-5 scans the Bridge Images to determine which three (3) Cultivated Rows are active and ready for planting during that Match. See Figure 37 below. See Appendix A for more information.

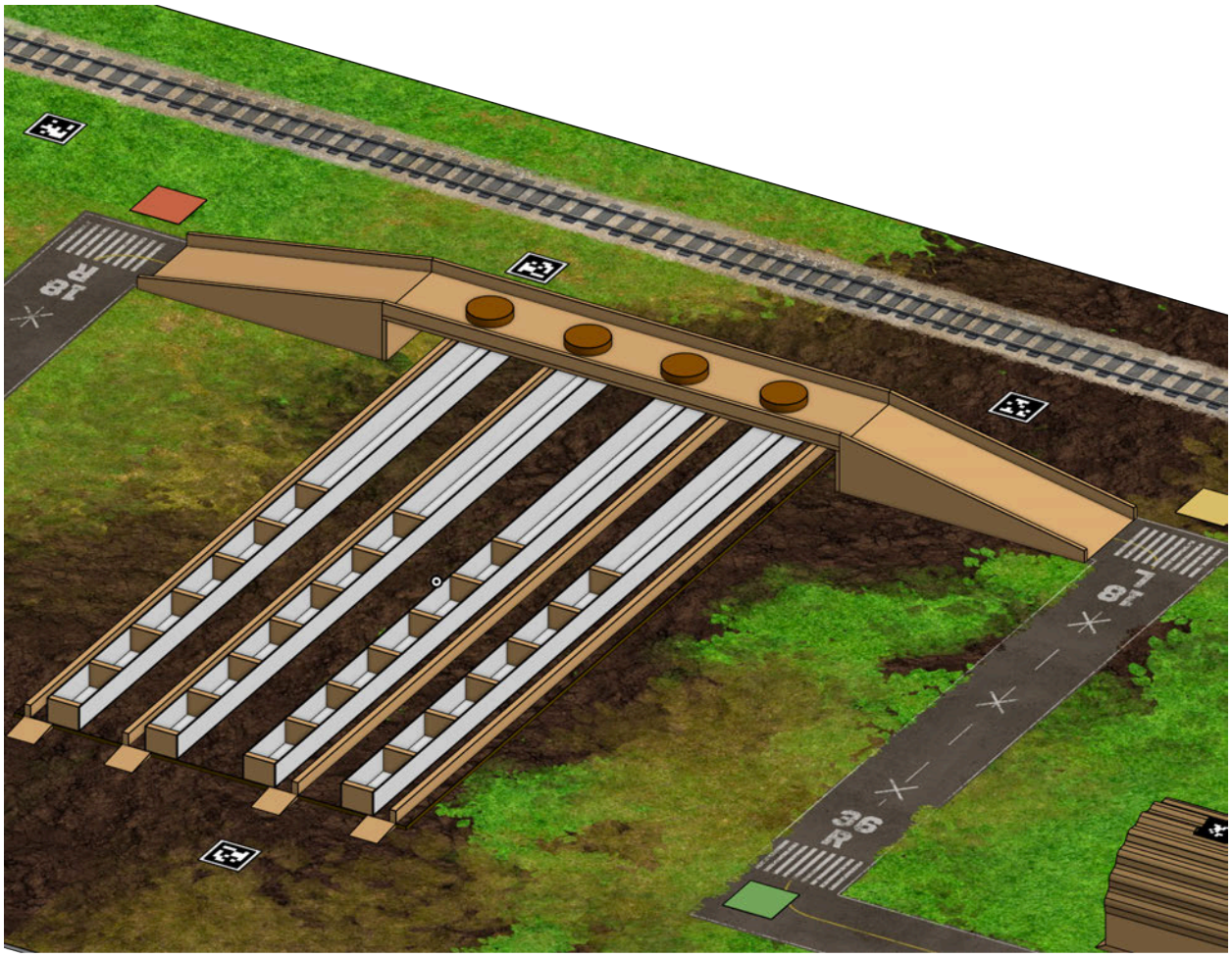


Figure 37: Bridge showing Bridge Coasters and Bridge Image Locations used during Mission 2.

Bridge Coasters – Removable covers placed over the four Bridge Image Locations. During Seeding Sprint, the four (4) Bridge Coasters are moved entirely off the Bridge structure for Bridge Coaster clearing points which also ensures Bridge Image Locations are exposed and ready to be scanned. As a contingency strategy, Teams may attempt to use DEXI-5 or DEXI-10 downwash to remove the Bridge Coasters if the RVR is unable to complete the task.

A Bridge Coaster is considered cleared when the entire Bridge Coaster has been moved completely off the Bridge structure and is resting on the Field floor, with no part of the Bridge Coaster touching the Bridge.

The Bridge Coasters will be made up of a 5” diameter black coaster on the top and a 5 ¼” diameter smooth wood coaster on the bottom. The coasters (both pieces attached to each other) will be roughly ⅞” tall. See Figure 38 on the following page. See Appendix A for more information.

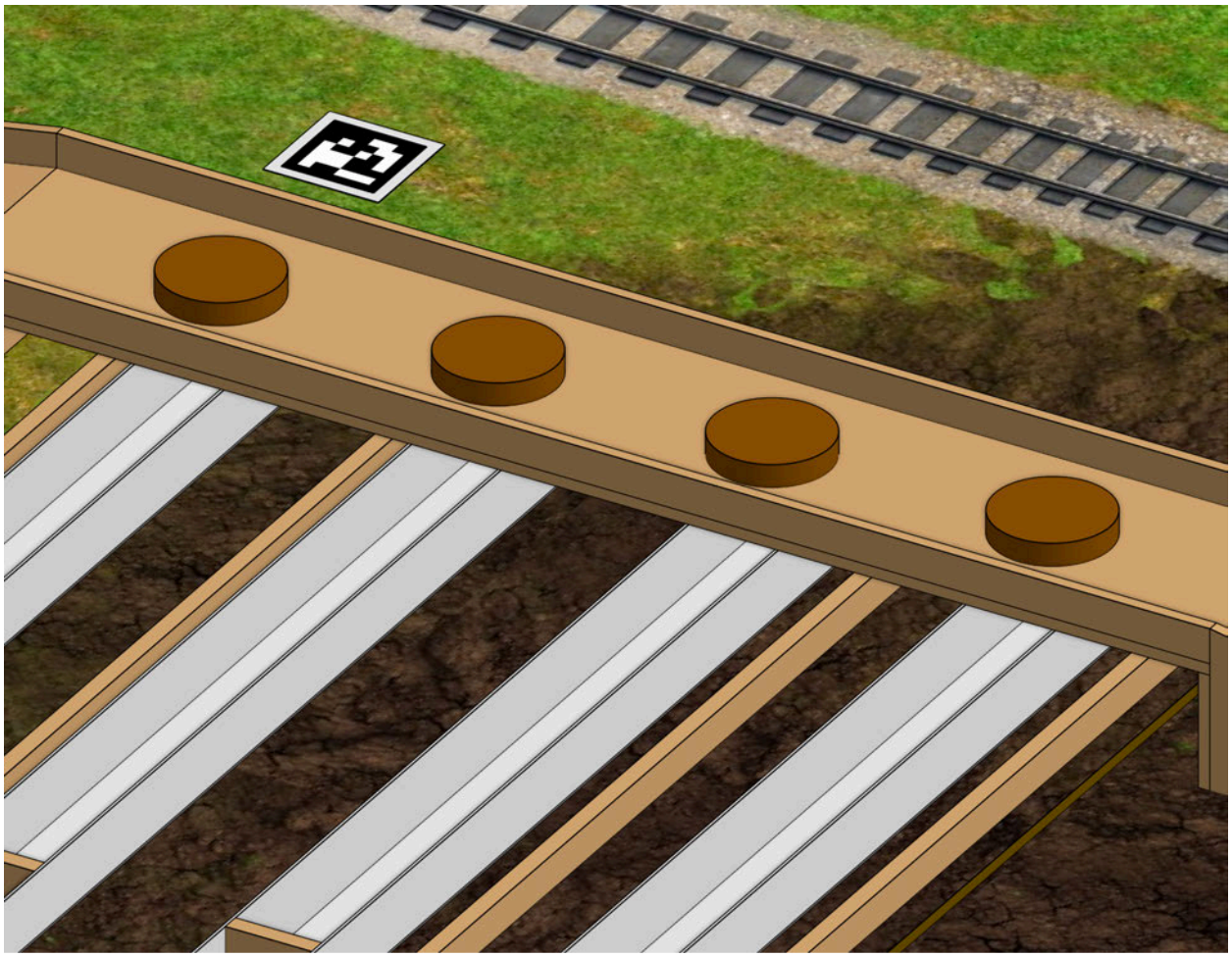


Figure 38: Bridge Coasters covering the Bridge Image Locations.

Bridge Images – Printed black and white images located on the Bridge which identify which crop rows are active and ready for planting. There are four (4) possible Cultivated Rows on the Field. During each Match, three (3) of the four rows are active. The Red Bridge Image contains one vertical white line on a black circle, the Green Bridge Image contains two vertical white lines, and the Blue Bridge Image contains three vertical white lines. The fourth location contains a solid black sticker with no Bridge Image to scan. These three Bridge Images correspond to the Red, Green, and Blue Seeds and Spheros. The inactive row does not receive Seed scoring during that Match.

DEXI-5 scans the Bridge Images and activates LED Signals to identify the active Cultivated Rows that are ready for Sphero verification and DEXI-10 aerial seeding. The positions of the Bridge Images and active rows will be randomized between Matches by the referees.

Bridge Images will be 3 inches in diameter as printed in the Bridge Image Locations.

See Figure 39 on the following page.

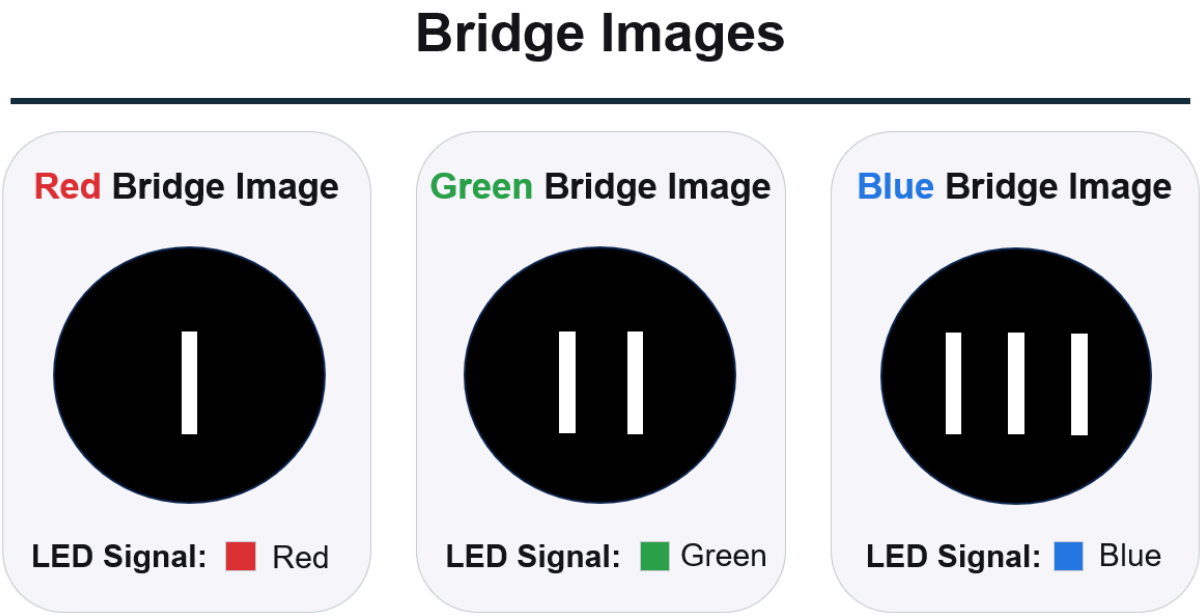


Figure 39: Bridge Images.

Cultivated Row – A designated crop row used during Seeding Sprint. There are four (4) Cultivated Rows on the Field, and three (3) are active during each Match. Active Cultivated Rows are identified through DEXI-5 scanning the Bridge Images and communicating the correct rows using LED Signals. Each Cultivated Row is divided into seven (7) sections for Seed scoring. See Figure 40 below. Yellow highlight outlines a Cultivated Row and red highlight outlines row section dividers.

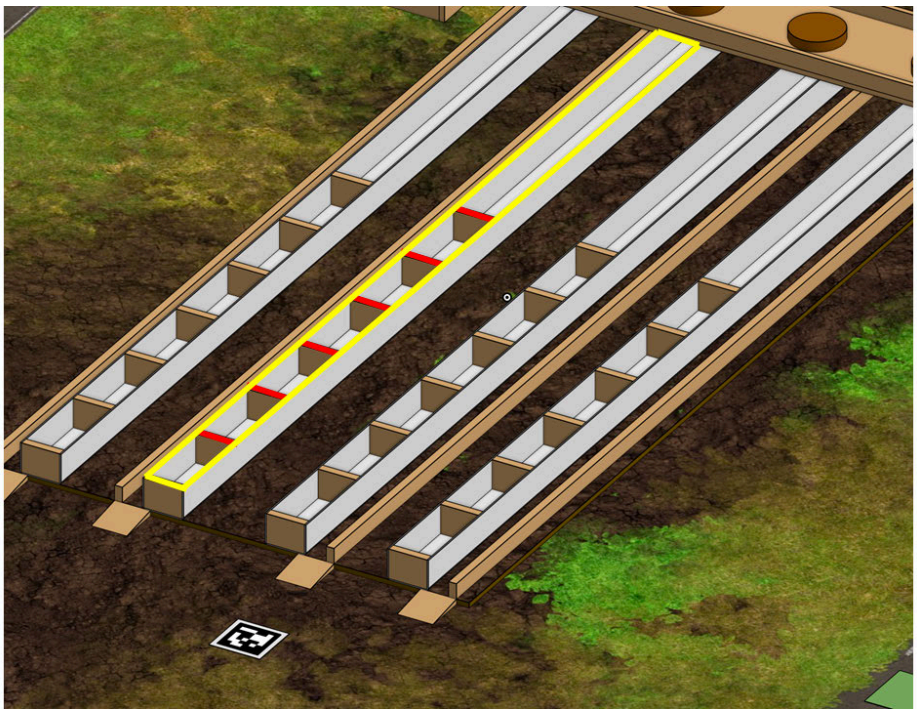


Figure 40: Cultivated Row and Row Sections

Freight Car – A Field Element used as the destination for hazardous materials removed from the former airfield. Freight Cars receive Gasoline Barrels and Toxic Fluid Barrels during Toxic Transfer. There are three (3) connected Freight Cars on the Field. Two (2) Freight Cars are active during each Match: one for Gasoline Barrels and one for Toxic Fluid Barrels. Each active Freight Car contains either a Gasoline or Toxic Fluid Image and the inactive Freight Car contains a black sticker. The third/inactive Freight Car does not receive hazardous Barrels for scoring during that Match.

During Toxic Transfer, the connected Freight Cars may be moved fully into Toxic Storage for additional points. A separate bonus is available when the designated Freight Car Front Hitch is used to connect to, and transport the Freight Cars fully into Toxic Storage.

See Figure 41 below. See Appendix A for more information.

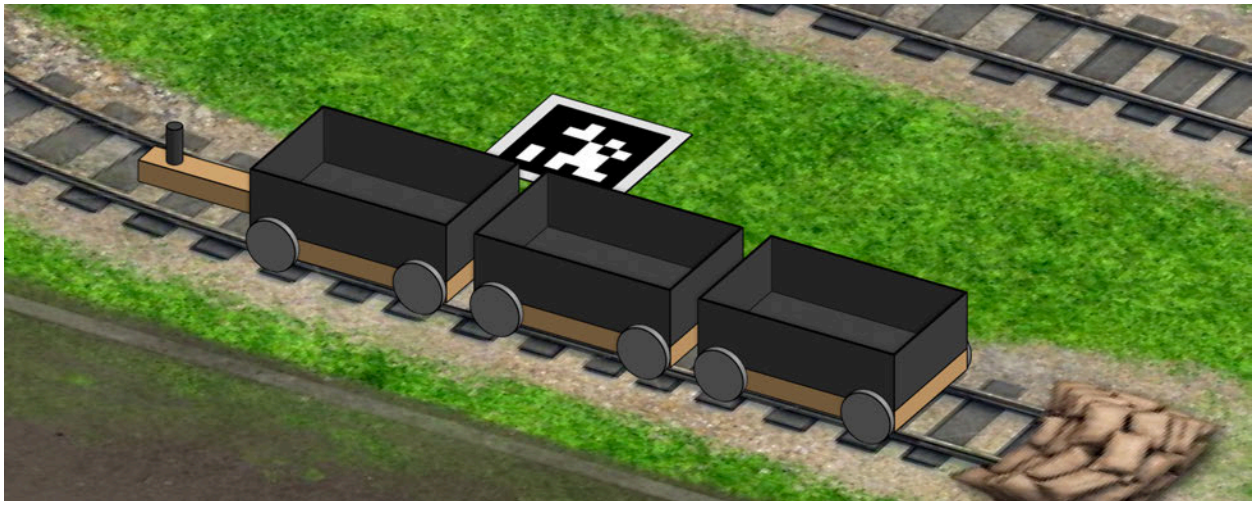


Figure 41: Freight Car Field Elements used for hazardous material removal.

Freight Car Delivery Area – The marked area surrounding the Freight Cars' starting position shown in Figure 42. The Freight Car Delivery Area will be outlined on the Field floor using tape or some other visual aid. New Freight Car Delivery placement points, including the 2-point Alongside Freight Car Delivery score and the 5-point Inside Freight Car Delivery score, may only be earned while the connected Freight Cars remain inside this area.

If the connected Freight Cars clearly leave the Freight Car Delivery Area, no additional Freight Car Delivery placement points may be earned unless the Freight Cars are returned to the area. Leaving the Freight Car Delivery Area does not prevent the Team from earning Freight Car movement points, the Front Hitch bonus, the Barrel transport bonus, or Toxic Storage placement points.

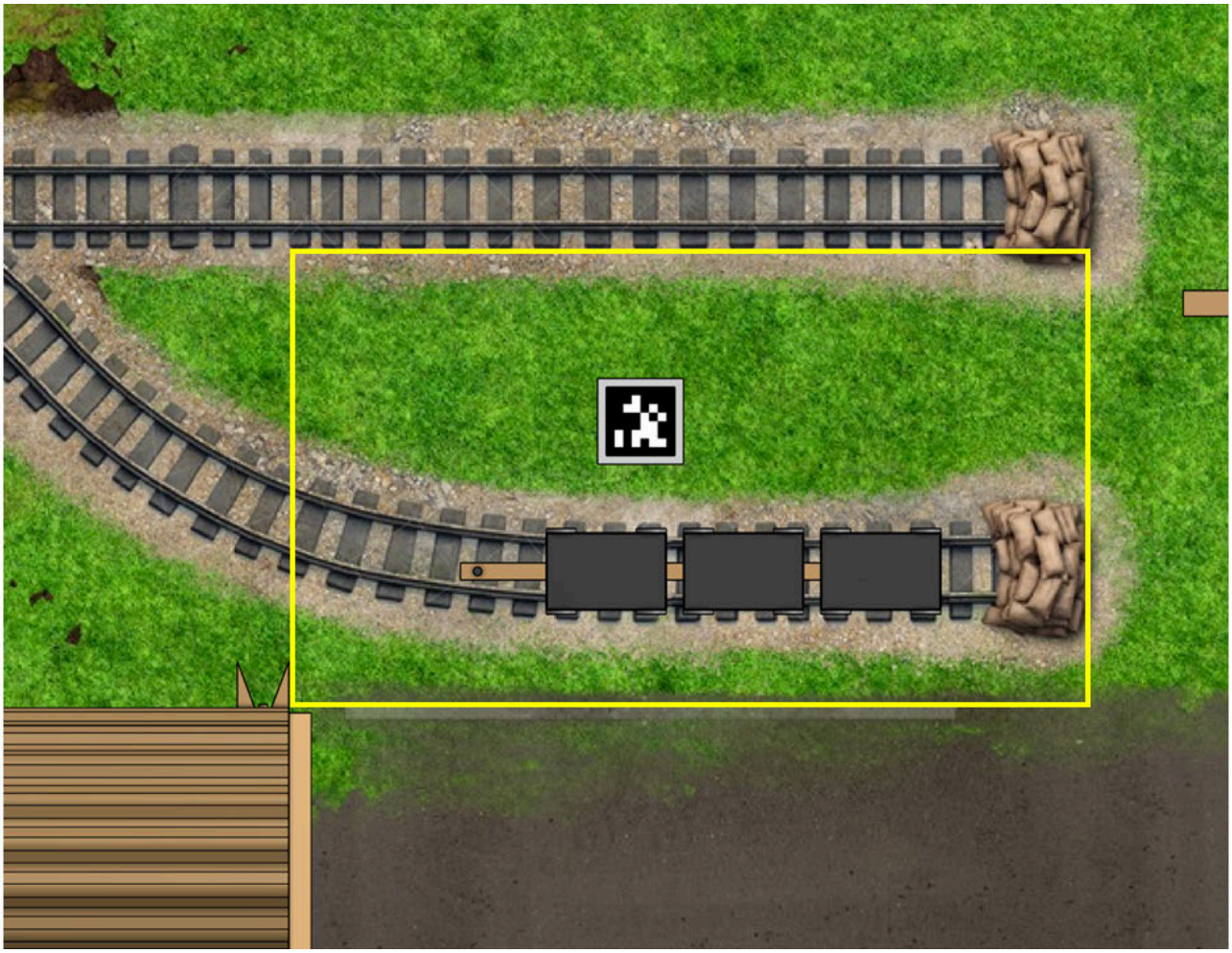


Figure 42: Freight Car Delivery Area

Freight Car Front Hitch – The area in the front of the Freight Car used for hitching/attaching to the Freight Cars during Toxic Storage transport. The hitch is made up of a beam sticking out the front of the first Freight Car. A cylinder sits centered on top of the wooden beam.

For the hitch/attachment bonus, an Aircraft or Vehicle may connect to the projecting beam, the cylinder mounted on the beam, or both. These components together make up the designated Freight Car Front Hitch and are the only portions of the Freight Car assembly that may be used as the attachment point for this bonus. Attaching to or using the Freight Car body, upper rim, wheels, axles, couplers, or another part of the Freight Car assembly does not qualify. See Figure 43 on the following page. Yellow highlight outlines the beam and cylinder considered part of the Front Hitch. See Appendix A for more information.

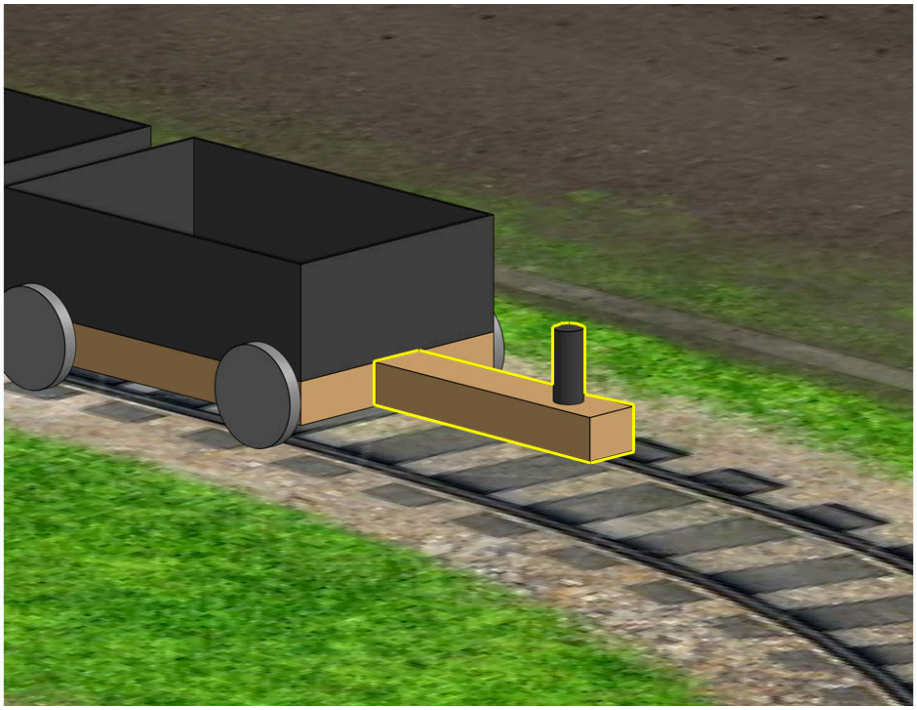


Figure 43: Freight Car Front Hitch to be used as attachment point.

Freight Car Images – Printed images located on the active Freight Cars that identify which hazardous material should be delivered to each Freight Car. DEXI-5 scans the Freight Car Images and activates the correct LED Signal to communicate where each hazardous Barrel should be delivered.

Freight Car Images include:

1. Gasoline Image - Red LED Signal
2. Toxic Fluid Image - Yellow LED Signal

Freight Car Images will be randomized between Matches by the referees.

See Figure 44 on the following page.

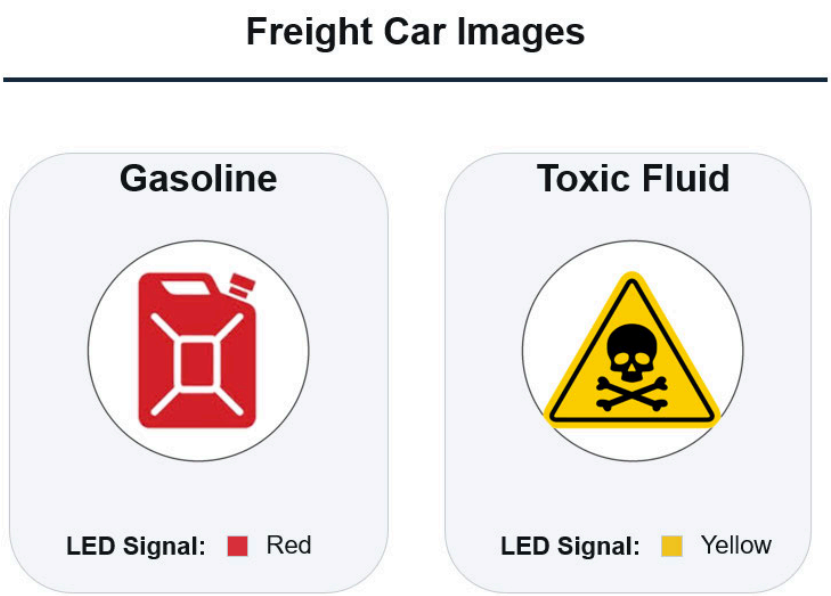


Figure 44: Freight Car Images used to identify Gasoline and Toxic Fluid destinations.

Gasoline Image – A printed mission image representing gasoline materials left at the former airfield. Barrels identified with the Gasoline Image must be transported to the correct Freight Car for removal from the site. The Gasoline Image uses a Red LED Signal. Gasoline Images will be two and five-eighths inches (2 ⅝”) in diameter and have a black border around the outside. See Figure 45 below which resembles the Gasoline Image as closely as possible to how it will be printed on the Field.

Figure 45: Gasoline Image.

Hangar – A Field Element representing the former airfield structures that contain Pallets to be removed during Mission 1 – Hangar Hustle. There are three (3) Hangars, each with one (1) Pallet inside. For each Match, two (2) of the three Hangars are identified as active by April Tags. The inactive Hangar uses a solid black sticker in place of an April Tag. The active Hangars will be randomized between Matches by the referees. See Figure 46 on the following page.

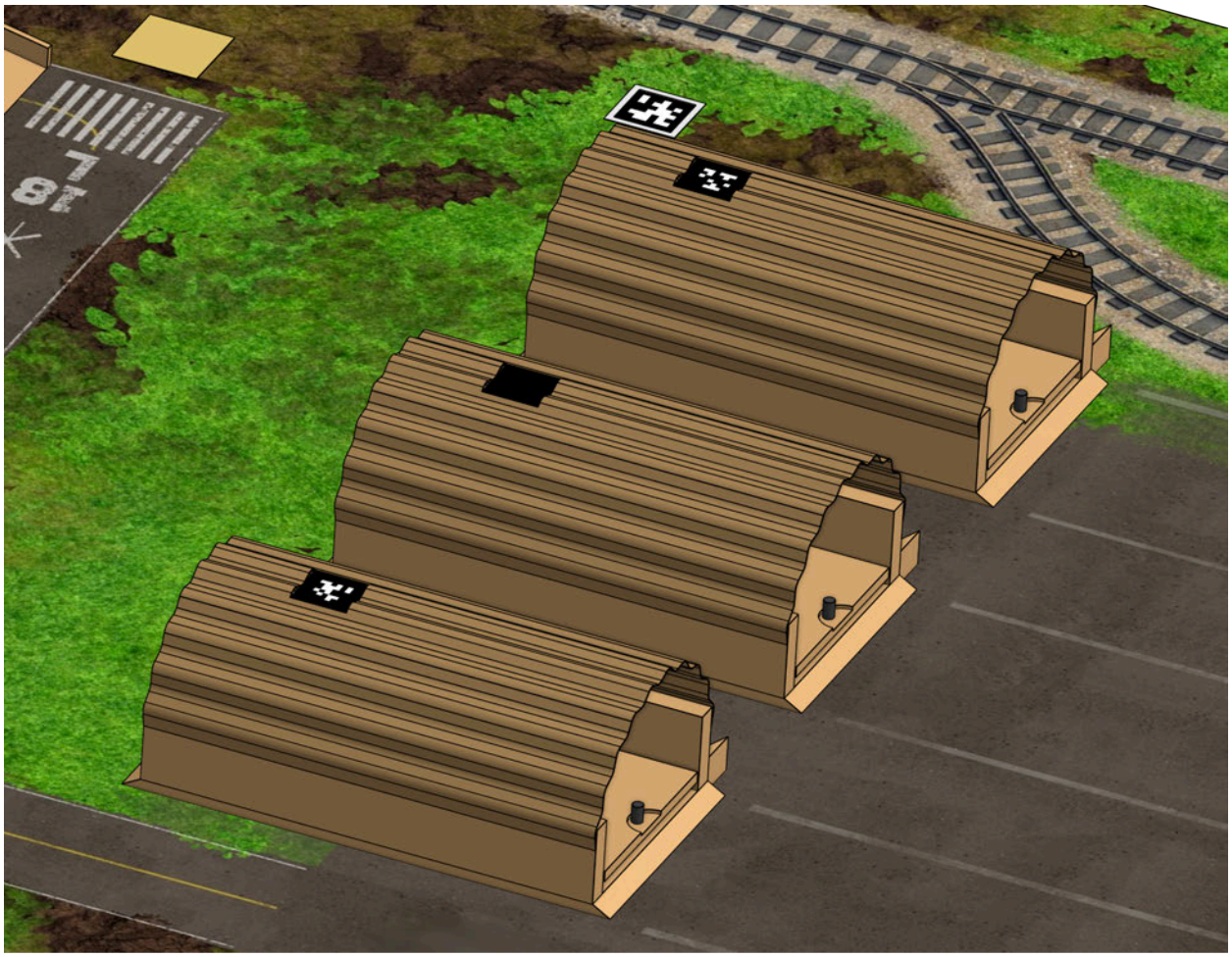


Figure 46: Hangars containing Pallets with Barrels and Hay Bales.

Hay Bale – A game object located on a Pallet inside a Hangar. Each Pallet contains one (1) Hay Bale. Hay Bales represent agricultural materials that may be transported to the no-image Barn during Barn Blitz.

Hay Bales are 3D printed objects and more information can be found in Appendix A. They do not have an image, do not require Object Recognition, and do not have an LED Signal.

See Figure 47 on the following page.

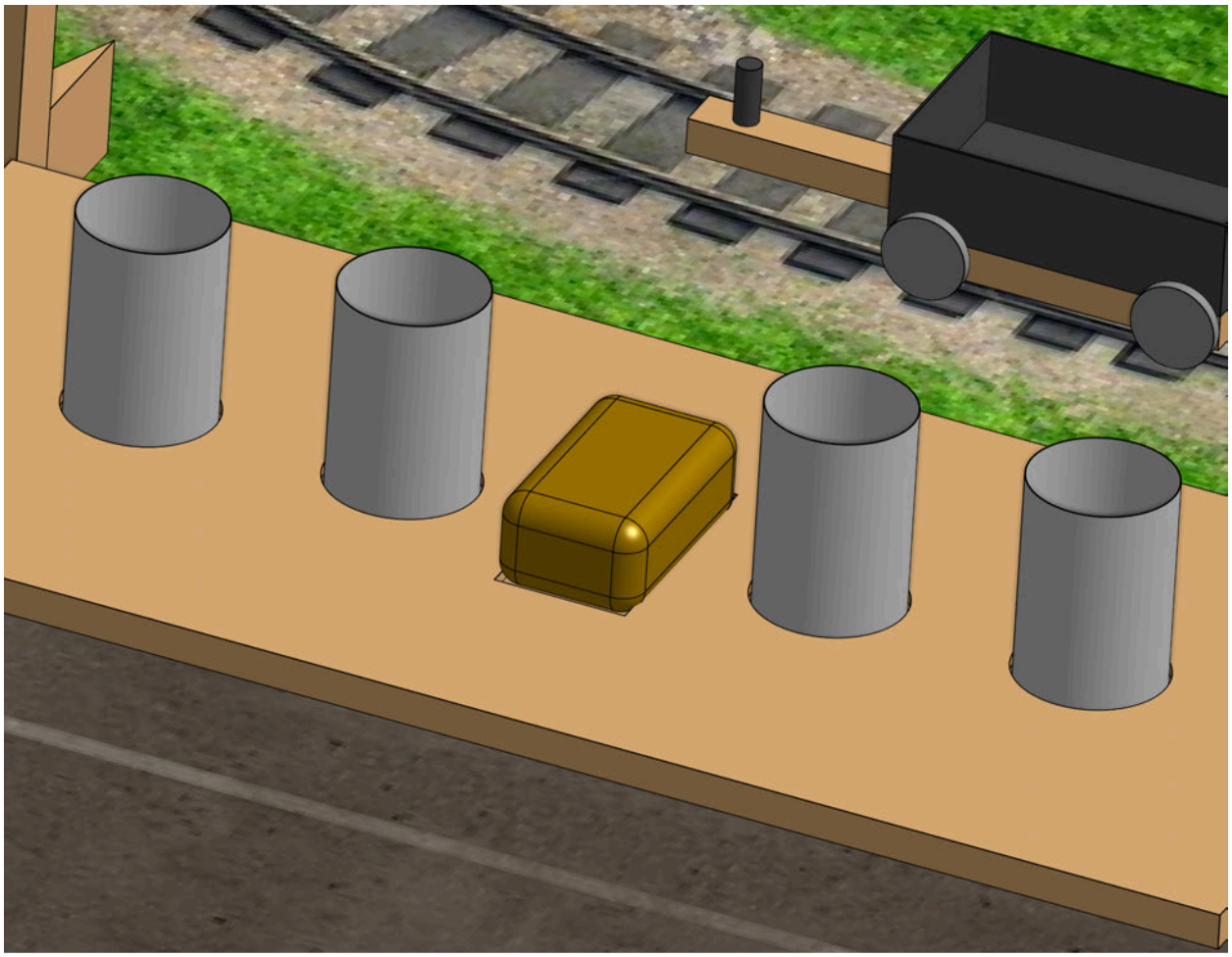


Figure 47: Hay Bale game object located on a Pallet.

Hitched/Attached – For the Toxic Transfer hitch/attachment bonus, an Aircraft or Vehicle must engage the designated Freight Car Front Hitch and use that connection while transporting the connected Freight Cars fully into Toxic Storage. Pushing, pulling, or contacting another part of the Freight Cars does not qualify for the hitch/attachment bonus. The Front Hitch connection must remain mechanically engaged throughout the qualifying transport until the connected Freight Cars are fully inside Toxic Storage.

Inside Freight Car Delivery – For Mission 4 Toxic Transfer, for a Barrel to be considered delivered inside a Freight Car in both Freight Car Delivery and Toxic Storage portions of the mission, it must be supported by the Freight Car and not resting on or supported by the Field Floor. It must not be upside down but it can be tipped, lying on its side, resting against the Freight Car rim or sitting on the Freight Car rim. During transport, normal bouncing or momentary movement does not invalidate this condition as long as the Barrel remains with the correct Freight Car and continues to meet the above criteria.

Tower Helipads/Helipads – Designated takeoff, landing, and parking areas located at the Towers on the Field. DEXI-5 begins at the top-right Tower Helipad, and DEXI-10 begins at the bottom-left Tower Helipad.

During Phase 3, DEXI-5 and DEXI-10 must return to their designated Tower Helipads to receive parking points. Each DEXI should be landed on top of the Tower Helipad they originally took off from, but imperfect landings may still score at referee discretion. To receive parking points, the aircraft may be partially on the Tower Helipad, but it may not be tilted more than approximately forty-five (45) degrees from a normal level takeoff/landing position. No measurement device will be used to verify this - final determination for points is made by the referee and may be escalated to the Head Referee if needed. “Dangle DEXIs” in general do not get points 😁.

The bullseye at the end of each DEXI Phase 1 April Tag route is not a Tower Helipad. It is the Phase 1 landing target used for the DEXI full-route bonus.

Figures 48 & 49: DEXI-5 (left) and DEXI-10 (right) Tower Helipads shown on the Field.

Pallet – A game object located inside each Hangar. Each Pallet contains four (4) Barrels and one (1) Hay Bale. Each active Pallet contains one Wheat Barrel, one Water Barrel, one Gasoline Barrel, one Toxic Fluid Barrel, and one Hay Bale. Barrel positions will be randomized between Matches by the referees. During Hangar Hustle, the RVR pulls the selected Pallets out of the Hangars so DEXI-5 can scan the Barrel Images and identify the materials for transport. See Figure 50 on the following page.

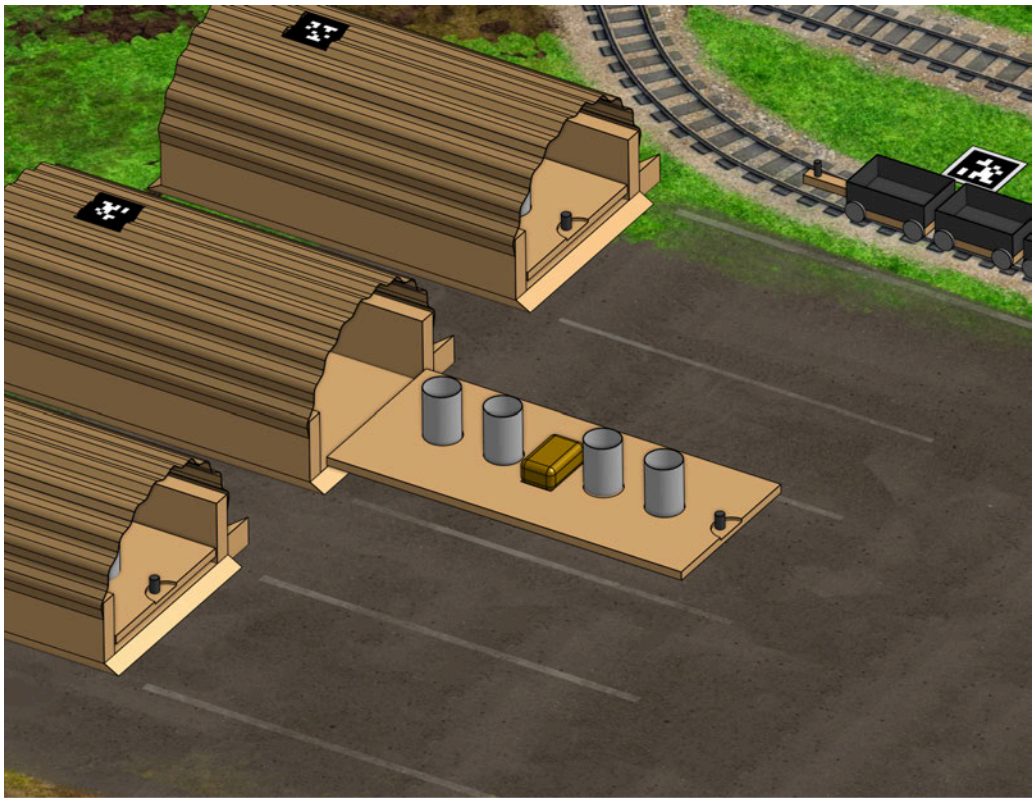
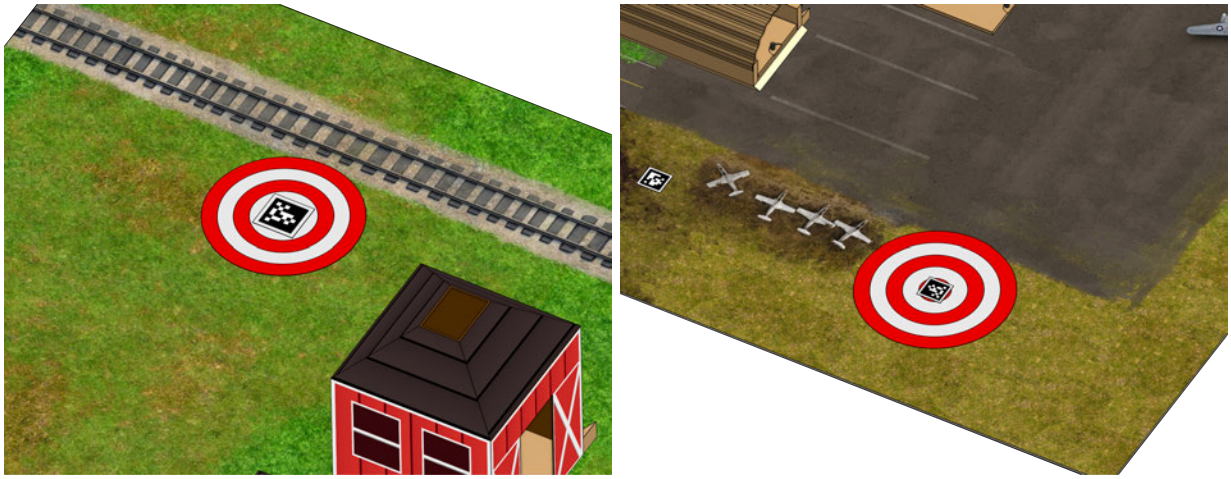


Figure 50: Pallet with four (4) Barrels and one (1) Hay Bale.

Phase 1 DEXI Landing Target – The bullseye located at the end of each DEXI Phase 1 April Tag route. Each DEXI route ends at an April Tag/checkpoint located inside the bullseye. To receive the full-route autonomous bonus, DEXI must complete the route from ID 0 through ID 6 hands-off, display the correct LED Signal for each April Tag/checkpoint before reaching the next April Tag/checkpoint, reach the final April Tag/checkpoint, and land right-side up, ideally on the bullseye, without manual intervention. Landing on the bullseye is ideal but is not required for the full-route bonus. At ID 6 the correct LED Signal must be shown before fully landing on the ground. See Figures 51 & 52 below.



Figures 51 & 52: Phase 1 DEXI-5 (left) and DEXI-10 (right) Landing Targets

NEW Seed – A Team-selected spherical game object representing crop seed that is delivered during Seeding Sprint. Seeds are Red, Green, and Blue to match the active Cultivated Rows and Spheros. There are seven (7) Seeds for each color. DEXI-10 is the primary Aircraft intended to perform aerial seeding by dropping Seeds into the correct active Cultivated Rows after the corresponding Spheros verify that the rows are ready for planting.

Seeds must meet all of the following requirements:

a. Seeds must be spherical balls between five-eighths (5/8) inch and seven-eighths (7/8) inch in diameter.
b. Seeds may be made of plastic, wood, or metal.
c. Glass or ceramic Seeds that could easily shatter or chip are prohibited.
d. Liquid-filled Seeds are prohibited.
e. Adhesives may not be used to make the Seed itself sticky or to directly attach a Seed to a deployment mechanism.
f. Seeds may not leave residue, powder, debris, or anything difficult to clean from the Field.
g. Seeds may not damage printed vinyl or other Field Elements.
h. Seeds may not be intentionally modified with features intended for gripping, tethering, or attachment - see additional detail in 5.3.12

Figure 53 below shows an example ¾” Steel Ball with identifying color.

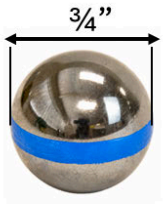


Figure 53: Example Seed object used for aerial seeding.

Seed Section – One of seven (7) scoring sections within a Cultivated Row. Seeds earn base points when they land in the correct active row. A Seed earns additional section bonus points if it lands alone in a Seed Section of the matching active Cultivated Row.

Sphero Row Verification – A scoring and mission confirmation action during Seeding Sprint. After DEXI-5 identifies the active Cultivated Rows, the corresponding Spheros travel all the way down the correct active rows, as close to the Bridge as they can get while remaining visible to referees. If a Sphero travels under the Bridge or is otherwise hidden from referee view, Sphero Row Verification points may not be awarded.

A row is considered verified when the correct color Sphero has traveled down the identified active Cultivated Row and reached the required location near the Bridge. **Spheros should remain in place throughout seeding to act as a reminder to their Team.** Sphero Row Verification points are separate from Seed scoring. If the correct Sphero does not complete verification, Seeds may still score if they land in the correct active Cultivated Row.

See Figures 54 & 55 on the following page.

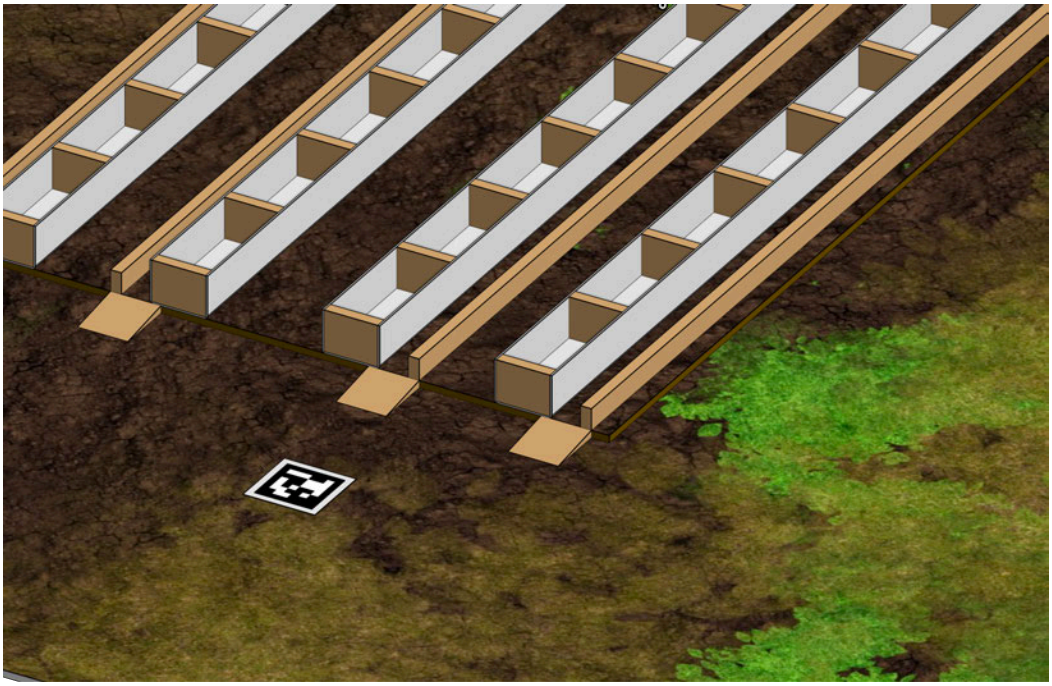


Figure 54: Ramps in front of Sphero Verification Rows/Gutters

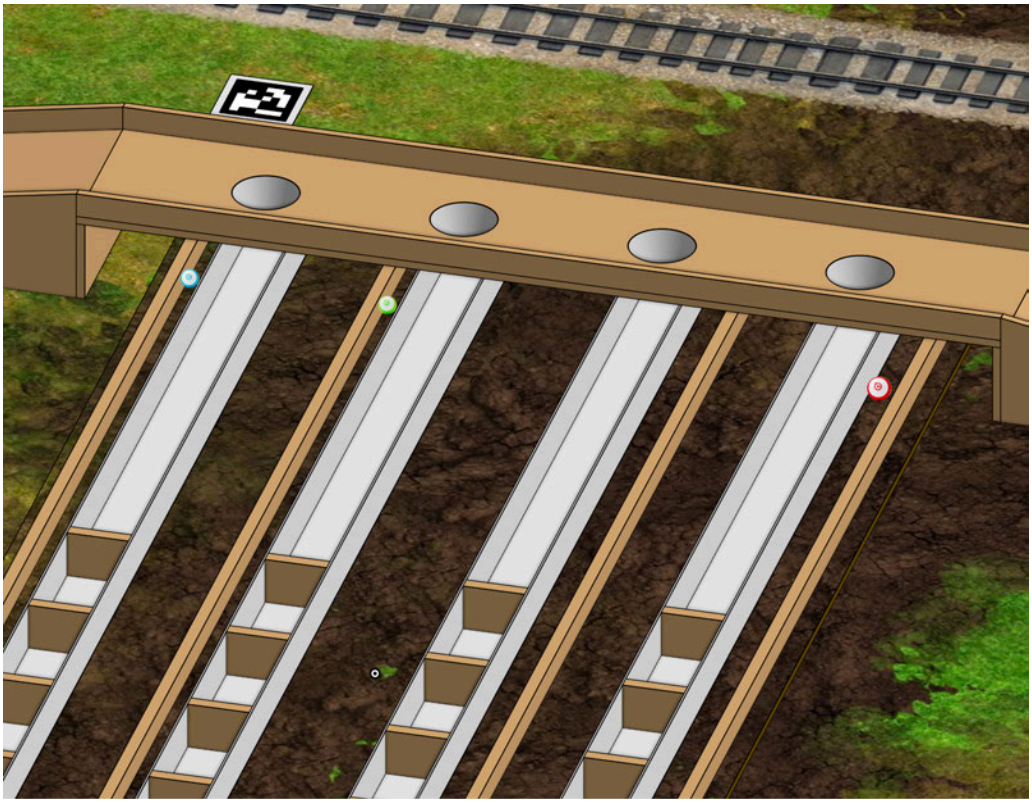


Figure 55: Sphero Row Verification showing Spheros positioned near the Bridge at the end of the Cultivated Rows.

Toxic Storage – A designated area on the Field where the connected Freight Cars may be moved during Toxic Transfer. Toxic Storage scoring is evaluated at the end of the Match. To be considered fully inside Toxic Storage, the Freight Cars and/or Barrels being scored must be completely inside the Toxic Storage boundary, with no part touching or crossing the boundary line. The Aircraft or Vehicle transporting the Freight Cars is not taken into consideration when verifying the Freight Cars are fully inside Toxic Storage - it does not matter what the position of the Aircraft or Vehicle is in relation to the Toxic Storage boundary.

Toxic Storage Boundary – The designated area that Freight Cars and Barrels are transported to and must be fully within to receive points in the Toxic Storage portion of Mission 4 Toxic Transfer. This area will be roughly centered over the printed train track graphics. The minimum dimensions for Toxic Storage are as follows:

- 34 inches long (measuring the same direction as the train tracks)
- 10 inches wide.

Toxic Storage will always be placed somewhere between DEXI-5's ID 5 and ID 6 Autonomy Challenge April Tags while roughly centered over the train tracks. This ensures ample room for maneuver on both ends of Toxic Storage. See Figure 56 below. See Appendix A for more information.

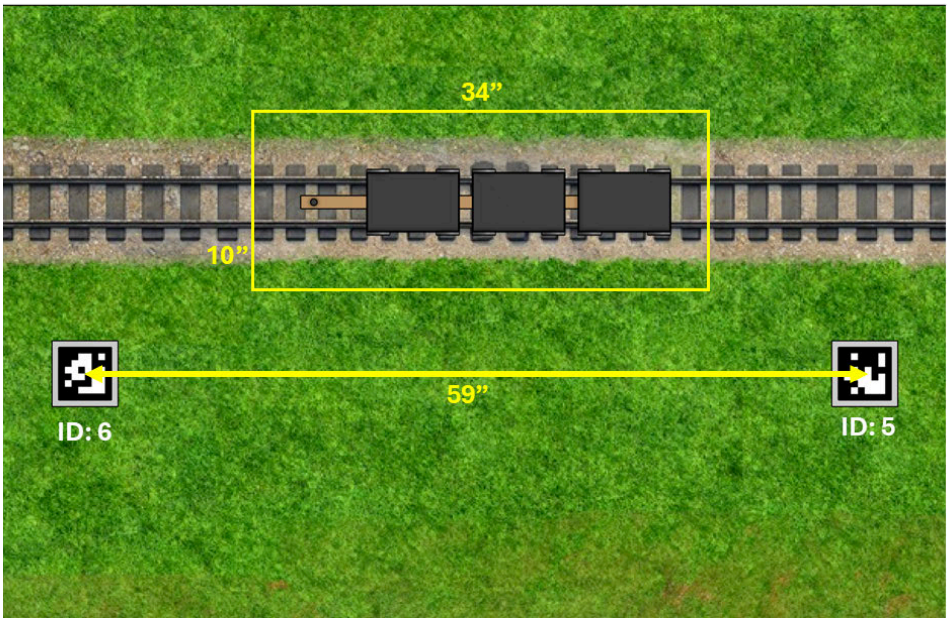


Figure 56: The dimensions of the Toxic Storage Boundary in Yellow Highlight additionally showing the 59” distance between April Tags for scale.

Toxic Storage will be defined by some type of painter's tape or gaffer tape placed onto the printed flooring and exact placement and dimensions will vary.

Teams should carefully take into consideration Barrel diameter and Freight Car width if only able to deliver Barrels alongside Freight Cars in Toxic Storage as it may require specific placement of the Freight Cars within Toxic Storage for success.

Toxic Fluid Image – A printed mission image representing hazardous fluid materials left at the former airfield. Barrels identified with the Toxic Fluid Image must be transported to the correct

Freight Car for safe removal from the site. The Toxic Fluid Image uses a Yellow LED Signal. Toxic Fluid Images will be two and five-eighths inches (2 ⅝”) in diameter and have a black border around the outside. See Figure 57 below which resembles the Toxic Fluid Image as closely as possible to how it will be printed on the Field.

Figure 57: Toxic Fluid Image.

Vehicle – The RVR or any of the Spheros.

Water Image – A printed mission image representing water resources used to support agricultural operations. Barrels identified with the Water Image must be transported to the Water Barn. The Water Image uses a Blue LED Signal. Water Images in Barrels will be two and five-eighths inches (2 ⅝”) in diameter and have a black border around the outside. See below: Figure 58, which resembles the Water Image as closely as possible to how it will be printed on the Field Barrels. Water Images in Barns will be 4 inches wide by 4 inches tall (same way dimensions were applied to April Tags) and have a black border around the outside. See Figure 59 on the following page, which resembles the Water Image as close as possible to how it will be printed in the Barns.

Figure 58: Water Image in Barrels.

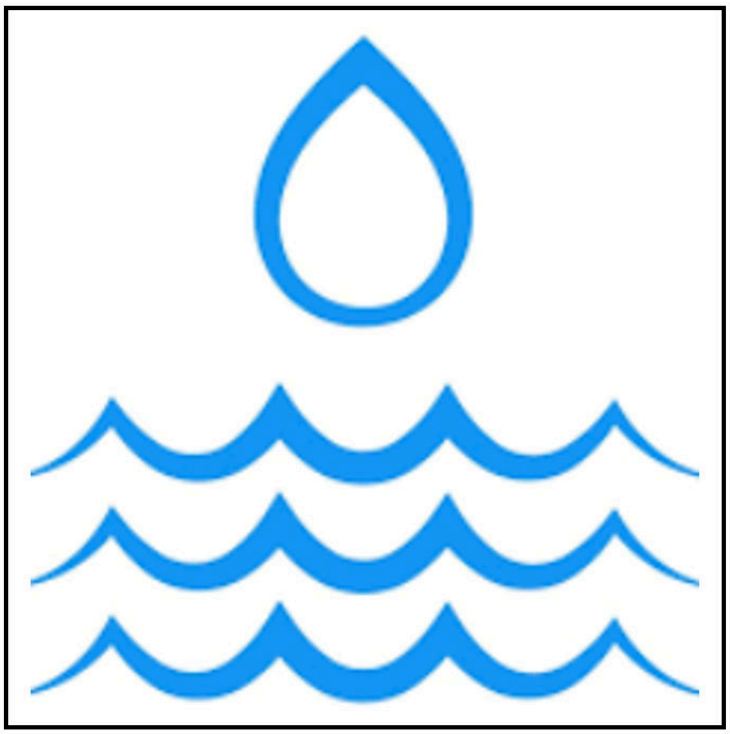


Figure 59: Water Image in Barns.

Wheat Image – A printed mission image representing wheat or crop-related agricultural supplies. Barrels identified with the Wheat Image must be transported to the Wheat Barn. The Wheat Image uses a Green LED Signal. Wheat Images in Barrels will be two and five-eighths inches (2 ⅝”) in diameter and have a black border around the outside. See below: Figure 60, which resembles the Wheat Image as closely as possible to how it will be printed on the Field Barrels. Wheat Images in Barns will be 4 inches wide by 4 inches tall (same way dimensions were applied to April Tags) and have a black border around the outside. See on the following page: Figure 61, which resembles the Wheat Image as close as possible to how it will be printed in the Barns.

Figure 60: Wheat Image in Barrels.

Figure 61: Wheat Image in Barns.

5 – The Game

5.1 – Scoring

A Team's score at the end of the Match is determined by adding all points from Phase 1, Phase 2, and Phase 3.

Phase 1 is the Autonomous Challenge, but Phase 1 scoring is not limited to autonomous operation. Teams may earn reduced-value manual route-completion points, higher-value autonomous route-completion points, and full-route autonomous bonus points.

For Phase 1 route scoring, each checkpoint or action may receive either manual points or autonomous points, but not both. Autonomous completion does not automatically earn the manual point for that same checkpoint or action.

Each Aircraft and Vehicle receives points for its best single Phase 1 route attempt. Points from multiple attempts may not be combined.

- Example: If a DEXI completes ID 0 through ID 3 autonomously and ID 4 through ID 6 manually on one attempt, then later completes ID 0 through ID 3 manually and ID 4 through ID 6 autonomously on a second attempt, the Team may not combine the autonomous portions of both attempts. The referee will score only the best single attempt. In this example, the first attempt would be scored because it included four autonomous April Tag checkpoints, while the second attempt included 3.

Unless specifically stated otherwise, Phase 2 scoring actions are not limited to a single Aircraft or Vehicle. Teams are encouraged to develop backup strategies that allow other capable Aircraft or Vehicles to complete scoring actions when possible.

A game object delivered to the wrong destination does not receive delivery or placement points.

Phase 1 route actions and checkpoints must be completed in the specified order. DEXI routes must follow April Tag ID 0 through ID 6. RVR and Sphero routes must follow the routes shown in the manual. Aircraft and Vehicles may not skip checkpoints, skip actions, or use shortcuts. If one misses a checkpoint or action and continues forward, it will not receive points for the missed checkpoint/action or any later checkpoint/action until it returns to the missed location and resumes the route in order.

Manual intervention removes full-route autonomous bonus eligibility for that attempt. However, after manual intervention, the Aircraft or Vehicle may still earn later manual or autonomous checkpoint/action points if those checkpoints/actions are completed in order.

If a Team attempts or restarts Autonomous Phase 1 route scoring after the first thirty (30) seconds, a Drive Team Member must clearly notify a referee before the attempt begins or continues so the referee can observe the route.

Phase 1 – Autonomous Challenge Scoring

Phase 1 – DEXI-5 and DEXI-10 Route Scoring	Points	Maximum Points
DEXI-5 manual April Tag and correct LED display, at the last April Tag (ID 6), lands	1 (per Checkpoint)	7
DEXI-5 completes April Tag checkpoint hands-off, shows correct LED color, and at the last April Tag (ID 6), lands	3 (per Checkpoint)	21
DEXI-5 completes full route hands off - no intervention	15	15
DEXI-10 manual April Tag and correct LED display, at the last April Tag (ID 6), lands	1 (per Checkpoint)	7
DEXI-10 completes April Tag checkpoint hands-off, shows correct LED color, and at the last April Tag (ID 6), lands	3 (per Checkpoint)	21
DEXI-10 completes full route hands off - no intervention	15	15
TOTAL MAX POINTS		**72**

**Additional Notes: DEXI-5 begins at the top-right Tower Helipad and travels from right to left along the top side of the Field. DEXI-10 begins at the bottom-left Tower Helipad and travels from left to right along the bottom side of the Field.

For manual and autonomous DEXI checkpoint points, the correct assigned LED Signal must be displayed before the aircraft reaches the next April Tag/checkpoint. DEXI does not need to stop over each April Tag/checkpoint. To receive the full-route bonus, DEXI must complete the route from ID 0 through ID 6 hands-off, display the correct LED Signal for each April Tag/checkpoint before reaching the next April Tag/checkpoint, reach the final April Tag/checkpoint, and land right-side up, ideally on the bullseye, without manual intervention. For April Tag ID 6, the DEXI must display the Magenta LED Signal before landing on the ground.

Manual checkpoint points and autonomous checkpoint points are alternatives for each checkpoint; a single checkpoint may not receive both.

Manual attempts are only allowed in the first 30 seconds of the Match; only autonomous attempts can begin or continue after the first 30 seconds of the Match.

Phase 1 – Sphero & RVR Route Scoring	**Points**	**Maximum Points**
Green Sphero manually completes route action	1 (per Action)	9
Green Sphero completes route action autonomous/hands off	3 (per Action)	27
Green Sphero full route autonomy bonus, no intervention, hands off	7	7
Red Sphero manually completes route action	1 (per Action)	6
Red Sphero completes route action autonomous/hands off	3 (per Action)	18
Red Sphero full route autonomy bonus, no intervention, hands off	6	6
Blue Sphero manually completes route action	1 (per Action)	9

Blue Sphero completes route action autonomous/hands off	3 (per Action)	27
Blue Sphero full route autonomy bonus, no intervention, hands off	7	7
RVR manually completes route action	1 (per Action)	6
RVR completes route action autonomous/hands off	3 (per Action)	18
RVR full route autonomy bonus, no intervention, hands off	7	7
TOTAL MAX POINTS		**117**
PHASE 1 TOTAL MAX POINTS		**189**

**Manual action points and autonomous action points are alternatives for each route action; a single route action may not receive both manual and autonomous points. Only the best single Phase 1 attempt for each Sphero or the RVR is scored. For example, if the RVR completes only its first route action manually in one attempt and later completes only that same first route action autonomously in another attempt, the autonomous attempt is the higher-scoring attempt and receives three (3) points. The one-point manual attempt is not also added to the score.

Manual Phase 1 operation is permitted only during the first thirty (30) seconds of the Match. At the thirty-second mark, all manual Phase 1 operation must stop. Only hands-off autonomous Phase 1 actions may continue or begin after that time.

Phase 2 – Airfield Reclamation Scoring

During Phase 2, Teams may complete the four Airfield Reclamation missions in any order. Unless specifically stated otherwise, Phase 2 scoring actions are not limited to a single Aircraft or Vehicle.

A game object delivered to the wrong destination does not receive delivery or placement points.

Phase 2 – Mission 1 – Hangar Hustle Scoring	Points	Maximum Points
DEXI identifies an active Hangar April Tag and activates the correct LED Signal	3 (per Active Hangar)	6
Correct color Sphero travels to the matching active Hangar, activates switch before Pallet is engaged for removal	3 (per Sphero)	6
Active Pallet is pulled fully out of the Hangar	2 (per Pallet)	4
DEXI identifies a Barrel Image and activates the correct LED Signal	2 (per Image)	16
Barrel or Hay Bale is removed from the Pallet	1 (per Object)	10
TOTAL MAX POINTS		**42**

Phase 2 – Mission 2 – Seeding Sprint Scoring	Points	Maximum Points
Bridge Coaster is moved fully off the Bridge	2 (per Bridge Coaster)	8
DEXI identifies correct Bridge Image and activates the correct LED Signal	2 (per Cultivated Row)	6
Correct color Sphero travels all the way down the correct Cultivated Row near the Bridge to validate the row	3 (per Sphero)	9
Correct color Seed lands in correct Cultivated Row	1 (per Seed)	21
Correct color Seed lands alone in section of correct row	1 (per Seed)	21
TOTAL MAX POINTS		**65**

**A Bridge Coaster is considered cleared when the entire Bridge Coaster has been moved completely off the Bridge structure and is resting on the Field floor, with no part of the Bridge Coaster touching the Bridge.

There are four (4) Cultivated Rows on the Field. Three (3) rows are active during each Match and may receive Seed scoring. The inactive row does not receive Seed scoring during that Match.

Seed Section bonus points stack with base Seed row points. A correct-color Seed that lands alone in a section of the matching active Cultivated Row may receive both the 1-point base Seed score and the 1-point section bonus.

A Seed cannot come to rest on top of a row boundary or section divider; it must be fully inside and on the bottom of section/row “buckets” to receive points.

Seed scoring is evaluated after the Match ends. If a Seed is moved by prop wash or other Aircraft or Vehicle movement before the end of the Match, its final resting location is used for scoring.

Phase 2 – Mission 3 – Barn Blitz Scoring	**Points**	**Maximum Points**
DEXI-5 or DEXI-10 identifies Barn Image and activates the correct LED Signal	3 (per Barn)	6
Correct color Sphero travels to matching Barn, activates switch to verify unloading location	3 (per Sphero)	6
Option 1: Correct Barrel or Hay Bale is delivered in through the matching Barn Entrance	2 (per Object)	12
Option 2: Correct Barrel or Hay Bale is deposited through the Top Opening of the matching Barn	5 (per Object)	30
TOTAL MAX POINTS		**42**

**Barn Images include Wheat and Water only. The Barn with no image is the Hay Bale Barn. No Sphero verification points are available for Hay Bale delivery. The Hay Bale Barn Switch Button does not provide scoring points.

A single object may not receive both the entrance delivery path and the top-opening deposit path. The maximum placement score for one Barn Blitz object is five (5) points.

If an object first earns the 2-point Barn Entrance score and is later successfully deposited through the Barn Top Opening, its placement score is upgraded to the 5-point top-opening score. The object does not receive both scores.

If a DEXI is used to transport a Barrel or Hay Bale to a Barn, the Taxiing restrictions in Rule 5.3.15 apply.

Phase 2 – Mission 4 – Toxic Transfer Scoring	Points	Maximum Points
DEXI identifies Freight Car Image and activates the correct LED Signal	3 (per Freight Car)	6
Any Sphero travels to and contacts an active Freight Car to verify unloading location	3 (per Sphero)	6
Option 1: Correct Gasoline or Toxic Fluid Barrel is pushed/placed alongside the matching Freight Car	2 (per Barrel)	8
Option 2: Correct Gasoline Barrel or Toxic Fluid Barrel is delivered inside the matching Freight Car	5 (per Barrel)	20
Connected Freight Cars are moved fully into Toxic Storage	2	2
Hitch is used to connect to Freight Cars and transport them fully into Toxic Storage	5	5
Correct Barrel remains inside matching Freight Cars while transported and until fully inside Toxic Storage	4 (per Barrel)	16
Correct Gasoline or Toxic Fluid Barrel alongside matching Freight Car while both are fully inside Toxic Storage	2 (per Barrel)	8
Correct Gasoline or Toxic Fluid Barrel is inside correct Freight Car while the Freight Cars are fully inside Toxic Storage	4 (per Barrel)	16
TOTAL MAX POINTS		**71**
PHASE 2 TOTAL MAX POINTS		**220**

If a Barrel first earns the 2-point alongside-Freight-Car score (for Freight Car Delivery before Toxic Storage transport) and is later successfully delivered inside the correct Freight Car (also for Freight Car Delivery before Toxic Storage transport), its placement score is upgraded to the 5-point Freight Car delivery score. The Barrel does not receive both scores.

Points for Freight Car Delivery alongside or inside the Freight Cars (before Toxic Storage tasks) are received as soon as a Barrel meets the alongside or inside delivery definitions in Section 4.2

Game Definitions. If a Barrel is accidentally knocked out of the Freight Car/out of the “alongside” definition area after receiving points, the points are not taken away. This also means that Barrels that have received inside Freight Car Delivery points do not need to remain in the Freight Cars during transport and if put inside the Freight Cars before the end of the Match, retain their Freight Car Delivery points and could still receive full inside delivery points for Toxic Storage. However, if Barrels do not remain inside the Freight Cars while being transported to Toxic Storage, they will not receive the point bonus.

Bonus points are received for Barrels that remain inside Freight Cars while transported and until fully inside Toxic Storage. These Barrels must continue to meet the definition of “inside” as stated in Section 4.2.

New Freight Car Delivery placement points may only be earned while the connected Freight Cars are inside the Freight Car Delivery Area. Leaving the area does not prevent the Team from earning Freight Car transport or Toxic Storage points. See Section 5.2.7.

For Toxic Storage, a single Barrel may not receive both the alongside Freight Car points and inside Freight Car delivery.

If the connected Freight Cars are moved fully inside Toxic Storage regardless of Barrel location, the Team receives the 2-point base movement score. If the Freight Car hitch is used to connect to the Freight Cars and they are transported fully inside Toxic Storage, the Team also receives the 5-point hitch/attachment bonus. The base 2 points are automatically awarded if a Team receives the 5-point hitch bonus.

If a correct Gasoline Barrel or Toxic Fluid Barrel is alongside the matching Freight Car and fully inside Toxic Storage while the Freight Cars are fully inside Toxic Storage, that Barrel receives the 2-point Toxic Storage base score. If a Barrel is instead inside the correct Freight Car while fully inside Toxic Storage, it receives the 4-point Freight Car Toxic Storage bonus. It does not receive both the base 2 points and 4 bonus points.

Toxic Storage points (not all of Toxic Transfer) are evaluated at the end of the Match. To receive Toxic Storage points, the connected Freight Cars must be fully inside Toxic Storage. Fully inside means no part of the Freight Cars or scored Barrels is touching or crossing the Toxic Storage boundary line. The Aircraft or Vehicle transporting the Freight Cars does not need to be fully inside Toxic Storage for the Freight Cars or Barrels to receive Toxic Storage points.

Phase 3 – Mission Wrap-Up Scoring

Phase 3 – Mission Wrap-Up Scoring	Points	Maximum Points
RVR parked fully under the roof of any Hangar	3	3
Green/Blue/Red Sphero parked in Barn without another Sphero in it	2 (per Sphero)	6
DEXI-5 landed and parked on designated Tower Helipad	3	3

DEXI-10 landed and parked on designated Tower Helipad	3	3
TOTAL MAX POINTS		**15**

**For Sphero parking, no more than one Sphero may receive parking points in the same Barn. To receive parking points, the Sphero must have completely crossed the Barn Entrance ramp drop-off and be inside the Barn. If Barrels or Hay Bales prevent a Sphero from fitting completely inside the Barn, the Sphero must be as far into the Barn as possible, as determined by the referee.

For RVR parking, the RVR may park under the roof of any Hangar. The RVR must be completely under the Hangar roof to receive parking points.

For DEXI parking, DEXI should be landed on top of the Tower Helipad, but imperfect landings may still score at referee discretion. To receive parking points, the aircraft may be partially on the Tower Helipad, but it may not be tilted more than approximately forty-five (45) degrees from a normal level takeoff/landing position. No measurement device will be used. Final determination is made by the referee and may be escalated to the Head Referee if needed. Dangling DEXIs do not receive parking points.

GRAND TOTAL = 424

5.2 – Mission Details

5.2.1 Introduction

Each Match is five (5) minutes long and is divided into three phases:

PHASE 1: AUTONOMOUS CHALLENGE → Begins at the start of the Match and officially lasts thirty (30) seconds. During Phase 1, DEXI-5, DEXI-10, the RVR, and all three Spheros attempt to complete their assigned route tasks. Teams may earn reduced-value manual route-completion points, higher-value autonomous route-completion points, and full-route autonomous bonus points.

PHASE 2: AIRFIELD RECLAMATION → Begins after the first thirty (30) seconds and continues until the Match has ended. Teams may complete the four Airfield Reclamation missions in any order. These missions include Hangar Hustle, Seeding Sprint, Barn Blitz, and Toxic Transfer.

PHASE 3: MISSION WRAP-UP → Begins at 4 minutes into the Match, with one minute of the Match remaining. During this final phase, Teams may return DEXI-5, DEXI-10, the RVR, and all three Spheros to their designated Ending Locations for additional points.

Teams may continue working on unfinished Autonomous Phase 1 route scoring after Phase 2 begins, but a Drive Team Member must clearly notify a referee before the attempt begins or continues so the referee can observe the route. Teams may also continue working on unfinished Phase 2 missions during Phase 3 while attempting to earn parking points.

A game object delivered to the wrong destination does not receive delivery or placement points.

5.2.2 Phase 1 – Autonomous Challenge

At the start of the Match, DEXI-5, DEXI-10, the RVR, and all three Spheros begin in their designated Starting Locations.

Phase 1 is called the Autonomous Challenge because hands-off operation is strongly emphasized and receives the highest point value. However, Teams may also complete Phase 1 route actions manually for reduced points.

Each Aircraft and Vehicle receives points for its best single Phase 1 route attempt. Within that attempt, each checkpoint or route action may receive either manual points or autonomous points, but not both. Points from separate attempts may not be combined.

Phase 1 route actions and checkpoints must be completed in the specified order. DEXI routes must follow April Tag ID 0 through ID 6. RVR and Sphero routes must follow the routes shown in the manual. Aircraft and Vehicles may not skip checkpoints, skip actions, or use shortcuts. If one misses a checkpoint or action and continues forward, it will not receive points for the missed checkpoint/action or any later checkpoint/action until it returns to the missed location and resumes the route in order.

Manual intervention removes full-route autonomous bonus eligibility for that attempt. However, after manual intervention, the Aircraft or Vehicle may still earn later manual or autonomous checkpoint/action points if those checkpoints/actions are completed in order. To regain eligibility for the full-route autonomous bonus, the Aircraft or Vehicle must restart and complete the full route hands-off.

If an Aircraft or Vehicle clearly leaves the route and returns to the start, that is considered a new attempt. Communication with referees is critical. If a Team attempts or restarts Autonomous Phase 1 route scoring after the first thirty (30) seconds, a Drive Team Member must clearly notify a referee before the attempt begins or continues.

Example: If a DEXI completes ID 0 through ID 3 autonomously and ID 4 through ID 6 manually on one attempt, then later completes ID 0 through ID 3 manually and ID 4 through ID 6 autonomously on a second attempt, the Team may not combine the autonomous portions of both attempts. The referee will score only the best single attempt.

Manual Phase 1 operation is permitted only during the first thirty (30) seconds of the Match. At the thirty-second mark, all manual Phase 1 operation must stop. Only hands-off autonomous Phase 1 actions may continue or begin after that time.

DEXI-5 and DEXI-10 April Tag Routes

DEXI-5 begins Phase 1 at the top-right Tower Helipad and travels from right to left along the top side of the Field. DEXI-10 begins Phase 1 at the bottom-left Tower Helipad and travels from left to right along the bottom side of the Field.

DEXI takeoff from the Tower Helipad is not scored as a separate Phase 1 action. The DEXI April Tag route begins at ID 0.

Each DEXI route includes seven (7) April Tag checkpoints in the following order:

1. ID 0 - Yellow
2. ID 1 - Red
3. ID 2 - Green
4. ID 3 - Blue
5. ID 4 - Purple

6. ID 5 - Orange
7. ID 6 - Magenta

For manual DEXI checkpoint scoring, the aircraft must travel over or past the April Tag/checkpoint area and display the correct assigned LED Signal before reaching the next April Tag/checkpoint. For April Tag ID 6, the DEXI must display the correct LED Signal before landing on the ground.

For autonomous DEXI checkpoint scoring, the aircraft must travel over or past the April Tag/checkpoint area hands-off, as determined by the referees, and display the correct assigned LED Signal before reaching the next April Tag/checkpoint. DEXI does not need to stop over each April Tag/checkpoint. For April Tag ID 6, the DEXI must display the correct LED Signal before it lands on the ground. For an autonomous run, this landing must also be completed hands-off.

To receive the full-route bonus, DEXI-5 or DEXI-10 must complete the route from ID 0 through ID 6 hands-off, display the correct LED Signal for each April Tag/checkpoint before reaching the next April Tag/checkpoint, reach the final April Tag/checkpoint, and land right-side up, ideally on the bullseye, without manual intervention.

Sphero Mini Autonomous Challenge Routes

Each Sphero completes a different route during Phase 1. Sphero actions are scored one action at a time. Actions include starting movement, completing required turns, and stopping movement. Each action may receive manual points or autonomous points, but not both.

The Green Sphero completes the route around the Barns. This route includes:

a. Start moving.
b. Seven (7) required turns.
c. Stop moving.

The Red Sphero completes the route around the Crop Area. This route includes:

a. Start moving.
b. Four (4) required turns.
c. Stop moving.

The Blue Sphero completes the route around the Hangars. This route includes:

a. Start moving.
b. Seven (7) required turns.
c. Stop moving.

Each Sphero may receive a full-route bonus only if it completes its entire assigned route from start to finish hands-off.

RVR Autonomous Challenge Navigation

The RVR completes a color-based route during Phase 1. RVR actions are scored one action at a time. Actions include starting movement, completing required color-based turns, and stopping movement. Each action may receive manual points or autonomous points, but not both.

The RVR route includes:

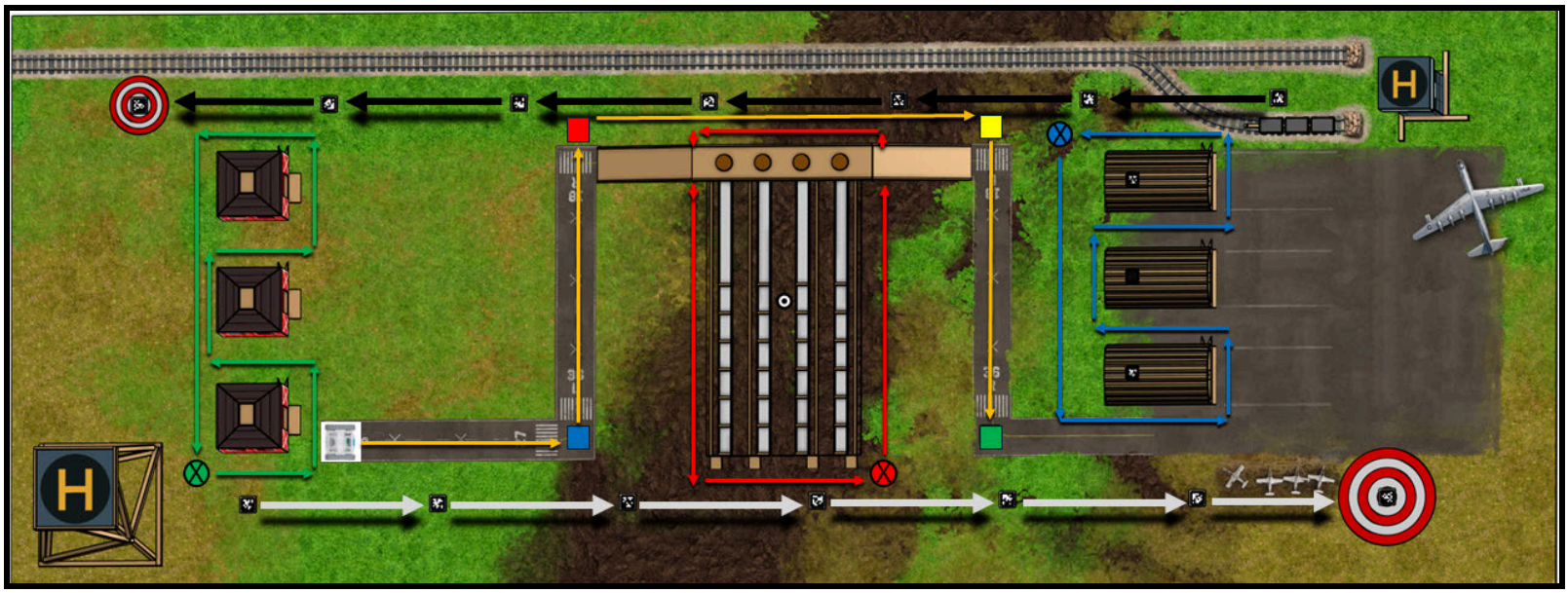
a. Start moving.
b. Four (4) required color-based turns.
c. Stop moving.

The RVR may receive a full-route bonus only if it completes its entire route from start to finish hands-off.

Autonomous Routes Visualized - NEW

Below is a figure containing all autonomous routes. The path each Aircraft/Vehicle takes is visualized with arrows.

The DEXI-5 is the path at the top of the figure using black arrows
The DEXI-10 is the path at the bottom of the figure using white arrows
The RVR path down the runways is shown using orange arrows
The Sphero paths are shown using green, red, and blue arrows and Sphero start locations are identified with colored circles with an X in them



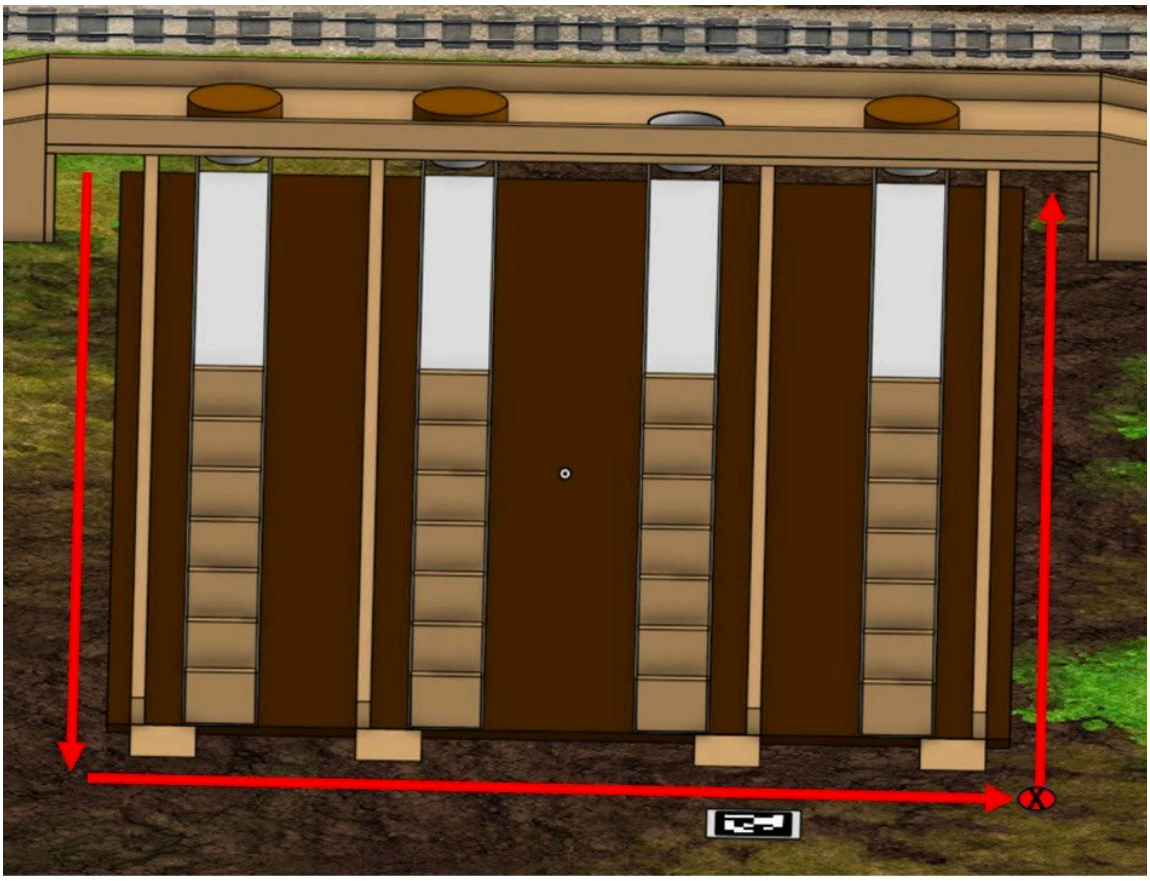


Figure 62: Visualization of all Autonomous Routes with color-coded arrows with additional view of Red Sphero route showing gap under Bridge and alignment with starting point.

5.2.3 Phase 2 – Airfield Reclamation

During Phase 2, Teams may complete the four Airfield Reclamation missions in any order:

I. **Mission 1 – Hangar Hustle**

II. **Mission 2 – Seeding Sprint**

III. **Mission 3 – Barn Blitz**

IV. **Mission 4 – Toxic Transfer**

Phase 2 is focused on identifying mission information, communicating that information through LED Signals, verifying correct locations with Spheros, and moving game objects to their correct destinations.

Unless a rule specifically states otherwise, Phase 2 scoring actions are not limited to a single Aircraft or Vehicle. Teams are encouraged to develop backup strategies that allow other capable Aircraft and Vehicles to complete scoring actions when possible.

DEXI-5 is the primary Aircraft for recognizing mission images and activating LED Signals. However, DEXI-10 may also be used for recognition and LED Signaling if necessary and if Teams develop that capability.

Sphero verification points are separate from delivery, seeding, Pallet movement, and Freight Car movement points. Spheros do not block other scoring actions. If the required Sphero verification action is not completed, the Team does not receive the Sphero verification points, but the Team may still receive other mission points for completed actions.

Where color matters, the wrong color Sphero does not receive verification points. During Toxic Transfer, any two Spheros may verify the active Freight Cars.

LED Signals are the primary method used to communicate correct mission information during Phase 2. If LED Signals are not functioning, Teams may still use live camera views or student callouts to continue completing mission actions, but LED Signal points are only awarded when the correct LED Signal is displayed as required by the scoring rules.

5.2.4 Phase 2 – Mission 1 – Hangar Hustle

Mission Objective

During Mission 1, Teams identify which Hangars are active, send the matching Spheros to those Hangars, remove the selected Pallets, scan the Pallet contents, and begin preparing Barrels and Hay Bales for transport.

There are three (3) Hangars on the Field. Each Hangar contains one (1) Pallet. Each Pallet contains four (4) Barrels and one (1) Hay Bale.

Only two (2) Hangars are active during each Match. The active Hangars are identified by April Tags and will be randomized between Matches by the referees.

Mission Sequence

i. DEXI scans the Hangars to identify the two active April Tags.

ii. The aircraft activates the correct LED Signal for each active Hangar.

iii. The correct color Sphero travels to the matching active Hangar and activates the Switch Button before an Aircraft or Vehicle engages the Pallet for removal

iv. The RVR, or another capable Aircraft or Vehicle, pulls the active Pallet fully out of the Hangar.

v. Once the Pallet is accessible, DEXI scans the Barrel Images

vi. The aircraft activates the correct LED Signal to identify each Barrel

vii. Barrels and Hay Bales may then be removed from the Pallet to be transported for delivery in Mission 3: Barn Blitz and Mission 4: Toxic Transfer

Pallet Removal - NEW

A Pallet is considered fully removed when it is pulled out of the Hangar far enough that the Pallet contents are accessible for scanning and transport and no part of the Pallet itself remains directly under the Hangar roof.

Pallets from inactive Hangars do not receive active Pallet removal points.

To receive the two (2)-point Pallet Removal score, the Pallet must be removed from the Hangar by pulling. Use of the Pallet Hitch is not required; Teams may use any legal mechanism to pull the Pallet. A Pallet that is intentionally pushed outward as part of completing its removal does not qualify for Pallet Removal points. This includes pushing the Pallet fully out and then attaching to it afterward, or partially pulling the Pallet and then pushing it to complete removal.

Sphero Hangar Verification

Each active Hangar has a Switch Button used for Sphero verification. To receive Sphero verification points, the correct color Sphero must activate the matching active Hangar Switch Button before any Aircraft or Vehicle intentionally engages the Pallet for removal. Spheros should remain at that verification location until an Aircraft or Vehicle starts to move the Pallet to act as a reminder to your Team.

The Switch Button includes a small LED indicator that turns on when activated. If the referee does not observe the activation, a Drive Team Member must ensure the referee sees the Sphero at the activated Switch Button location for points to be awarded. In general, Teams should ensure they have the attention of a referee to see the Sphero verification action happen for points during the game.

Once an Aircraft or Vehicle intentionally engages a Pallet for removal, Sphero verification points for that Hangar can no longer be earned. It is up to the Teams to remember the flow and be precise with timing. Early is on time and on time is late.

Barrel and Hay Bale Identification

Each active Pallet contains four (4) Barrels and one (1) Hay Bale. Barrel Images include:

1. Wheat Image - Green LED Signal
2. Water Image - Blue LED Signal
3. Gasoline Image - Red LED Signal
4. Toxic Fluid Image - Yellow LED Signal

Hay Bales do not have an image and do not require LED Signaling.

Wheat Barrels, Water Barrels, and Hay Bales must be delivered to the correct Barns during Barn Blitz. Gasoline Barrels and Toxic Fluid Barrels must be delivered to the correct Freight Cars during Toxic Transfer.

Object Removal from Pallet

A Barrel or Hay Bale is considered removed from the Pallet when no part of it is touching the Pallet.

Object removal points may be earned during Hangar Hustle. Delivery and placement points are earned later during Barn Blitz or Toxic Transfer.

5.2.5 Phase 2 – Mission 2 – Seeding Sprint

Mission Objective

During Mission 2, Teams expose the Bridge Images, identify which Cultivated Rows are ready for planting, send the correct Spheros to verify those rows, and use DEXI-10 to perform aerial seeding.

Mission Sequence

i. The RVR travels over the Bridge and clears the Bridge Coasters.

ii. Once the Bridge Images are visible, DEXI scans the Bridge Images.

iii. The aircraft activates the correct LED Signals to identify the Cultivated Rows that are ready for planting.

iv. The corresponding Spheros travel all the way down the correct Cultivated Rows, as close to the Bridge as they can get to validate the row.

v. DEXI-10 drops Seeds into the correct Cultivated Rows and receives additional points for depositing Seeds individually in row sections.

Bridge Coasters

Bridge Coasters are removable covers placed over the four Bridge Image Locations. A Bridge Coaster is considered cleared when the entire Bridge Coaster has been moved completely off the Bridge structure and is resting on the Field floor, with no part of the Bridge Coaster touching the Bridge. Bridge Coaster clearing points are awarded when these criteria are first met and are not removed if the Bridge Coaster later moves or comes back into contact with the Bridge.

The RVR is the primary vehicle intended to clear Bridge Coasters. As a backup strategy, Teams may use another Aircraft or Vehicle, including DEXI-5 or DEXI-10 downwash, to clear Bridge Coasters if needed.

Bridge Images and Cultivated Rows

There are four (4) Cultivated Rows on the Field. During each Match, three (3) of the four rows are active and ready for planting. DEXI scans the Bridge Images and activates the correct LED Signals to communicate which active Cultivated Rows are ready for planting.

The active Bridge Image positions will be randomized between Matches by the referees. The inactive row does not receive Seed scoring during that Match.

The Red Bridge Image contains one vertical white line on a black circle, the Green Bridge Image contains two vertical white lines, and the Blue Bridge Image contains three vertical white lines. The fourth location contains a solid black blackout circle with no Bridge Image to scan.

Sphero Row Verification - NEW

A Cultivated Row is considered verified when the correct color Sphero travels all the way down the identified row and reaches the location as close to the Bridge as it can get without going under (if under the Bridge, it will make it difficult for referees to see and potentially cause missed points).

If the correct Sphero does not reach the required location, the row is not considered verified for Sphero Row Verification points. Although this may cause the Team to lose Sphero verification points, it does not prohibit seeding points.

Spheros should remain at their verification position near the Bridge during seeding to act as a reminder to their Team, though no extra points are received during that time. In general, Teams should ensure they have the attention of a referee to ensure the Sphero verification was seen to receive points.

To receive Sphero Row Verification points, the correct Sphero must complete verification before the Team intentionally releases its first Seed during Seeding Sprint. Once the Team intentionally releases its first Seed, no additional Sphero Row Verification points may be earned during that Match. This timing requirement does not affect Seed scoring; Seeds may still receive points even if one or more Sphero Row Verification actions were not completed.

Aerial Seeding

Seeds are Red, Green, and Blue to match the active Cultivated Rows and Spheros. There are seven (7) Seeds for each color. Each Cultivated Row is divided into seven (7) scoring sections.

Teams may choose their own Seed objects, but all Seeds must be spherical balls between five-eighths (5/8) inch and seven-eighths (7/8) inch in diameter. Seeds may be made of plastic, wood, or metal. Glass or ceramic Seeds that could easily chip or shatter and liquid-filled Seeds are prohibited. Adhesives may not be used to make the Seed itself sticky or to directly attach a Seed to a deployment mechanism. Seeds may not leave residue, powder, debris, or anything difficult to clean from the Field, and may not damage printed vinyl or other Field Elements. Seeds may not be intentionally modified with features intended for gripping, tethering, or attachment - see additional detail in 5.3.12.

A Seed earns base points if it is the correct color and lands in the matching active Cultivated Row. A Seed earns additional section bonus points if it lands alone in one section of the matching active Cultivated Row.

For section bonus scoring, a Seed is considered alone in a section only if no other Seed is in that same section at the end of the Match. If multiple Seeds are in the same section, correct-color Seeds may still receive base row points, but only Seeds that are alone in their section may receive the section bonus.

A Seed cannot come to rest on top of a row boundary or section divider; it must be fully inside and on the bottom of section/row “buckets” to receive points. A Seed resting on a row boundary or Seed Section divider is not considered to be inside either adjacent Seed Section and therefore does not prevent an otherwise valid Seed in either section from being considered alone.

Seed scoring is evaluated after the Match ends. Teams should be aware that prop wash or other Aircraft or Vehicle movement after seeding may move Seeds before scoring is evaluated.

5.2.6 Phase 2 – Mission 3 – Barn Blitz

Mission Objective

During Mission 3, Teams identify the correct Barn destinations and deliver agricultural materials to those Barns.

Agricultural materials include:

1. Wheat Barrels
2. Water Barrels
3. Hay Bales

Wheat Barrels must be delivered to the Wheat Barn, Water Barrels must be delivered to the Water Barn, and Hay Bales must be delivered to the Barn with no image. Objects delivered to the wrong Barn do not receive delivery or placement points.

Mission Sequence

i. DEXI scans the Barn Images.

ii. The aircraft activates the correct LED Signal to communicate which material belongs at each Barn.

iii. The correct color Sphero travels to the matching Wheat or Water Barn and activates the Switch Button to verify the unloading location. Green verifies Wheat, and Blue verifies Water.

iv. After the Barn locations are identified, the correct Barrel or Hay Bale may be transported to the correct Barn.

v. The object may be delivered through the Barn Entrance or deposited through the Barn Top Opening.

Barn Images

Barn Images include:

1. Wheat Image
2. Water Image

The Barn without an image is the Hay Bale Barn. Barn Image locations will be randomized between Matches by the referees.

Sphero Barn Verification

The Wheat Barn and Water Barn each have a Switch Button used for Sphero verification. To receive Sphero verification points, the correct color Sphero must activate the matching Wheat or Water Barn Switch Button before a Barrel or Hay Bale begins passing through the Barn Entrance or Barn Top Opening. Spheros should remain at that verification location through the delivery window to act as a reminder to your Team, though no extra points are received while doing so.

The Hay Bale Barn also has a Switch Button, but that Switch Button does not provide scoring points because no Sphero verification is required for Hay Bale delivery.

Each Switch Button includes a small LED indicator that turns on when activated. If the referee does not observe the activation, a Drive Team Member must ensure the referee sees the Sphero at the activated Switch Button location for points to be awarded.

Barn Delivery

A correct Barrel or Hay Bale may be transported and delivered through the matching Barn Entrance for delivery points. An object is considered delivered through the Barn Entrance when no part of it remains protruding out of the entrance, it has been pushed fully over the ramp and over the ramp drop off into the Barn floor, and is inside the Barn. Barn Entrance delivery points are awarded when the object first meets these criteria.

When a DEXI is used for Barn Blitz transport, it must fly during the main transport portion to the Barn. During the main transport portion, the transported Barrel or Hay Bale must be airborne and may not remain in contact with the Field floor. Brief Taxiing during pickup and final delivery positioning is permitted. See Rule 5.3.15.

Top Opening Deposit - NEW

Barrels and Hay Bales may be deposited through the Top Opening of the matching Barn for the higher-value placement score.

A single object may not receive both the Barn Entrance delivery path and the top-opening deposit path. The maximum placement score for one Barn Blitz object is five (5) points.

For Top Opening Deposit scoring, a correct Barrel or Hay Bale is considered successfully deposited through the Top Opening once it has been released and is no longer supported by or in contact with the delivering Aircraft or Vehicle and either passes completely through the opening or comes to rest in or across the Top Opening. The object does not need to fall to the Barn floor and may be supported by the Top Opening rim, the Barn Image below the opening, or another internal Barn surface, including while resting at an angle. An object resting only on the exterior Barn roof and not extending into the open area does not qualify. **Once these criteria are first met, the five (5)-point Top Opening Deposit score is immediately awarded and is not removed if the object later bounces, shifts, or falls farther into the Barn.**

5.2.7 Phase 2 – Mission 4 – Toxic Transfer

Mission Objective

During Mission 4, Teams identify the correct Freight Car destinations, deliver Gasoline Barrels and Toxic Fluid Barrels to those Freight Cars, and move the connected Freight Cars to Toxic Storage.

Hazardous materials include:

1. Gasoline Barrels
2. Toxic Fluid Barrels

Gasoline Barrels and Toxic Fluid Barrels must be delivered to the Freight Car with the matching Freight Car Image. Barrels delivered to the wrong Freight Car do not receive delivery or placement points.

Mission Sequence

i. DEXI scans the Freight Car Images.

ii. The aircraft activates the correct LED Signal to communicate which hazardous material belongs at each active Freight Car.

iii. Any two Spheros travel to the active Freight Cars and contact them to verify the unloading location. One Sphero cannot validate both Freight Cars.

iv. After the Freight Car locations are identified, the correct Gasoline Barrel or Toxic Fluid Barrel may be transported to that matching Freight Car.

v. The Barrel may be pushed alongside the Freight Car or delivered inside the Freight Car for more points.

vi. The connected Freight Cars are moved fully into Toxic Storage. Gasoline Barrels and Toxic Fluid Barrels may also earn Toxic Storage points if they are alongside or inside the Freight Cars while fully inside Toxic Storage as long as the connected Freight Cars are fully inside Toxic Storage.

vii. Bonus points may be earned by connecting to the Freight Cars using the Front Hitch and moving them fully into Toxic Storage. Barrels may earn additional bonus points if they remain inside the correct Freight Cars while fully inside Toxic Storage.

Freight Car Images

Freight Car Images include:

1. Gasoline Image - Red LED Signal
2. Toxic Fluid Image - Yellow LED Signal

Freight Car Images will be randomized between Matches by the referees. Only two Freight Cars are active during each Match. The third/inactive Freight Car uses a solid black sticker in place of an image and does not receive hazardous Barrels for scoring during that Match.

Sphero Freight Car Verification

Any two Spheros may verify the active Freight Cars. The Sphero colors do not need to match the Freight Car Image colors. Each active Freight Car may receive Sphero verification points only once. Two different Spheros must be used to verify the two active Freight Cars, and each Sphero may verify no more than one Freight Car.

To receive Sphero verification points, a Sphero must contact the active Freight Car before a Barrel first satisfies either the Alongside Freight Car Delivery or Inside Freight Car Delivery scoring criteria at that Freight Car. Spheros should remain as long as possible to act as a reminder to their Team but be careful not to get in the way of a Barrel delivery! Extra points are not received while Spheros remain in place.

Teams are responsible for ensuring a referee observes the Sphero contacting the active Freight Car. An unobserved verification action may not receive points.

Alongside Freight Car Delivery

A correct Gasoline Barrel or Toxic Fluid Barrel may be pushed alongside the matching Freight Car for lower-value placement points in both Freight Car Delivery and Toxic Storage portions of the Toxic Transfer Mission.

This action may be completed by any Aircraft or Vehicle capable of moving the Barrel. The RVR is the primary vehicle intended for this action, but Teams may use other Aircraft or Vehicles as part of a backup strategy.

Refer to the Alongside Freight Car Delivery definition in section 4.2 for what is considered “Alongside”. It is critical to ensure you get the attention of a referee during the Match if you are unsure whether you meet the criteria for points.

Freight Car Delivery

A correct Gasoline Barrel or Toxic Fluid Barrel may be delivered inside the matching Freight Car for the higher-value placement score.

A single Barrel may not receive both the alongside Freight Car points and the inside Freight Car points. If a Barrel first earns the 2-point alongside-Freight-Car score and is later successfully delivered inside the correct Freight Car, its placement score is upgraded to the 5-point Freight Car Delivery score.

The connected Freight Cars must remain inside the Freight Car Delivery Area for Teams to earn new Alongside Freight Car Delivery or Inside Freight Car Delivery points. If the Freight Cars leave the area, Teams may return them to the Freight Car Delivery Area to resume earning these placement points. If the Freight Cars are not returned, no additional Freight Car Delivery placement points may be earned for alongside or inside within the Freight Car Delivery portion of Toxic Transfer; however, Freight Car movement points, Front Hitch points, Barrel transport bonus points, and Toxic Storage points remain available. Freight Cars leaving the Freight Car Delivery Area only prevents the “Option 1”, 2 points per Barrel alongside and “Option 2”, 5 points per Barrel inside delivery points from being scored in Freight Car Delivery.

For the 4-point-per-Barrel “inside” transport bonus, the qualifying transport begins when the connected Freight Cars clearly leave the Freight Car Delivery Area on a transport attempt toward Toxic Storage. The Barrel must already meet the definition of Inside Freight Car Delivery in its correct Freight Car at that time and must continue to meet that definition until the connected Freight Cars are fully inside Toxic Storage.

Toxic Storage

The final piece of Toxic Transfer is Toxic Storage - moving the connected Freight Cars and hazardous Barrels fully into Toxic Storage. Freight Cars are considered fully inside Toxic Storage only when no part of the Freight Cars is touching or crossing the Toxic Storage boundary line.

If the connected Freight Cars are moved fully inside Toxic Storage, the Team receives the base Freight Car movement score. If the Front Hitch is used to connect to the Freight Cars and move them fully inside Toxic Storage, the Team also receives the hitch/attachment bonus.

There are also bonus points for matching Barrels staying inside the Freight Cars while being transported until fully inside Toxic Storage. These Barrels must continue to meet the definition of Inside Freight Car Delivery while being transported.

Correct Gasoline Barrels and Toxic Fluid Barrels may also receive Toxic Storage points by being fully contained within Toxic Storage. A correct Barrel earns Toxic Storage points if it is fully inside Toxic Storage and alongside the matching Freight Car at the end of the Match while the Freight Cars are also fully inside Toxic Storage. A correct Barrel earns additional points if it remains inside the correct Freight Car while the Freight Cars are fully inside Toxic Storage.

For Toxic Storage, if a Barrel first earns the 2-point alongside-Freight-Car score and is later successfully delivered inside the correct Freight Car in Toxic Storage, its placement score is upgraded to the 4-point inside Freight Car score if it remains inside that correct Freight Car after the end of the Match. The Barrel does not receive both scores.

Toxic Storage scoring is evaluated at the end of the Match.

The connected Freight Cars must remain supported by and move along the Field floor during transport. They may not be picked up or flown into Toxic Storage. See Rule 5.3.16.

5.2.8 Phase 3 – Mission Wrap-Up

Mission Objective

Phase 3 begins at the four-minute mark, with one minute remaining in the Match.

During Phase 3, Teams may return DEXI-5, DEXI-10, the RVR, and all three Spheros to their designated Parking Locations for additional points.

Teams may continue completing unfinished Phase 2 scoring actions during Phase 3 as long as Match time remains.

DEXI-5 and DEXI-10 Parking

DEXI-5 and DEXI-10 must return to their designated Tower Helipads to receive parking points. DEXI should be landed on top of the Tower Helipad, but imperfect landings may still score at referee discretion. To receive parking points, the aircraft may be partially on the Tower Helipad, but it may not be tilted more than approximately forty-five (45) degrees from a normal level takeoff/landing position. No measurement device will be used. Final determination is made by the referee and may be escalated to the Head Referee if needed. Dangling DEXIs do not receive parking points.

RVR Parking

The RVR may park under the roof of any Hangar. To receive parking points, the RVR must be completely under the Hangar roof. The RVR may park under a Hangar where a Pallet remains, but it must still be completely under the Hangar roof at the end of the Match.

Sphero Parking

Each Sphero may park inside any Barn. No more than one Sphero may receive parking points in the same Barn. To receive parking points, the Sphero must have completely crossed the Barn Entrance ramp drop-off and be inside the Barn. If Barrels or Hay Bales prevent a Sphero from fitting completely inside the Barn, the Sphero must be as far into the Barn as possible, as determined by the referee.

Parking is evaluated at the end of the Match.

5.3 – Gameplay Rules - NEW

Unless a specific rule states otherwise, accidental, momentary, or minor violations of the following rules will result in a warning. Intentional, egregious, or score-affecting violations will result in a Disqualification. Repeated warnings may escalate to a Disqualification at the Head Referee's discretion. Rules which refer to setup actions must be met in order for a Match to start.

5.3.1 Only Drive Team Members may be in the Driver Station during a Match. Drive Team Members must stay in the Driver Station for the duration of the Match unless directed otherwise by a referee or event official.

5.3.2 Drive Team Members may not fulfill ***more than one*** of the following roles during any given Match unless discussed with and approved directly by the Head Referee:

a. DEXI-10 pilot - using the radio transmitter
b. DEXI-5 pilot - using the radio transmitter

c. Navigator (DEXI Ground Control Station Operator) – using a laptop with QGroundControl, DroneBlocks, Python, or other approved software required for operation of the DEXI-5 and/or -10
    i. Teams may use one Ground Control Operator for the DEXI-5 & one for the DEXI-10 if desired
d. RVR driver – using a laptop or mobile device with the Sphero Edu app
e. Sphero driver – using a laptop or mobile device with the Sphero Edu app
f. Drive Team Support
    i. This person may perform any of the following functions: Observation, callouts and answering direct Team questions, referee coordination, holding and updating court status game aids such as graphic signs
g. Team Photographer/Videographer
h. Other Personnel - at the discretion of the Head Referee

5.3.3 A maximum of 12 Drive Team Members are allowed in the Driver Station during a Match. These roles are clearly defined and established to promote fairness regardless of Team size. The Drive Team Roles and maximum Team members per role are as follows:

1. DEXI-5 Pilot - 1 max
2. Navigator (DEXI-5 GCS Operator) - 1 max
3. DEXI-10 Pilot - 1 max
4. Navigator (DEXI-10 GCS Operator) - 1 max
5. RVR Operator - 1 max
6. Green Sphero Operator - 1 max
7. Blue Sphero Operator - 1 max
8. Red Sphero Operator - 1 max
9. Drive Team Support - 2 max
10. Team Photographer/Videographer - 1 max
11. Other Personnel - At the discretion of the Head Referee

Limits are subject to change

Not filling a role or fulfilling the maximum does not allow a Team to exceed the maximum in another role. For example, Teams with a combined DEXI-5 & DEXI-10 GCS Operator cannot trade the unused Navigator/GCS position to gain an extra Drive Team Support member.

5.3.4 Other Team Members that are not Drive Team Members may not help their Team with callouts during a Match. However, Team Members not assigned a Drive Team Role are not prohibited from cheering for their Team - that is expressly encouraged. Cheering may not include specific technical callouts such as “You forgot that tag”, or “Hitch the Freight Car”. Such callouts could easily be seen as assisting the Drive Team Members in competition tasks and creating an unfair advantage due to the number of Team members participating during a Match.

We recognize that this creates some ambiguity but we encourage EVERYONE participating in AVR events to report any potential issues to judges, referees, or other AVR officials.

Decisions and punitive actions will be at the sole discretion of the Head Referee, and if violations are extreme and repetitive enough, could result in forfeiture of a Match or disqualification.

5.3.5 The DEXIs, RVR, and Spheros must begin the Match in their designated starting locations shown in Figures 17-22.

5.3.6 Phase 1 route actions and checkpoints must be completed in the specified order. DEXI routes must follow April Tag ID 0 through ID 6. RVR and Sphero routes must follow the routes shown in this Game Manual. Aircraft and Vehicles may not skip checkpoints, skip

actions, or use shortcuts.

5.3.7 If an Aircraft or Vehicle misses a Phase 1 checkpoint or action and continues forward, it will not receive points for the missed checkpoint/action or any later checkpoint/action until it returns to the missed location and resumes the route in order.

5.3.8 Each Aircraft and Vehicle receives points for its best single Phase 1 route attempt. Points from separate attempts may not be combined.

5.3.9 If a Team attempts or restarts Autonomous Phase 1 route scoring after the first thirty (30) seconds of the Match, a Drive Team Member must clearly notify a referee before the attempt begins or continues so the referee can observe the route. Manual Phase 1 operation is permitted only during the first thirty (30) seconds of the Match. At the thirty-second mark, all manual Phase 1 operation must stop. Only hands-off autonomous Phase 1 actions may continue or begin after that time. A manual Phase 1 checkpoint or action must be fully completed before the thirty-second mark to receive manual points.

5.3.10 Sphero verification points are separate from delivery, seeding, Pallet movement, and Freight Car movement points. A failed, late, or incorrect Sphero does not prevent a Team from earning other mission points unless a scoring rule specifically states otherwise.

5.3.11 Teams are responsible for ensuring a referee observes required Sphero verification actions. Switch Button verification points may not be awarded if the referee cannot verify that the appropriate Sphero activated the required Switch Button.

5.3.12 Seeds must be spherical balls between five-eighths (5/8) inch and seven-eighths (7/8) inch in diameter. Seeds may be made of plastic, wood, or metal.
Glass or ceramic Seeds that could easily chip or shatter, liquid-filled Seeds, Seeds that leave residue/powder/debris, and Seeds that may damage printed vinyl or other Field Elements are prohibited. Adhesives may not be used to make the Seed itself sticky or to directly attach a Seed to a deployment mechanism. The Seed itself must remain a substantially spherical ball and may not be intentionally modified with features intended for gripping, tethering, or attachment. This means drilled or through-holes, slots, grooves, flat gripping surfaces, hooks, loops, rings, tabs, stems, soldered attachment points, or similar intentional protrusions/recesses are not permitted. Minor manufacturing seams, surface imperfections, or normal variation from a perfect mathematical sphere are acceptable. A legal spherical Seed may be carried, captured, or contained by a separate deployment mechanism provided the Seed itself would independently satisfy all Seed requirements if removed from the deployment mechanism.
Additionally, a Team may use no more than seven (7) Seeds of each color during a Match. All Seeds intended for use during the Match must begin onboard a DEXI at the start of the Match and may not be staged elsewhere on the Field for later pickup.

5.3.13 For ease of scoring and in the spirit of the game, only one DEXI may serve as the active Phase 2 scanning and LED Signaling Aircraft while both DEXIs remain capable. Teams are encouraged to develop scanning and LED Signaling capability on the second DEXI as a contingency strategy. If the DEXI performing Phase 2 scanning and LED Signaling becomes unable to perform those tasks, the other DEXI may immediately take over as the main scanning and LED Signaling Aircraft. Head Referee approval is not required for this contingency use. Teams may not intentionally divide Phase 2 scanning or LED Signaling tasks between two capable DEXIs as part of their normal Match strategy.
Any exception allowing both capable DEXIs to perform Phase 2 scanning and/or LED Signaling as part of normal Match strategy must be coordinated with AVR competition leadership and communicated by the Head Referee to all affected Teams before Match play. Such an exception will not be granted to an individual Team on a per-Match basis.
This rule applies only to Phase 2 missions and does not prohibit Phase 1 DEXI autonomous attempts after the first thirty (30) seconds of the Match

5.3.14 Only Barrels and Hay Bales originating from the two active Pallets are eligible for Hangar Hustle Barrel Image identification points, Hangar Hustle object-removal points and Barn Blitz scoring during that match. Only Barrels originating from the two active pallets are eligible for Toxic Transfer scoring during that Match. Teams may not intentionally remove Barrels or Hay Bales from the inactive Pallet for use in scoring tasks. If a Team does so egregiously, Match scoring will only be allowed for Phase 1, Phase 2 - Seeding Sprint, and Phase 3. All Phase 2 - Barn Blitz, - Hangar Hustle, and - Toxic Transfer mission points will be removed. Continued intentional violations will result in disqualification.

5.3.15 DEXI-5 and DEXI-10 may not use Taxiing as the primary method of transporting a Barrel or Hay Bale to a Barn during Barn Blitz. After acquiring an object, the DEXI must become airborne for the main transport portion between the Hangar/Pallet area and the destination Barn. During the main transport portion, the transported Barrel or Hay Bale must be airborne and may not remain in contact with the Field floor. Brief ground movement during pickup and final delivery positioning at the Barn is permitted. Additionally, during Seeding Sprint, Seeds must be released while the DEXI is airborne to receive Seed scoring. Seeds released while the DEXI is Taxiing, resting on, or supported by the Field floor, a Cultivated Row structure, the Bridge, or any other Field Element do not qualify for Seed scoring. The DEXI may hover or otherwise maneuver while seeding, but it must be airborne and unsupported by a Field Element when the Seed is released. For Seed scoring, a Seed may remain captured or contained by a legal separate deployment mechanism after being released from the DEXI.

5.3.16 The connected Freight Cars must remain supported by and move along the Field floor during transport. Teams may push, pull, or otherwise move the Freight Cars using any legal contact method, but may not intentionally lift, carry, or fly the Freight Cars off the Field floor. Use of the Freight Car Front Hitch is only required to receive the separate hitch/attachment bonus. Momentary loss of floor contact caused by normal bumps, flex, or unintended movement is not considered a violation. A first violation of this rule will result in a warning. A subsequent violation may result in Match forfeiture or Disqualification at the Head Referee's discretion.

5.3.17 Repeated deliveries of *the same* Barrel and/or Hay Bale for the *same scoring action* do not award additional points. During Barn Blitz, the same Barrel or Hay Bale will not earn points more than once for being delivered through the Barn Entrance more than once or Deposited through the Barn Top Opening more than once. This does not prohibit a scoring upgrade when an object is later delivered using a higher-value scoring path. This same rule applies to Toxic Transfer, but Freight Car Delivery and Toxic Storage *are separate scoring actions*. For example, a Barrel may earn Inside Freight Car Delivery points and later earn Inside Toxic Storage points without being considered a repeated delivery.

6 – Presentations

6.1 – Overview

6.1.1 The presentation portion of the competition is designed to challenge Students to think critically about their lessons learned throughout the competition. The presentation will consist of a description of the Team's design process and lessons learned.

6.1.2 Teams are given three minutes to set up and 12 minutes to present and address questions.

a. The first three minutes of set up are not scored.
b. The 12 minutes of scored time are divided into nine minutes for presentation material and three minutes for Q&A from the judges.
c. **NEW** Teams will be cut off from their presentation material at nine minutes, although they may choose to end the presentation early. If a Team ends the presentation material before nine minutes, the remaining time may be used for additional judge Q&A. Teams will be cut off at the 12-minute mark to conclude their total presentation time.

6.1.3 It is expected that at least three students on the Team speak during the presentation. Points will be deducted for less than three students taking part in the presentation portion prior to the Q&A.

a. All members of the Team, regardless of whether they are given speaking roles, must be present during the presentation.

6.1.4 **NEW** Teams must bring the following to their presentation:

a. DEXI-5, DEXI-10, RVR, Spheros, and Seeds
b. Teams may also bring any mechanisms used on the DEXIs, RVR, or Spheros that are not currently attached that help explain the engineering process and design iterations, and other custom designed elements critical to a Team's success throughout the season and helpful for the presentation.
c. Visual aids, including a PC/laptop if showing a slide presentation. Any digital visual aids should be compatible with HDMI and be downloaded locally on the device.

6.2 – Details

6.2.1 Each Team can use any visual aids they deem necessary (e.g., PowerPoint, Prezi, videos, collages, etc.).

a. Video shown during a presentation may not exceed two minutes in length.
b. **NEW** Any digital visual aids should be downloaded locally on the device.

6.2.2 **NEW** Teams keeping an Engineering Notebook should turn them in during Team check-in at the start of the event.

a. Engineering Notebooks will be provided back to Teams to use during their presentation. Usage of the Engineering Notebook during the Team presentation is encouraged.
b. See Appendix C for more details on the Engineering Notebook.

6.2.3 The design process portion of the presentation should include any specific design process, communication/planning methods, and project management strategies used (e.g., rapid prototyping, agile, etc.)

6.2.4 Teams should include any winning strategies they devised for the competition.

6.3 – Presentation Scoring

6.3.1 Teams will be scored based on eight categories, which cover a number of aspects of the presentation, including content and style. More points will be awarded for extra research, truly innovative thinking, and synthesis between competition experiences and professional engineering skills.

6.3.2 **NEW** Judges will be instructed to score subjectively on a 0-50 point scale for the first seven categories in the rubric and a 0-100 point scale for the Engineering Notebook category.

6.3.3 The full rubric for presentations is shown in Appendix B.

7 – Tournament Logistics

7.1 Teams will compete in four (4) Matches over the course of a one-day Event.

7.2 Teams will be ranked based on the sum of their Match scores and Presentation score (i.e., the Presentation can be thought of as an additional "Match", in terms of rankings).

a. If there are any ties based on this sum, the first tiebreaker will be the Team with the highest Presentation score, followed by the highest single Match score.

7.3 The Team's lowest Match score will be excluded from the rankings total.

a. The Presentation score cannot be excluded.

b. For example, in the set of scores listed below, the score for Match 3 would be excluded from the rankings.

Match 1	130
Match 2	110
Match 3	90
Match 4	125
Presentation	150

7.4 The Head Referee has ultimate authority on all rule decisions.

a. The Head Referee may not review any photo or video Match recordings to determine a score or ruling.

b. The Head Referee is the only individual permitted to explain a rule, Disqualification, or warning to the Teams.

c. The Head Referee must give the rule number of the rule violated when issuing a Disqualification or warning to a Team.

7.5 Any Team is permitted to immediately appeal the Head Referee's ruling after the Match. The appeal must be made by a single designated Team Captain to dispute a score or ruling, and they must do so prior to their next Match.

7.6 Match replays, i.e., playing a Match over again from its start, are at the discretion of the Event Coordinator and Head Referee and will only be issued in the most extreme circumstances. Some example situations that may warrant a Match replay are as follows:

a. Game Elements not starting in the correct positions.

b. Game Elements detaching or moving beyond normal tolerances (not as a result of Aircraft or Vehicle interactions).

c. Scoring Field elements are moved or reset before referees are able to gather end of Match scores and are unable to determine a final Match score.

7.7 Teams must be ready to play when they arrive at the Field and set up their equipment within the allotted setup time. Failure to do so promptly may result in a Disqualification at the Head Referee's discretion.

7.8 **NEW** The order of operations when a Team finishes a Match is as follows:

a. DEXI Pilots, RVR Drivers, and Sphero Drivers: proceed to their respective aircraft/vehicle, and upon confirming that referees have captured final return to home scores, recover all aircraft/vehicles without disturbing any scoring Field elements.

b. GCS Operators or other Drive Team Members using courtside tables: clear all table space for the next Team to begin setup.

c. All other Drive Team Members (if present): proceed to one of the following and ONLY upon confirming with a referee that scoring elements can be reset, reset them:

i. Barns:
- Reset Barrels and Hay Bales - Give to Team member at Hangars
- Reset Sphero switches

ii. Seeding Rows:
- Pick up Team Seeds
- Reset Coasters

iii. Hangars:
- Place Barrels and Hay Bales on the carts and leave them pulled out of the Hangar
- Reset Sphero switches

iv. Toxic Storage:
- Reset Barrels - Give them to Team member at Hangars
- Return Freight Cars to their starting point near DEXI-5 Helipad Tower

d. After resetting court elements, the DEXI Pilots, RVR Driver, and Sphero Drivers should remain near the court but outside the Driver Station so that referees may approach with any questions.

e. Teams are released when they have received their final Match score from the referees.

7.9 **NEW** Championship Qualification Criteria

a. The 2026 AVR Championship Event will be held at the Henry B. Tippie National Aviation Education Center in Dallas, Texas on December 4th. More details will be available on the website (theavr.org), and will be shared directly with invited Teams.

b. Each Qualifying Event held in November is allotted one (1) qualification spot for the Championship Event. This spot will be awarded to the 1st Place Team at the event, i.e., the Team that has scored the most points towards their rankings, per 7.2 and 7.3.

c. If the 1st Place Team has already qualified, the allotted Championship Event spot will be awarded to the next highest-ranked Team in the following order:

i. 2nd Place Team
ii. 3rd Place Team
iii. Best Overall Design Award
iv. Exemplary Team Award
v. Presentation Award
vi. Judge's Choice Award

d. Additional open spots for the Championship Event will be filled by EduEverything staff by order of the Highest Total Score at a single event. Season Standings will be available on the 2026 Season Results webpage: **theavr.org/standings**

i. If there is a tie in the overall ranking that will affect which Team will be invited to the Championship Event, the first tiebreaker will be the Team with the highest Presentation score, followed by the highest single Match score.
ii. Teams that are available to attend the Championship Event and would like to be considered for an invitation should add themselves to the Championship Waitlist no later than November 20th, 2026. The Championship Waitlist submission link can be found near the bottom of the 2026 Season Results webpage: **theavr.org/standings**

7.10 **NEW** Teams should arrive at Events with all required forms complete and ready to turn in upon Team check-in. Required forms will be shared with advisors ahead of the event, and are also available under 'Event-Day Documents' on the 'Team Resources' page on the AVR website: **theavr.org/resources**

8 – Aircraft and Vehicle Specification and Build Guidelines

8.1 – General

8.1.1 Aircraft and Vehicles found in violation of one or more of these rules during a Match may be Disabled or Disqualified at the Head Referee's discretion, and will not be permitted to play in any further Matches until they have corrected the violation.

8.1.2 DEXI-5 and DEXI-10 must pass a "wall test". As a general rule of thumb, if the aircraft approaches a wall from any angle, any other part of the aircraft, such as propeller guards, should be the first thing to contact the wall.

a. Similarly, if an aircraft is flying towards a netted cage, propeller guards must be the first thing to contact the net, mitigating risk of propeller entanglement.

8.1.3 DEXI-5 and DEXI-10 must clearly and legibly display a Team's number.

8.1.4 There are no dimensional or weight limits for any Aircraft or Vehicle.

a. DEXI-5 and DEXI-10 may have recommended maximum flight weights based on the final aircraft configuration. Exceeding recommended limits may cause unstable flight, shorter battery life, or other unexpected behavior.

8.2 – **NEW** Electronics & Software

For the following electronic control system components, DEXI-5 and DEXI-10 may only use the items provided in the Team registration kit or otherwise approved by AVR staff:

Item	DEXI-5	DEXI-10
Batteries	6S 4000mAh A45 Li-ion	5200mAh 4S LiPo
Flight Control Computer (FCC)	ARK Pi6X Flow	Holybro Pixhawk 6X*

Compute	Raspberry Pi CM4 or CM5	Raspberry Pi 5 with DroneBlocks Compute Kit
Motors	AOS Supernova 2207 1980kv	2216 KV920*
Propellers	5.5 inch Tri-Blade props but supports 5 to 5.5 inch props	1045 two-blade
Electronic Speed Controllers	ARK 4-in-1 50A	Holybro BLHeli_S 20A*
Transmitter/ Receiver	RadioMaster Pocket TX and RadioMaster ELRS RX or comparable equipment	RadioMaster Pocket TX and RadioMaster ELRS RX or comparable equipment
Camera	Raspberry Pi Camera Board, V2, Sony IMX219 8-Megapixel Sensor (CSI)	Arducam 12MP IMX708 USB UVC module (USB)
Position Hold Sensing (Optical Flow + Rangefinder)	Integrated in the ARK Pi6X Flow (PAW3902 optical flow + AFBR-S50LV85D rangefinder)	Holybro H-Flow (PAA3905E1 optical flow + AFBR-S50LV85D rangefinder)
Telemetry Radio (not included in kit)	Any PX4-approved telemetry radio as described on this page: https://docs.px4.io/main/en/telemetry/	Any PX4-approved telemetry radio as described on this page: https://docs.px4.io/main/en/telemetry/

** Denotes a component that may differ in modified versions of the legacy AVR Drone. Contact info@theavr.org with any questions.*

8.2.1 Teams may use any additional commercially available sensors or actuators, such as servo motors, for DEXI-5 or DEXI-10 provided that they abide by the following criteria:

a. Components may only receive power from the onboard battery listed above.
b. Components may only be controlled by/interface with the existing Companion Computer or Flight Controller as described above.
c. Components must not violate any other rules, including creating safety hazards, creating wireless interference, or damaging Field Elements.

8.2.2 Exposed wiring of any kind is prohibited. All wiring connections must be covered by either heat shrink or electrical tape.

8.2.3 Teams and their Aircraft and Vehicles may only use the following forms of wireless communication:

a. WiFi between the DEXI-5 or DEXI-10 Companion Computer and the Ground Control Operator laptop or wireless router.
b. WiFi between DEXI-5, DEXI-10, and a Drive Team Member's laptop or mobile device.
c. Bluetooth between the RVR and a Drive Team Member's laptop or mobile device.

d. Bluetooth between the Spheros and a Drive Team Member's laptop or mobile device.
e. 5.8GHz radio between the FPV transmitter and receiver, if used.
f. 2.4GHz radio between the Flight Controller's receiver and a Drive Team Member's transmitter.
g. 900-915MHz or WiFi between an optional telemetry receiver and transmitter.
h. A second 2.4GHz radio is allowed between an RVR receiver and a Drive Team Member's transmitter to actuate mechanism(s).

8.2.4 Software created before the current season begins, such as from previous seasons, is only permitted if the source code is made publicly available to all Teams via a post on forum.theavr.org, a public GitHub repository, or something similar.

8.3 – Hardware

8.3.1 The primary airframe for DEXI-5 and DEXI-10 must be built from the components included in the applicable DEXI kit, unless otherwise approved by AVR staff.

8.3.2 Carbon fiber frame components included in the two DEXI kits may not be modified in any way.

8.3.3 Rules 8.3.1 and 8.3.2 do not apply to assembly hardware, such as screws or standoffs, or 3D printed parts. Teams may modify, customize, add, or remove 3D printed parts at will.

8.3.4 There are no material restrictions on additional mechanisms or accessories added to DEXI-5, DEXI-10, the RVR, Spheros, or Team-designed mission mechanisms, provided that no other rules are violated.

9 – Safety & Conduct

9.1 – General Safety

9.1.1 If Aircraft and/or Vehicle operation or Team actions are deemed unsafe during a Match, the offending Team may receive a Disablement or Disqualification at the Head Referee's discretion.

a. If a Team or any of its members, Students or any Adults associated with the Team, are disrespectful or uncivil to event staff, volunteers, or fellow competitors, they may be Disqualified from a current or upcoming Match.
b. Team conduct pertaining to this rule may also impact a Team's eligibility for judged awards.

9.1.2 Competitors must follow all relevant FAA (Federal Aviation Administration) safety regulations to guarantee the safety of students, spectators, and teachers.

9.1.3 All competitors must wear safety glasses when at the Field. This includes both in the Driver Station and when interacting with Aircraft and Vehicles inside of the Field.

9.2 – Flight Safety Rules

9.2.1 Unless it is inside of a netted Field, DEXI-5 and DEXI-10 must never:
   a. Have Propellers mounted
   b. Be Armed

9.2.2 DEXI-5 and DEXI-10 may only be Armed if all of the following conditions are met:
   a. The aircraft is inside of a netted Field.
   b. There are no humans inside of the Field.
   c. The aircraft has legal Propeller Guards attached (see Rule 8.1.2). Flying DEXI-5 or DEXI-10 outside of a netted area is considered to be a violation of Rule 9.1 and could result in Disqualification from an Event.
   d. There are no exceptions to these rules.

9.2.3 If DEXI-5 or DEXI-10 crashes, is Disabled, or otherwise becomes unresponsive during a Match, no action may be taken by Teams to continue flying. The aircraft should be disarmed immediately to prevent further damage.

10 – Honors and Awards

There are three (3) Competition Awards and four (4) Judge's Awards. Competition Awards are based on a Team's performance during the event. All Teams are eligible for Judge's Awards. Judge's awards will be evaluated by presentation judges, referees, event staff, and other volunteers.

10.1 – Competition Awards

10.1.1 Competition Awards will be given to the 1st, 2nd, and 3rd place Teams, based on their ranking at the end of the event as described in Section 7.3.

10.2 – Best Overall Design Award

10.2.1 The Best Overall Design Award will be given to the Team that demonstrates the best overall combined design for their DEXI-5, DEXI-10, RVR, Spheros, and related mission mechanisms or accessories.

10.2.2 This award will be evaluated primarily by judges of the presentation event, in conjunction with the referees who observe each Team in competition.

10.2.3 Judges will consider uniqueness of design, aesthetics and form factor of the platform, intentionality of design decisions, functionality of systems and modules, realistic features, innovative controls, and reliability/durability.

10.2.4 Teams must submit an Engineering Notebook in order to be considered for this award.

10.3 – Exemplary Team Award

10.3.1 The AVR Competition prides itself on the simultaneously competitive and collaborative environment it cultivates for participants. Because of this, an award will be given to the Team that best demonstrates professionalism, passion, and respect to both fellow competitors and event staff.

10.3.2 This award will be judged by the behavior of students in the competition arena, pit area, and the venue as a whole. It will be based on a combination of spirit and sportsmanship.

10.3.3 This award will be given to the Team most enjoyable to compete against, and will recognize Teams that demonstrate pride, loyalty and cheers, assist and support both competitors and teammates, and demonstrate superior professionalism.

10.4 – Presentation Award

10.4.1 This award will be given independent of on-Field performance, and is instead based solely on the Team's performance in the presentation event and the submission of their Engineering Notebook for the judges' review.

10.4.2 This award will be evaluated solely by the presentation judges.

10.4.3 This award will recognize the Team with the cleanest presentation, including:

a. Helpful and well-crafted media
b. Well-spoken and confident presenters
c. Camaraderie with team spirit (coordinated attire, team name, etc.)
d. Clear indication of practice and effort
e. Clear structure of the presentation
f. Quality and thoroughness of ideas
g. Content and quality of the Engineering Notebook (especially as referenced/included in the presentation)

10.5 – Judge's Choice Award

10.5.1 The Judge's Choice Award will be given to an outstanding Team who doesn't necessarily fit into the category of one of the other three Judge's Awards.

10.5.2 This award will recognize Teams that stand out among their peers, either in superior subject matter expertise, attitude, communication and teamwork ability, or other qualities that the judges deem worthy of recognition.

Appendix A – Field Specifications - NEW

Full Game Field

The majority of dimensions and specifications for the **From Runway to Roots** Field are provided in the 3D CAD model using OnShape.

Field components may vary slightly from event to event. This is to be expected; Teams will need to adjust accordingly. It is good design practice to create mechanisms capable of accommodating variances in the Field elements.

Links to CAD files for the Full Game Field can be found on the 'Team Resources' page on the AVR website: **theavr.org/resources**

The OnShape model linked from that page is view-only, which will still allow Teams to get measurements. To download, you must have (or sign up for a free) an OnShape account. While logged in, click the three lines for the menu in the top left and copy the workspace to your account.

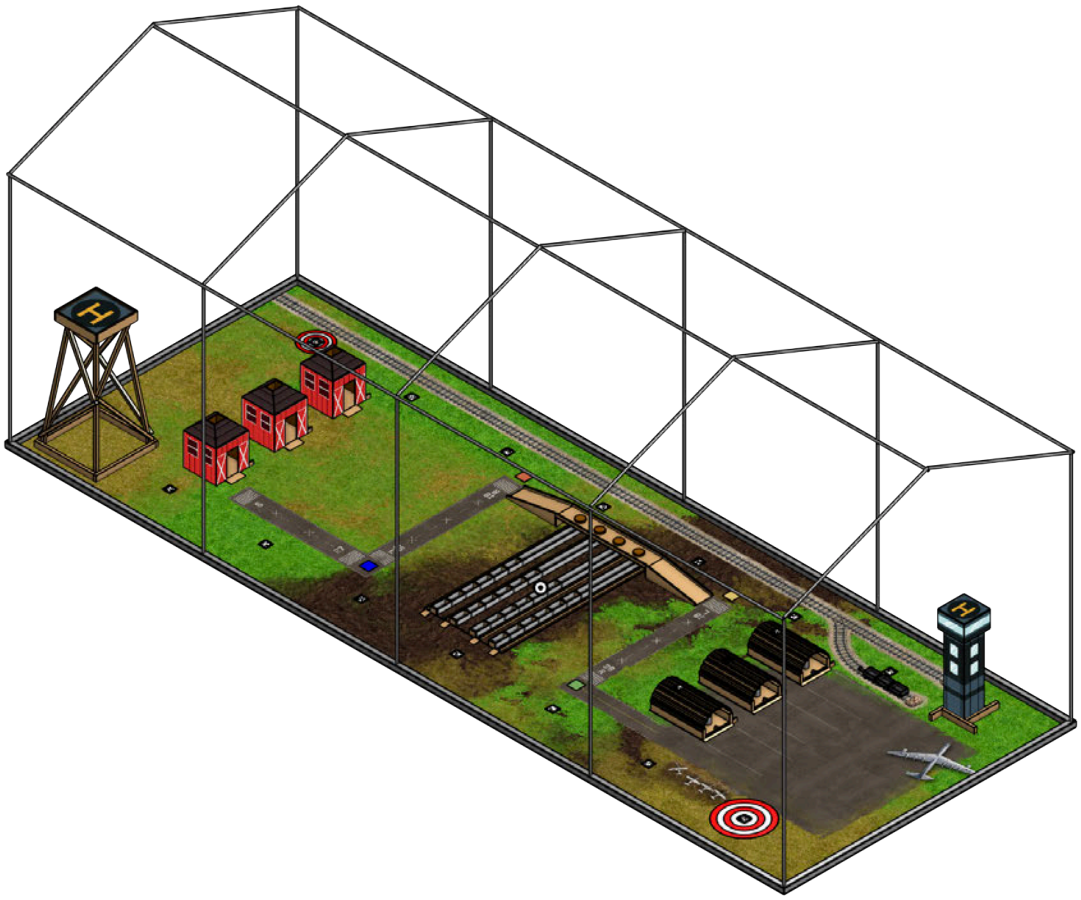


Figure 63: From Runway to Roots - Full Game Field CAD File using OnShape

Below is more detailed information for the AVR Field Elements to assist Teams in building court elements for practice. For more detailed/other information, refer to the OnShape model. Where explicitly stated below that measurements differ from the OnShape, the measurements and information to be used are those from the below Appendix information and not the OnShape.

Barn - Wooden structure with a ½” tall raised floor. The Barn Entrance is 7” wide and 15” tall. The Barn Top Opening when looking at the Front Entrance is 7” wide by 5” deep. The ramp in front of the Barn Entrance is 4” deep, 7” wide matching the width of the Barn Entrance, and the tall end of the ramp is ½” taller than the height of the Barn floor (1” tall measured from the court floor).

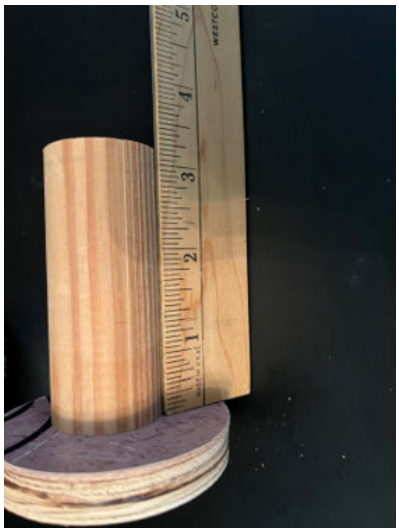
The pictures below show the images inside the Barn top opening along with examples of Barrels and Hay Bales sitting in the top opening to illustrate the depth the images sit inside the Barn top opening. The images sit roughly 3 ¼” below the Top Opening of the Barn.

Barrels - 300 x 407 type cans with regular lid (not pop top/easy open) with nominal 3” outer diameter and 4-7/16” height. The type of can itself the products are made from can be found here as an example. Examples of cans that will fit these measurements are as follows:

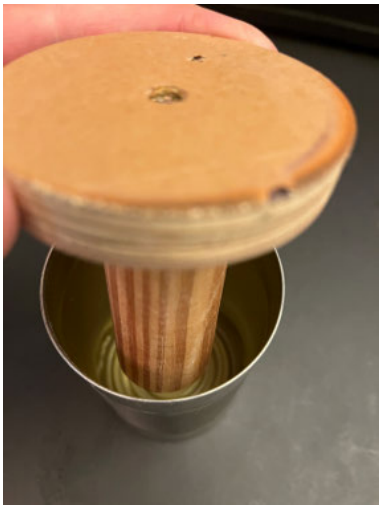
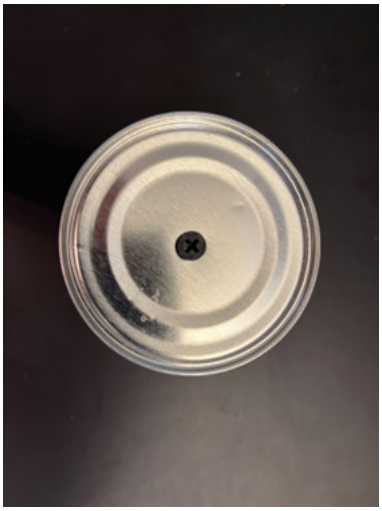
- https://www.delmonte.com/products/tomatoes/diced-tomatoes/diced-tomatoes-no-salt-added
- https://www.redgoldtomatoes.com/redgoldtomatoes/product/no-salt-added-diced-tomatoes-14-5-oz/

- https://www.redgoldtomatoes.com/redgoldtomatoes/product/diced-tomatoes-14-5-oz/

Of course it's not just tomato cans that have those measurements, there are many more products that exist that use the 300x407 cans. The Barrels/cans will have a rod and disk insert that will also verify whether the cans purchased are the same size as what will be in the qualifier and championship fields. The left picture below shows a 2 ¾" diameter disk which makes the top of the insert (a 3" hole saw was used to produce this). The middle picture shows the rod at 3 ⅛" tall and this rod is also 1 ¼" in diameter. The total rod and disk together on the right picture is 3 ⅝" tall. Just the disk is ½" tall.



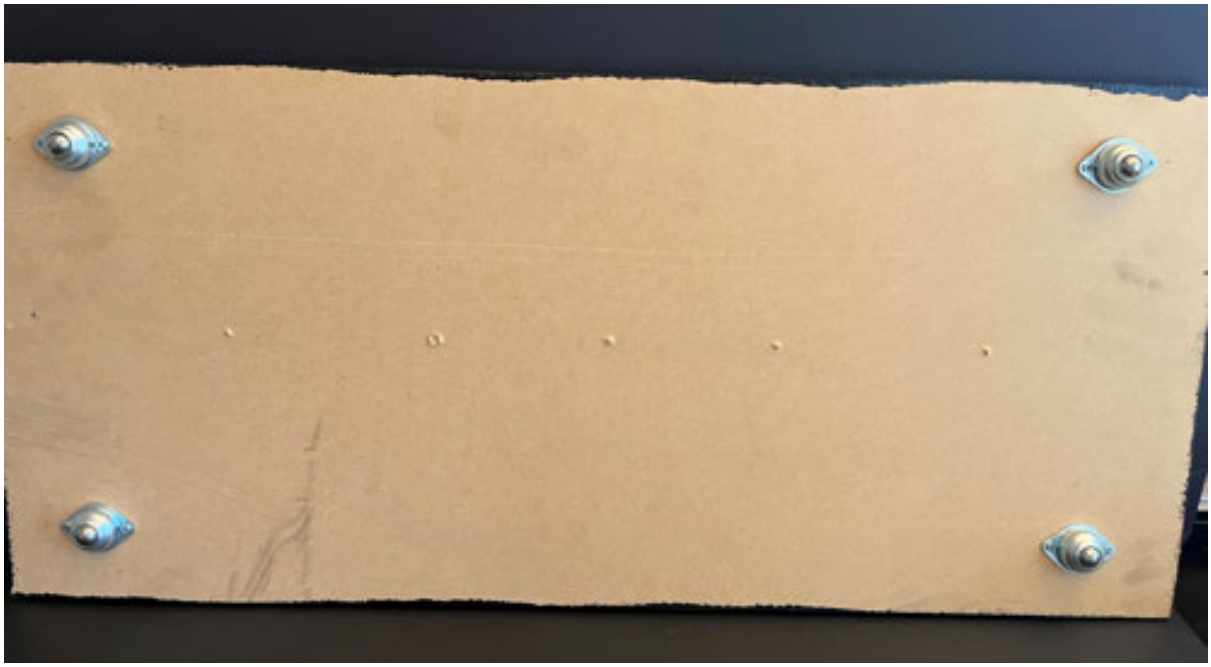
The pictures below show the rod and disk fit into the can with small margins. A screw secures the rod to the bottom of the can and the top of the disk which is the flat part that image stickers will be put on. This top flat part of the disk sits ½" down from the top of the can.

To reiterate - Do not buy cans with a 3.5" outer diameter or easy open, pop top cans as the dimensions will not match what is being used in the competition. Consumer cans are almost always not marked '300 × 407'; verify the nominal dimensions and lid style before purchasing.

A Barrel with the rod and disk inserted along with an image on top as it would be used on a competition court was weighed at 117 grams. There will be variances between barrel weights. This is a rough estimate of what they may weigh for competition. Teams should be able to accommodate heavier and lighter barrels.

Pallet - ¾” thick MDF board that is 14 ½” wide and 32” long. Has 4 cutouts for Barrels and one cutout for a Hay Bale. On the bottom side, has 4 two-hole flange ball caster wheels. Also contains a cutout area on one end for the hitch. The pallet caster rollers link can be found here. The pictures below show the caster rollers installed on the bottom side.

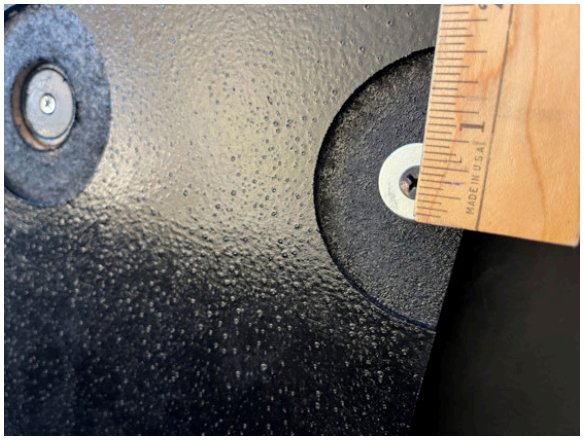


The Pallet magnets are the same as the Freight Car magnets and can be found here.

The pictures below show the painted Pallet with these magnets in the Barrel cutout holes as well as the Hay Bale cut out. It also shows a painted Pallet with 3 Barrels and a Hay Bale in position with a 4th Barrel placement uncovered.

Pallet Hitch - ¾” wide and ½” tall plastic/nylon spacer with a washer on top that screws into the Pallet board. While the Pallet sits fully inside the raised Hangar floor, the top of the hitch sits approximately 3” high from the actual floor. The Pallet Hitch is the same distance from the end of the Pallet as the Freight Car Front Hitch - the center of the hitch cylinder sits ½” back from the end of the Pallet. When the Pallet is pulled out of the Hangar, the hitch sits approximately 2” high. **Teams will need to ensure they accommodate this height drop as the Pallet is pulled off the raised Hangar floor.**

The pictures below show that the hitch made of a spacer, washer, and screw is ½” tall and ¾” wide. This differs from the OnShape.

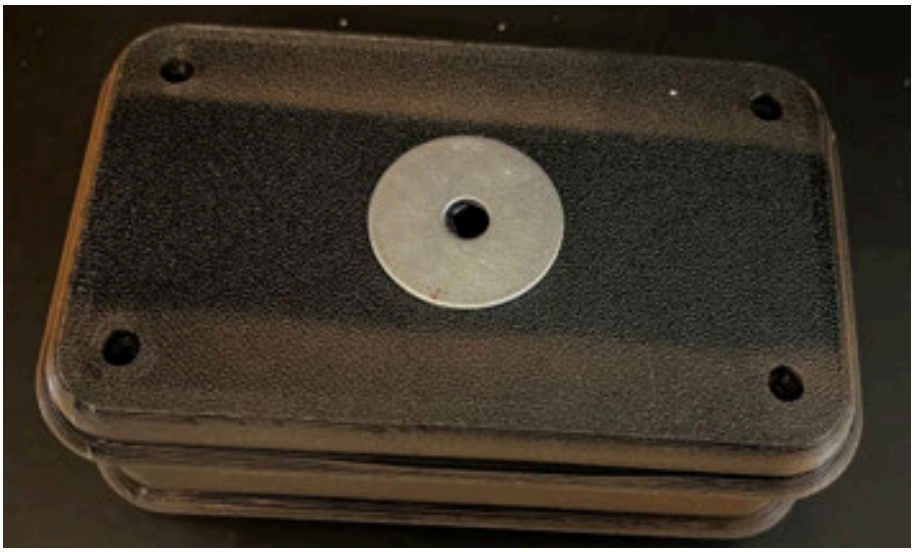


The pictures below show the height difference of an unpainted Pallet in the Hangar vs out of the Hangar. The raised Hangar floor and ramp are reflected properly in OnShape.

Hay Bales - 3D printed game objects. [This link will take you to the 3D print for the Hay Bale](). The pictures below illustrate that the bottom of the hay bale uses a screw to hold a washer in place so it can interact with the Pallet magnets.

The top left image is a top view of the printed Hay Bale. The top right image is an edge view from the bottom of the Hay Bale. The 3rd image shows a side view of the Hay Bale from underneath. The 4th image shows a more detailed view of the bottom of the Hay Bale.

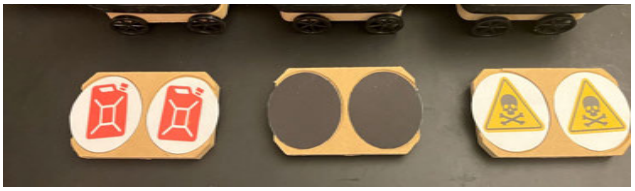
A Hay Bale with the washer installed as it would be for competition was weighed in at 107 grams. There will be variances between Hay Bale weights. This is a rough estimate of what they may weigh for competition. Teams should be able to accommodate heavier and lighter Hay Bales.



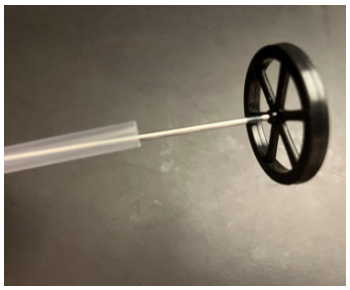
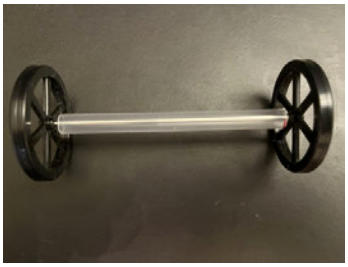
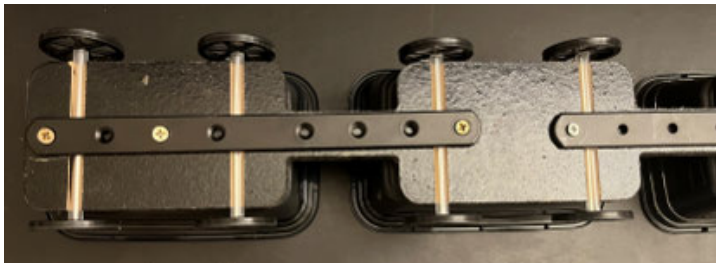
Freight Cars - Base structure of the Freight Cars is ¾” MDF. Heavy-duty plastic trays are used as the individual Freight Car bodies. These are secured to the MDF with screws. An MDF cutout is then inserted into the trays that contain the same magnets used on the Pallet for the Barrels and Hay Bales. Basic spindle and plastic wheels are used on the sides of the Freight Cars. The

MDF cutout will contain the Image stickers which are moveable and will be randomized by the referees between Matches.

The below pictures show the unpainted MDF one-piece structure that makes the base of the Freight Cars (non flexible rigid piece) as well as the MDF insert containing magnets and eventually stickers/images.



The below pictures show the painted and final Freight Cars including a measurement for the hitch showing the height at roughly 2” which differs from the OnShape 2 ½” height. Additionally, the wheels and wheel shaft are shown along with the brackets that hold the wheel shaft in.

This is the link for the wheels.

Below shows the painted MDF inserts with magnets screwed in. They are shown both outside and inside the Freight Car along with a barrel on top.

The link for the magnets is here.

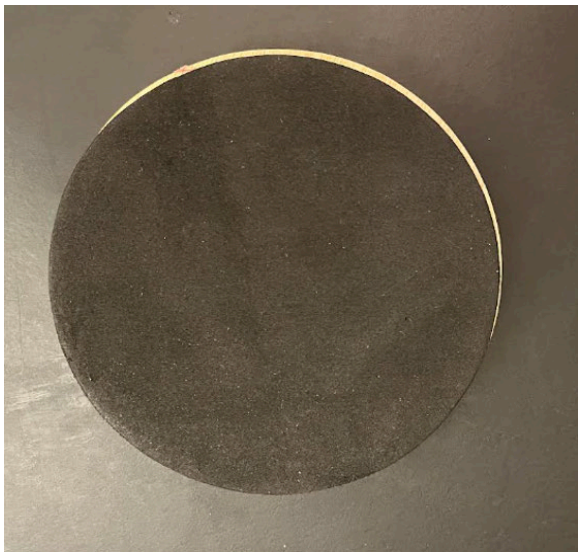
The fully assembled three-car Freight Car assembly as it would be setup for competition (without barrels on it) was weighed at 1400 grams. This weight was the entire 3 car body fully assembled with inserts that had magnets in two of the cars and one insert that was non magnetic in the third car. The weight of the insert without magnets was 170 grams and the weight of the insert with magnets was 200 grams. This is a rough estimate of what these elements may weigh for competition. Teams should be able to accommodate heavier and lighter weights.

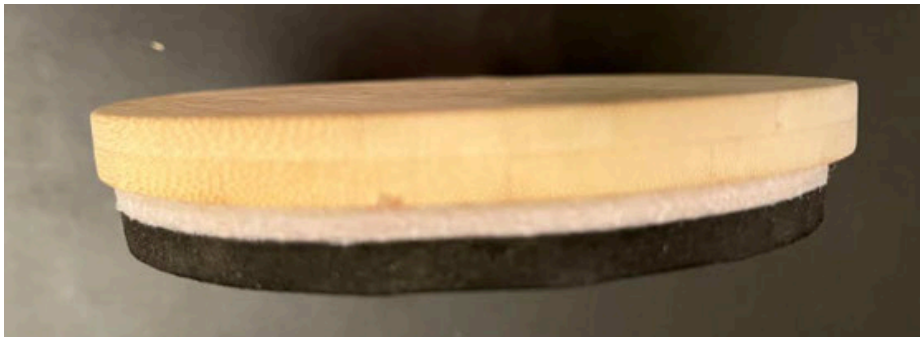
Freight Car Front Hitch - It uses the same parts as the Pallet Hitch and has the same ¾” wide and ½” tall dimensions. The center of the cylinder sits roughly ½” back from the front edge of the wooden beam and is roughly 2” high. The wooden beam is roughly 5” long, ¾” tall and 1” wide.

Bridge - Refer to the OnShape model for details. Specific information can be provided upon request.

Bridge Coaster - The Bridge Coasters will be made up of a black 5” coaster on top and a 5 ¼” smooth wood coaster on the bottom. The coasters (both pieces attached to each other) will be roughly ⅞” tall. The coasters are specifically made up of a wood coaster that can be found here and a pad coaster which can be found here. These are glued together.

Pictures of the coasters are below. The wood, pad, and then both glued together.





Cultivated Rows and Sections - Refer to the OnShape model for details. Additional information can be provided upon request.

Seed Ramp for Sphero Verification - Refer to the OnShape model for details. Additional information can be provided upon request.

Bridge Gap for Sphero Autonomous Route - The plywood used for the Cultivated Row base is 48” wide and the Bridge is 56” long leaving 4” on both sides for the Sphero to roll through on the floor in between the Cultivated Row Base and the Bridge Ramp Structure.

Switch Button - 3D printed enclosure containing a switch, small Arduino and LED that toggles on/off upon the switch being depressed. Specific print information along with hardware and other specs is coming soon!

The picture below shows the 3D printed switch button used in prior-year games which will be used this year as well.

Toxic Storage Boundary – The minimum dimensions for Toxic Storage are as follows:

- 34 inches long (measuring the same direction as the train tracks)
- 10 inches wide.

Toxic Storage will be identified with gaffer tape, scotch tape, or some other method. As the above are minimum dimensions, the exact boundaries may vary. The exact placement will also vary. However, Toxic Storage will always be placed somewhere between DEXI-5's ID 5 and ID 6 Autonomous Challenge April Tags while roughly centered over the train tracks. This ensures ample room for maneuvering on both ends of Toxic Storage.

Appendix B – Presentation Rubric

Team Number: _____ Judge Name: _____	**Score**
Design Approach and Process	
Comments:	/50
Demonstrated Engineering Skills	
Comments:	/50
Game Winning Strategy	
Comments:	/50
Lessons Learned	
Comments:	/50
Teamwork, Communication, & Team Spirit	
Comments:	/50
Quality of Materials and Presentation (including coordinated apparel)	
Comments:	/50
Demonstrated Effort and Research	
Comments:	/50
Quality and Content of Engineering Notebook	
Comments:	/100

Overall Total: /450

Appendix C – Engineering Notebook

The Engineering Notebook is not mandatory but highly recommended, not just for the point value, but for learning a discipline for future projects.

The Engineering Notebook is documentation of the Team, Team plans, Aircraft and Vehicle designs, software development, mechanisms, strategy, testing, and lessons learned throughout the season. This documentation should include sketches, discussions and Team meetings, design evolution, processes, obstacles, and each Team member's thoughts throughout the journey for the entire season.

Teams may use either classic pen and paper to create the notebook (Spiral notebooks, lab notebooks, loose pages, or a combination of any or all of these), or they may keep an electronic version on a computer or tablet or on a shared resource such as Google Drive. Notebooks should contain notes of all Team meetings, sketches of changes and modifications, any engineering calculations used in the design, and photographs of the build and the Team activities.

Notebooks submitted for judging MUST be printed on paper and submitted in a single 3-ring binder with a ring diameter of no more than 3 inches. Handwritten material may be scanned for inclusion in the final notebook. All materials must be fastened to pages, no loose materials will be accepted. The Team Number MUST be printed on the outside of the notebook.

Engineering Notebooks are to be submitted at the beginning of the Event Day as part of Team Check-In. Judges will evaluate the notebooks during the day but will provide them back to the Team for the Presentation Session.

Suggested Guidelines for Engineering Notebooks:

1. Title page
2. Summary page with important pages noted and reasons why they are important (Summary is ONE page only)
3. Table of contents (Labeled tabs for the notebook are nice but not required)
4. Sections:
   A. Team bios including role and contributions to the Team (First Names only)
   B. Safety Processes
      i. Meeting Discussion
      ii. Workshop Safety
      iii. Flight Safety
   C. **NEW** Aircraft and Vehicle designs – This should describe the design and development of elements beyond the base DEXI-5, DEXI-10, RVR, and Sphero Mini platforms. This may include mechanisms, attachments, software, sensors, LED Signaling systems, transport devices, seeding systems including the process for choosing what to use for the "Seed", supporting details, and design iteration information, Pallet/Freight Car handling systems, and other Team-developed solutions. Teams should include initial designs, testing, implementation, and changes made over the course of development to show application of the engineering design process.
   D. Game strategies – This would be the determinations of where the Team will focus the strategy as they play. This should include any decisions and developments made over time.

E. Artistic elements – Any extra efforts to make the designs, mechanisms, Aircraft and Vehicles, or Field interactions realistic and connected to the From Runway to Roots theme (Aviation, Agriculture, and Freight themes being shown in a unique way like giving the RVR tractor or train engine decals, or the DEXIs adopting unique aviation markings)

F. **NEW** Autonomous Challenge & Advanced Software Efforts - For Teams that attempt autonomous navigation, computer vision, or other advanced software challenges, the Engineering Notebook should include representative code, flowcharts, screenshots or pictures, test results, and/or explanations showing how the Team developed and tested its autonomous systems, image recognition, LED Signaling, and Aircraft or Vehicle control strategies. Teams do not need to print every line of source code; the goal is to clearly document the engineering and testing process.

G. Team meeting/work session documentation – this can include:
   - i. Date, time, and location of meeting/work session
   - ii. Attendees including coaches and mentors (if any)
   - iii. Meeting/session goals (if defined)
   - iv. Accomplishments – including lessons learned through training, practice, and failure
   - v. Design decisions made including sketches, calculations, notes, and photos. This will include the design items from above but here they are spread throughout the timeline of work vs. the design section where they are all pulled together.
   - vi. Game strategy planning
   - vii. Event and presentation discussions
   - viii. Processes followed including safety processes.
   - ix. Issues (if any)
   - x. Reflection

The documentation should include enough detail for another person to look at your notebook and be able to follow through the steps your Team took to get to your final designs.