FIRST ROBOTICS COMPETITION

REBUILT™

PRESENTED BY HAAS Gene Haas Foundation

FIRST® AGE™
presented by Qualcomm

firstinspires.org/robotics/frc

2026 *FIRST*® Robotics Competition

Field Manual

Table of Contents

1 General Notes

This document has step-be-step guidance on building the 2026 playing field, intended for use by a *FIRST* Technical Advisor (FTA) or Field Supervisor. Also included are cautions and general reminders about FTA tasks and the Competition components. Before you begin, you are urged to review these instructions completely and get comfortable with the tasks at hand.

Safety and other important notes are highlighted in red.

Images for this Field Manual were created using Onshape, a *FIRST*® Modeling Solutions Sponsor.

1.1 Field Build Volunteers

Depending on the venue, you may receive help from either contract or union labor and/or from a dedicated field build volunteer group. Some will have experience from prior competitions; others will be seeing the equipment for the first time.

Due to the nature of the job, Field builders should be physically able individuals capable of lifting 50 lbs. above shoulder height and should be aware of general safety. The FTA and Field Supervisor will probably want to set up “build teams” to each major section of the field, as detailed in Section 1.4 Assembly Teams.

1.2 Field Build Assembly

FIRST strives to deliver playing fields that are as identical as possible at all events. These fields travel, are unpacked, used, and repacked repeatedly. While the Field is in your care, it is your responsibility to ensure that it is treated in a manner consistent with the demands of multiple uses; protect it, keep it organized, and keep it complete.

FIRST requires the cooperation of all to not modify field components without first contacting *FIRST* Engineering for approval. This includes adding stickers, writing, tape, cable tie mounts, hook and loop strips, etc.

Unless specifically instructed by *FIRST*:

- Do not remove any button head bolts or rivets from any field structure.
- Do not drill, bend, straighten, shim, or cut field components.
- Do not add any hook, loop, or cable tie points.

Hex head and Phillips head bolts are intended to be removed during tear down for shipping purposes, but any bolt that requires a hex key is intended to stay together. Once a field has been built once, it is likely that everything will fit nicely. If it does not fit, it is likely in the wrong position, location, or orientation. Do not force anything together with a hammer or mallet unless permission is given by *FIRST* staff through online support.

1.3 Tools

A small number of tools are needed to assemble the 2026 field. All the necessary tools are provided in the Tools Road Case – Case 8. You can expect to use 100' tape measures, knives, scissors, wire cutters, mallets, shears, wrenches, screwdrivers and a chalk line. You will also use cable ties to attach cables and plastic sheets to the field framework.

There are three different kinds of cable ties – high (120lb), medium (50lb), and low (18lb) strength. High strength cable ties are used to hold plastic sheets to the Guardrail. High and medium strength cable ties are used for assembling field components. Low-strength cable ties are used to dress Field wiring and cables.

FTAs and Field Supervisors may bring a power drill to aid in field assembly. Use of a power drill to tighten nuts and bolts should be done with caution, as over-tightening can result in breaking PEM nut fasteners, crushing metal field components, or stripping threads on fasteners. Start on a low torque setting and check to see how tight of a connection that creates before increasing to a higher torque setting. **Impact Drivers should never be used** to build the field as they are more likely to cause damage to the field components.

1.4 Assembly Teams

Setting up volunteer teams to manage the various tasks required to build the field can increase efficiency, leading to quicker, more effective build times. The FTA and the Field Supervisor should discuss the teams needed, the tasks involved, and the ideal number of people per team. Tasks that include lifting heavy parts of the field should include more than enough volunteers or should pull volunteers away from other tasks briefly to assist in the lift.

1.5 Electronics: General Reminders & Notes

- Field Electronics installation happens in the following categories:
  - The Scoring Table
  - Field ends also known as Alliance Wall
  - Referee Panels
  - Game Specifics – Hub (wires run as part of Fixed Side Bump and Trenches)

> *FIRST* Engineering asks that you do NOT add or remove any markings (sharpie, label with gaff tape, etc.) on items (including cables!) without express permission from *FIRST* Engineering. Please discuss any actions with your Support staff member beforehand.

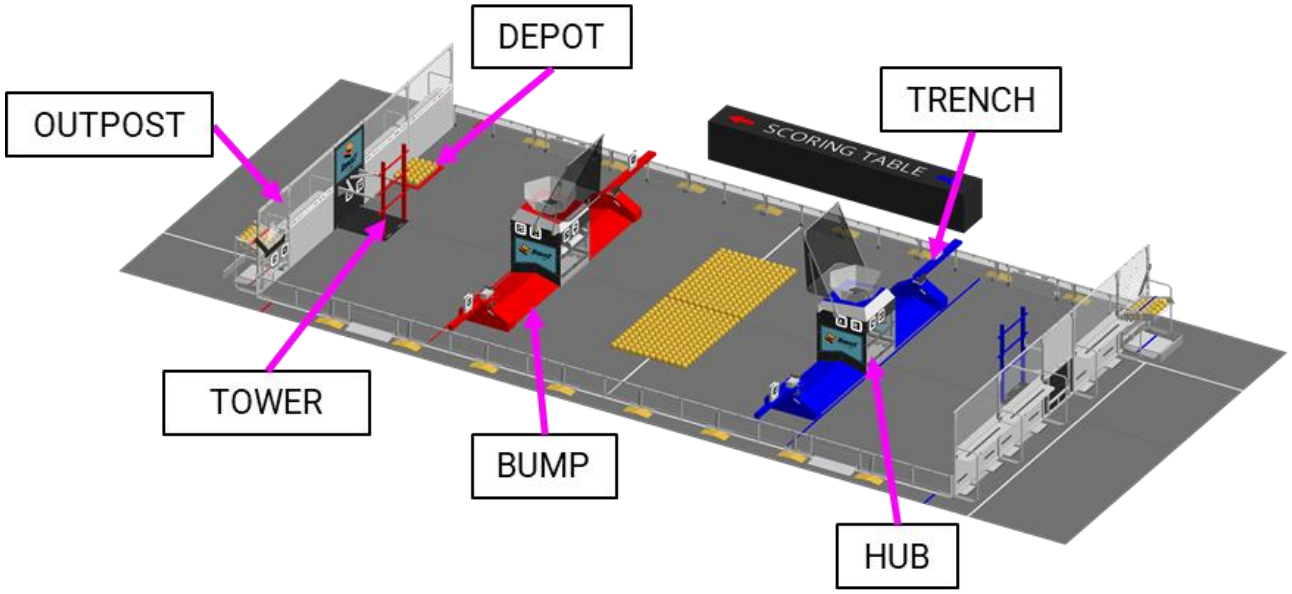
- Testing has been extensive to ensure quick response through the industrial network of the FMS. Allowing access to these connections could have detrimental effects on field performance. The only people permitted to connect to the FMS network are:
  - FTA
  - Game Announcers/Emcees
  - Official *FIRST* webcast using Case 35
  - If internet access is requested at the scoring table for webcasting the event, judges, DJ's, etc. contact FMS Support for assistance.
- Be alert for additional power or camera cabling running along the field border supporting the A/V crew and confirm that the cable will not interfere with the gates and is safely stowed along the side of the field.
- Avoid network loops. Ensure not to cross connect (i.e. loop) any network cables (e.g. venue ethernet, SCCs, etc.) into the ethernet switch, as you may cause a network error.
- The SCCs and Field AP Ethernet must plug into their specified ports on Case 33.

> Most of the connectors are made of plastic and will break if stepped on. When installing or removing, hang the cable connectors on the field end or other places where they are not prone to damage.

- Electronics case information:
  - **Case 6** – Field End Electronics: includes Station Control Cabinets (SCCs), LED Display units, Team Lights, E-Stops, A-Stops, and field electrical cables.
  - **Case 7** – Scoring System: includes power strips, printer, monitors, keyboards, mice, Field Access Point (AP), Pit Display laptop, Audience Display laptop, WPA/Radio Kiosk laptop, FTA laptop, other game specific hardware, April Tags, DMX Controller and miscellaneous cables.
  - **Case 19** – spares, FTA Toolbox (outlet tester, multimeter, USB-to-Ethernet adapter, etc.) consumable Driver Station Ethernet cables.
  - **Case 33** – Scorpion: Includes primary server, backup server, field router, UPS, Arena Signal Light, and Arena E-stop.
  - **Case 34** – touchscreens, stands, associated cabling, and DMX Light Bars.
    - Case 34 also includes a PTZ camera for regional fields.
    - New year there are 9 DMX controlled light bars. 4 per Hub + 1 spare.
      - Brand: OPPSK Model: 60W RGB DJ Light Bar - 40" 224LED Pixel Lights Quantity: 4 per Hub
  - **Case 35** – Webcast (See Webcast instructions for help with the Webcast units) - Regional Trucks only.

2 Field Components by Name

Figure 2-1: REBUILT FIELD

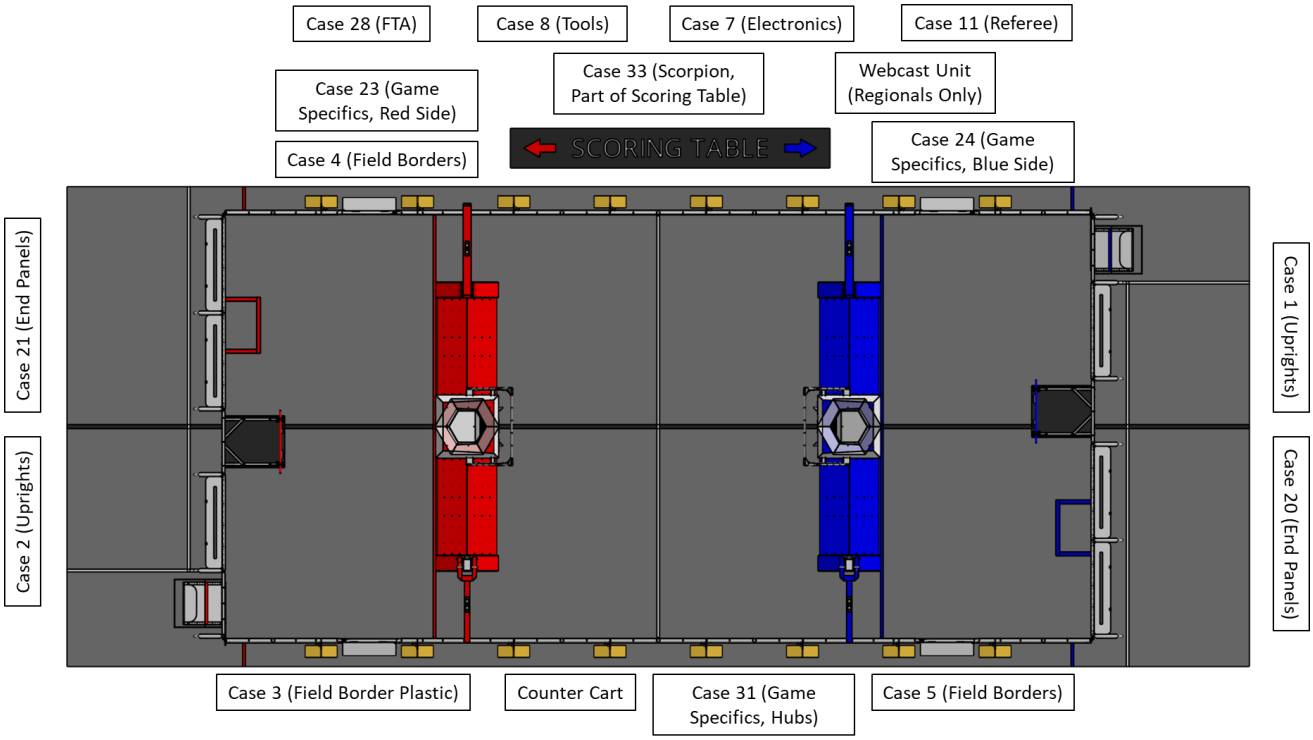


3 Competition Field

3.1 Road Case Layout

The first step in building the field is proper case location. Properly locating cases saves time and unnecessary carrying and lifting. The diagram below provides a suggested initial position of road cases. Space may be limited at some venues, requiring road cases to be brought into the field area in stages.

Figure 3-1: Suggested Road Case Layout



- **Case 23 and 24** are each alliance-color specific cases for the Trenches, Bumps, Outposts, and Towers.
- **Case 31** contains items for Hubs and Depots.
- **A custom cart** contains the Fuel Counters needed for the Hub assembly.
- **Case 32** contains all the parts for the Test Area and can be moved to that location.

3.2 Carpet Installation

- The playing field carpet is 74’ x 30’.
- Carpet should be centered under AV equipment (where applicable).
- Minimize bumps and ripples as much as possible.
- Accurate chalking and taping are paramount to correctly building the field.
- Gaff tape should be used for carpet marking, not for queuing.

3.2.1 Laying Carpet

3.2.1.1 Tools & Equipment Required

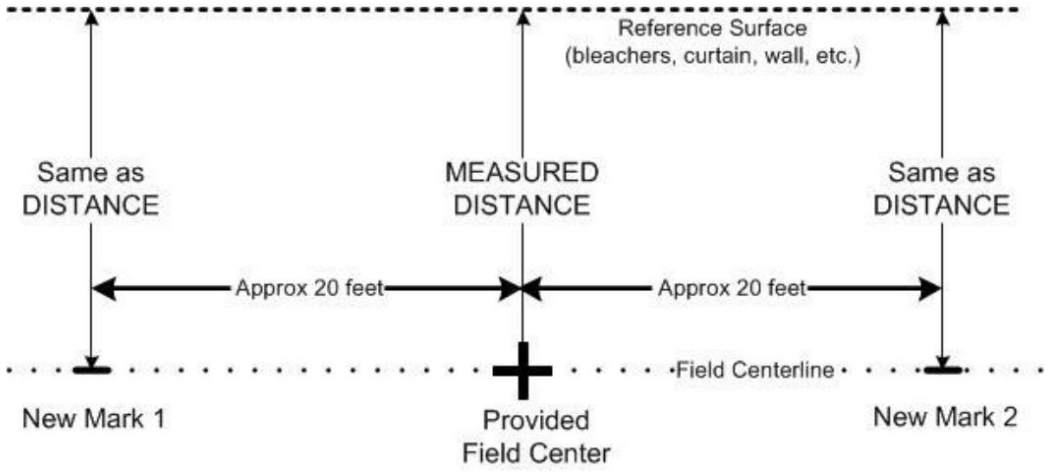
- Two Gray Carpet Rolls – 74’ long
- Carpet Tape – 1 roll
- 3” Black Gaffer’s Tape – 3 rolls
- Sharpie and/or White Paint Markers – 1 or more
- 100’ Measuring Tape – 1
- 25’ or 30’ Measuring Tape – 1
- 100’ Chalk Line – 1
- Utility Knife – 1
- Carpet Knife – 1 (pictured right)

3.2.1.2 Steps

1. Work with AV crew and event management to decide when you can install the carpet.
2. Locate field center. Field center is the mark that is located on the centerline where the two carpet rolls meet and is equidistant from the ends of the rolls. This point may be supplied by the AV crew or event management. If not, it will be up to the FTA to locate. Consider any pedestrian or robot traffic lanes that may be needed. Also consider the locations of referee stands when marking field center.
3. Establish your field centerline. Find a nearby wall, set of bleachers, drapes, stand, etc. that will be parallel to the field center and measure the shortest distance to the field center (the “measured distance” in the diagram). Using small bits of Gaffer’s tape, put two marks on the floor the same “distance” from the reference surface, but about 20’ from the field center.

Note: If there is no obvious reference surface, align the field by eye to the best of your ability.

Figure 3-2: Finding the Centerline



4. Position both carpet rolls 37’ from the field center point such that the carpet will uncoil in the intended direction, parallel to the field centerline.
5. Roll out the carpets, keeping the inner edges approximately 3” from the field centerline. Eliminate any ridges and bumps in the carpet by stretching carpet sides. Verify by measurement that the carpet is at least 74’ long.
6. Trim the uncarpeted material from each roll. Try to trim the material in a long, clean, straight line along the edge of the carpet pile edge using a carpet knife. Working in tandem, one person cuts and the other keeps tension on the loose portion. Avoid cutting into the carpet weave.

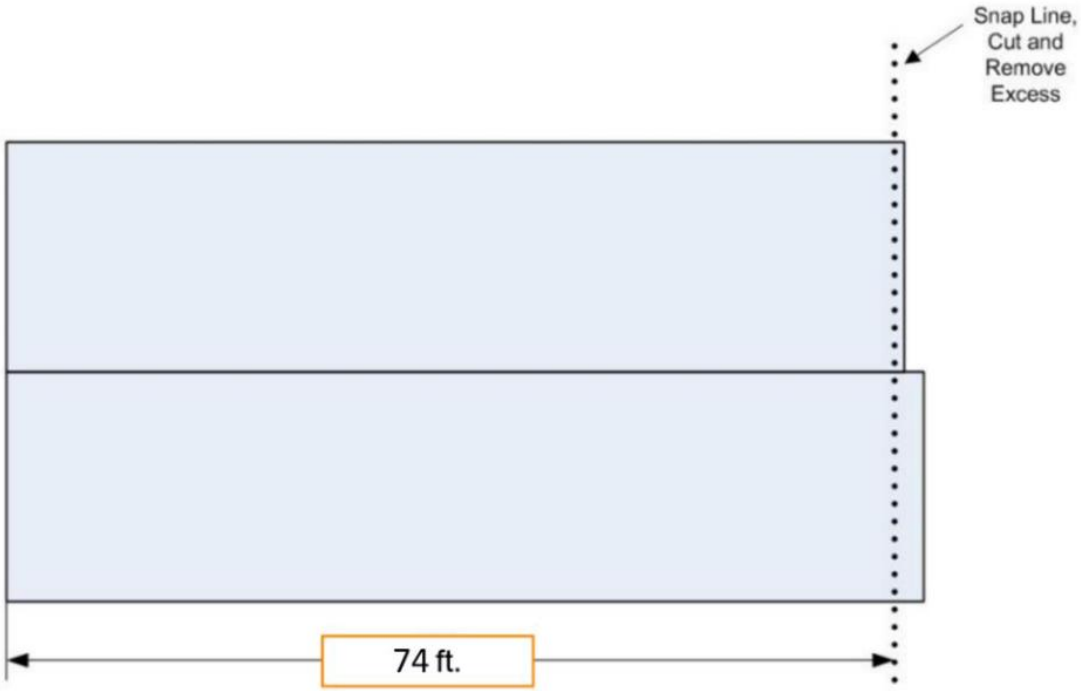
Figure 3-3: Trimming Carpet

7. Measure and mark 37’ from the end of one carpet down the centerline edge. Repeat the process for the second roll, measuring from the same end.
8. Align one carpet based on measurements made in previous steps. Align the interior edge with the previously marked field centerline. Align the mark made at 37’ in the previous step with the established field center mark.
9. Align the second carpet to the first one. The 37’ mark should line up with each other on both carpets. The seam should be smooth and straight with very little gap. One end of each carpet (the one measured from to identify the 37’ mark) should line up with each other.

Figure 3-4: Aligning Carpet Edges

10. Measure 74’ from the end of each carpet along the outer edge. Mark using a sharpie. Snap a chalk line across the carpet at this location. Cut excess carpet and discard.

Figure 3-5: Measuring Carpet Length



11. Fold back the carpets along the field center width as shown. Begin affixing your roll of carpet tape to the edge of one carpet with half the width of the tape beyond the edge of the carpet. Extend this by about 6”. As you continue to apply the tape, gradually unfold the carpet, returning it to the floor. As you do so, unfold the other carpet to lie on top of the newly exposed edge of the carpet tape. Continue along making a straight, smooth center seam as you go the width of the carpet. Ensure no overlapping of carpet occurs along the seam.

3.2.2 Initial Carpet Marking

Note: There are different markings for AndyMark fields. See Section 3.2.2.3.

3.2.2.1 Tools Required

100ft Measuring Tape – 1

25ft Measuring Tape – 1

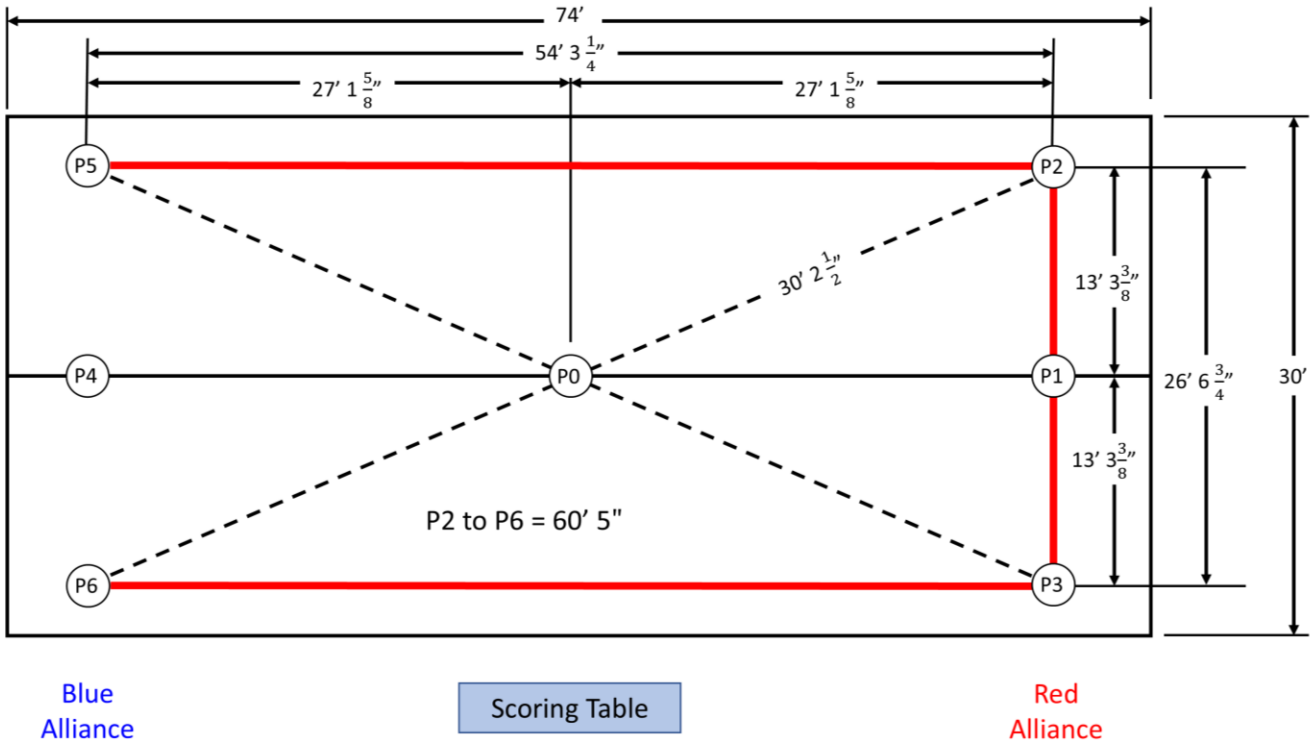
Sharpie or White Paint Pen – 1

Chalk Line – 1

2in White Gaff Tape – 1 Roll

3.2.2.2 Markings

Figure 3-6: Initial Carpet Marking Diagram



2026 Carpet Markings for Field Position and Layout - 1

Note - The "P" used on the Carpet Markings diagram above and the accompanying text means "Point". The compass notations (i.e. "North") are provided to assist in locating items with the field and are not meant to imply any particular orientation of the field reference to geographic north.

1. Snap the centerline of the field where the edges of the two carpets meet. The exact length does not matter, provided it is longer than 55ft and is centered on the carpet. If P0 is no longer directly on the line, transfer the mark to the closest point of the snapped line.

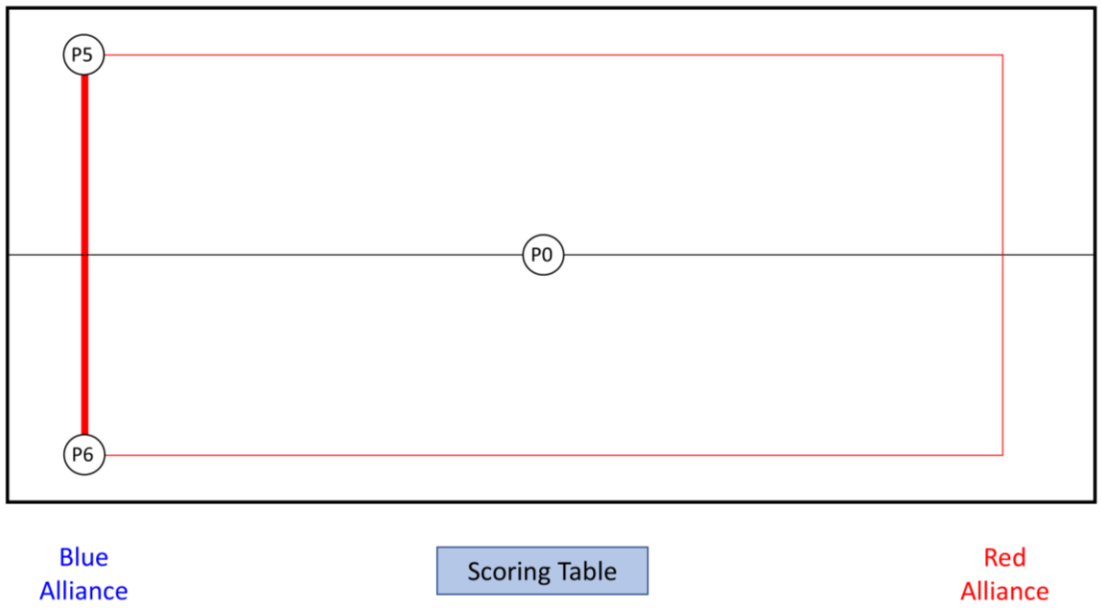
2. Locate the P2 field corner. Starting from P0, measure east along the center chalk line 27ft 1-5/8in and mark P1. Starting again from P0, measure northeast 30ft 2-1/2in. At the same time, starting from P1, measure north 13ft 3-3/8in. Place a small piece of gaff tape at the intersecting point to temporarily mark the intersection as the P2 field corner. After you remove the tape measures, make a bold "+" at this point with the sharpie.

3. Using the same technique as above, locate and mark the P3 field corner. Verify 26ft 6-3/4in between P2 and P3.
4. Using the same technique as above, locate and mark the P5 and P6 field corners. Verify 26ft 6-3/4in between P5 and P6.
5. Verify that the distance from P2 to P6 and from P3 to P5 is 60ft 5in.
6. Snap the following chalk lines: P2 to P3, P2 to P5, and P3 to P6

   Suggestions for snapping chalk lines:

   - Be sure there is a sufficient level of chalk in the marker container. If you need to add chalk, do so away from the carpet and over a trash can.
   - Extend the chalk line over a trash can while standing off the carpet to the necessary distance. Then move onto the carpet to lay the marks.
   - Prior to snapping the line, hold and stretch the line taut so the line will snap as straight as possible.
   - When winding the line up, stand off the carpet to prevent accidental marking.
7. Follow instructions to place the red alliance wall and side borders. Snap a line from the end of one side border to the next. The line should be adjacent to the metal plate at the end of the side border. This line may not be exactly from P5 to P6 due to tolerances or gaps in the side border. If you have concerns, contact your mechanical support person.

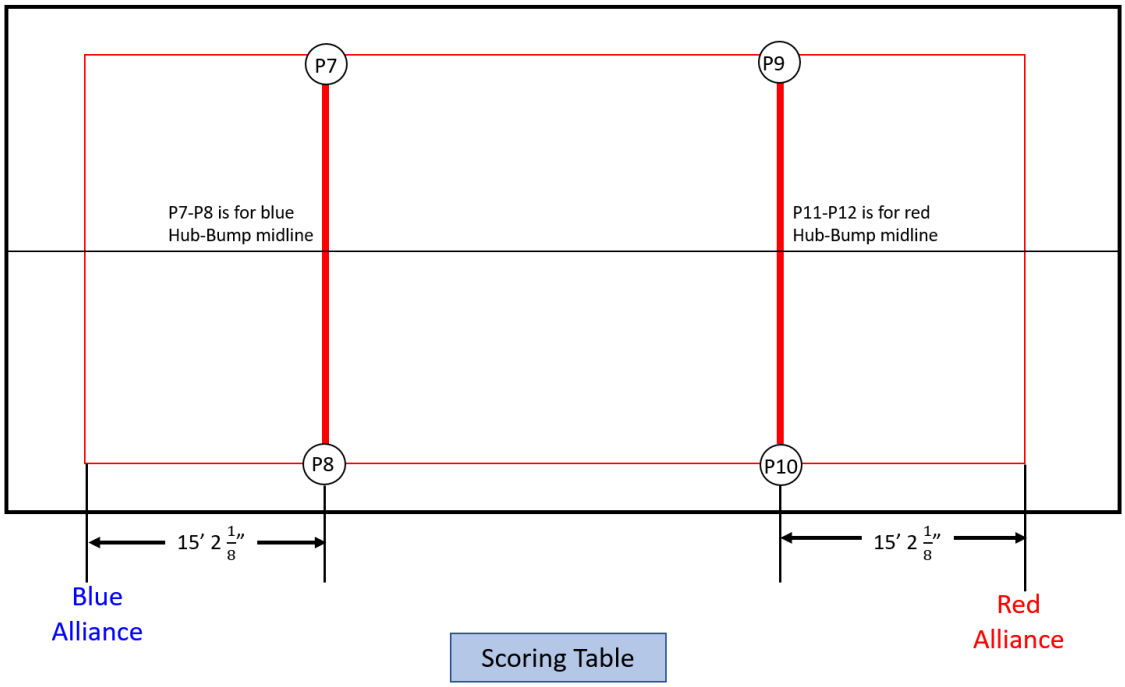
Figure 3-7: Measuring & Marking P5 & P6



2026 Carpet Markings for Field Position and Layout - 2

8. Measure from each corner of the field 15ft 2-1/8in (P7, P8, P9 and P10 in the diagram). Snap lines from P7 to P8 and P9 to P10.

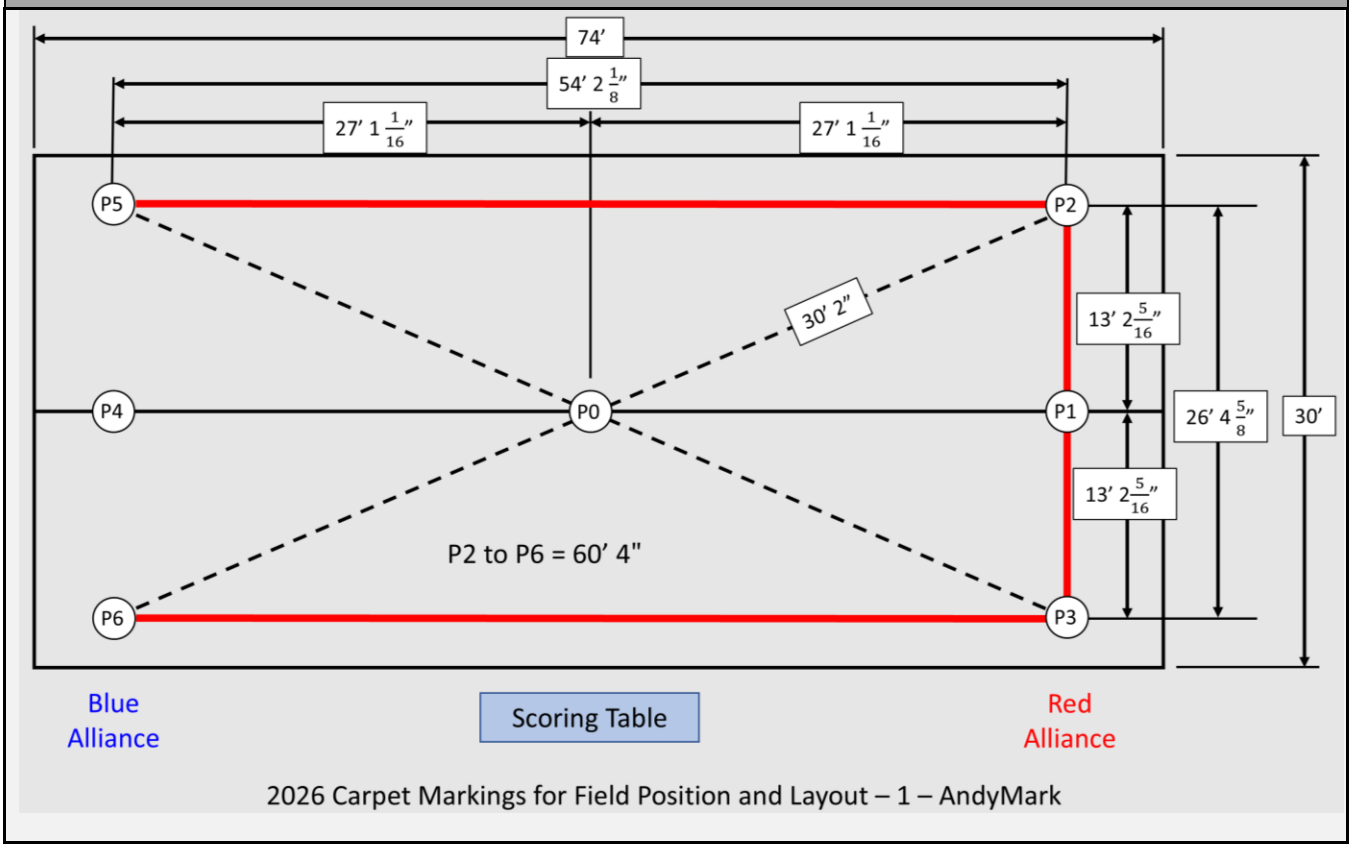
Figure 3-8: Measuring & Marking P7-P10



2026 Carpet Markings for Field Position and Layout - 3

3.2.2.3 AndyMark Field Markings

FOR ANDYMARK FIELD ONLY



2026 Carpet Markings for Field Position and Layout – 1 – AndyMark

3.3 Side Borders and Gates

In this step you will build two complete Side Borders with their respective Gates. The two sides can be built simultaneously.

Note: When unloading and handling border segments containing Gates, make sure they are in the closed and locked position.

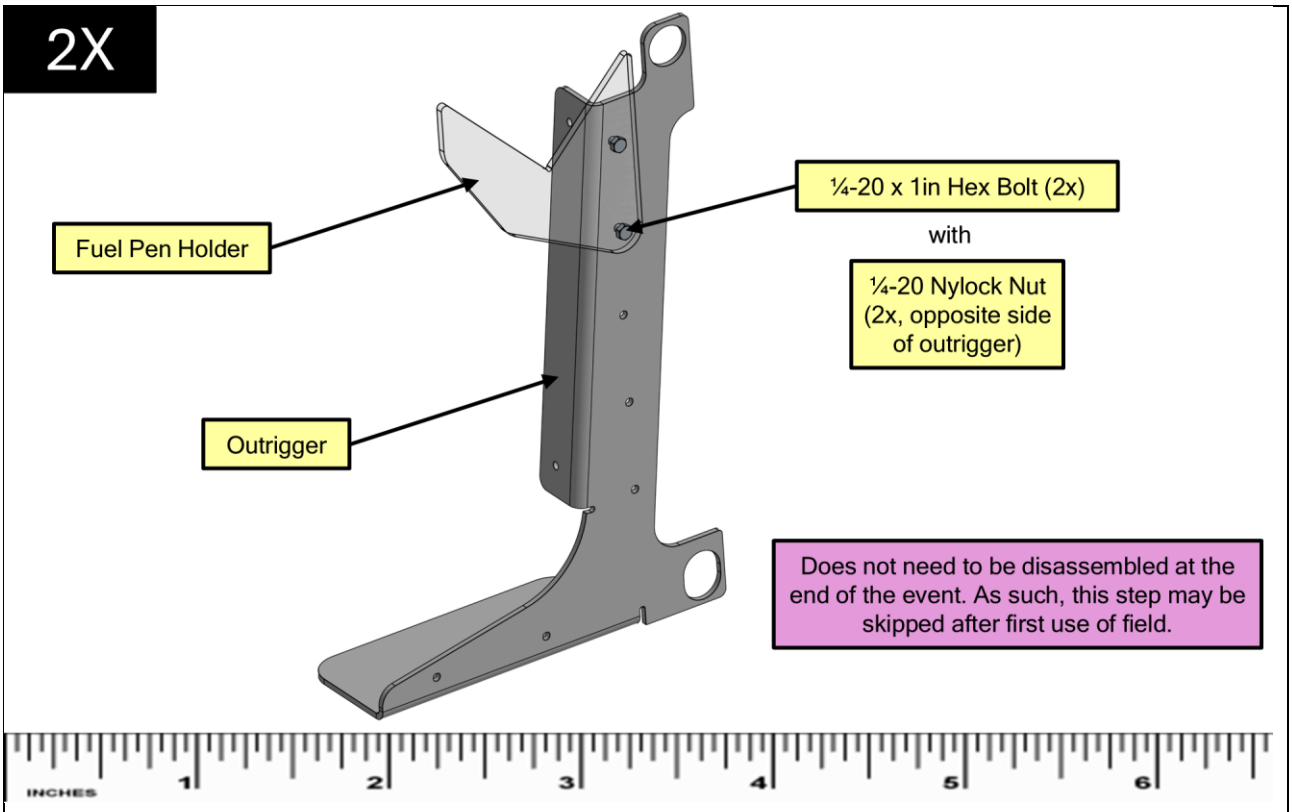
3.3.1 Tools & Equipment

- Side Border Cases (Cases 03, 04, and 05)
- 7/16” Wrenches or socket/ratchet combination (first use only)

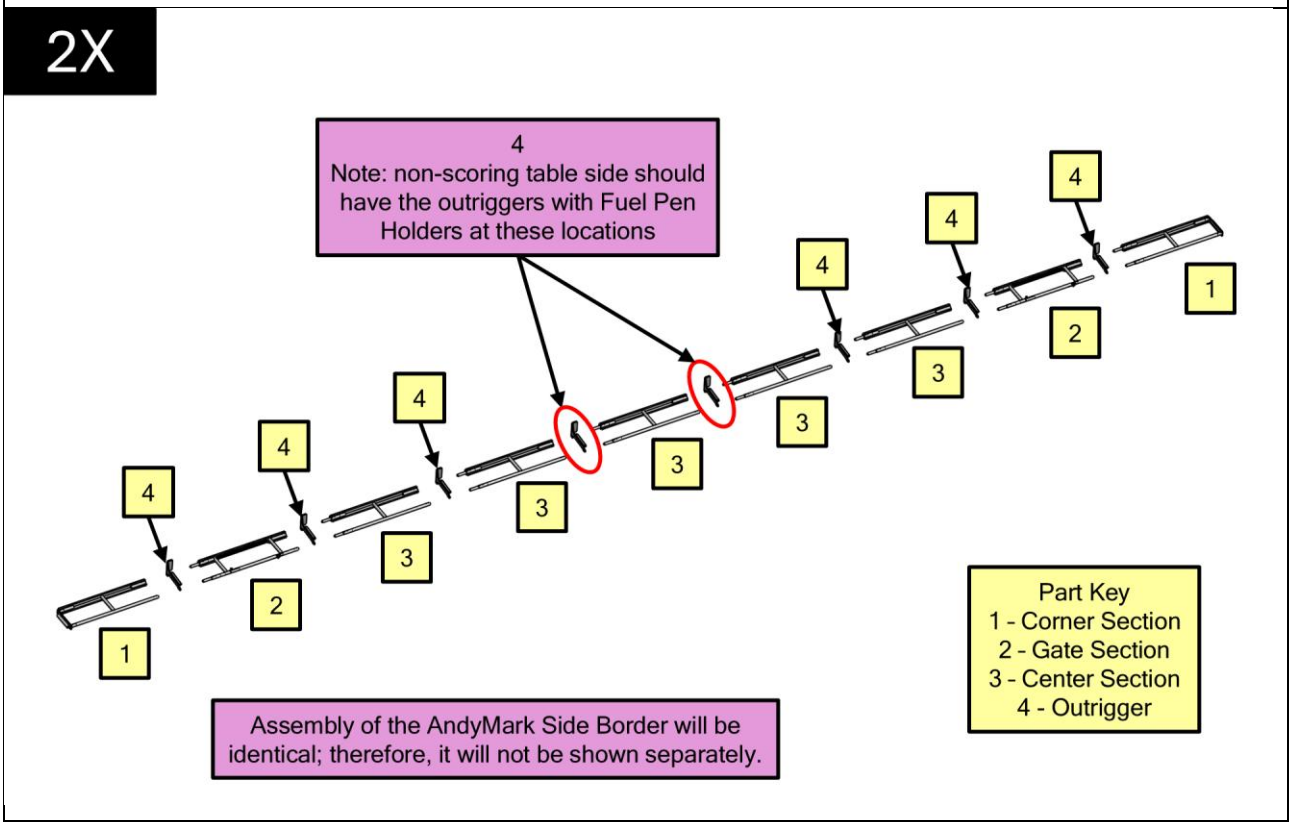
3.3.2 Assembly

1. 

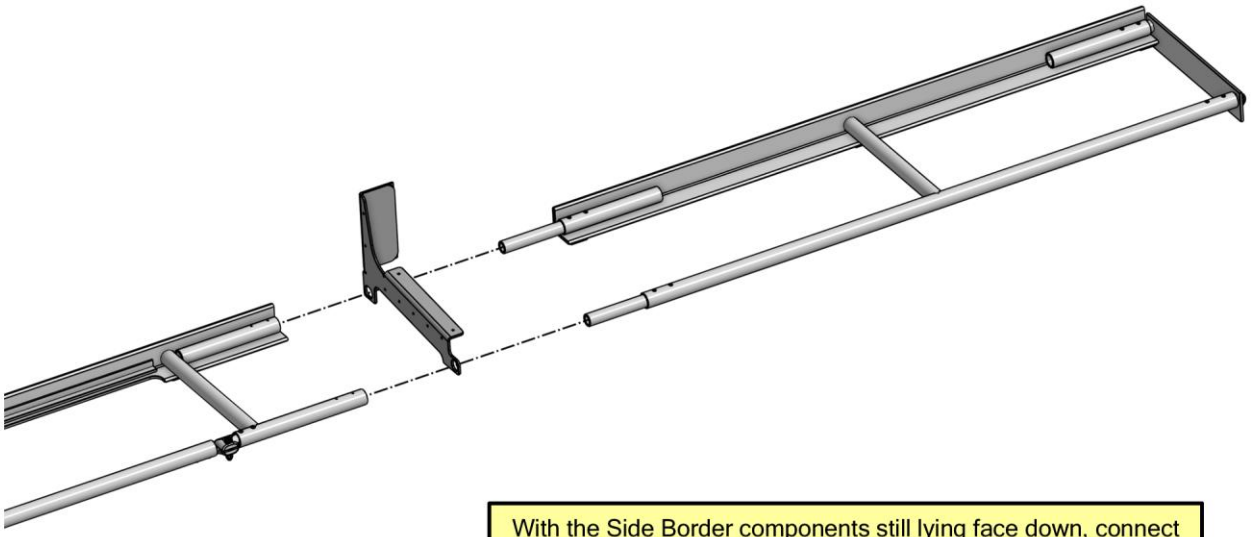
2.


2X
Fuel Pen Holder
¼-20 x 1in Hex Bolt (2x)
with
¼-20 Nylock Nut (2x, opposite side of outrigger)
Outrigger
Does not need to be disassembled at the end of the event. As such, this step may be skipped after first use of field.
INCHES
1
2
3
4
5
6

3.


2X
4
Note: non-scoring table side should have the outriggers with Fuel Pen Holders at these locations
Part Key
1 - Corner Section
2 - Gate Section
3 - Center Section
4 - Outrigger
Assembly of the AndyMark Side Border will be identical; therefore, it will not be shown separately.

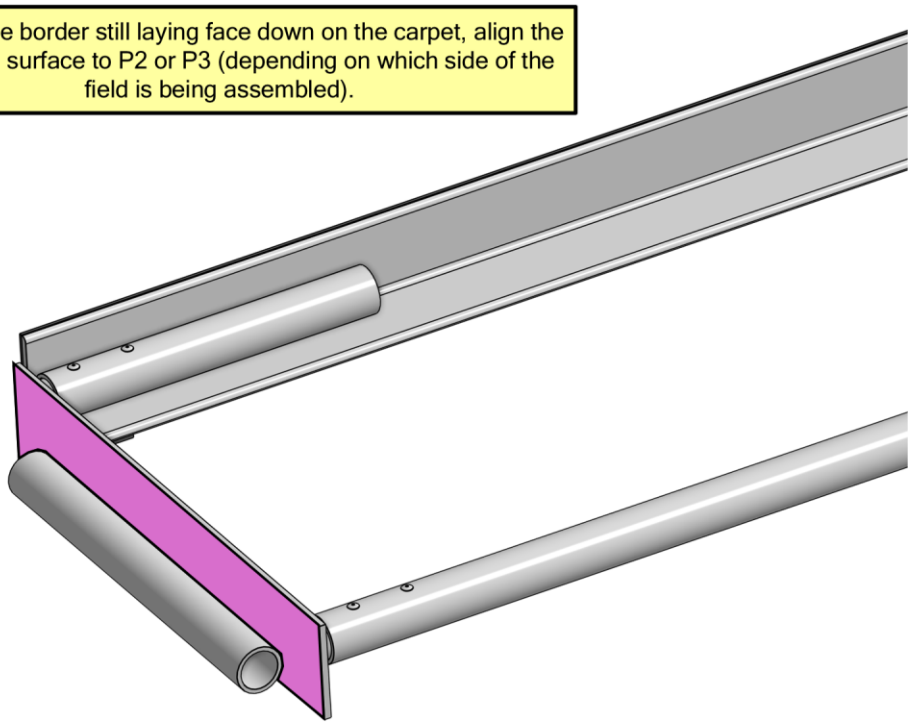
4.



With the Side Border components still lying face down, connect the segments by sliding the smaller tubes into the larger ones. Be sure to slide the Outriggers on between the rails.

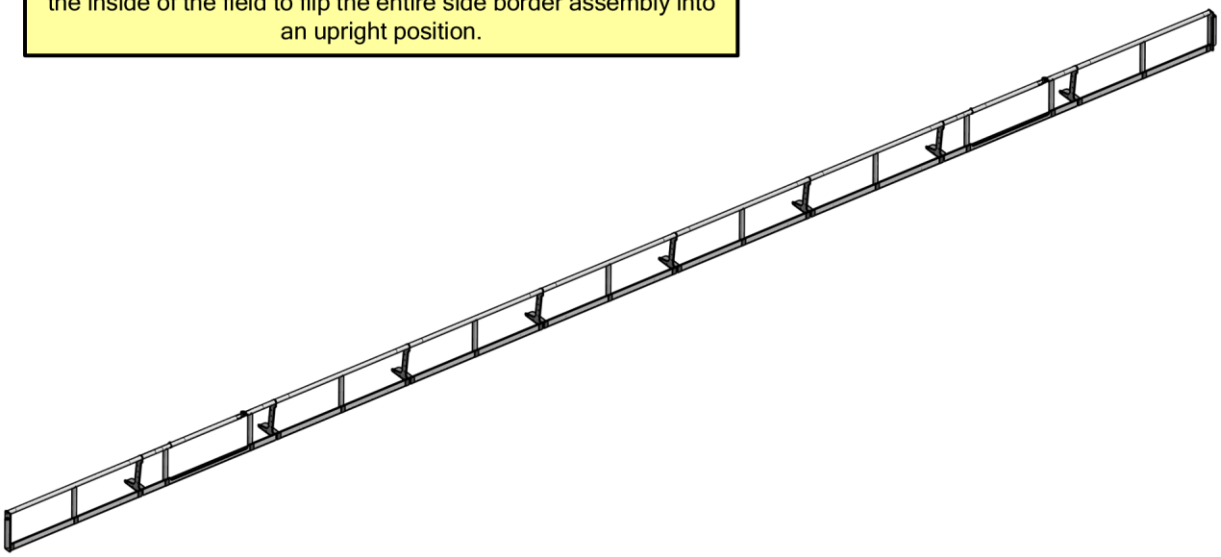
5.

With the side border still laying face down on the carpet, align the highlighted surface to P2 or P3 (depending on which side of the field is being assembled).



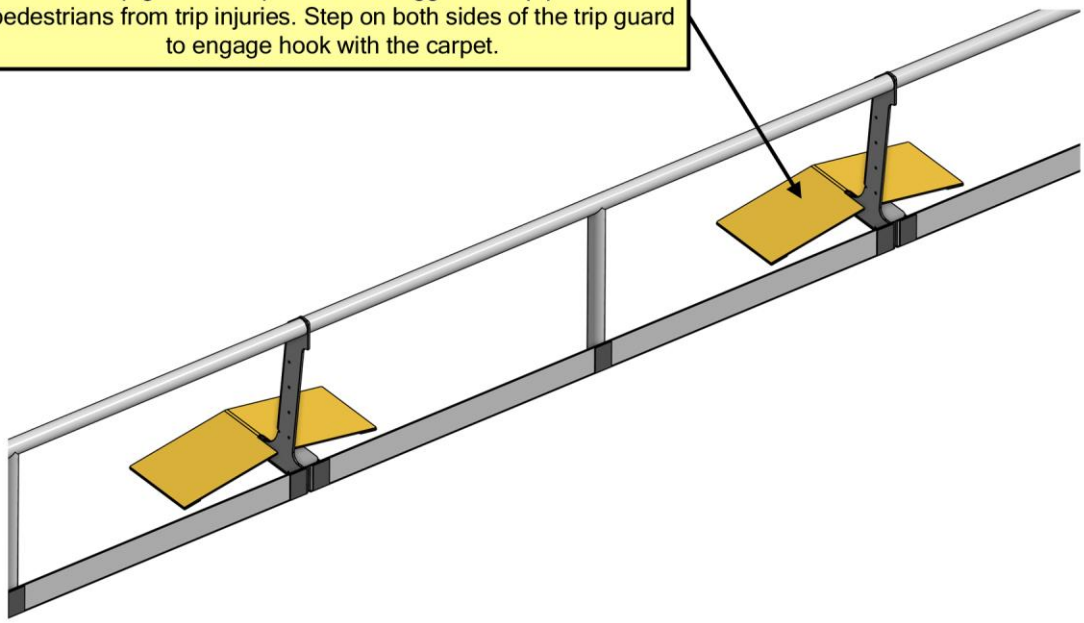
6.

Once all segments are attached and the side border has been lined up with chalk lines, use four or more people positioned on the inside of the field to flip the entire side border assembly into an upright position.

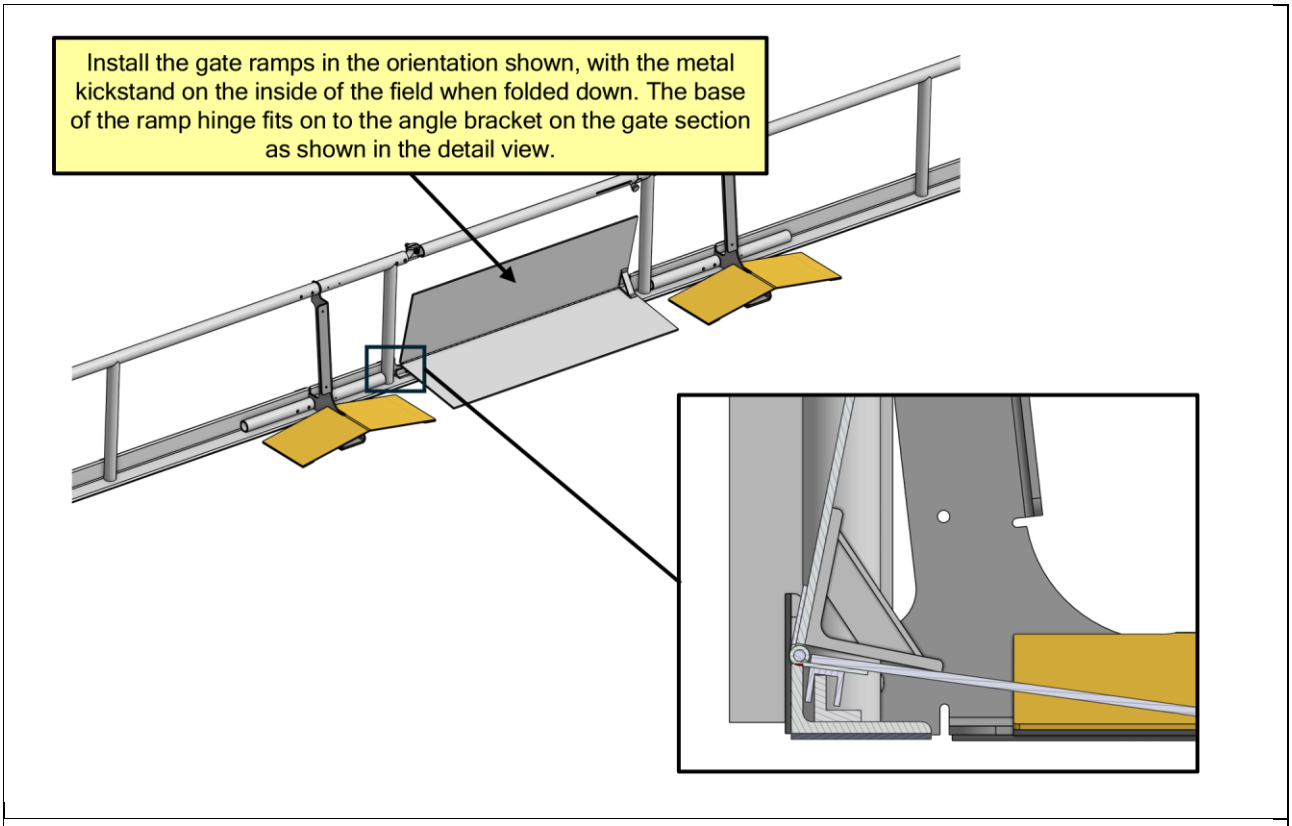


7.

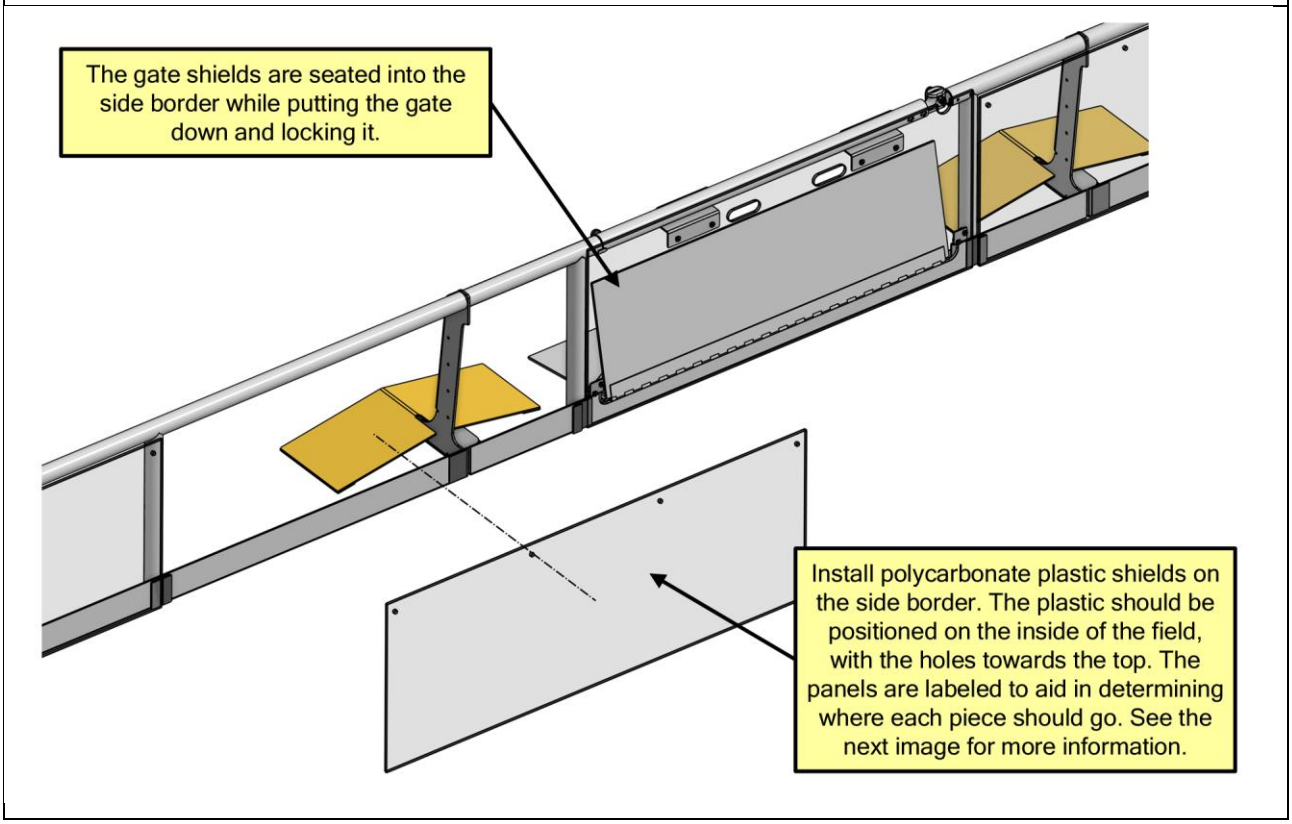
Put a trip guard on top of each outrigger to help prevent pedestrians from trip injuries. Step on both sides of the trip guard to engage hook with the carpet.



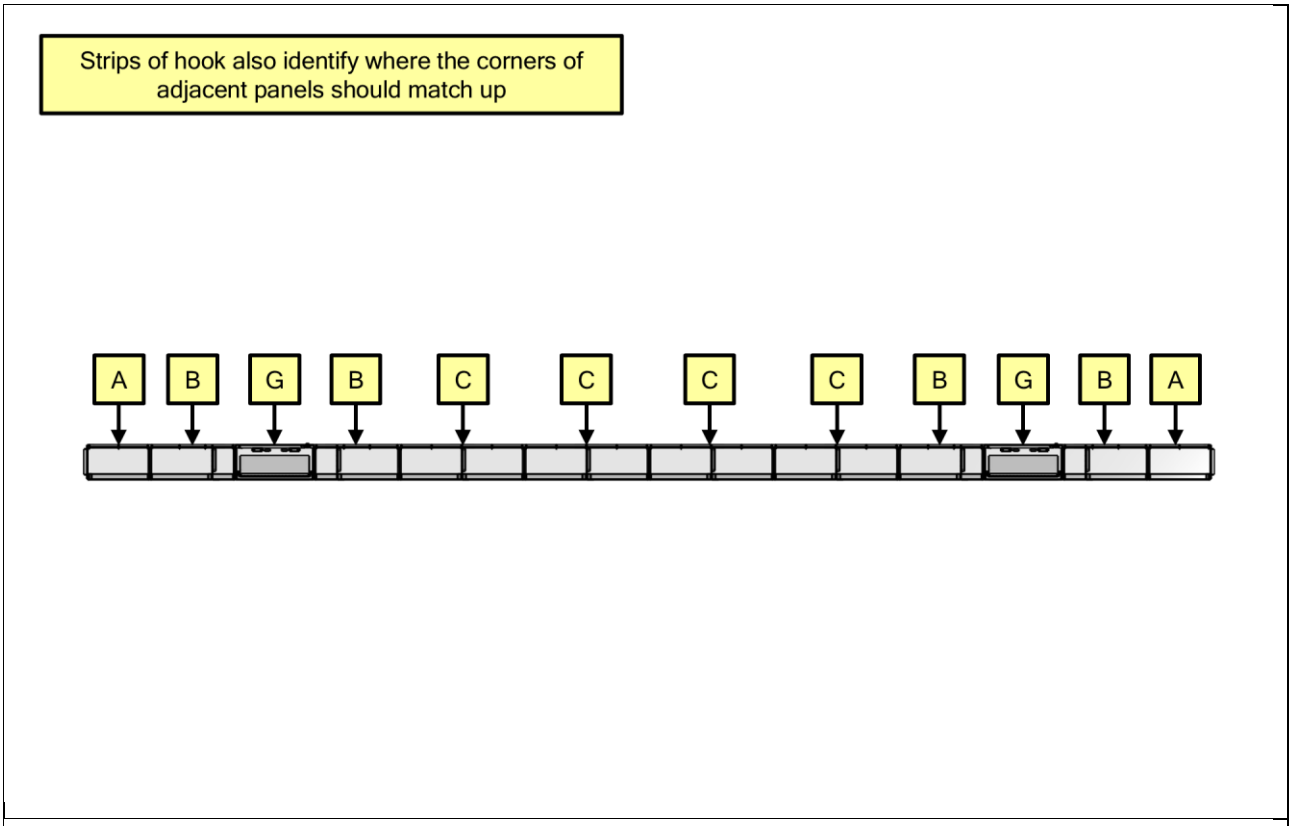
8.


Install the gate ramps in the orientation shown, with the metal kickstand on the inside of the field when folded down. The base of the ramp hinge fits on to the angle bracket on the gate section as shown in the detail view.

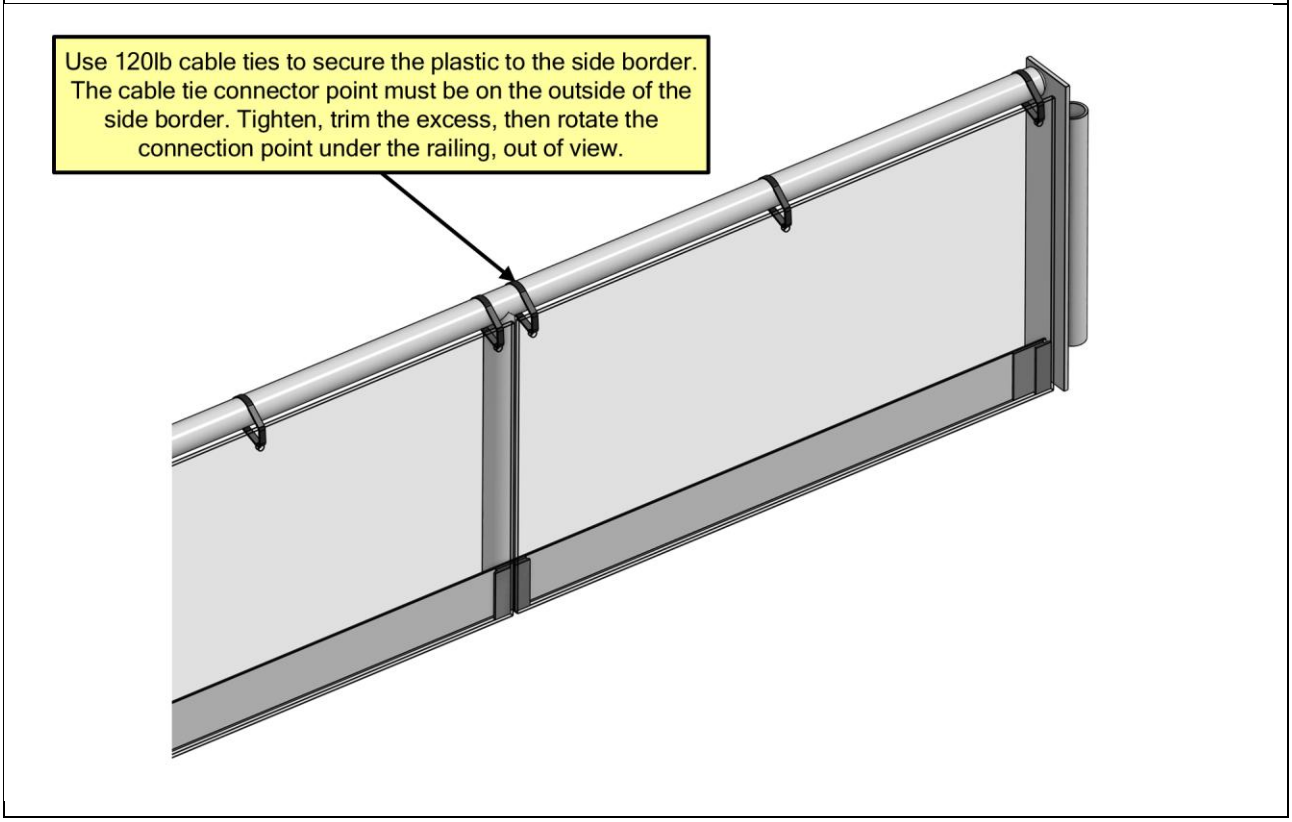
9.


The gate shields are seated into the side border while putting the gate down and locking it.
Install polycarbonate plastic shields on the side border. The plastic should be positioned on the inside of the field, with the holes towards the top. The panels are labeled to aid in determining where each piece should go. See the next image for more information.

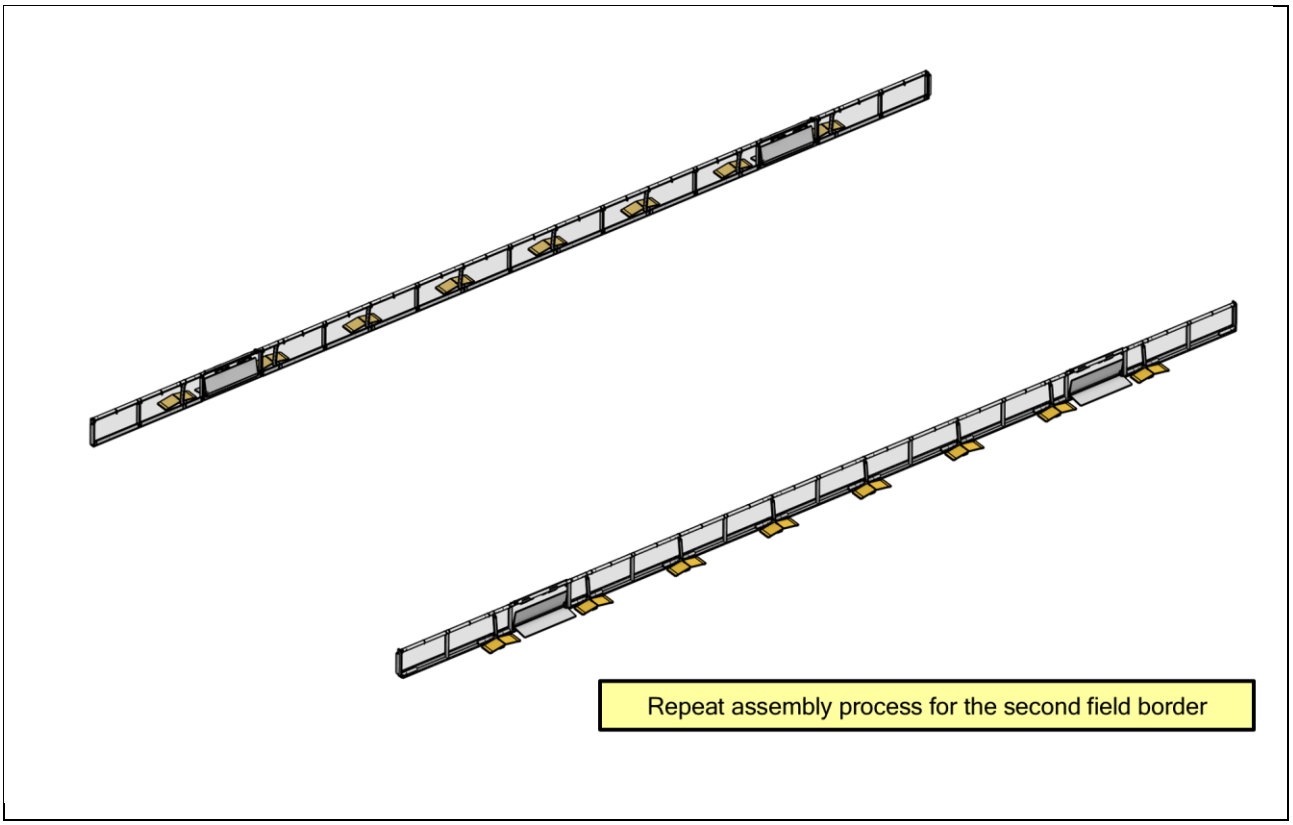
10.


Strips of hook also identify where the corners of adjacent panels should match up
A
B
G
B
C
C
C
C
B
G
B
A

11.


Use 120lb cable ties to secure the plastic to the side border. The cable tie connector point must be on the outside of the side border. Tighten, trim the excess, then rotate the connection point under the railing, out of view.

12.

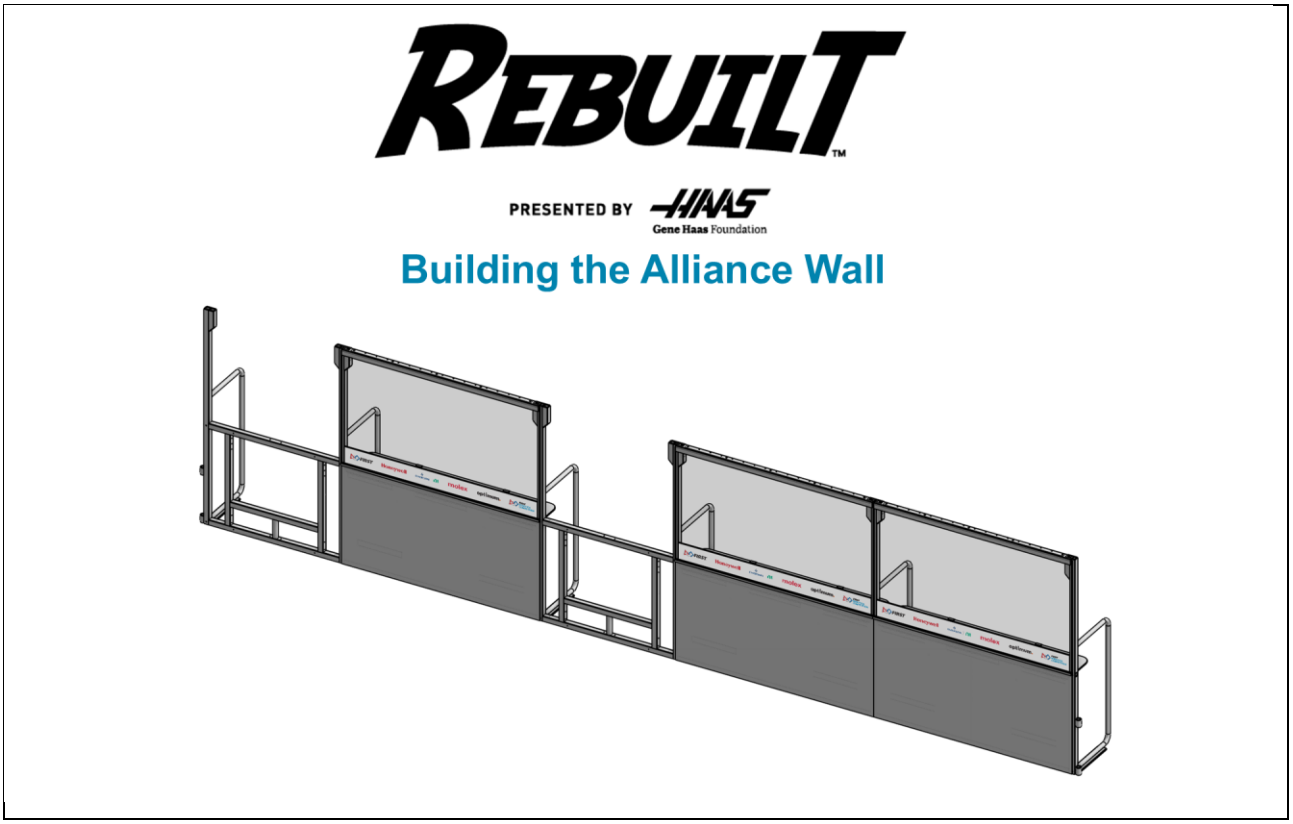


3.4 Alliance Wall

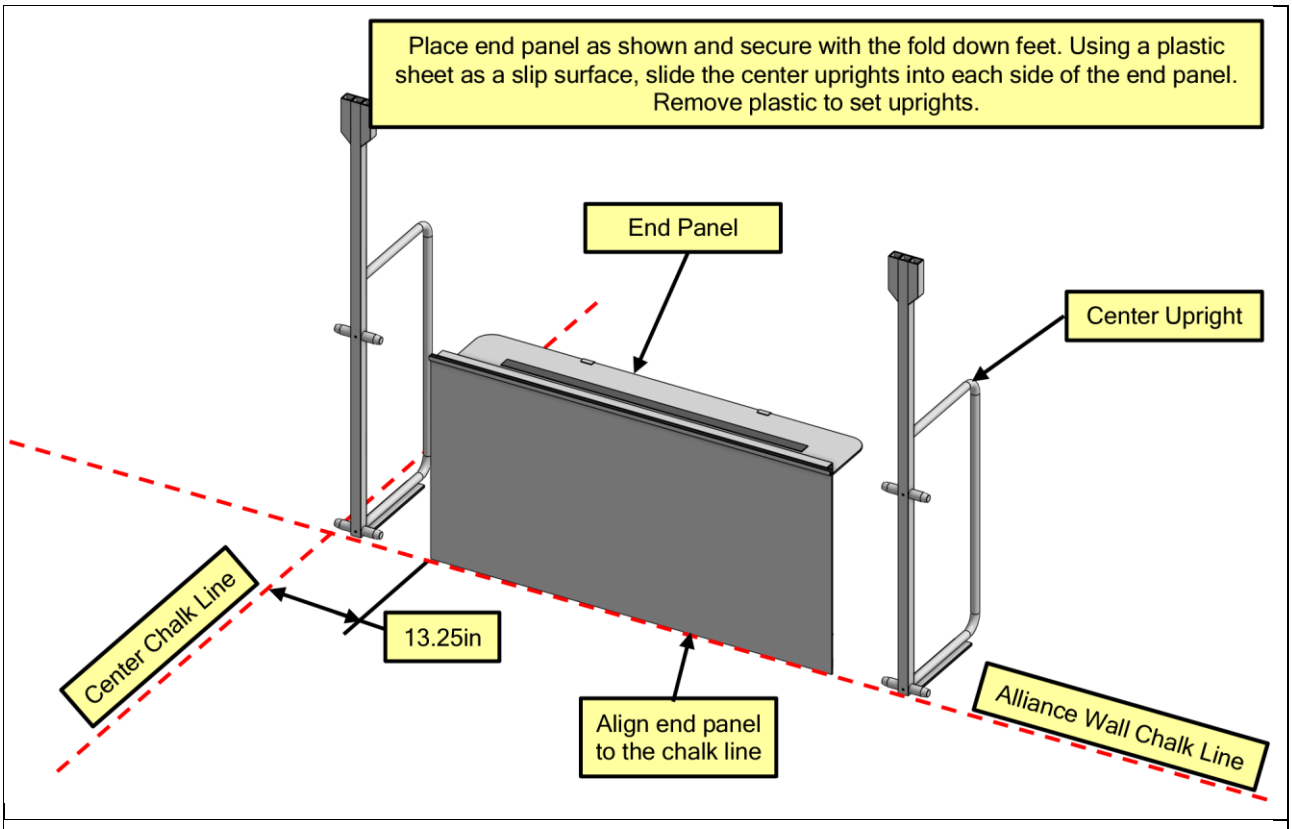
3.4.1 Tools & Equipment

- Case 20 or 21
- Case 23 or 24
- 25ft Tape Measure
- Sharpie
- HDPE Sheets (from Case 1 or 2)

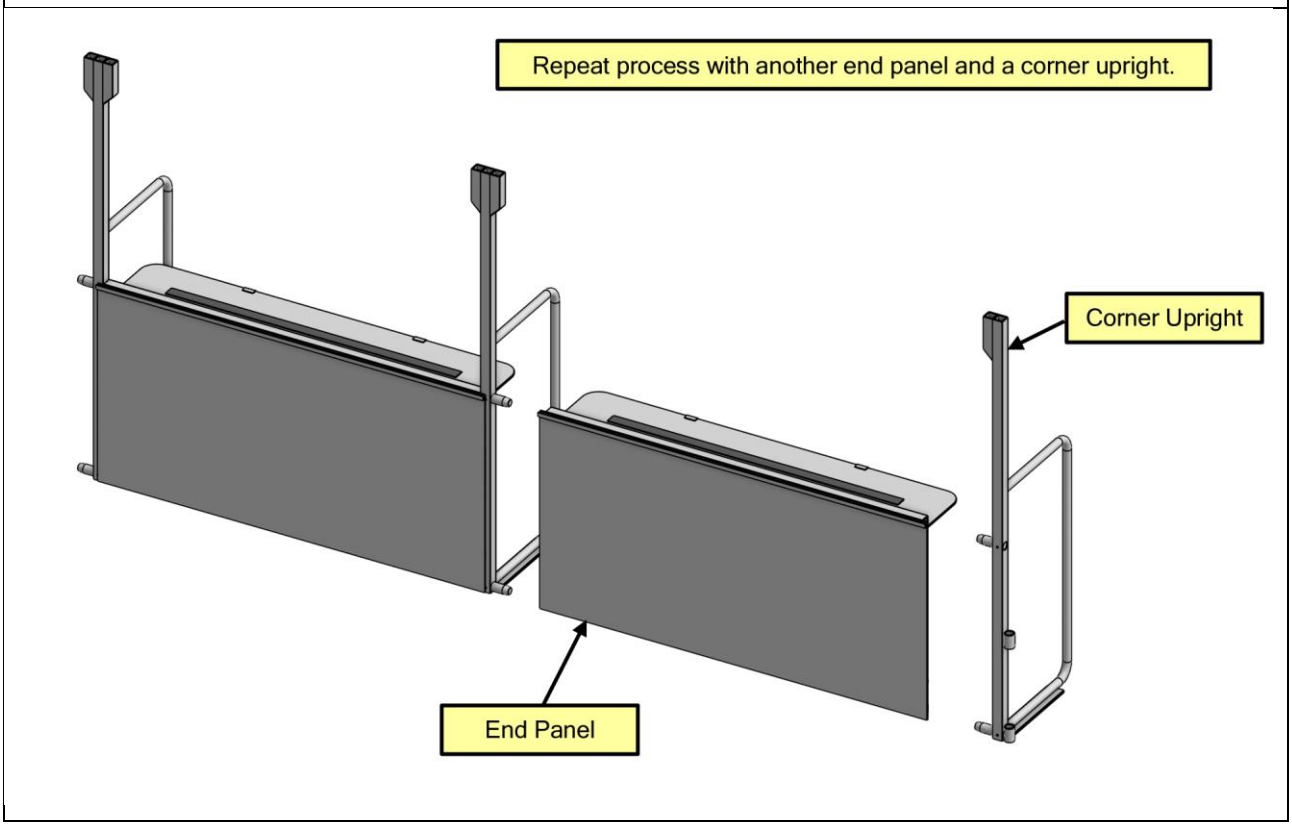
3.4.2 Assembly

1. 

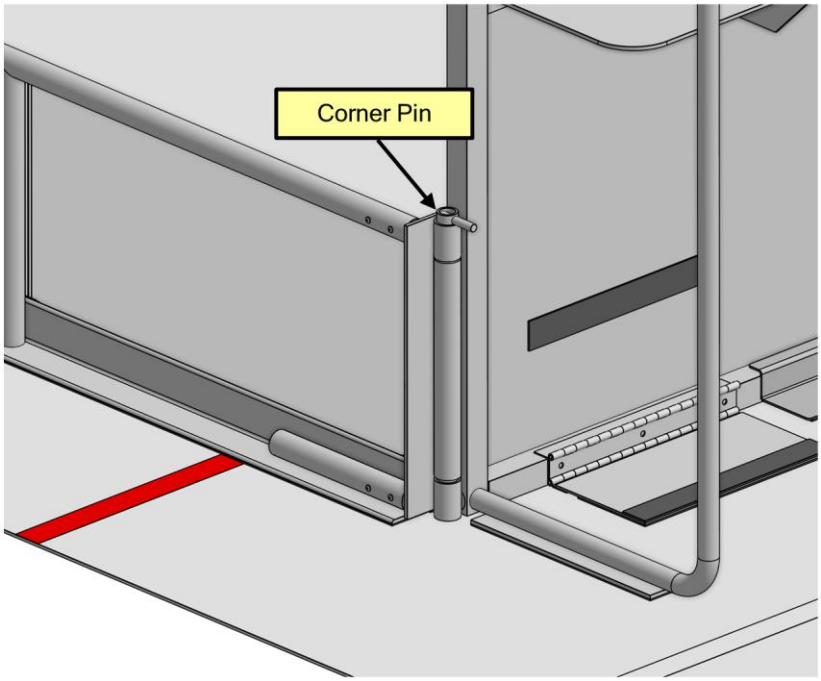
2.


Place end panel as shown and secure with the fold down feet. Using a plastic sheet as a slip surface, slide the center uprights into each side of the end panel. Remove plastic to set uprights.
End Panel
Center Upright
Center Chalk Line
13.25in
Align end panel to the chalk line
Alliance Wall Chalk Line

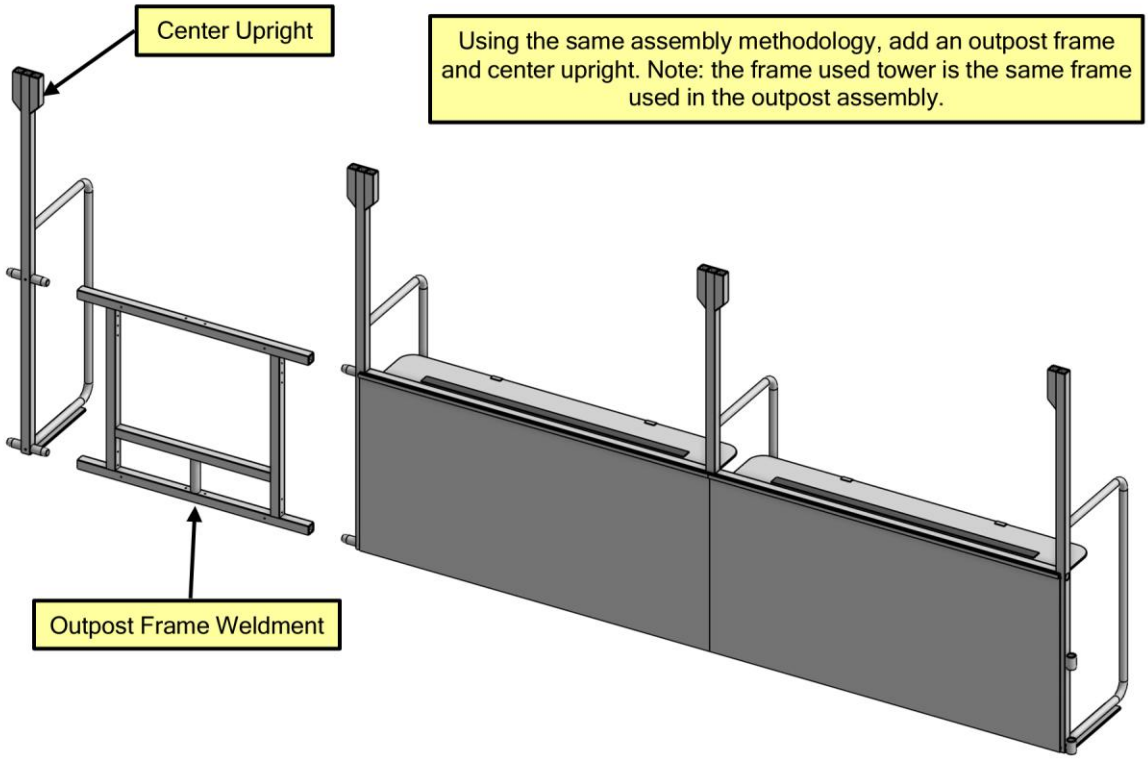
3.


Repeat process with another end panel and a corner upright.
Corner Upright
End Panel

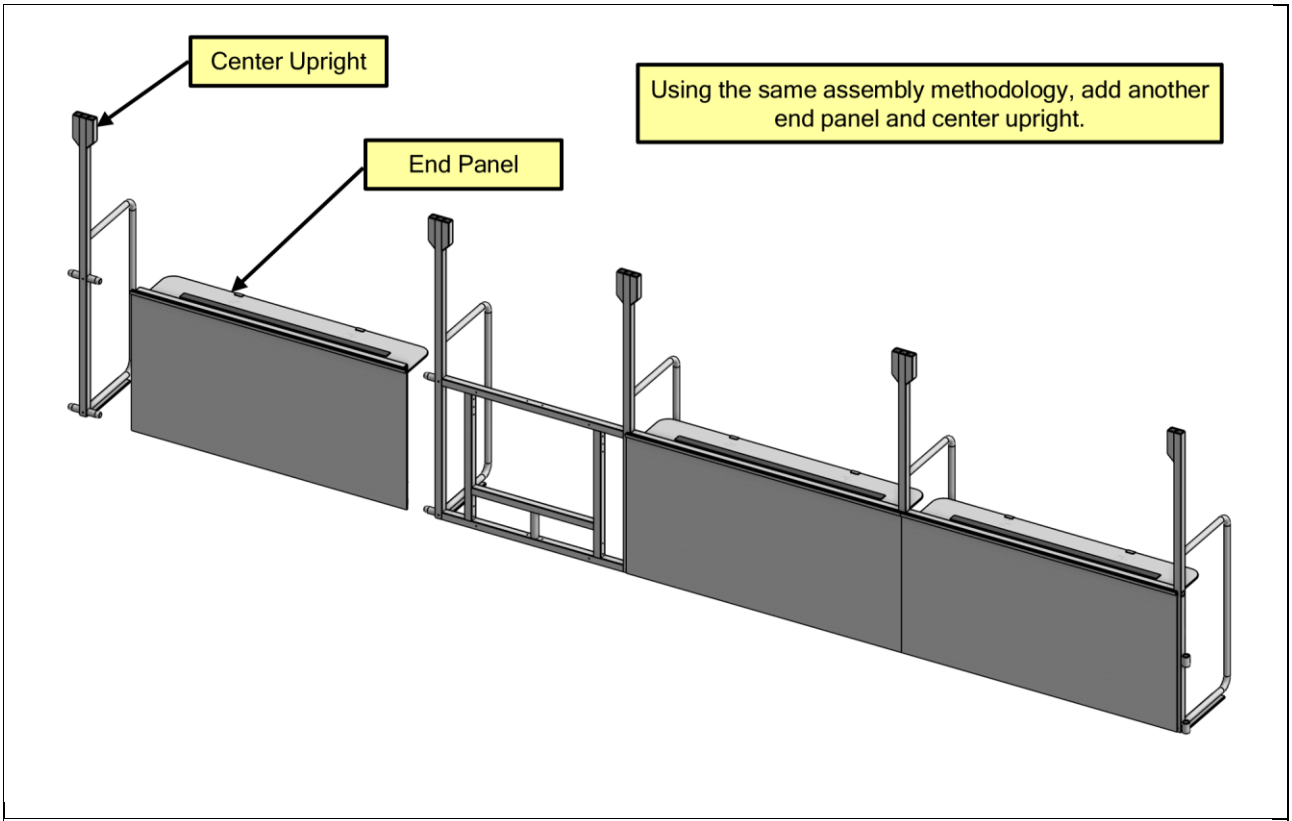
4. Secure the alliance wall to the side border using a corner pin.



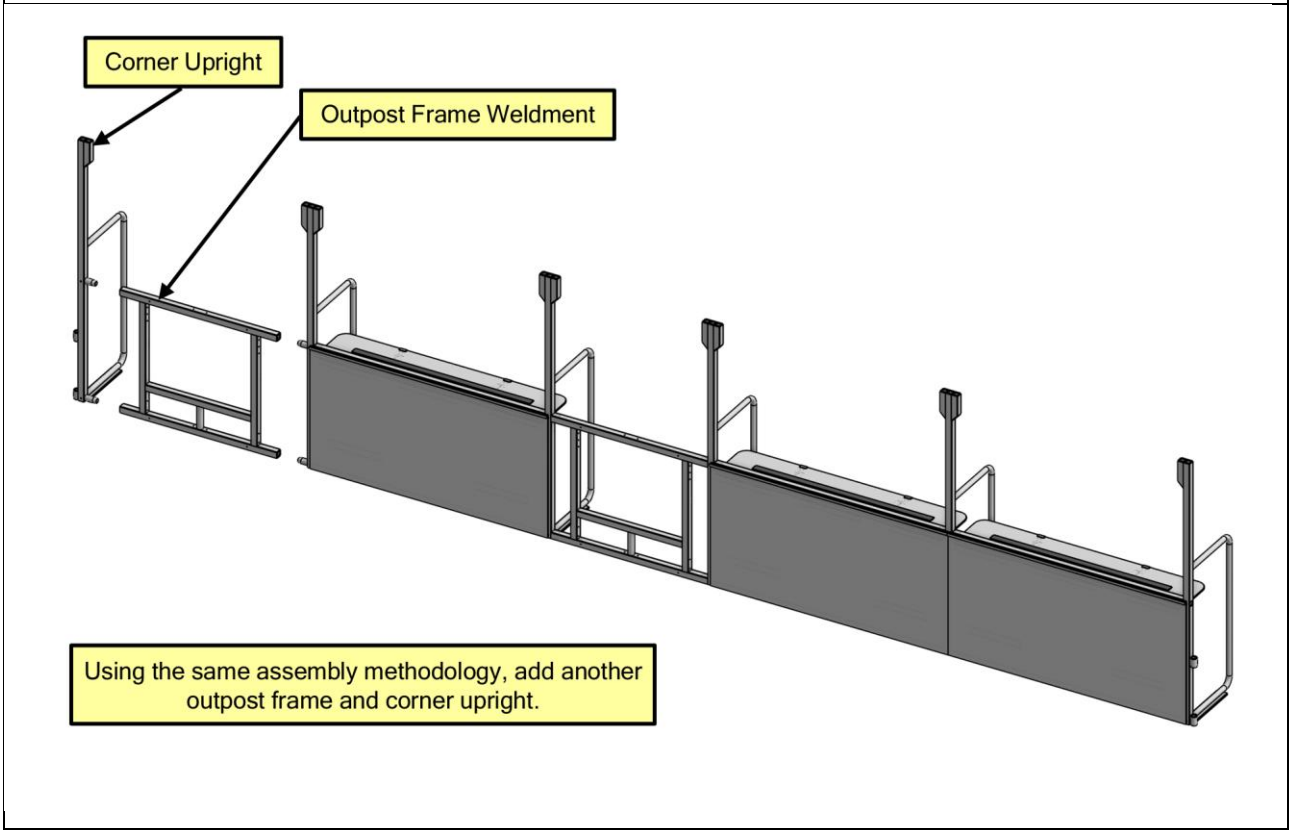
5. Using the same assembly methodology, add an outpost frame and center upright. Note: the frame used tower is the same frame used in the outpost assembly.



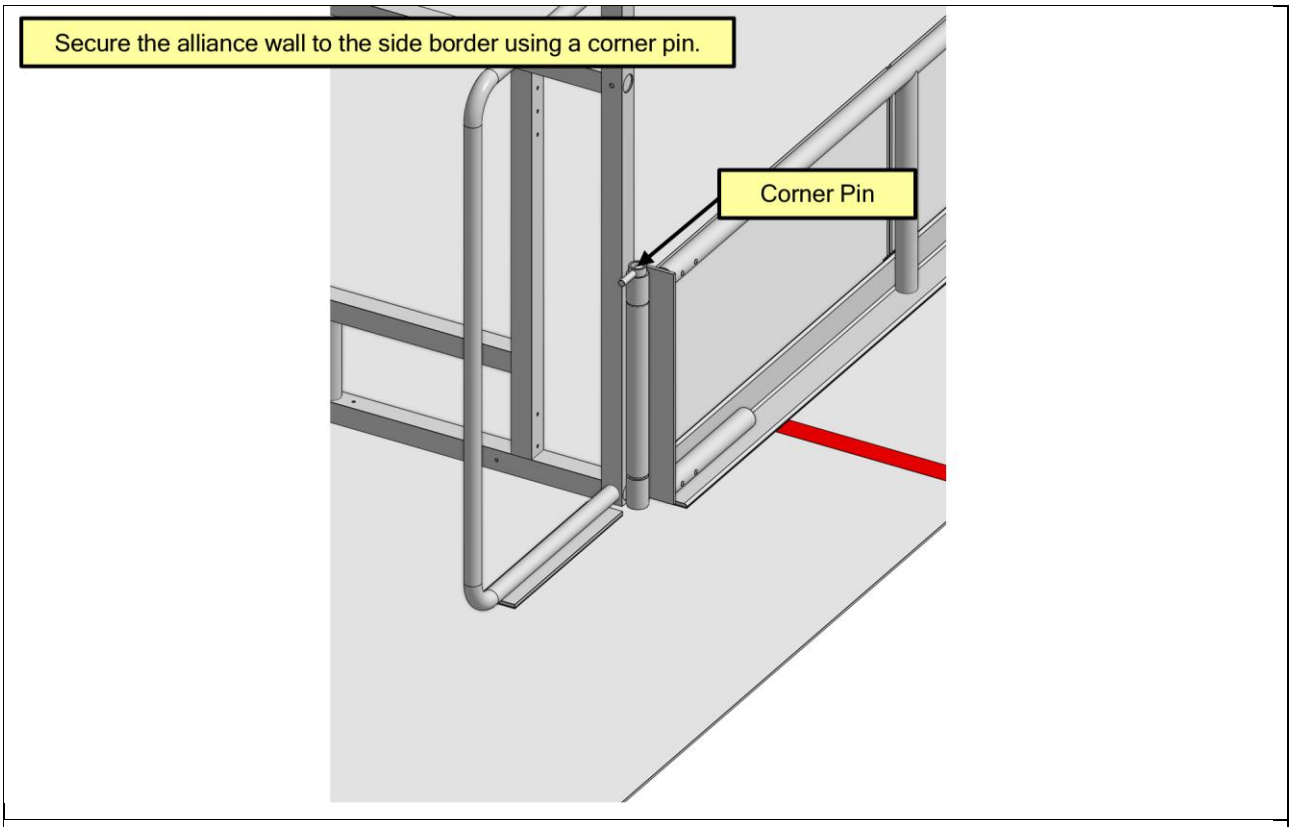
6.


Center Upright
End Panel
Using the same assembly methodology, add another end panel and center upright.

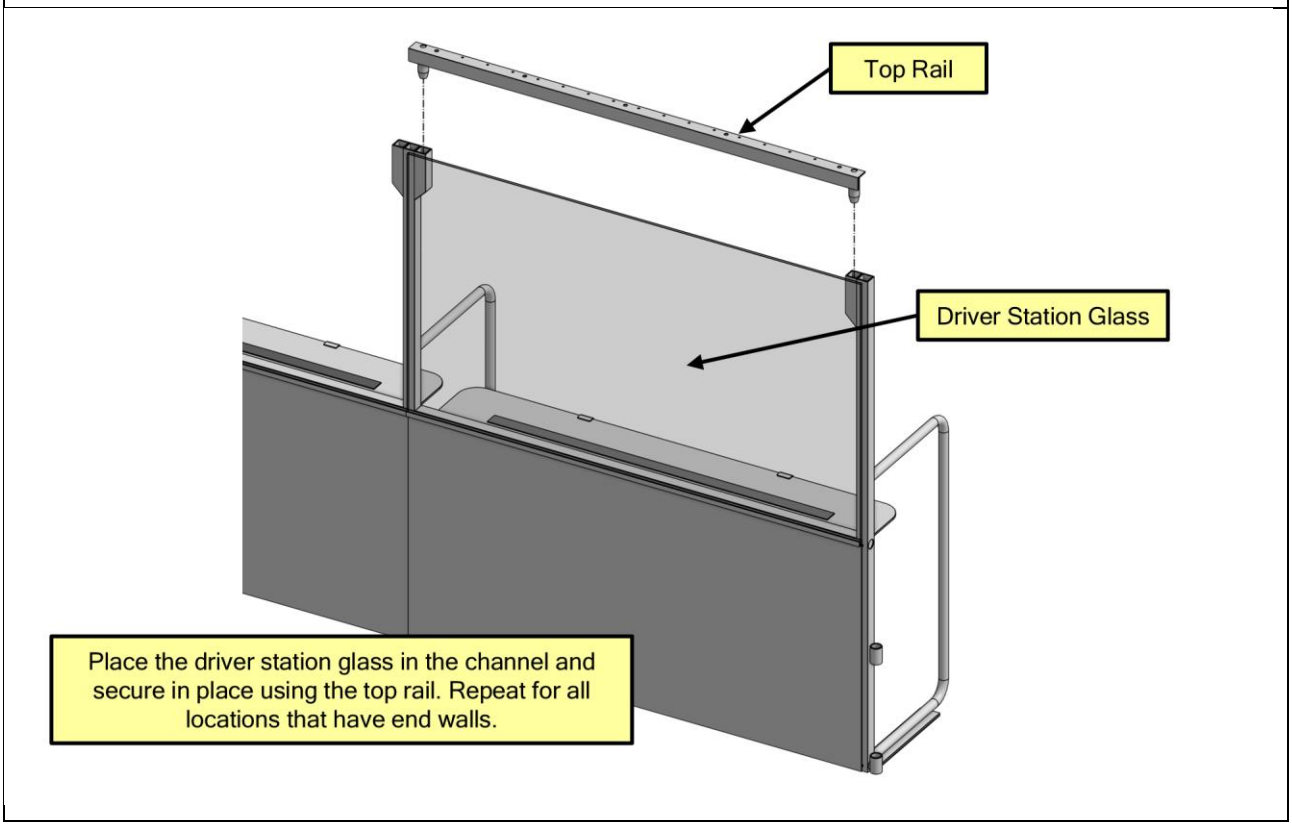
7.


Corner Upright
Outpost Frame Weldment
Using the same assembly methodology, add another outpost frame and corner upright.

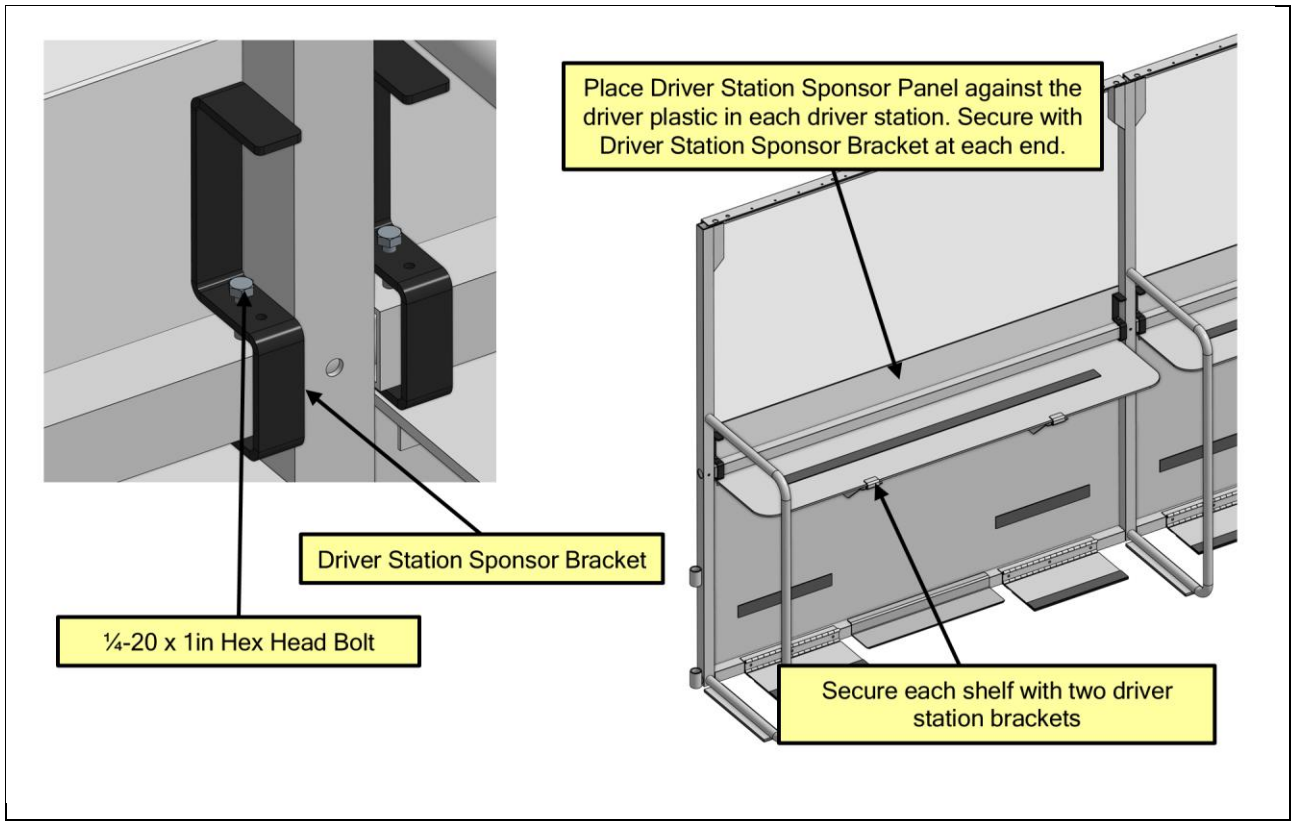
8.


Secure the alliance wall to the side border using a corner pin.
Corner Pin

9.


Top Rail
Driver Station Glass
Place the driver station glass in the channel and secure in place using the top rail. Repeat for all locations that have end walls.

10.



3.4.3 Field Reinforcement

Will not be used in 2026.

3.4.4 Alliance Wall Electronics

3.4.4.1 Equipment list

- **Case 6**
  - 2 (75'-100') AC Power cables
  - 2 Station Control Cabinets (SCCs) (one red and one blue)
    - 2 power cables for SCCs
  - 8 Cypress Team signs. (4 red and 4 blue)
  - 6 Team Stack Lights (3 red and 3 blue)
  - 6 E-Stops
  - 6 A-Stops
  - Yellow AB Cables
    - 6 A/E-Stop Y-Cables
    - 2 A/E-Stop Cables 5m
    - 4 Team Light cables 5m
    - 2 Team Light cables 10m
  - Ethernet cables
    - SCC Ethernet – 20m (teal, Allen Bradley)
    - 6 Team Sign Ethernet cables 5m
    - 2 Team Sign Ethernet cables 10m
  - 2 8-Outlet power strips (Tripp Lite or similar)
  - 2 sets of Driver Station power outlets

3.4.4.2 Equipment Layout

> The field should be run on at least 2 20-Amp electrical circuits to minimize the risk of tripping a breaker.

Use the steps below to layout the Alliance Wall Electronics. The images below also show the layouts as an example.

1. **SCC:** Place one (1) Station Control Cabinet at each end of the field behind the tower as shown in the image above. The SCC has tape on the handle to indicate the field end at which it should be placed.
   a. The SCC with blue tape is placed at the blue alliance end of the field. (when powered some have blue LED's)
   b. The SCC with red tape is placed at the red alliance end of the field. (when powered some have red LED's)

> The Spare SCC is stored in Case 19 and has black or white tape on its handle. It has no lights.

2. **Team Stack Lights:** Mount one Team Stack Light onto each of the three Driver Stations by sliding the light hanger over the middle hole of the rail. Secure the light by inserting the locking pin through the light plate and hole in the top rail.
    a. Each light is centered in its Driver Station, the 8th hole from either side.
3. **E-Stops:** Place one E-Stop on the left edge of the Driver Station shelf.
4. **A-Stops:** Place one A-Stop on the right edge of the Driver Station.

> The E-Stops and A-Stops both connect to the E/A-Stop Y-Cable with the A-Stop connected to the end labeled "A" and the E-Stop to the end labeled "B". An extension cable may be required to reach the SCC from the base of the Y-Cable. If FMS indicates both buttons are pressed when both buttons are in their reset position (i.e. up) they may be plugged into the wrong ends of the Y-cable.

5. **Team Power Outlets:** For the Team Power outlets to reach each station, the outlets should be routed starting at power strip next to the SCC, with the first outlet going on the left side of player station 3, behind the A-Stop. The next outlet should be on the right side of player station 2 behind the E-Stop. The final outlet should be on the right side of player station 3 behind the E-Stop.
6. **Power Strip:** Place one power strip on the floor behind the Tower to the left of the SCC.

Figure 3-9: Driver Station 1 Electronics Locations

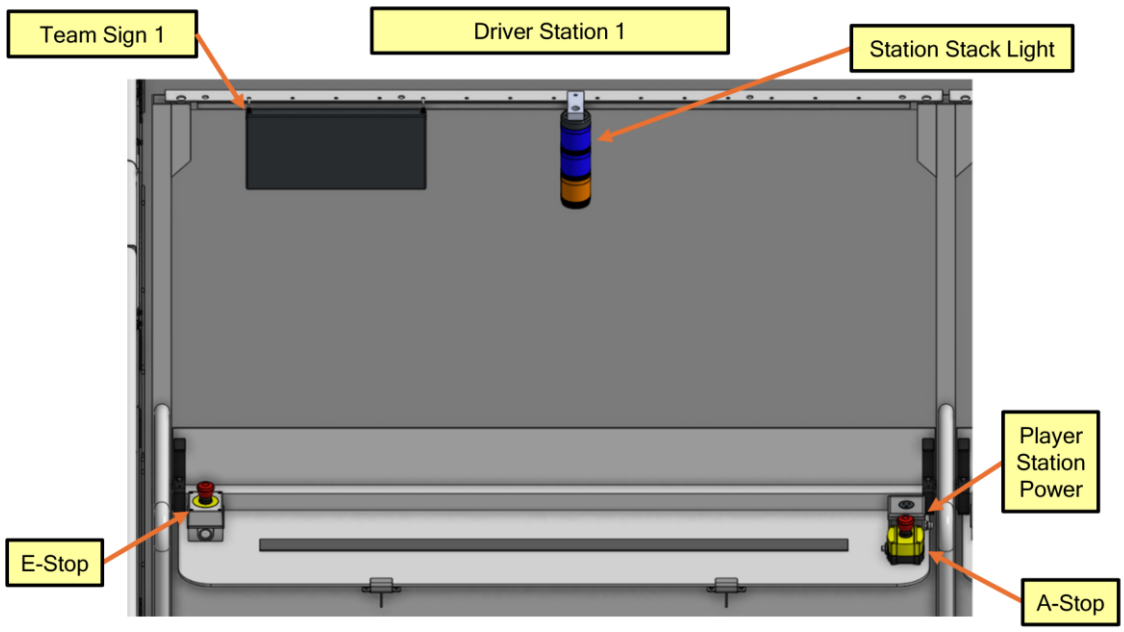


Figure 3-10: Driver Station 2 Electronics Locations

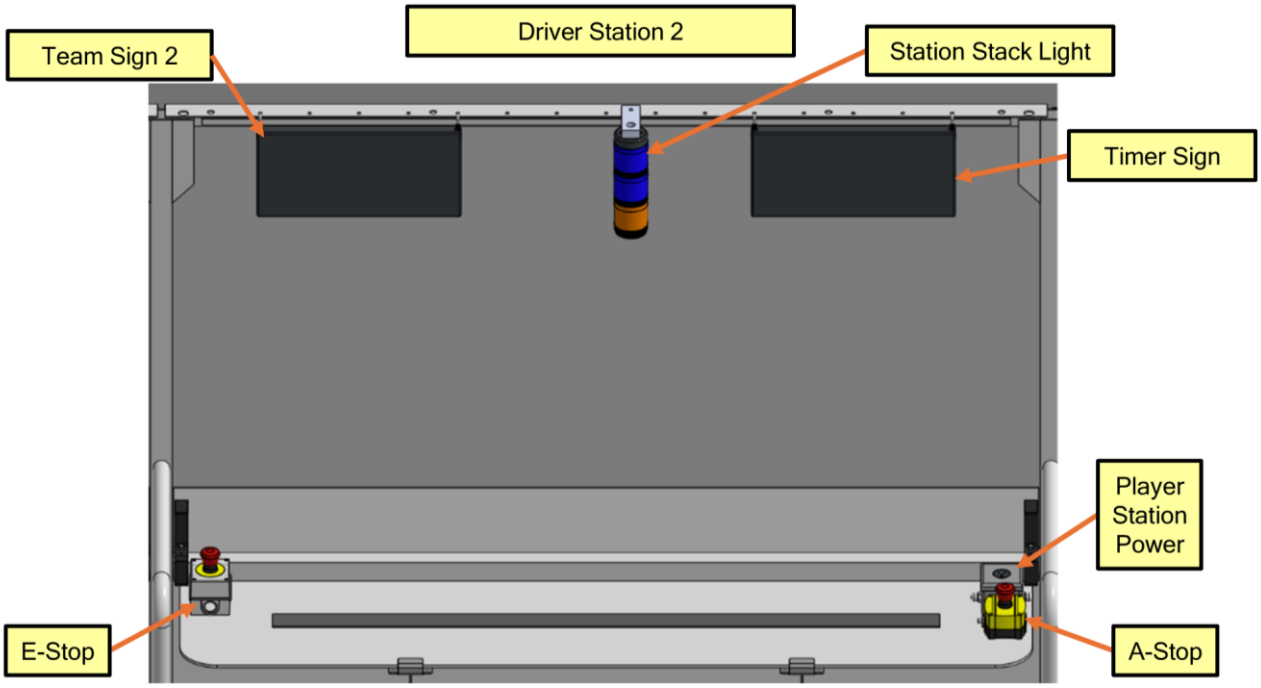


Figure 3-11: Driver Station 3 Electronics Locations

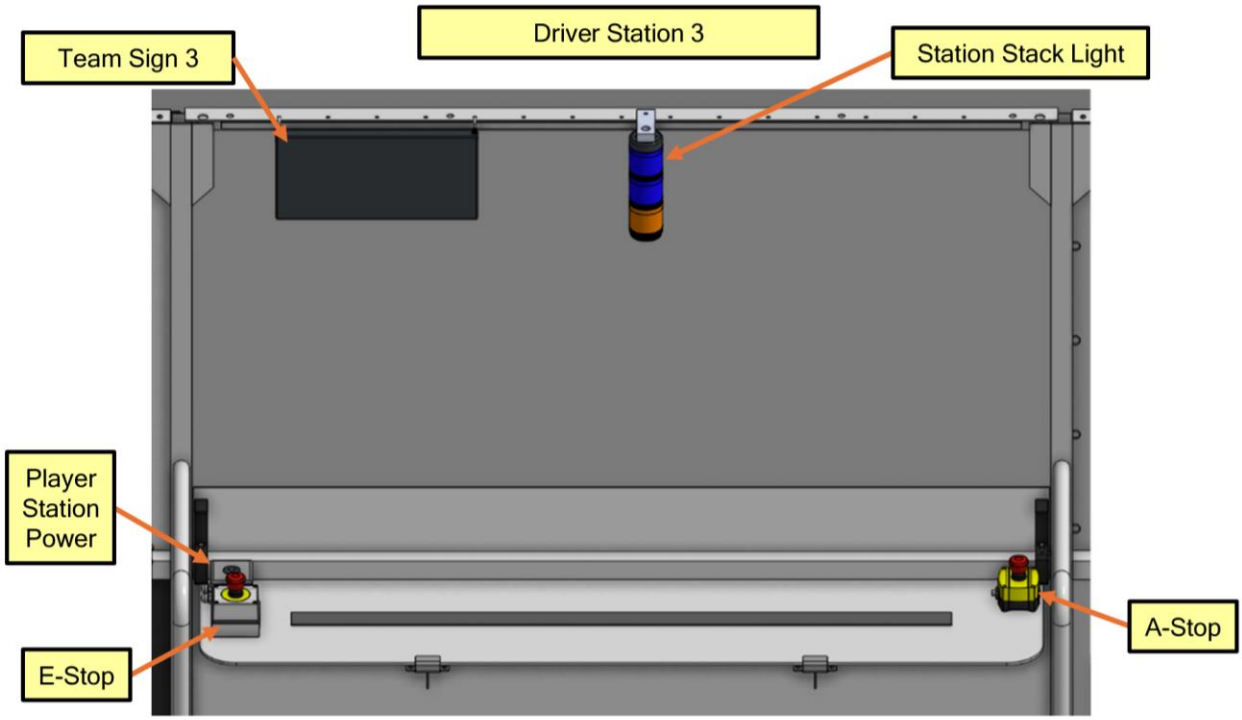


Figure 3-12: Station Control Cabinet

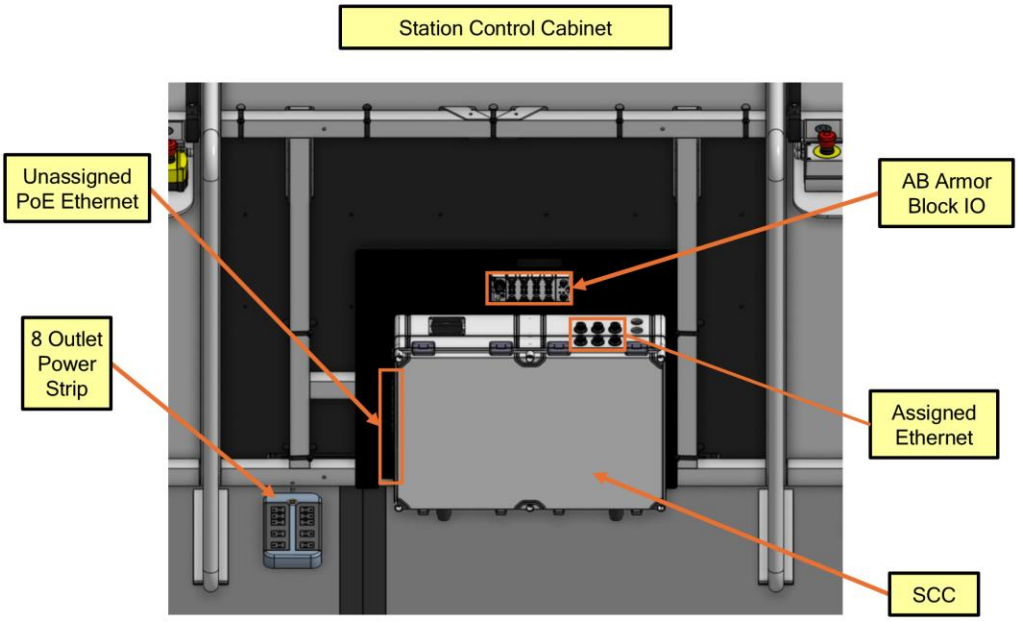


Figure 3-13: SCC AB Armor Block IO

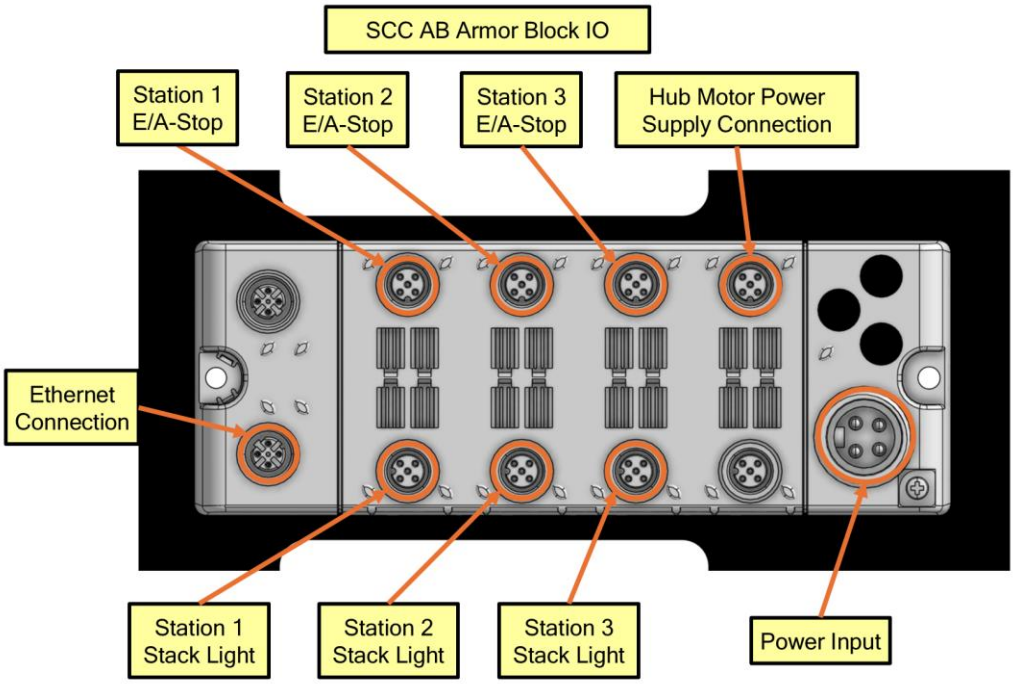
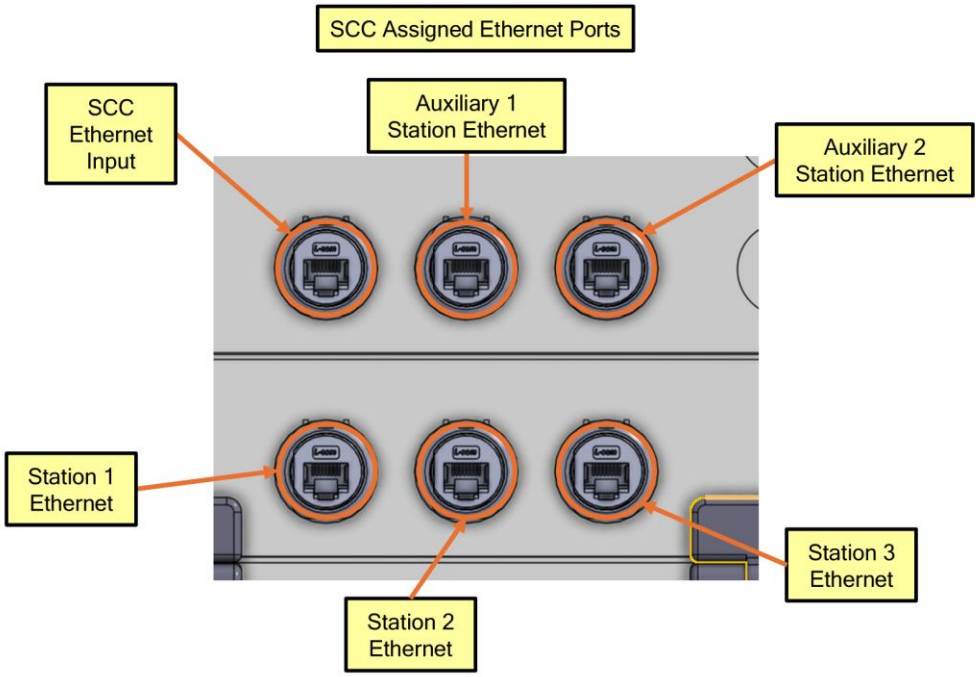


Figure 3-14: Assigned Ethernet Ports for the SCC



3.4.4.3 Wiring

Use the images below for recommended ways to wire the Alliance Wall Electronics.

Figure 3-15: Wiring Path for Team Signs

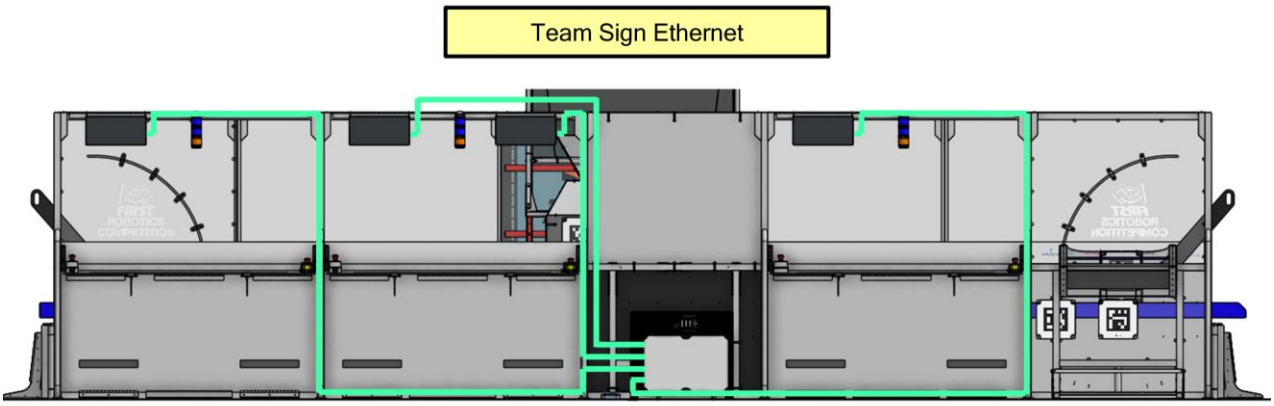


Figure 3-16: Wiring Path for Stack Lights

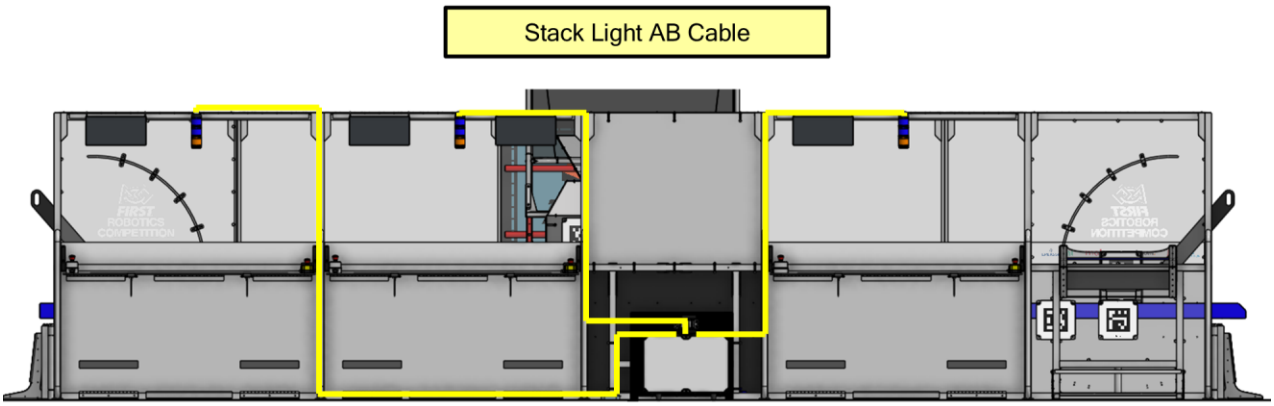


Figure 3-17: Wiring Path for Driver Station Power

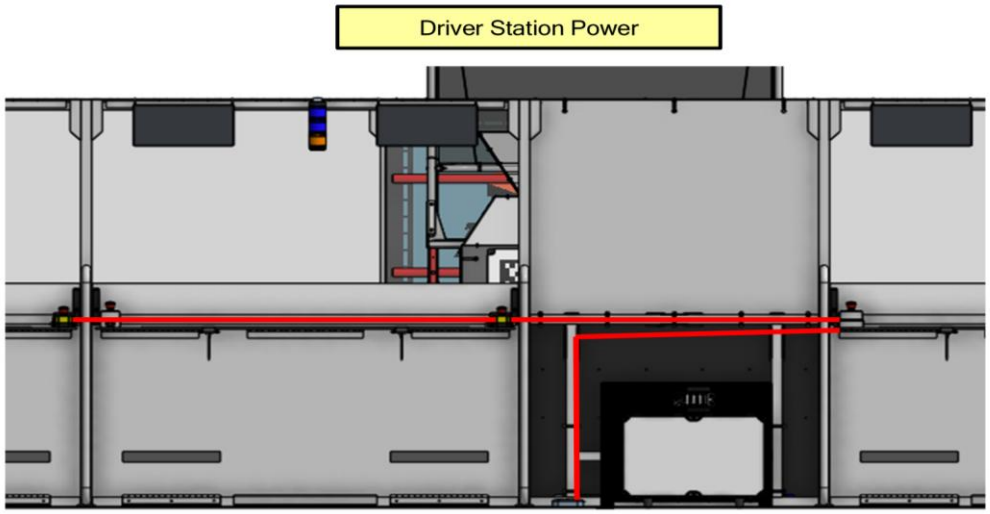


Figure 3-18:Wiring Path for Driver Station Ethernets

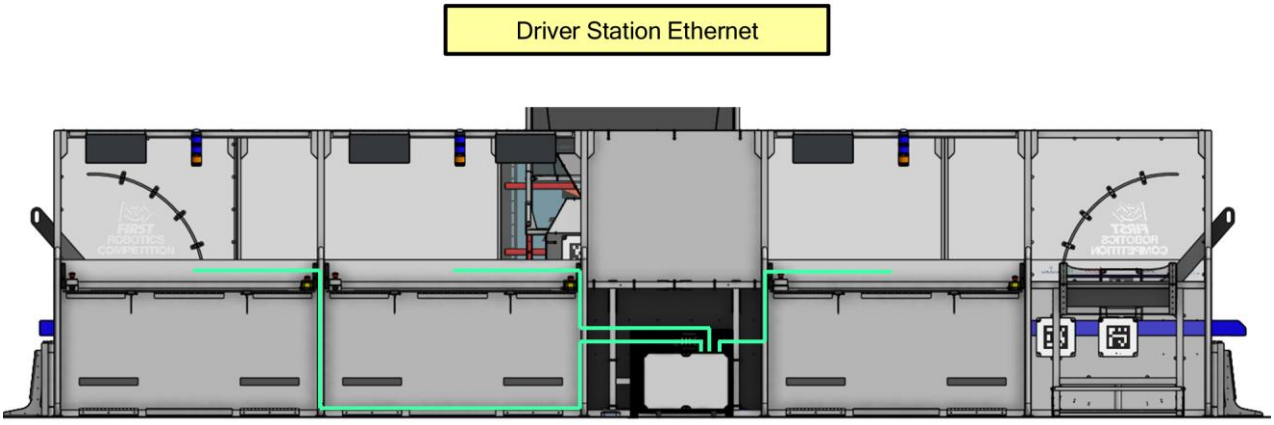
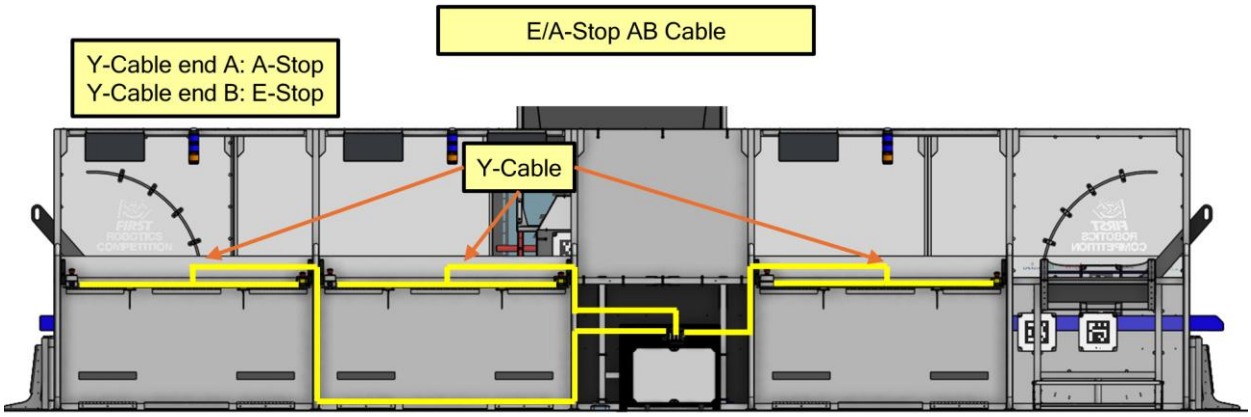


Figure 3-19: Wiring Path for E/A-Stops

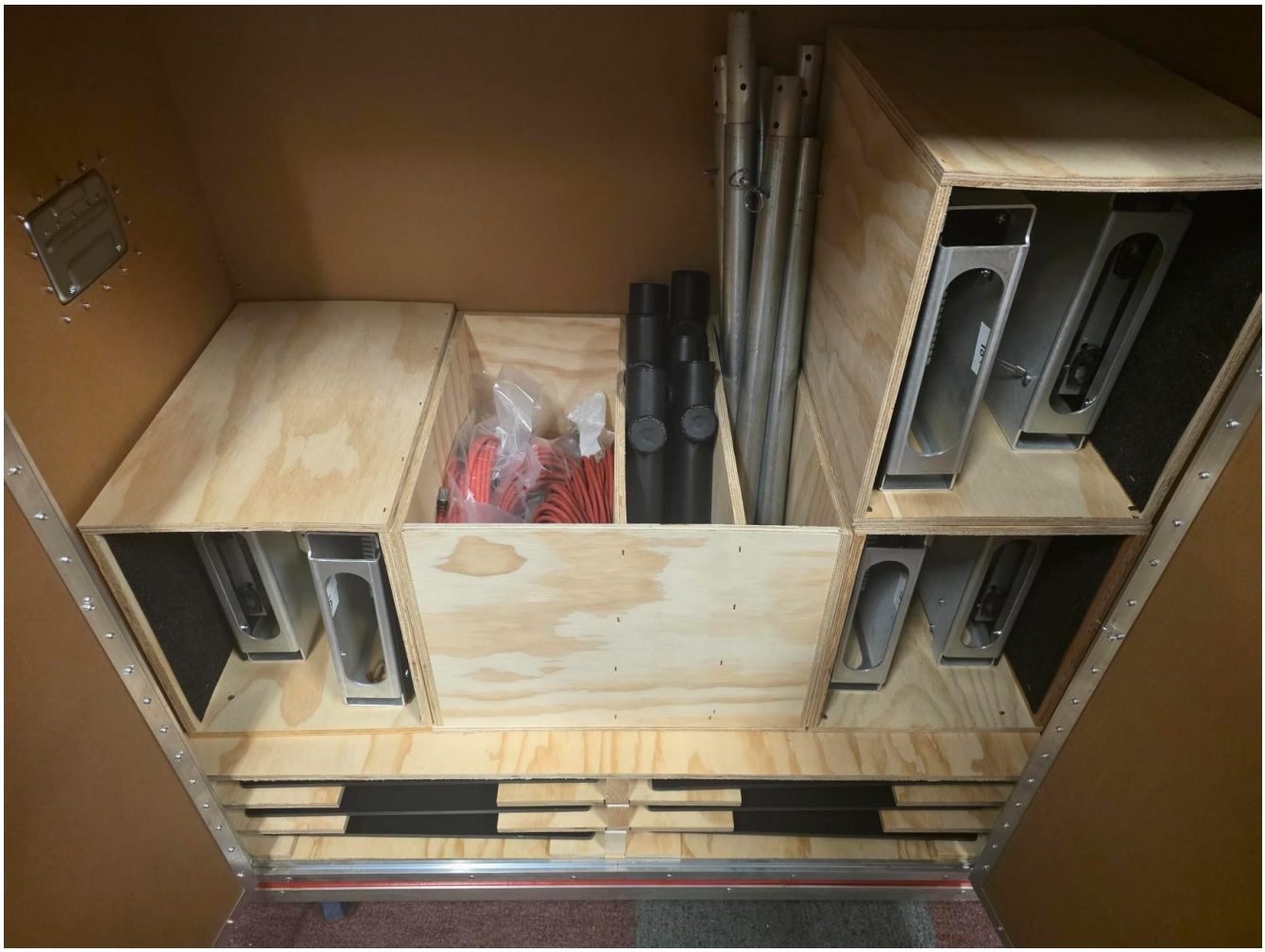


3.5 Referee Panels

3.5.1 Equipment – Found in Case 34

- Referee Panel touchscreens
- Referee Panel Bases
- Lower Mounting Pole
- Upper Mounting Pole
- 5 red 15m Ethernet cables
- Mounting Pins (3 per Referee Panel)

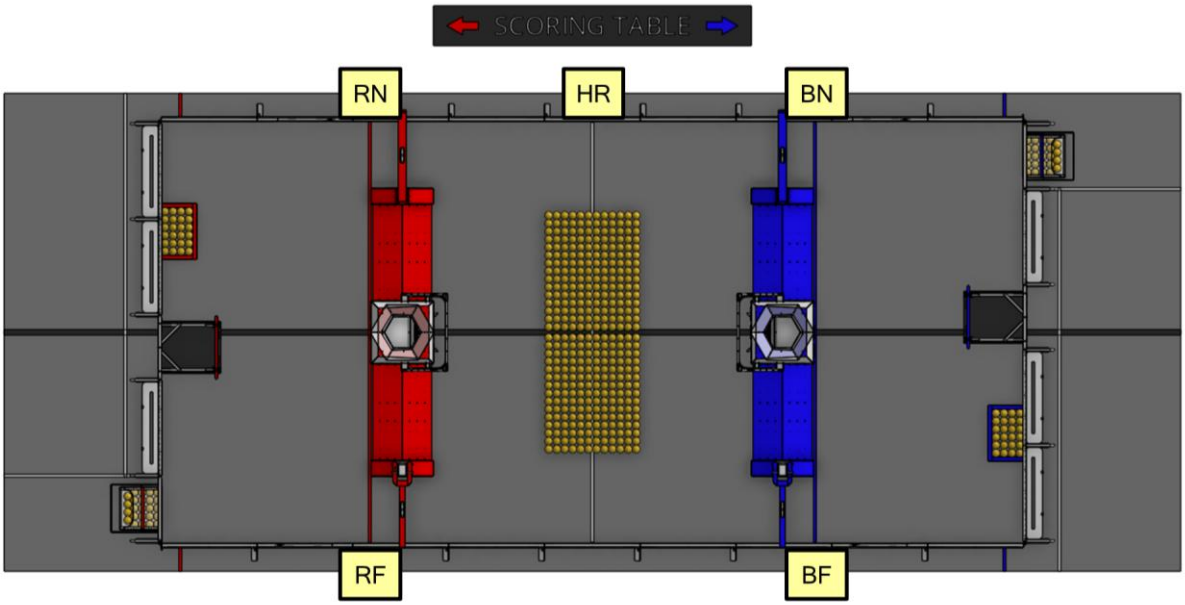
Figure 3-20: Case 34 Referee Case Contents



3.5.2 Location

Each referee location on the field uses 1 of each item in the list. The locations are shown in Figure 3-21 in the yellow boxes.

Figure 3-21: Referee Panel Locations



3.5.3 Wiring

Power for the Referee Panels is over ethernet, make sure all Referee Panels are plugged into POE capable ports.

- The Head Referee (HR) panel is the only panel to receive its ethernet connection from the Scoring Table.
- The Red Near (RN) and Red Far (RF) panels connect to the Red SCC using the red ethernet cables.
- The Blue Near (BN) and Blue Far (BF) panels connect to the Blue SCC using the red ethernet cables.

> Some SCCs have been observed to have issues providing enough power to Referee Panels. If a Referee Panel is randomly powering off and restarting, please discuss any actions with your Support staff member before moving the Referee power to another location.

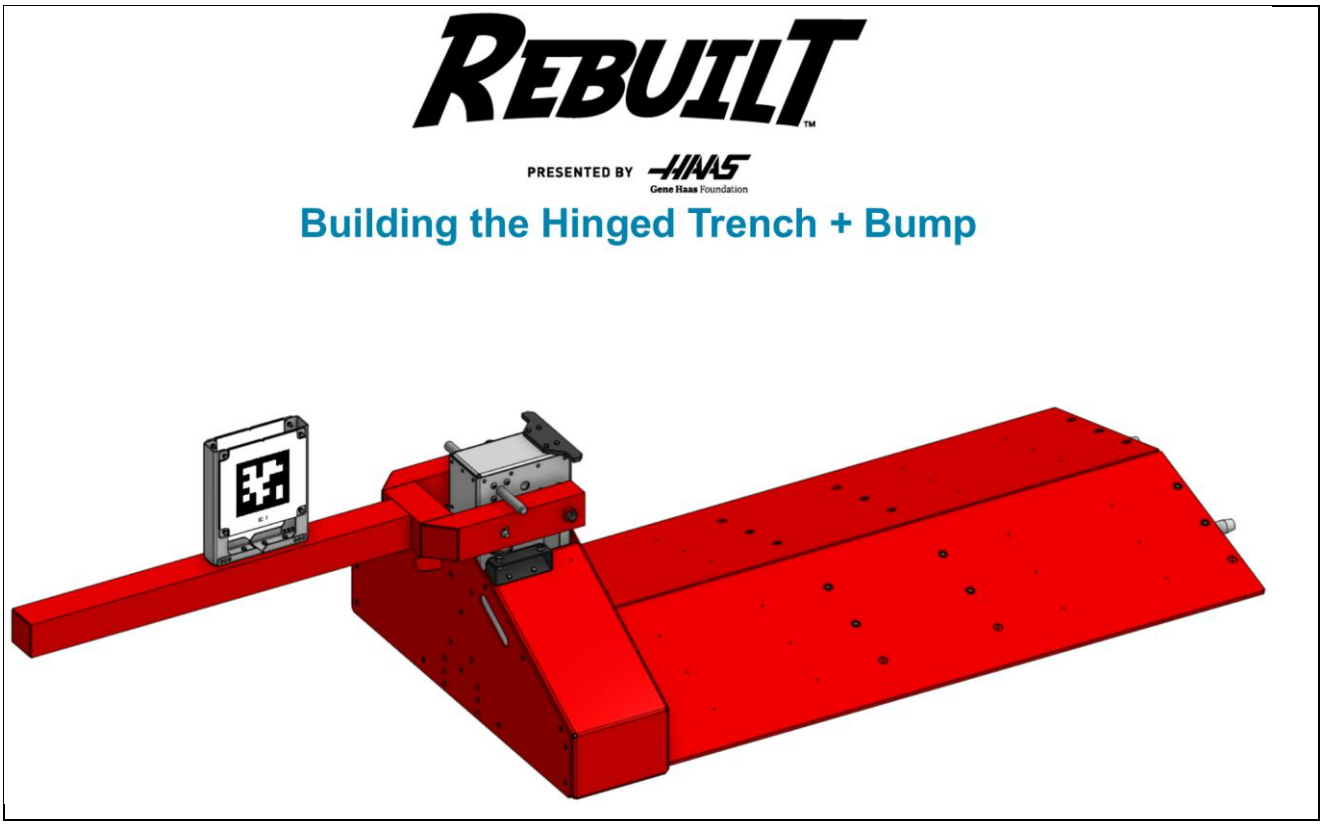
3.6 Bump and Trenches (Hinged Side – Audience Side)

There are 2 Hinged Side Bump and Trench sets per field, 1 red and 1 blue. These require the corresponding Hub Base be placed as described in Section 3.8, Step 16.

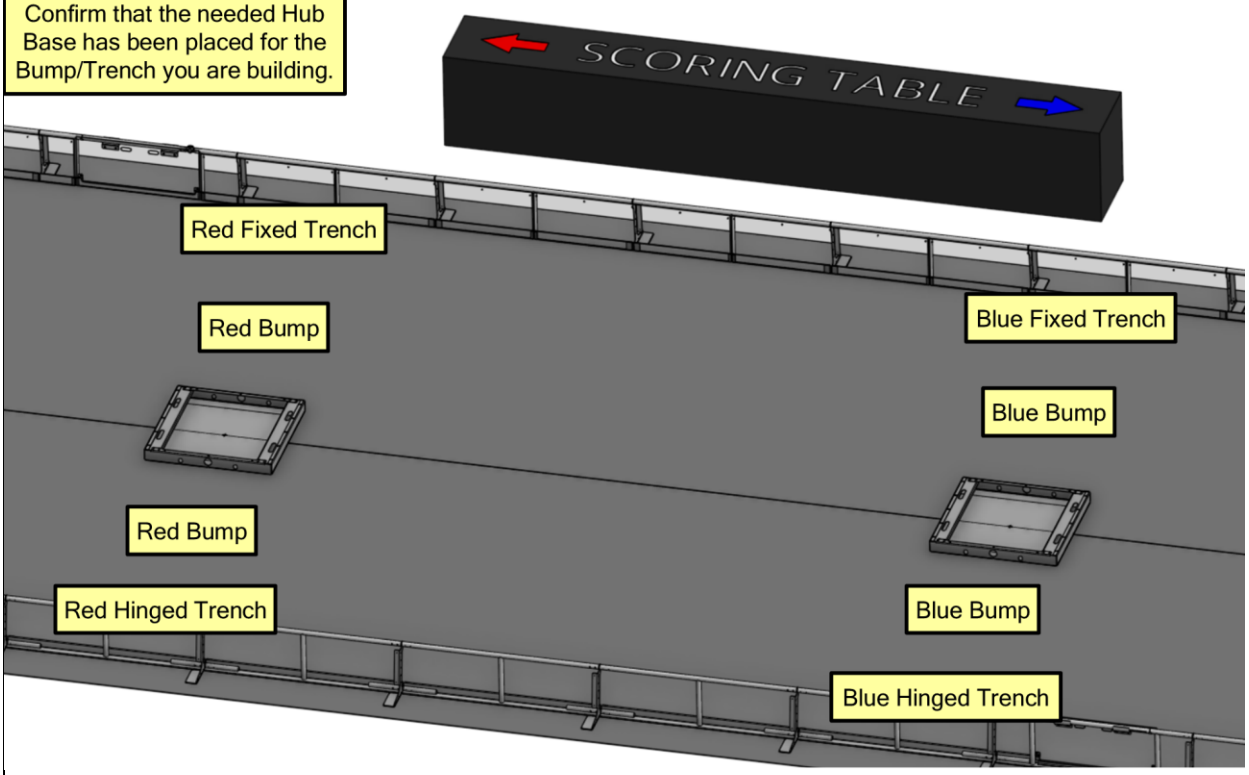
3.6.1 Tools & Equipment

- 7/16” Wrenches and or sockets with ratchets
- ¾” Wrench
- Side Cutters
- Phillips Screwdriver (P2)
- 50lb Cable Ties – Qty. 4
- ¼-20 x 1” Hex Bolts – Qty. 46
- ¼-20 x 1” Flat head Phillips Bolt – Qty. 27
- ½-13 Nut – Qty. 2
- Threaded Leveling Mount – Qty. 2

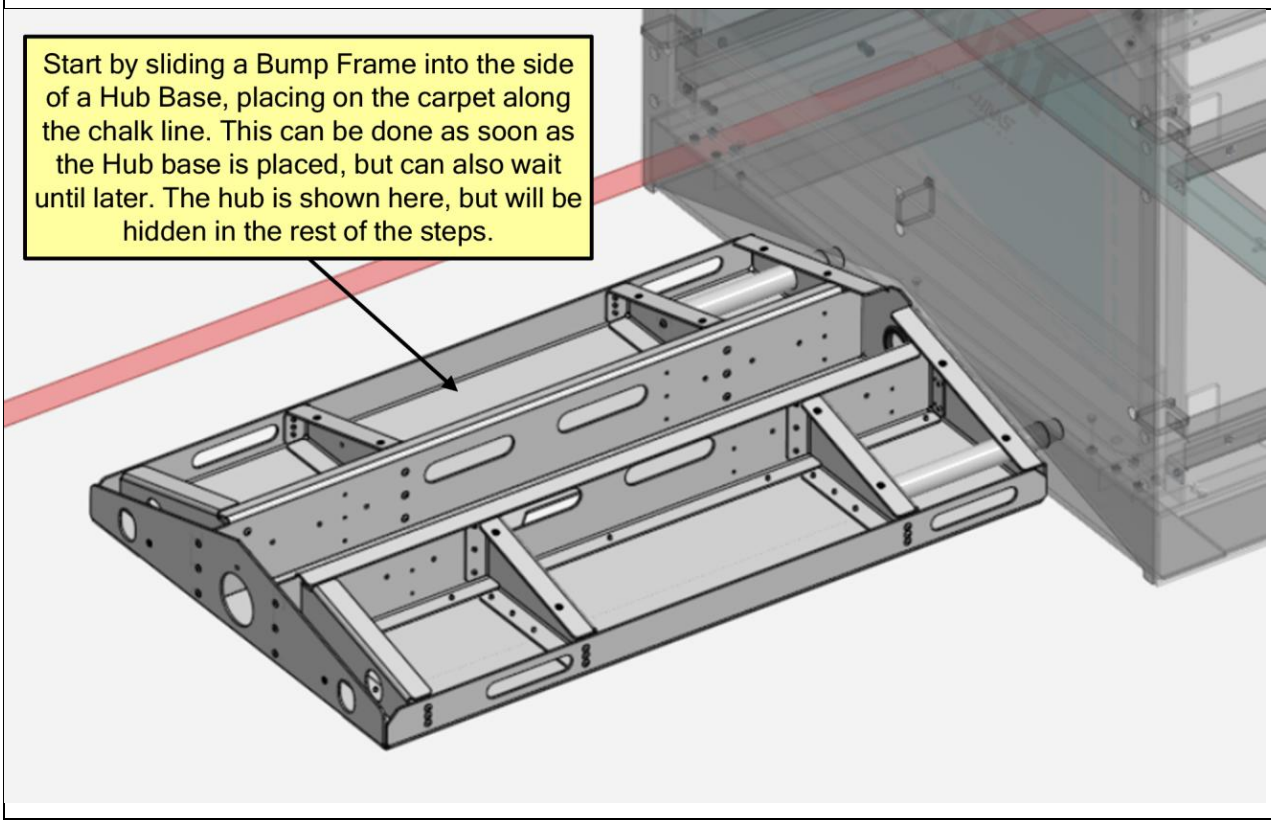
3.6.2 Assembly

1. 

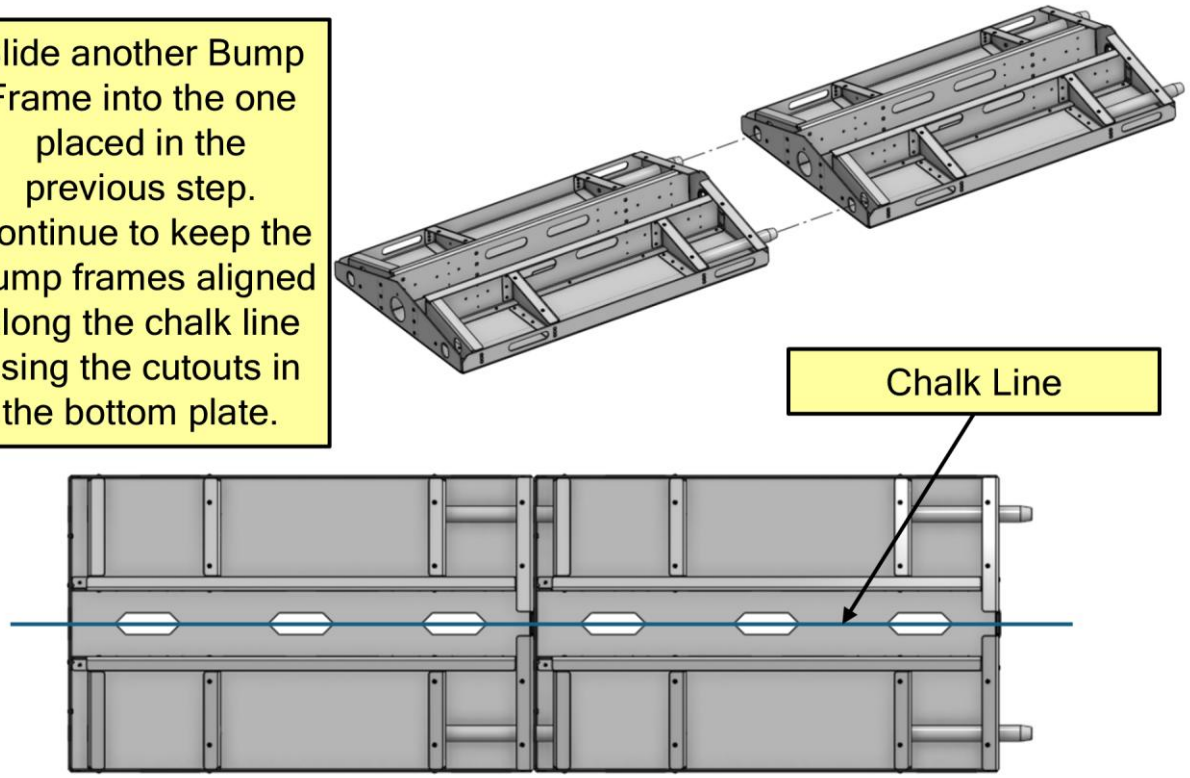
2. The Hub Base placement is described in Section 3.8, Step 16.



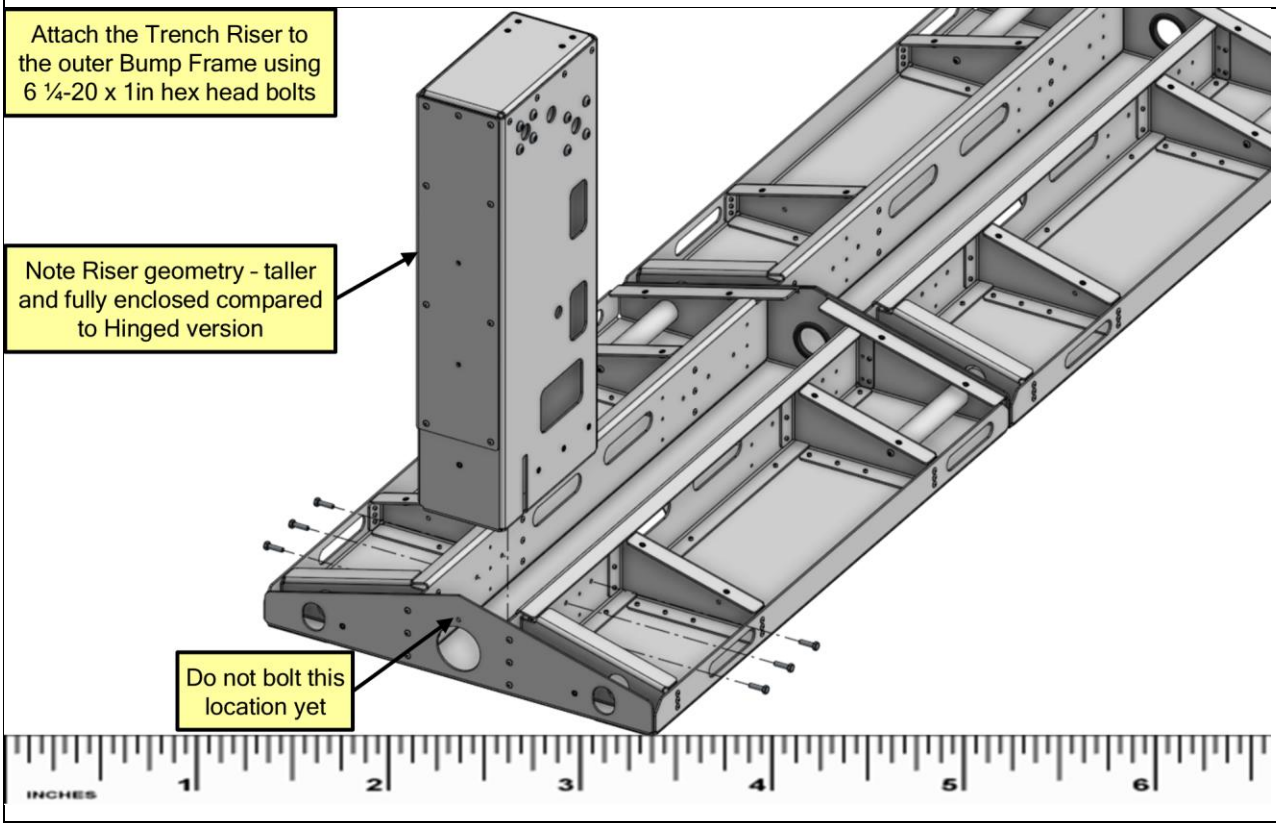
3.



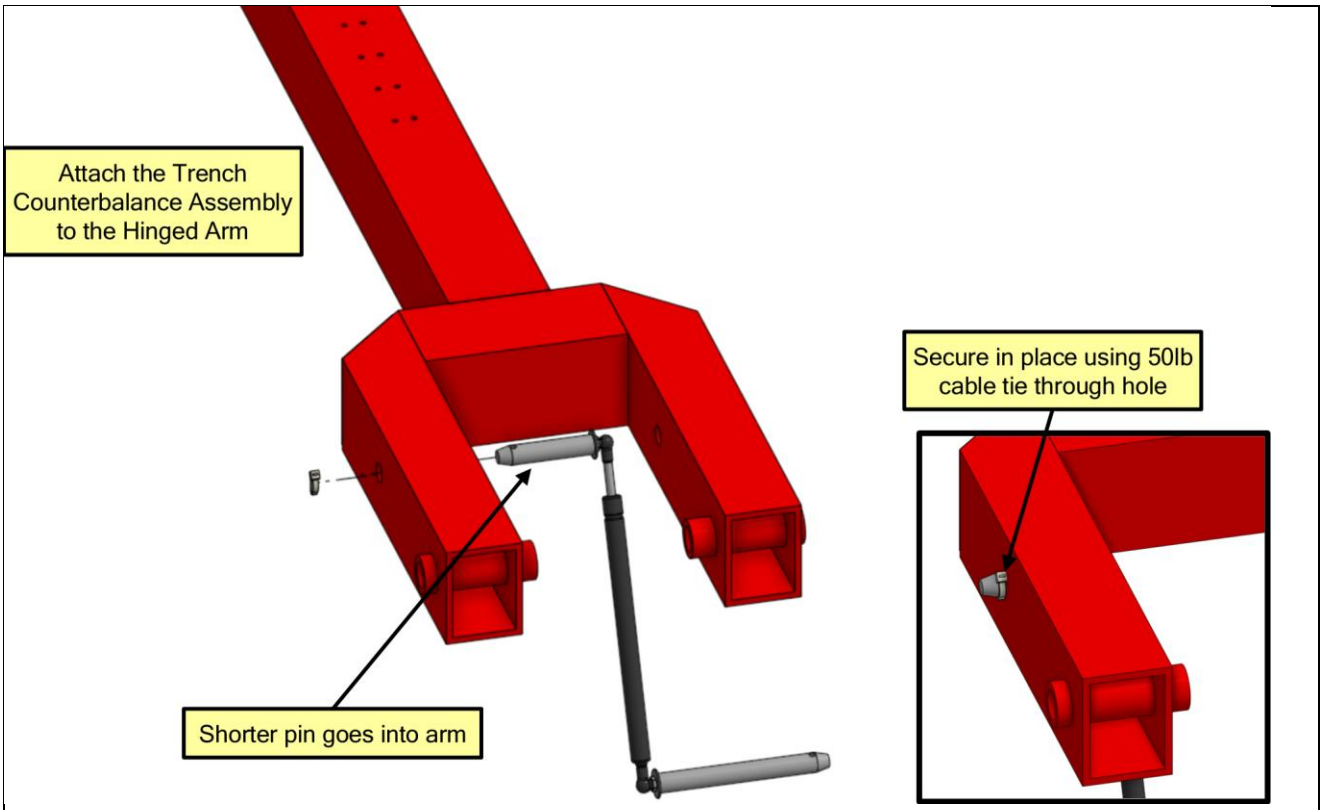
4. Slide another Bump Frame into the one placed in the previous step. Continue to keep the Bump frames aligned along the chalk line using the cutouts in the bottom plate.



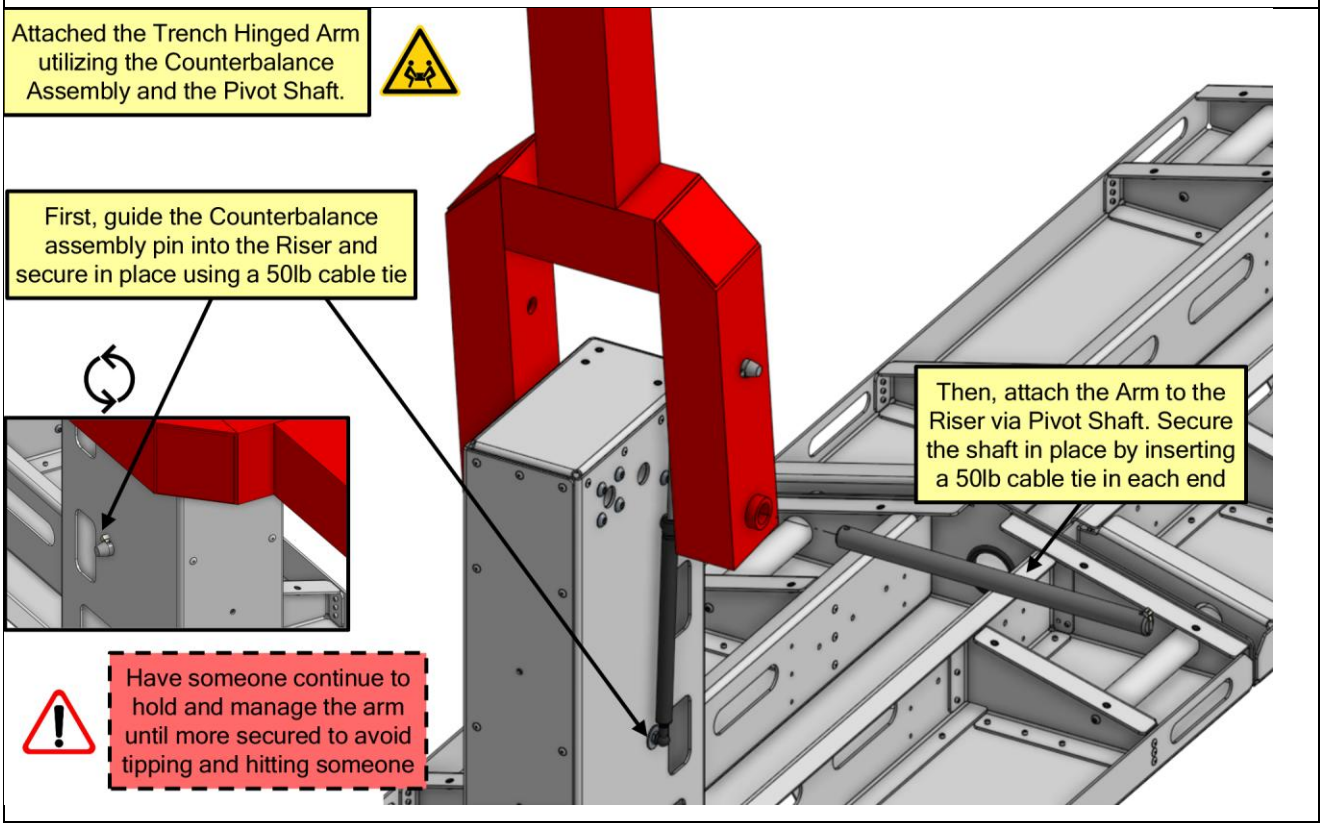
5. Attach the Trench Riser to the outer Bump Frame using 6 ¼-20 x 1in hex head bolts



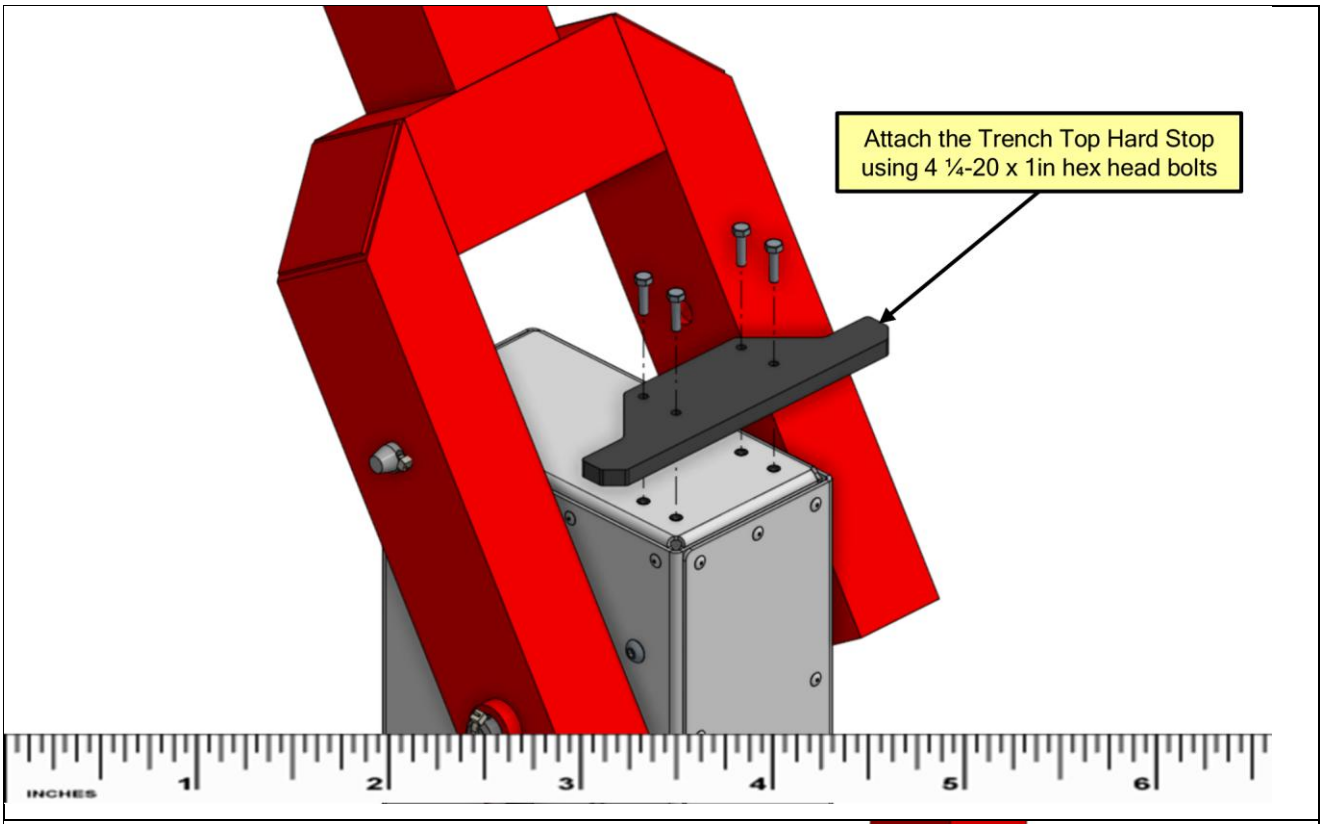
6.


Attach the Trench Counterbalance Assembly to the Hinged Arm
Secure in place using 50lb cable tie through hole
Shorter pin goes into arm

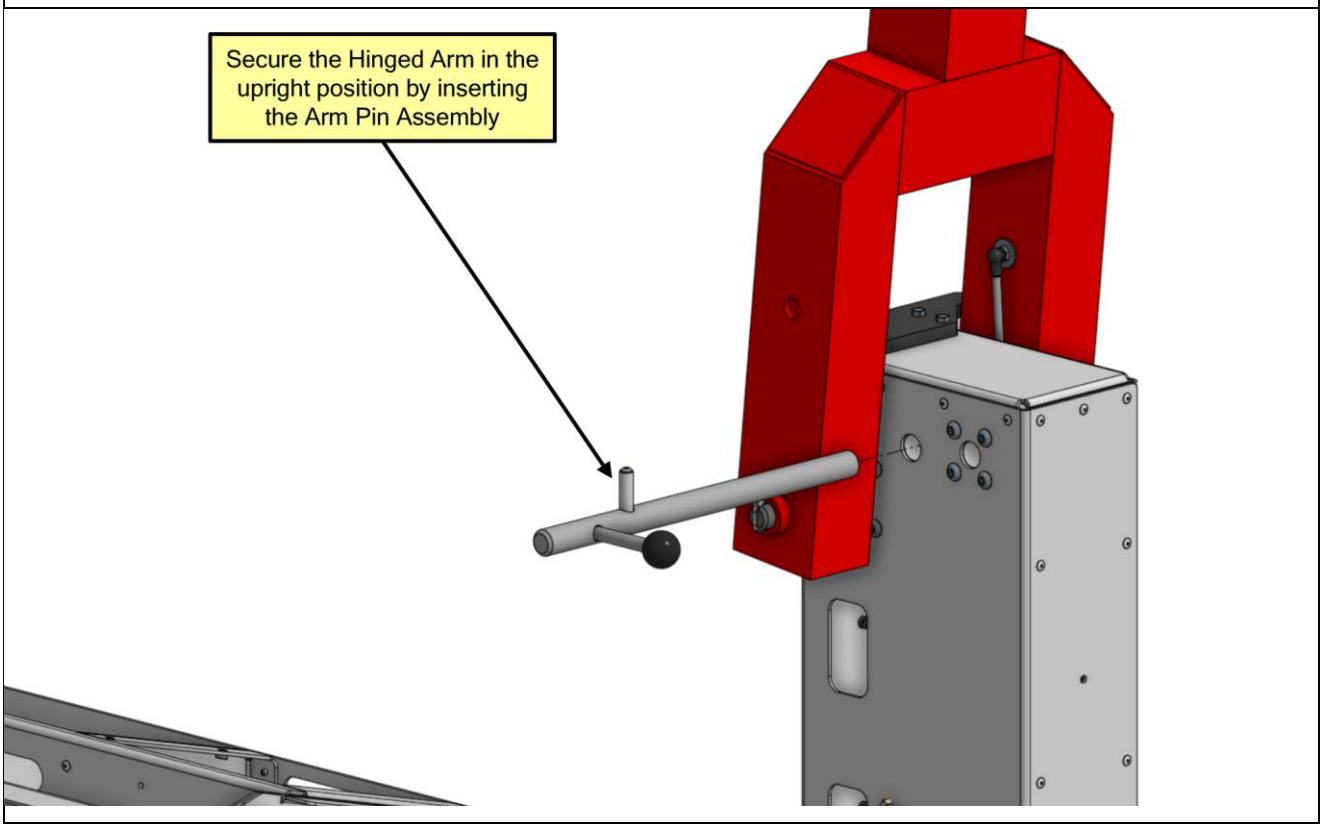
7.


Attached the Trench Hinged Arm utilizing the Counterbalance Assembly and the Pivot Shaft.
First, guide the Counterbalance assembly pin into the Riser and secure in place using a 50lb cable tie
Then, attach the Arm to the Riser via Pivot Shaft. Secure the shaft in place by inserting a 50lb cable tie in each end
Have someone continue to hold and manage the arm until more secured to avoid tipping and hitting someone

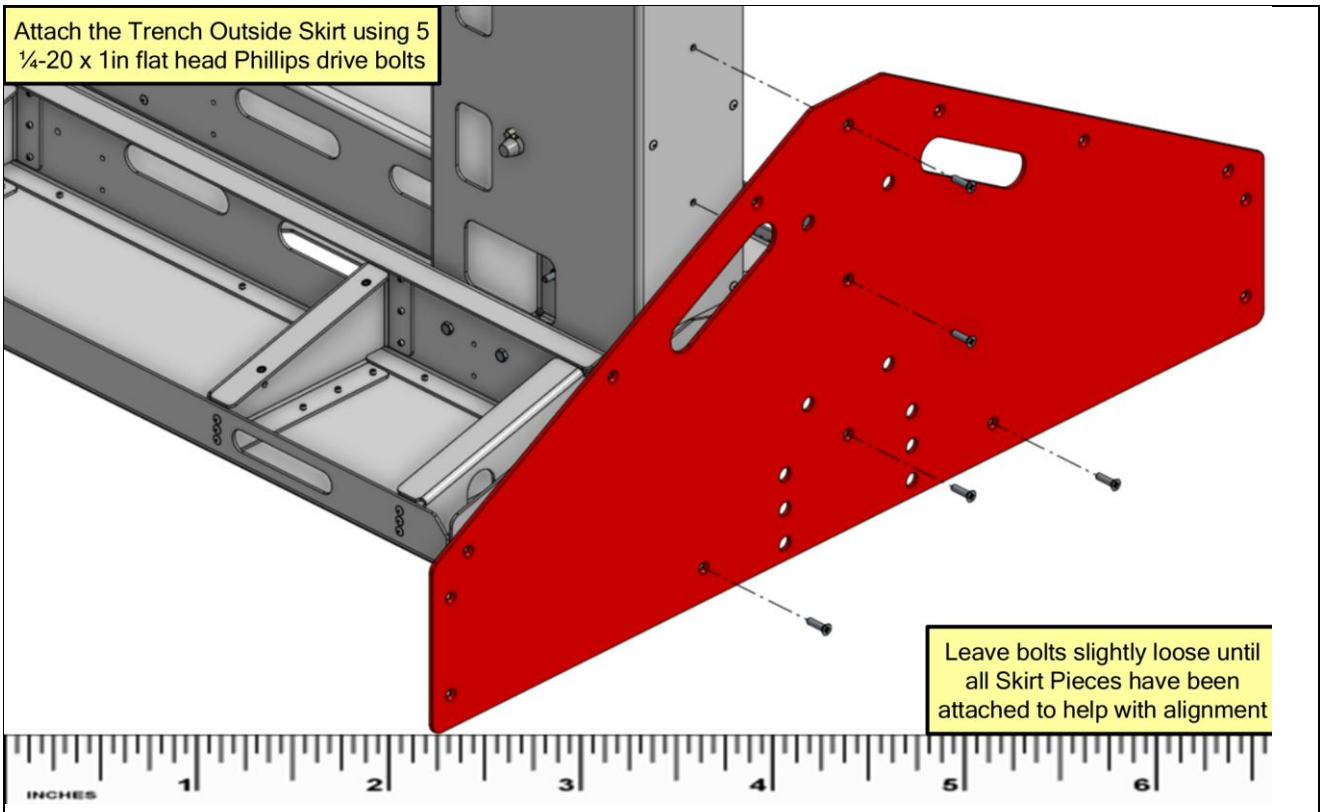
8.


Attach the Trench Top Hard Stop using 4 ¼-20 x 1in hex head bolts
INCHES
1
2
3
4
5
6

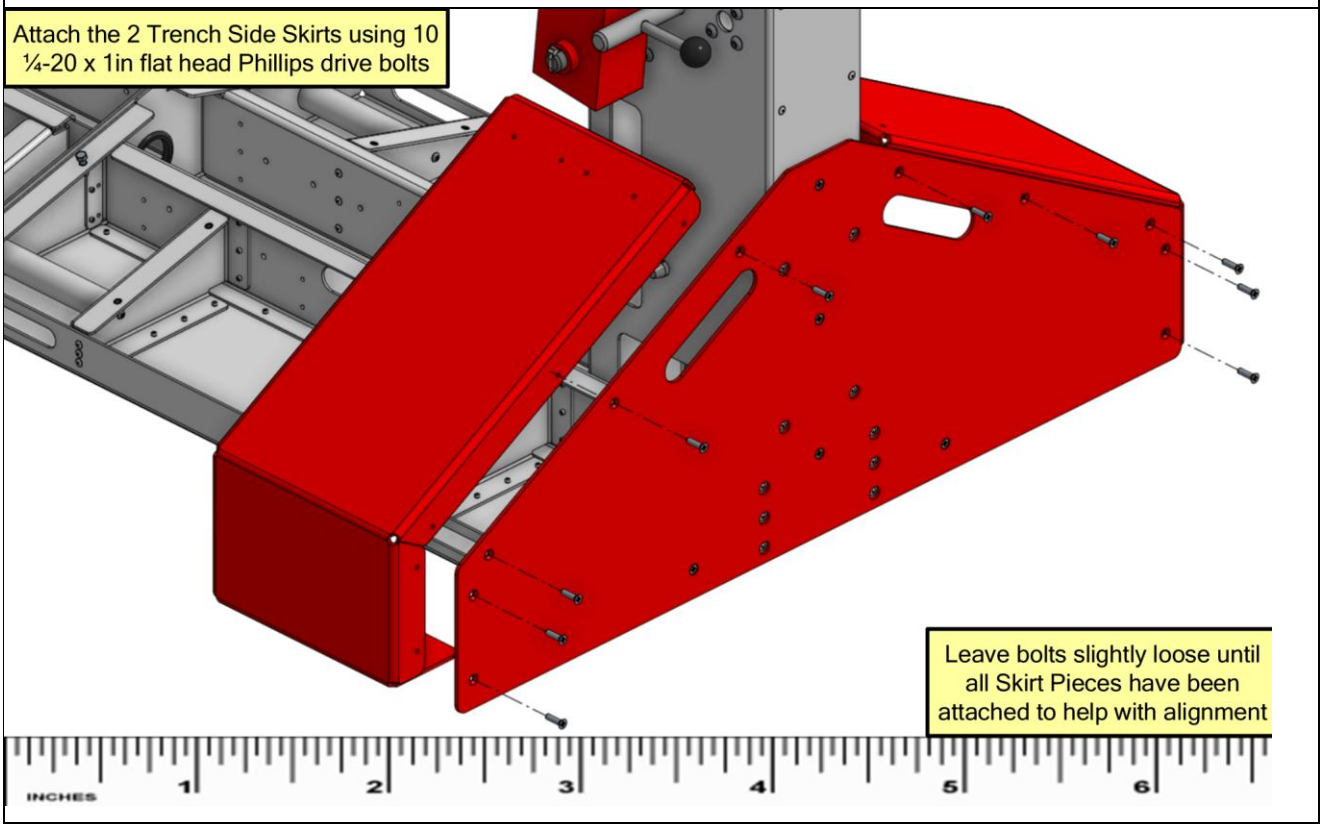
9.


Secure the Hinged Arm in the upright position by inserting the Arm Pin Assembly

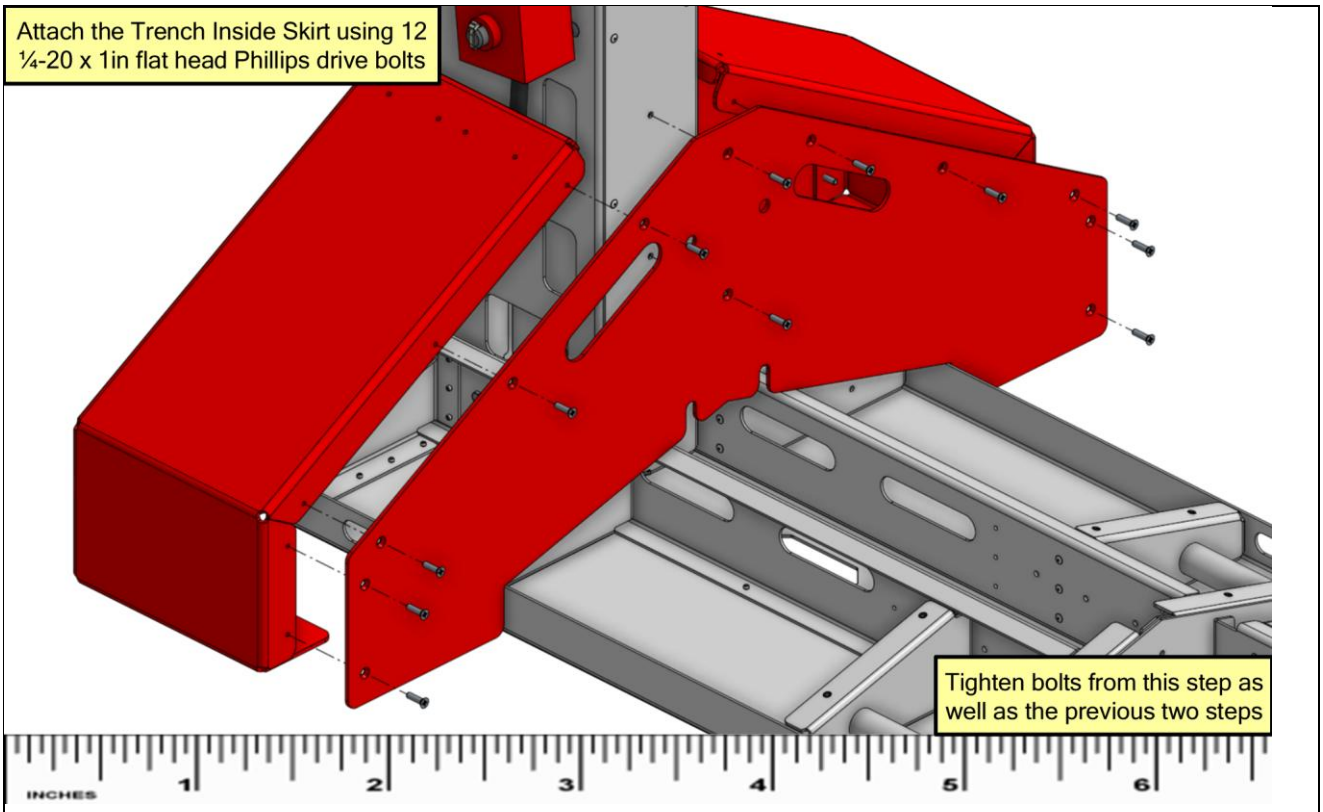
10. Attach the Trench Outside Skirt using 5 ¼-20 x 1in flat head Phillips drive bolts



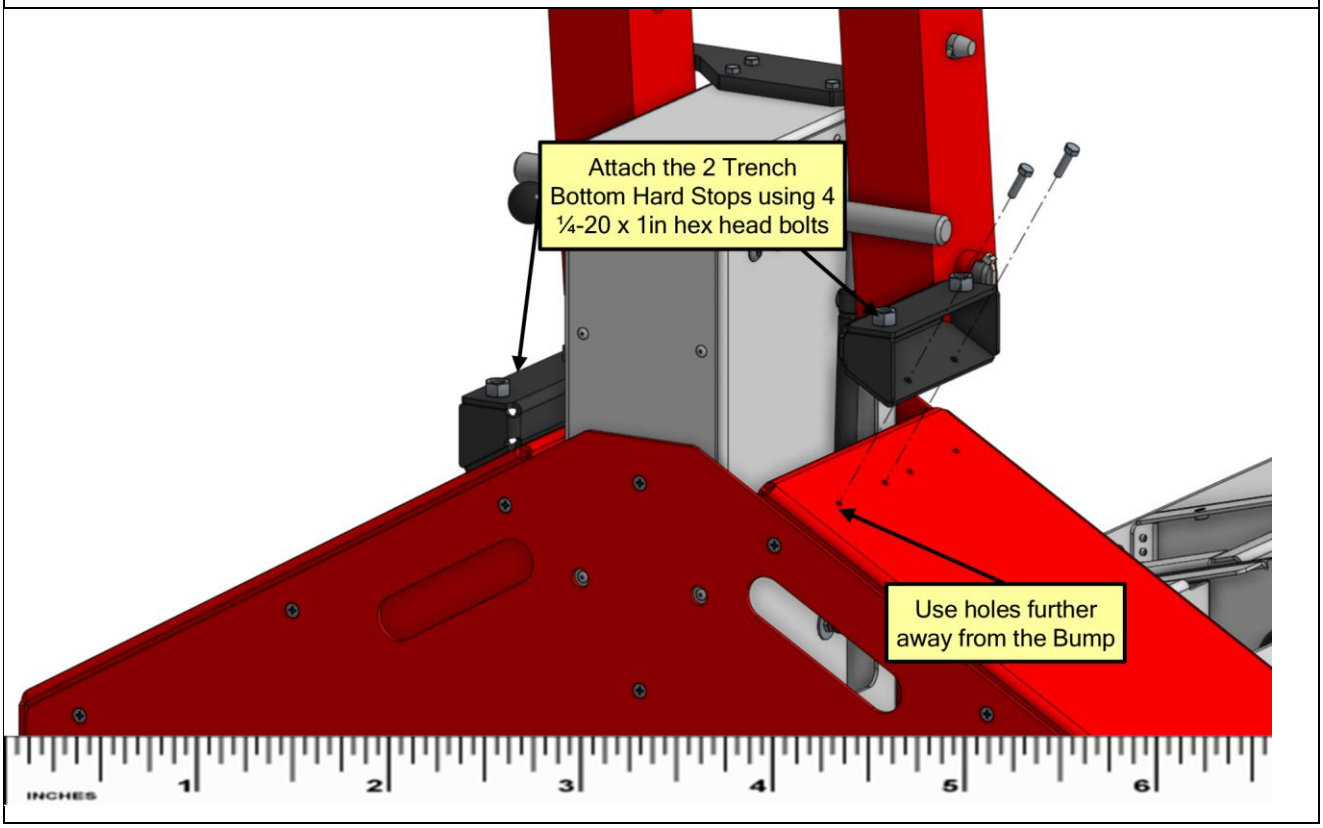
11. Attach the 2 Trench Side Skirts using 10 ¼-20 x 1in flat head Phillips drive bolts

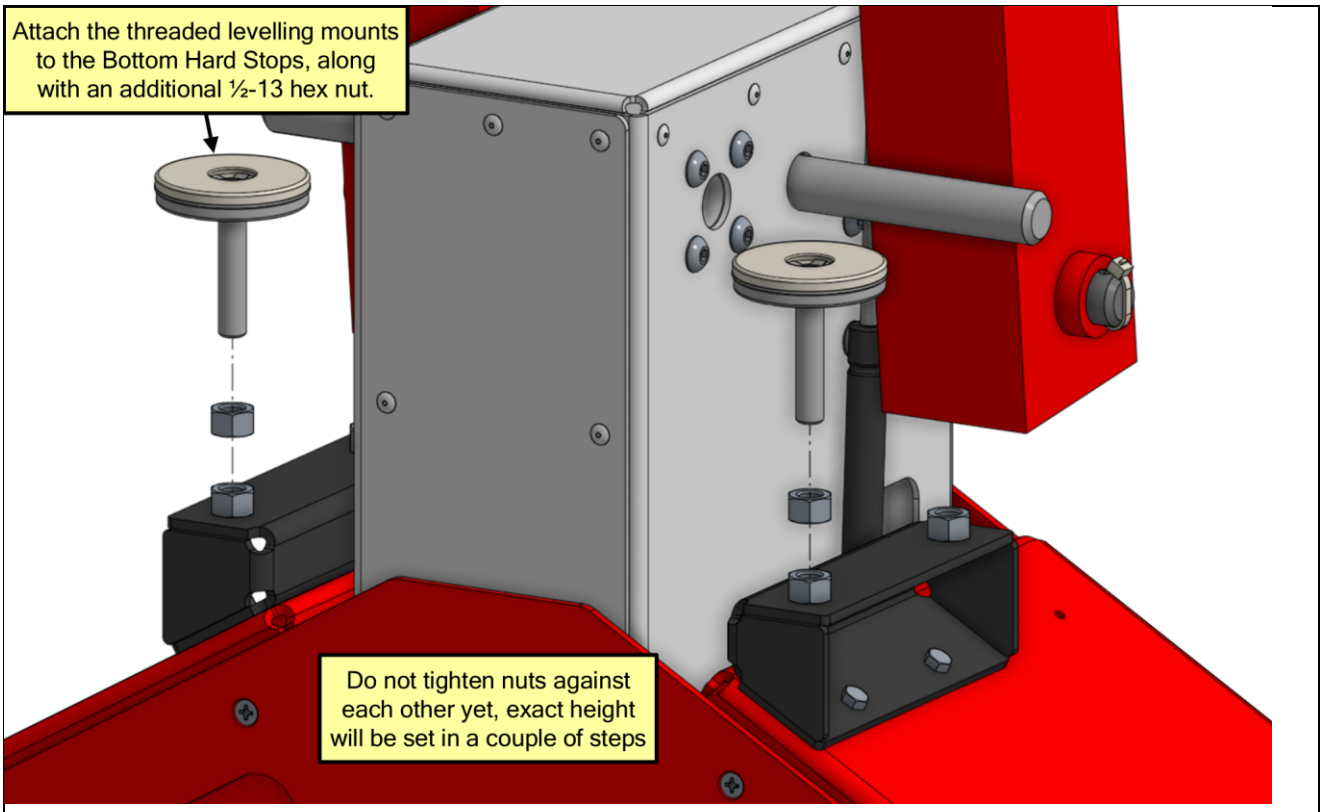


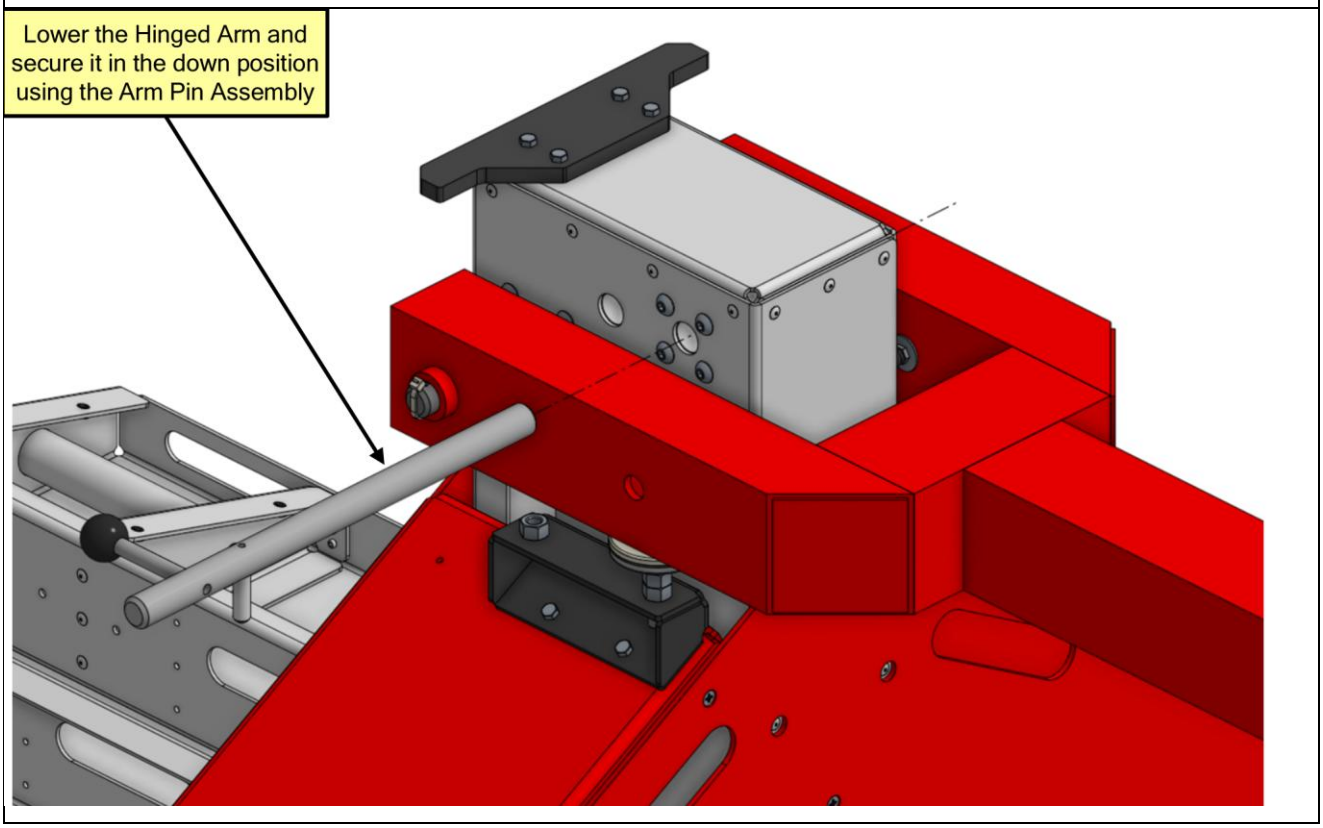
12.


Attach the Trench Inside Skirt using 12 ¼-20 x 1in flat head Phillips drive bolts
Tighten bolts from this step as well as the previous two steps
INCHES
1
2
3
4
5
6

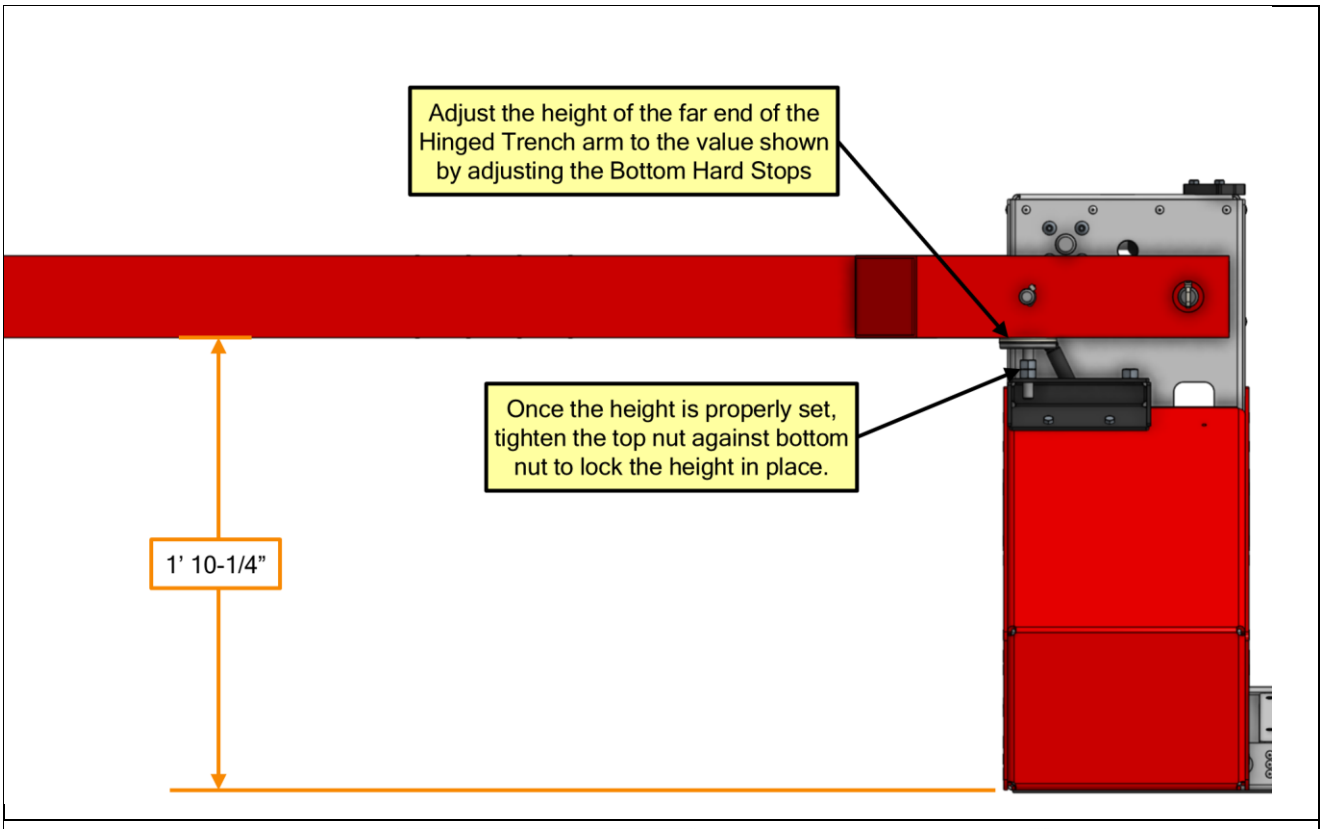
13.


Attach the 2 Trench Bottom Hard Stops using 4 ¼-20 x 1in hex head bolts
Use holes further away from the Bump
INCHES
1
2
3
4
5
6

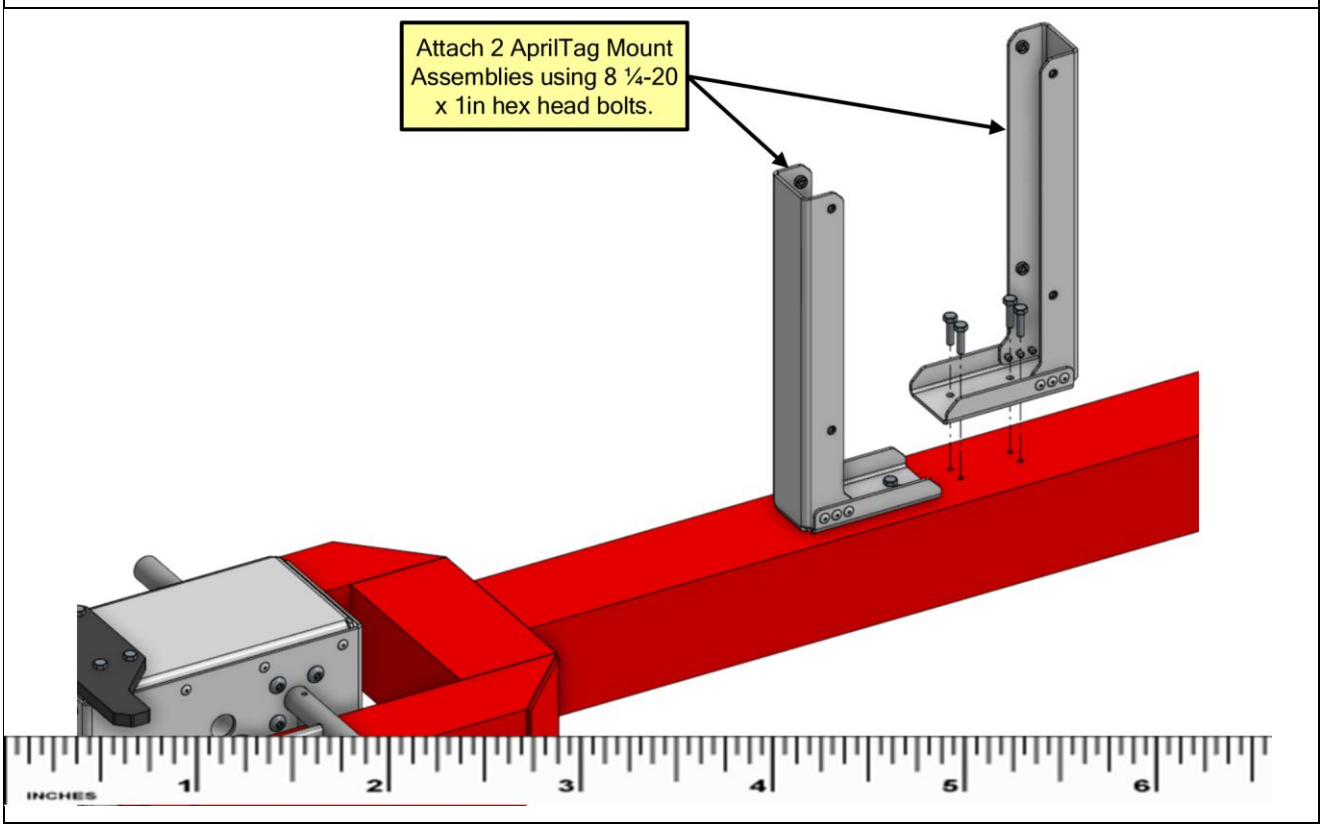
14. 
Attach the threaded levelling mounts to the Bottom Hard Stops, along with an additional ½-13 hex nut.
Do not tighten nuts against each other yet, exact height will be set in a couple of steps

15. 
Lower the Hinged Arm and secure it in the down position using the Arm Pin Assembly

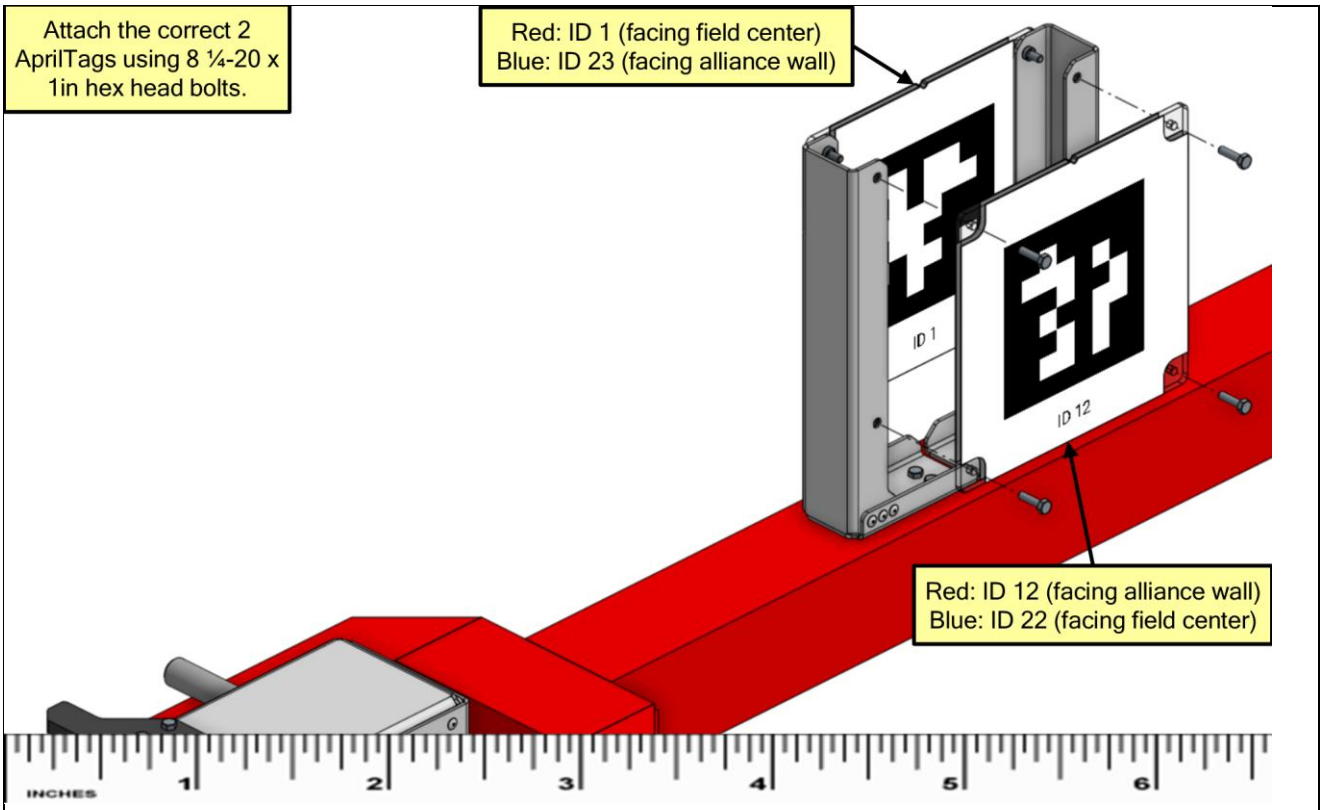
16.


Adjust the height of the far end of the Hinged Trench arm to the value shown by adjusting the Bottom Hard Stops
Once the height is properly set, tighten the top nut against bottom nut to lock the height in place.
1' 10-1/4"

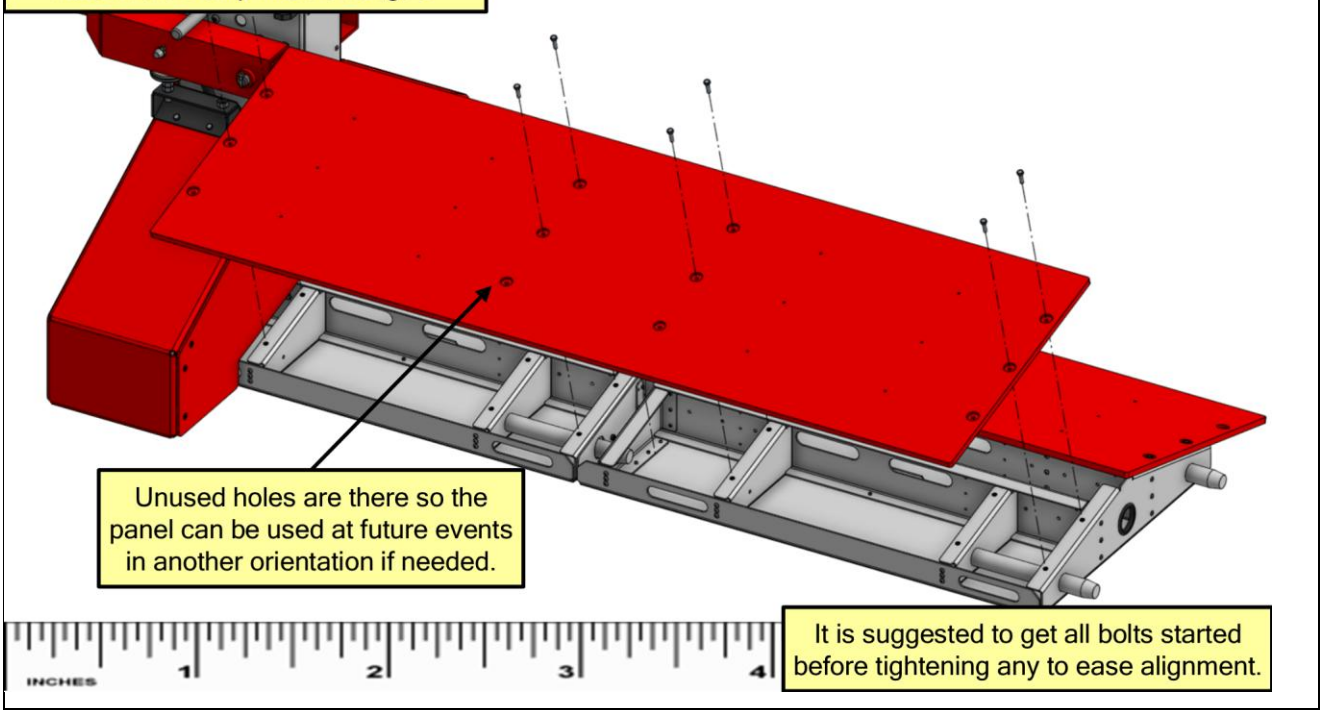
17.


Attach 2 AprilTag Mount Assemblies using 8 ¼-20 x 1in hex head bolts.
INCHES
1
2
3
4
5
6

18. Attach the correct 2 AprilTags using 8 ¼-20 x 1in hex head bolts.



19. Attach 2 Bump Plastic Panels with 16 ¼-20 x 1in hex head bolts into the PEM nuts in the Bump Frame flanges.



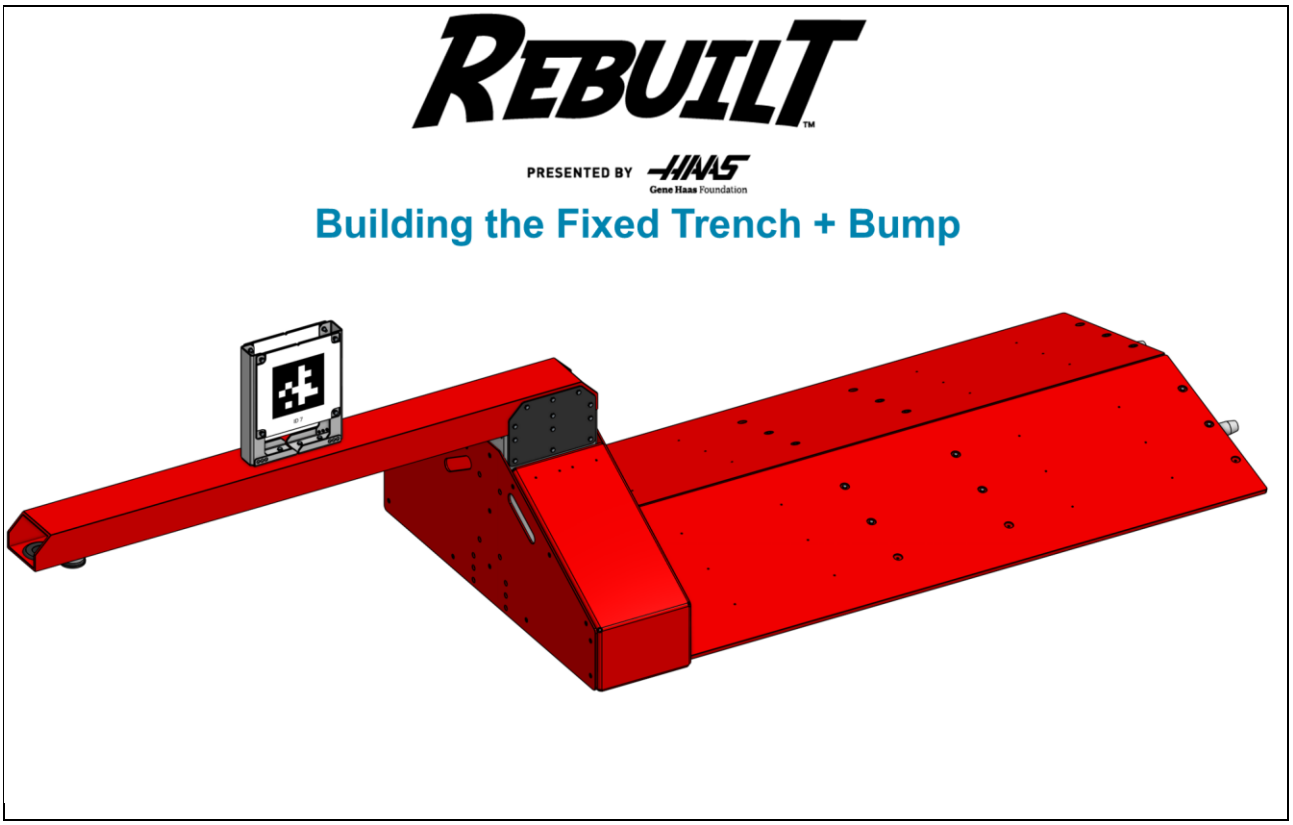
3.7 Bump and Trenches (Fixed Side – Scoring Table Side)

There are 2 Fixed Side Bump and Trench sets per field, 1 red and 1 blue. These require the corresponding Hub Base be placed, and running the wires to the Hub as part of this assembly is required to be able to continue that assembly beyond a certain step.

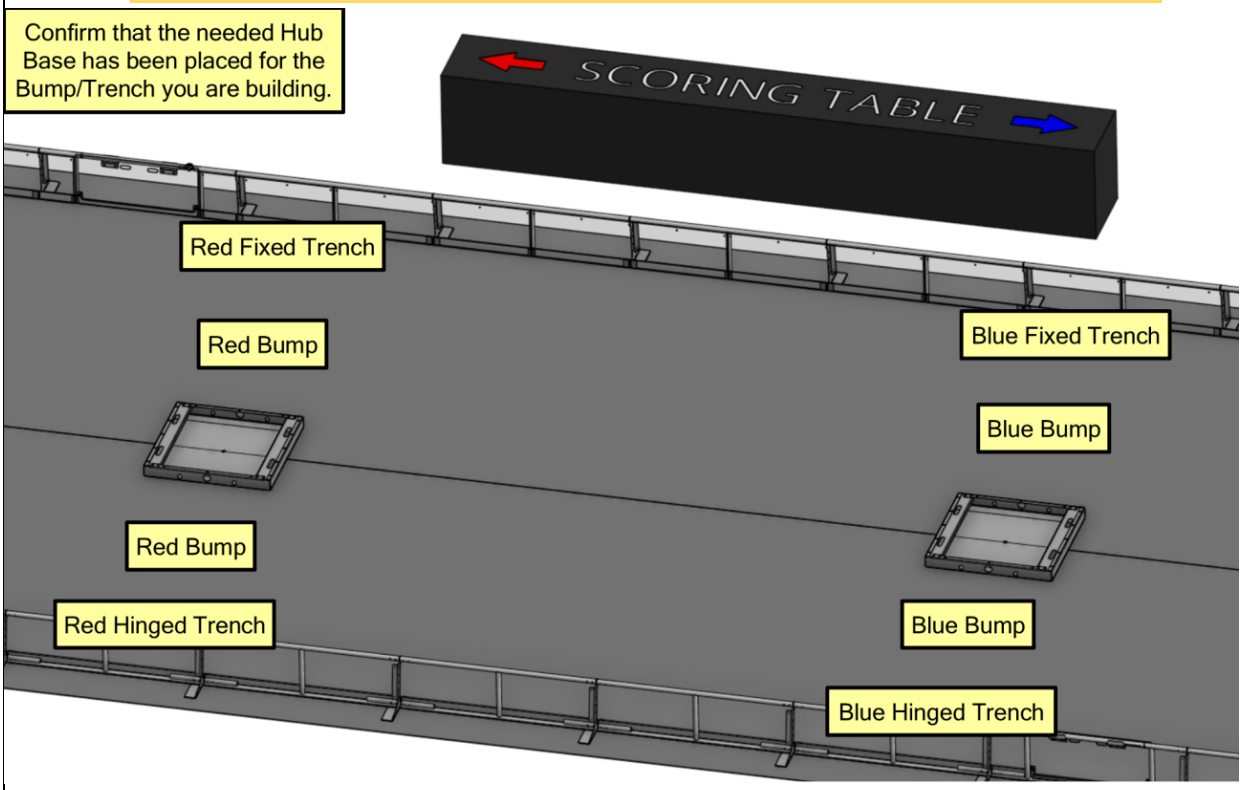
3.7.1 Tools & Equipment

- 7/16” Wrenches and or sockets with ratchets
- ¾” Wrench
- Phillips Screwdriver (P2)
- ¼-20 x 1” Hex Bolts – Qty. 62
- ¼-20 x 1” Flat head Phillips Bolt – Qty. 27
- ½-13 Nut – Qty. 1
- Threaded Leveling Mount – Qty. 1

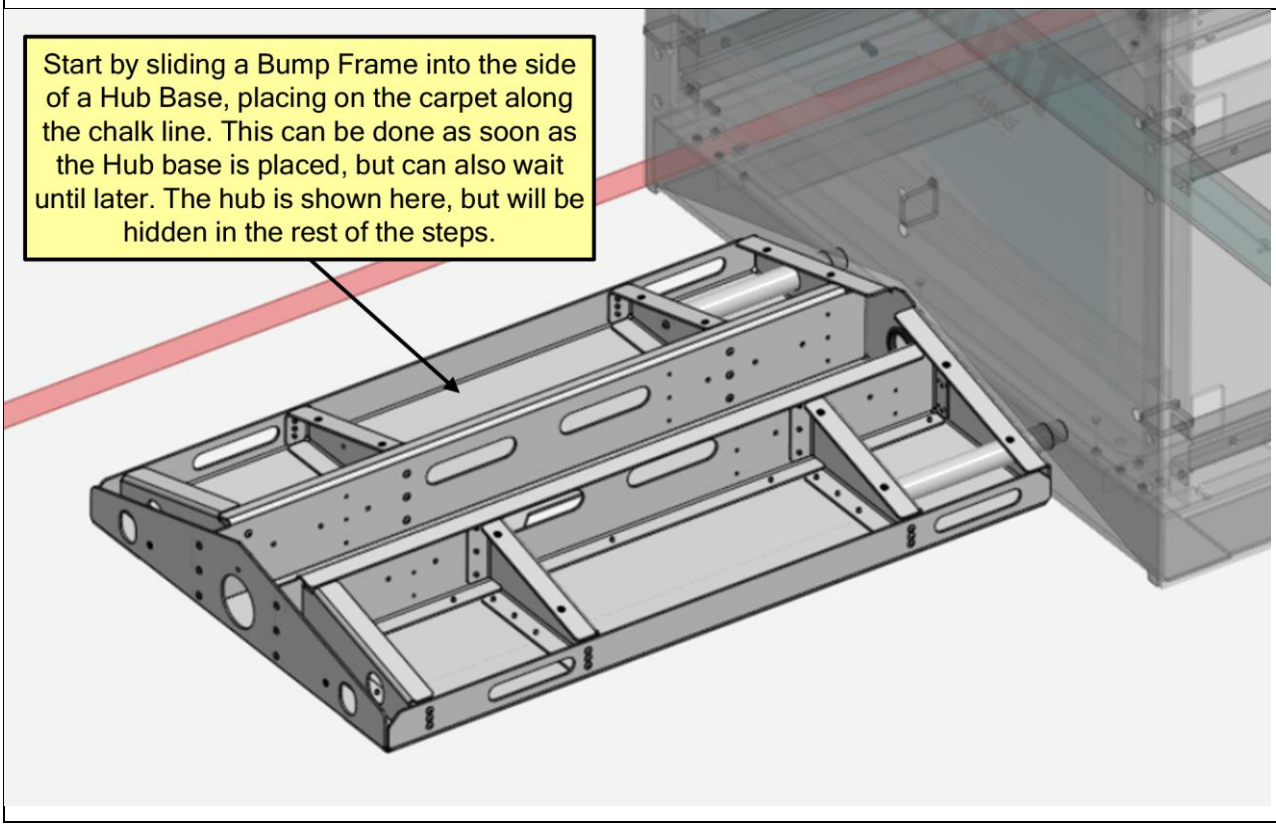
3.7.2 Assembly

1. 

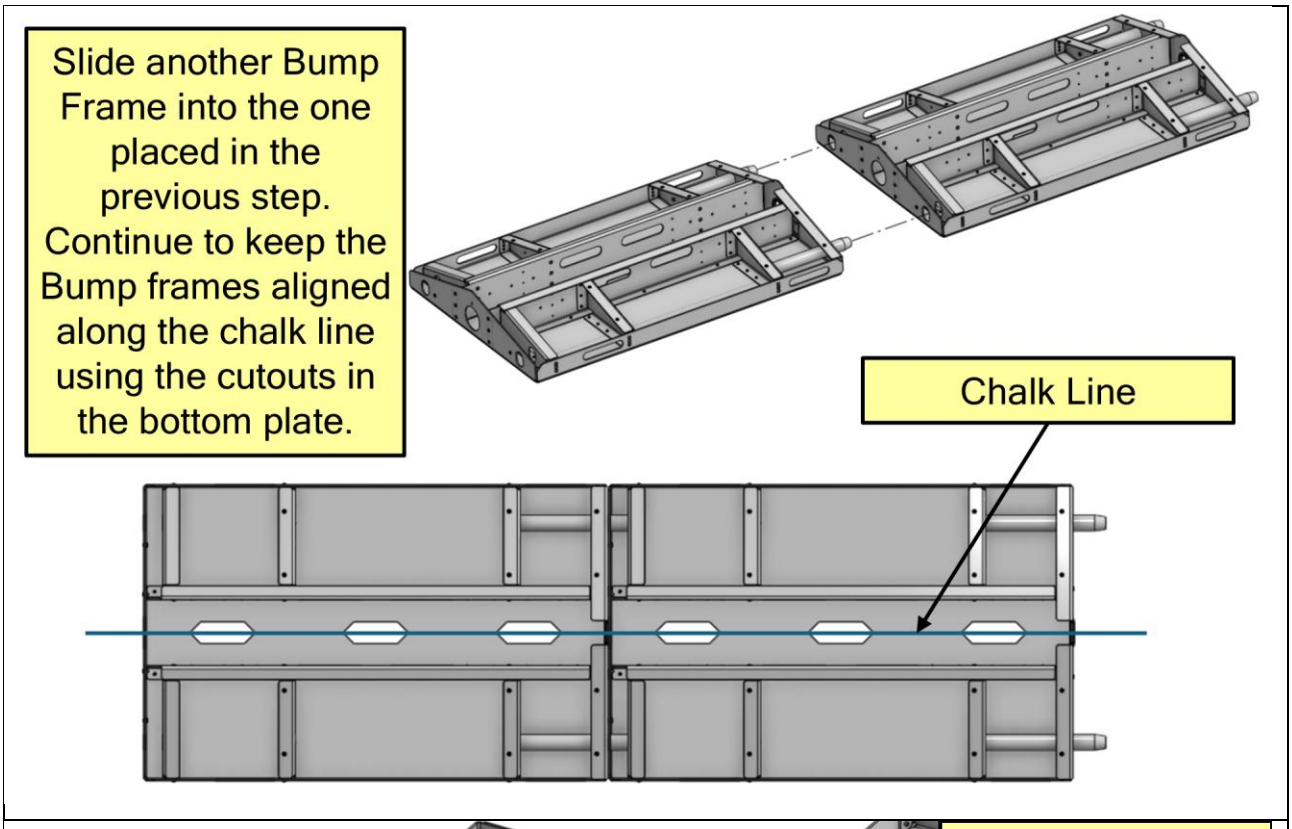
2. The Hub Base placement is described in Section 3.8, Step 16.



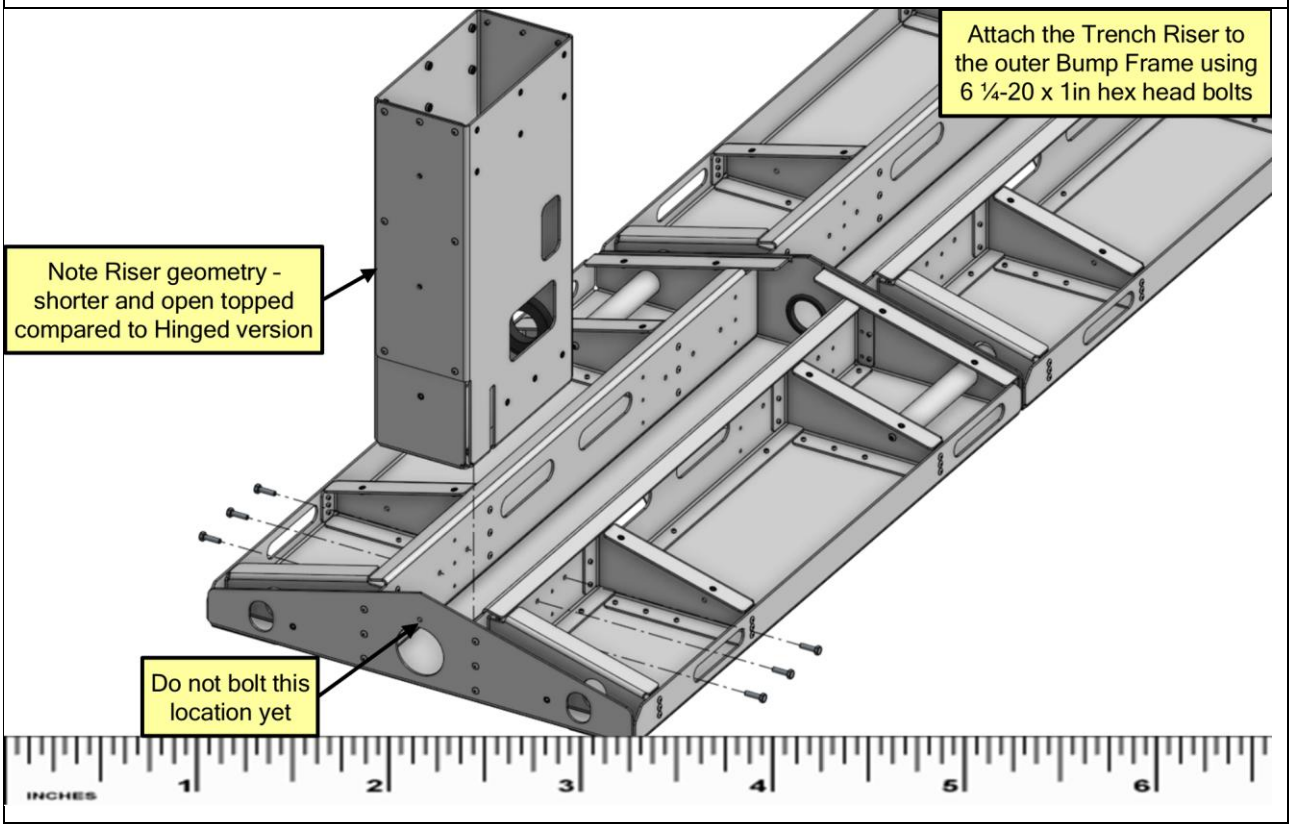
3.



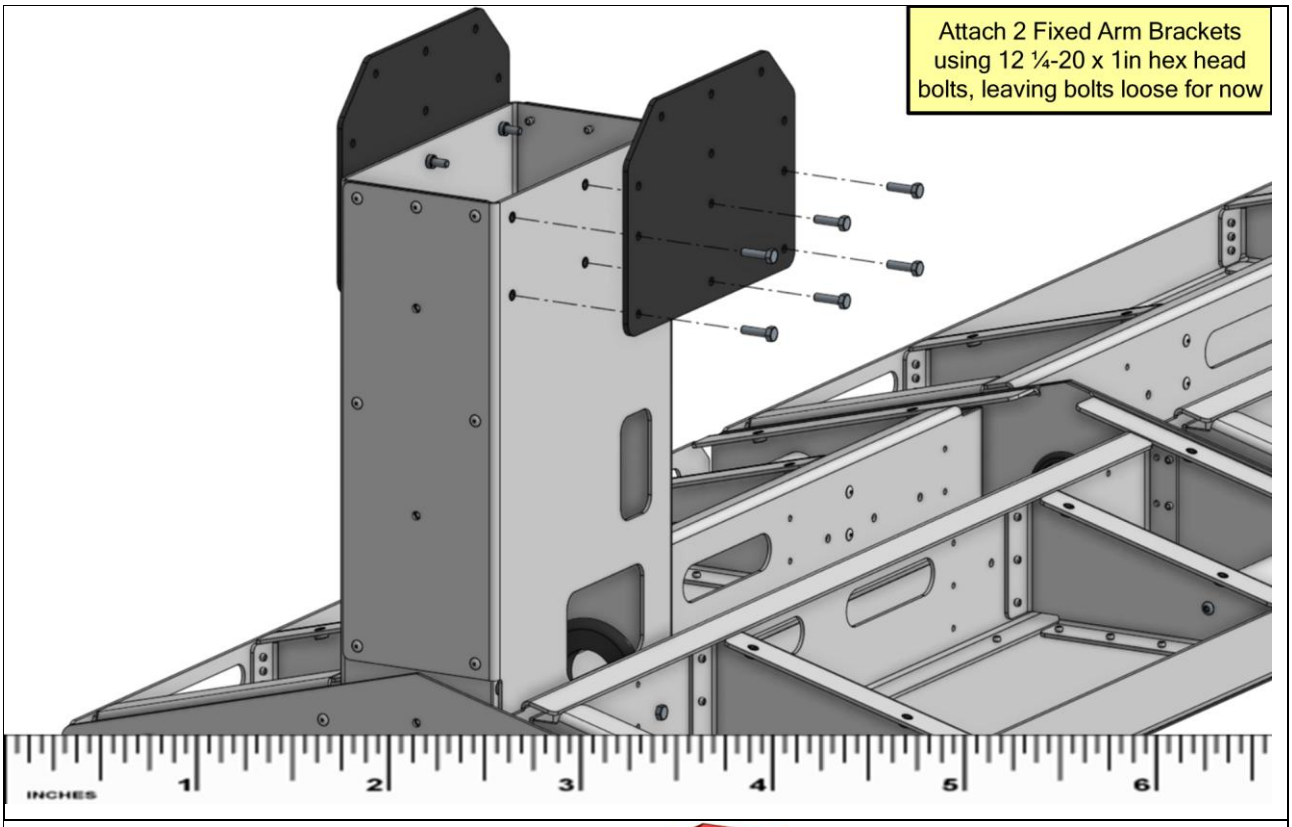
4.


Slide another Bump Frame into the one placed in the previous step. Continue to keep the Bump frames aligned along the chalk line using the cutouts in the bottom plate.
Chalk Line

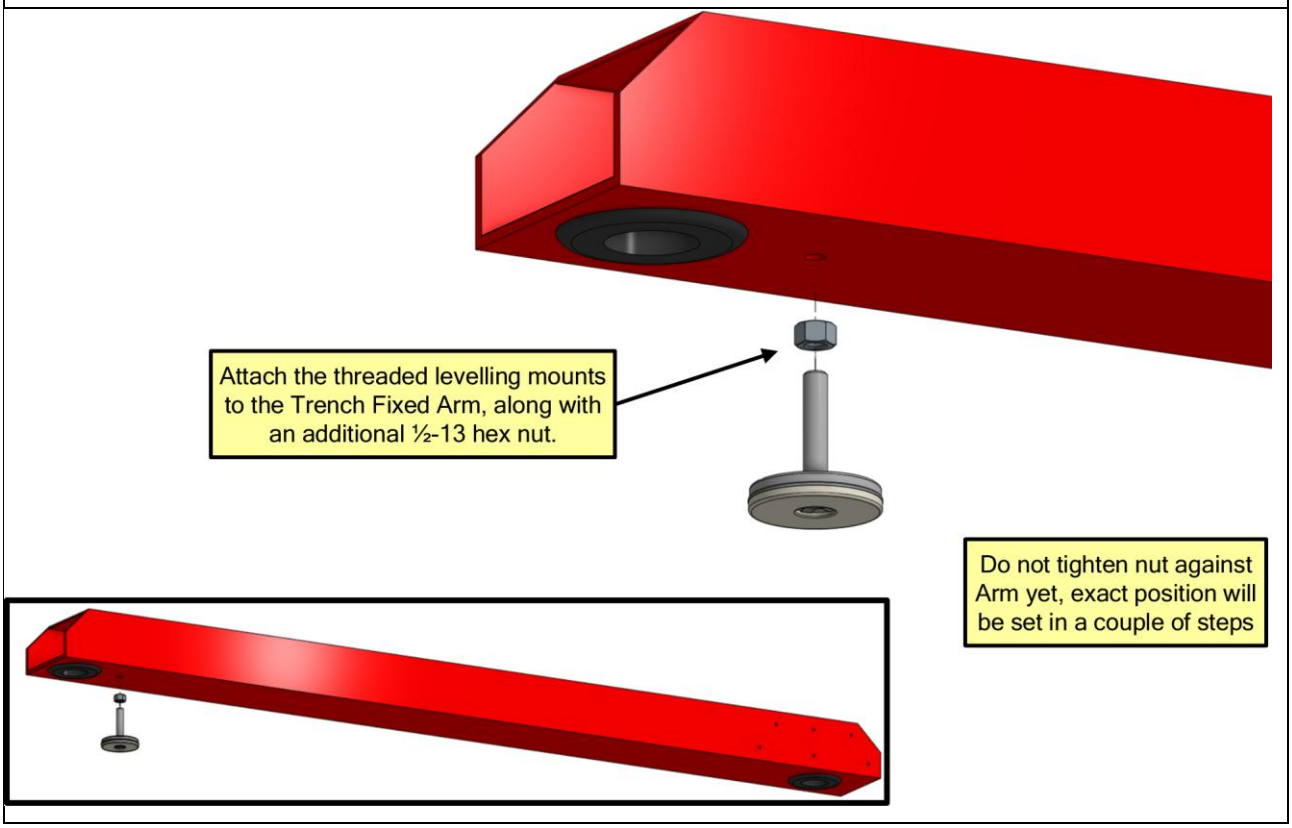
5.


Attach the Trench Riser to the outer Bump Frame using 6 ¼-20 x 1in hex head bolts
Note Riser geometry - shorter and open topped compared to Hinged version
Do not bolt this location yet
INCHES
1
2
3
4
5
6

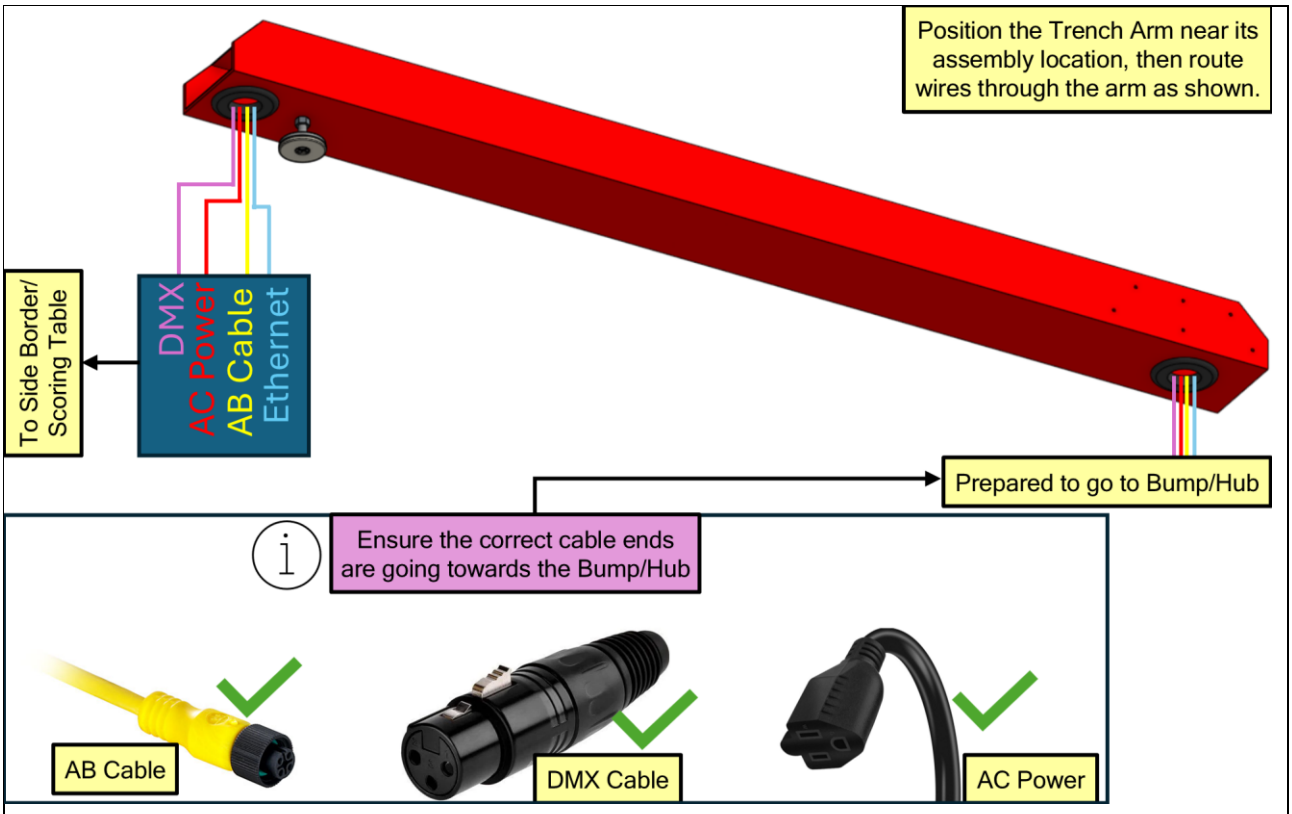
6.


Attach 2 Fixed Arm Brackets using 12 ¼-20 x 1in hex head bolts, leaving bolts loose for now
INCHES
1
2
3
4
5
6

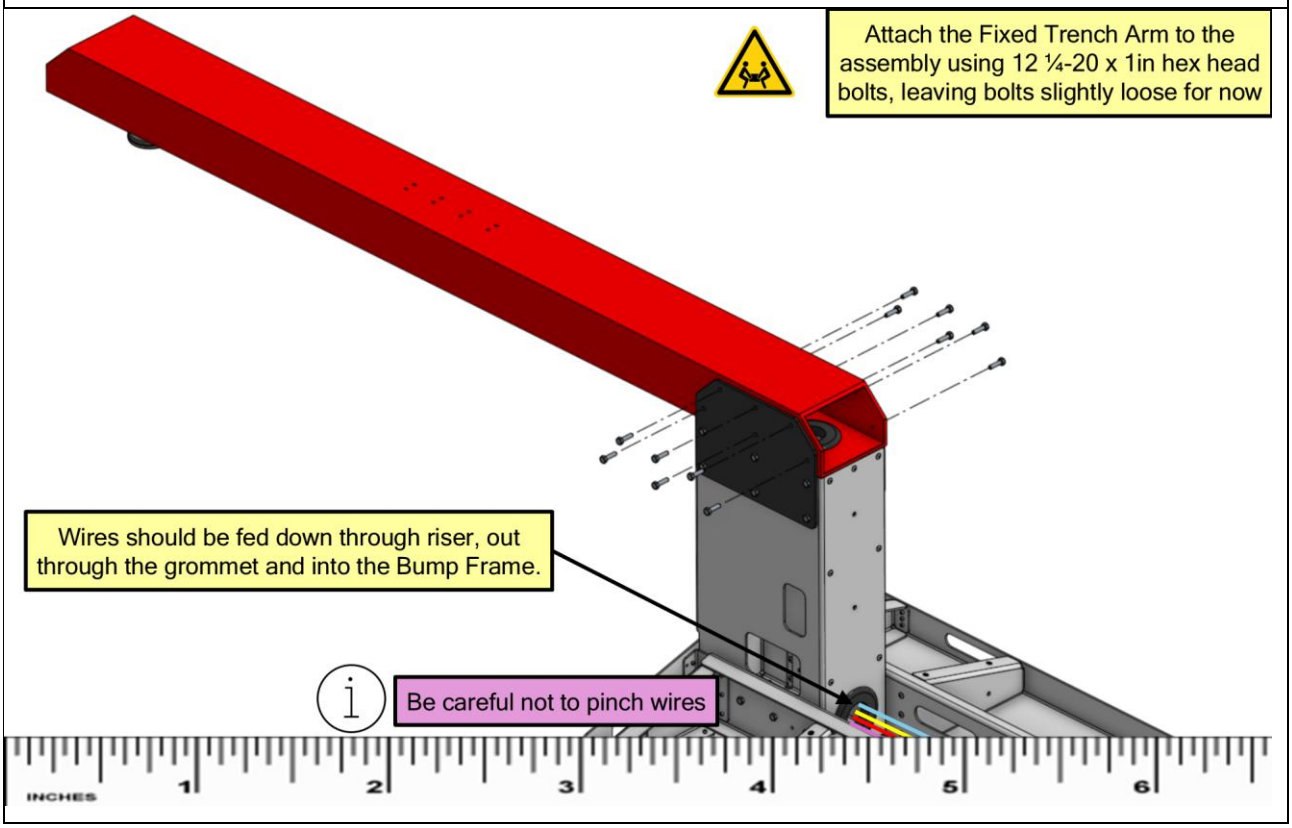
7.


Attach the threaded levelling mounts to the Trench Fixed Arm, along with an additional ½-13 hex nut.
Do not tighten nut against Arm yet, exact position will be set in a couple of steps

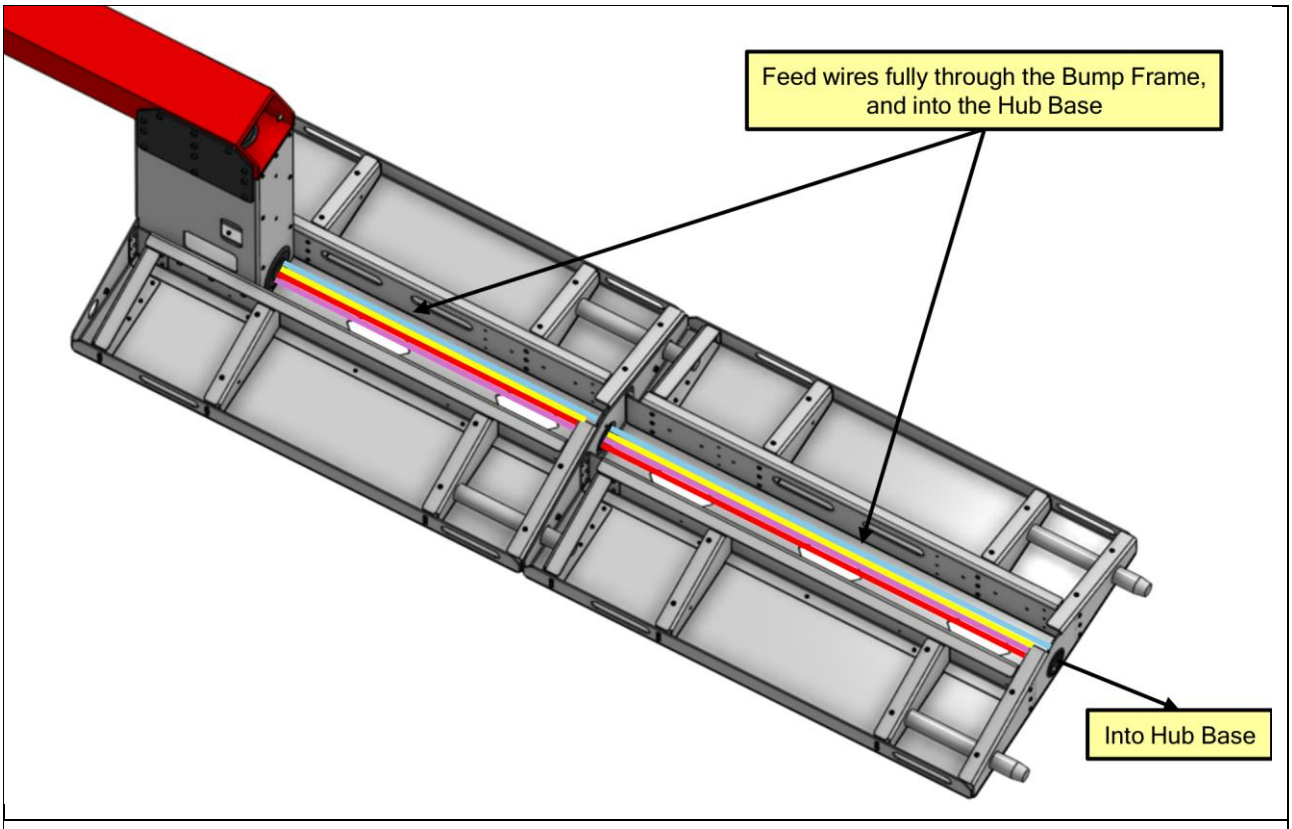
8.


Position the Trench Arm near its assembly location, then route wires through the arm as shown.
To Side Border/ Scoring Table
DMX
AC Power
AB Cable
Ethernet
Prepared to go to Bump/Hub
Ensure the correct cable ends are going towards the Bump/Hub
AB Cable
DMX Cable
AC Power

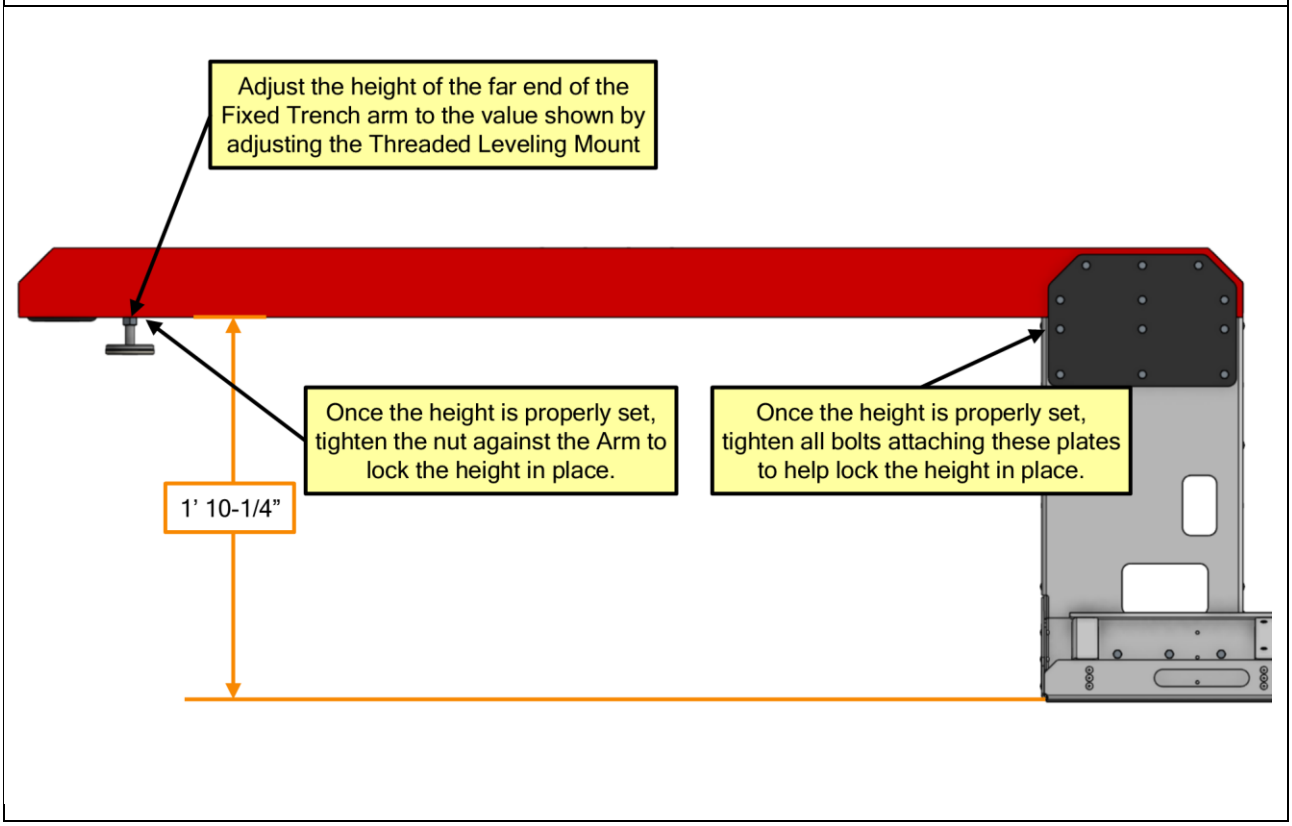
9.

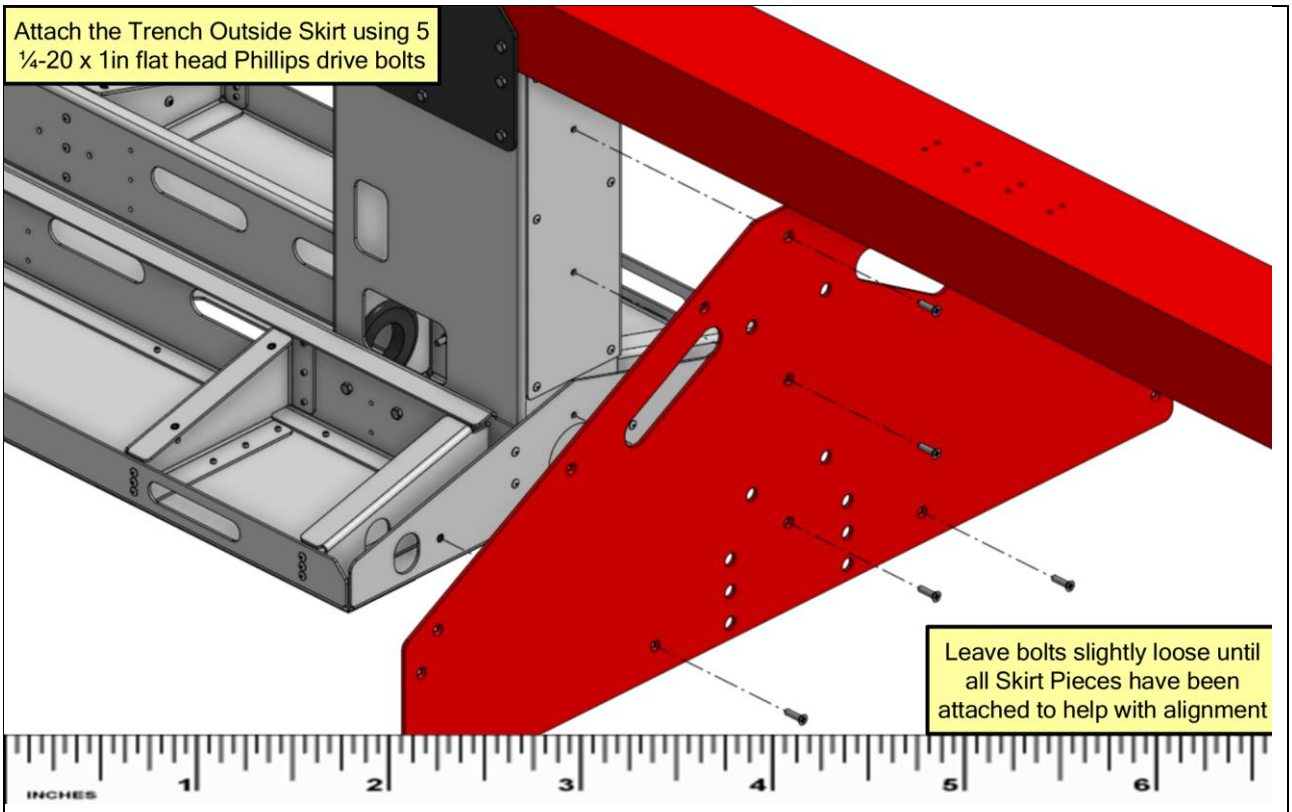

Attach the Fixed Trench Arm to the assembly using 12 ¼-20 x 1in hex head bolts, leaving bolts slightly loose for now
Wires should be fed down through riser, out through the grommet and into the Bump Frame.
Be careful not to pinch wires
INCHES
1
2
3
4
5
6

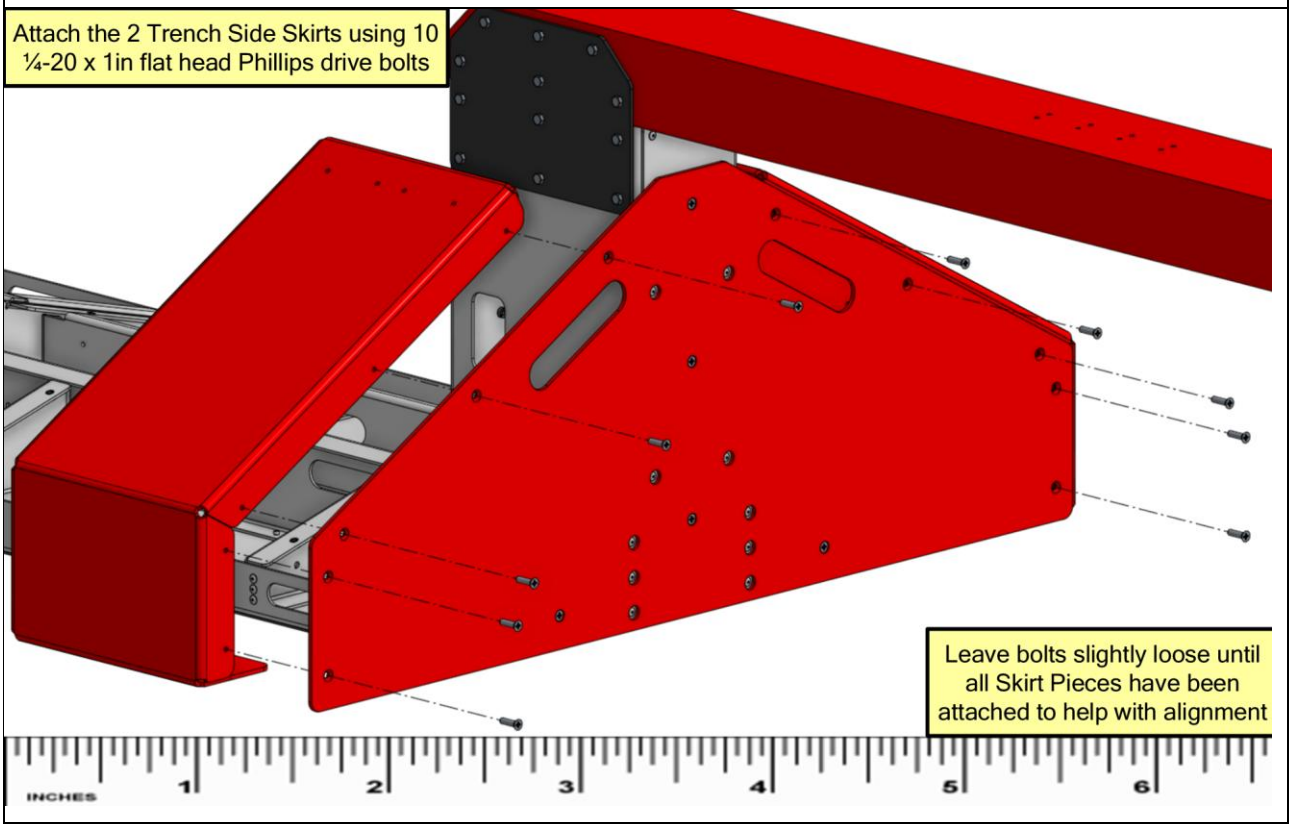
10.


Feed wires fully through the Bump Frame, and into the Hub Base
Into Hub Base

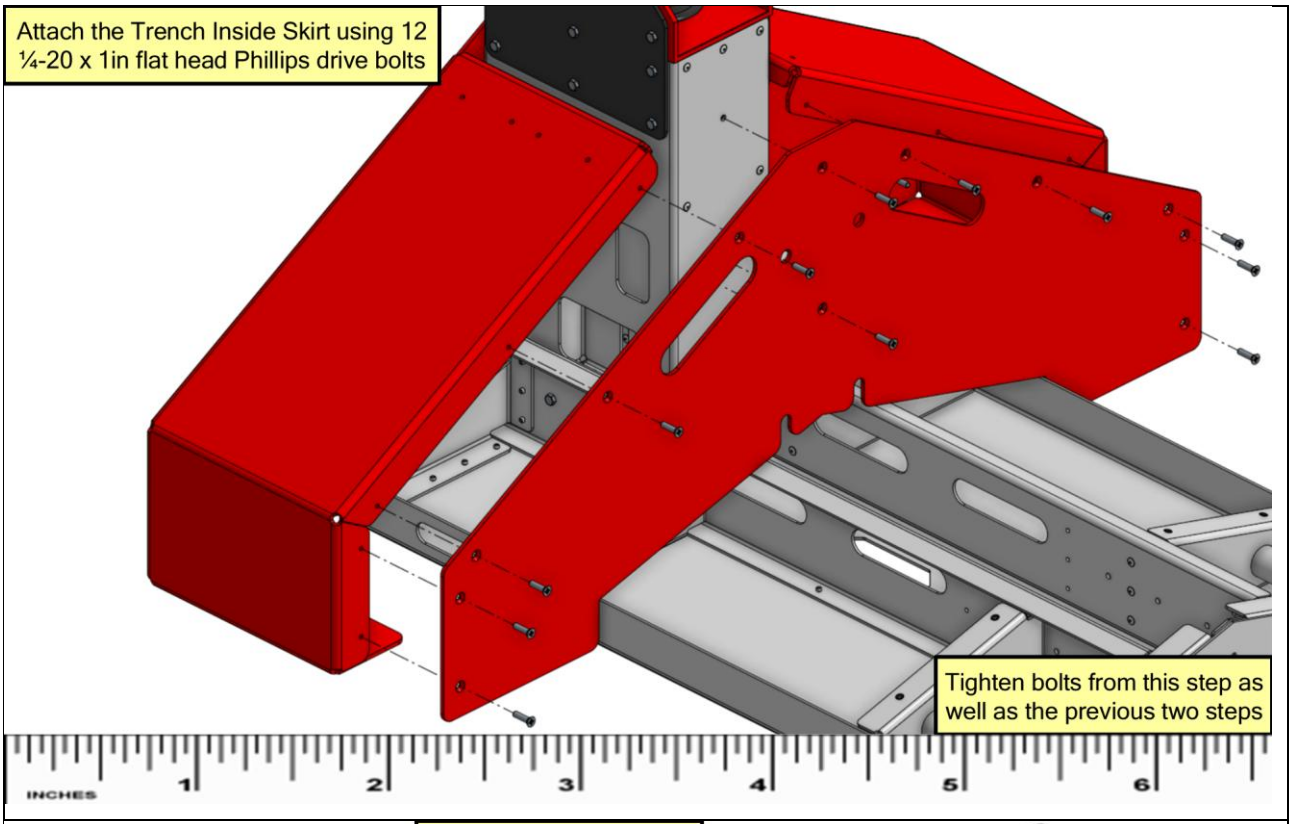
11.


Adjust the height of the far end of the Fixed Trench arm to the value shown by adjusting the Threaded Leveling Mount
Once the height is properly set, tighten the nut against the Arm to lock the height in place.
Once the height is properly set, tighten all bolts attaching these plates to help lock the height in place.
1' 10-1/4"

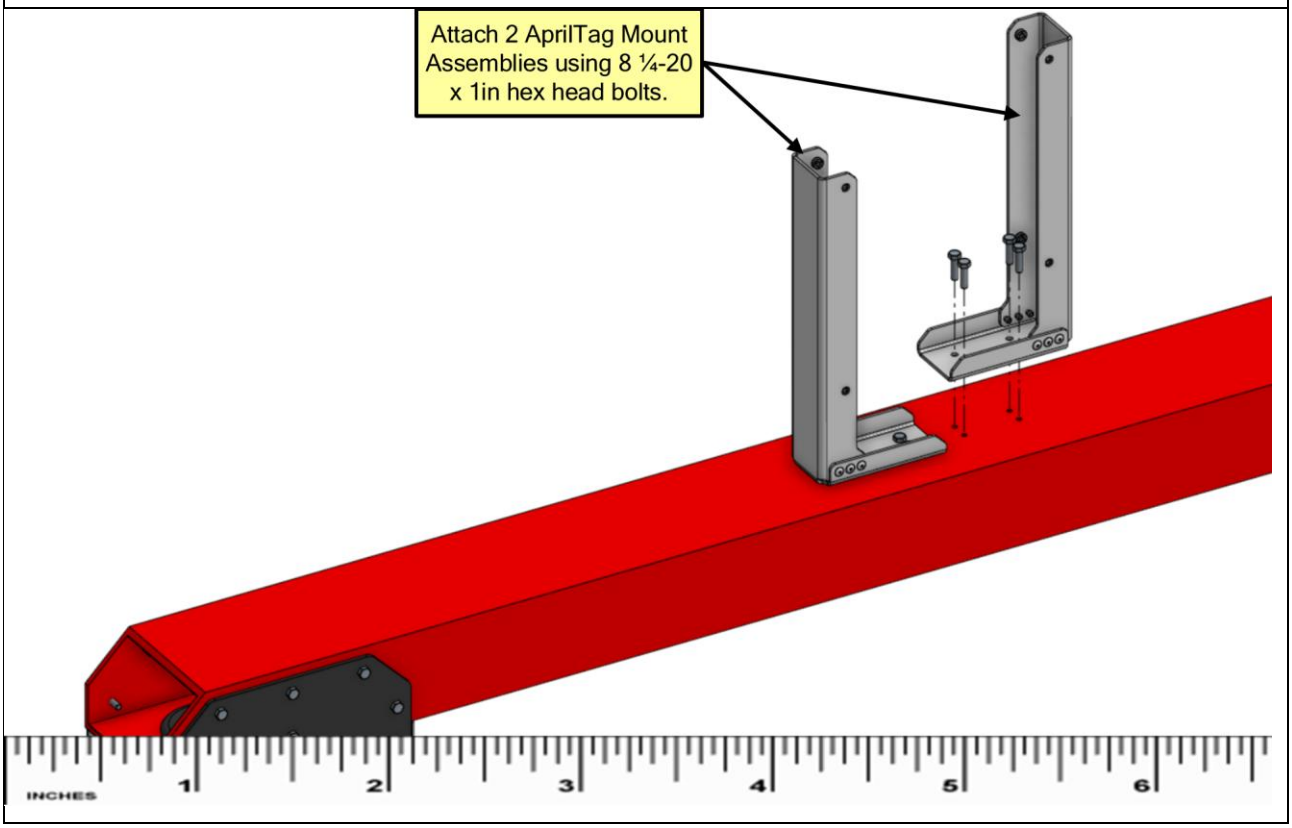
12. 
Attach the Trench Outside Skirt using 5 ¼-20 x 1in flat head Phillips drive bolts
Leave bolts slightly loose until all Skirt Pieces have been attached to help with alignment
INCHES
1
2
3
4
5
6

13. 
Attach the 2 Trench Side Skirts using 10 ¼-20 x 1in flat head Phillips drive bolts
Leave bolts slightly loose until all Skirt Pieces have been attached to help with alignment
INCHES
1
2
3
4
5
6

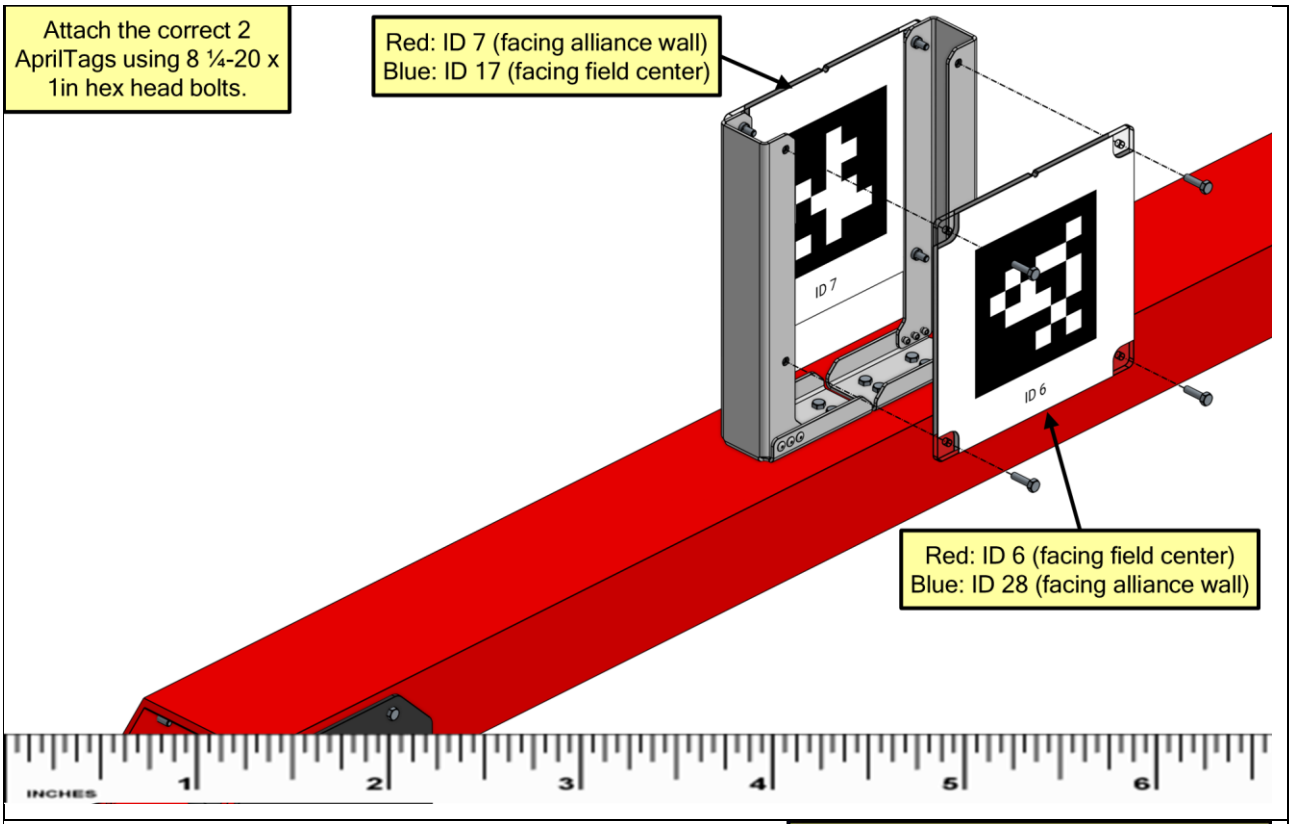
14.


Attach the Trench Inside Skirt using 12 ¼-20 x 1in flat head Phillips drive bolts
Tighten bolts from this step as well as the previous two steps
INCHES
1
2
3
4
5
6

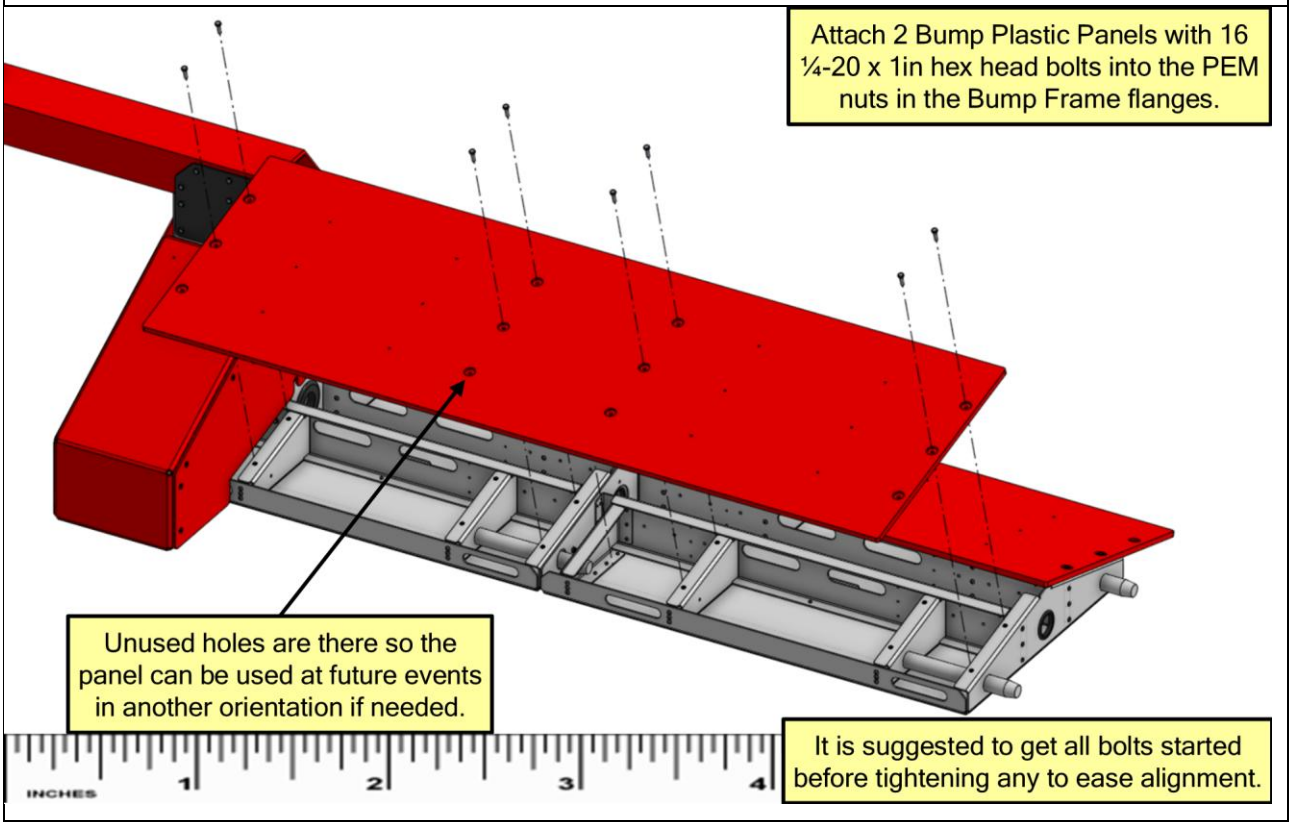
15.


Attach 2 AprilTag Mount Assemblies using 8 ¼-20 x 1in hex head bolts.
INCHES
1
2
3
4
5
6

16. Attach the correct 2 AprilTags using 8 ¼-20 x 1in hex head bolts.



17. Attach 2 Bump Plastic Panels with 16 ¼-20 x 1in hex head bolts into the PEM nuts in the Bump Frame flanges.



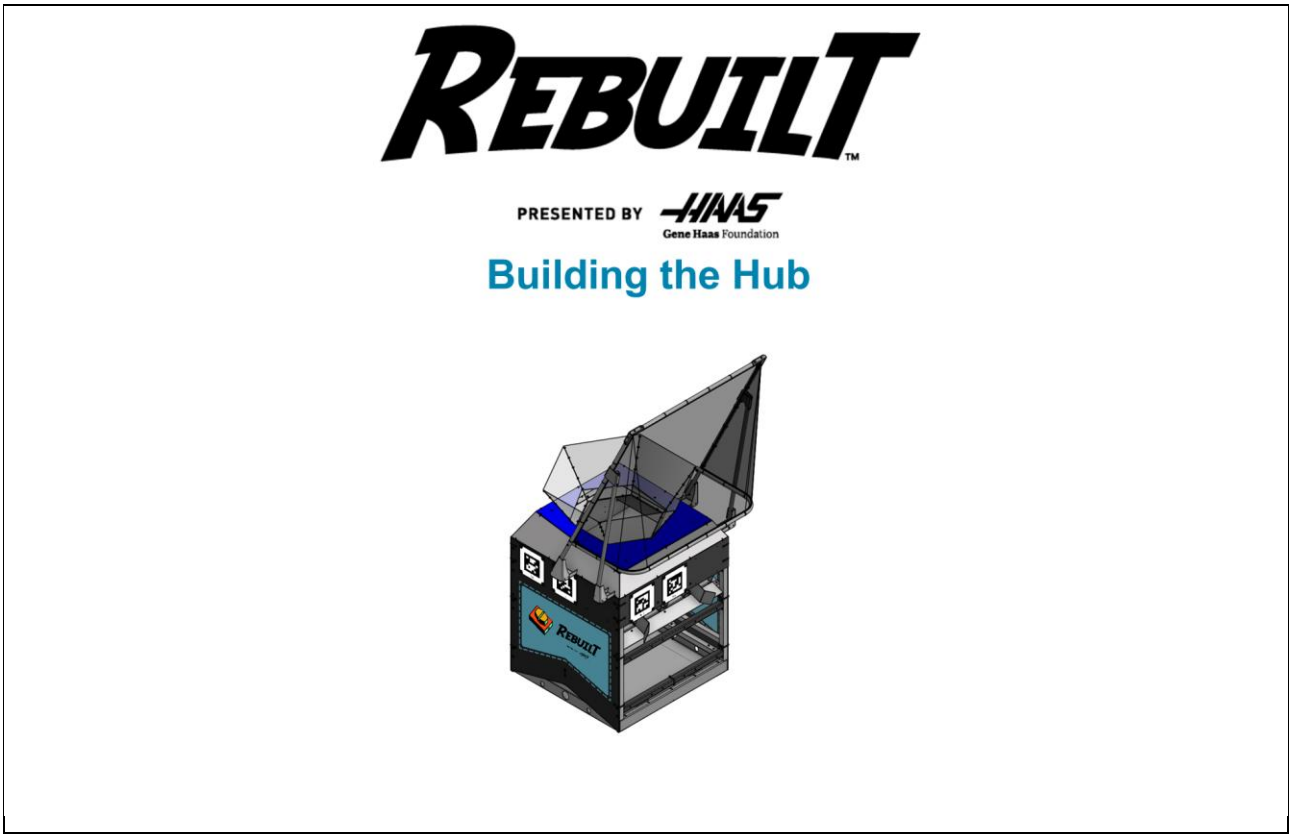
3.8 Hub

There is one red and one blue Hub per field.

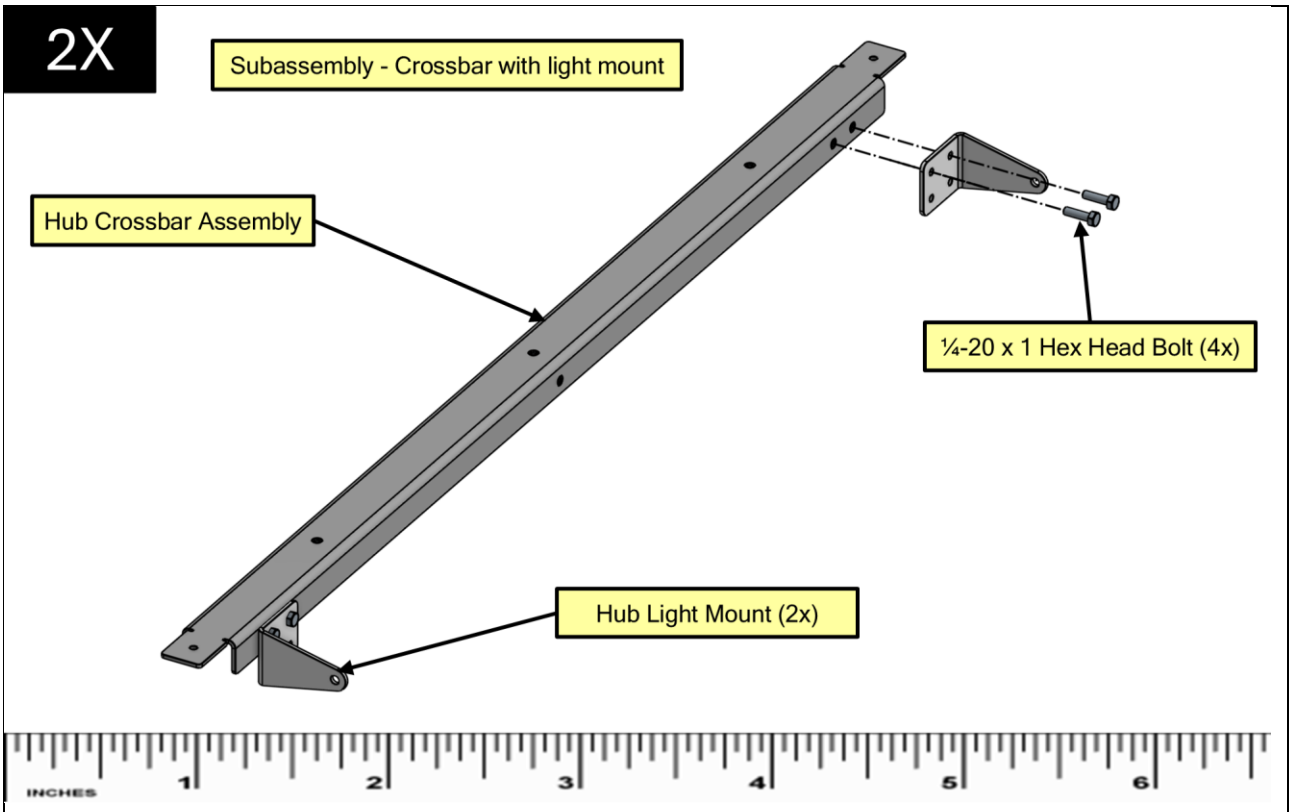
3.8.1 Tools & Equipment

- 7/16” Wrenches and or sockets with ratchets
- Side Cutters
- 50lb Cable Ties – Qty. 106
- 120lb Cable Ties – Qty. 22
- ¼-20 x 1” Hex Bolts – Qty. 82
- ¼-20 x 1.75” Hex Bolts – Qty. 24
- ¼-20 x 2.5” Hex Bolts – Qty. 46
- ¼-20 x 3” Hex Bolts – Qty. 10
- ¼-20 Nylock Nuts – Qty. 62

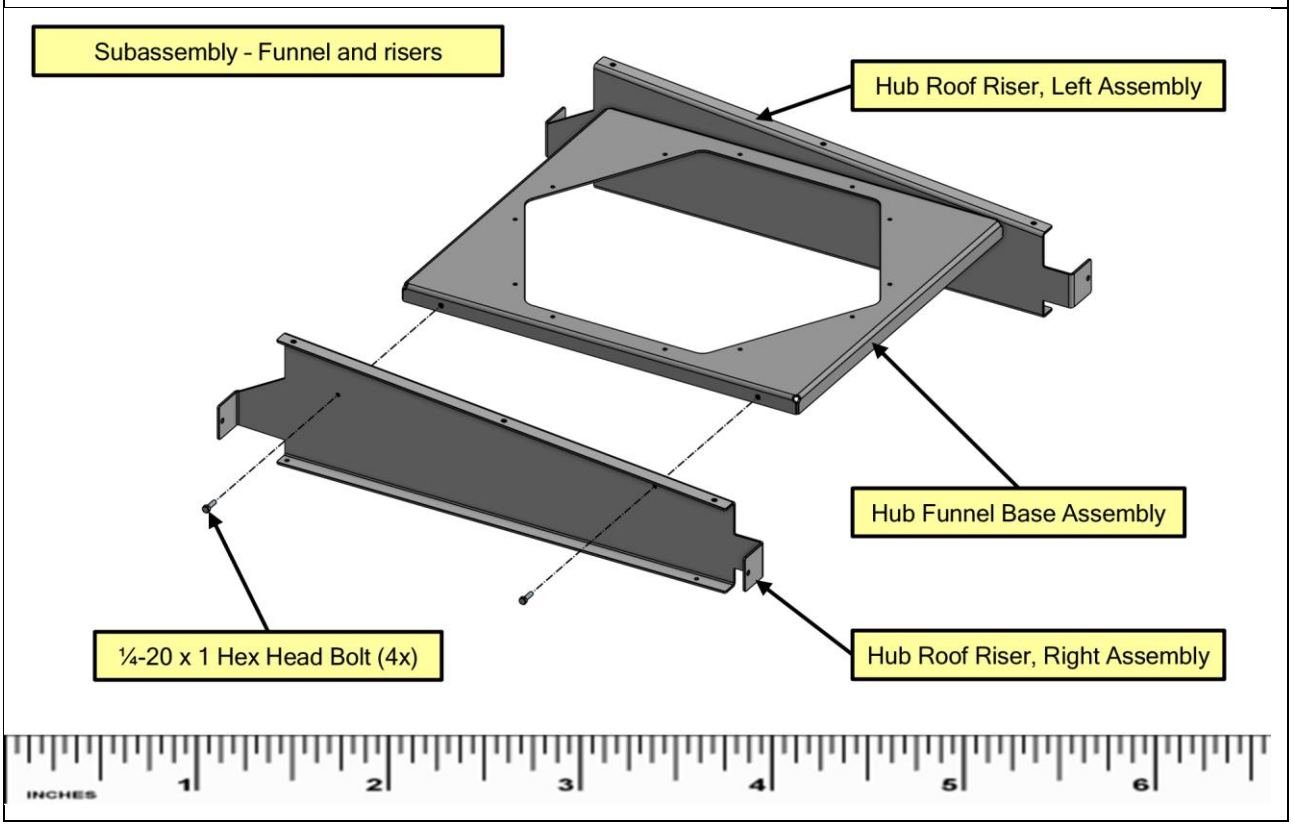
3.8.2 Assembly

1. 

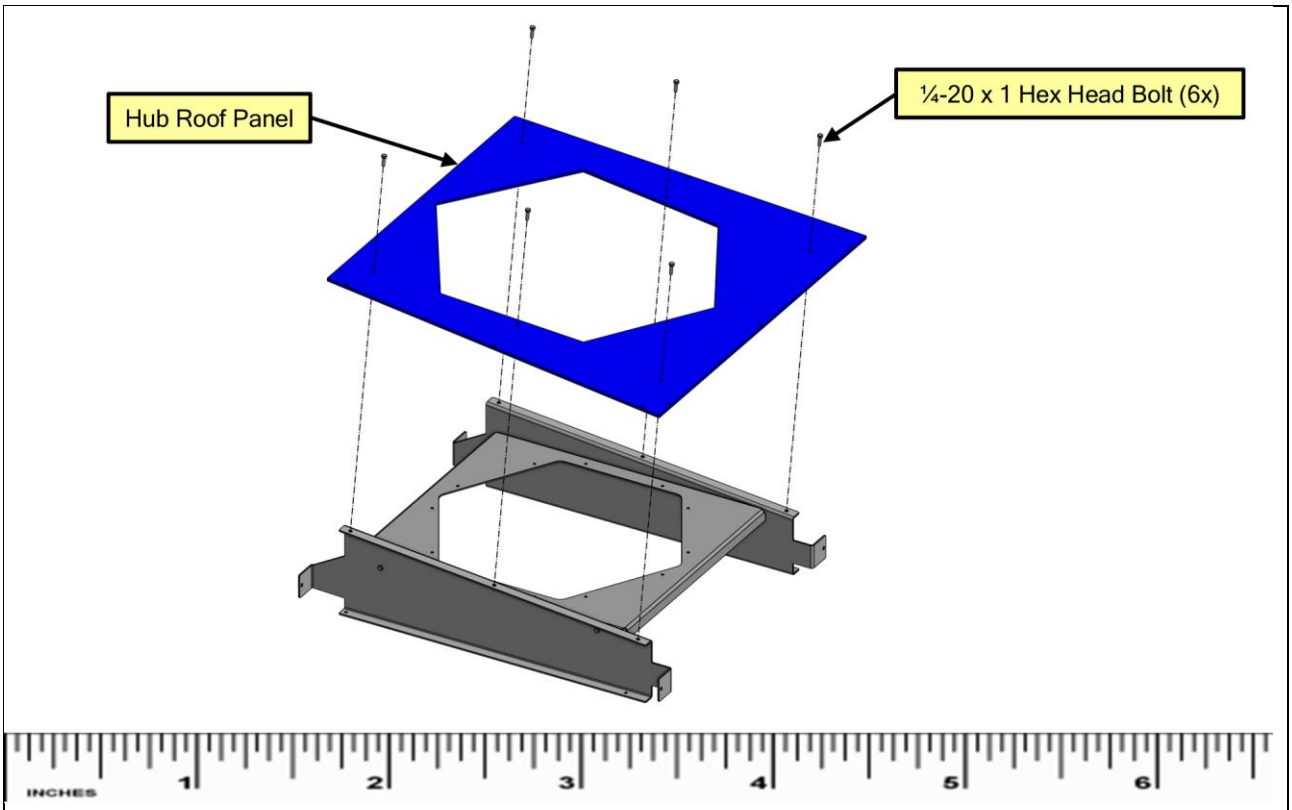
2.


2X
Subassembly - Crossbar with light mount
Hub Crossbar Assembly
¼-20 x 1 Hex Head Bolt (4x)
Hub Light Mount (2x)
INCHES
1
2
3
4
5
6

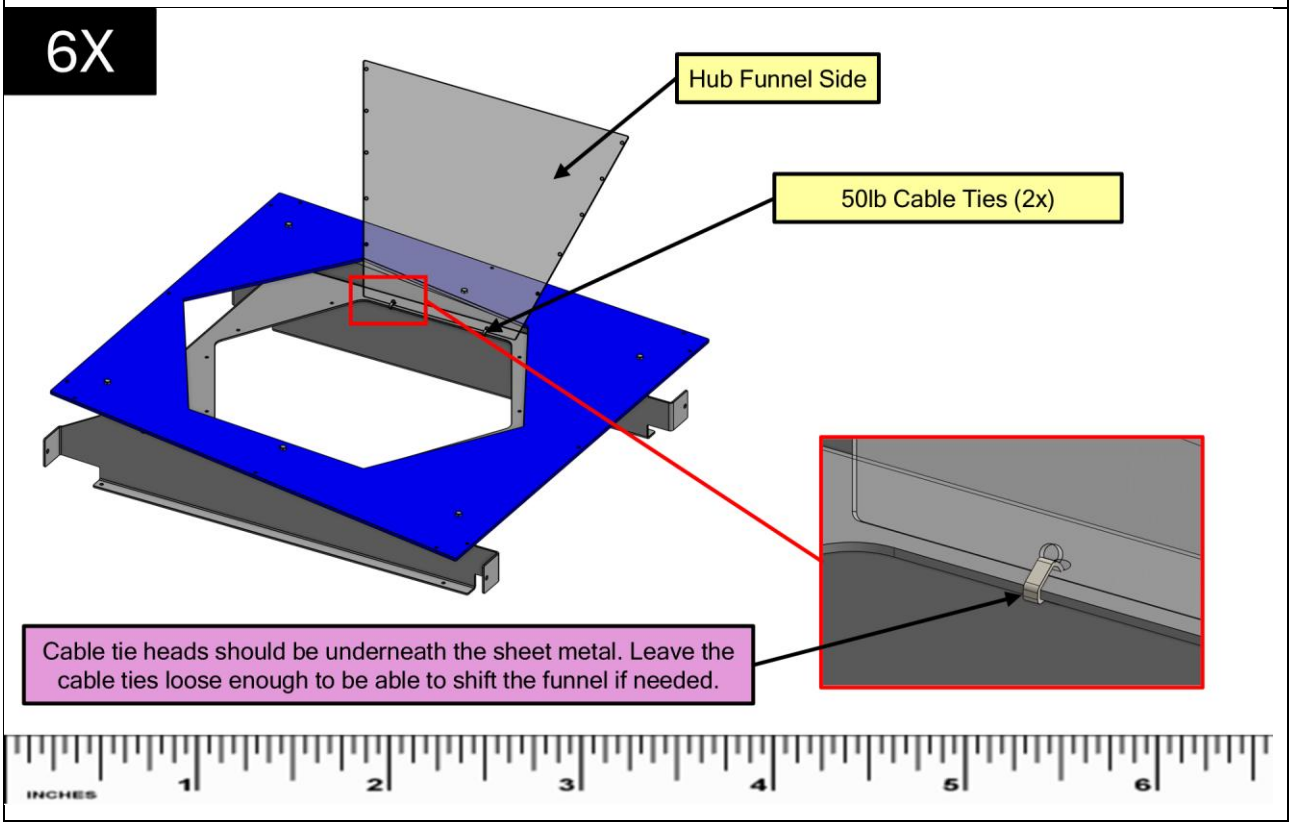
3.


Subassembly - Funnel and risers
Hub Roof Riser, Left Assembly
Hub Funnel Base Assembly
¼-20 x 1 Hex Head Bolt (4x)
Hub Roof Riser, Right Assembly
INCHES
1
2
3
4
5
6

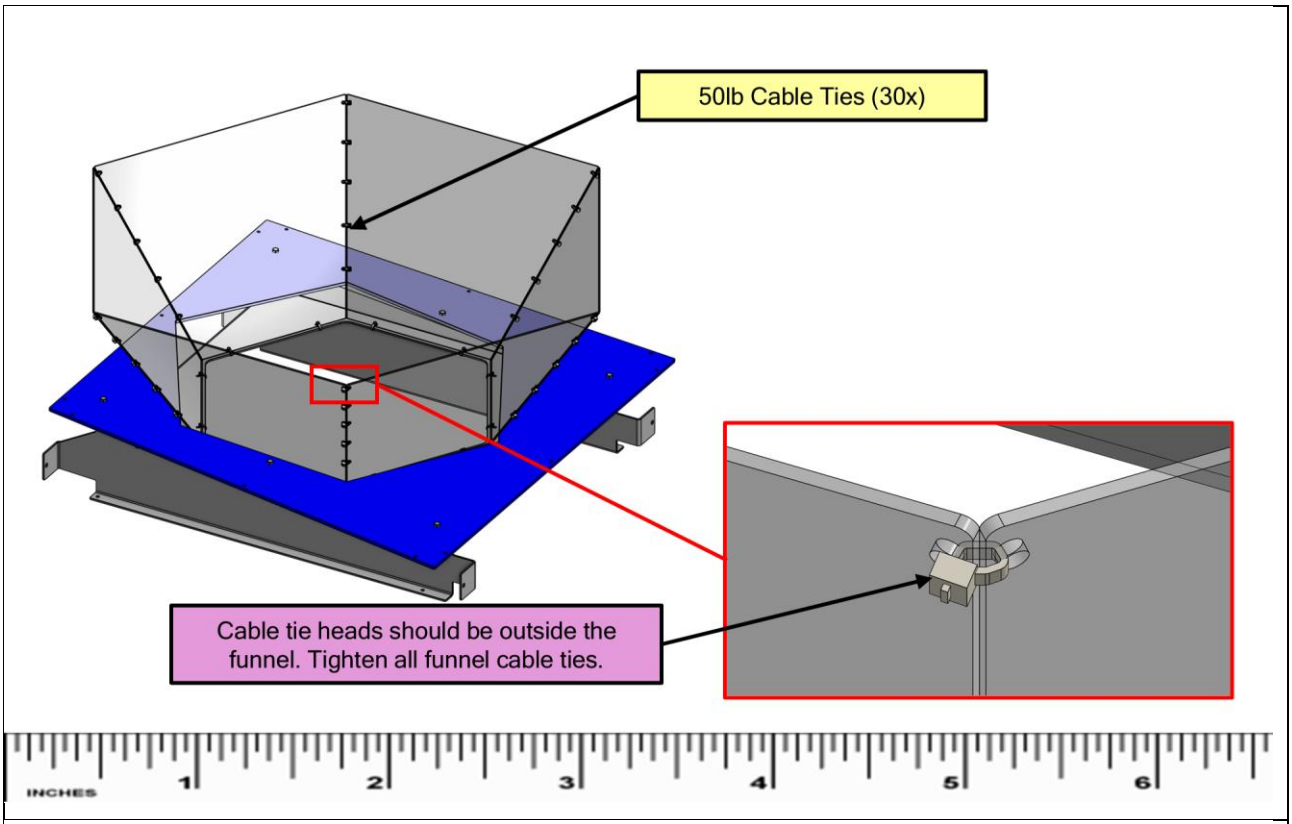
4.


Hub Roof Panel
¼-20 x 1 Hex Head Bolt (6x)
INCHES
1
2
3
4
5
6

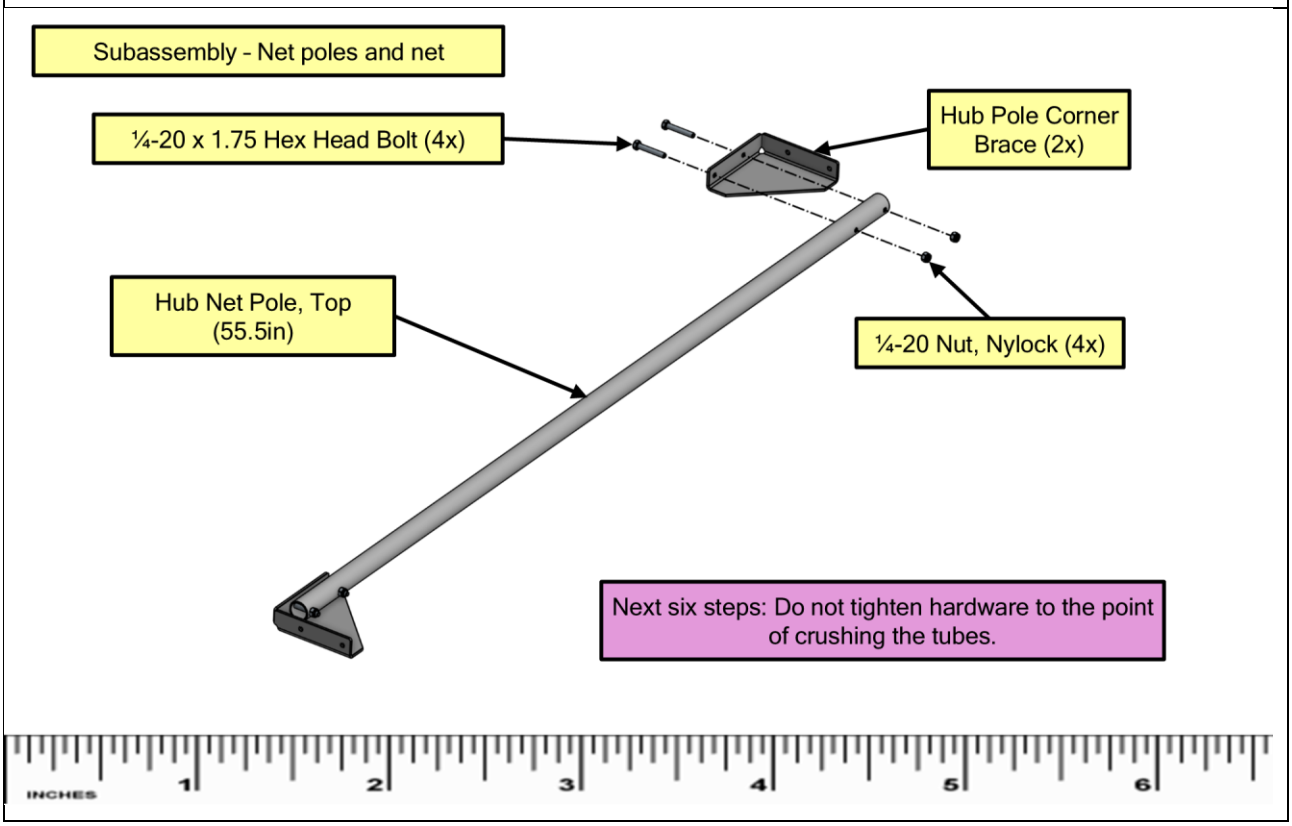
5.


6X
Hub Funnel Side
50lb Cable Ties (2x)
Cable tie heads should be underneath the sheet metal. Leave the cable ties loose enough to be able to shift the funnel if needed.
INCHES
1
2
3
4
5
6

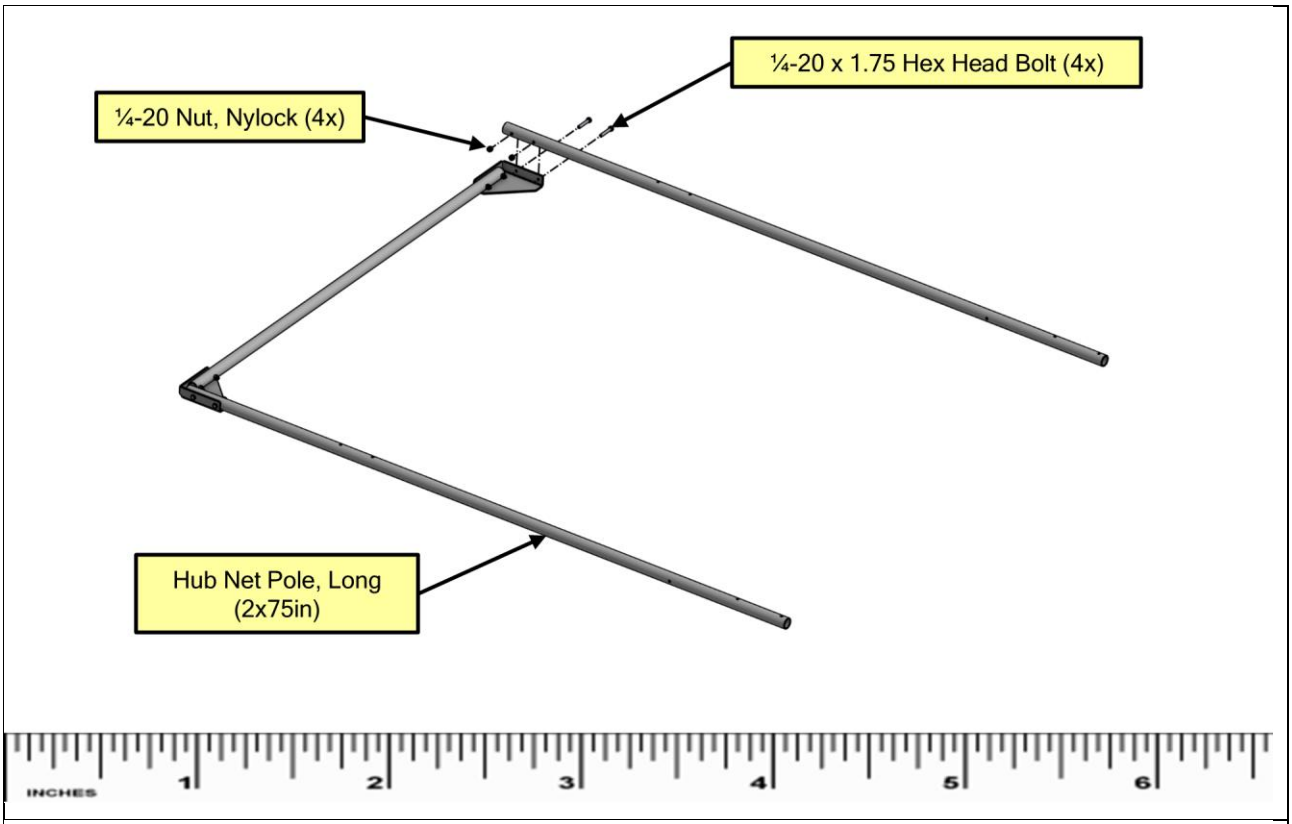
6.


50lb Cable Ties (30x)
Cable tie heads should be outside the funnel. Tighten all funnel cable ties.
INCHES
1
2
3
4
5
6

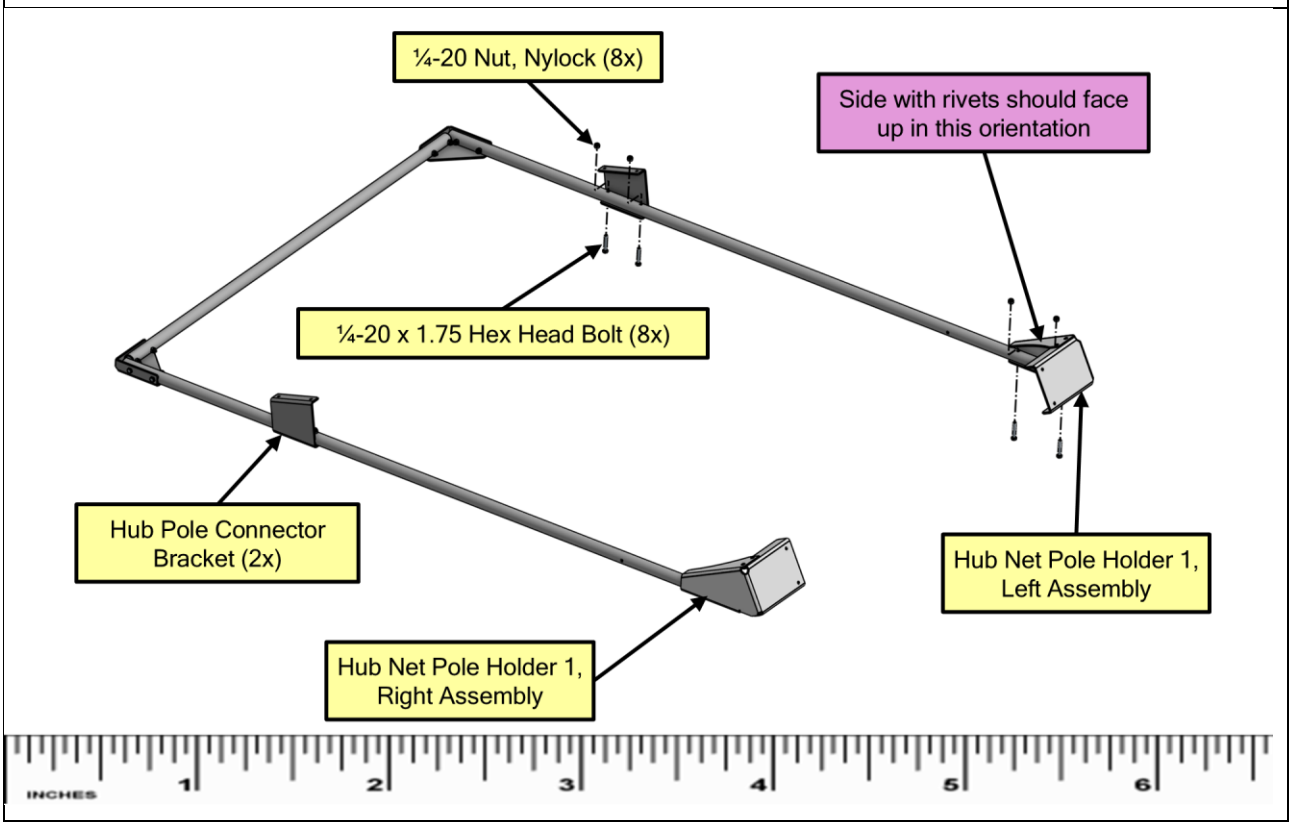
7.


Subassembly - Net poles and net
¼-20 x 1.75 Hex Head Bolt (4x)
Hub Pole Corner Brace (2x)
Hub Net Pole, Top (55.5in)
¼-20 Nut, Nylock (4x)
Next six steps: Do not tighten hardware to the point of crushing the tubes.
INCHES
1
2
3
4
5
6

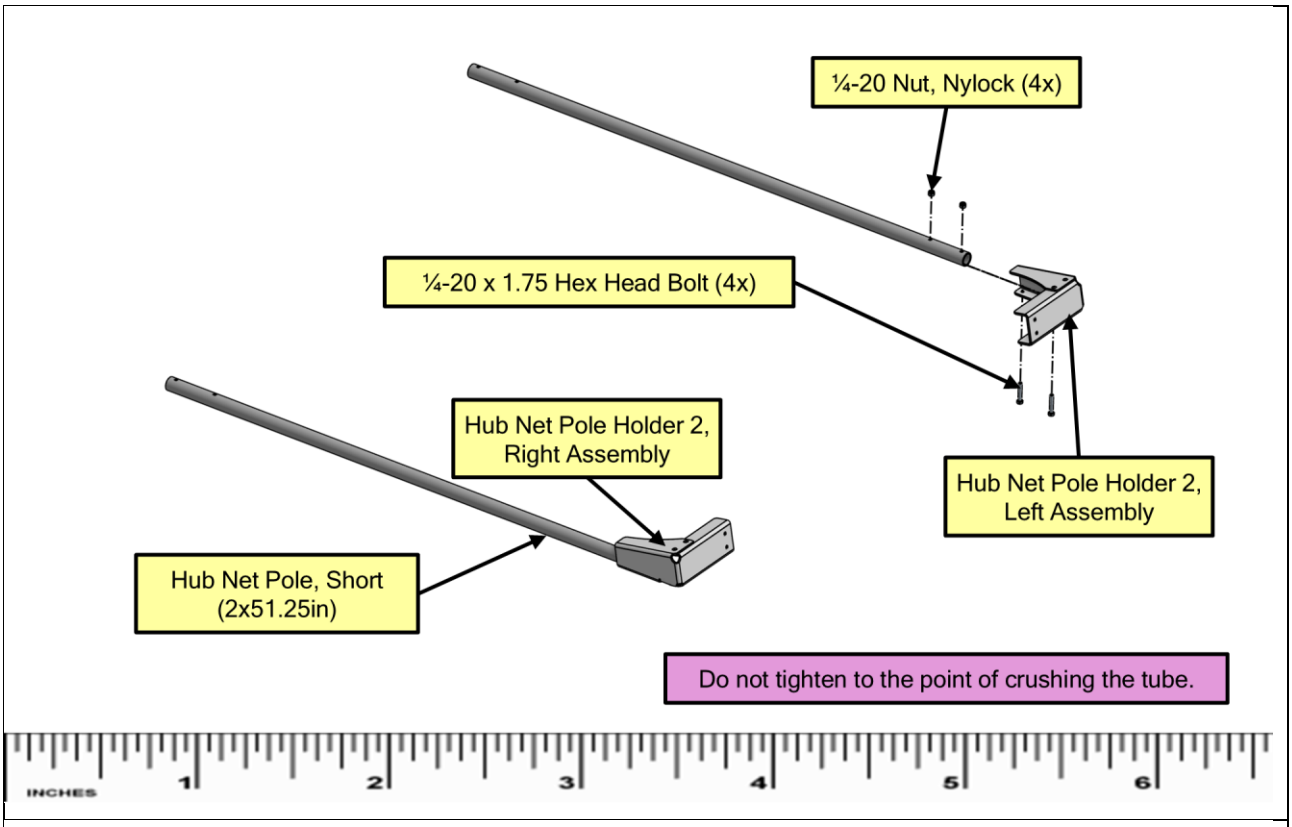
8.


¼-20 x 1.75 Hex Head Bolt (4x)
¼-20 Nut, Nylock (4x)
Hub Net Pole, Long (2x75in)
INCHES
1
2
3
4
5
6

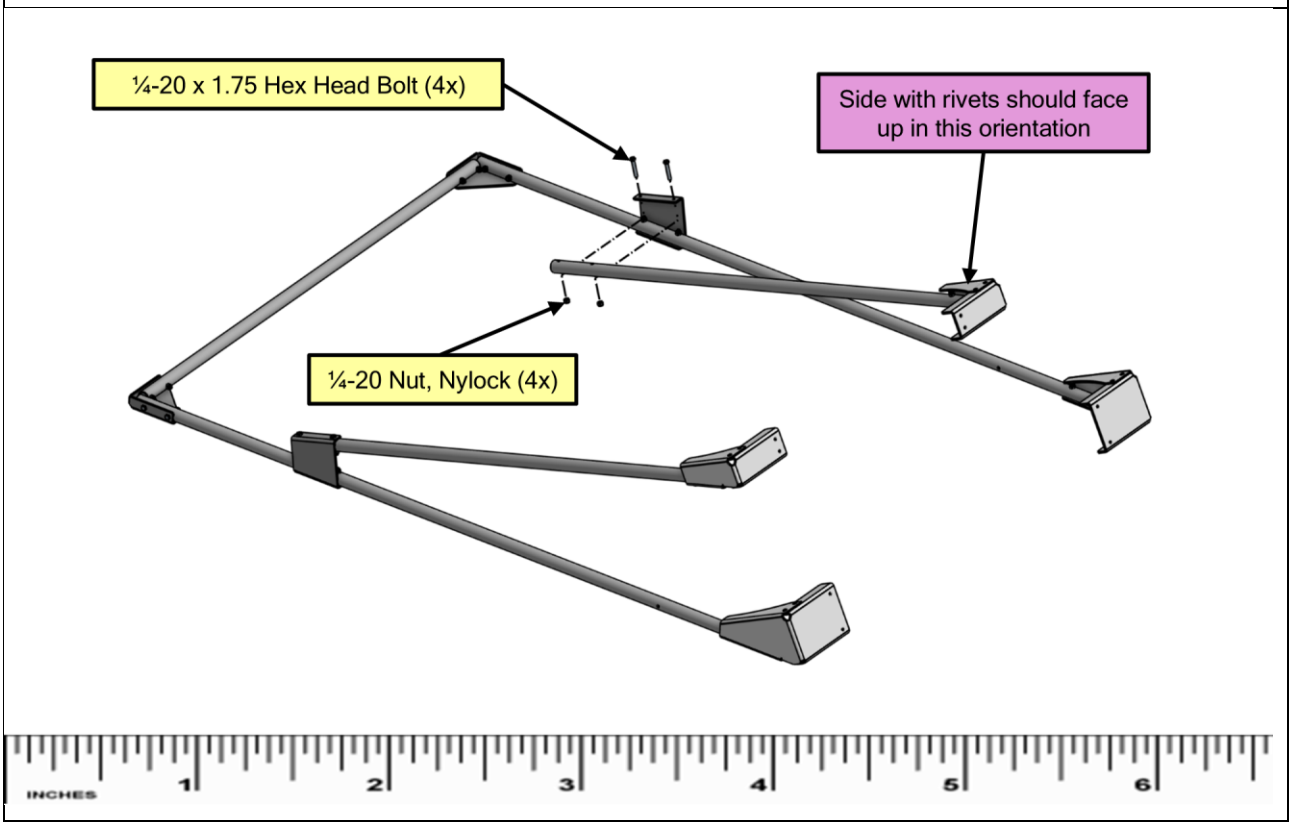
9.


¼-20 Nut, Nylock (8x)
Side with rivets should face up in this orientation
¼-20 x 1.75 Hex Head Bolt (8x)
Hub Pole Connector Bracket (2x)
Hub Net Pole Holder 1, Left Assembly
Hub Net Pole Holder 1, Right Assembly
INCHES
1
2
3
4
5
6

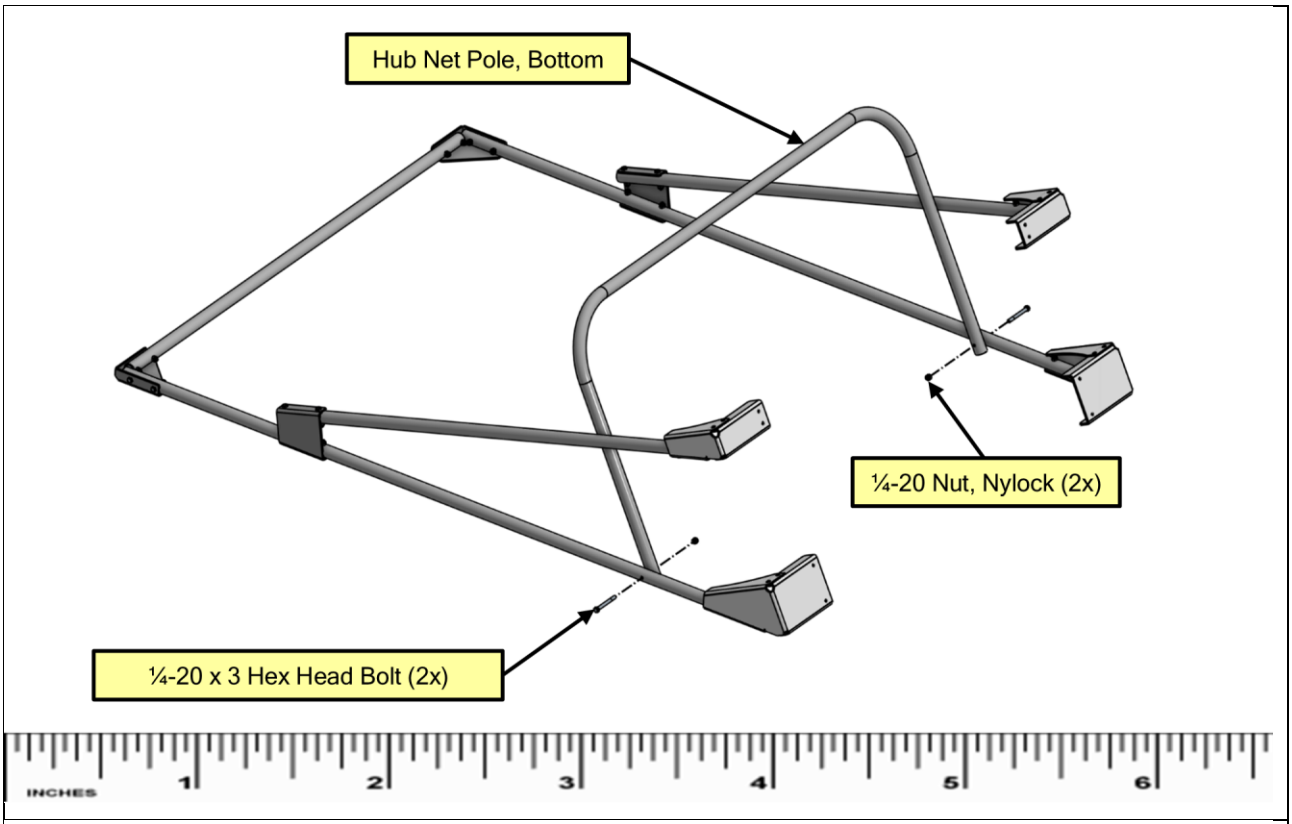
10.


¼-20 Nut, Nylock (4x)
¼-20 x 1.75 Hex Head Bolt (4x)
Hub Net Pole Holder 2, Right Assembly
Hub Net Pole Holder 2, Left Assembly
Hub Net Pole, Short (2x51.25in)
Do not tighten to the point of crushing the tube.
INCHES

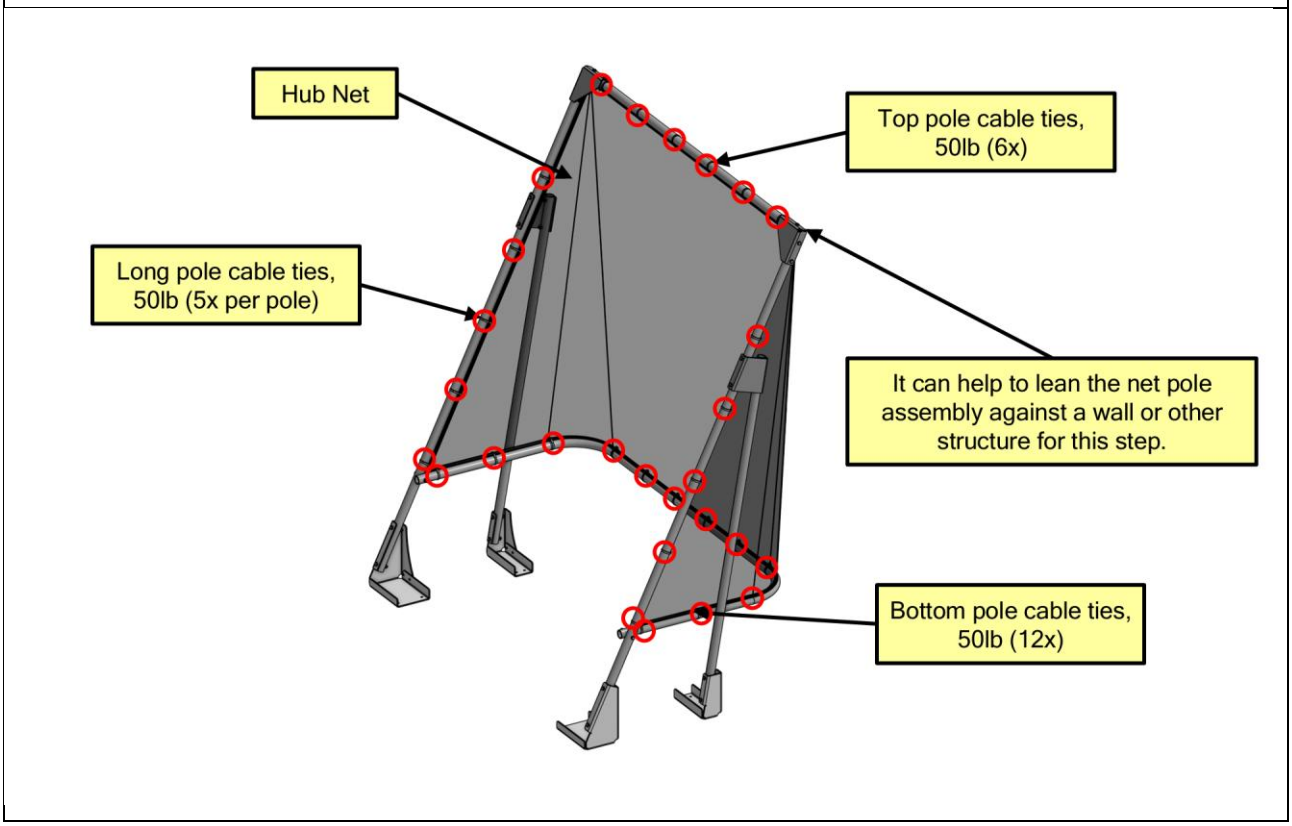
11.


¼-20 x 1.75 Hex Head Bolt (4x)
Side with rivets should face up in this orientation
¼-20 Nut, Nylock (4x)
INCHES

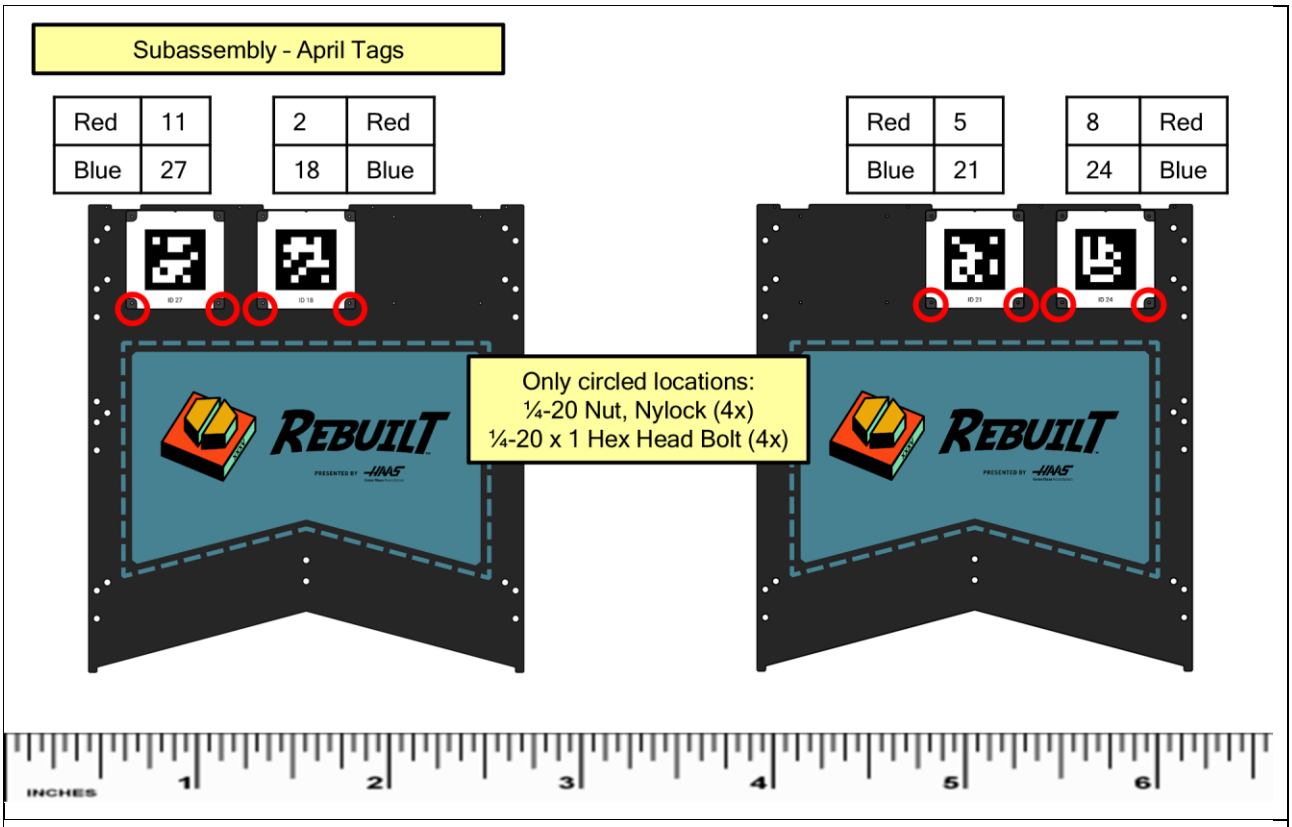
12.


Hub Net Pole, Bottom
¼-20 Nut, Nylock (2x)
¼-20 x 3 Hex Head Bolt (2x)
INCHES
1
2
3
4
5
6

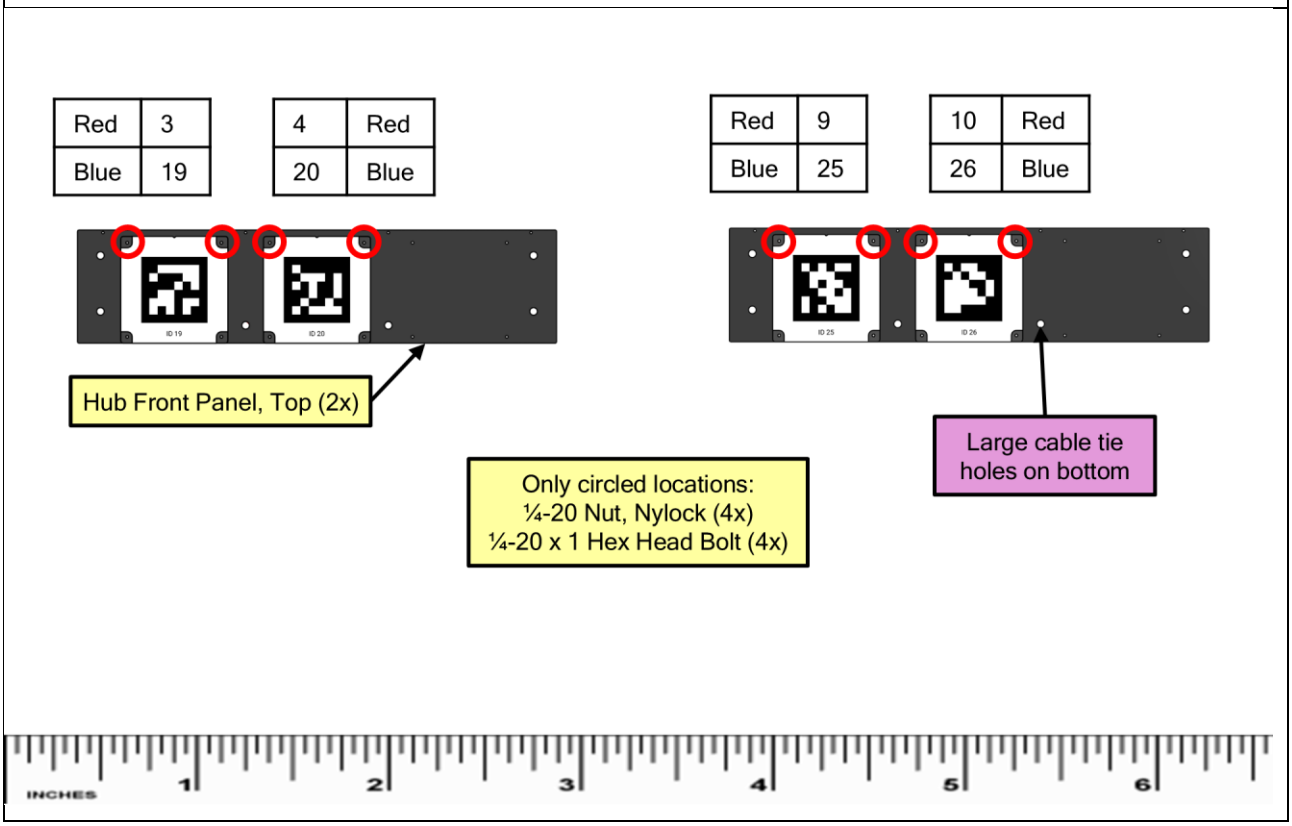
13.


Hub Net
Top pole cable ties, 50lb (6x)
Long pole cable ties, 50lb (5x per pole)
It can help to lean the net pole assembly against a wall or other structure for this step.
Bottom pole cable ties, 50lb (12x)

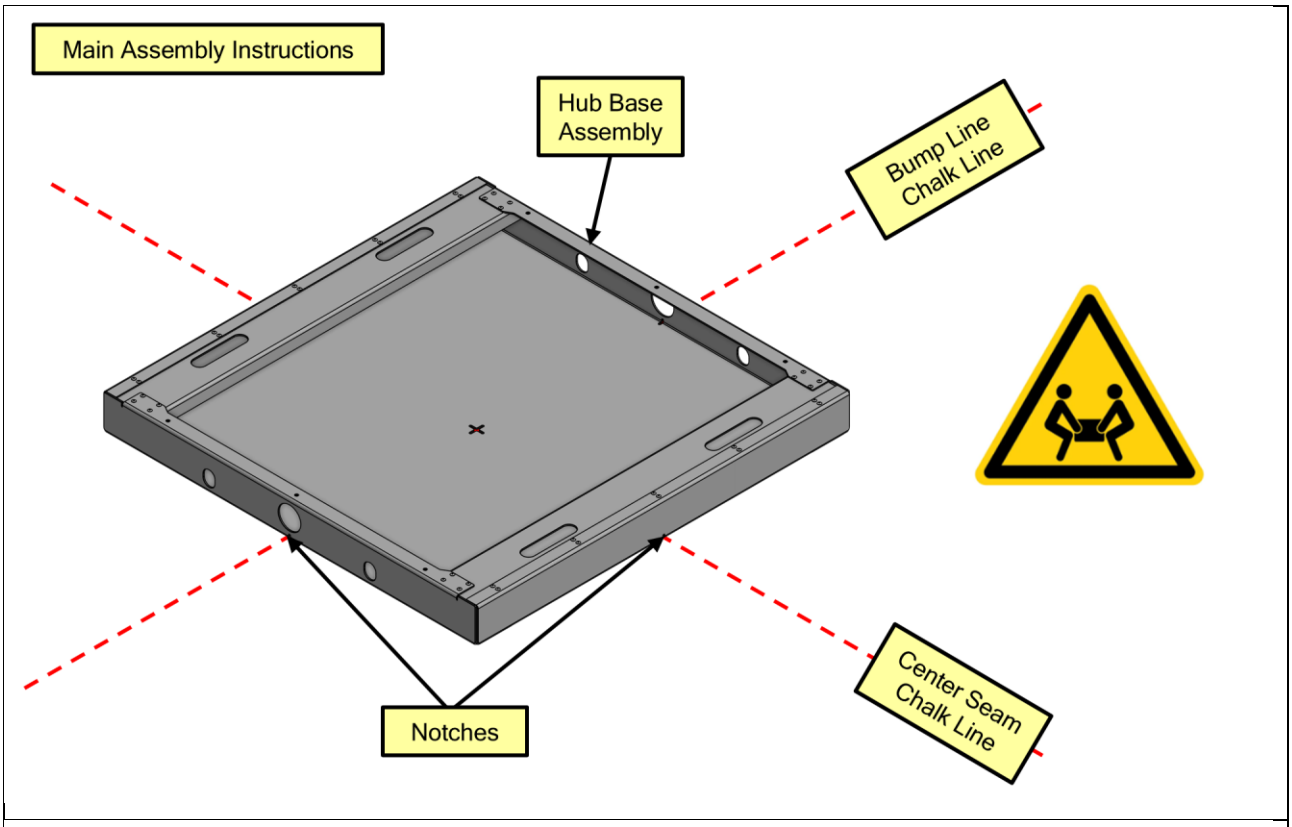
14.


Subassembly - April Tags
Red 11
Blue 27
2 Red
18 Blue
Red 5
Blue 21
8 Red
24 Blue
Only circled locations:
¼-20 Nut, Nylock (4x)
¼-20 x 1 Hex Head Bolt (4x)
REBUILT
INCHES

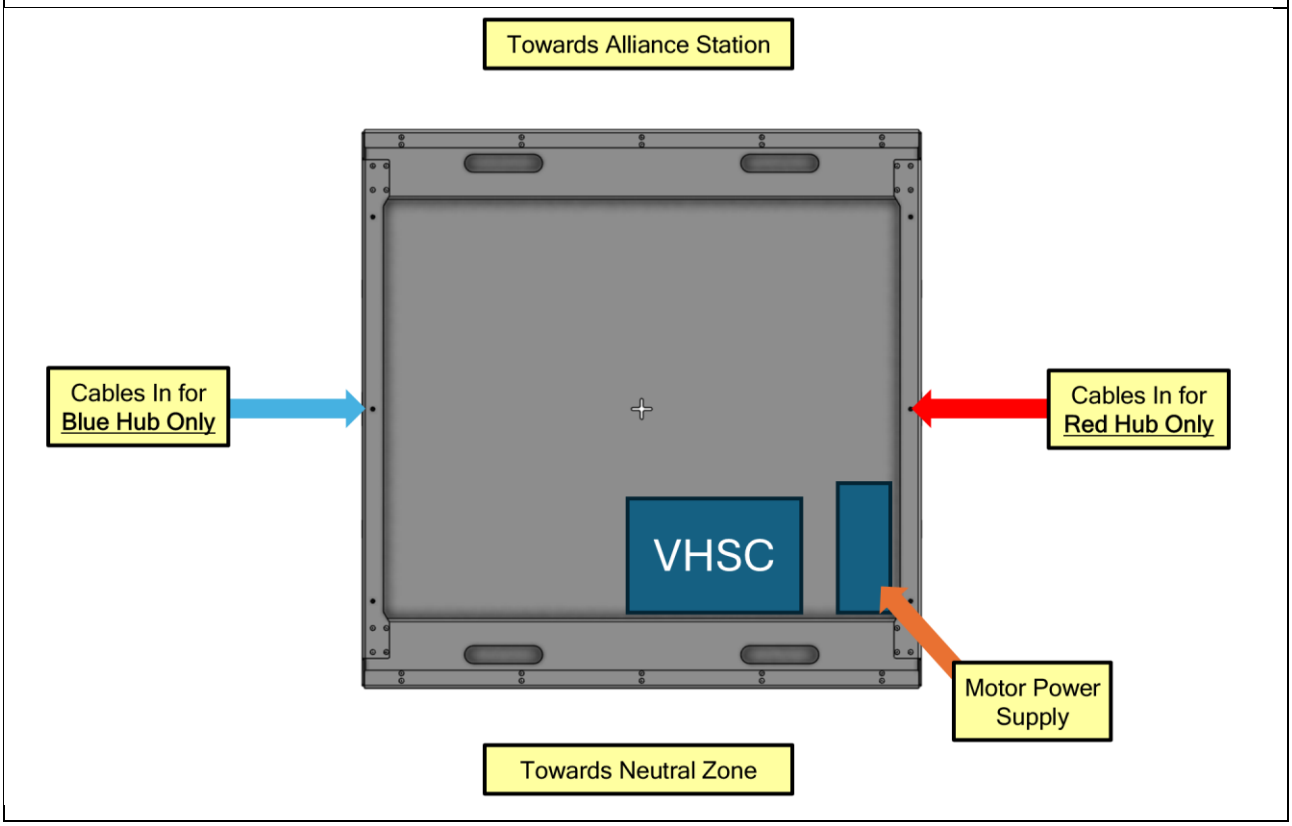
15.


Red 3
Blue 19
4 Red
20 Blue
Red 9
Blue 25
10 Red
26 Blue
Hub Front Panel, Top (2x)
Large cable tie holes on bottom
Only circled locations:
¼-20 Nut, Nylock (4x)
¼-20 x 1 Hex Head Bolt (4x)
INCHES

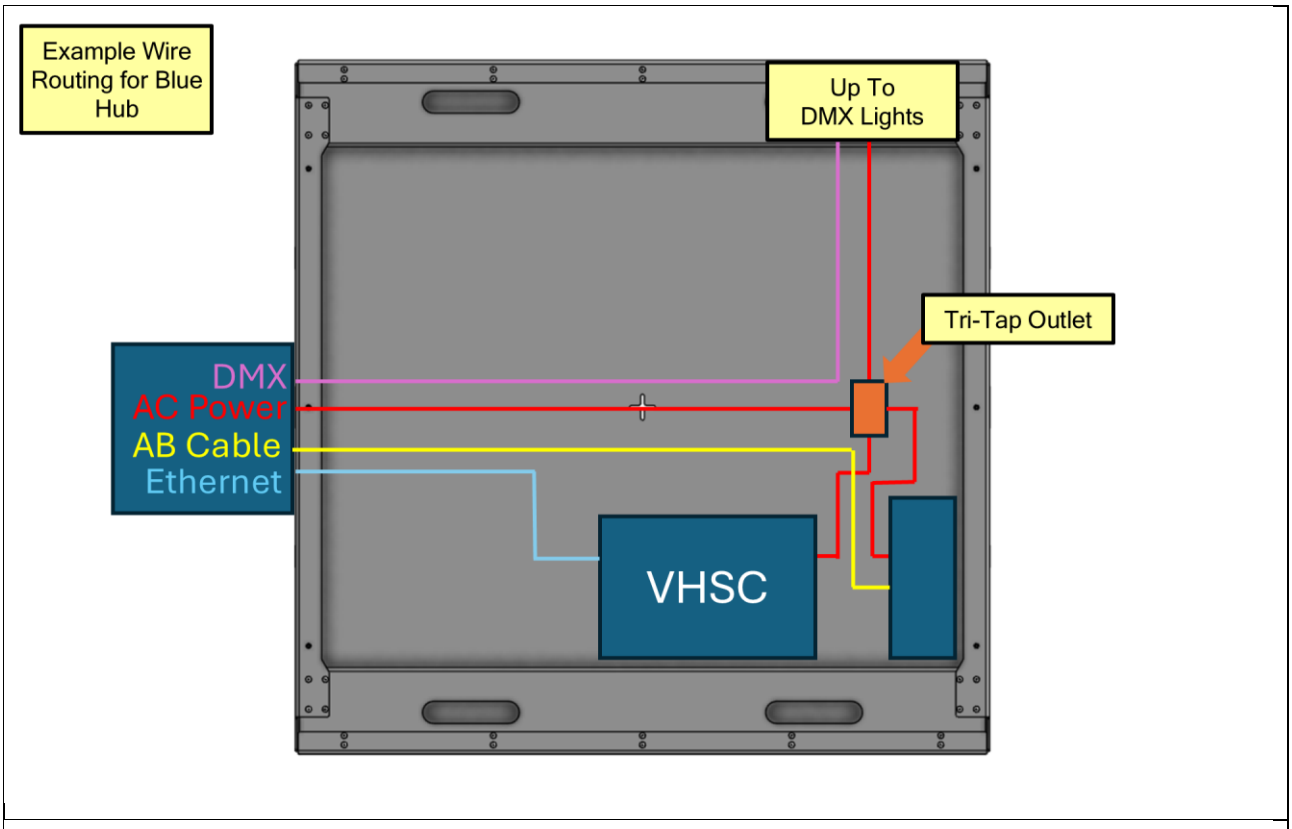
16.


Main Assembly Instructions
Hub Base Assembly
Bump Line Chalk Line
Notches
Center Seam Chalk Line

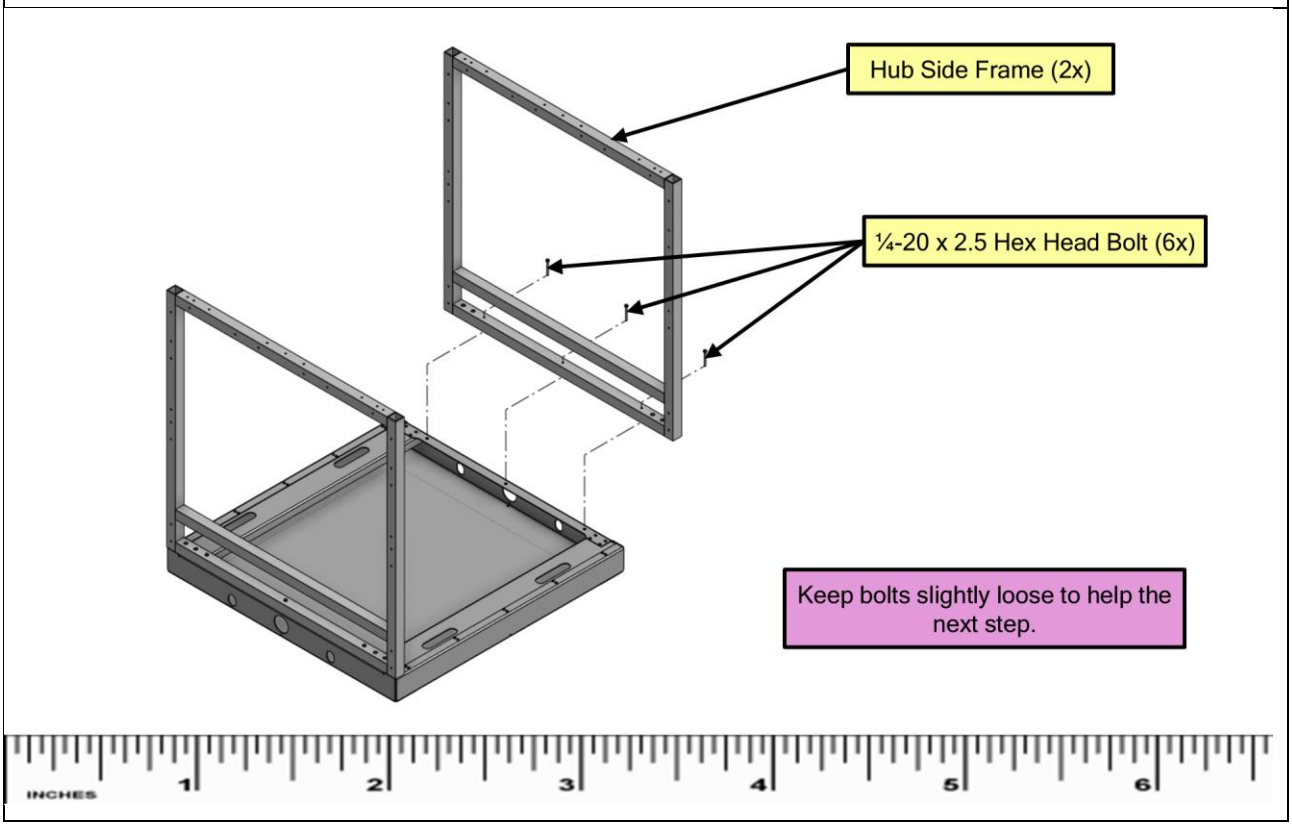
17.


Towards Alliance Station
Cables In for Blue Hub Only
Cables In for Red Hub Only
VHSC
Motor Power Supply
Towards Neutral Zone

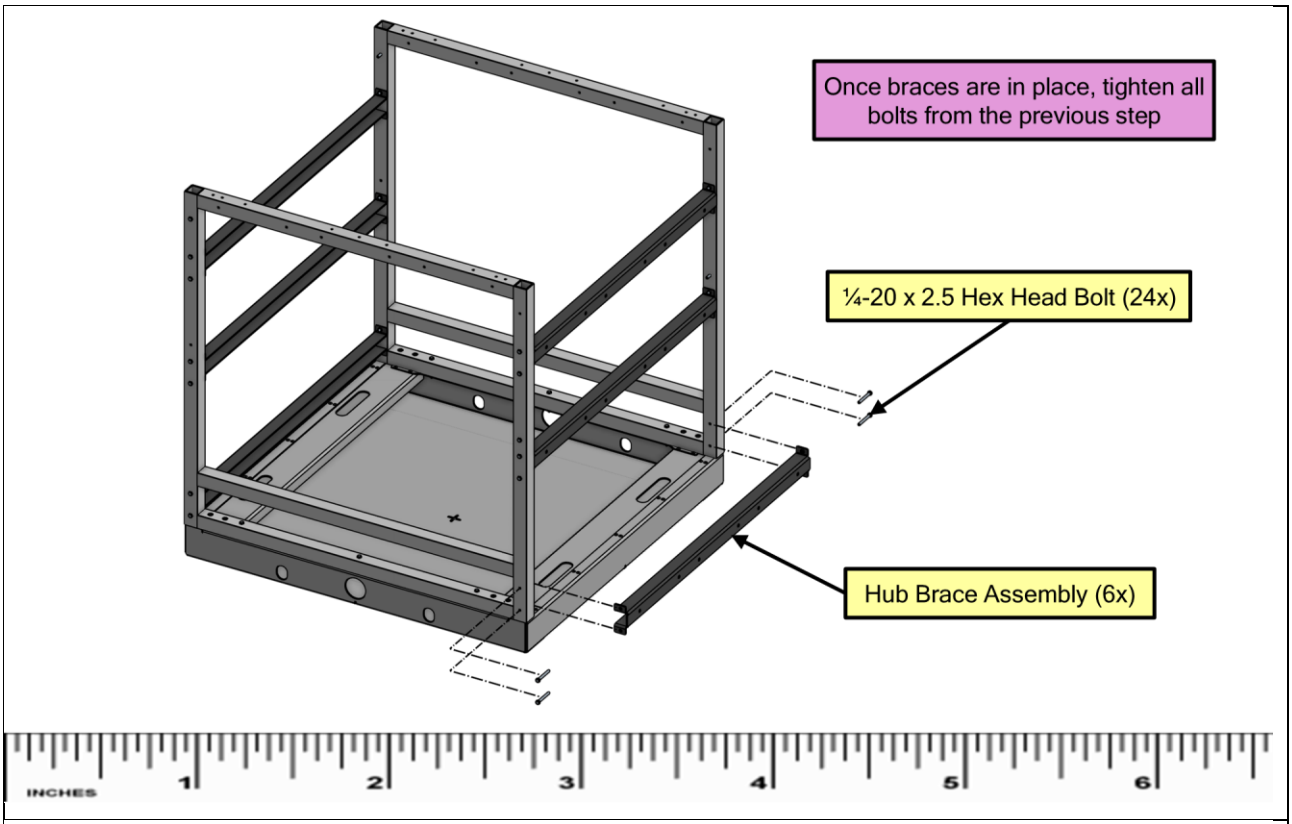
18.


Example Wire Routing for Blue Hub
Up To DMX Lights
Tri-Tap Outlet
DMX
AC Power
AB Cable
Ethernet
VHSC

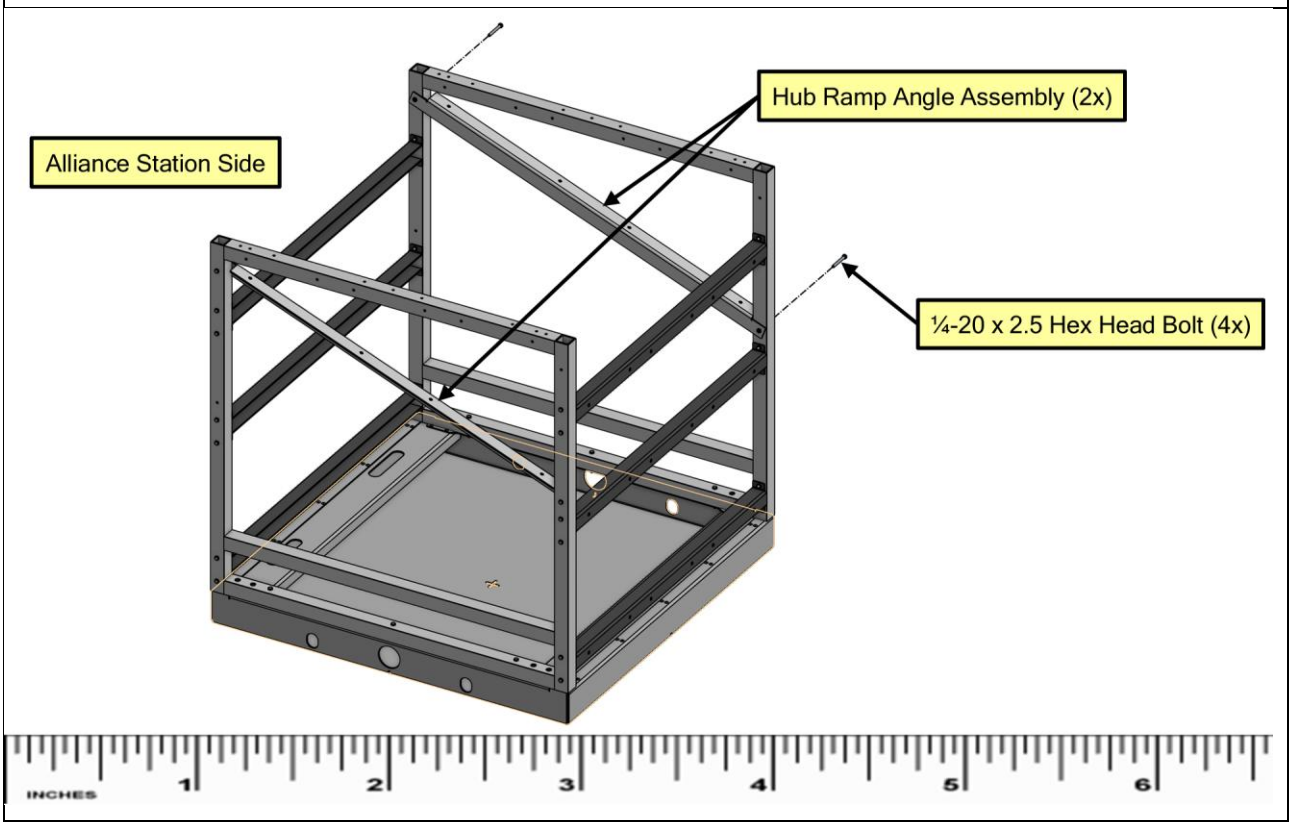
19.


Hub Side Frame (2x)
¼-20 x 2.5 Hex Head Bolt (6x)
Keep bolts slightly loose to help the next step.
INCHES
1
2
3
4
5
6

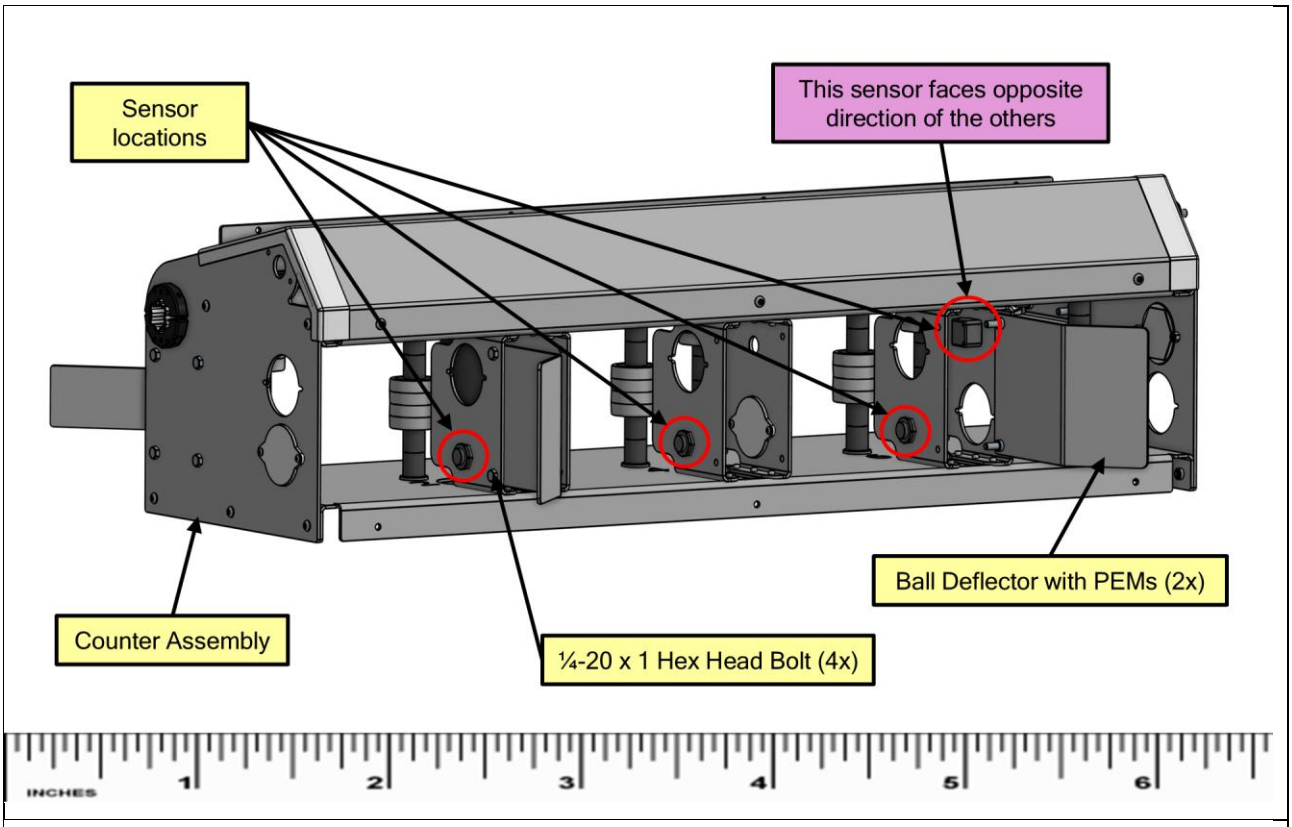
20.


Once braces are in place, tighten all bolts from the previous step
¼-20 x 2.5 Hex Head Bolt (24x)
Hub Brace Assembly (6x)
INCHES
1
2
3
4
5
6

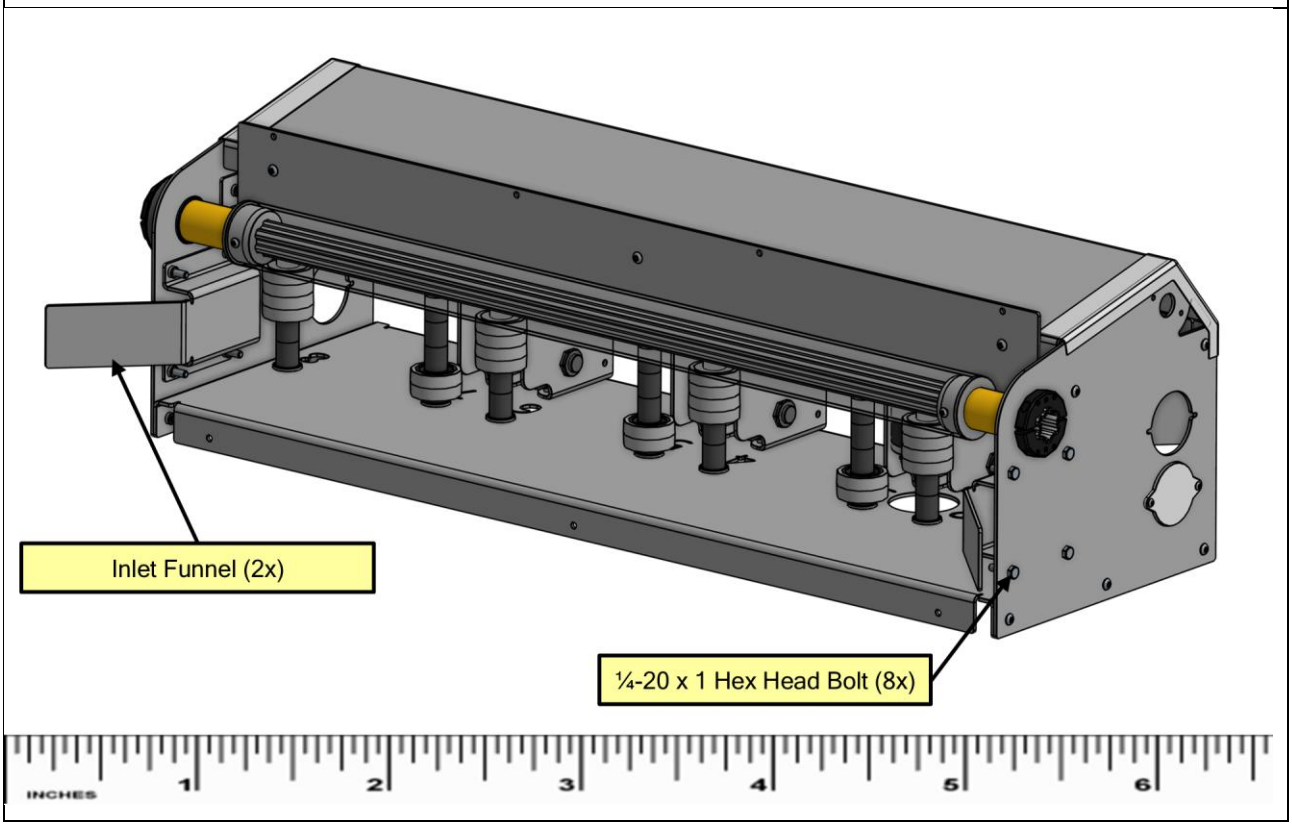
21.


Alliance Station Side
Hub Ramp Angle Assembly (2x)
¼-20 x 2.5 Hex Head Bolt (4x)
INCHES
1
2
3
4
5
6

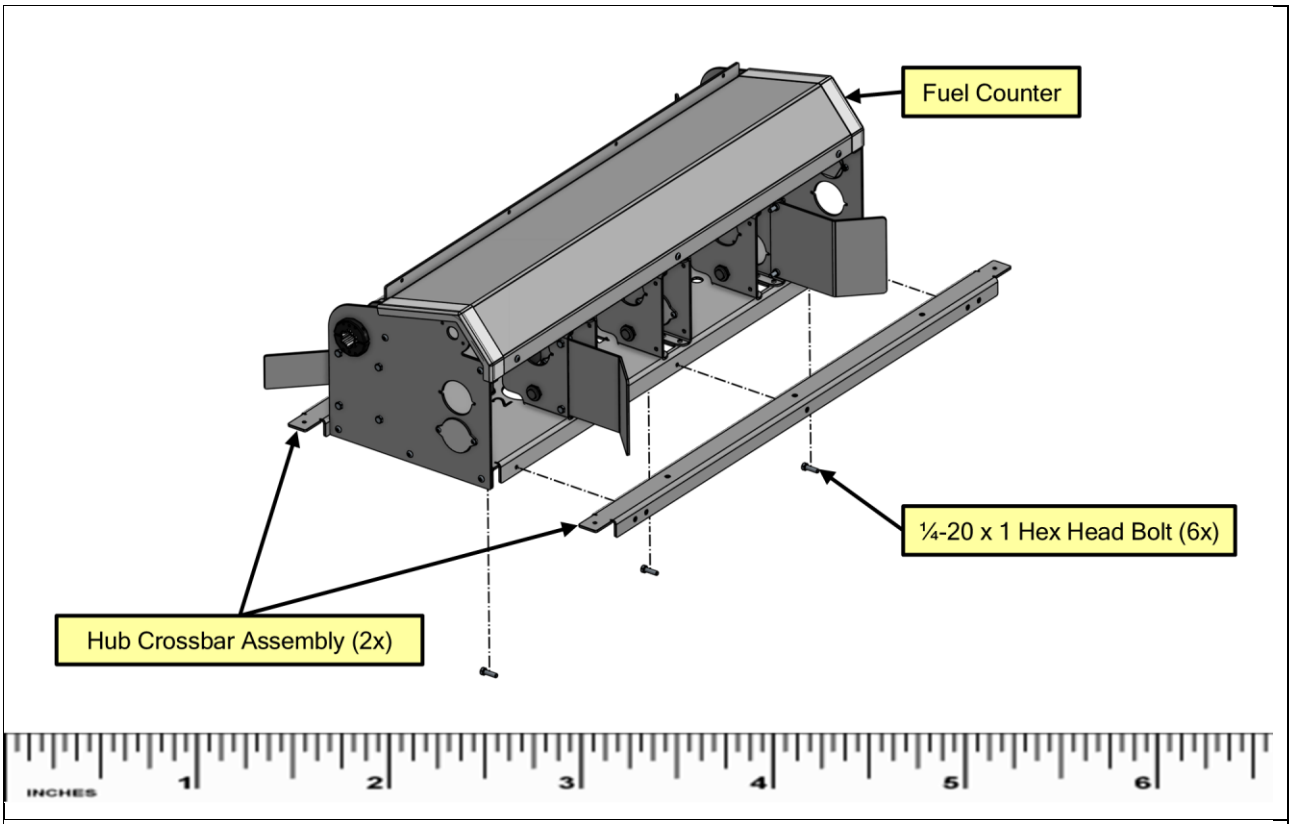
22.


Sensor locations
This sensor faces opposite direction of the others
Ball Deflector with PEMs (2x)
Counter Assembly
¼-20 x 1 Hex Head Bolt (4x)
INCHES
1
2
3
4
5
6

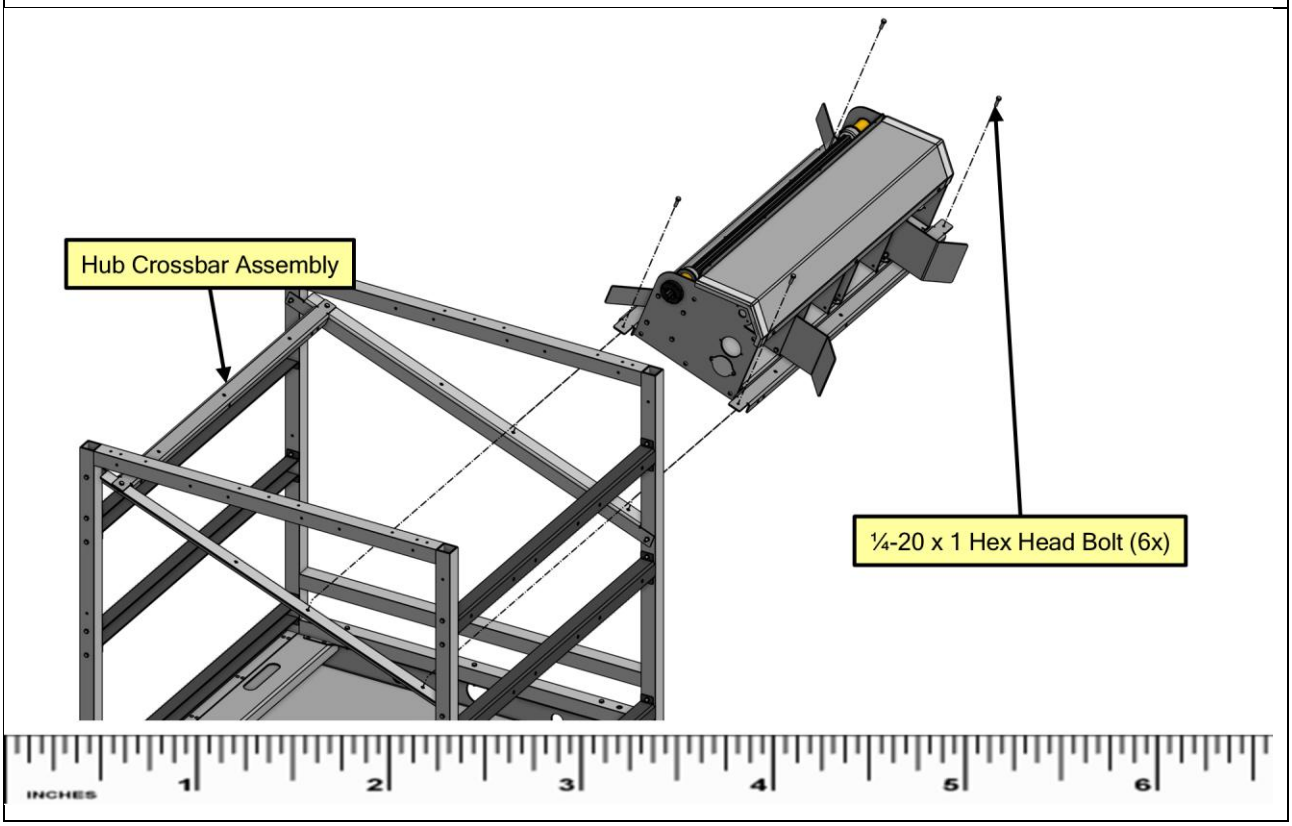
23.


Inlet Funnel (2x)
¼-20 x 1 Hex Head Bolt (8x)
INCHES
1
2
3
4
5
6

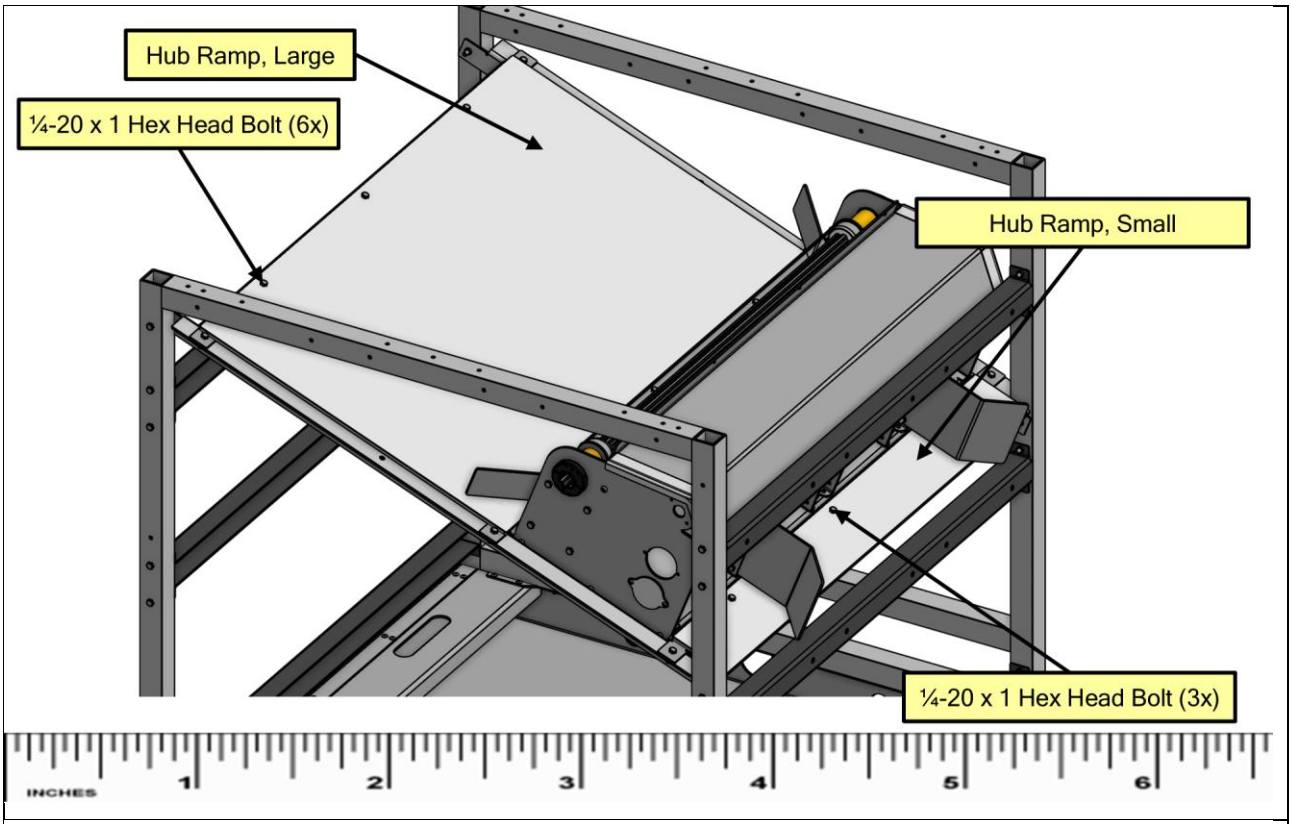
24.


Fuel Counter
¼-20 x 1 Hex Head Bolt (6x)
Hub Crossbar Assembly (2x)
INCHES
1
2
3
4
5
6

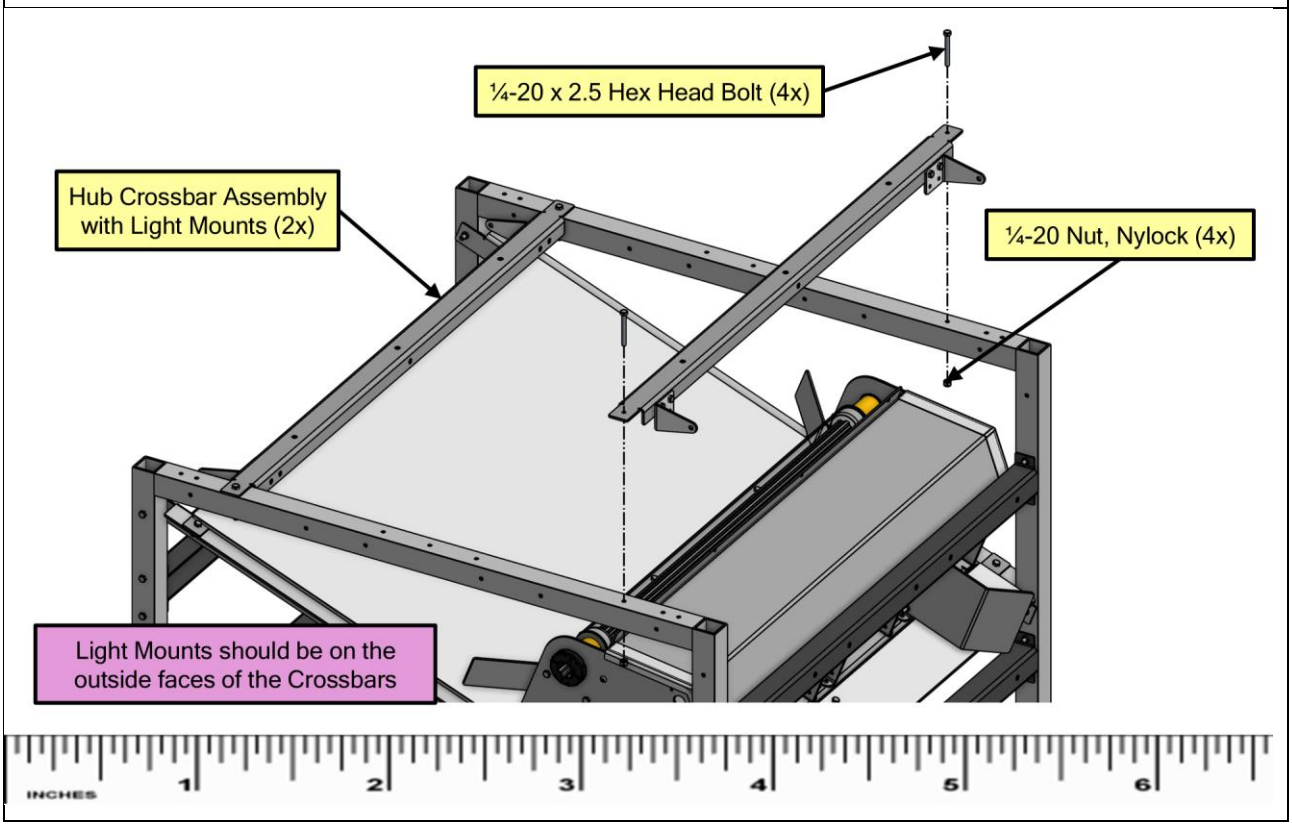
25.


Hub Crossbar Assembly
¼-20 x 1 Hex Head Bolt (6x)
INCHES
1
2
3
4
5
6

26.

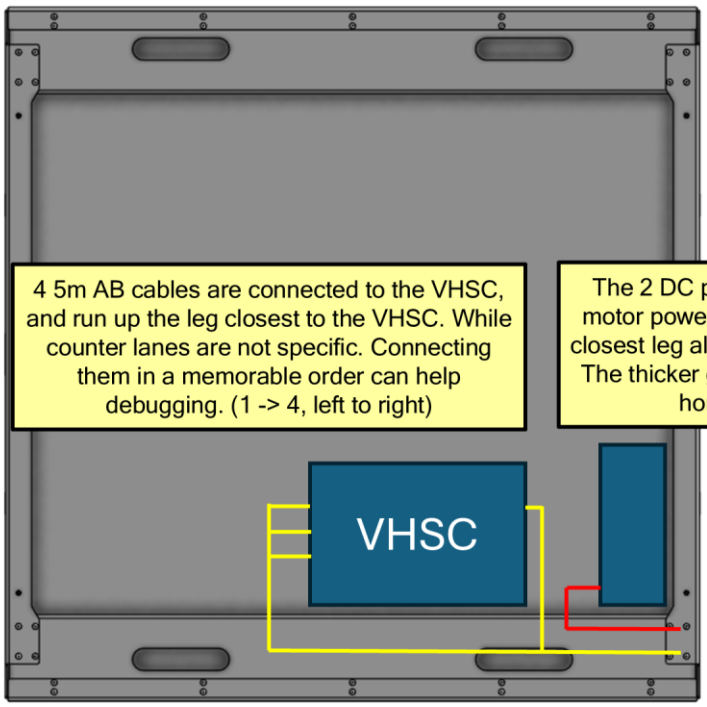

Hub Ramp, Large
¼-20 x 1 Hex Head Bolt (6x)
Hub Ramp, Small
¼-20 x 1 Hex Head Bolt (3x)
INCHES
1
2
3
4
5
6

27.

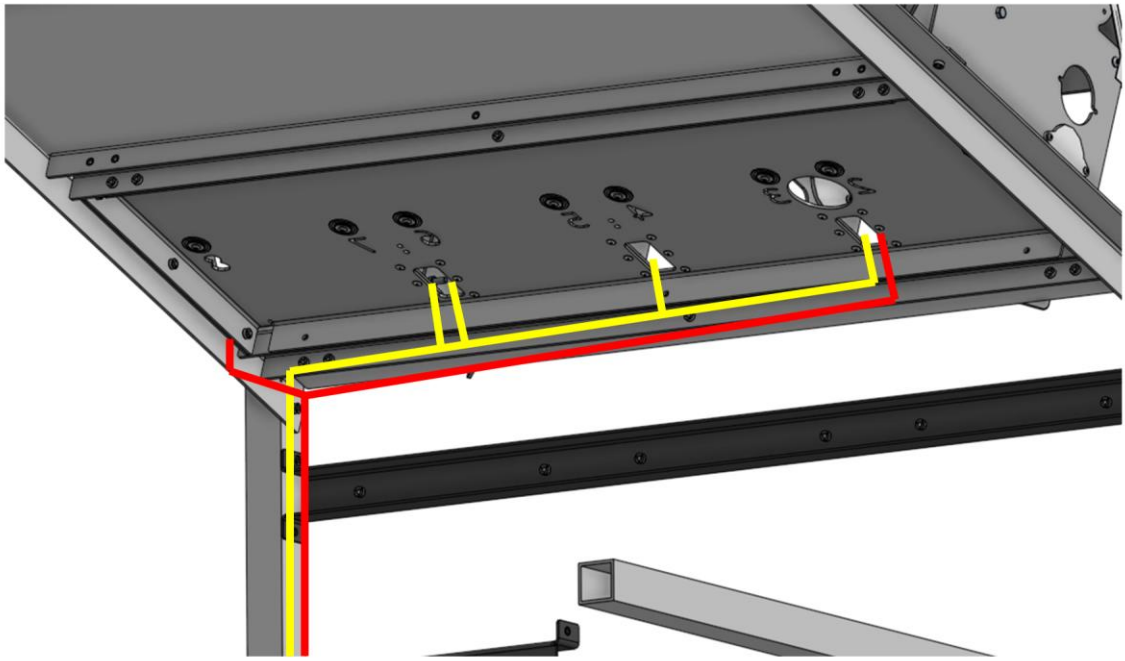

¼-20 x 2.5 Hex Head Bolt (4x)
Hub Crossbar Assembly with Light Mounts (2x)
¼-20 Nut, Nylock (4x)
Light Mounts should be on the outside faces of the Crossbars
INCHES
1
2
3
4
5
6

28.

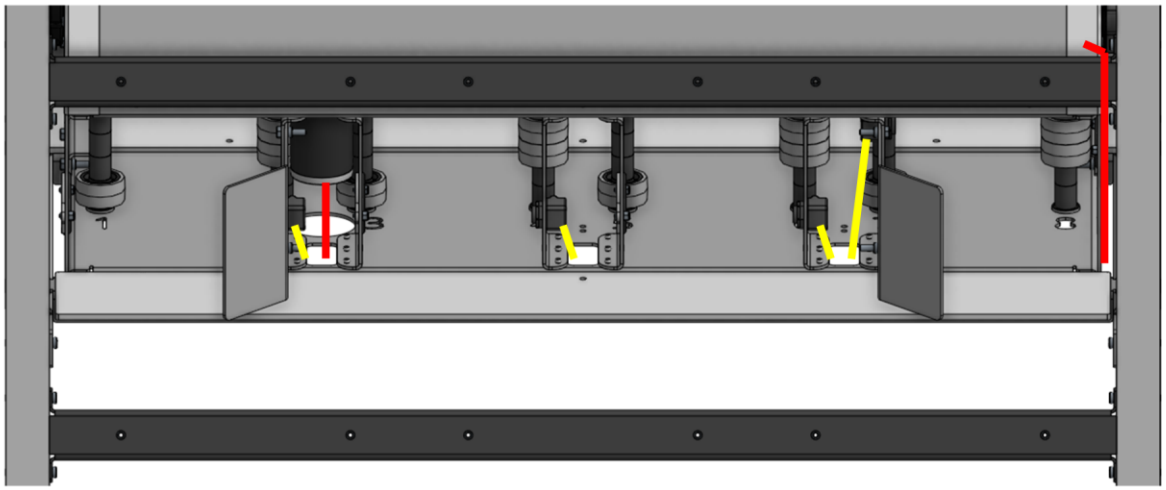
Wiring the sensors and motors



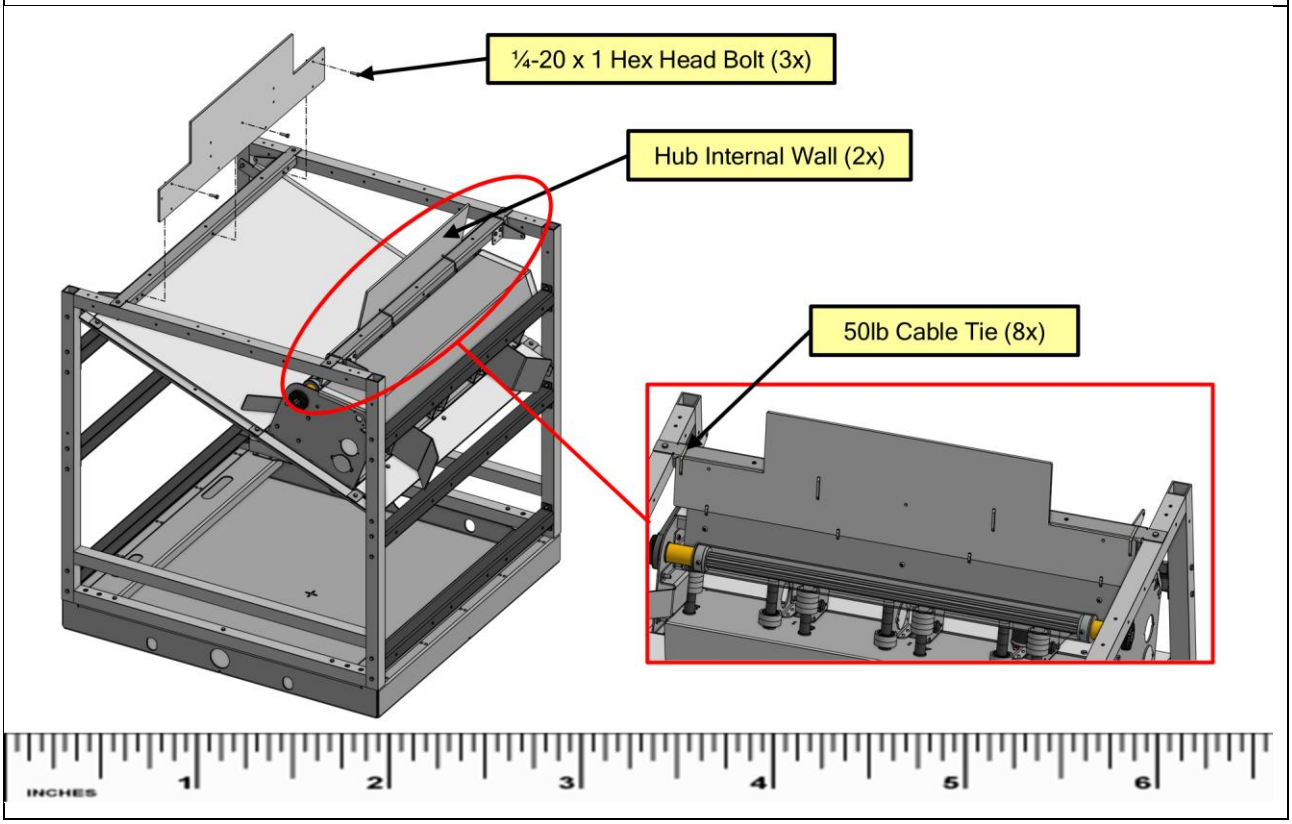
29.



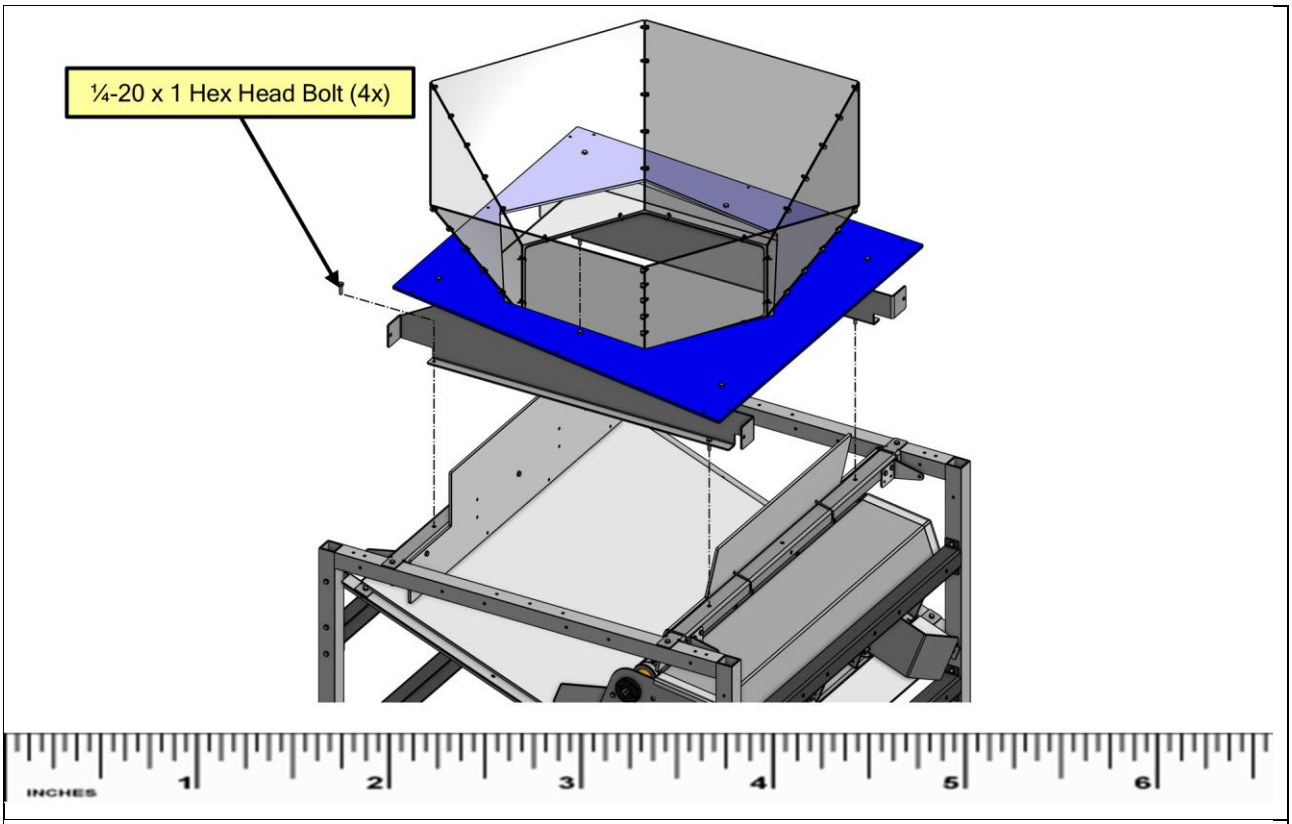
30.



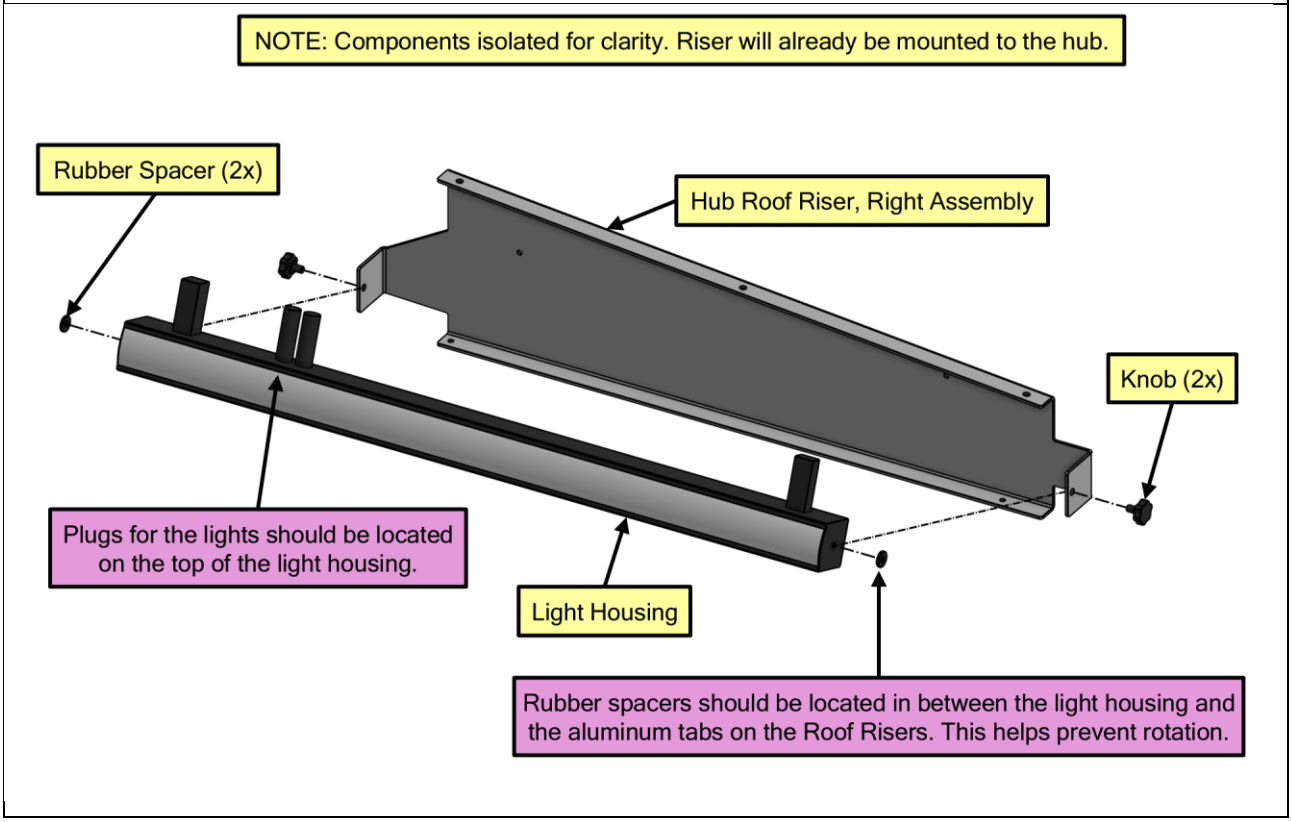
31.


¼-20 x 1 Hex Head Bolt (3x)
Hub Internal Wall (2x)
50lb Cable Tie (8x)
INCHES
1
2
3
4
5
6

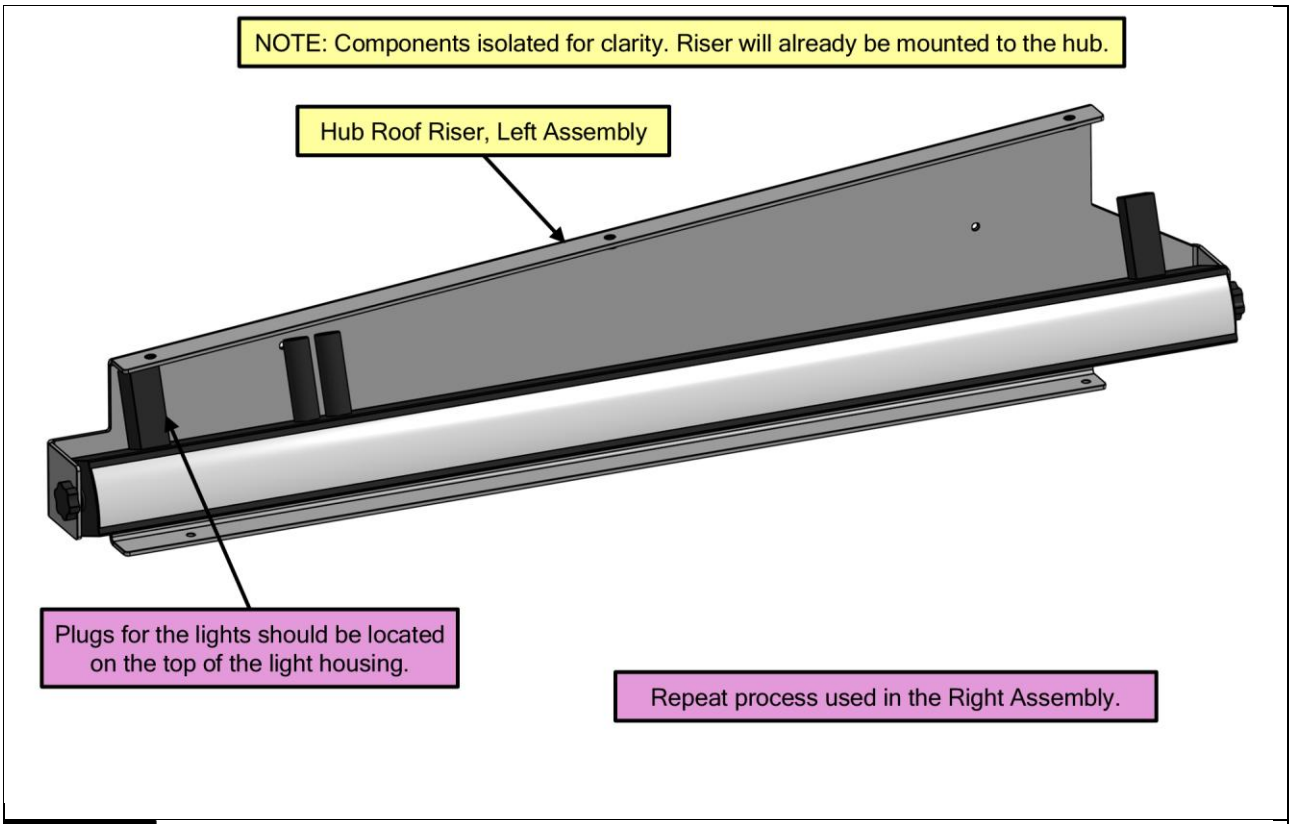
32.


¼-20 x 1 Hex Head Bolt (4x)
INCHES
1
2
3
4
5
6

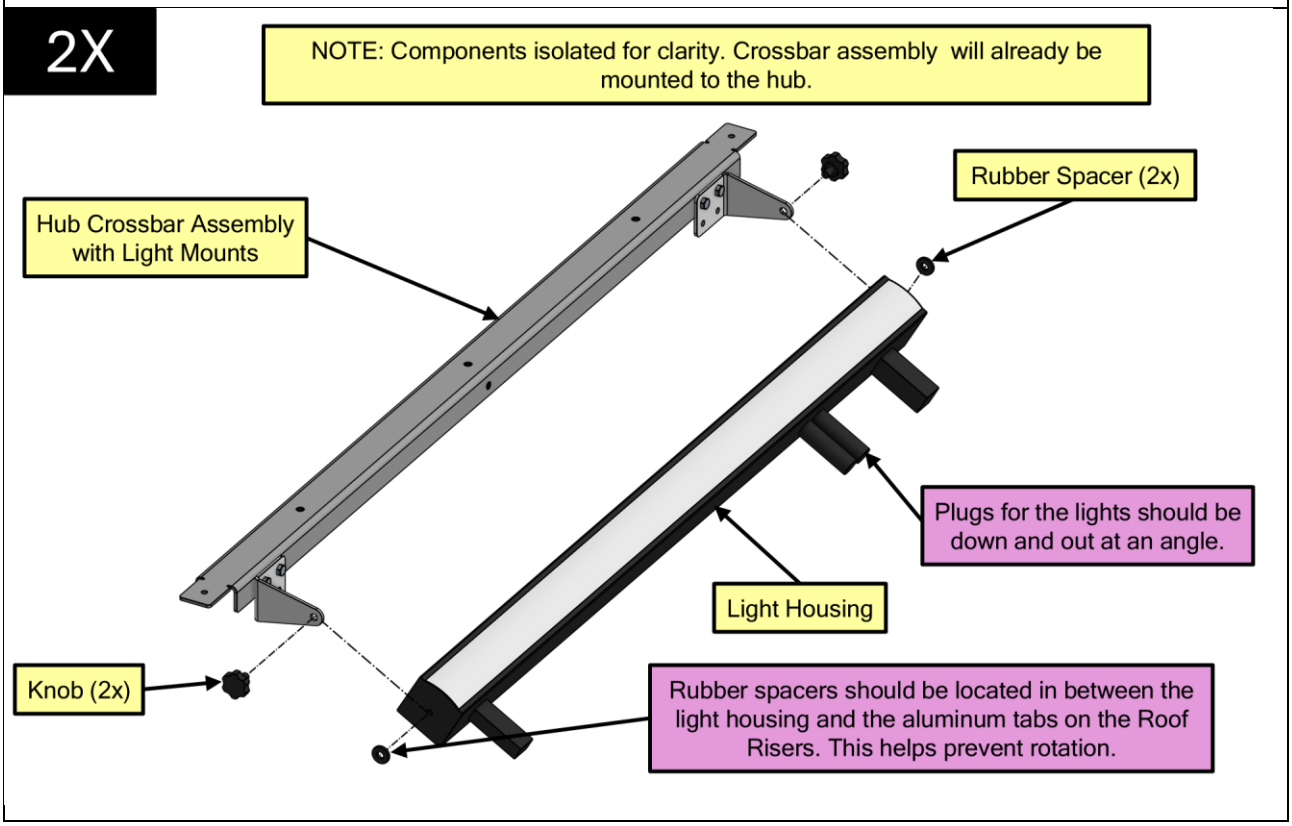
33.


NOTE: Components isolated for clarity. Riser will already be mounted to the hub.
Rubber Spacer (2x)
Hub Roof Riser, Right Assembly
Knob (2x)
Plugs for the lights should be located on the top of the light housing.
Light Housing
Rubber spacers should be located in between the light housing and the aluminum tabs on the Roof Risers. This helps prevent rotation.

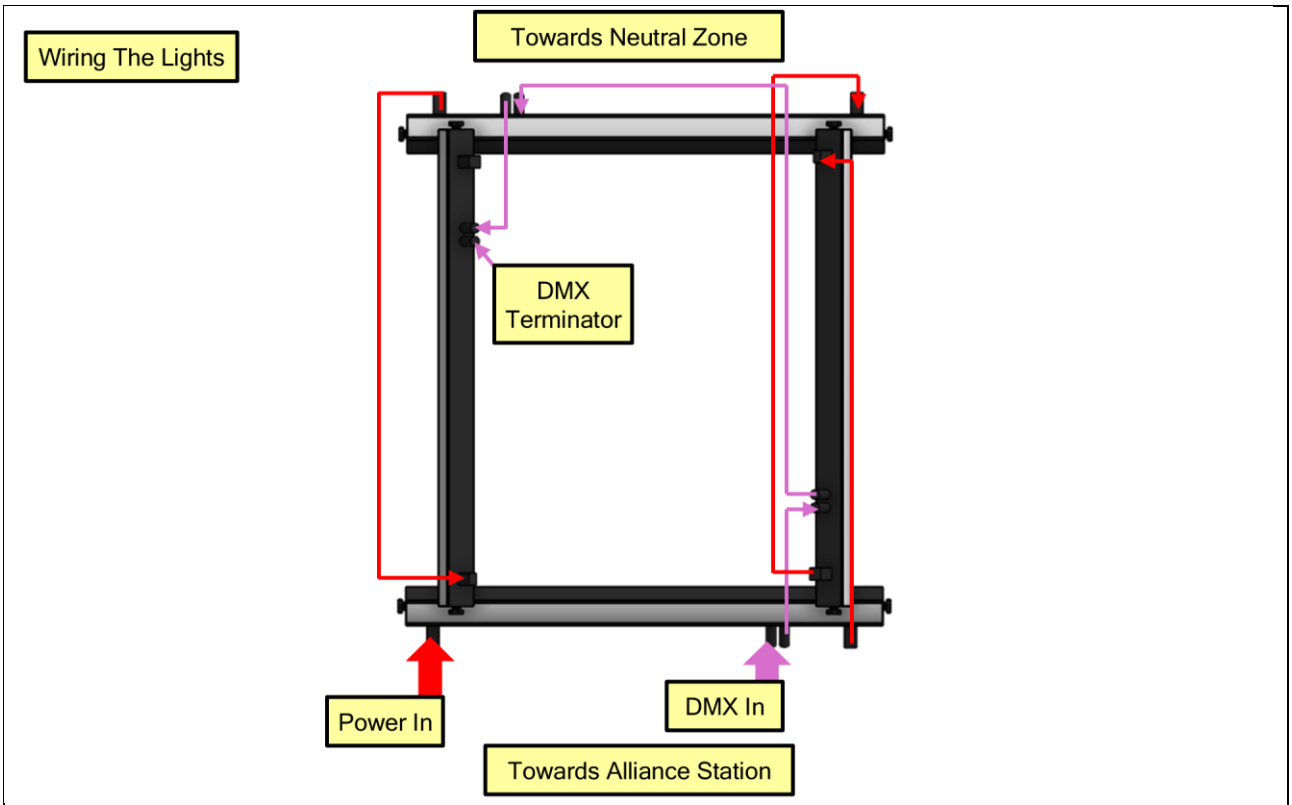
34.


NOTE: Components isolated for clarity. Riser will already be mounted to the hub.
Hub Roof Riser, Left Assembly
Plugs for the lights should be located on the top of the light housing.
Repeat process used in the Right Assembly.

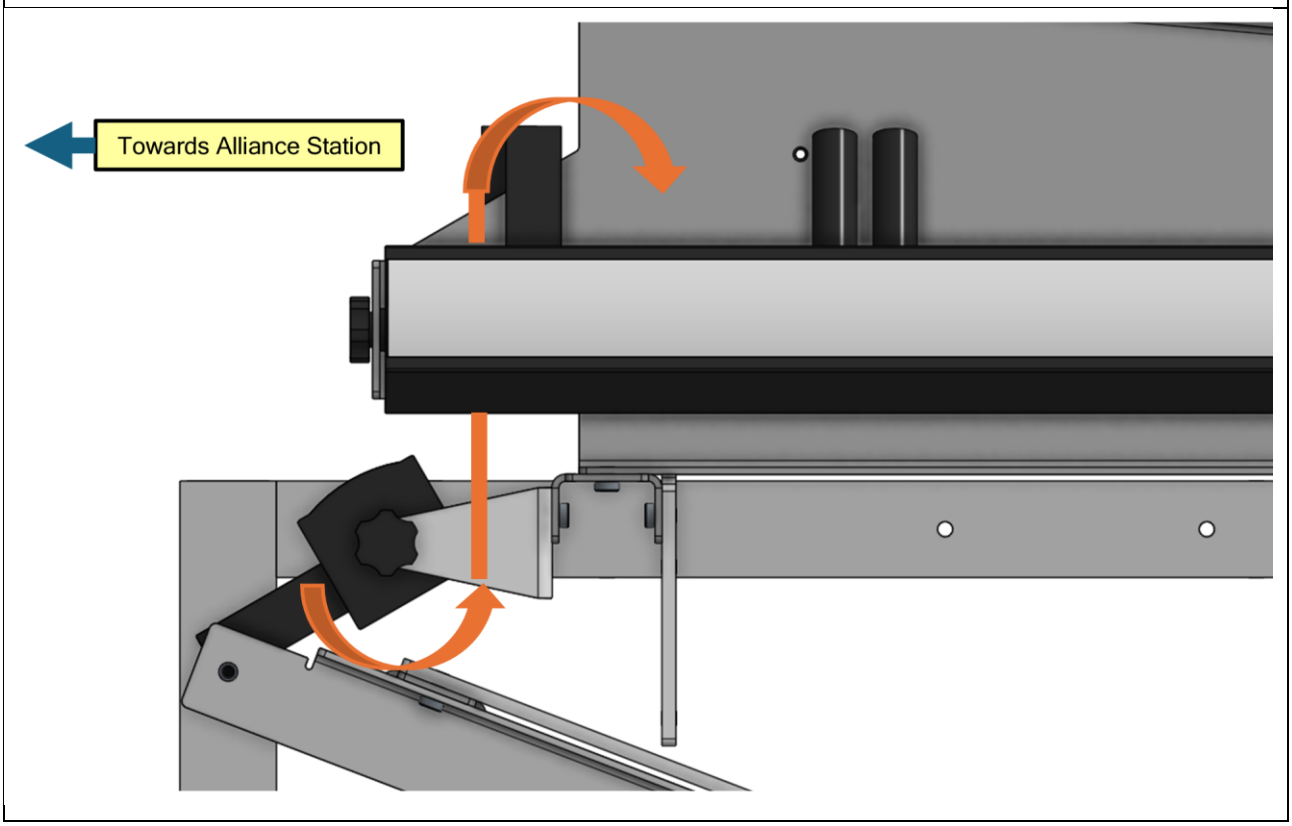
35.


2X
NOTE: Components isolated for clarity. Crossbar assembly will already be mounted to the hub.
Hub Crossbar Assembly with Light Mounts
Rubber Spacer (2x)
Plugs for the lights should be down and out at an angle.
Light Housing
Knob (2x)
Rubber spacers should be located in between the light housing and the aluminum tabs on the Roof Risers. This helps prevent rotation.

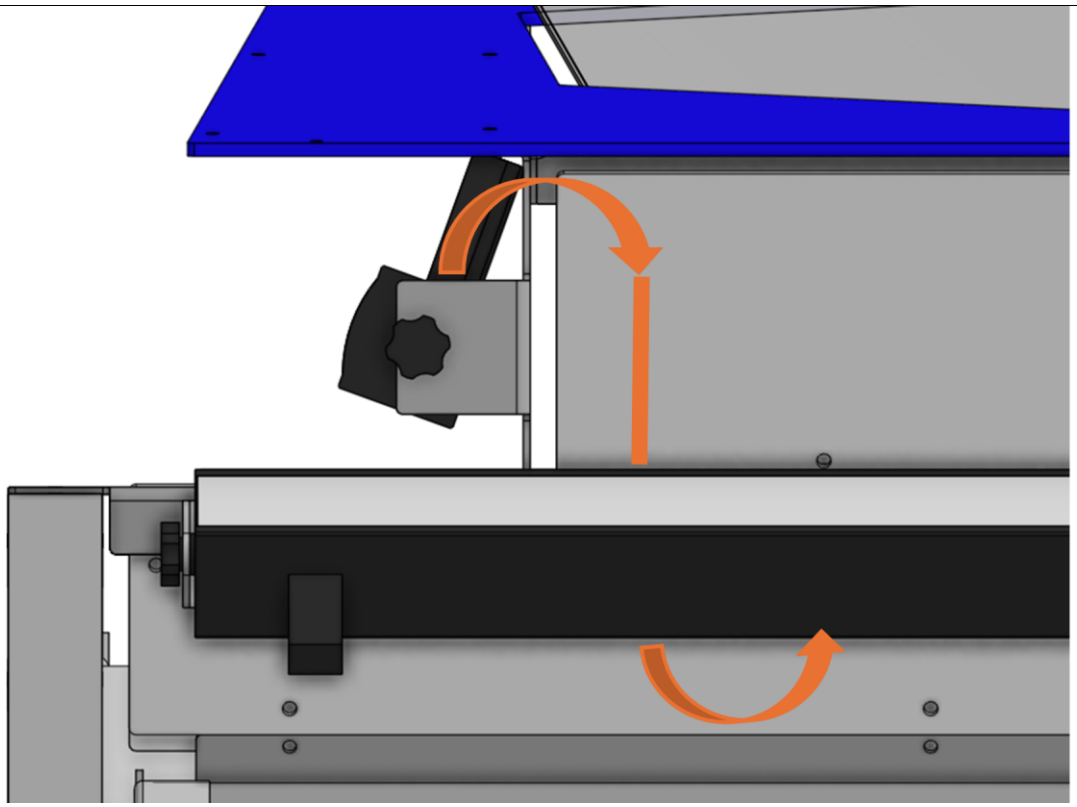
36.


Wiring The Lights
Towards Neutral Zone
DMX Terminator
Power In
DMX In
Towards Alliance Station

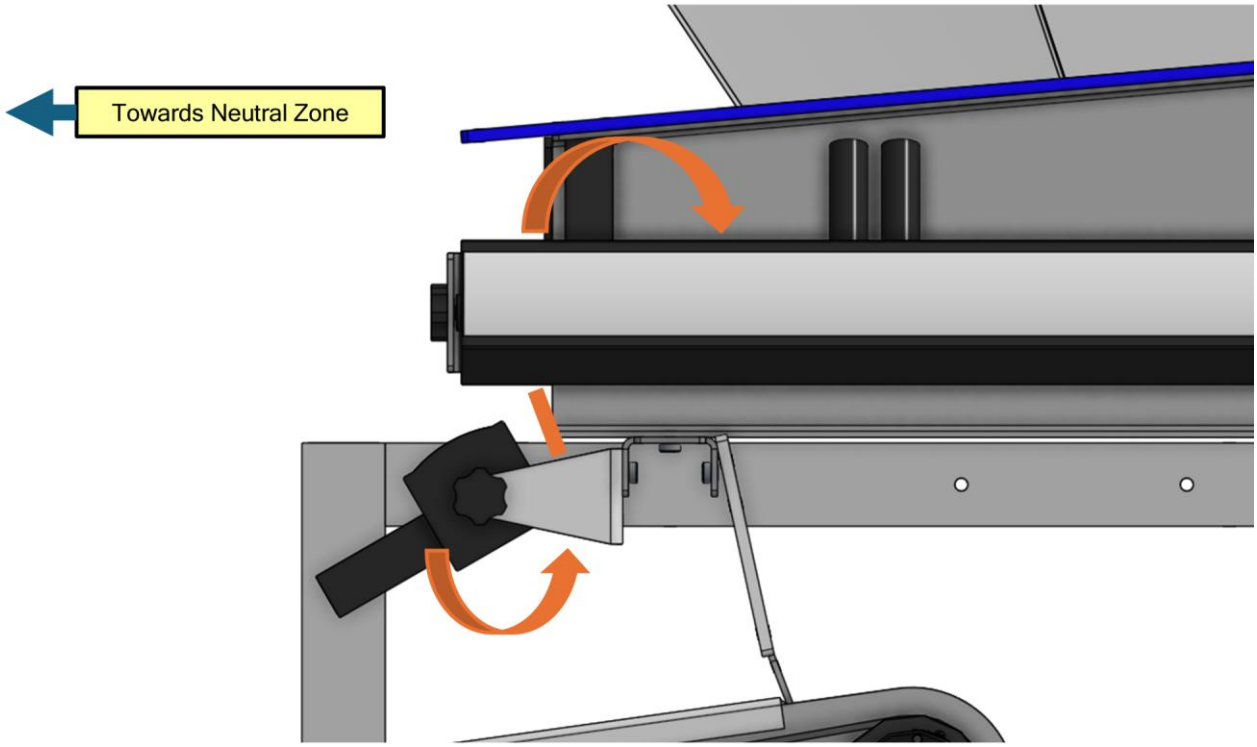
37.


Towards Alliance Station

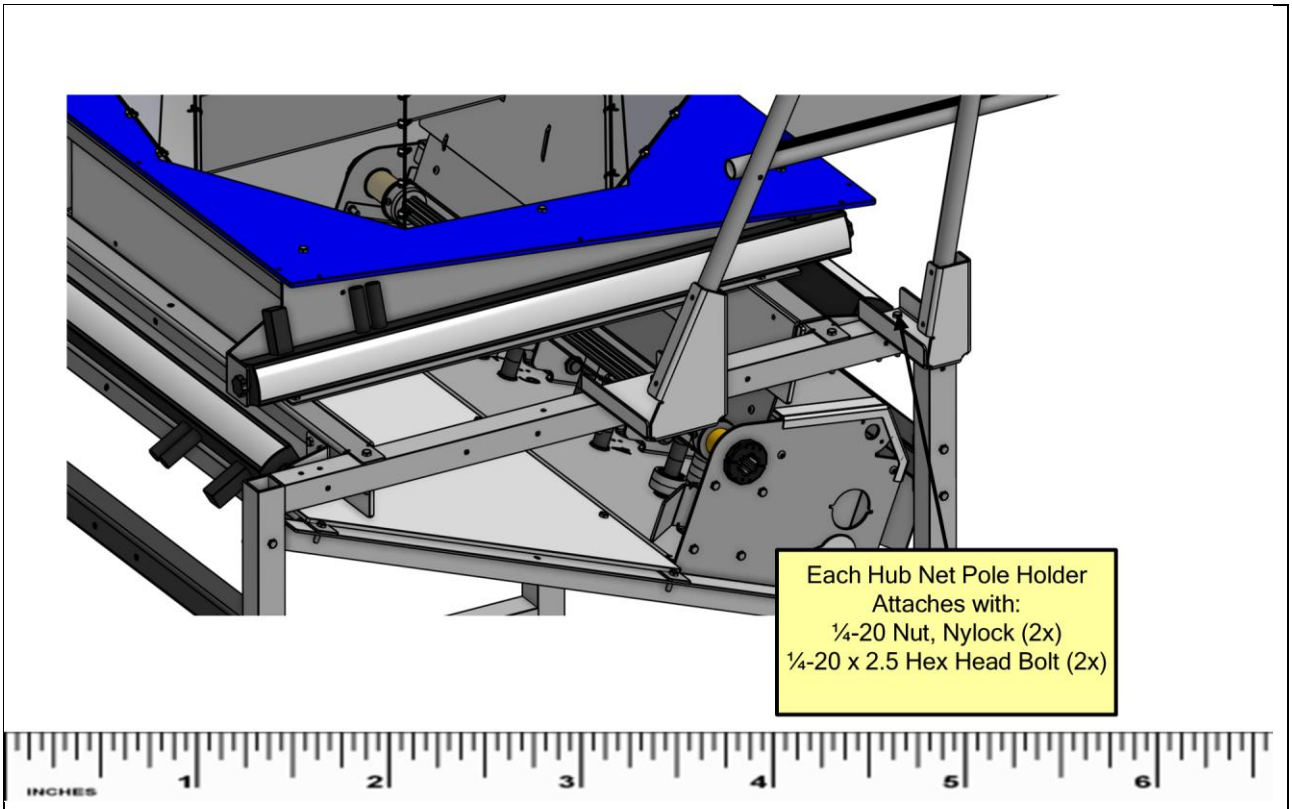
38.



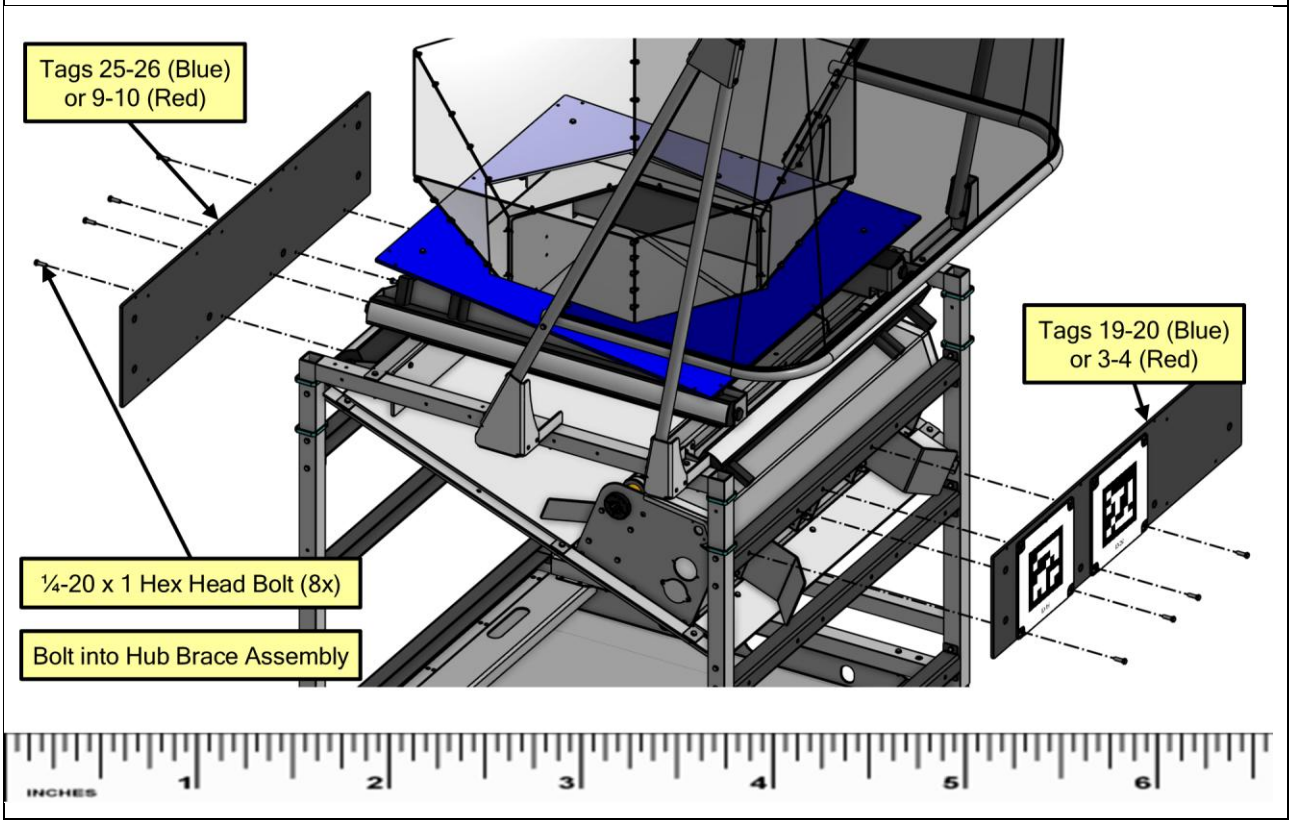
39.



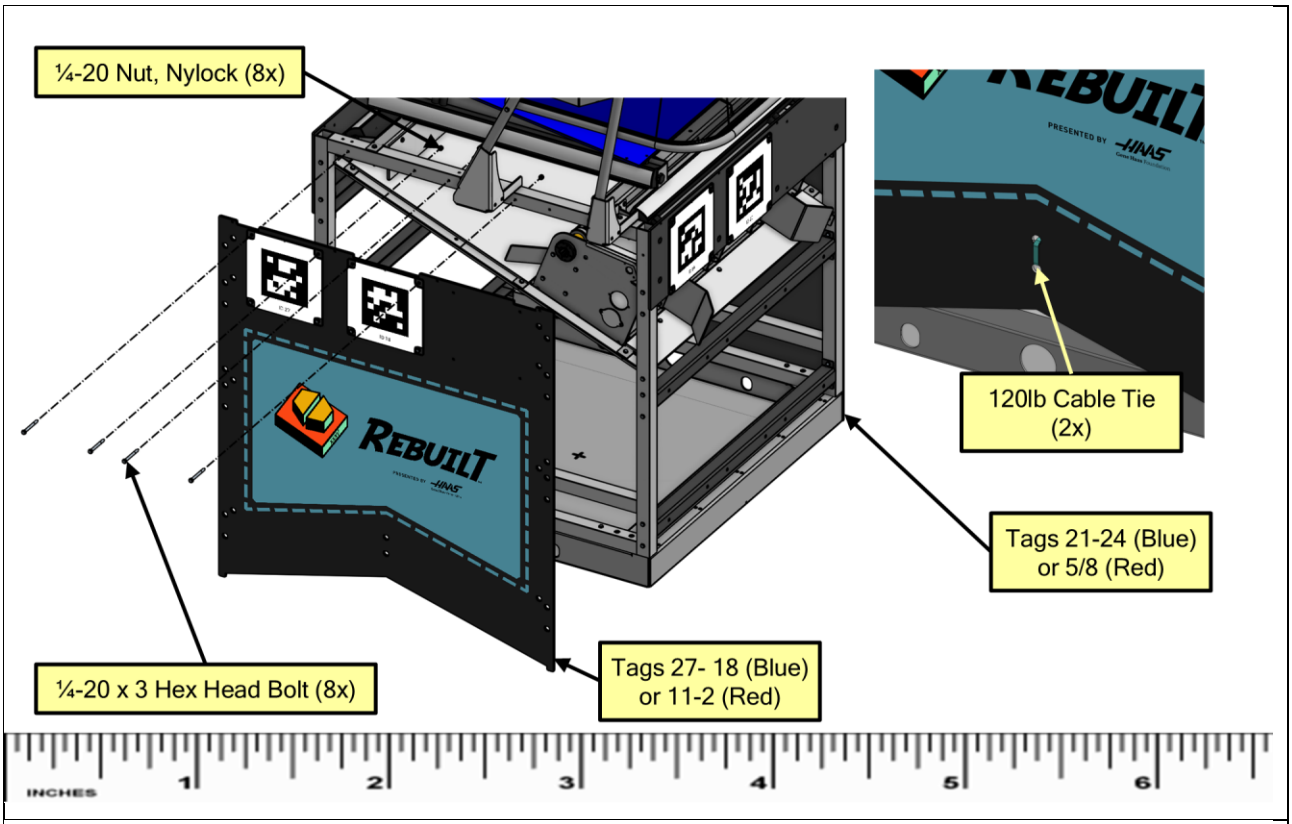
40.


Each Hub Net Pole Holder
Attaches with:
¼-20 Nut, Nylock (2x)
¼-20 x 2.5 Hex Head Bolt (2x)
INCHES
1
2
3
4
5
6

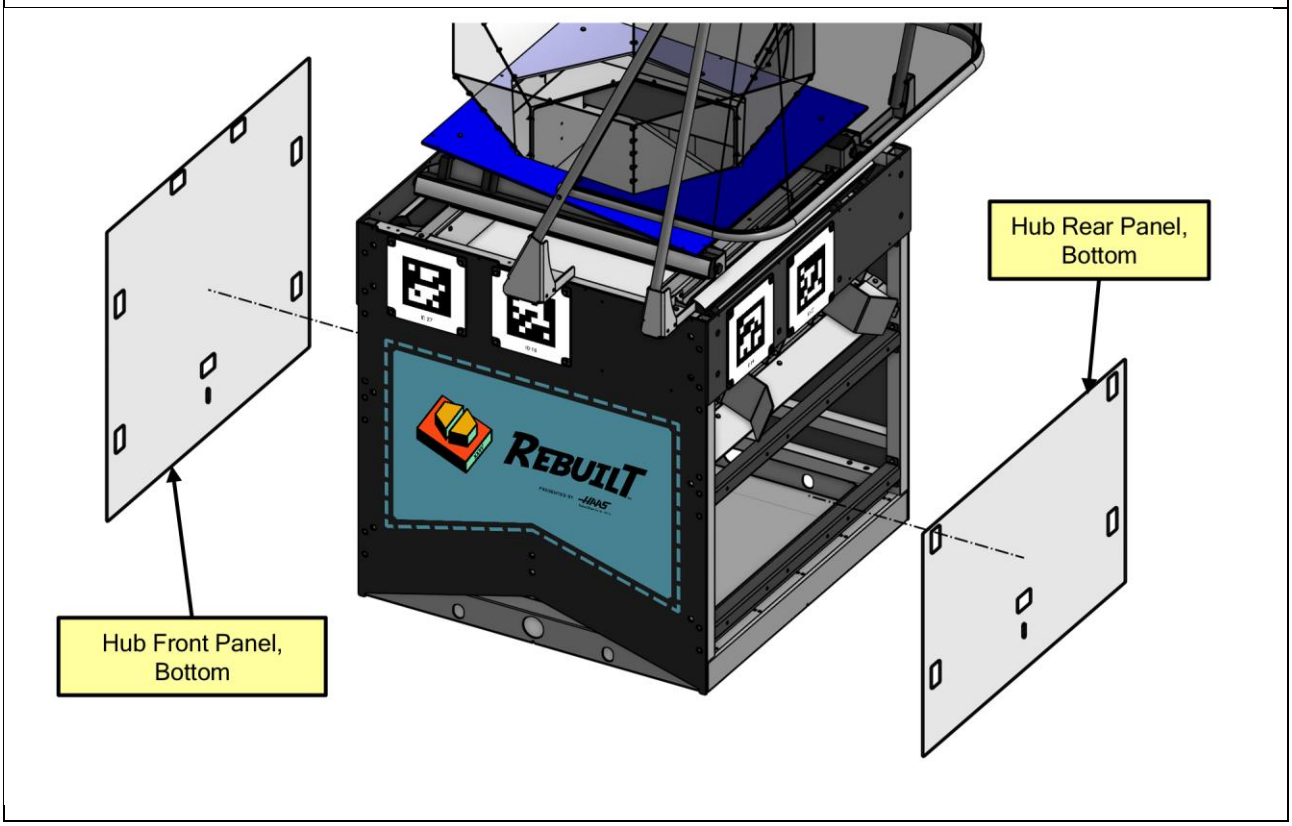
41.


Tags 25-26 (Blue)
or 9-10 (Red)
Tags 19-20 (Blue)
or 3-4 (Red)
¼-20 x 1 Hex Head Bolt (8x)
Bolt into Hub Brace Assembly
INCHES
1
2
3
4
5
6

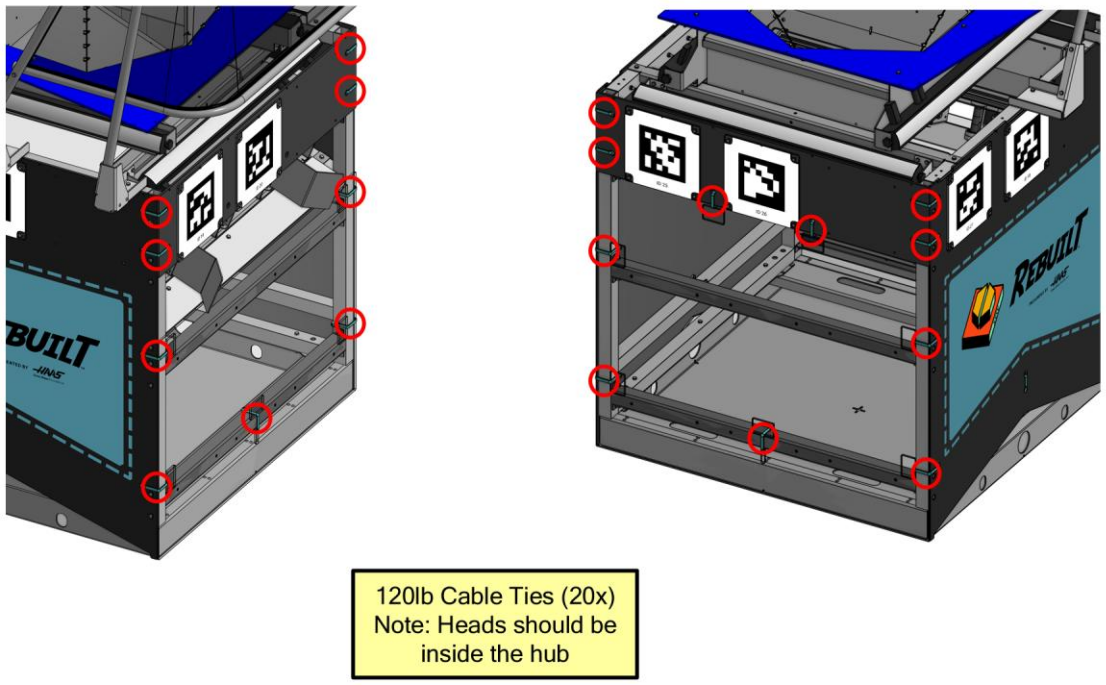
42.


¼-20 Nut, Nylock (8x)
120lb Cable Tie (2x)
Tags 21-24 (Blue) or 5/8 (Red)
Tags 27- 18 (Blue) or 11-2 (Red)
¼-20 x 3 Hex Head Bolt (8x)
INCHES
1
2
3
4
5
6

43.

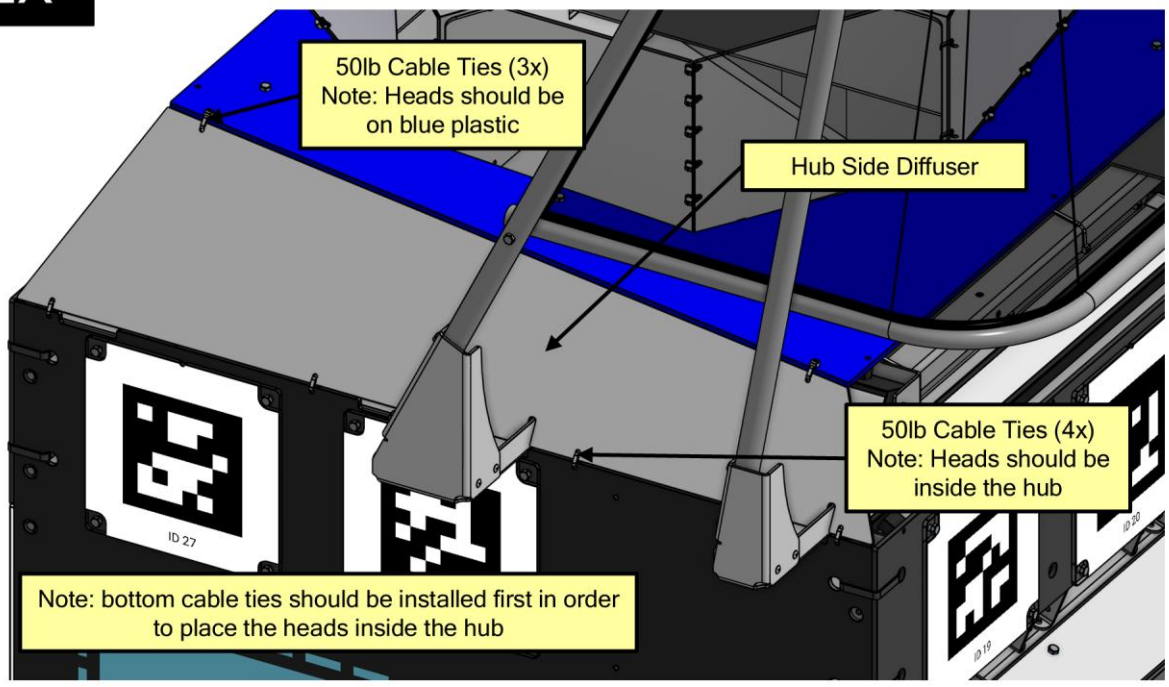

Hub Rear Panel, Bottom
Hub Front Panel, Bottom

44.

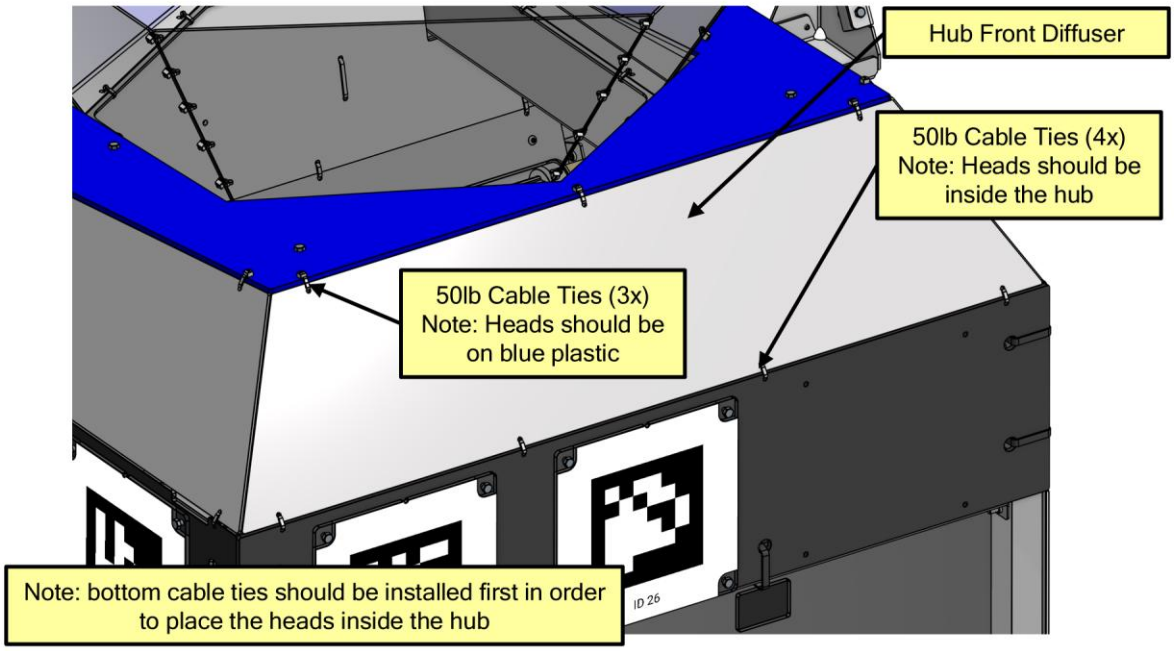

120lb Cable Ties (20x)
Note: Heads should be inside the hub

45.

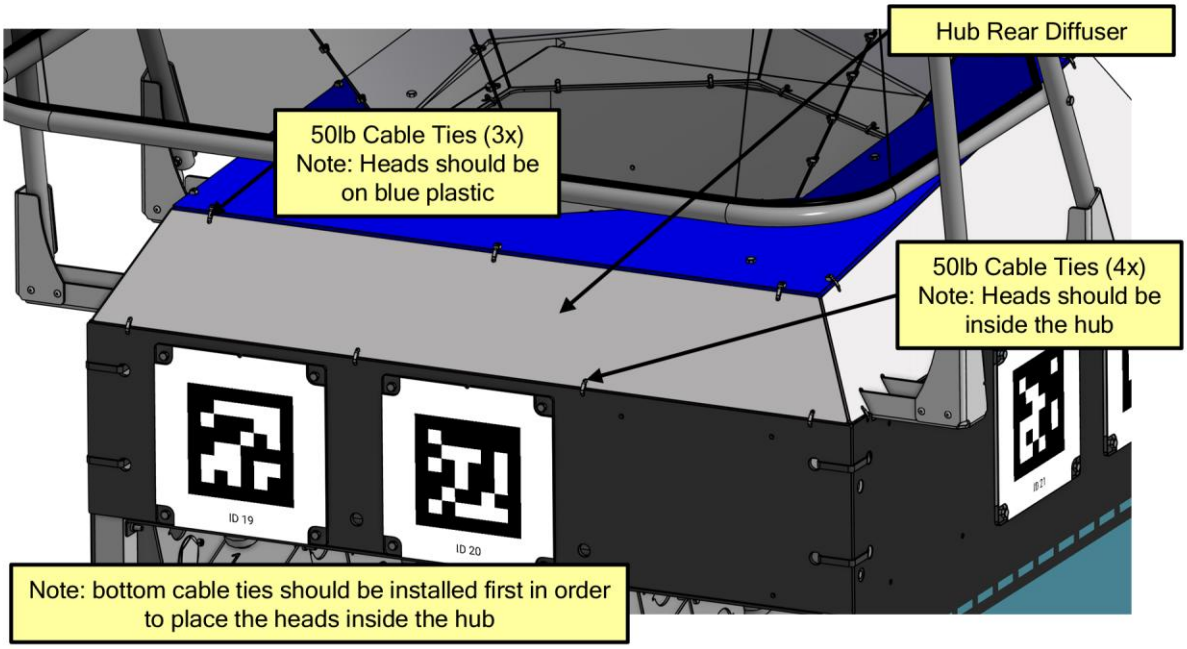
2X


50lb Cable Ties (3x)
Note: Heads should be on blue plastic
Hub Side Diffuser
50lb Cable Ties (4x)
Note: Heads should be inside the hub
Note: bottom cable ties should be installed first in order to place the heads inside the hub

46.


Hub Front Diffuser
50lb Cable Ties (4x)
Note: Heads should be inside the hub
50lb Cable Ties (3x)
Note: Heads should be on blue plastic
Note: bottom cable ties should be installed first in order to place the heads inside the hub
ID 26

47.


Hub Rear Diffuser
50lb Cable Ties (3x)
Note: Heads should be on blue plastic
50lb Cable Ties (4x)
Note: Heads should be inside the hub
ID 19
ID 20
Note: bottom cable ties should be installed first in order to place the heads inside the hub

3.9 Tower and Depot

There will be one tower and depot for each alliance wall. These can be installed as soon as the alliance walls are finished.

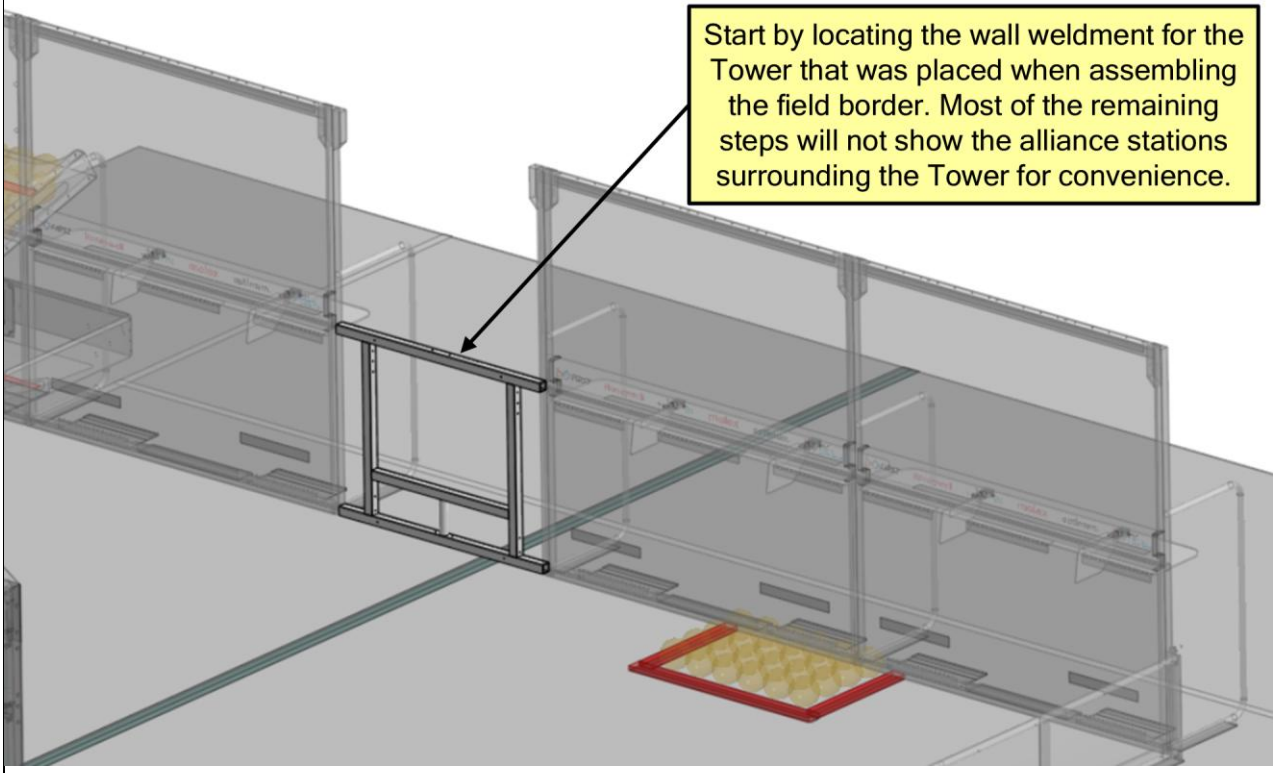
3.9.1 Tools & Equipment

- 7/16” Wrenches, Sockets and Ratchet
- Side Cutters
- 120lb Cable Ties
- Case 23 or 24 and 31

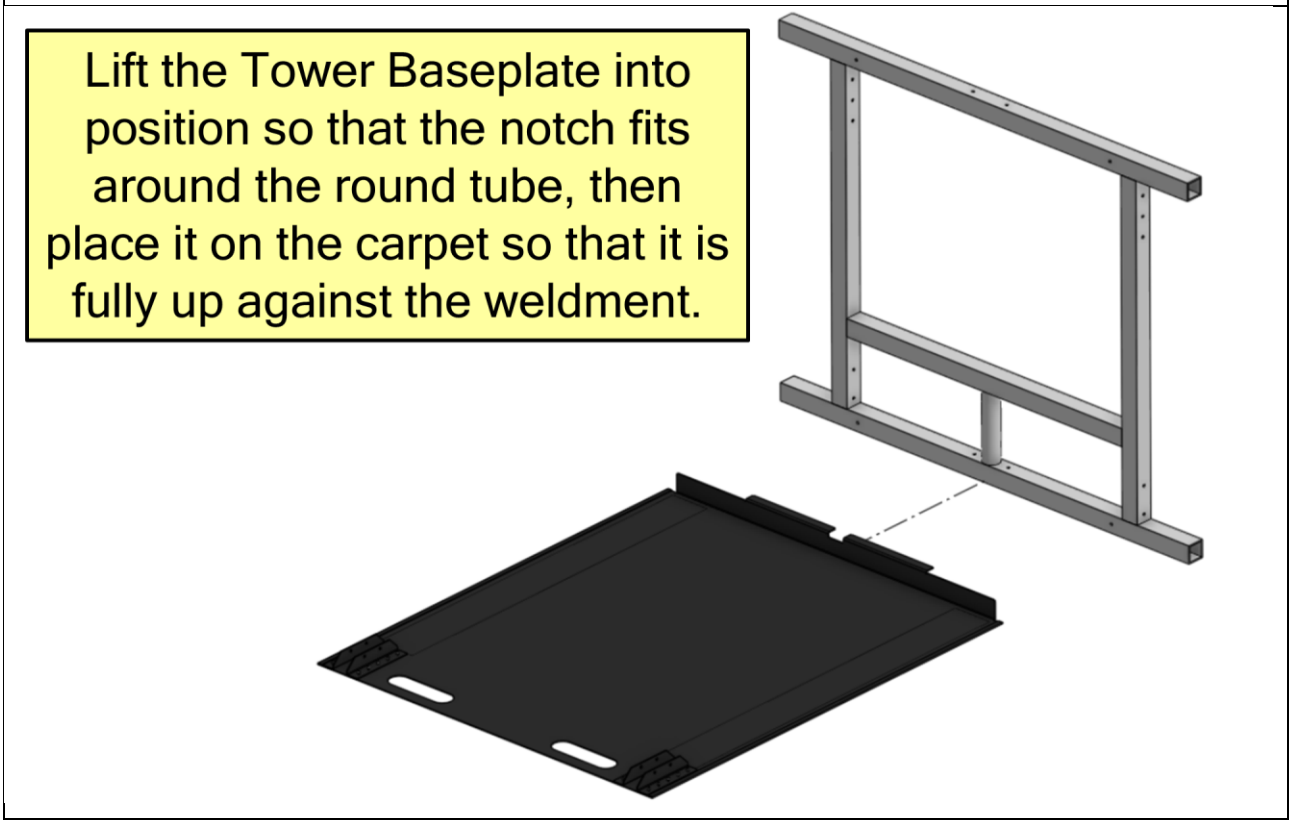
3.9.2 Assembly

1. 

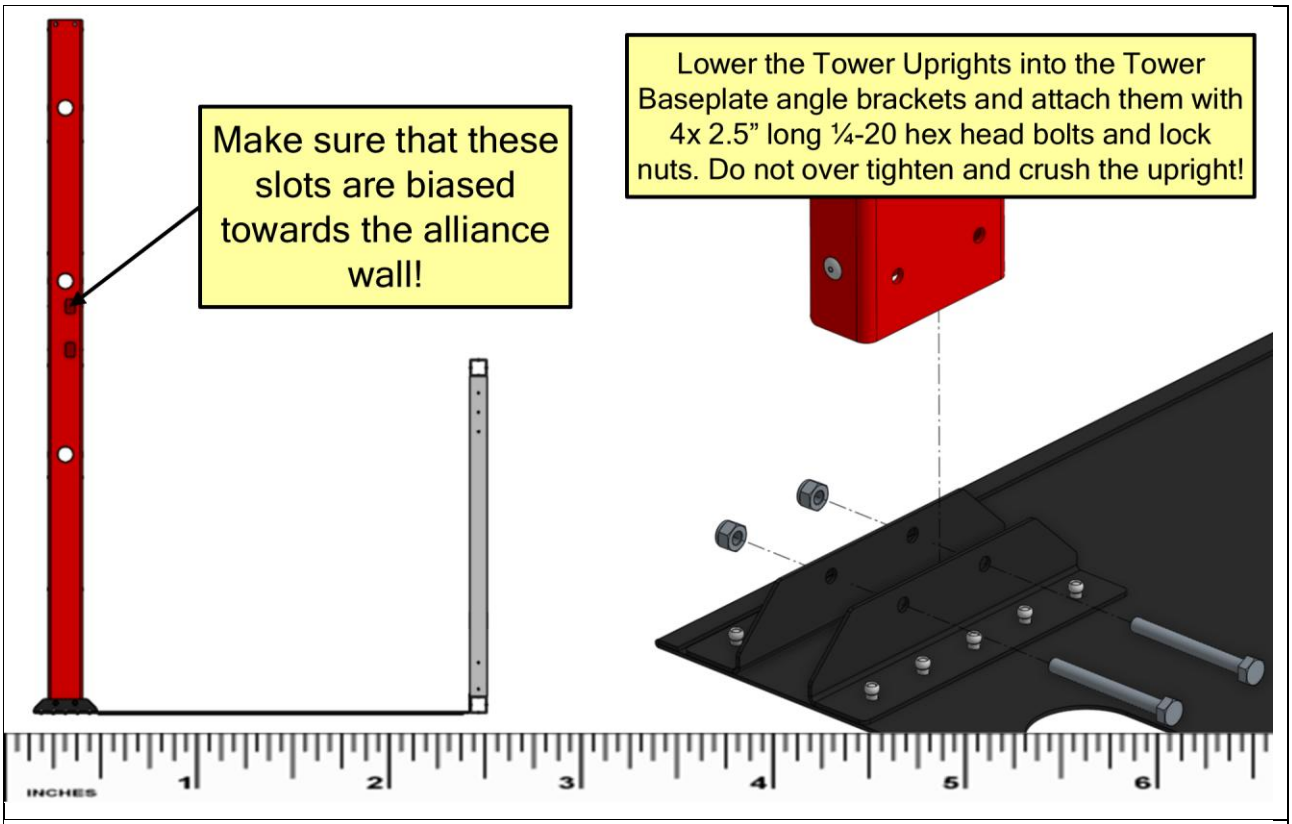
2.


Start by locating the wall weldment for the Tower that was placed when assembling the field border. Most of the remaining steps will not show the alliance stations surrounding the Tower for convenience.

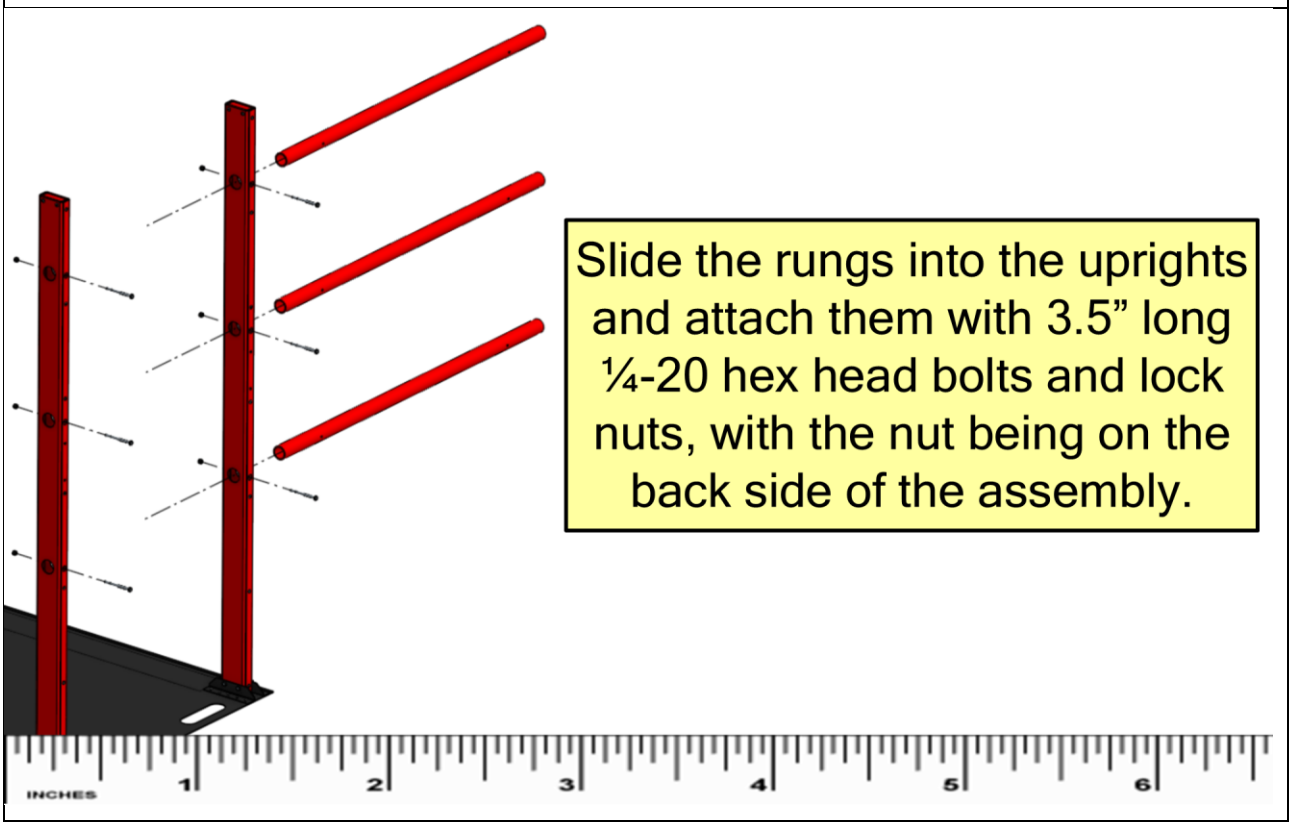
3.


Lift the Tower Baseplate into position so that the notch fits around the round tube, then place it on the carpet so that it is fully up against the weldment.

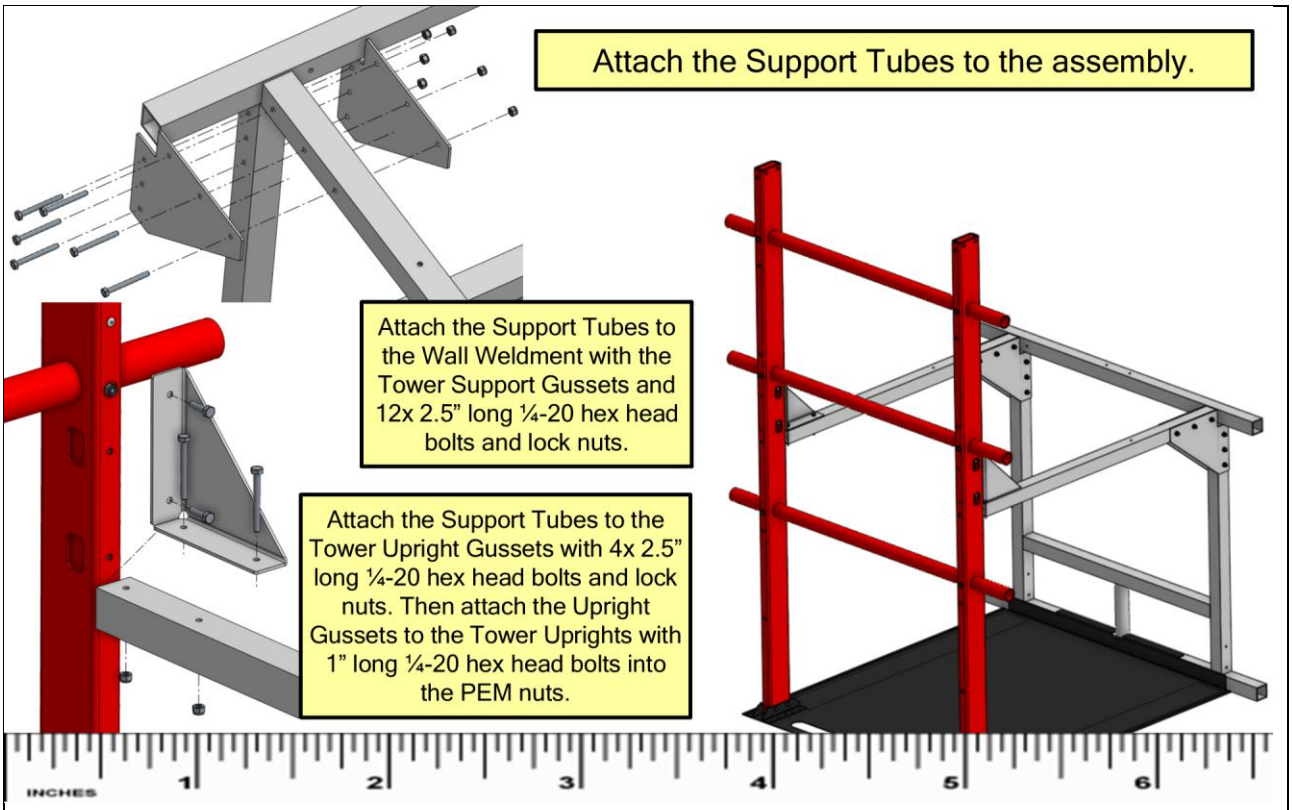
4.


Make sure that these slots are biased towards the alliance wall!
Lower the Tower Uprights into the Tower Baseplate angle brackets and attach them with 4x 2.5” long ¼-20 hex head bolts and lock nuts. Do not over tighten and crush the upright!
INCHES
1
2
3
4
5
6

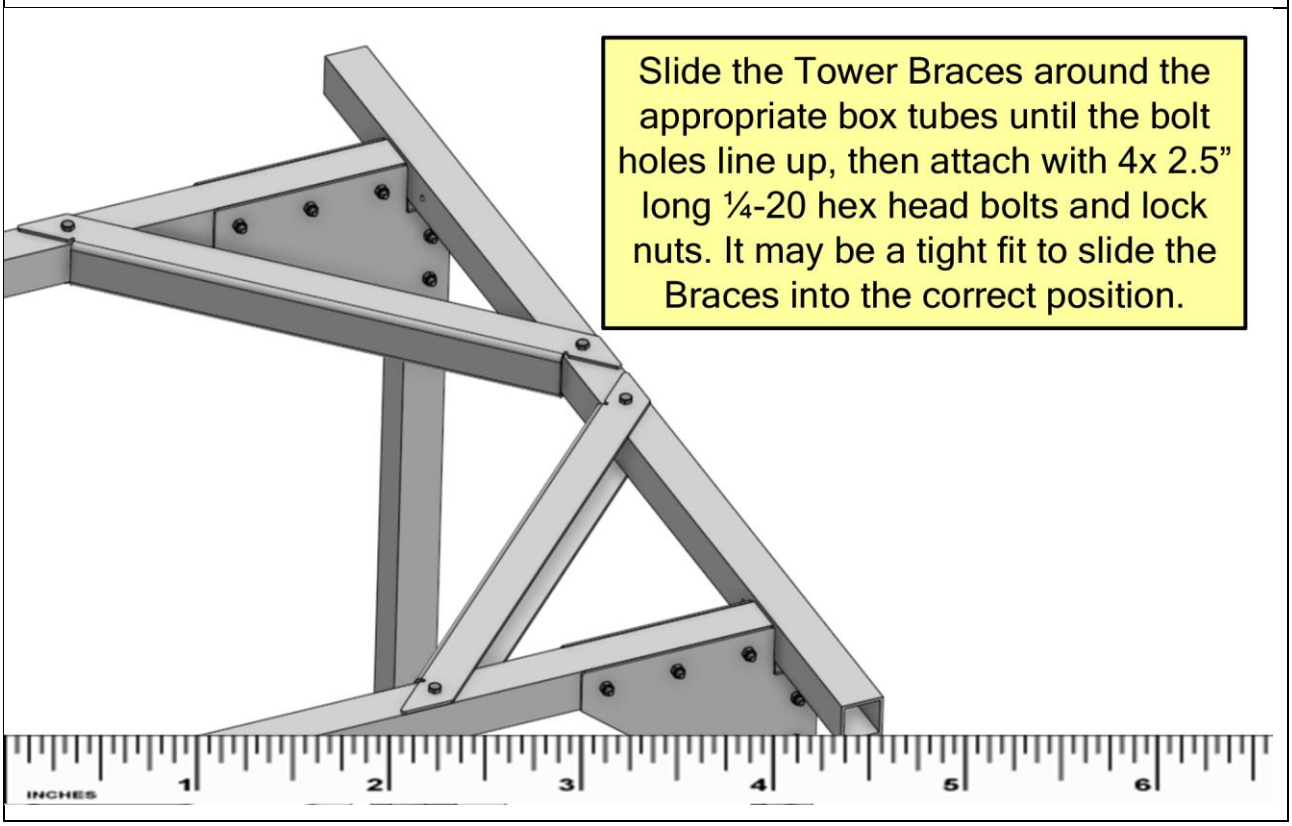
5.


Slide the rungs into the uprights and attach them with 3.5” long ¼-20 hex head bolts and lock nuts, with the nut being on the back side of the assembly.
INCHES
1
2
3
4
5
6

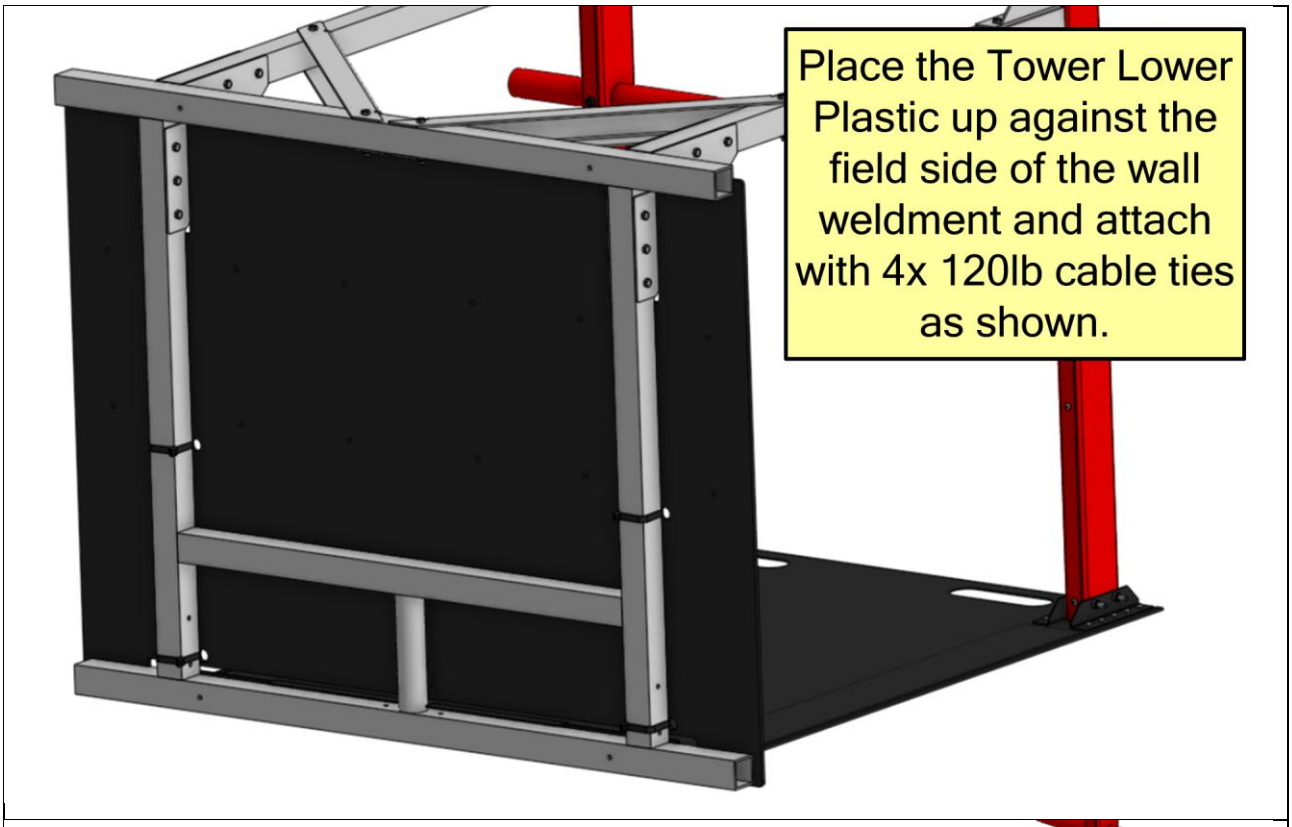
6.


Attach the Support Tubes to the assembly.
Attach the Support Tubes to the Wall Weldment with the Tower Support Gussets and 12x 2.5" long ¼-20 hex head bolts and lock nuts.
Attach the Support Tubes to the Tower Upright Gussets with 4x 2.5" long ¼-20 hex head bolts and lock nuts. Then attach the Upright Gussets to the Tower Uprights with 1" long ¼-20 hex head bolts into the PEM nuts.
INCHES
1
2
3
4
5
6

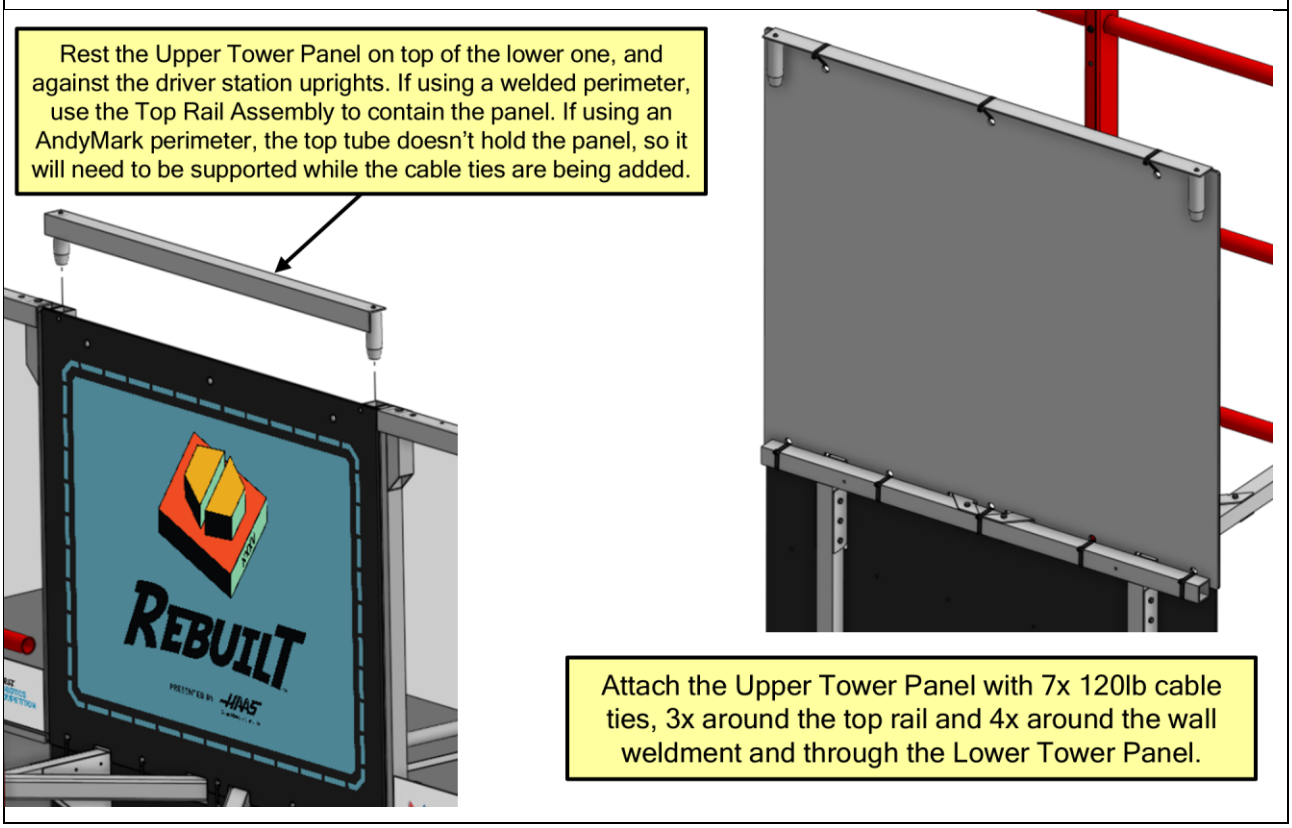
7.


Slide the Tower Braces around the appropriate box tubes until the bolt holes line up, then attach with 4x 2.5" long ¼-20 hex head bolts and lock nuts. It may be a tight fit to slide the Braces into the correct position.
INCHES
1
2
3
4
5
6

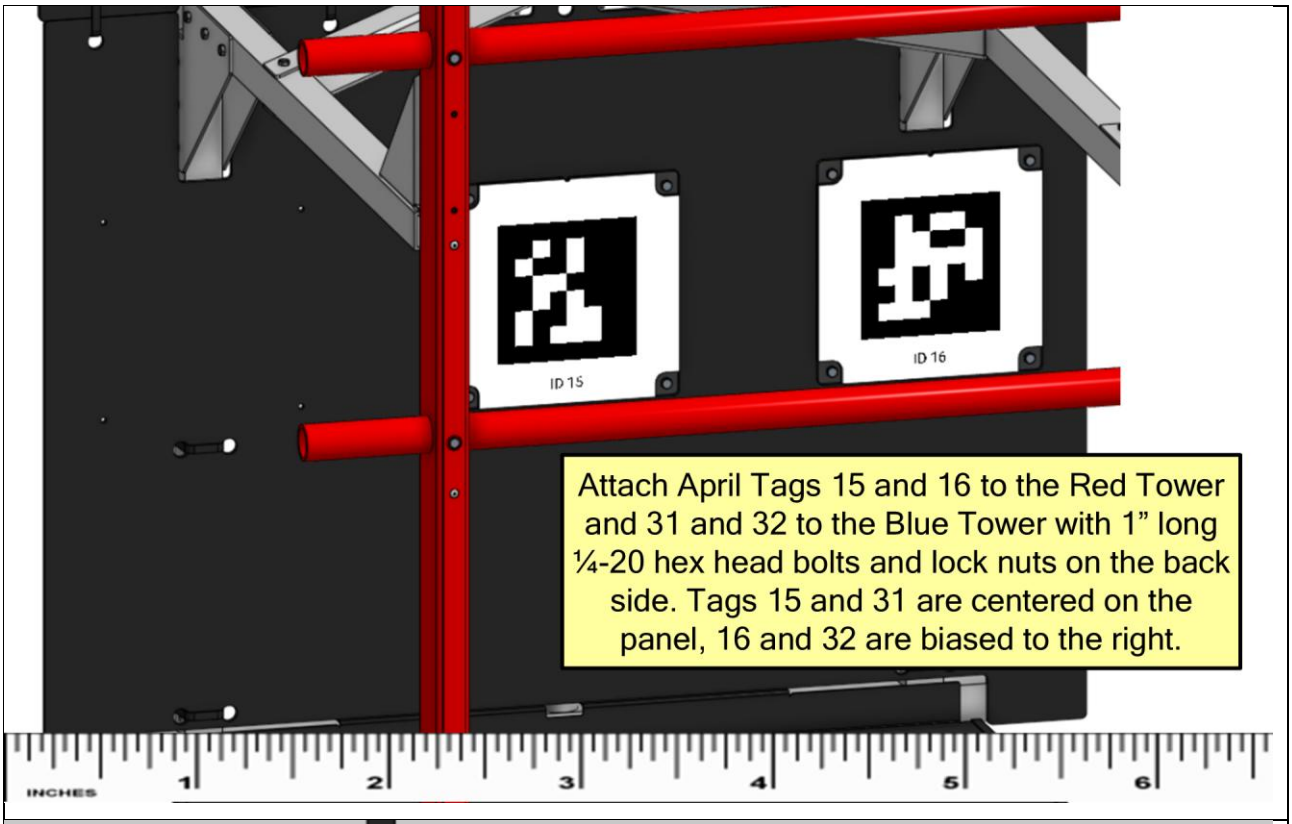
8.


Place the Tower Lower Plastic up against the field side of the wall weldment and attach with 4x 120lb cable ties as shown.

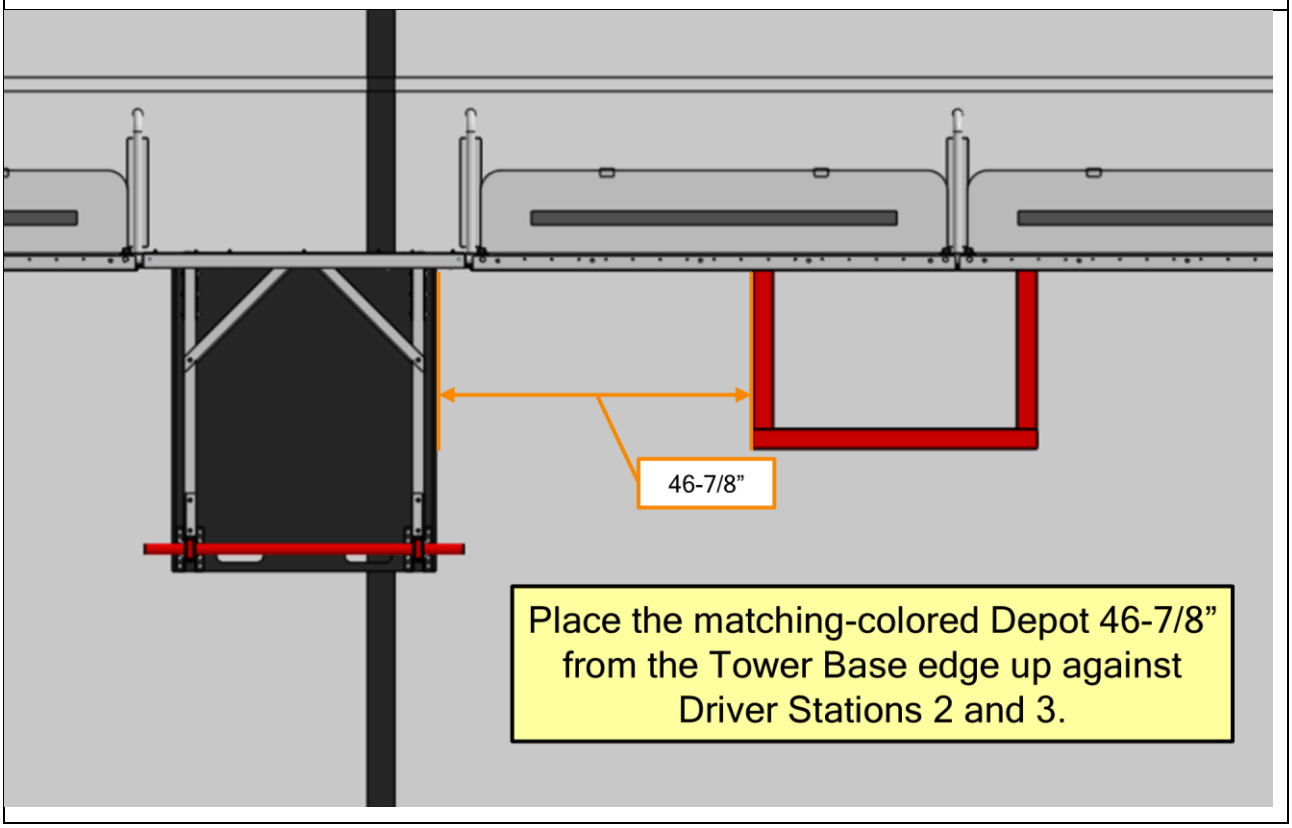
9.


Rest the Upper Tower Panel on top of the lower one, and against the driver station uprights. If using a welded perimeter, use the Top Rail Assembly to contain the panel. If using an AndyMark perimeter, the top tube doesn't hold the panel, so it will need to be supported while the cable ties are being added.
REBUILT
Attach the Upper Tower Panel with 7x 120lb cable ties, 3x around the top rail and 4x around the wall weldment and through the Lower Tower Panel.

10.


ID 15
ID 16
Attach April Tags 15 and 16 to the Red Tower and 31 and 32 to the Blue Tower with 1” long ¼-20 hex head bolts and lock nuts on the back side. Tags 15 and 31 are centered on the panel, 16 and 32 are biased to the right.
INCHES
1
2
3
4
5
6

11.


46-7/8”
Place the matching-colored Depot 46-7/8” from the Tower Base edge up against Driver Stations 2 and 3.

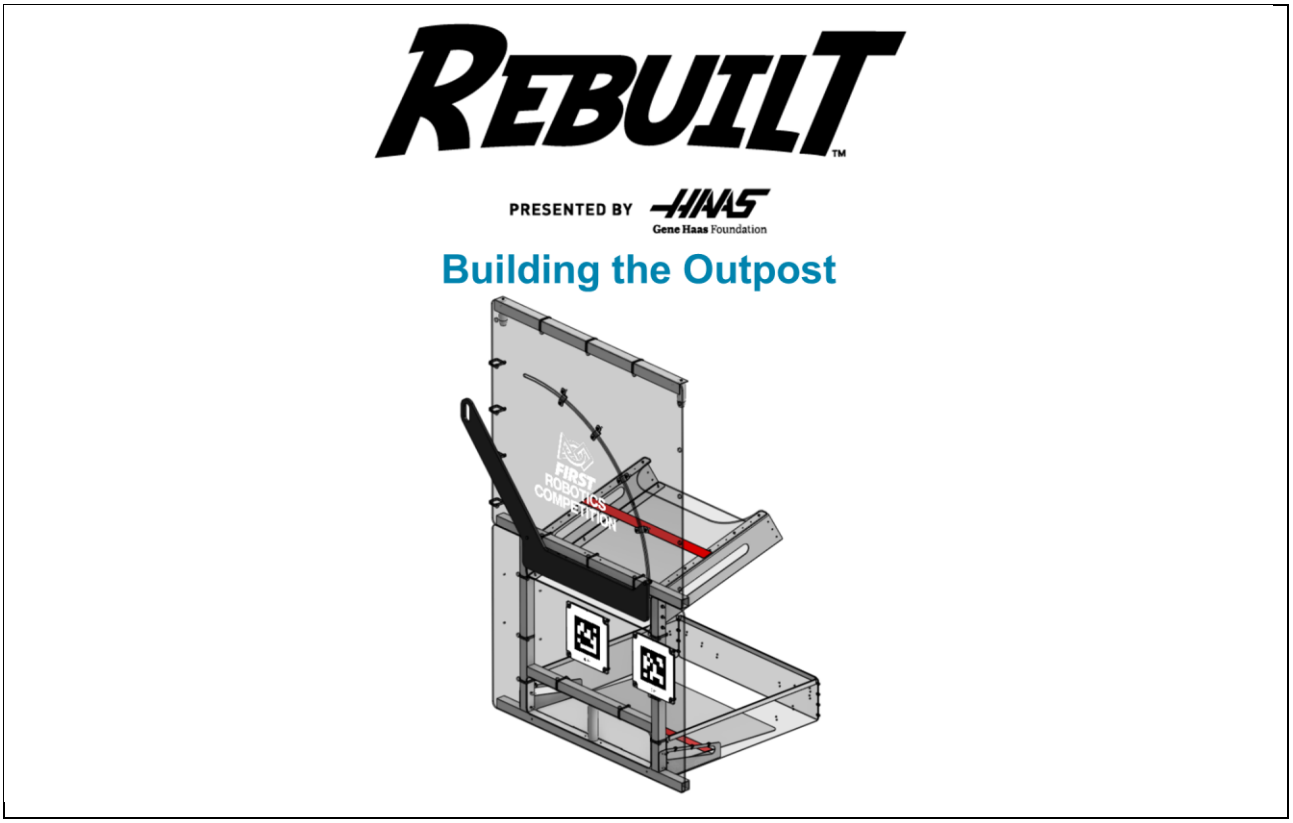
3.10 Outpost

There will be two outposts, one in each alliance wall. Assembly can begin once the alliance wall is built.

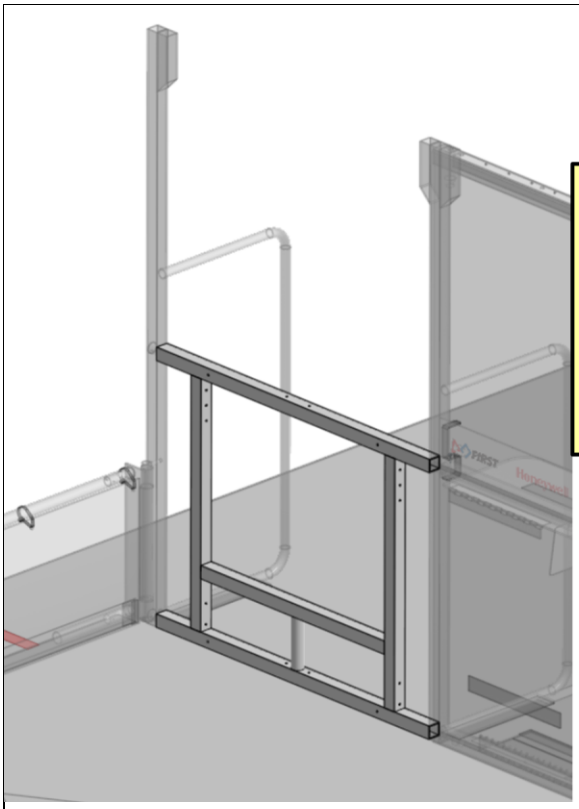
3.10.1 Tools & Equipment

- Case 23 or 24
- Phillips Screwdriver (P2)
- Side Cutters
- 7/16” Wrenches, Socket and Ratchet
- Red, White and Blue Gaff Tape (week 1 only)
- Drill with 3/16” bit (optional)

3.10.2 Assembly

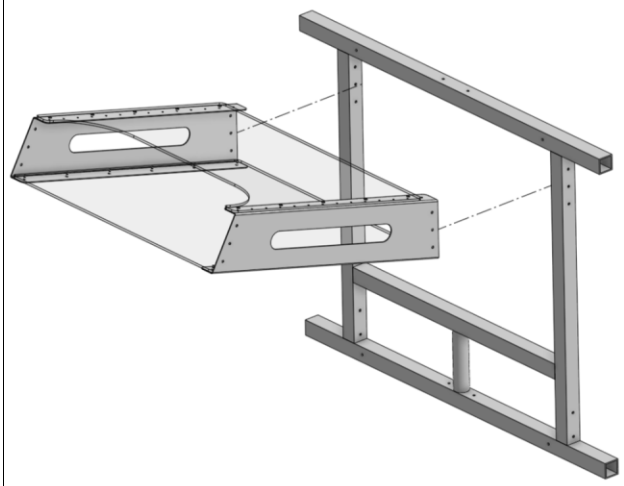
1. 

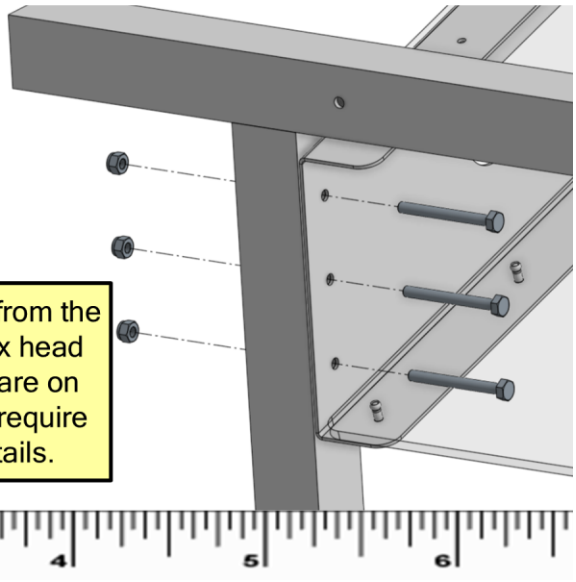
2.



Start by locating the wall weldment for the Outpost that was placed when assembling the field border. Most of the remaining steps will not show the alliance stations surrounding the Outpost for convenience.

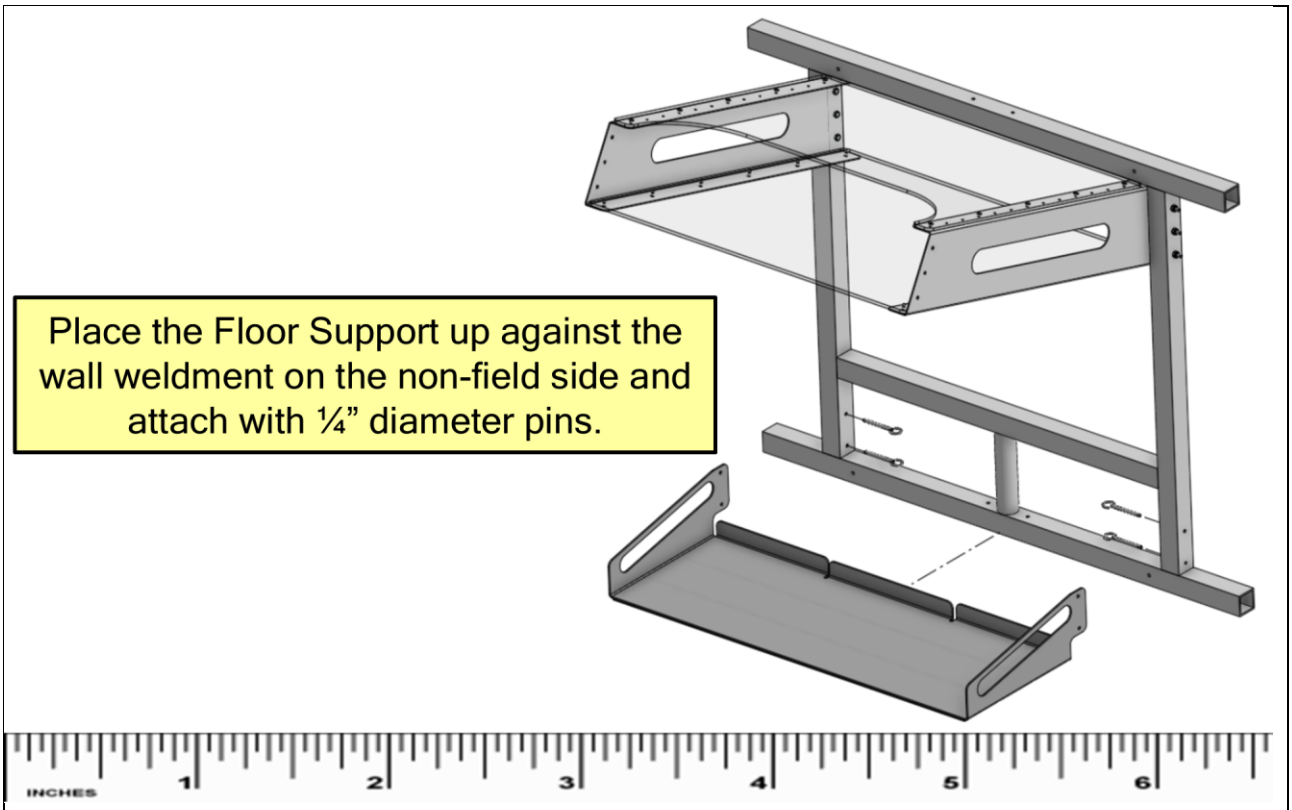
3.



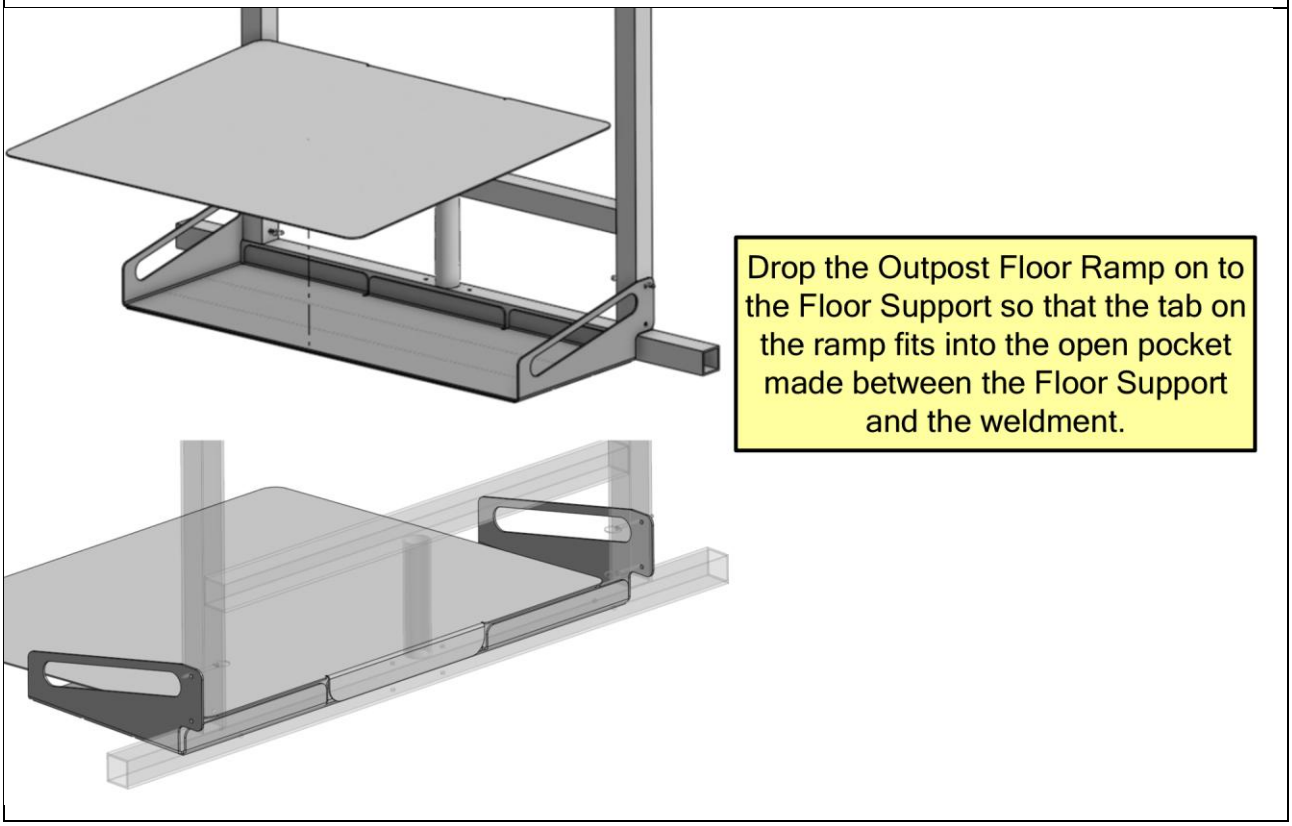


Slide the Chute into the inside of the wall weldment from the non-field side and attach with 6x 2.5" long ¼-20 hex head bolts and lock nuts. Make sure that the bolt heads are on the inside of the Chute. This may be very tight and require some extra attention – see Section 6 for more details.

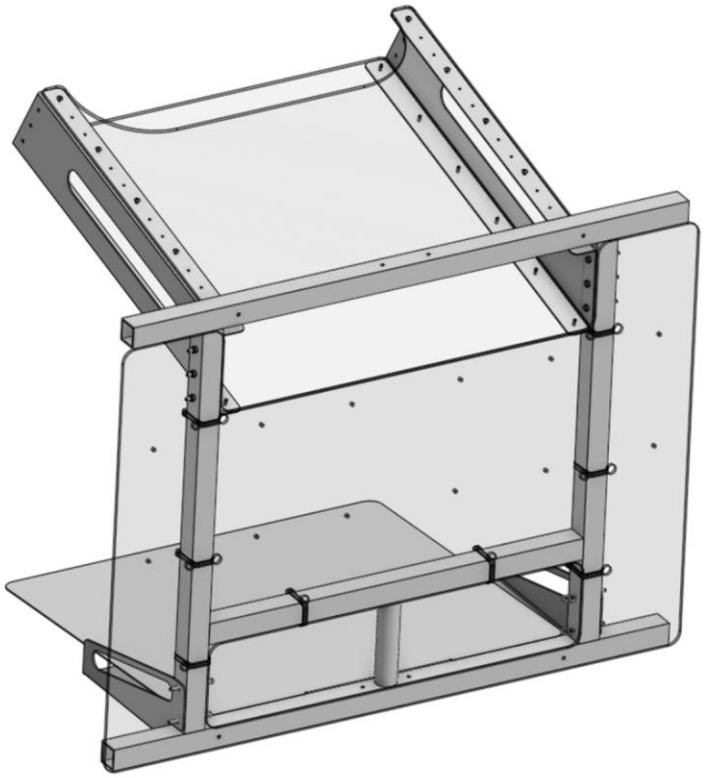
4.


Place the Floor Support up against the wall weldment on the non-field side and attach with ¼" diameter pins.
INCHES
1
2
3
4
5
6

5.

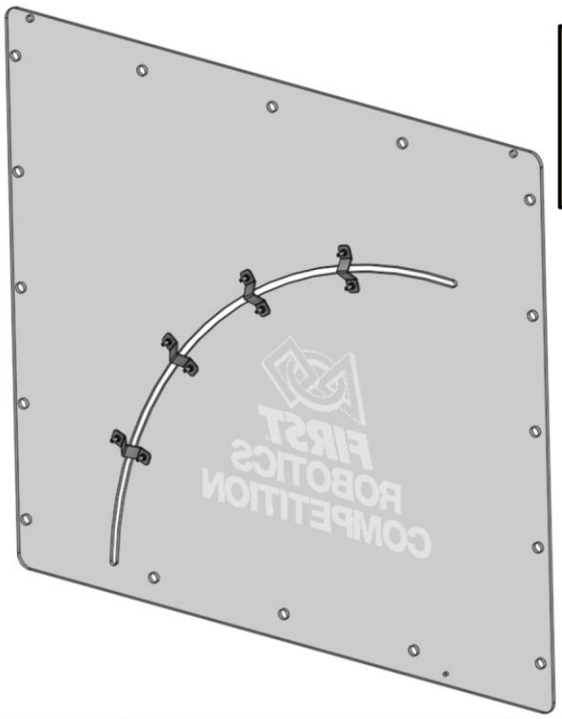

Drop the Outpost Floor Ramp on to the Floor Support so that the tab on the ramp fits into the open pocket made between the Floor Support and the weldment.

6.

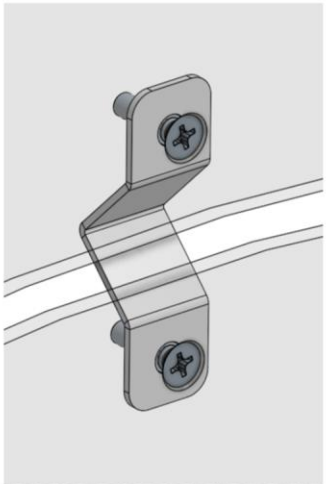


Place the Outpost Lower Panel up against the weldment on the floor, using the cutouts to line up. Attach using 8x 120lb cable ties, keeping cable tie heads on the back of the assembly and out of any of the openings.

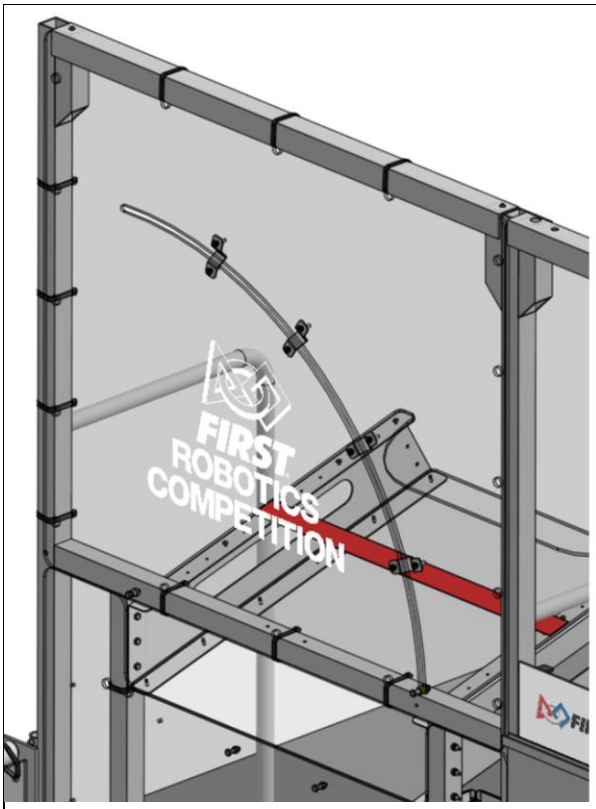
7.



Attach the Outpost Slot Support brackets to the Outpost Upper Panel using 1” long ¼-20 Countersink Bolts into the PEM nuts. The bracket should be on the back side of the panel so that the logo is backwards when looking at the side the brackets are on.

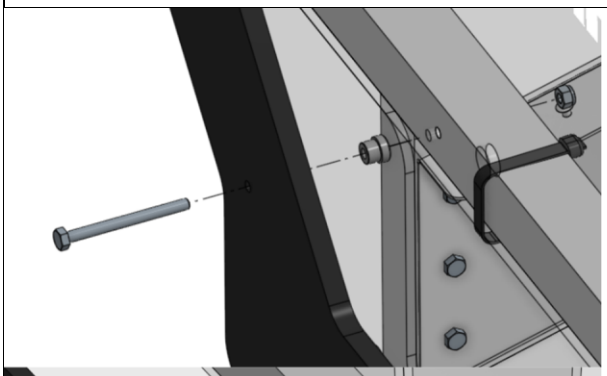


8.

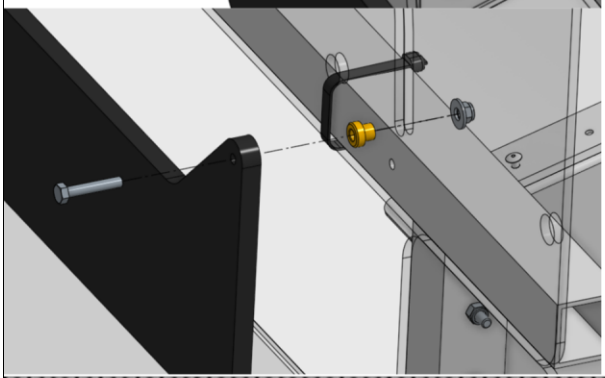


Rest the Upper Tower Panel on top of the lower one, and against the driver station uprights. If using a welded perimeter, use the Top Rail Assembly to contain the panel. If using an AndyMark perimeter, the top tube doesn't hold the panel, so it will need to be supported while the cable ties are being added. Attach the panel with 10x 120lb cable ties, 3x to the top rail, 3x around the wall weldment and 4x around the corner upright of the field border.

9.

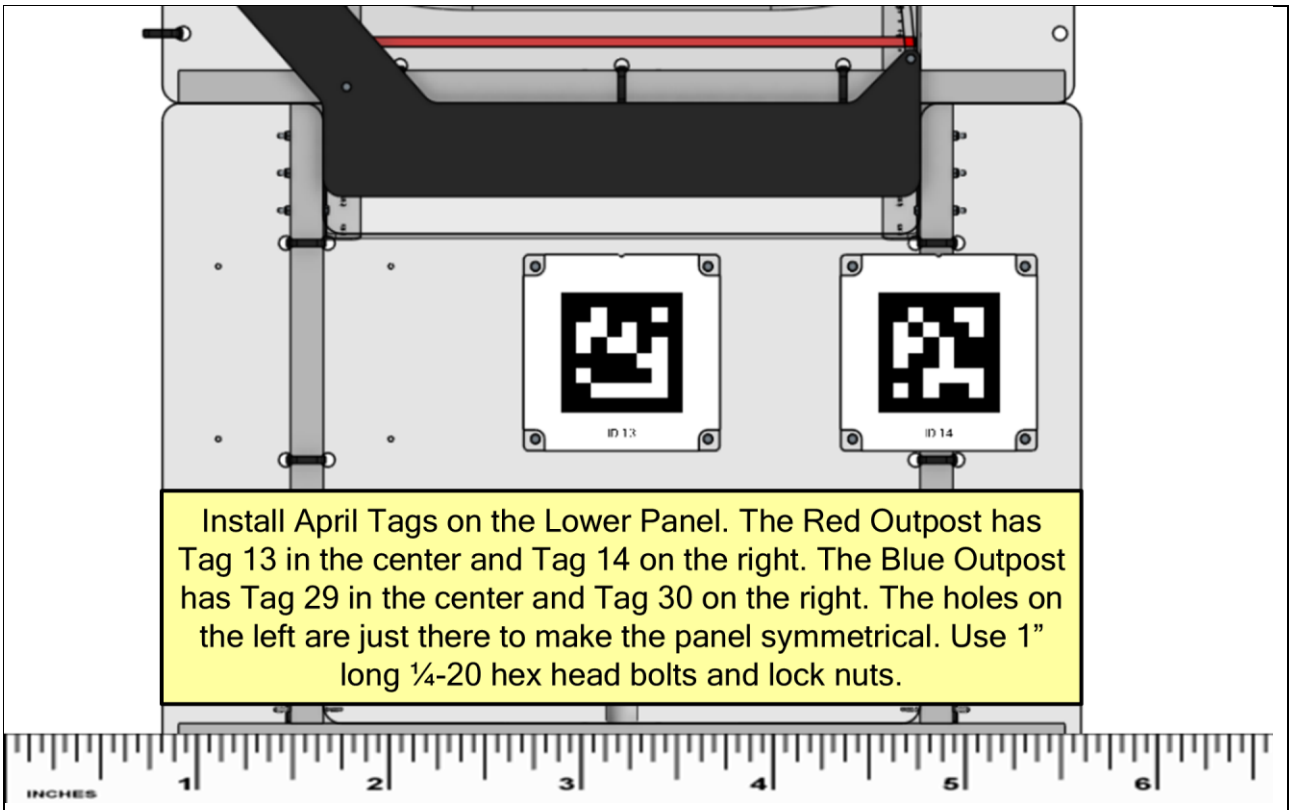


Press the bronze bushing into the Chute Door, then install through both the upper panel and corresponding hole in the wall weldment. You may need two people to help line this up. Attach with a 2.5" long ¼-20 hex head bolt and lock nut.



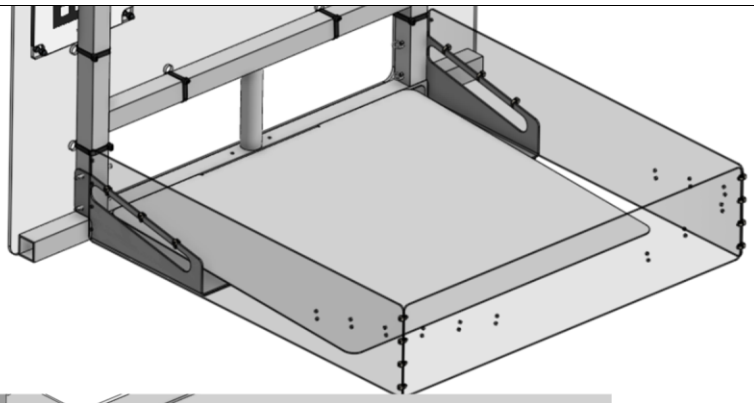
Assemble the hard stop by putting another bolt through the hole on the end of the chute door, sliding the 3D printed bushing onto the bolt so that it fits in the large curved slot, and then tightening it with a washer and locknut. Tightness should be loose enough to allow the Chute Door to slide easily.

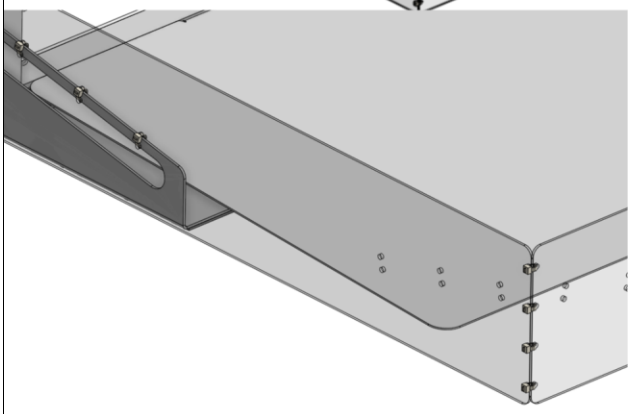
10.



Install April Tags on the Lower Panel. The Red Outpost has Tag 13 in the center and Tag 14 on the right. The Blue Outpost has Tag 29 in the center and Tag 30 on the right. The holes on the left are just there to make the panel symmetrical. Use 1" long ¼-20 hex head bolts and lock nuts.

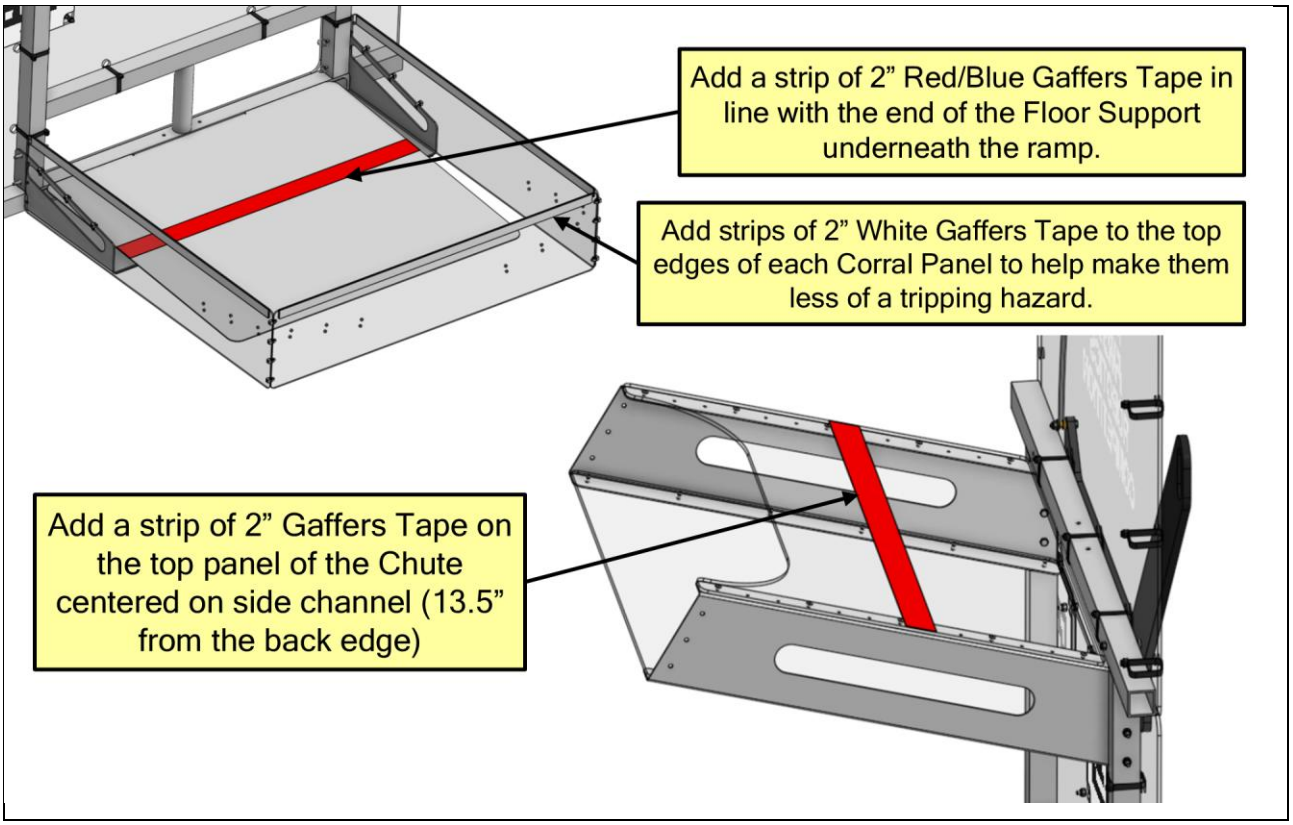
11.





Attach the 3 identical Corral Panels using 14x 50lb cable ties.

12.


Add a strip of 2” Red/Blue Gaffers Tape in line with the end of the Floor Support underneath the ramp.
Add strips of 2” White Gaffers Tape to the top edges of each Corral Panel to help make them less of a tripping hazard.
Add a strip of 2” Gaffers Tape on the top panel of the Chute centered on side channel (13.5” from the back edge)

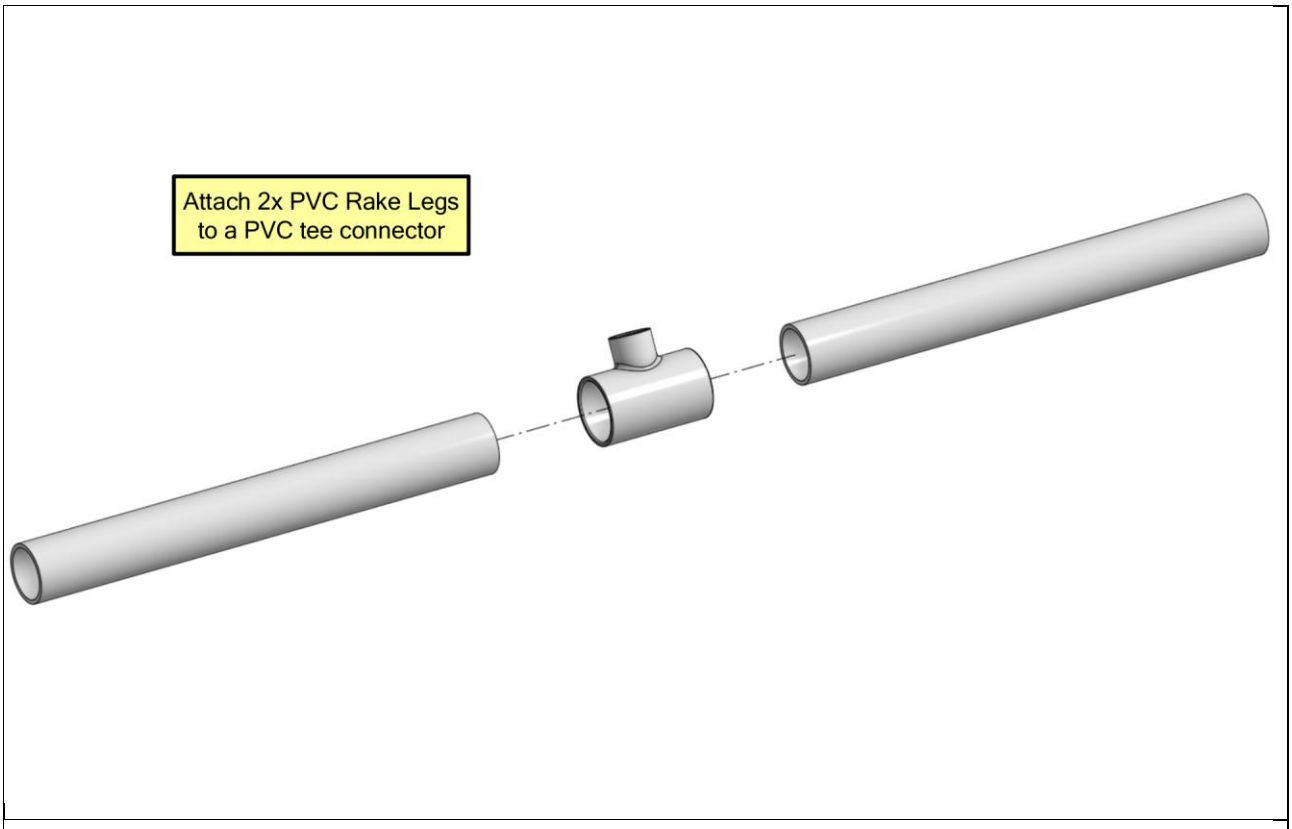
3.11 Field Reset Tools

There are a few tools provided to assist with Field Reset. This section details preparing the Fuel Rakes and Fuel Trays for use. 4 Fuel Rakes can be assembled, and 10 Fuel Tray boxes are provided for the first events. The FTA/Field Supervisor may decide how many of each are needed to properly perform field reset functions. Particularly, the number of boxes provided is expected to be excessive for use during one event.

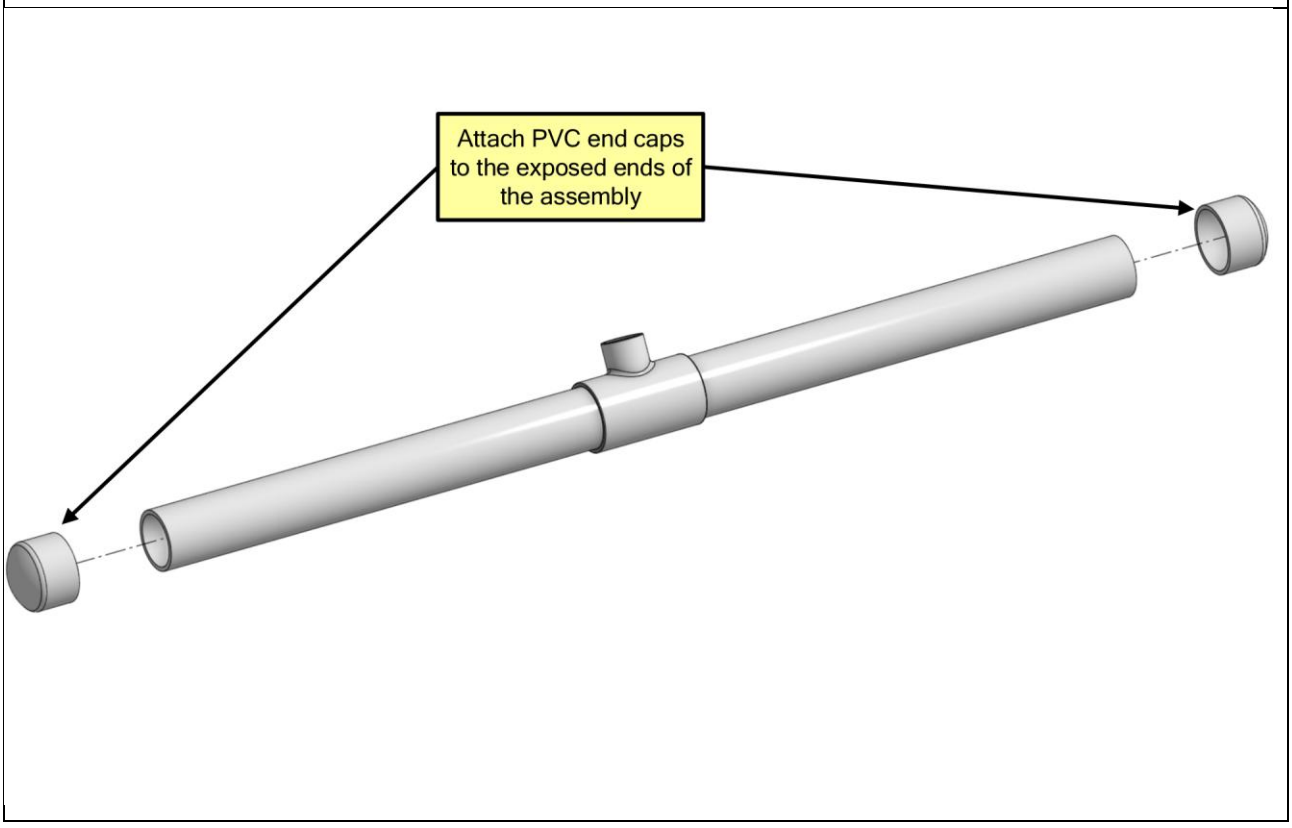
3.11.1 Assembly

1. 

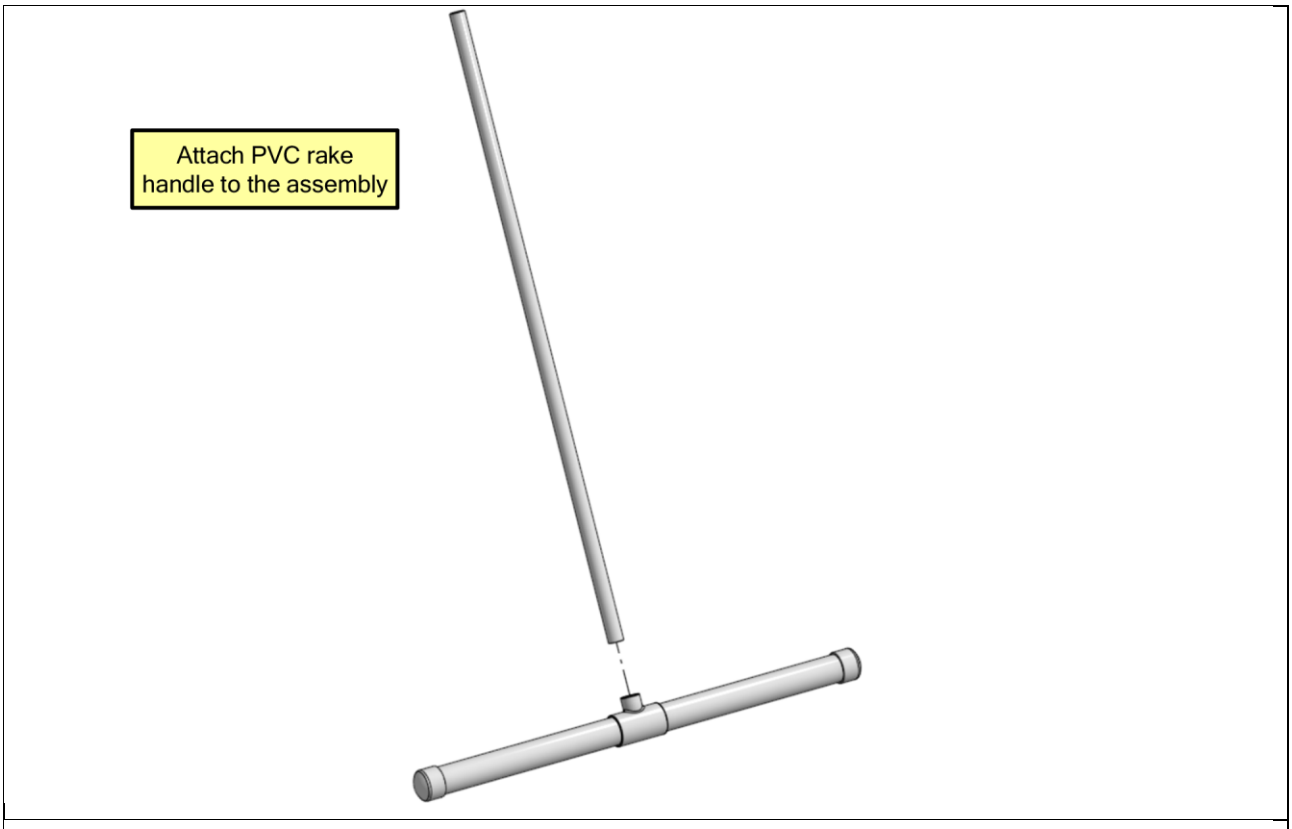
2.


Attach 2x PVC Rake Legs to a PVC tee connector

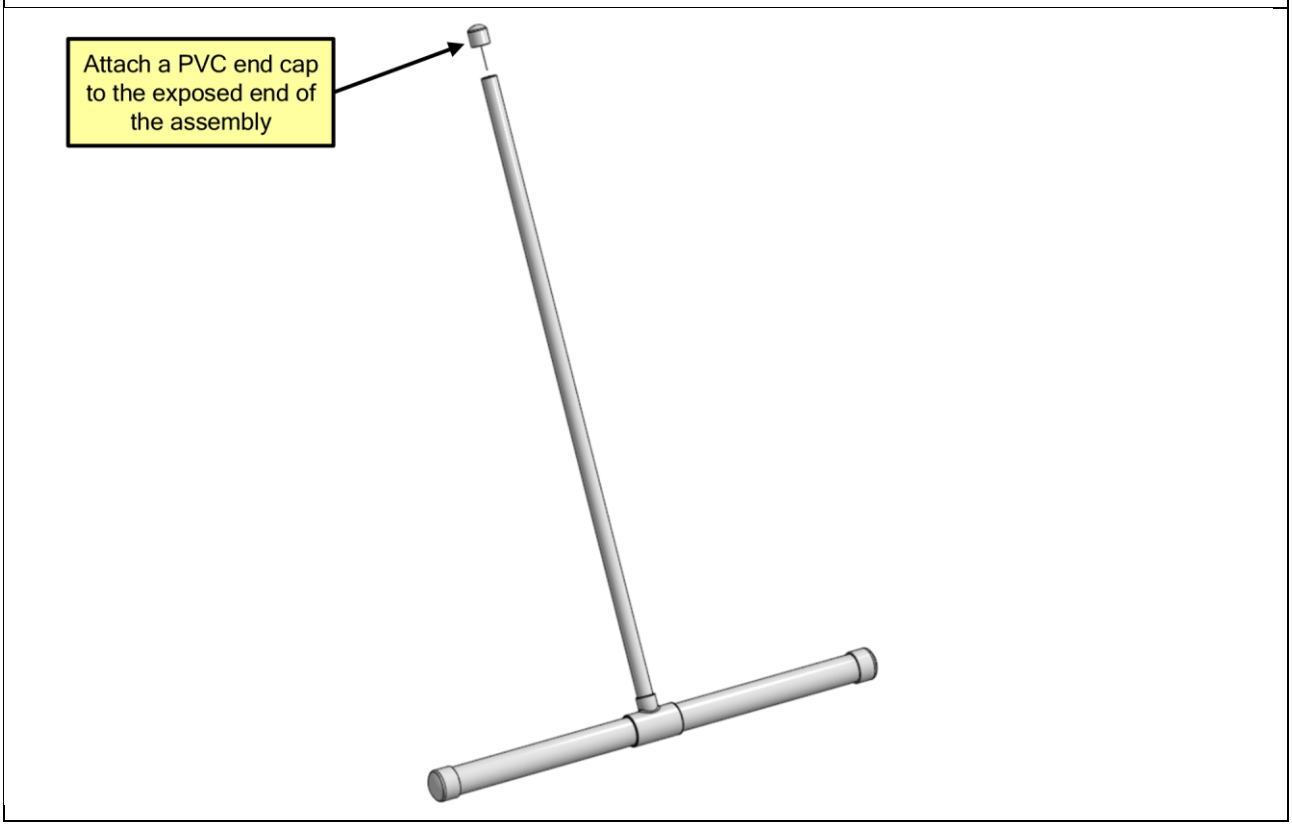
3.


Attach PVC end caps to the exposed ends of the assembly

4.


Attach PVC rake handle to the assembly

5.


Attach a PVC end cap to the exposed end of the assembly

6.

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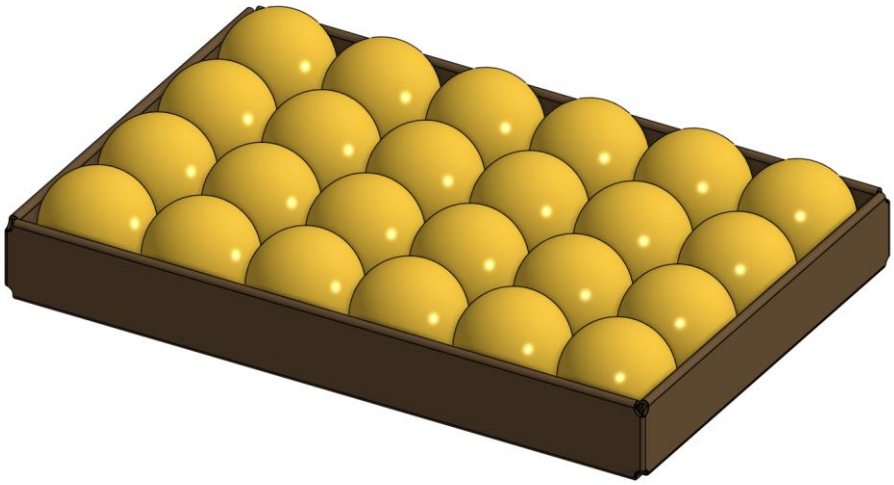
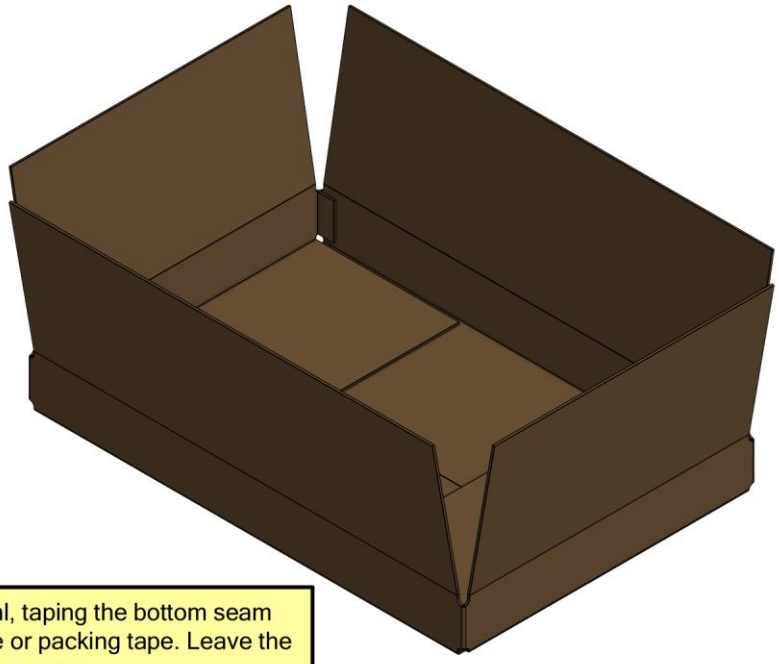
Modifying Fuel Trays

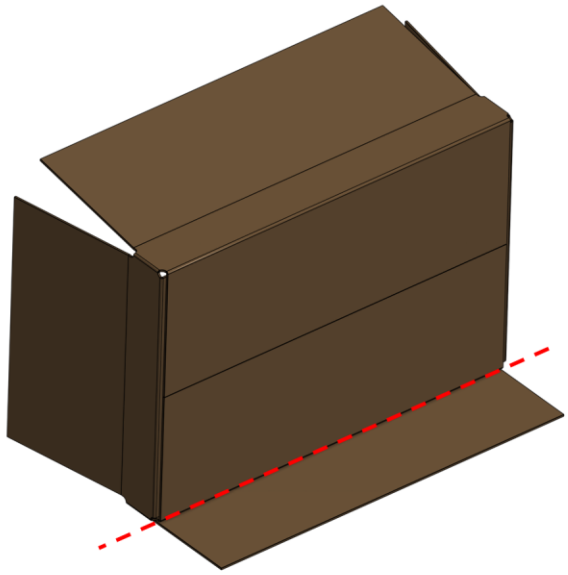


7.



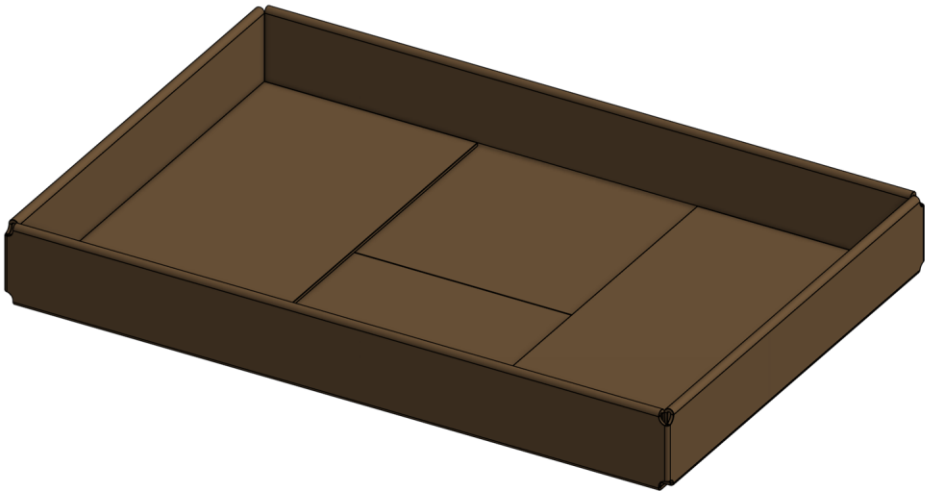
Fold box as normal, taping the bottom seam closed with gaff tape or packing tape. Leave the top open.

8.



Fold one of the top flaps outward so that it protrudes past the bottom of the box. Trim the flap so that it is even with the bottom of the box. Repeat for all four top flaps.

9.



Fold the top flaps into the middle of the box. If they do not stay on their own, you may need to apply some tape so that they do not unfold.

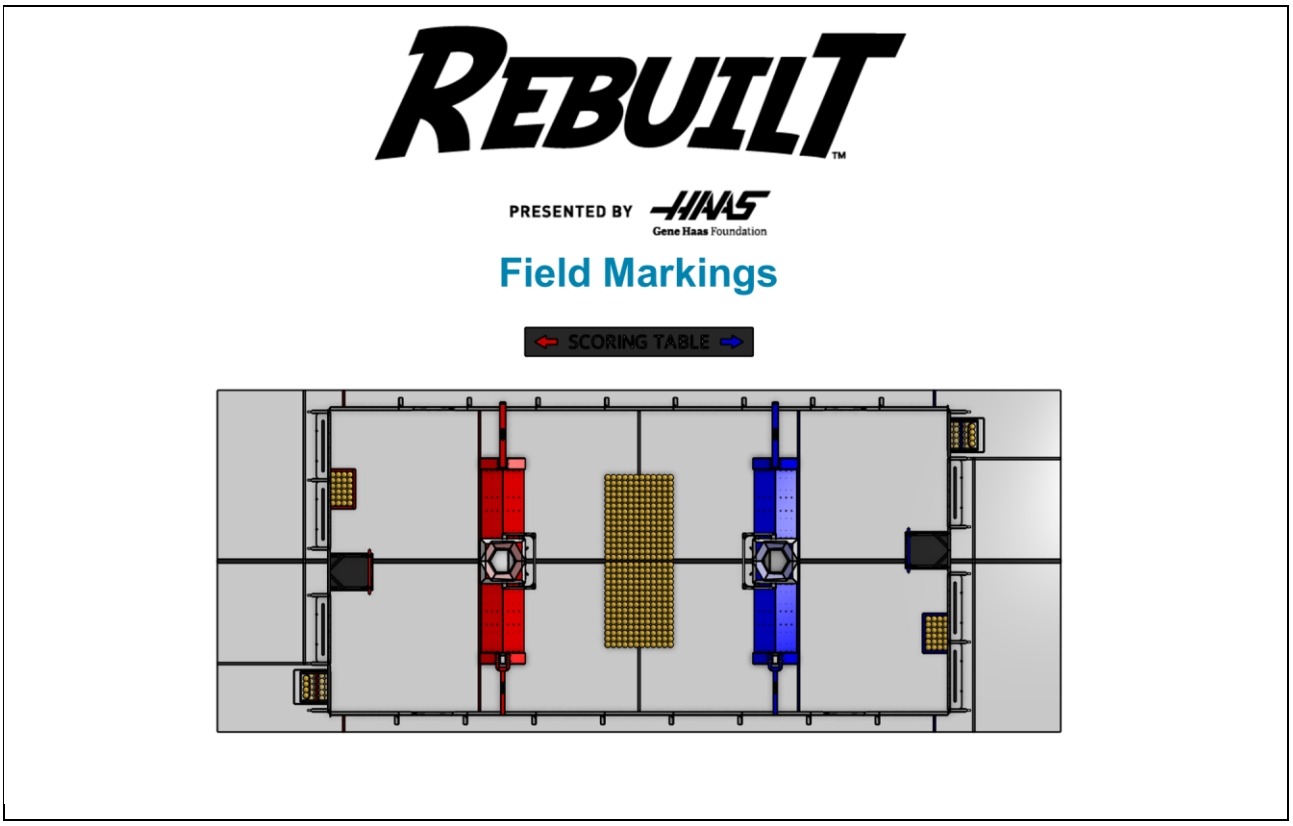
3.12 Field Markings

This will document the layout of the tape and field reset markings.

3.12.1 Tools & Equipment

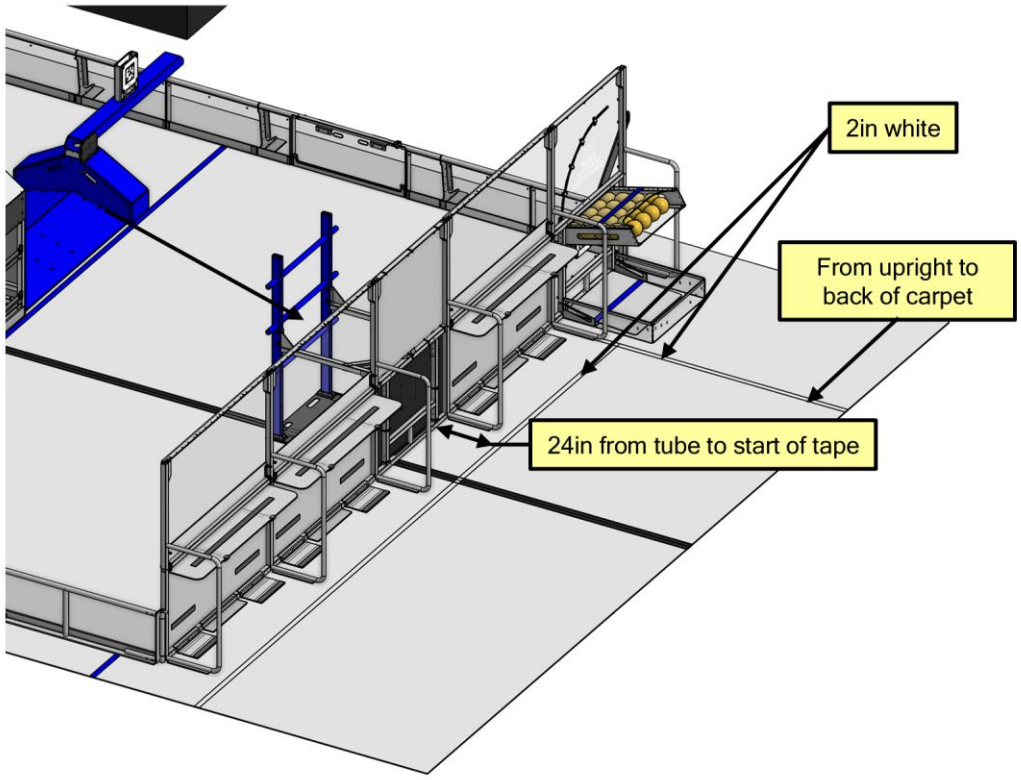
- Sharpie
- 2” Gaff Tape (Red, Blue, and White)
- 25’ Tape Measure
- Chalk Line

3.12.2 Assembly

10. 

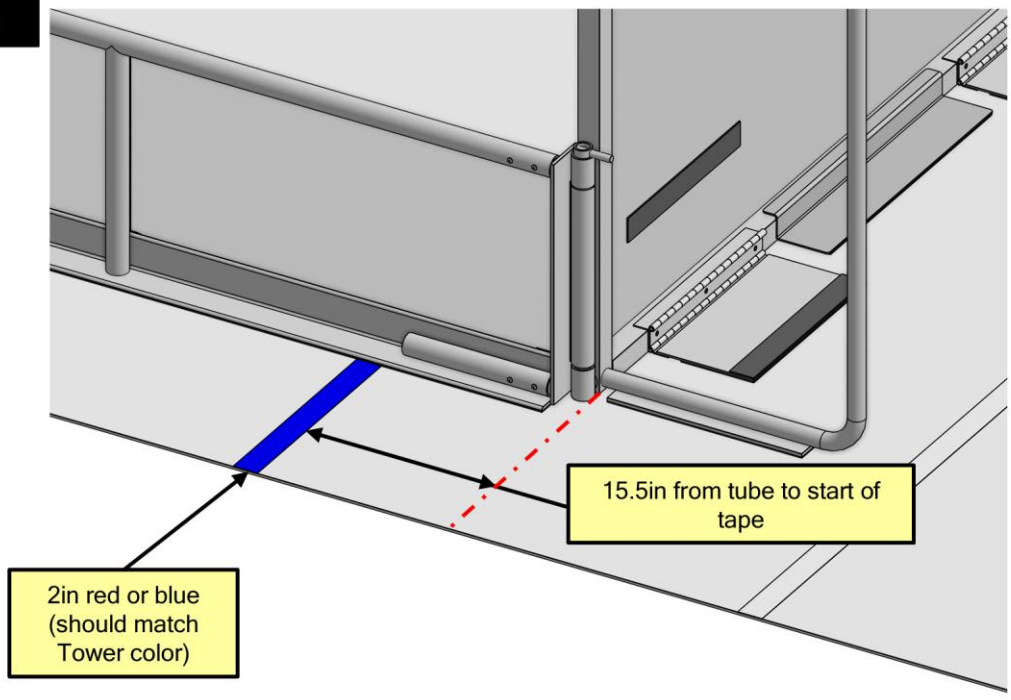
11.

2X

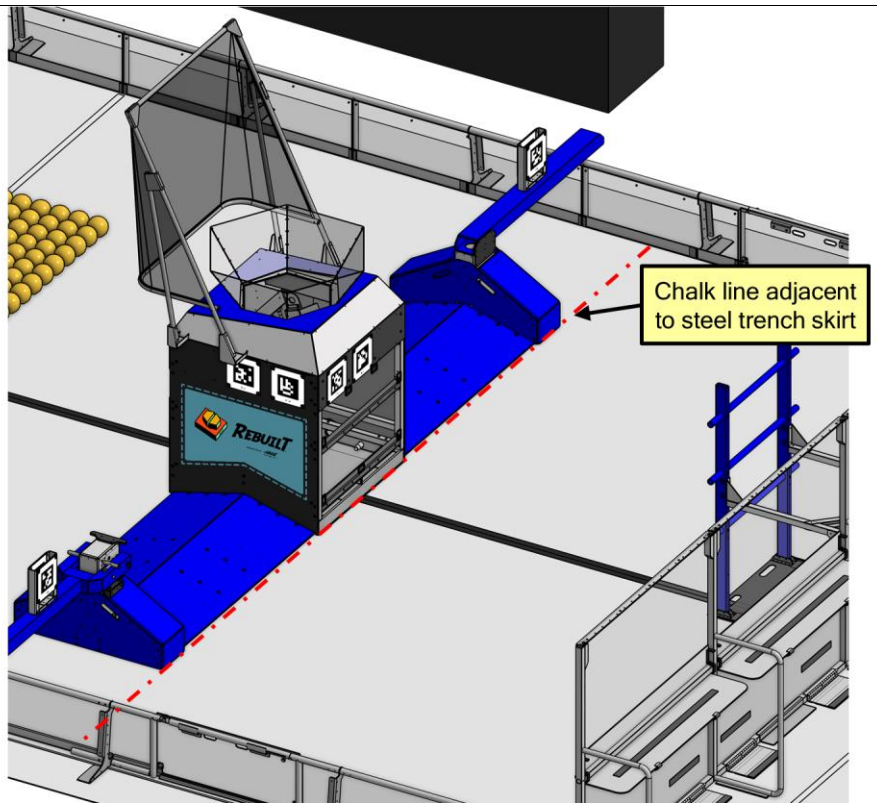

2in white
From upright to back of carpet
24in from tube to start of tape

12.

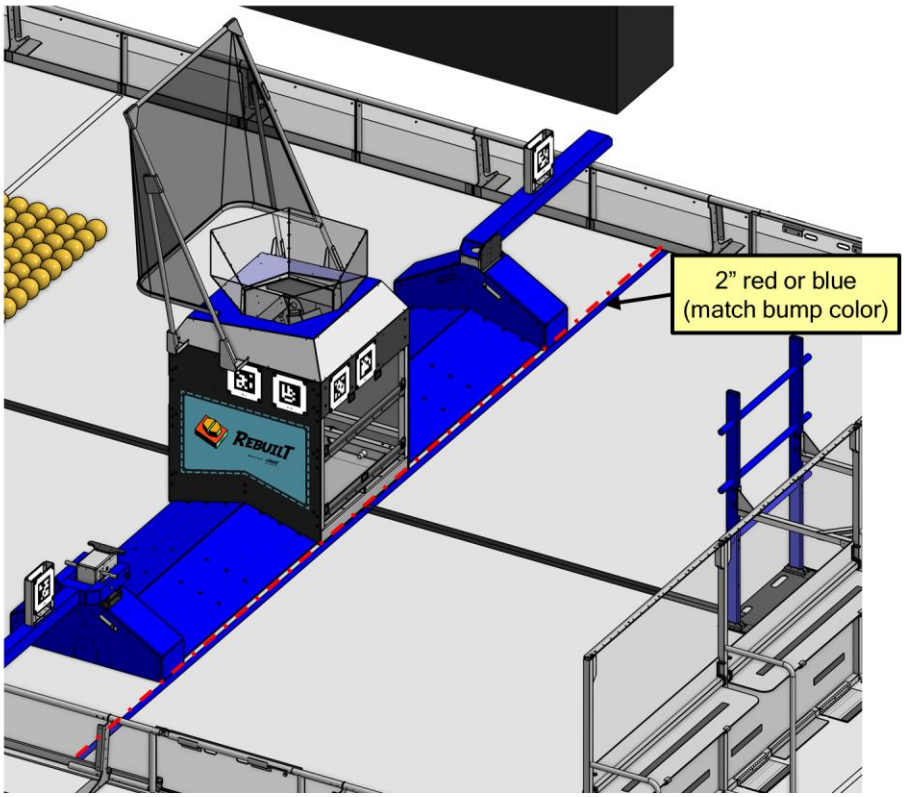
4X


15.5in from tube to start of tape
2in red or blue (should match Tower color)

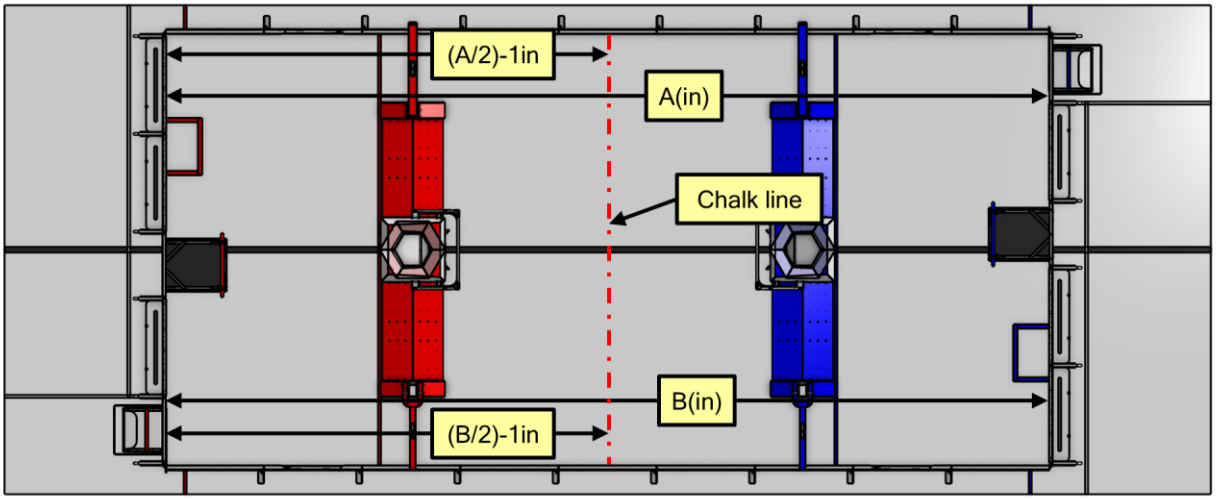
13. 2X


Chalk line adjacent to steel trench skirt

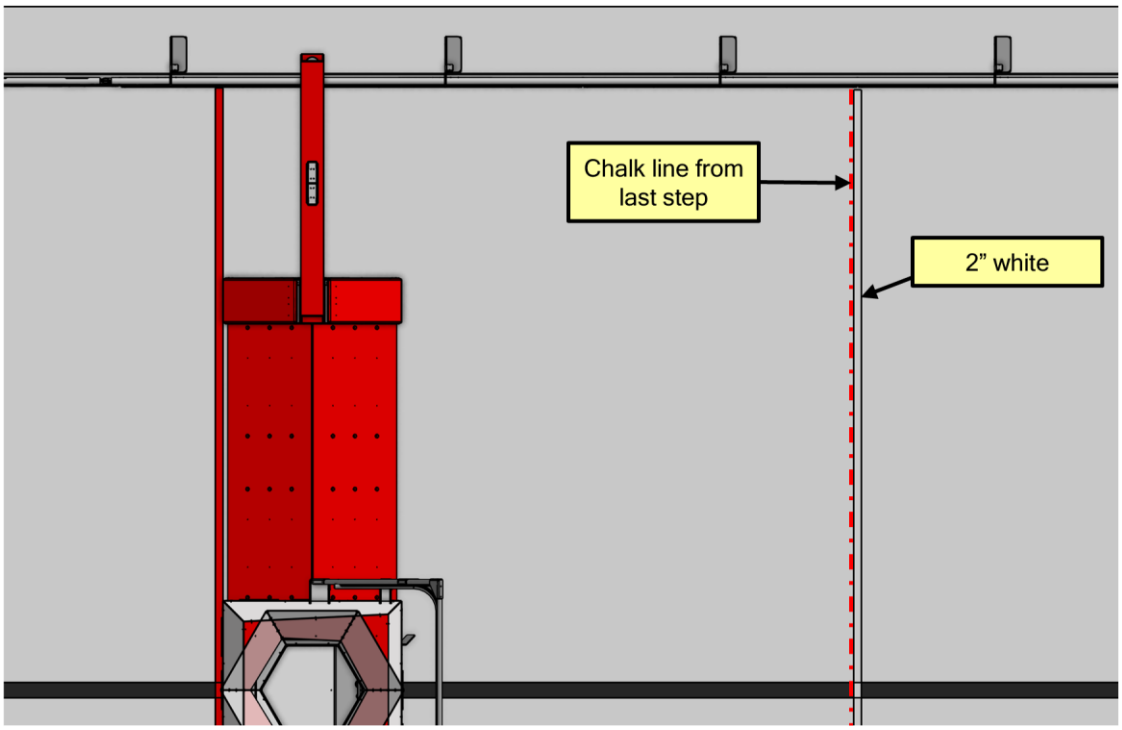
14. 2X


2” red or blue (match bump color)

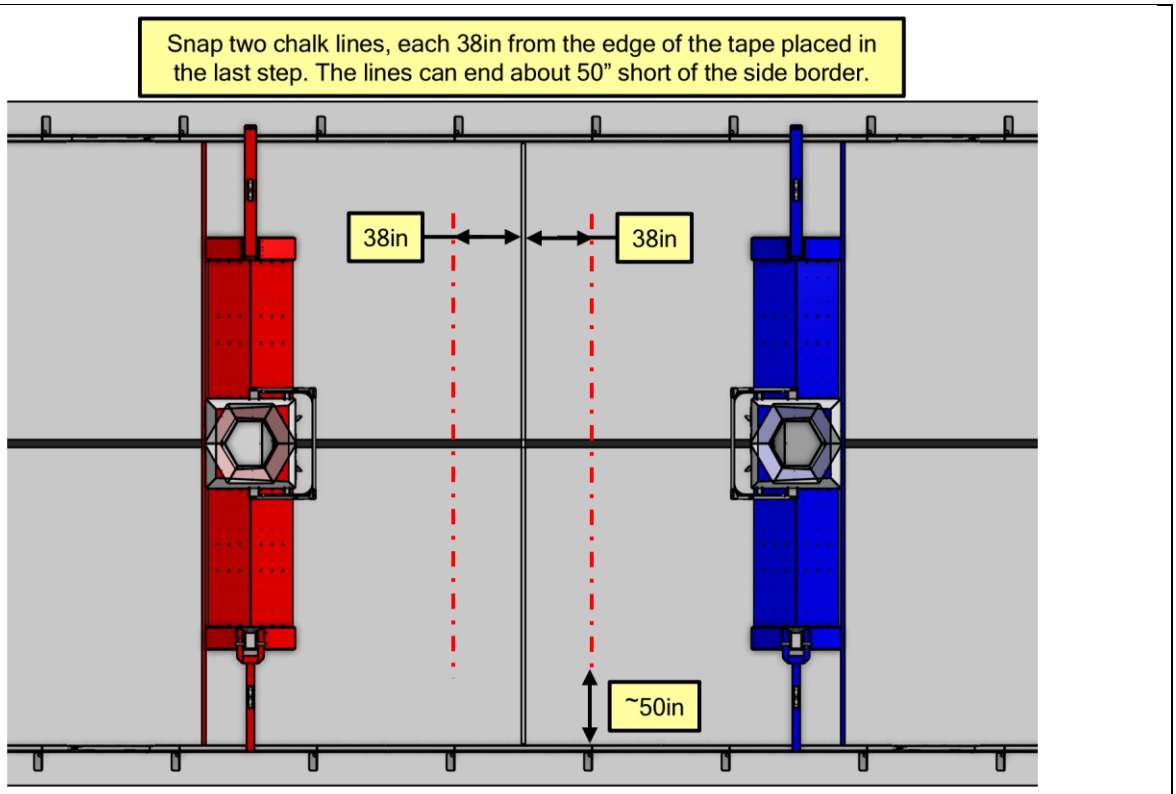
15.


(A/2)-1in
A(in)
Chalk line
B(in)
(B/2)-1in

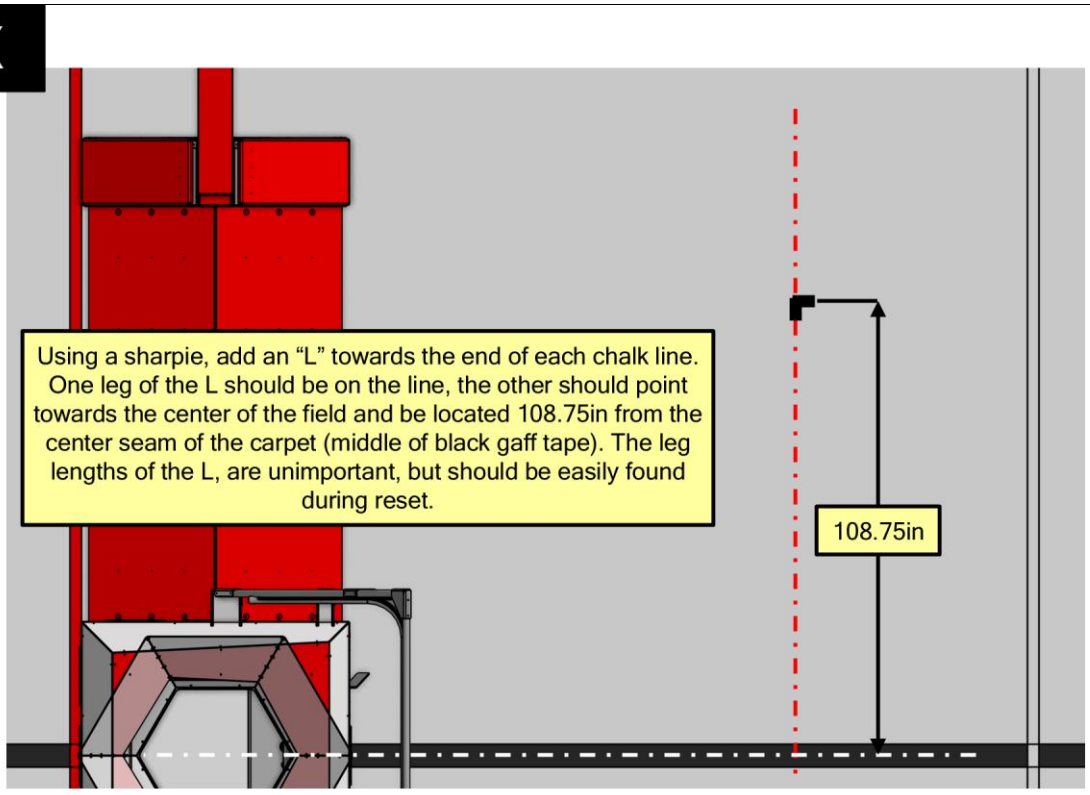
16.


Chalk line from last step
2” white

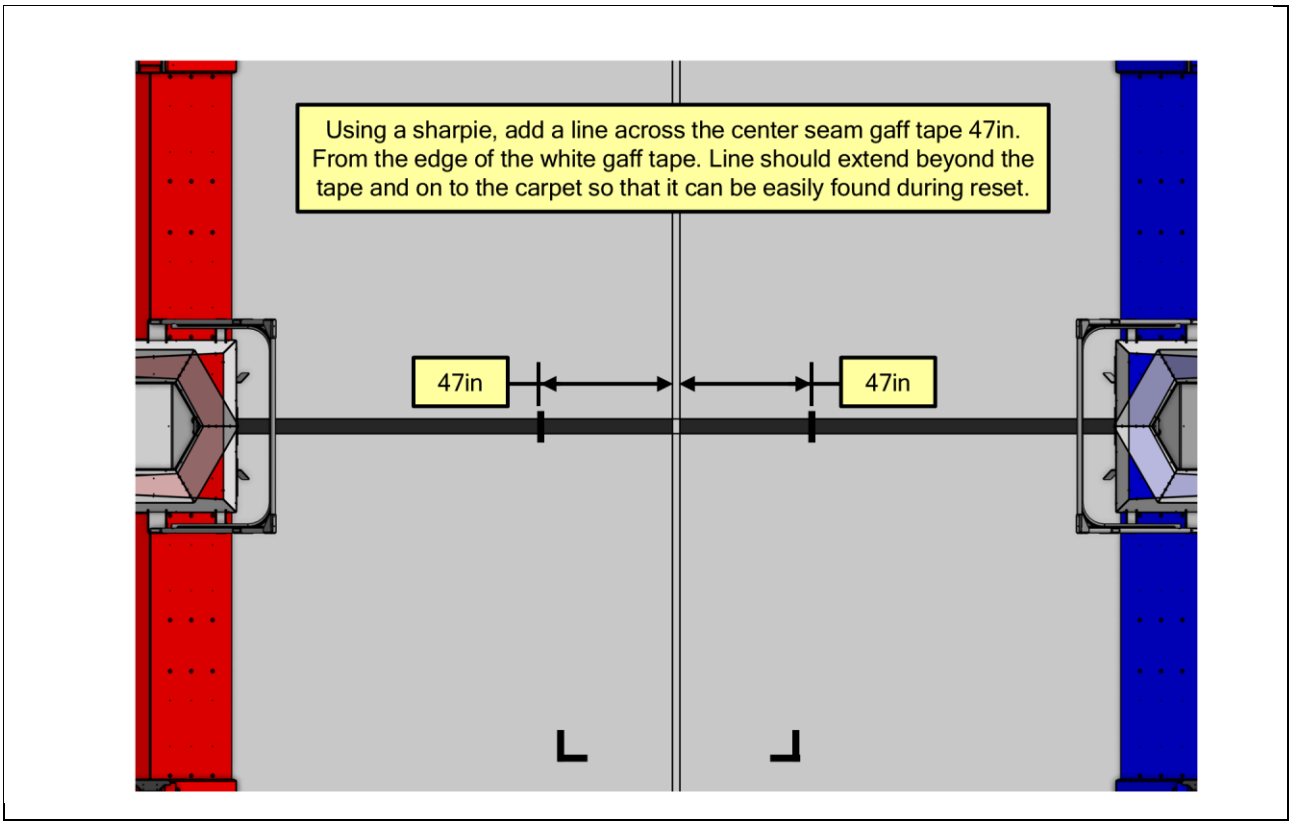
17.


Snap two chalk lines, each 38in from the edge of the tape placed in the last step. The lines can end about 50” short of the side border.
38in
38in
~50in

18.


4X
Using a sharpie, add an “L” towards the end of each chalk line. One leg of the L should be on the line, the other should point towards the center of the field and be located 108.75in from the center seam of the carpet (middle of black gaff tape). The leg lengths of the L, are unimportant, but should be easily found during reset.
108.75in

19.


Using a sharpie, add a line across the center seam gaff tape 47in. From the edge of the white gaff tape. Line should extend beyond the tape and on to the carpet so that it can be easily found during reset.
47in
47in

3.13 Scoring Elements

Fuel should be inspected upon initial field setup for gashes, lost chunks, or other abnormalities that would cause it to act differently than intended. Fuel that is planned on being used should be taken out of their cardboard boxes during field setup, as they can have some small flat spots from being up against the edges of the box during shipping, and time sitting outside of the box will allow the foam to relax and reduce these spots.

During the event, field staff should replace Fuel with significant damage or wear.

Guidance will be provided on the timing and quantities for replacements. This guidance will be updated throughout the season as data and feedback is collected from events.

Examples of Fuel that should be replaced:

- Large gouges.

- Large cuts or abrasions. Damage that exposes a significant amount of underlying foam are the types of the most concern.


- Wear that has removed a large amount of skin.


Examples of Fuel that are suitable to be used:

- Marking or scuffing.


- Faded or worn logos (including completely missing logos).

- Small cuts or abrasions. Deep cuts that are narrow enough not to expose a large amount of foam and aren't likely to entangle or continue tearing may continue to be used.


At the end of the event, the FTA should get a count of Fuel in the following categories:

- Fuel that is no longer playable.
- Fuel that has been used but is still playable.
- Fuel that has not been used at all yet (brand new).

> This information needs to be shared in the event report, and **in the case of a concern that the next event will not have enough Fuel, *FIRST* staff should be contacted directly**. Used or non-playable fuel should not be thrown away and should be forwarded to the next event in clearly labeled boxes.

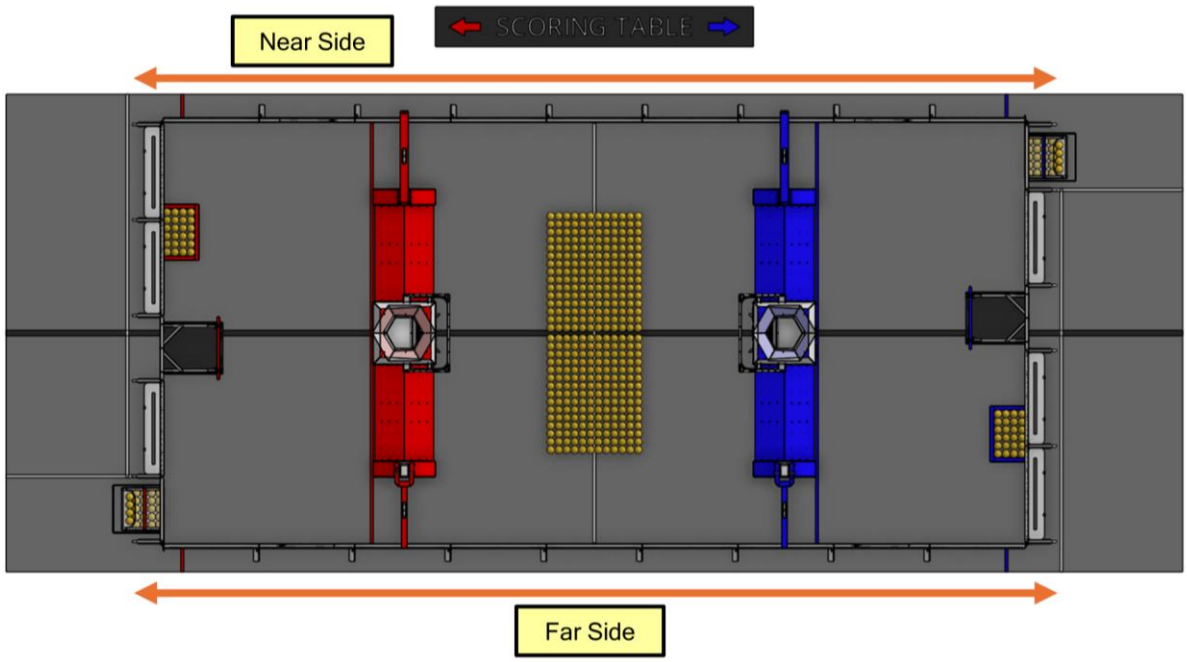
3.14 Scoring Table

The Scoring Table is the headquarters of the field. The field ends and game specifics scoring structure all communicate with the Scoring Table in some form. Placement around the field is relative to the Scoring Table. “Near” is the long side closest to the Scoring Table; “Far” is the opposite side. The blue alliance is to the left of the Scoring Table and the red alliance to the right.

3.14.1 Scoring Table Location

The Scoring Table is located at mid-field and ~5-6 feet from the field side border. The blue alliance and blue field equipment are located to the left-hand end of the field when observed from the Scoring Table.

Figure 3-22: Field Layout



3.14.2 Location of Equipment

Having determined the location of the Scoring Table, crew can unload the contents of Case 7 and move Case 33 into position at the Scoring Table.

> There are two versions of Case 33. Version 2 has a drawer that slides out and contains the Arena Stack Light, Arena Estop and power cable for the case.

The equipment noted below is placed on top of the Scoring Table as shown in Figure 3-23:

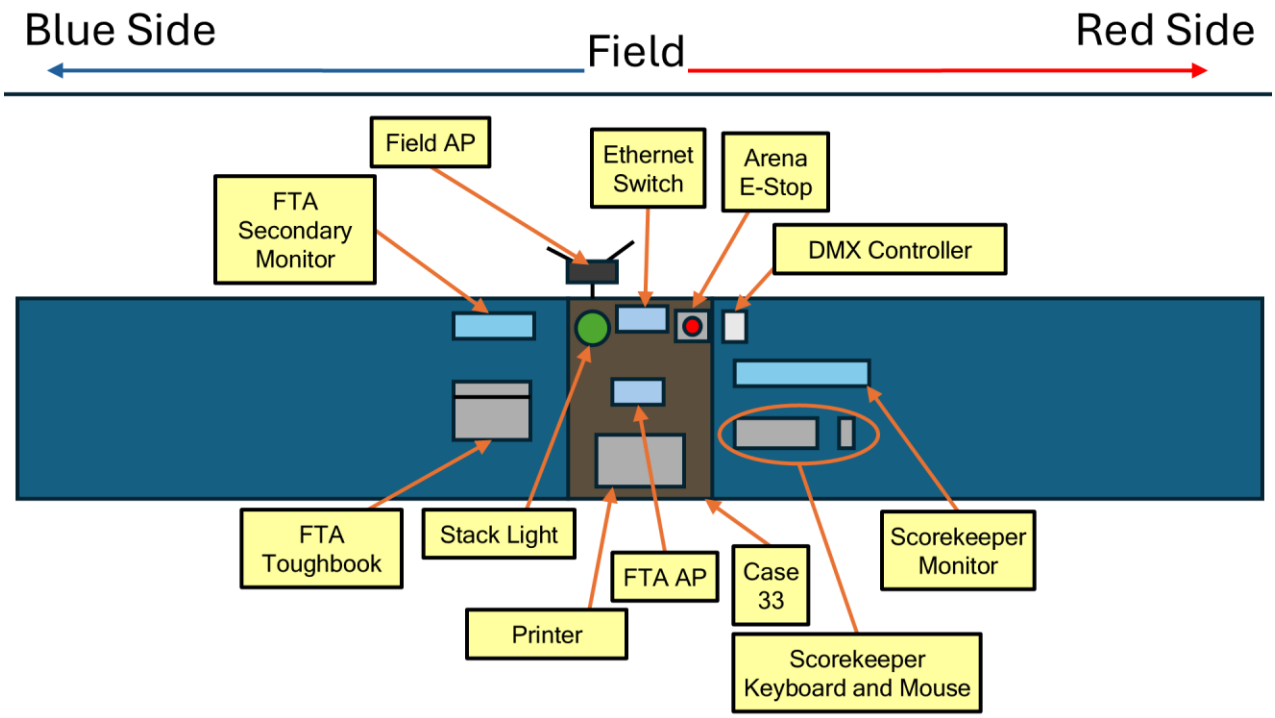
- Keyboard and mouse for the scorekeeper
- Monitor for the scorekeeper

- Field Access Point
  - AP Tray (found in case 7)
  - POE Adapter (found in case 7)
  - AP Stand (found in case 34)
- FTA Access Point (optional)
- Arena E-Stop
- Ethernet Switch (not needed with version 2)
- FTA Toughbook w/ secondary monitor
- Arena Stack Light
- DMX Controller

Equipment placed under the Scoring Table:

- 2 8-outlet power strips

Figure 3-23: Scoring Table Layout



Each Case 33 has a Field side and a Scorekeeper side. The “field side” faces the field and is easily distinguished by the Ethernet ports for the blue and red SCCs. Figure 3-24 and Figure 3-25 show version 1 of Case 33.

Figure 3-24: Case 33 – Version 1 – Field Side

Figure 3-25: Case 33 - Version 1 – Scorekeeper side

Figure 3-26: Case 33 - Version 2 – Field side

Figure 3-27: Case 33 - Version 2 – Scorekeeper side

3.14.3 Primary Server indication

All primary servers are Lenovo machines and indicated by a green dot, see images below for reference.

Figure 3-28: Primary server (with green dot) on bottom

Figure 3-29: Primary server (with green dot) on top

3.14.4 Wiring the Scoring Table

Connections from the Venue: Verify with the Event office and/or Facility services that the following are installed and available at the Scoring Table:

1. Two dedicated and independent 120VAC/15A drops (one for Scoring Table/Blue Side, and the other for the Red Side)
2. At least one Ethernet (CAT5e or CAT6) for Internet, and the Ethernet cable routed to the Pit in the spot designated for the Pit Toughbook.

8-Outlet power strips: Each power strip is connected to a separate power drop. One is used to power the blue side of the field and the Scoring Table, the other powers the red side of the field.

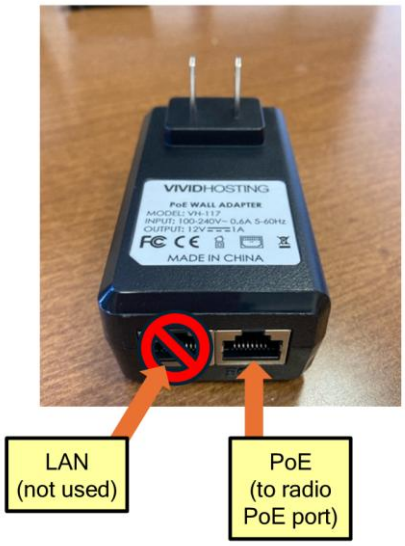
The Field Access Point (AP): A Vivid Hosting VH-113 radio

1. Orient radio as shown in Figure 3-30, indicator lights face the Scoring Table.
2. Ethernet cable from FMS port on the AP to the *Field AP* port on Case 33.
3. Ethernet cable from the PoE port on the wall adapters to the *PoE* port on the AP.

> These need to be 2 separate cables to ensure gigabit capability. No cable goes into the LAN port on the wall adapter.

Figure 3-30: Field Access Point

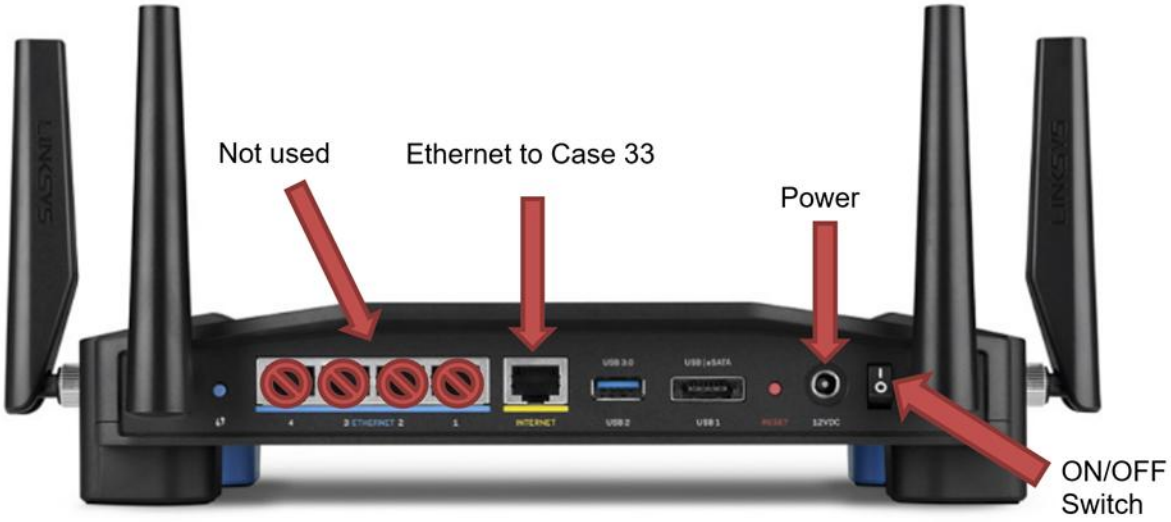
Figure 3-31: Field Access Point PoE Adapter



Default FTA Access Point: A Linksys radio with the following connections (as shown in Figure 3-32) :

1. Ethernet to POE switch at Scoring Table
2. Power Supply to the power strips
3. 4 Radio antennas

Figure 3-32: FTA Access Point



Keyboard and Mouse: Connect into USB ports on the scorekeeper's side of Case 33.

Monitor for scorekeeper: The monitor has two cables; the power cable plugs into the monitor power plug on Case 33.

> Utilizing the monitor power outlets in Case 33 ensure that safe shutdown of the case can be performed in the event of extended power loss to the field.

Ethernet Switch: Connect to the FCUI/PIT port (version 1 only)

Field Monitor: The external monitor connected into the FTA Toughbook and cases the field to display the Field Monitor display webpage to the FTA. Power is connected to the power strip.

Arena Stack Light: Connected to Case 33 and placed on top of the road case beside the Arena E-Stop.

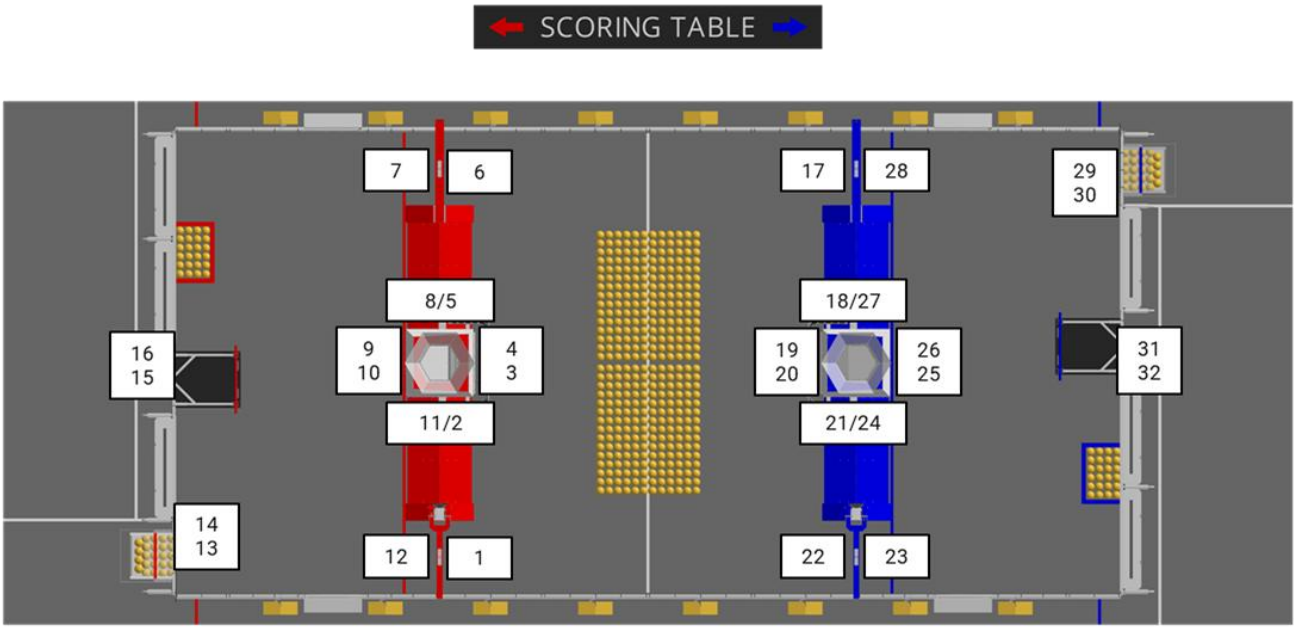
Arena E-Stop: Connects to the yellow Allen Bradley cable attached to Case 33 and is interchangeable with the E-Stops used in each Driver Station.

Field Access Point PoE Adapter: Plugged into the second monitor power plug.

> Utilizing the monitor power outlet in Case 33 prevents the AP from being exposed to voltage spikes and power fluctuations that could negatively impact the device.

3.15 AprilTag Locations

Figure 3-33: AprilTag Locations

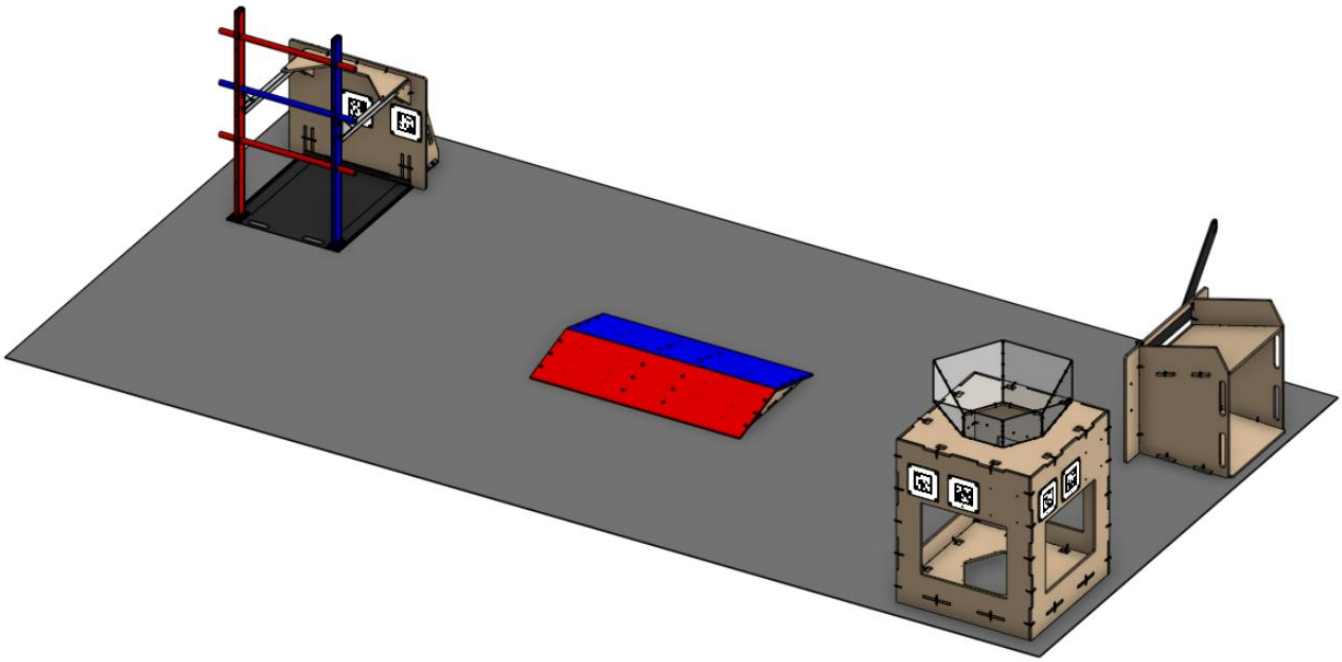


AprilTags are reversible and should be flipped in the case of any scrapes, cuts or peels that could cause robot cameras to mis-identify them. In the case that both sides have damage, white and black gaffers' tape can be used to cover the damaged sections and still match the pattern of the Tag. If both sides have serious damage, contact *FIRST* staff for replacements through the event report system to help aid in replacement for the next event.

4 Test Area

Below is the proposed layout for the Team Test Area (formerly known as the Practice Field). This layout should be followed unless venue constraints require a different layout. Putting the Hub in a corner or surrounded by road cases may be beneficial to keep Fuel from scattering into nearby areas.

Figure 4-1: Test Area Layout

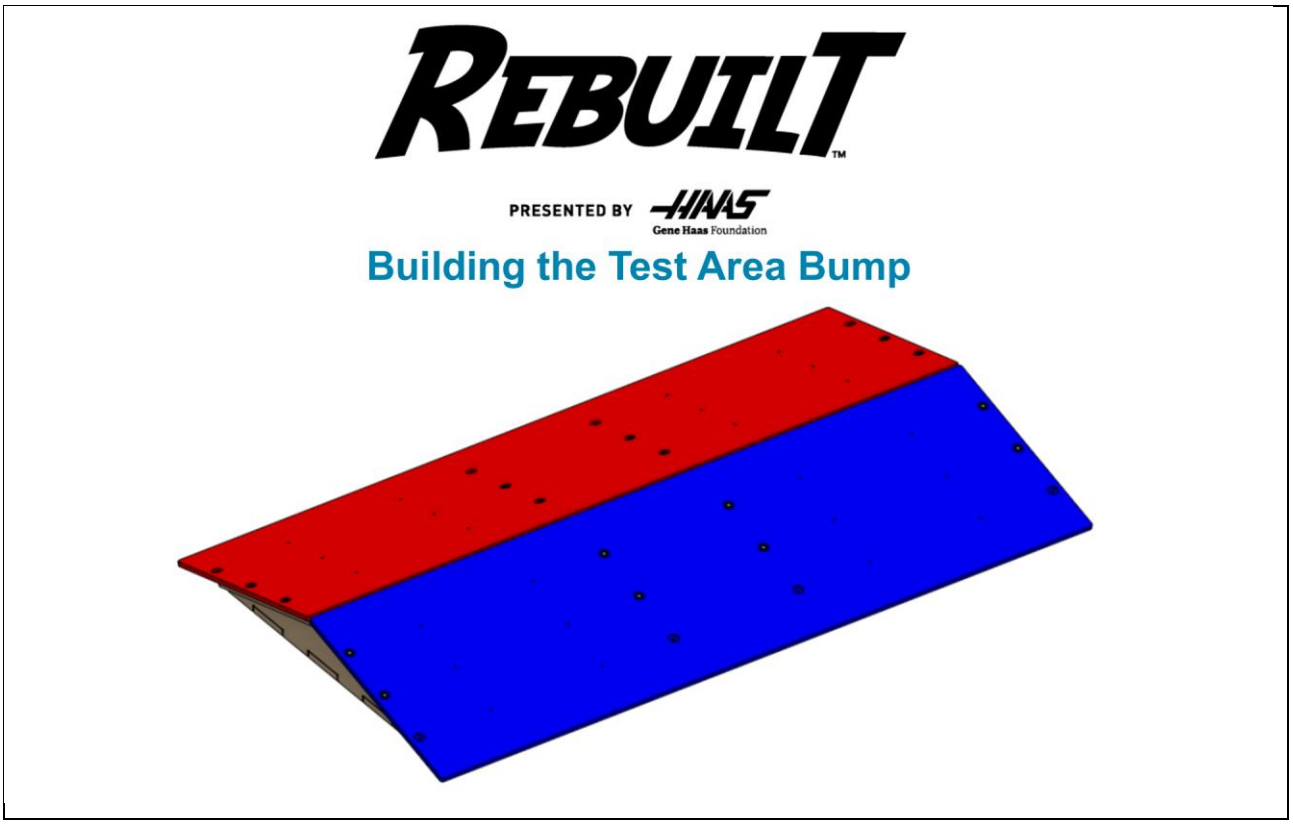


4.1 Test Area Bump

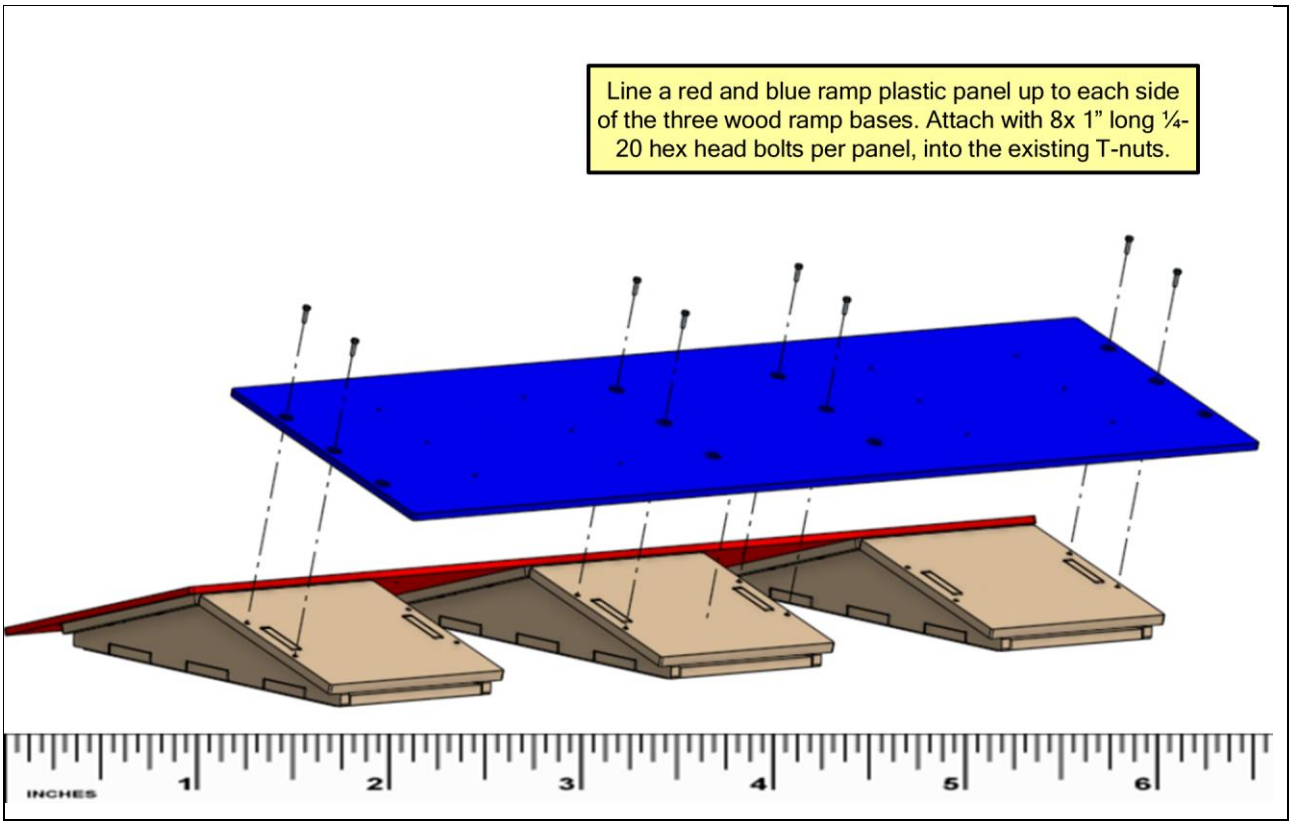
4.1.1 Tools & Equipment

- 7/16 Nut Driver

4.1.2 Assembly

1. 

2.

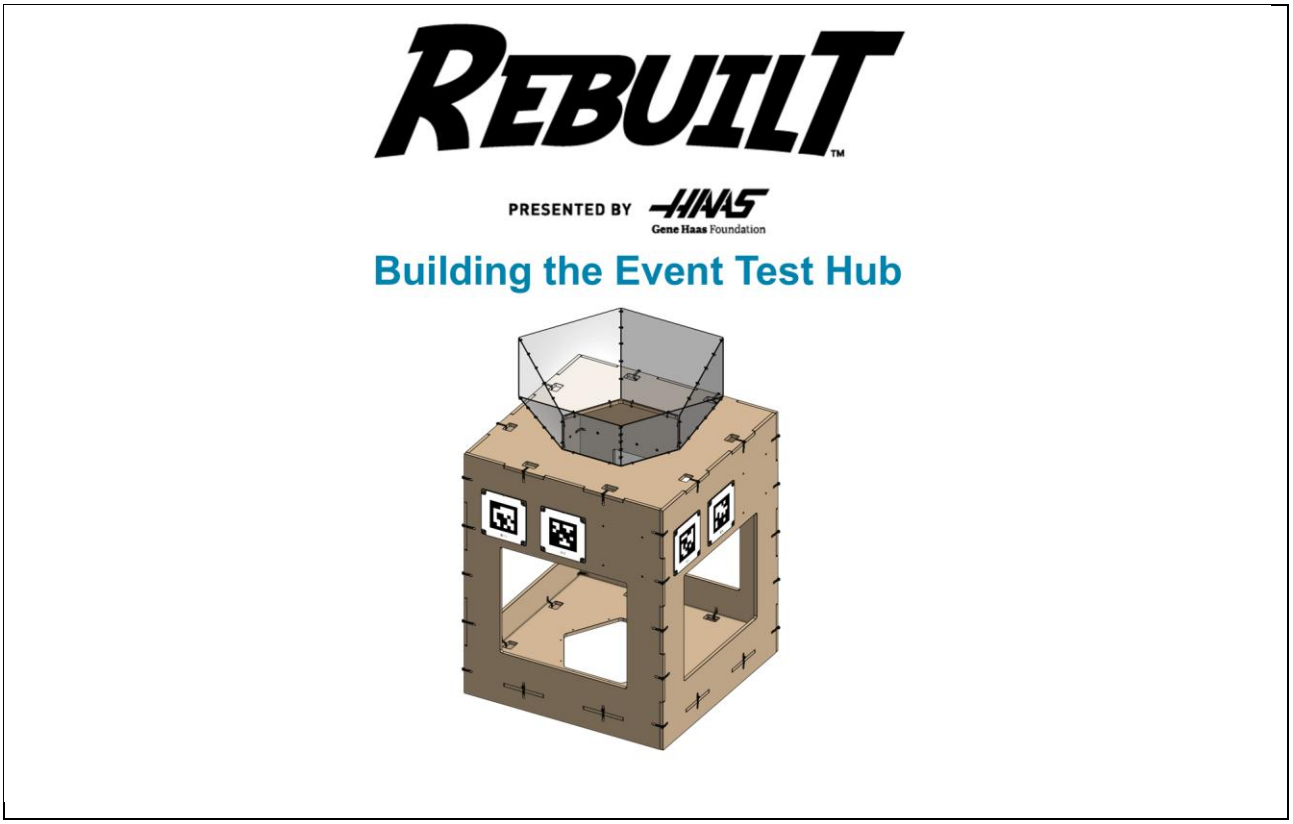

Line a red and blue ramp plastic panel up to each side of the three wood ramp bases. Attach with 8x 1" long ¼-20 hex head bolts per panel, into the existing T-nuts.
INCHES
1
2
3
4
5
6

4.2 Test Area Hub

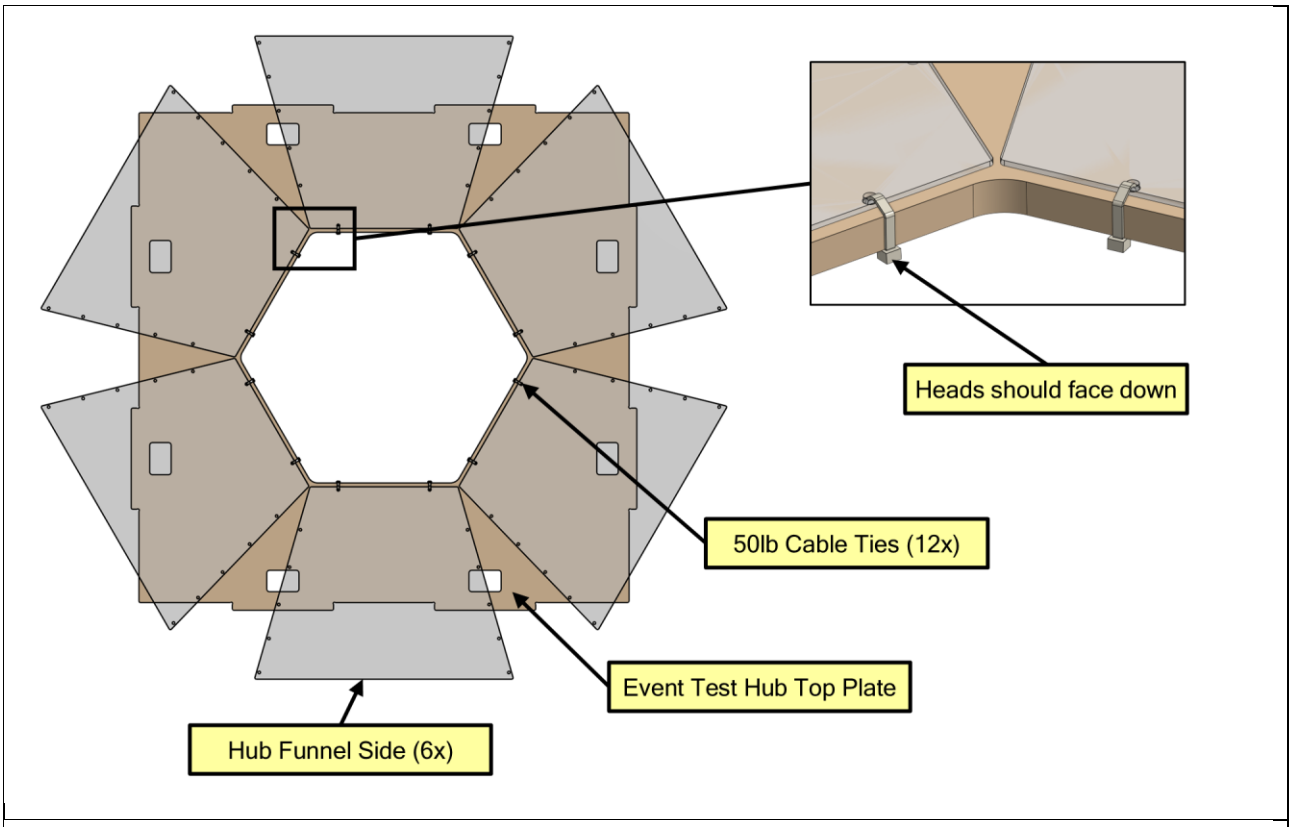
4.2.1 Tools & Equipment

- 7/16” Hex Wrench
- Side Cutters
- 120lb Cable Ties – Qty. 36
- 50lb Cable Ties – Qty. 42
- ¼-20 x 1” Hex Bolts – Qty. 32

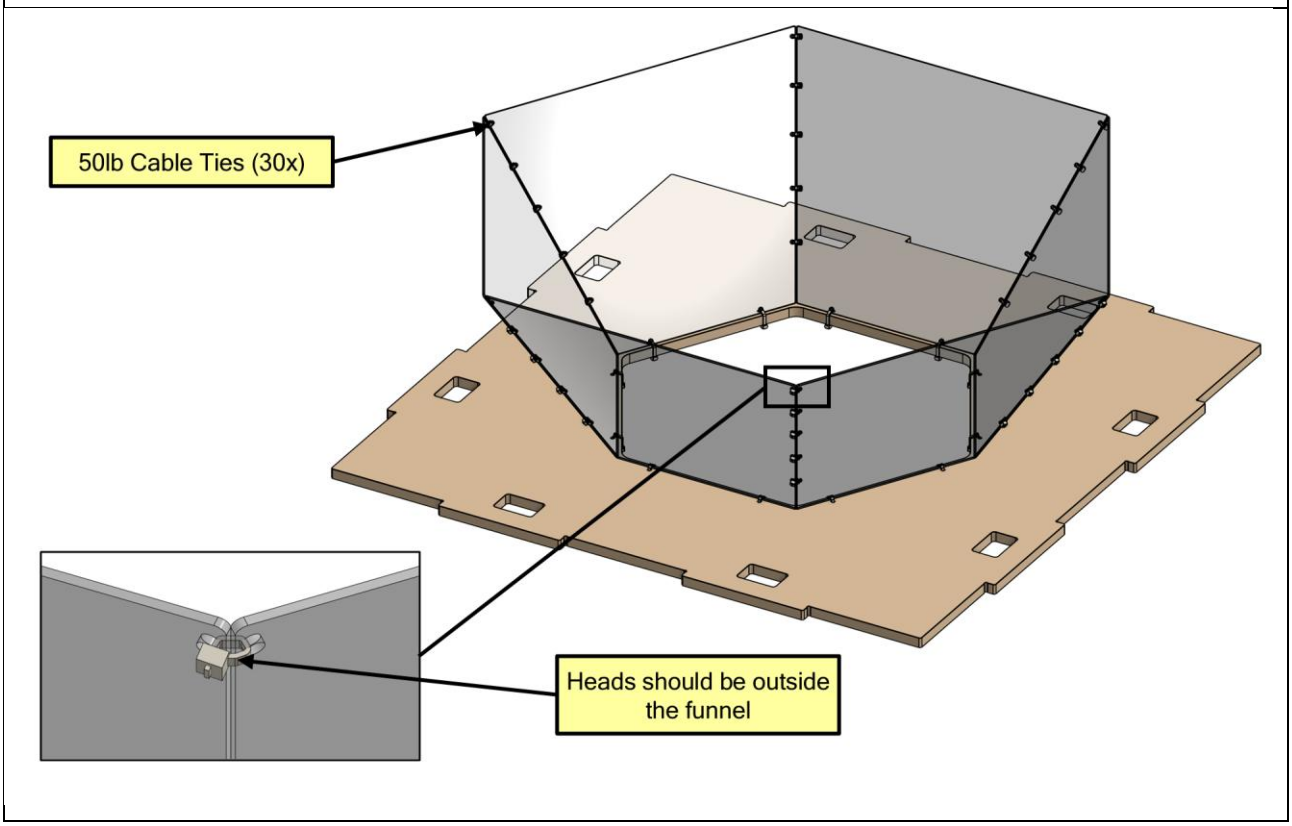
4.2.2 Assembly

1. 

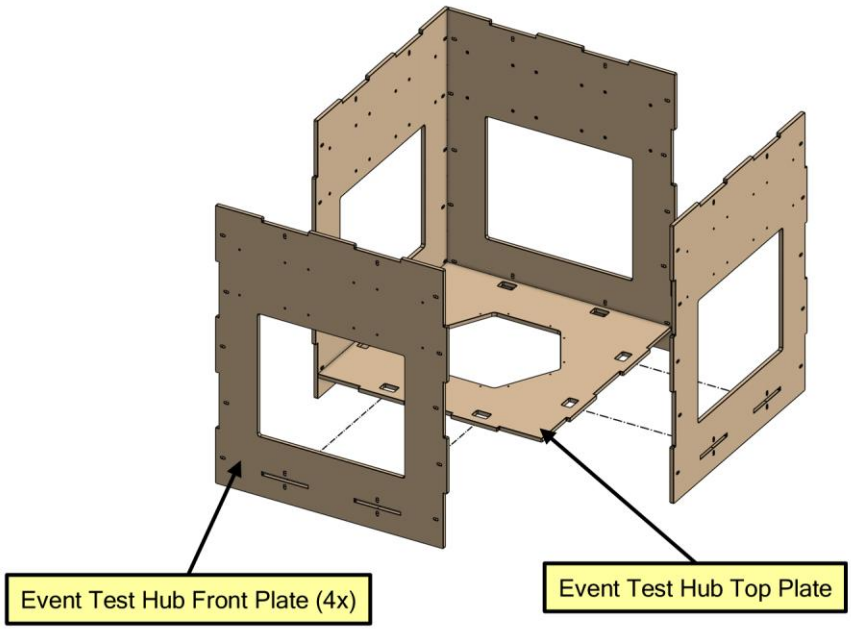
2.


Heads should face down
50lb Cable Ties (12x)
Event Test Hub Top Plate
Hub Funnel Side (6x)

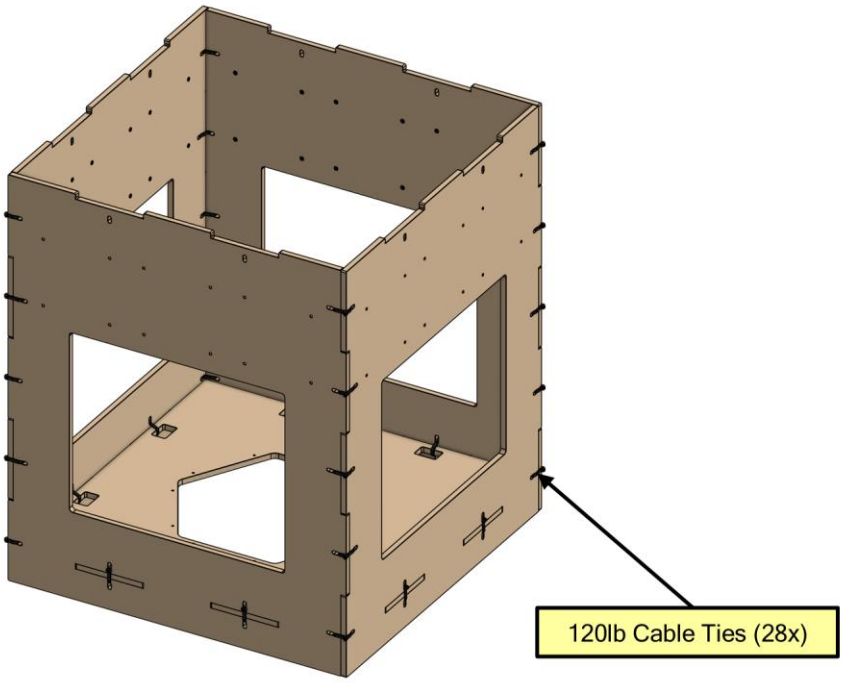
3.


50lb Cable Ties (30x)
Heads should be outside the funnel

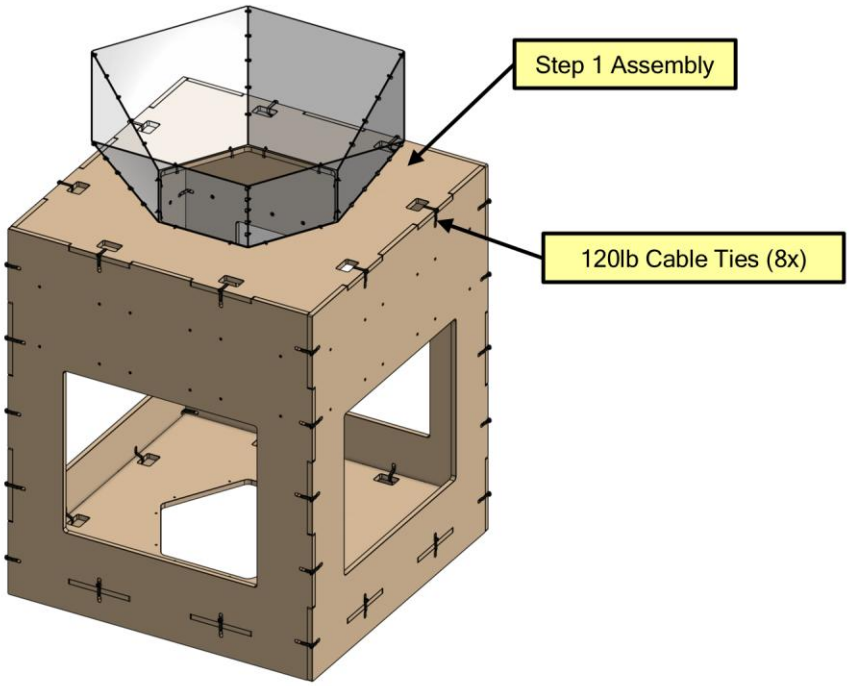
4.


Event Test Hub Front Plate (4x)
Event Test Hub Top Plate

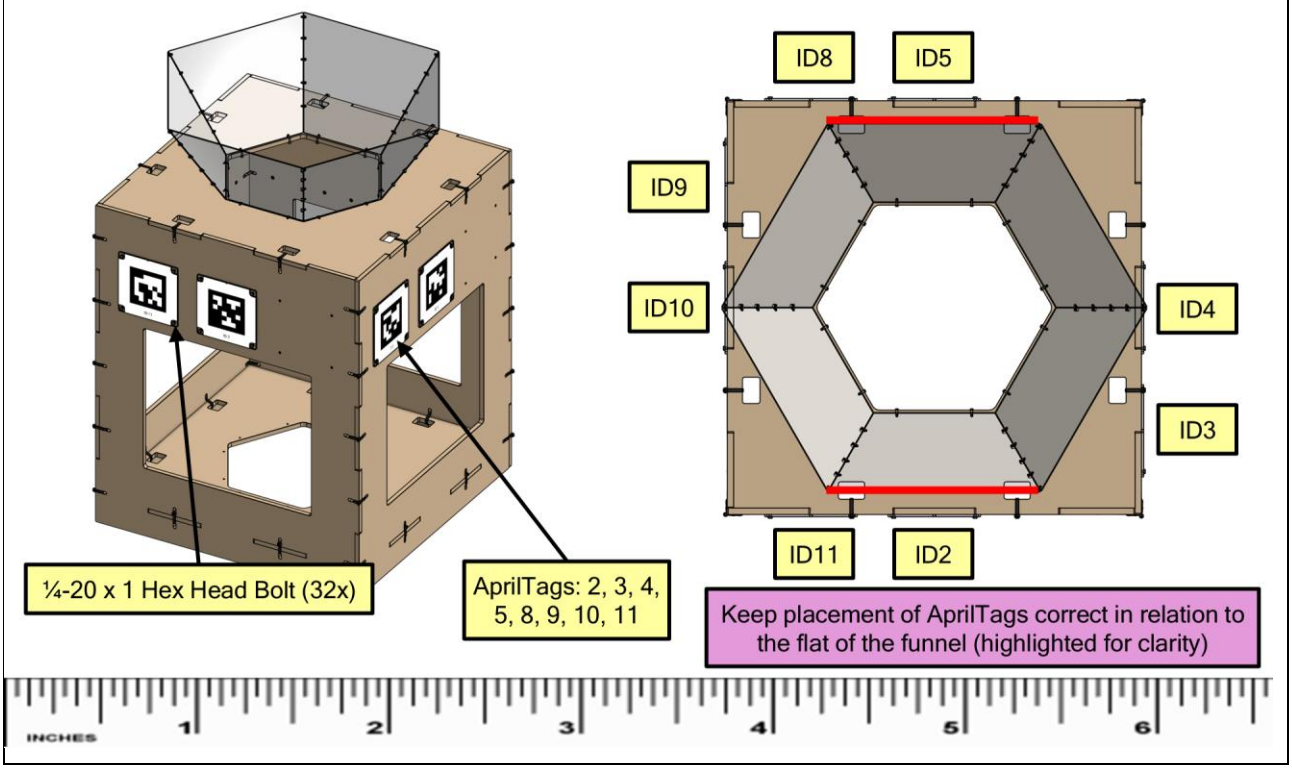
5.


120lb Cable Ties (28x)

6.


Step 1 Assembly
120lb Cable Ties (8x)

7.

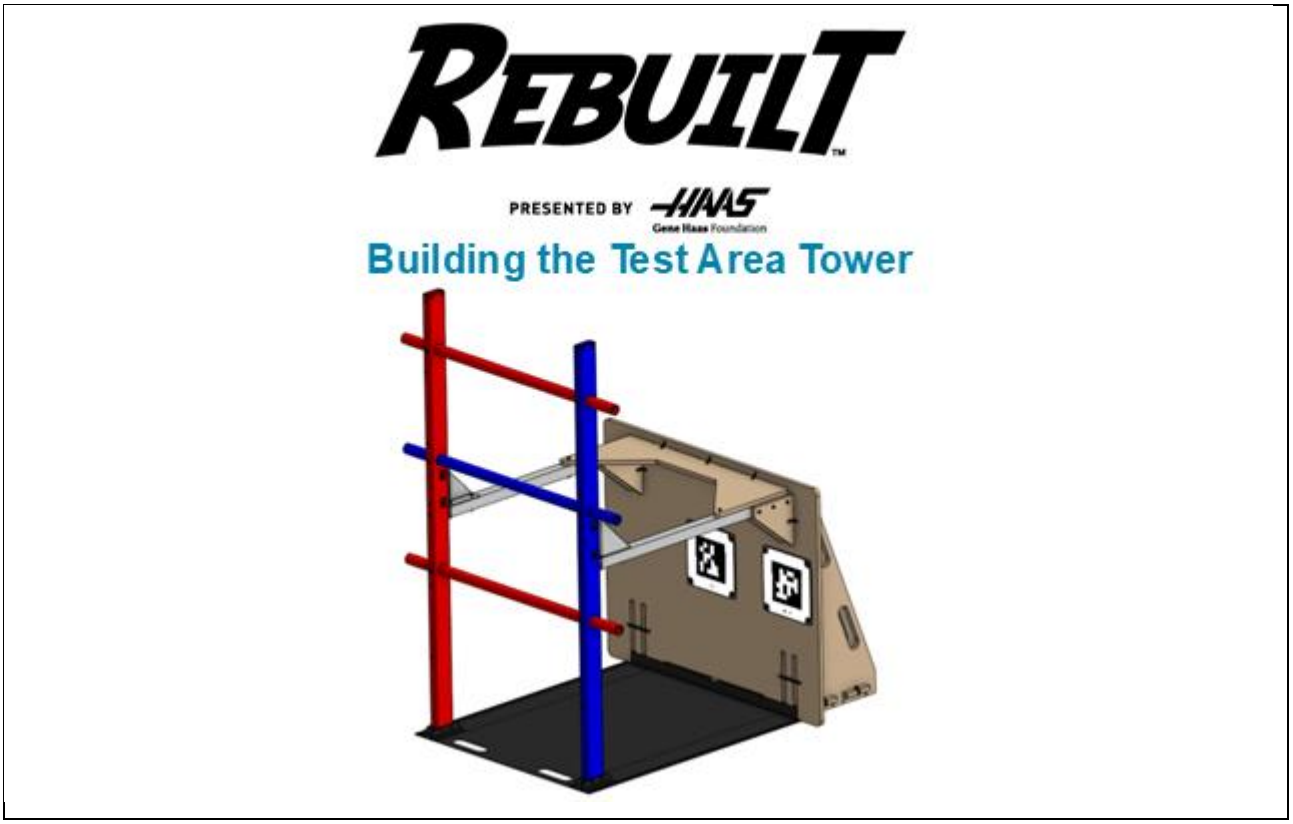

ID8
ID5
ID9
ID10
ID4
ID3
ID11
ID2
¼-20 x 1 Hex Head Bolt (32x)
AprilTags: 2, 3, 4, 5, 8, 9, 10, 11
Keep placement of AprilTags correct in relation to the flat of the funnel (highlighted for clarity)
INCHES
1
2
3
4
5
6

4.3 Test Area Tower

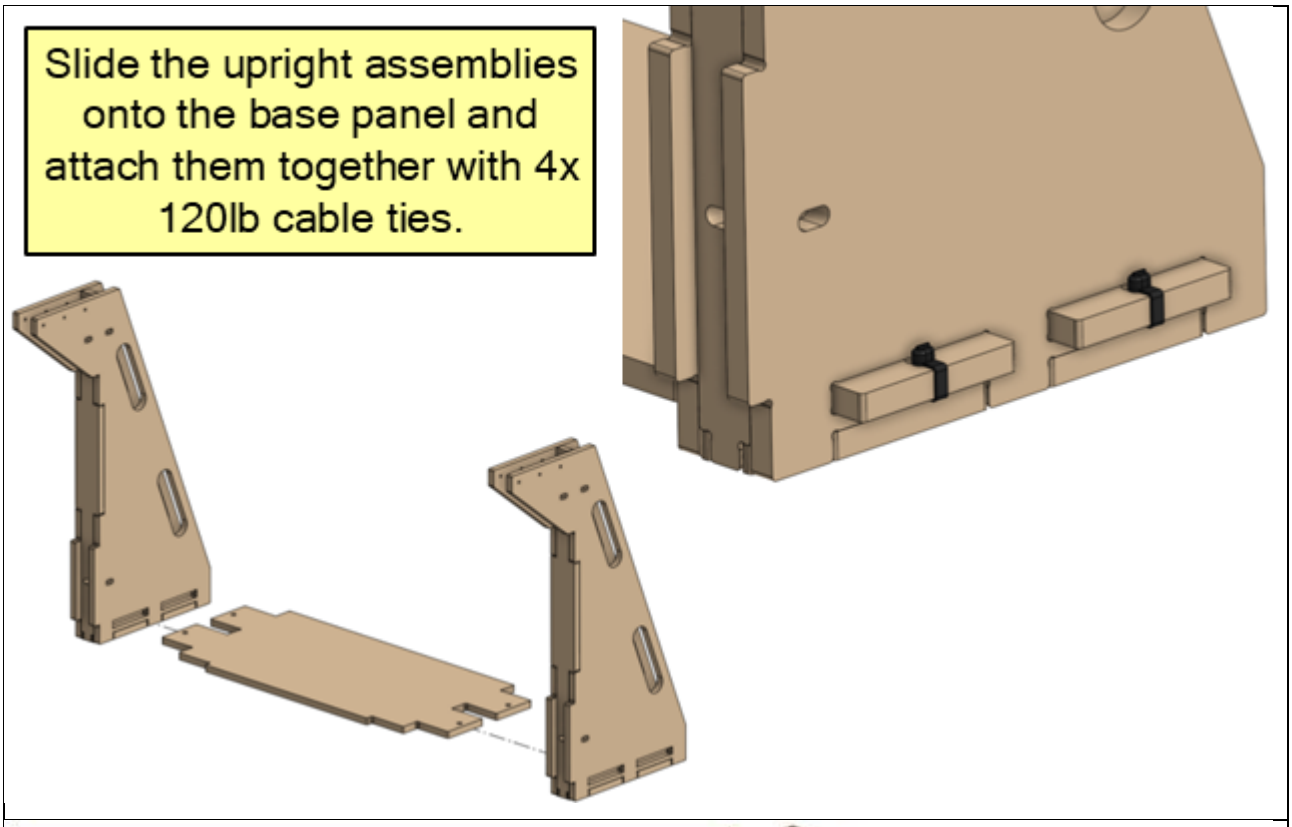
4.3.1 Tools & Equipment

- 120lb Cable Ties
- 7/16” Wrenches, Socket and Ratchet
- Side Cutters

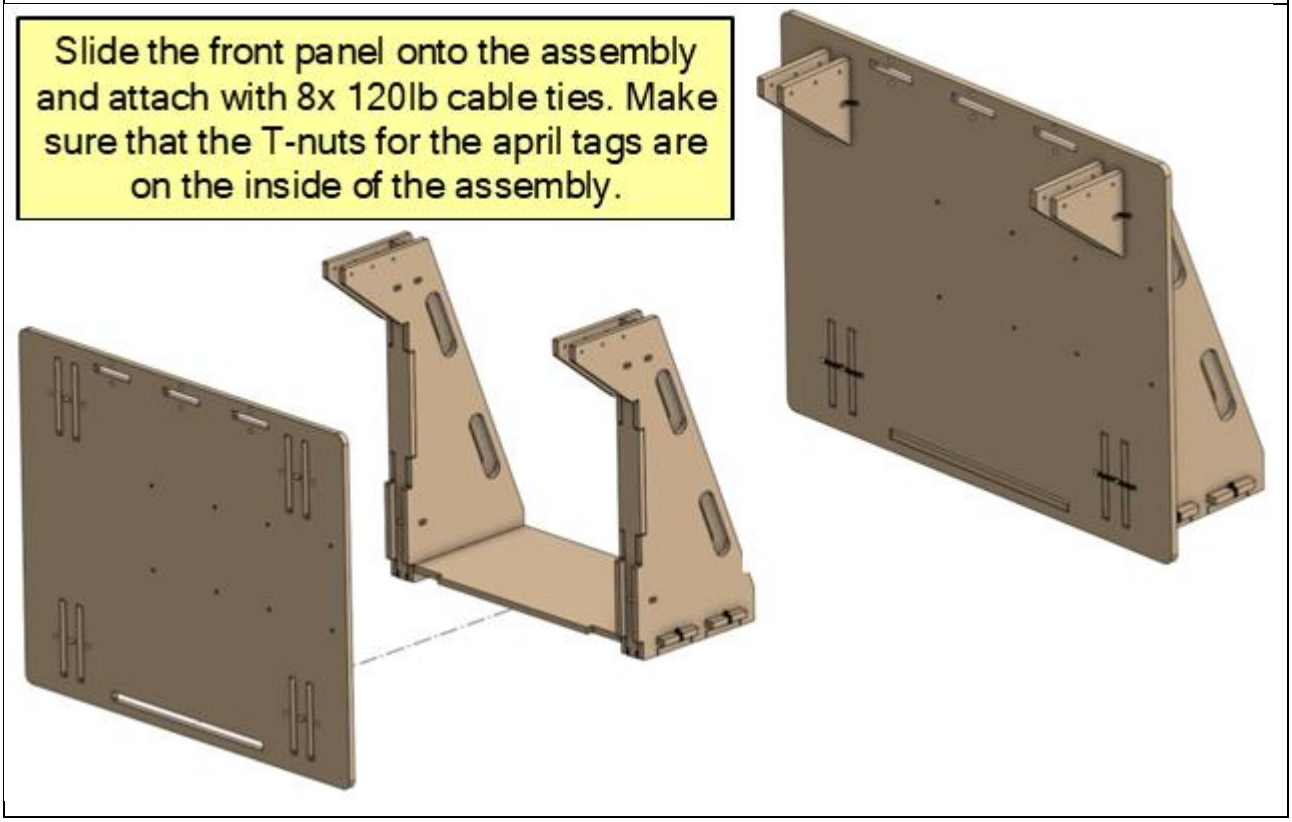
4.3.2 Assembly

1. 

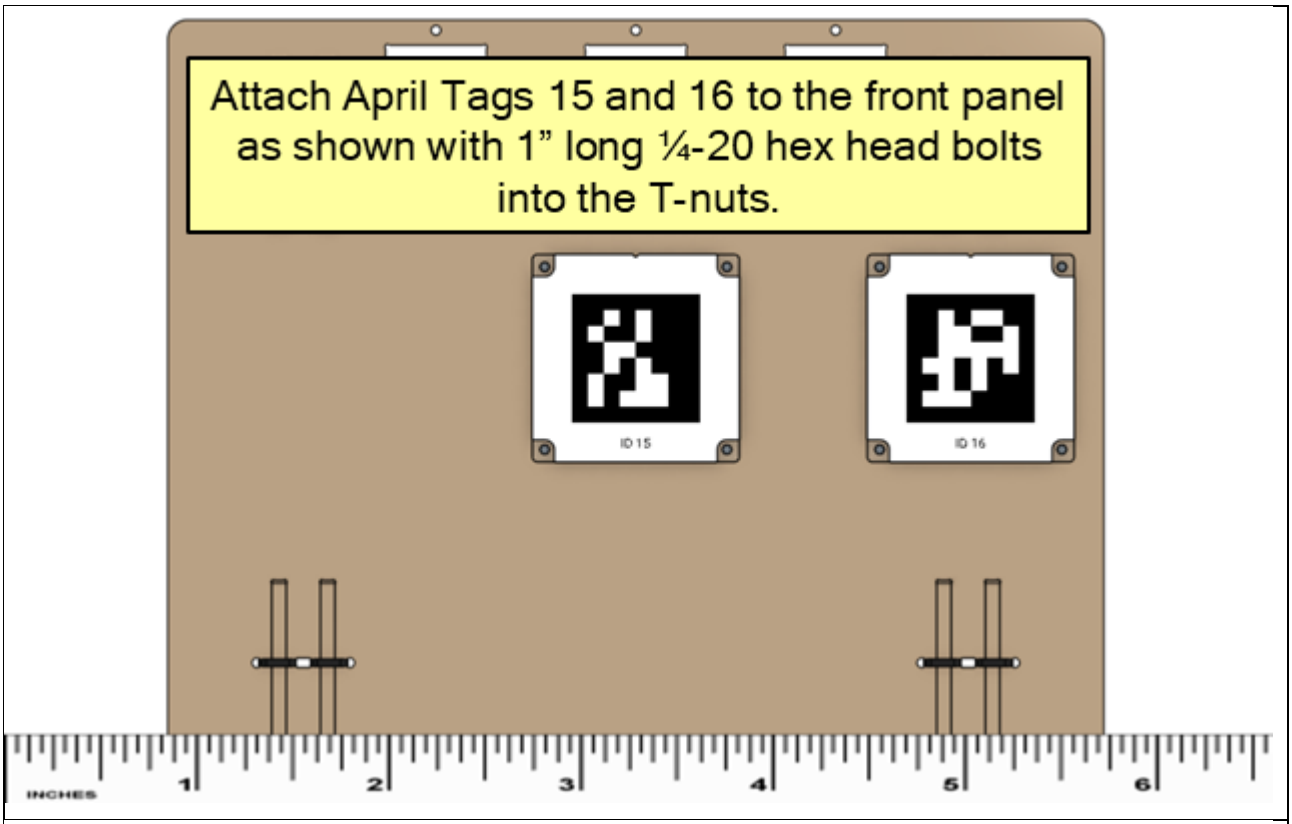
2. Slide the upright assemblies onto the base panel and attach them together with 4x 120lb cable ties.



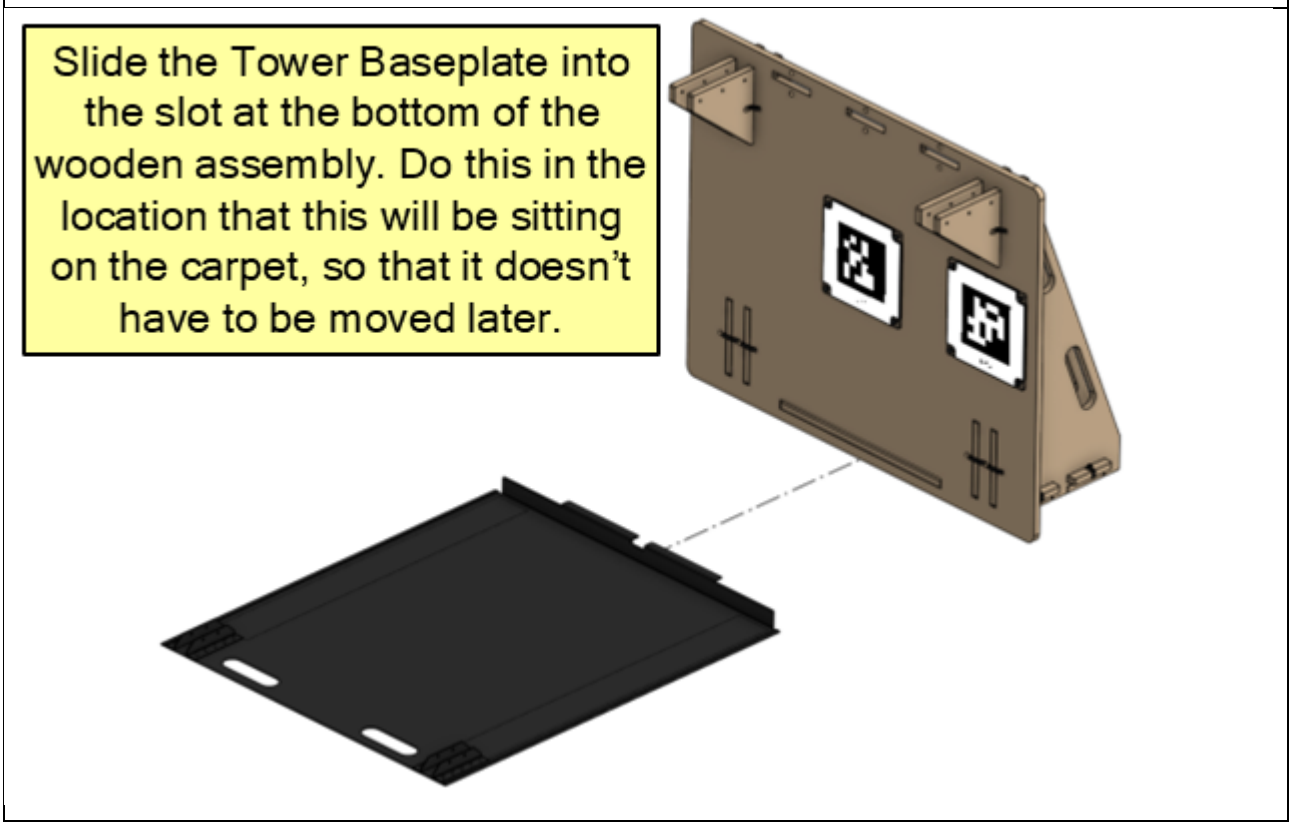
3. Slide the front panel onto the assembly and attach with 8x 120lb cable ties. Make sure that the T-nuts for the april tags are on the inside of the assembly.



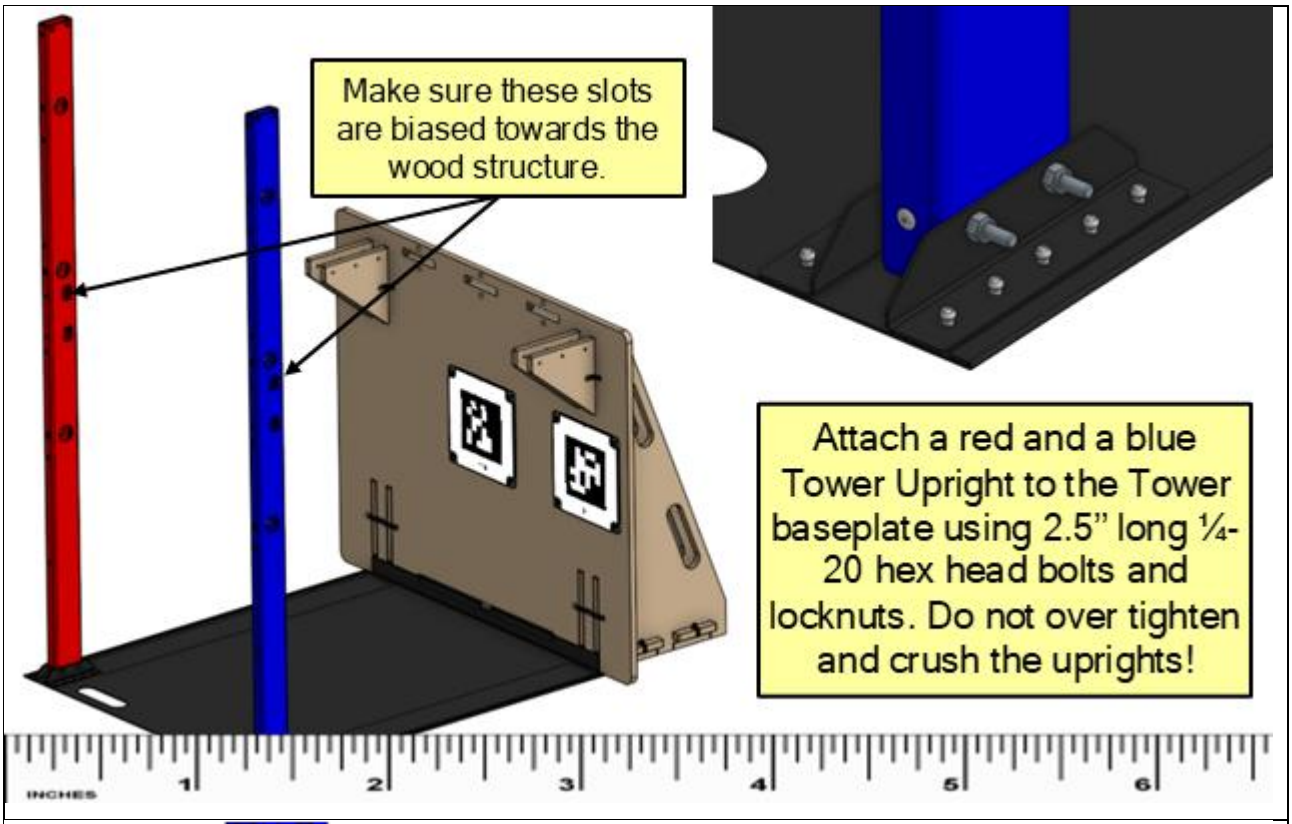
4.


Attach April Tags 15 and 16 to the front panel as shown with 1" long ¼-20 hex head bolts into the T-nuts.
ID 15
ID 16
INCHES
1
2
3
4
5
6

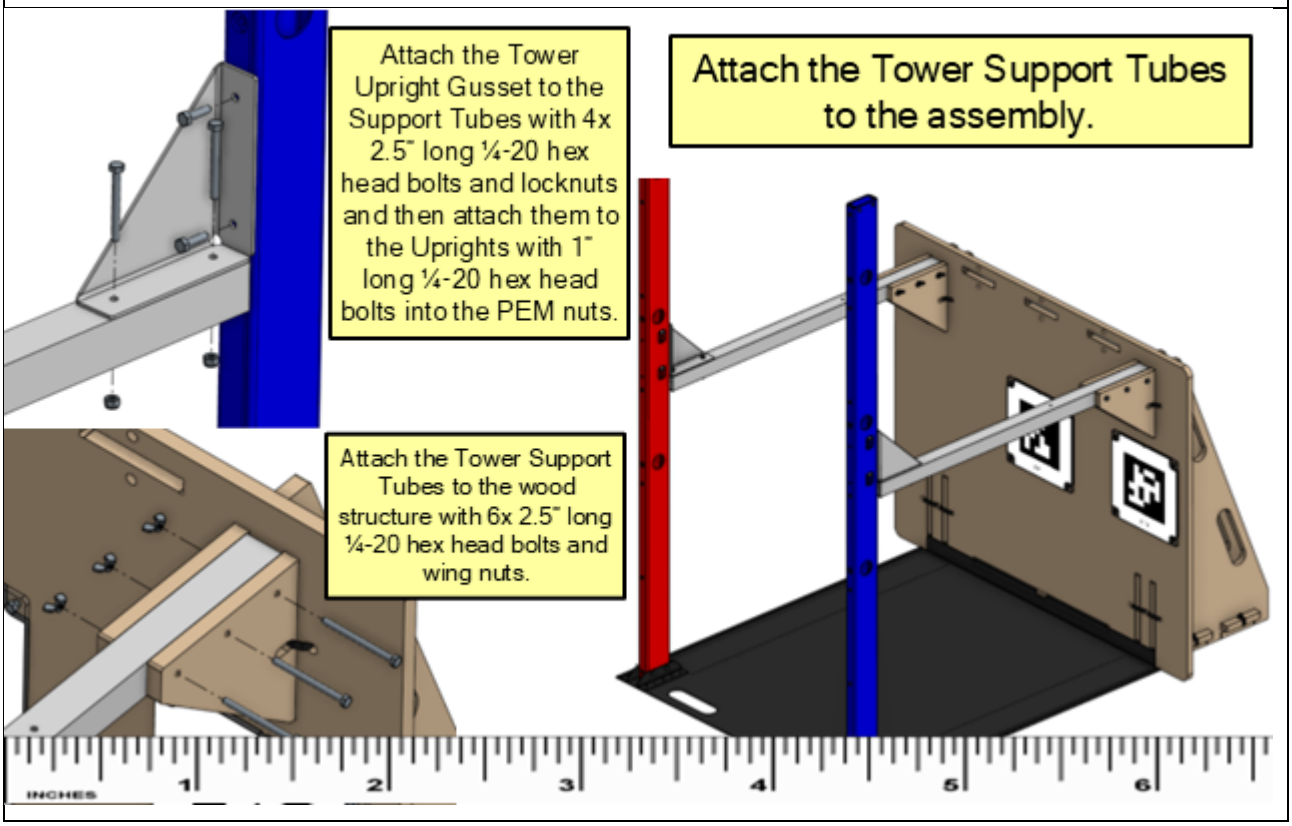
5.


Slide the Tower Baseplate into the slot at the bottom of the wooden assembly. Do this in the location that this will be sitting on the carpet, so that it doesn't have to be moved later.

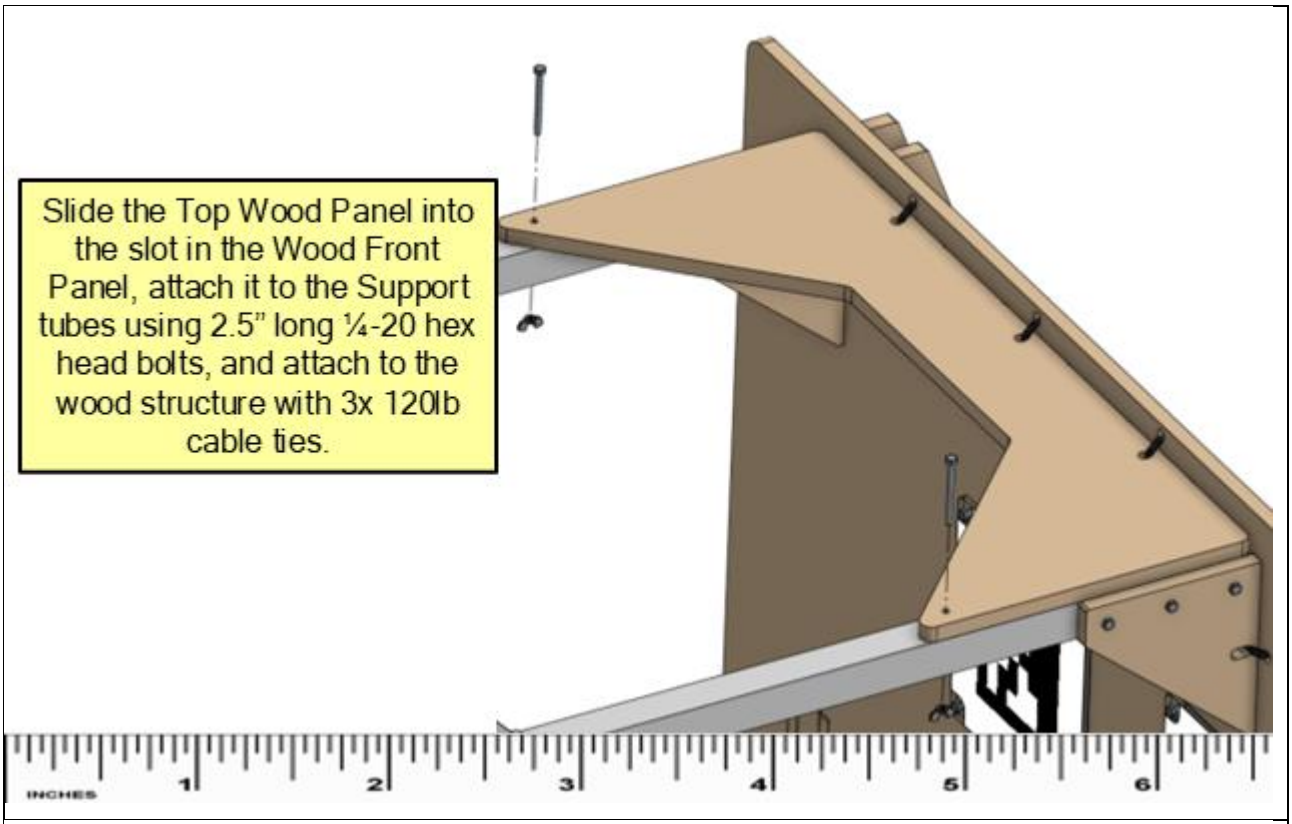
6.


Make sure these slots are biased towards the wood structure.
Attach a red and a blue Tower Upright to the Tower baseplate using 2.5" long ¼-20 hex head bolts and locknuts. Do not over tighten and crush the uprights!
INCHES

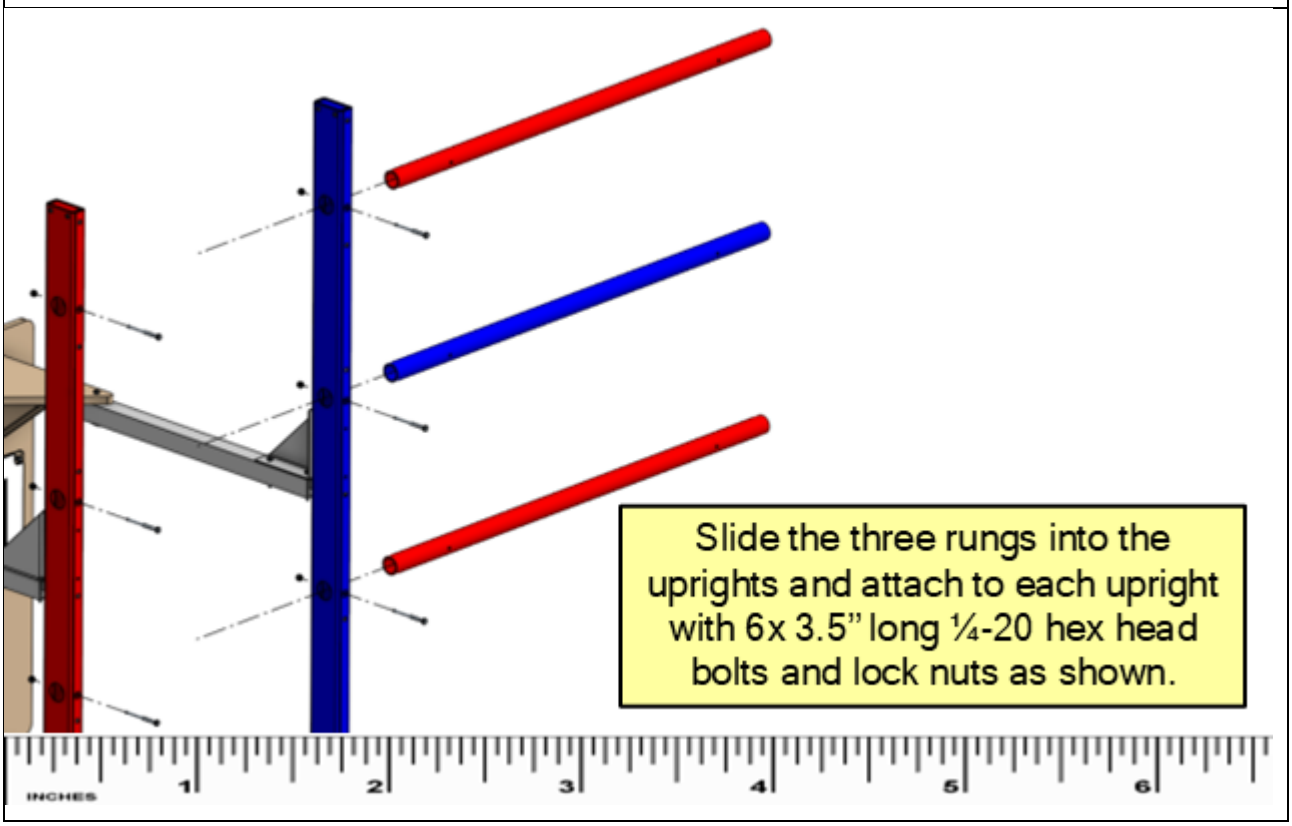
7.


Attach the Tower Upright Gusset to the Support Tubes with 4x 2.5" long ¼-20 hex head bolts and locknuts and then attach them to the Uprights with 1" long ¼-20 hex head bolts into the PEM nuts.
Attach the Tower Support Tubes to the assembly.
Attach the Tower Support Tubes to the wood structure with 6x 2.5" long ¼-20 hex head bolts and wing nuts.
INCHES

8.


Slide the Top Wood Panel into the slot in the Wood Front Panel, attach it to the Support tubes using 2.5" long ¼-20 hex head bolts, and attach to the wood structure with 3x 120lb cable ties.
INCHES
1
2
3
4
5
6

9.

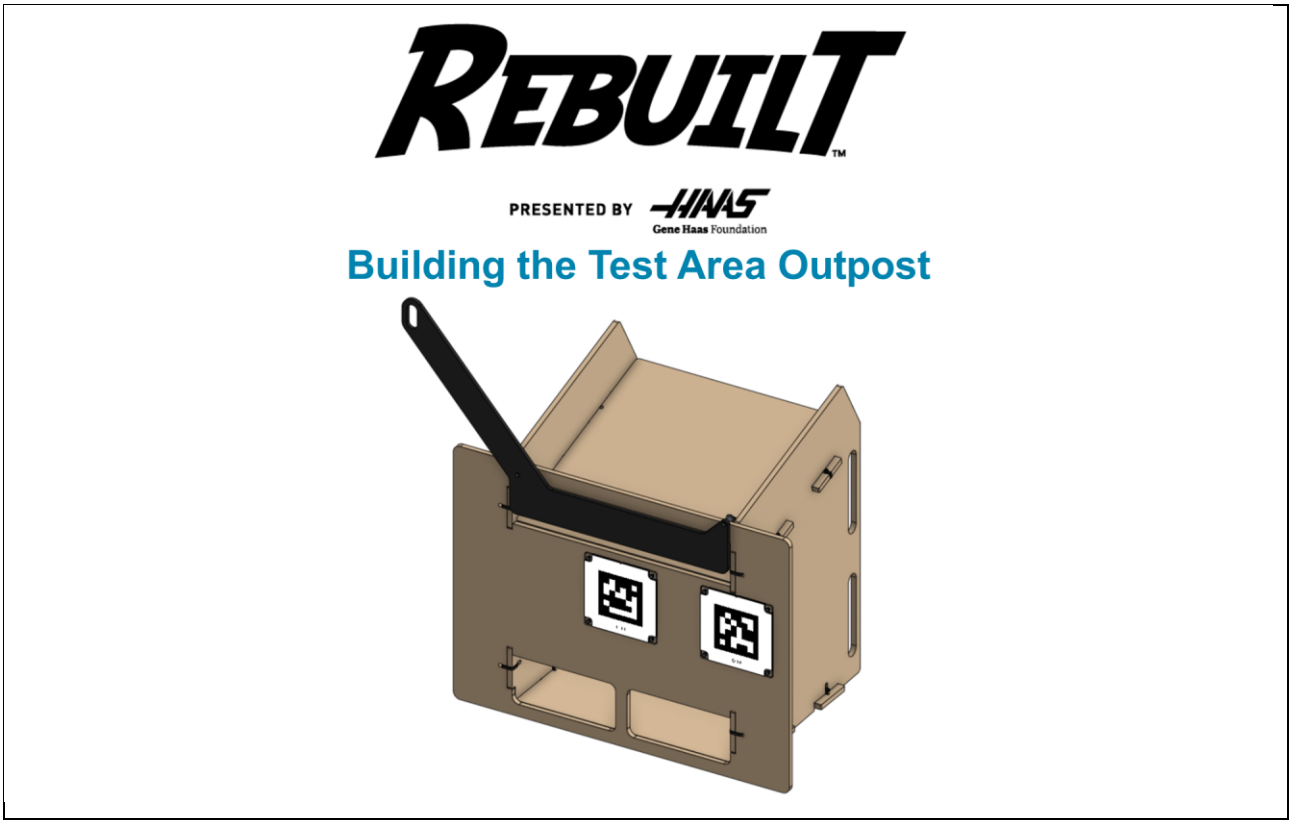

Slide the three rungs into the uprights and attach to each upright with 6x 3.5" long ¼-20 hex head bolts and lock nuts as shown.
INCHES
1
2
3
4
5
6

4.4 Test Area Outpost

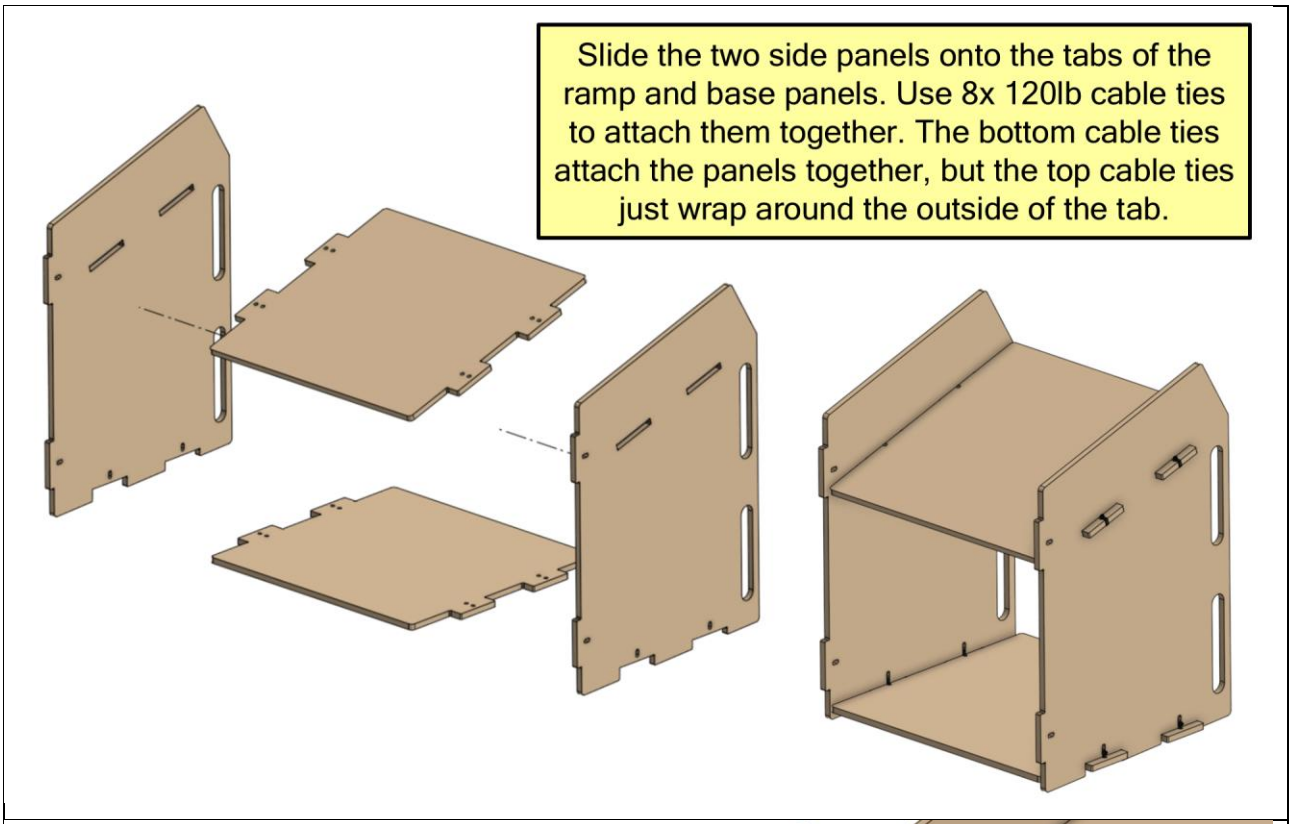
4.4.1 Tools & Equipment

- 120lb Cable Ties
- 7/16” Wrenches, Socket and Ratchet
- Side Cutters

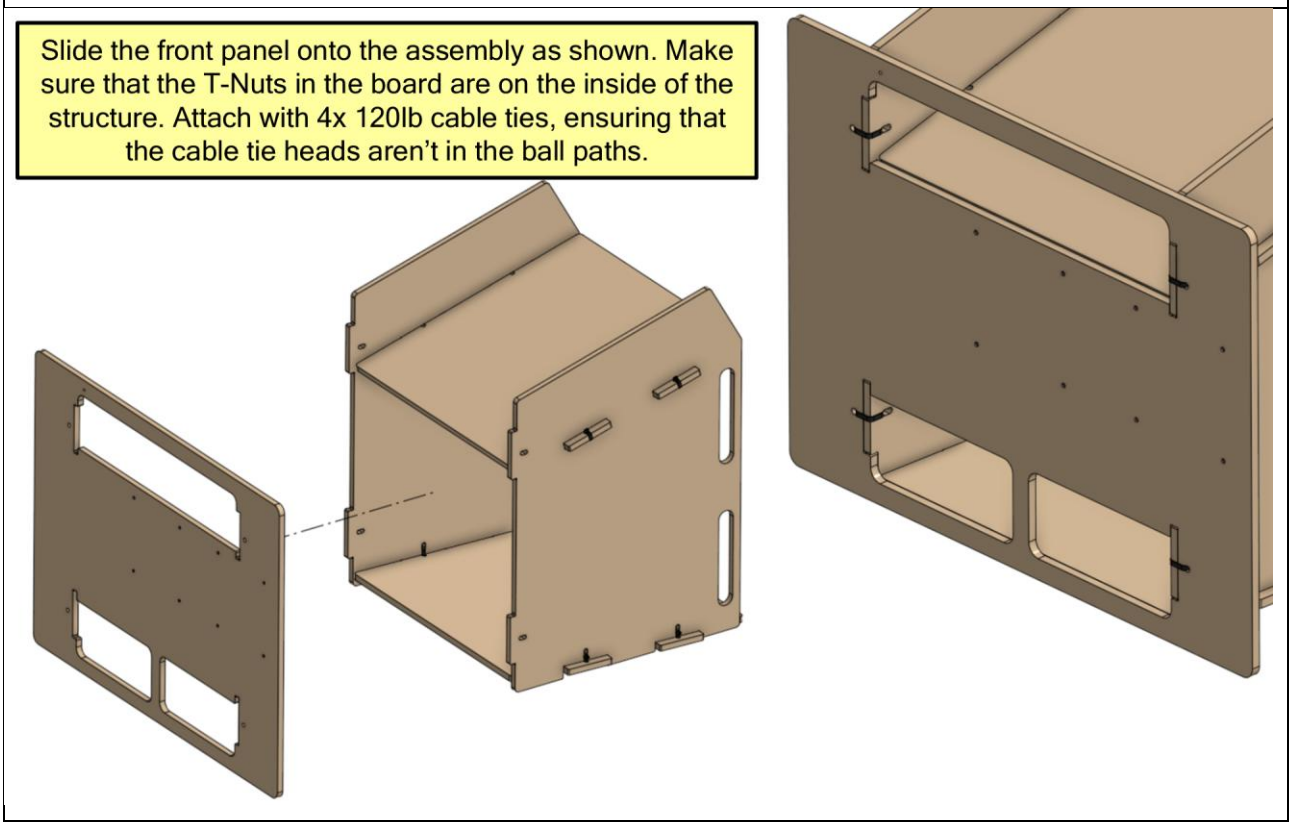
4.4.2 Assembly

1. 

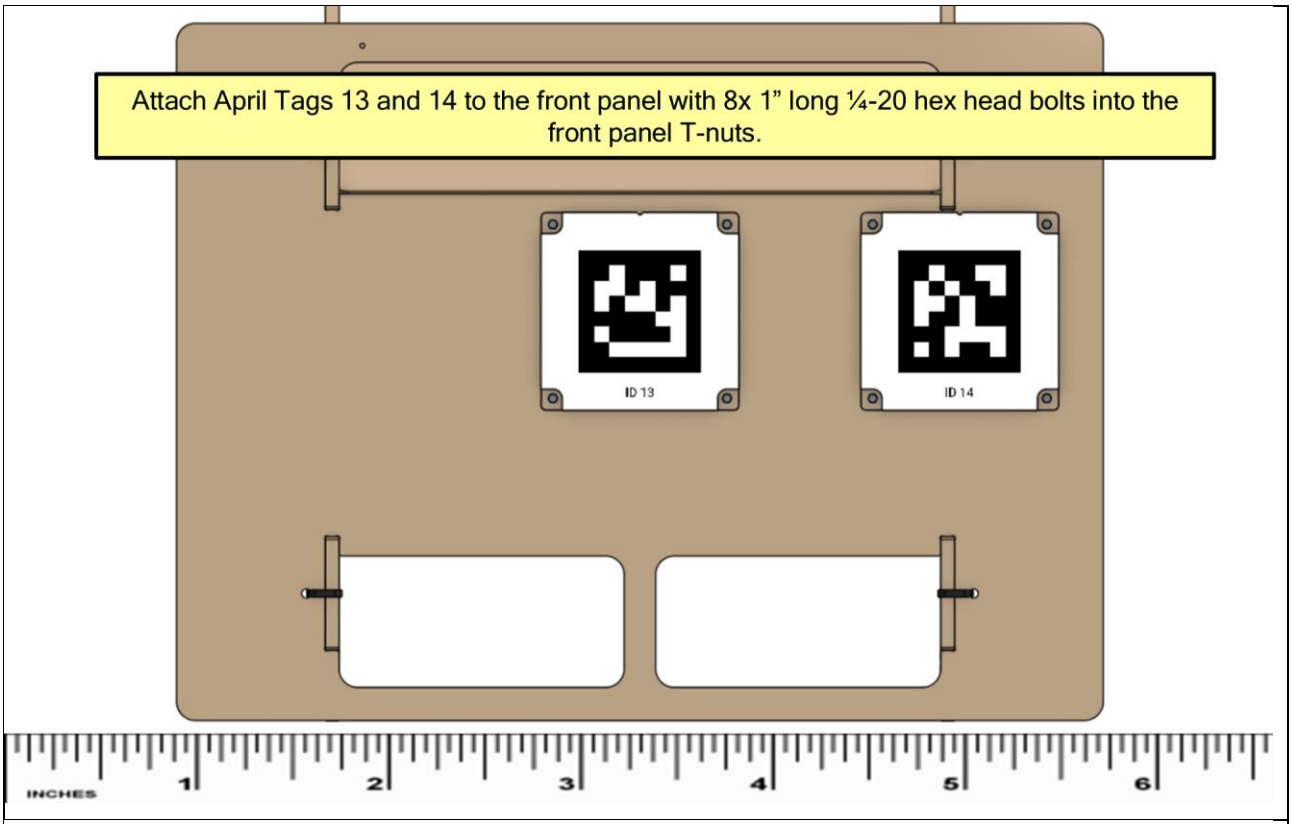
2.


Slide the two side panels onto the tabs of the ramp and base panels. Use 8x 120lb cable ties to attach them together. The bottom cable ties attach the panels together, but the top cable ties just wrap around the outside of the tab.

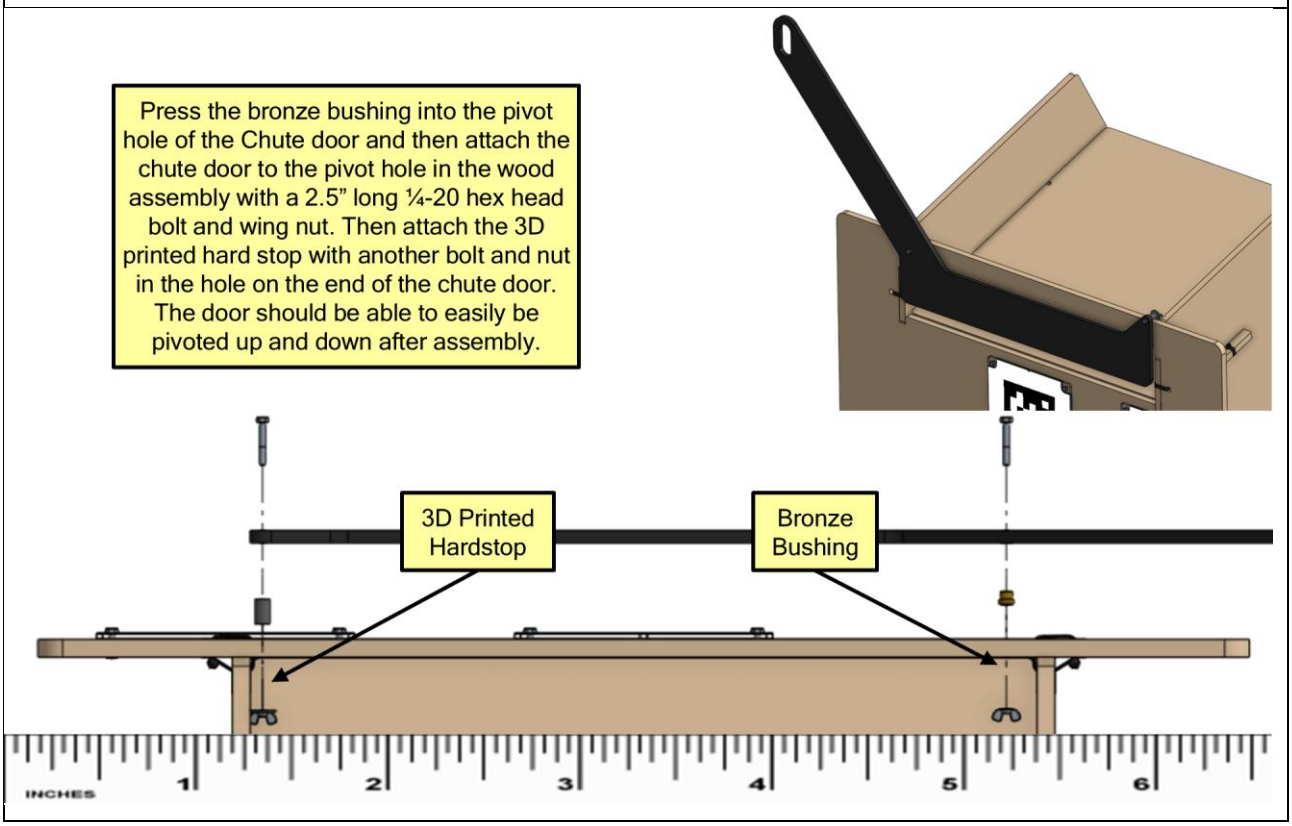
3.


Slide the front panel onto the assembly as shown. Make sure that the T-Nuts in the board are on the inside of the structure. Attach with 4x 120lb cable ties, ensuring that the cable tie heads aren't in the ball paths.

4.


Attach April Tags 13 and 14 to the front panel with 8x 1" long ¼-20 hex head bolts into the front panel T-nuts.
ID 13
ID 14
INCHES
1
2
3
4
5
6

5.


Press the bronze bushing into the pivot hole of the Chute door and then attach the chute door to the pivot hole in the wood assembly with a 2.5" long ¼-20 hex head bolt and wing nut. Then attach the 3D printed hard stop with another bolt and nut in the hole on the end of the chute door. The door should be able to easily be pivoted up and down after assembly.
3D Printed Hardstop
Bronze Bushing
INCHES
1
2
3
4
5
6

5 Tearing Down & Packing the Field

5.1 Before the Awards Ceremony

The general preference is that you should not begin disassembly of any field cabling or components prior to or during the Awards Ceremony. Please be aware of noises generated and any physical distractions that could adversely affect the program. Ordinarily the Scoring Table remains intact while the Award winners are posted and updated to the web. You could retrieve the Pit computer but be aware that teams may still be assembled at the monitor viewing the Final Rankings display.

If you begin breakdown early and volunteers start removing devices and distracting the audience (or disassembly noise is distractive), cease disassembly until the ceremony has ended.

Teams, particularly the winners, will want to take pictures on the field after the event is over. That is okay but be sure that teams do not damage the field, hang from or stand on Field Elements, or stand on the driver's station shelves for a photo.

You can still get started with parts of the packing process even while they are on the field. Cutting cable ties, disconnecting cabling, and starting to pack E-stops, SCC units, LED's and electronics can all be accomplished while photos are being taken on the field. You should also gather up all game pieces and other specific items such as the fire extinguisher, miscellaneous tapes and tools from the Scoring Table, etc.

5.2 Field Disassembly Organization

During the disassembly of the Field at the end of the event, take time to monitor the repacking of the field components. All parts to the field and FMS have specific locations in the road cases, and they must be packed according to the photographs and diagrams provided in each road case and in this document.

Missing or damaged components must be reported to *FIRST* as soon as possible to ensure repair or replacement for the next event. FTAs should utilize their event reports to communicate this information and contact Engineering Support directly with major issues.

The best defense against loss or confusion is to observe where things come from in the first place, and how they are packed. When in doubt refer to the many photos that are provided here, in Chapter 3, and inside or on the road cases.

Also please refer to the Truck Packing Diagram for information on the proper location of the cases once reloaded onto the truck. All regional trucks should be the same size and will utilize the truck packing diagram, but some district and international events may have their own transportation systems with different packing plans.

Seek to gain solid control of the field breakdown process in advance. As early as possible on the final competition day, the Field Supervisor should find and organize the 10+ volunteers that will assist in field disassembly and packing. Recall that Unionized Venues may specify “who will help” before you completely populate your crew. You may need to factor in their help.

The Field Supervisor should organize them so that 10+ people are designated for the dismantling and packing team. Other workers should standby to retrieve the empty cases and carts for distribution around the field. They also can push full carts and cases to the designated staging area or loading dock.

Here are a couple of General Rules and Guidelines to work by:

- Field disassembly is not necessarily the reverse of assembly. It is important to read this section thoroughly to understand case and cart packing requirements to prepare. To ensure success at the next event, please pack everything properly.

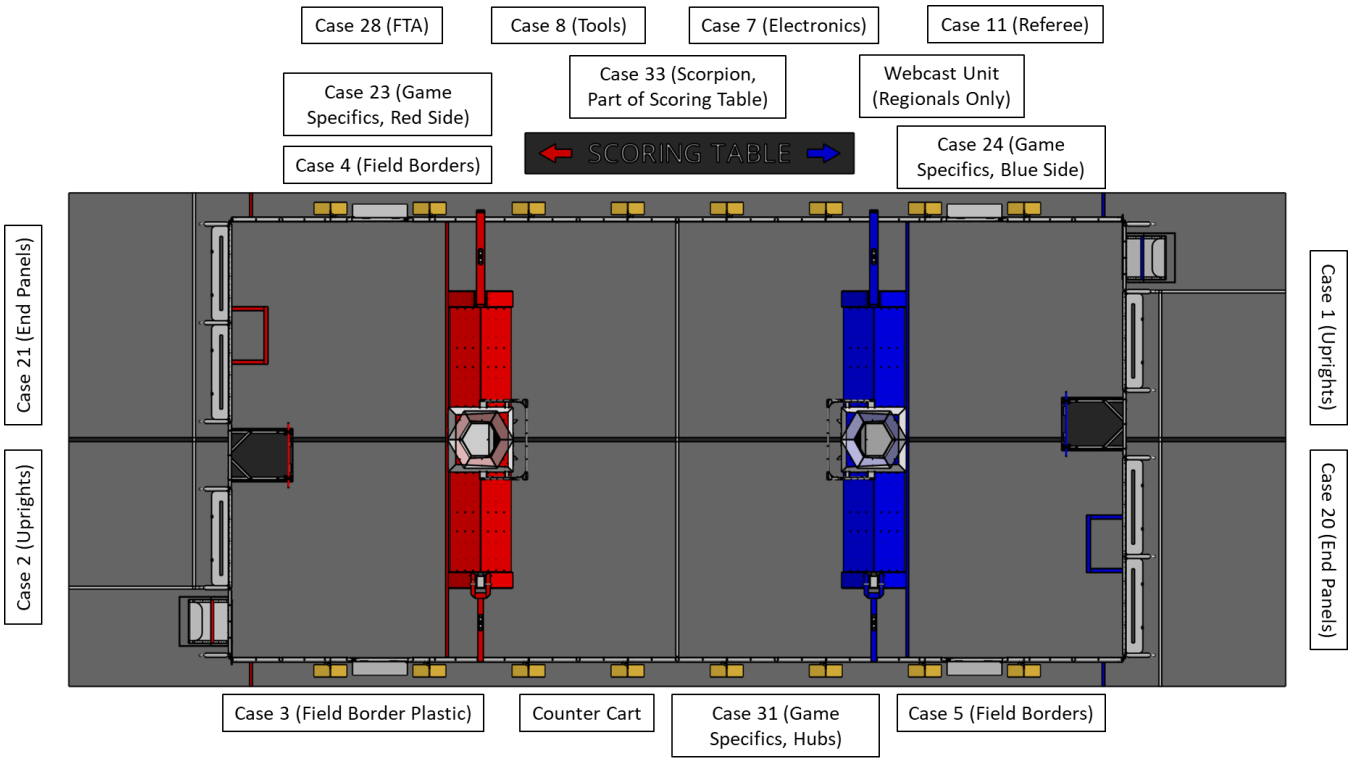
Nothing should be left over after the packing is complete. Coordinate with everyone to verify that FIRST will leave the event with everything that FIRST brought. Once again, make sure your people know what is going to happen ahead of time. As cases and carts are filled, they should be systematically checked and prepped to go to the loading dock. Items that are easy to miss during packing are ladders, handicap ramps, carpet dollies, vacuum cleaners, fire extinguishers, game pieces, etc.

5.3 Field Tear Down

Following the conclusion of the competition the event manager, the event assistant, pit admin, and others will dismantle their own areas and pack their cases and carts. They will then either move their packed containers toward the field or to the loading dock. One exception to this may be the re-packing of the Inspection cart in the Pit, which includes the sizing box, scale, calibration weights, Inspection documents, and supplies. The packing responsibility ultimately falls on the FTA and field crew to ensure packing of the Inspection case is completed.

Be careful when selecting a staging area some venues have limited dock space and share access with A/V. Also, carefully follow the truck-packing plan. Anticipating the proper order of things needing to go to the loading dock to be loaded on the truck is very important.

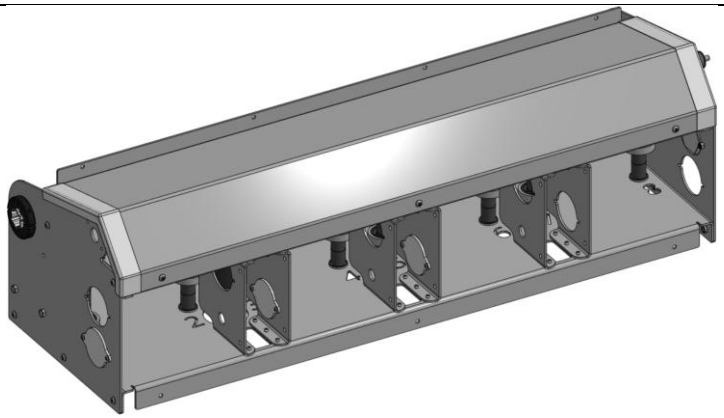
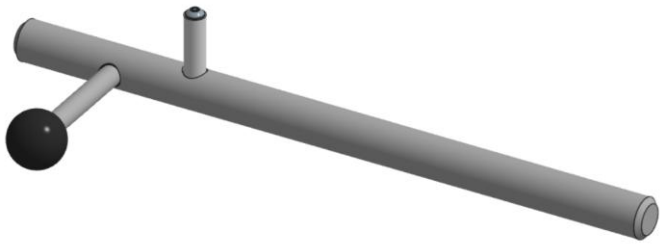
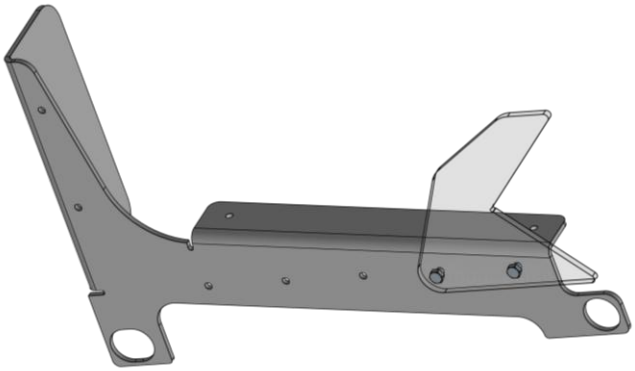
Figure 5-1: Road Case Locations for Field Build & Tear Down



The cases are numbered and labeled according to type of field components. It is critical to load the proper contents into the proper cases to avoid possible injury to people and damage to field components. For example, field support items, such as the fire extinguisher, scissors, tape, etc. must be collected and repacked into Case 8.

Fasteners that are **not** meant to be removed by volunteers generally require hex keys. Additionally, there are parts assembled on Week 1 that will not need to be disassembled for subsequent events. For these parts, use a marker to color the fasteners that should not be removed by volunteers. Don't forget to remind your volunteers that marked fasteners and most fasteners using hex keys should remain in place. Plan on having someone be in charge of collecting and organizing hardware as it is removed from the field elements.

5.3.1 Items that Should Not Be Disassembled

Fuel Counters* (See Section 1.1.1 for details on what should be removed)	
Trench Arm Pin	
Trench Counterbalance Assembly	
Outriggers with Fuel Pen Holders	

5.4 Electronics

The Scoring electronics packing includes all the electronics components contained in Cases 6, 7, 19, 33, 34 and the webcast case. It is recommended to coordinate with the Key Volunteers working with this equipment during the event to see if they can remain to assist with the packing process. All field cable ties can be cut in preparation for the removal, coiling, and packaging of cables in the proper cases.

During disassembly, it's easy for the extension cords and 20M Ethernet cables used to connect the Scoring Table to the field ends to mistakenly end up with the A/V equipment. Keep track of these cables to ensure they end up back in Case 6 to avoid expensive replacement costs.

The Pit Display, WPA Kiosk, and Audience Display laptops should be shut down, accessories gathered and returned to the Scoring Table for packing in Case 7.

Move Case 6 to one end of the field for packing of all the associated components from the Alliance Station, then move the case to the other Field end and repeat the process.

1. E-Stops
2. A-Stops
3. Team Sign and Timers
4. Team Lights
5. SCCs
6. All associated cabling

Figure 5-2: SCC Packed in Field Electronics Case

5.5 Side Border Disassembly

1. Remove all clear plastic Side Rail Shields from the Side Borders by cutting and removing the cable ties. Place them into Case 3 as you progress.
2. Remove the pins from the corners of each field end.
3. Once the corners have been disassembled, lay the side railings face down on the carpet towards the field center.
4. Bring Case 4 (Side Borders) to one side of the field, Case 5 to the other.
5. Disassemble Side Border Elements, including Outriggers, at one end and work towards the opposite end.

The sequence of photos below illustrates the packing portion of this procedure:

6. Load sequential sections into the Side Border case, alternating top and bottom with the rail of one section sitting on the flat base of the next. Always have the flat side facing up. Don't mix sections between two sides/cases.
7. Insert the Outriggers down between the rail sections. Yellow Trip Guards go into same case together with four short pins.
8. When all rails are stowed, close the case(s) and verify proper fit.

Figure 5-3: Correct Loading for the Side Borders Case

5.6 Field Ends

It takes a crew of four to dismantle and pack one field end. Another crew of four should be assigned to dismantle and pack the other end. Before you can do the mechanical disassembly, the electronics and cables must already be removed.

Cut all cable ties and remove any remaining Scoring and Field Electronics cabling between the Scoring Table and field ends and from electronic modules on the field ends. Stow the cables in the appropriate cases.

If not already done, remove all electronic modules from the field end panels including the LED modules, E-stops, Team Lights, and the Station Control Consoles and re-pack the components into the designated locations in Case 6.

Figure 5-4: Field Ends Case

You are now ready to disassemble the Field Ends.

1. One person removes the Top Rail Lexan holders one at a time and places them in case 1 or 2; as the rail is removed, a team of two people carry and pack the Station Lexan panels and corner Lexan into Case 20 or 21
2. Lower the player station shelves and then lift/rotate/lock the Velcro footpads on all of the Player Station panels.
3. Place the end panels into Case 20 or 21 as shown.

As you progress, put the uprights aside, ready to go into Case 1 or 2.

4. As the end panels are disassembled, take any game specific wall weldments to their respective game specific cases.
5. As Station End panels are removed, people need to carry them and insert them in the case as shown. Repeat until it's done.

You are now ready to load the uprights into the Uprights case. Do not mix pieces from the two ends; all of one end's uprights go into Case 1, the other end's uprights go into Case 2.

The photo sequence below depicts loading the components into the Uprights case.




5.7 Carpet

The Practice Field Carpet must be rolled up and sent to the next event. **No exceptions.**

The Competition Carpet handling varies from event to event. Most competitions give their carpet away to teams or other local *FIRST* participants (such as folks who run off-season events). Be sure to talk with your Event Manager to confirm the plan. The notable exceptions to this rule are the fields that get sent to *FIRST* Championship.

If you are uncertain about any of the above, please check with *FIRST* to confirm.

If your field is one of those designated "Dispose of" the Regional or Volunteer Coordinator may arrange with a local team to take the used carpet for their own use at local events. If the carpet remains unclaimed, notify the venue that the carpet should be trashed.

Two full-sized carpet rolls will be traveling on the truck for the next event. The carpet will be delivered to your venue on Wednesday or Thursday. Please contact Mechanical Support immediately on Friday morning if the carpet has not arrived at your event. Each FTA will be responsible for loading the carpet on to the truck during load out.

5.7.1 Carpet Rolling

1. Remove the gaffer's tape from the perimeter of the carpet; use a carpet knife to cut the carpet down the middle so that you cut through the gaffer's tape and the under-carpet seaming tape. Be careful of the floor underneath.
2. Separate the 2 pieces of carpet a little to simplify rolling; with 15' wide carpet, 5 people should do the rolling.
3. Roll the carpet by starting with a very tight roll and maintain good alignment; otherwise, it may end up looking like a sharpened pencil.
4. After rolling, tape the carpet in 4 spots to keep it bound together; this will require the tape to totally encircle the roll plus a little.
5. If available use carpet dollies to roll the carpet off to the side or to a location from which the team can take it out, or the venue will let you dispose of it. Ensure you take back the carpet dollies!

If the carpet is unclaimed, move the carpet to a wall edge (out of the way) and notify the venue maintenance of its location and disposition.

> **Note**: As previously noted, some regionals need to load their complete, uncut carpets onto the truck for *FIRST* Championship.

5.8 Game Pieces

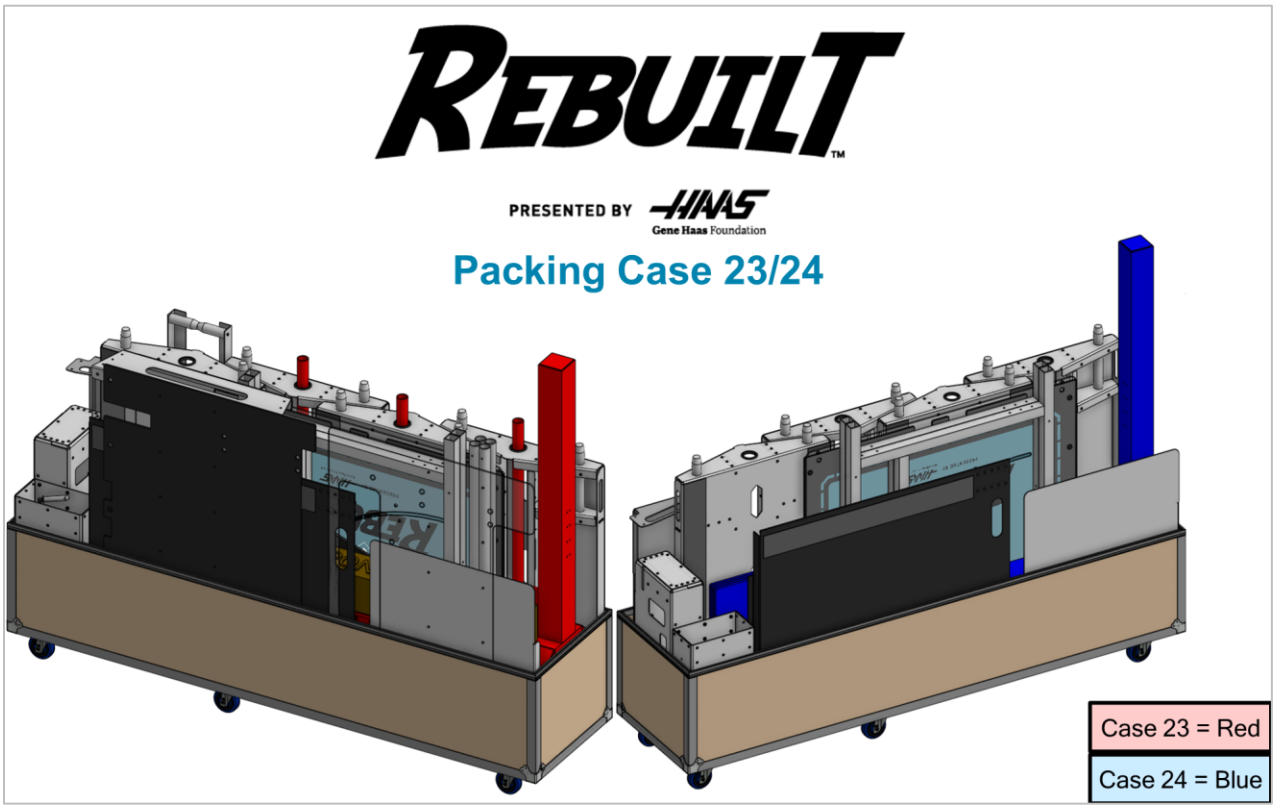
Please plan on packing new and used game pieces to carry to the next event. Be sure it is easy identify which Fuel are new and which are used.

Unless you are given permission by *FIRST* management, do not give away game pieces.

5.9 Case Packing

5.9.1 Case 23/24

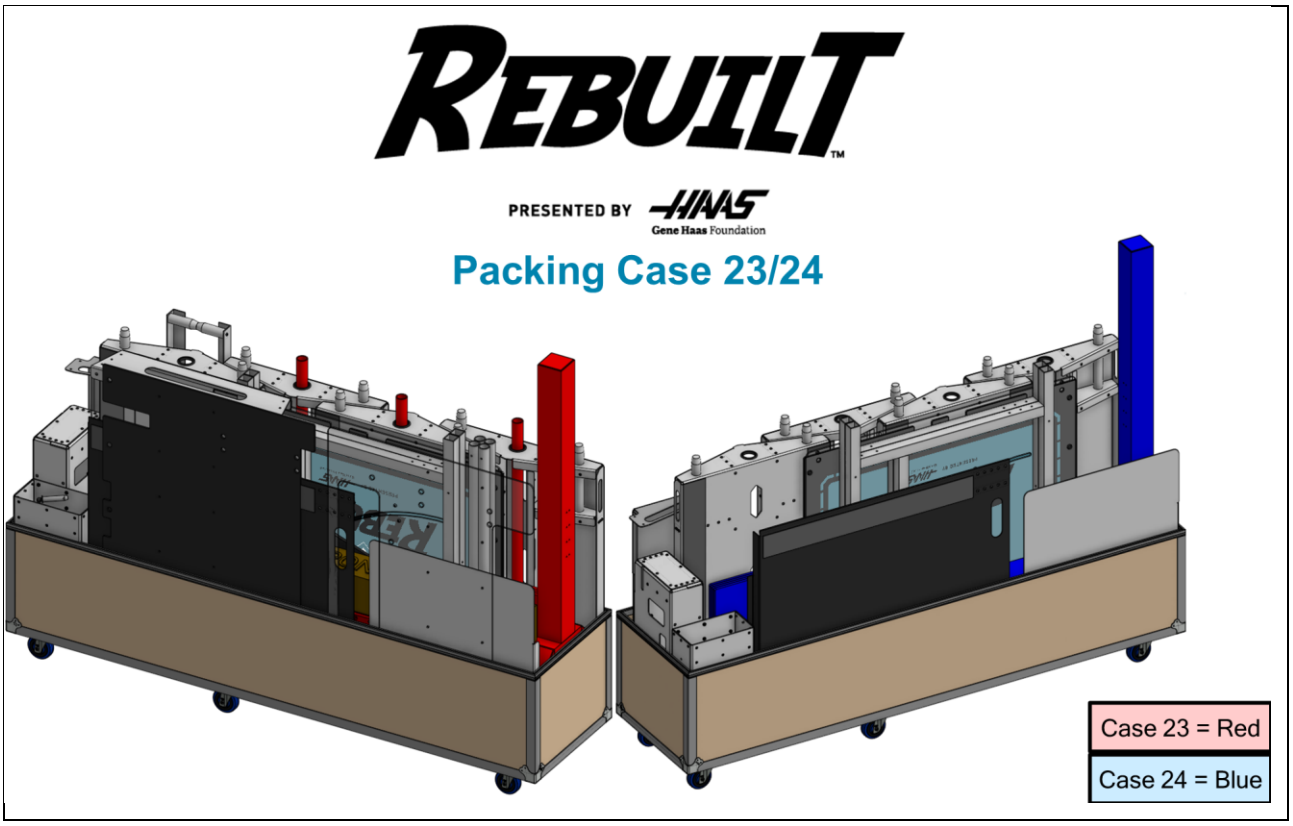
Case 23 and 24 are nearly identical, so they are presented together in this section. Case 23 packs the Red Alliance Trenches, Bumps, Towers, and Outpost. Case 24 contains the Blue Alliance Trenches, Bumps, Towers, and Outpost. The only other difference between the cases is that Case 23 packs the Driver Station Sponsor Panel box in the final step.



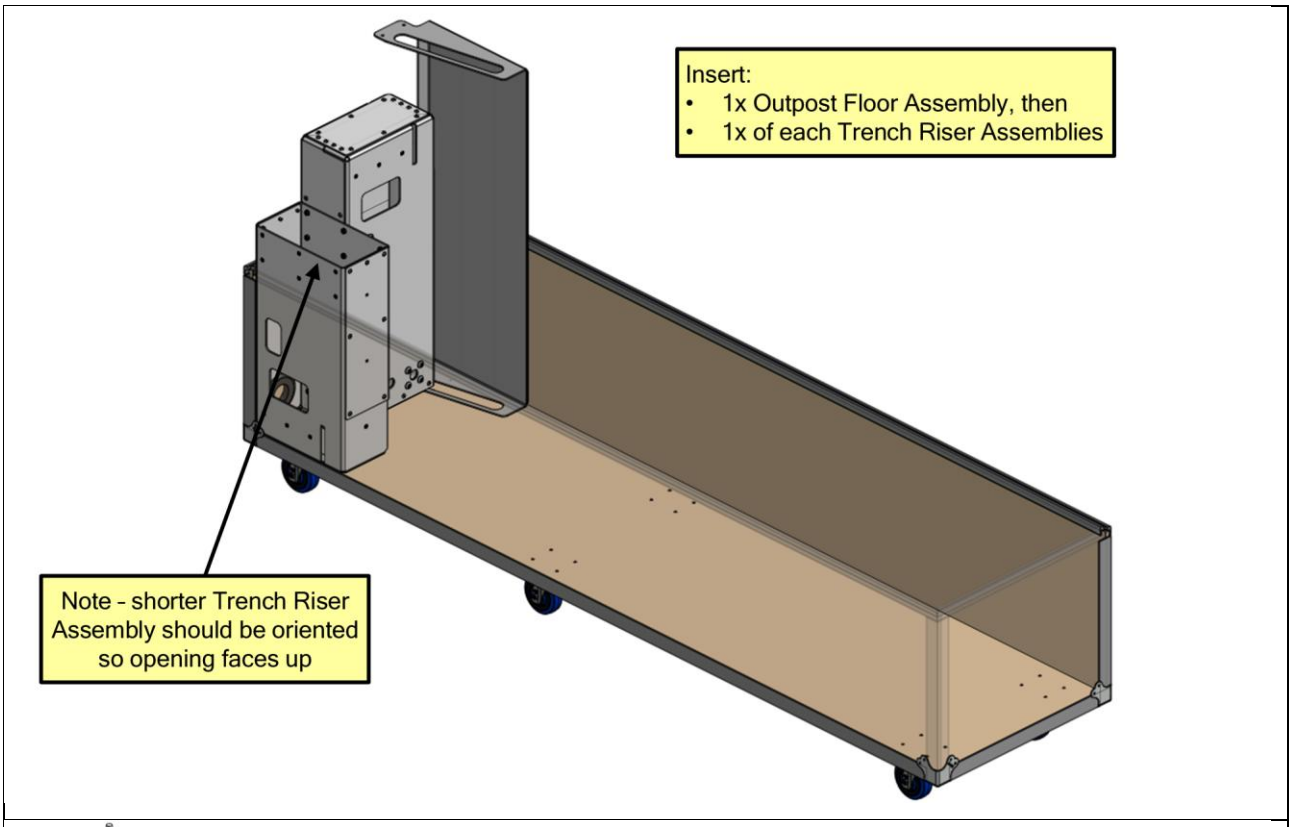
5.9.1.1 Contents

Item Name/Description	Qty	Notes
Outpost Floor Support Assy	1	
Trench Hinged Riser Assy	1	
Trench Fixed Riser Assy	1	
Bump Base Assy	4	
Trench Hinged Arm Weldment	1	Red or Blue
Bump Plastic	4	Red or Blue
Outpost Upper Panel Assy	1	
Tower Upper Plastic and Vinyl	1	
Outpost Frame Weldment	2	
Trench Outside Skirt	2	Red or Blue
Trench Inside Skirt	2	Red or Blue
Outpost Exchange Border	3	
Trench Side Skirt	4	Red or Blue
Outpost Exchange Ramp	1	
Tower Base	1	
Trench Fixed Arm Assy	1	Red or Blue
Outpost Chute Assy	1	
Outpost Chute Door	1	
Tower Upright	2	Red or Blue
Outpost Lower Panel	1	
Tower Lower Plastic	1	
Outpost Bri-Weld Top Rail Assy	2	
Tower Rung	3	Red or Blue
Tower Support Tube	2	
Trench Counterbalance Assy	1	
Outpost AndyMark Top Rail	4	
Tower Brace	2	
Trench AprilTag Mount Assy	4	
Trench Top Hard Stop	1	
Trench Fixed Arm Bracket	2	
Tower Upright Gusset	2	
Tower Support Gusset	4	
Trench Pivot Shaft	1	
Trench Arm Pin Assy	1	
Trench Bottom Hard Stop Weldment	2	
DS Sponsor Panel Box	1 box of 8	Case 23 Only

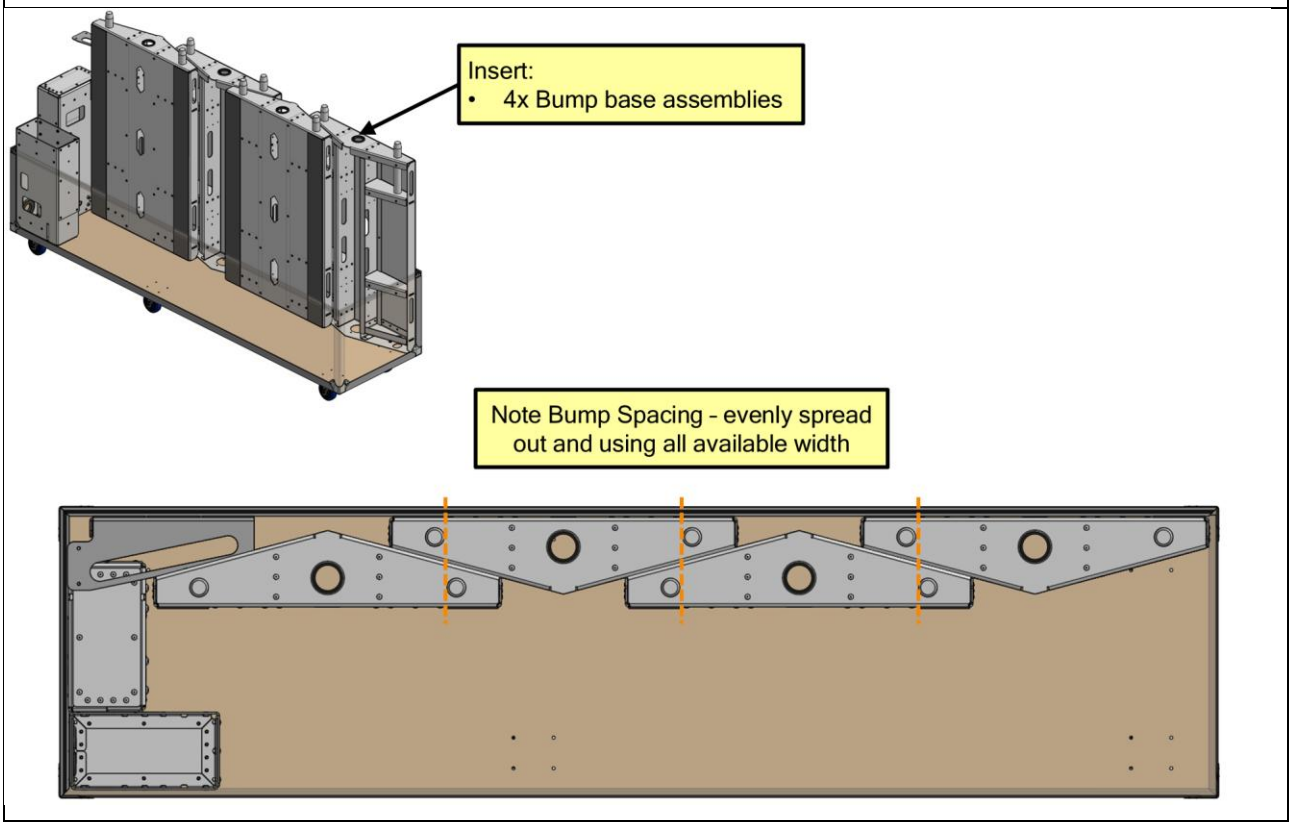
5.9.1.2 Packing Steps

1. 

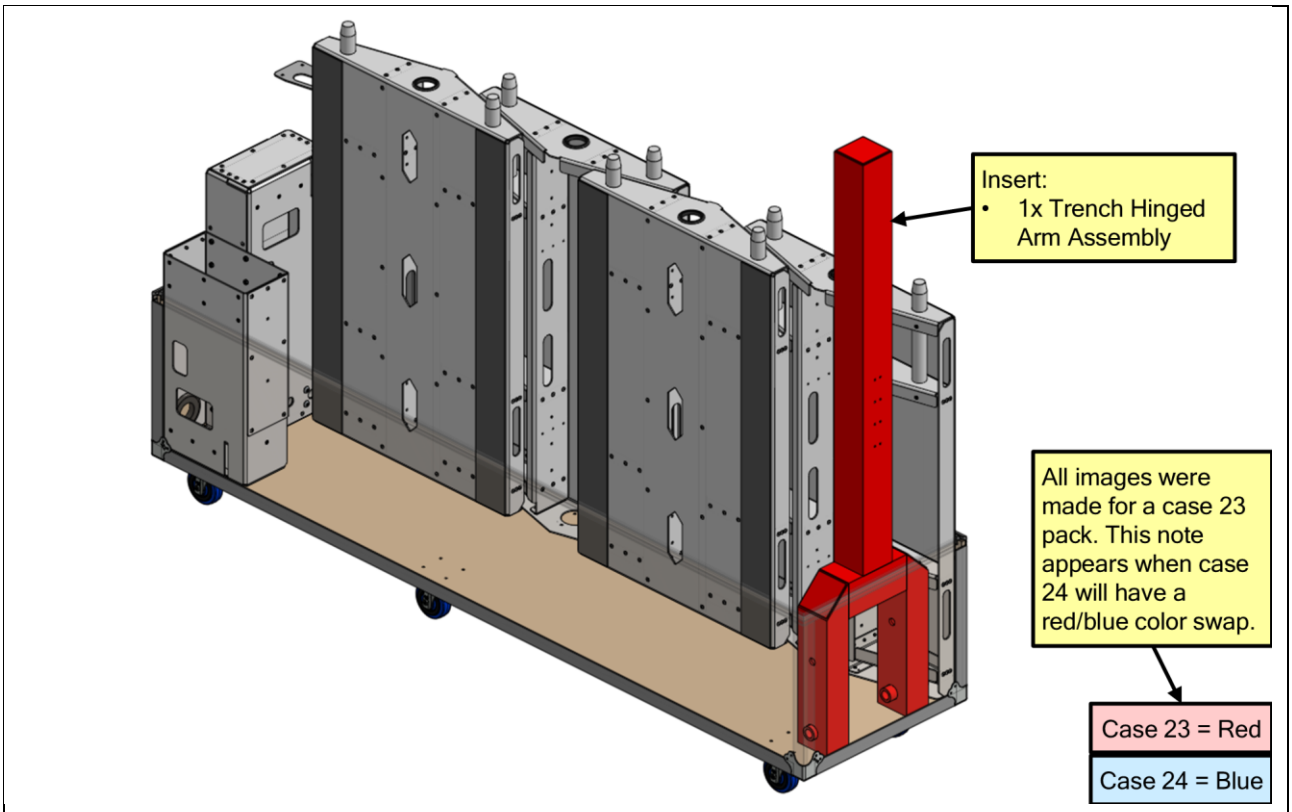
2.


Insert:
• 1x Outpost Floor Assembly, then
• 1x of each Trench Riser Assemblies
Note - shorter Trench Riser Assembly should be oriented so opening faces up

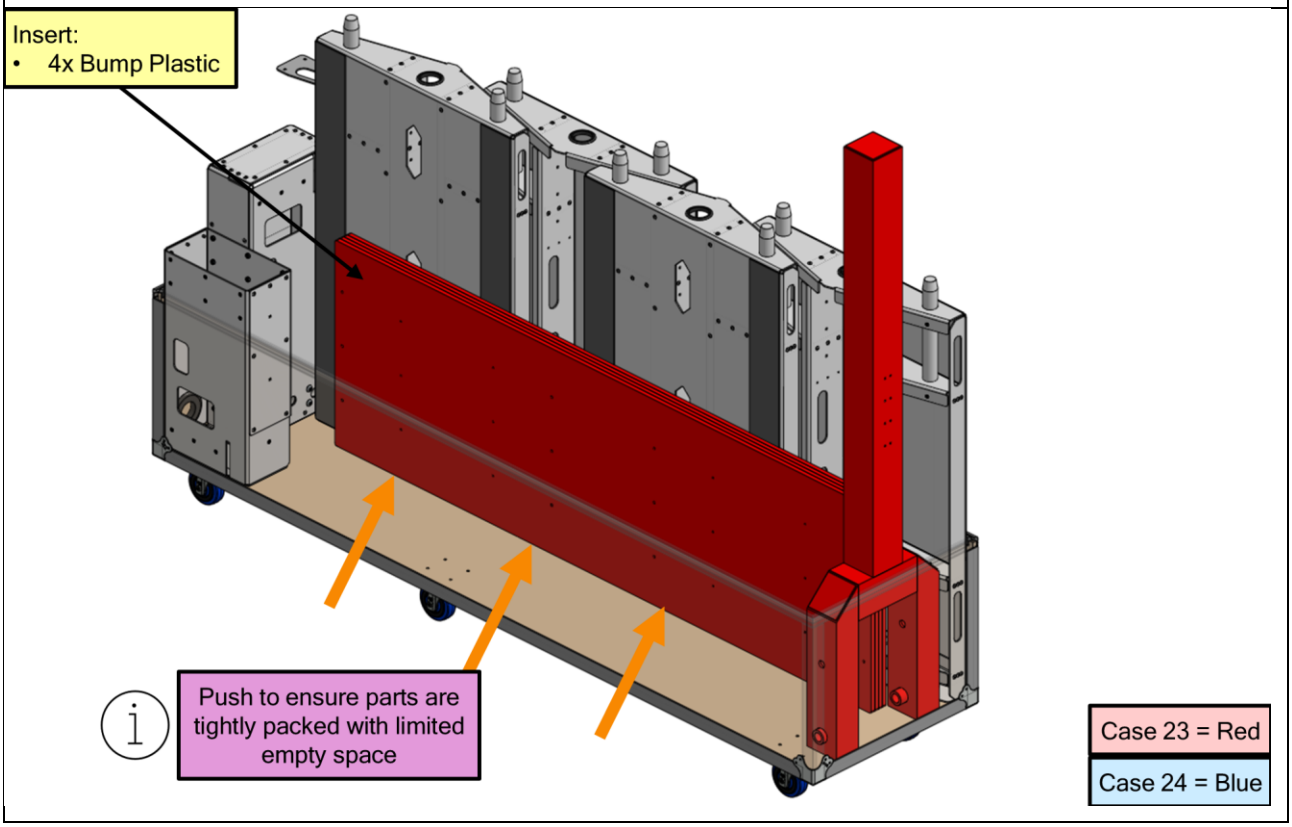
3.


Insert:
• 4x Bump base assemblies
Note Bump Spacing - evenly spread out and using all available width

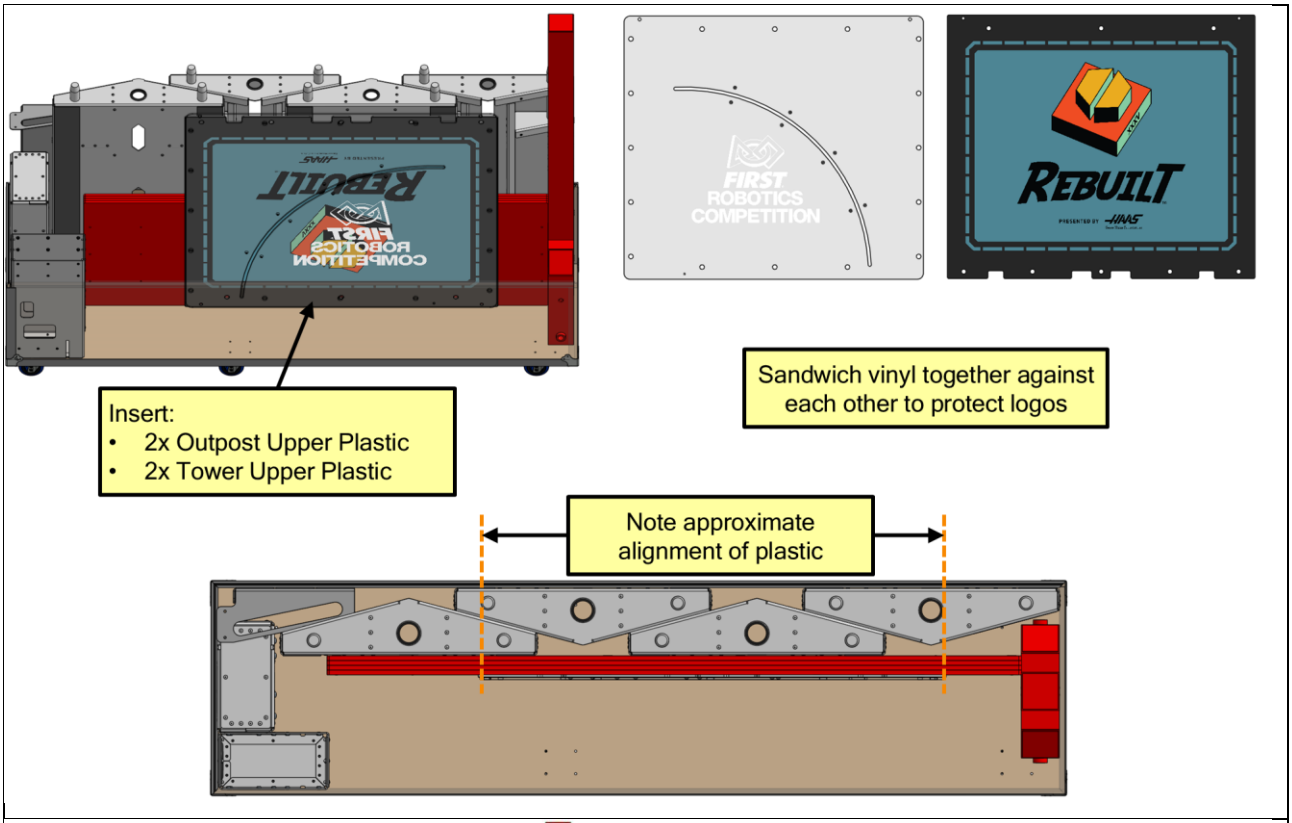
4.


Insert:
• 1x Trench Hinged Arm Assembly
All images were made for a case 23 pack. This note appears when case 24 will have a red/blue color swap.
Case 23 = Red
Case 24 = Blue

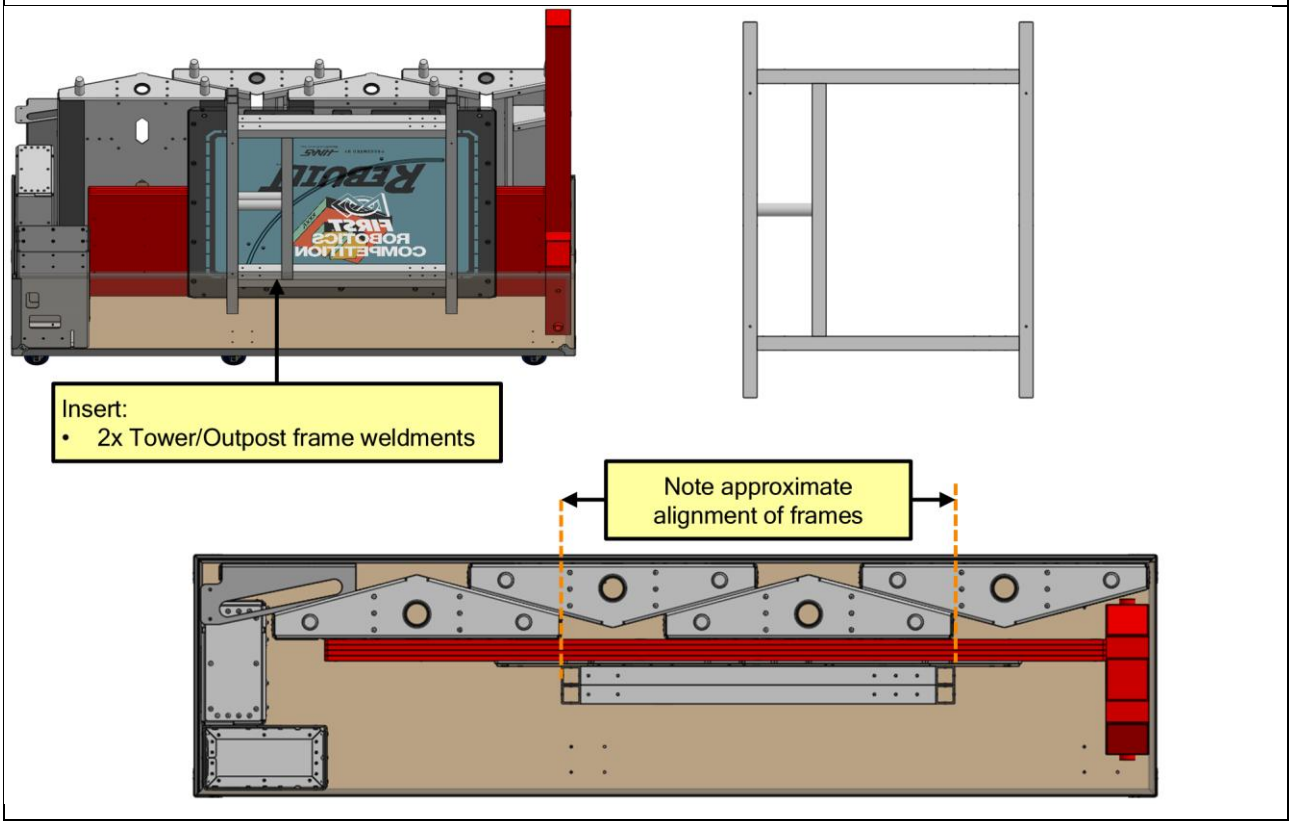
5.


Insert:
• 4x Bump Plastic
Push to ensure parts are tightly packed with limited empty space
Case 23 = Red
Case 24 = Blue

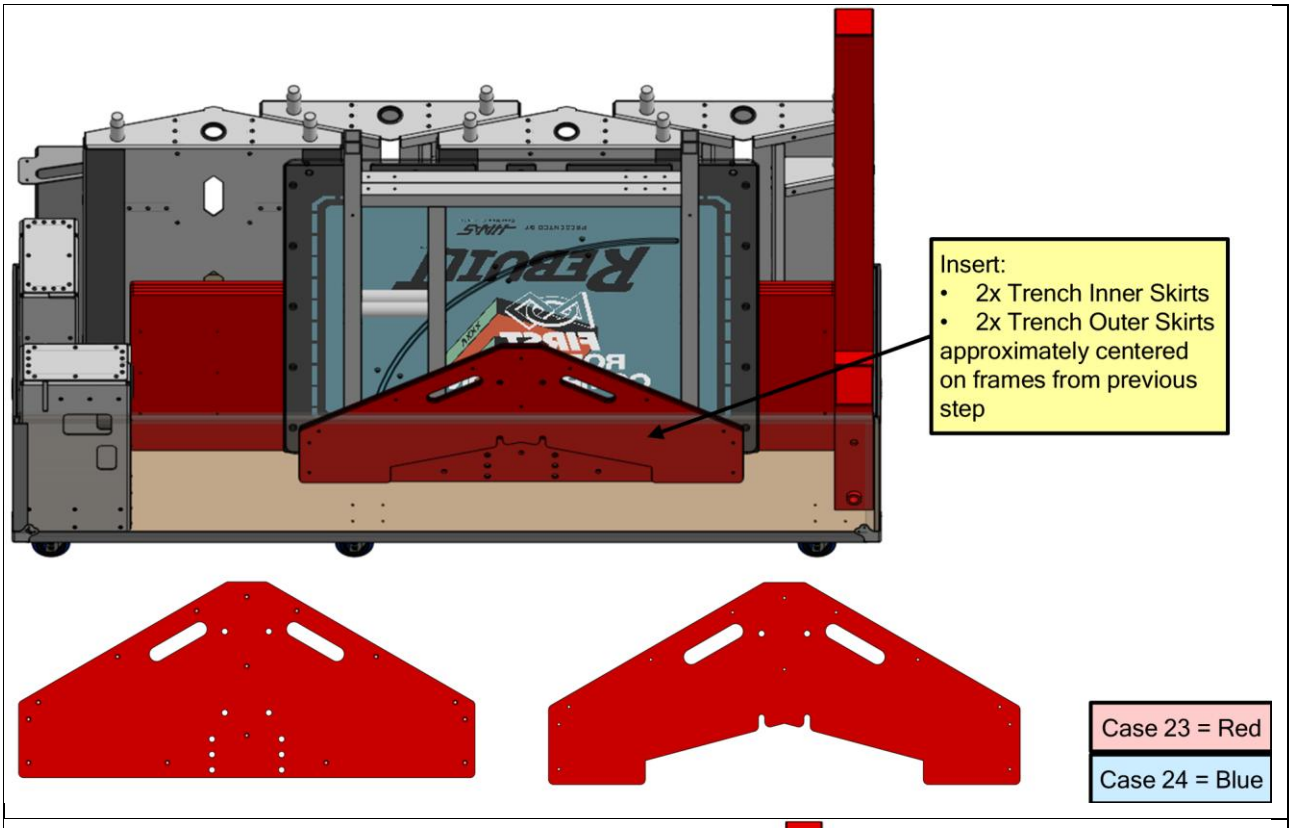
6.


Insert:
• 2x Outpost Upper Plastic
• 2x Tower Upper Plastic
Sandwich vinyl together against each other to protect logos
Note approximate alignment of plastic

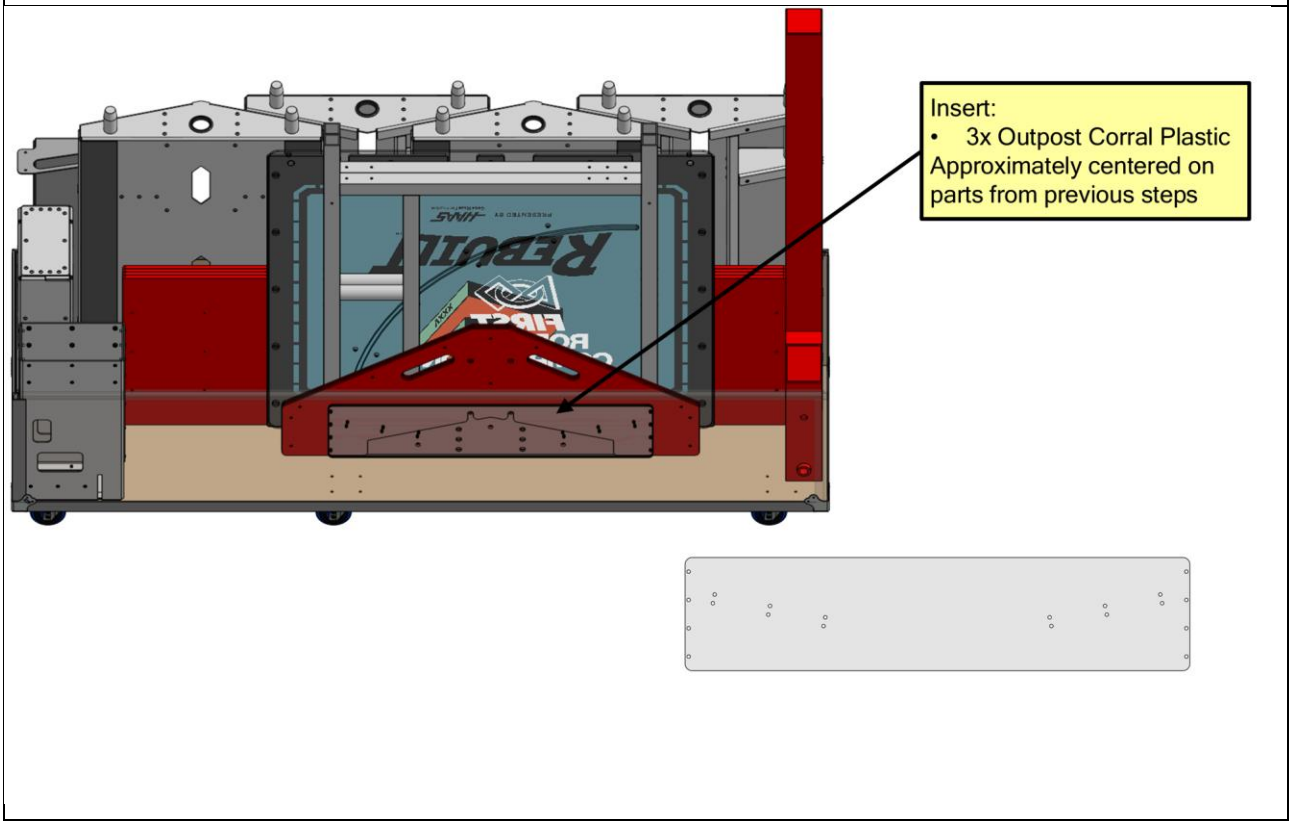
7.


Insert:
• 2x Tower/Outpost frame weldments
Note approximate alignment of frames

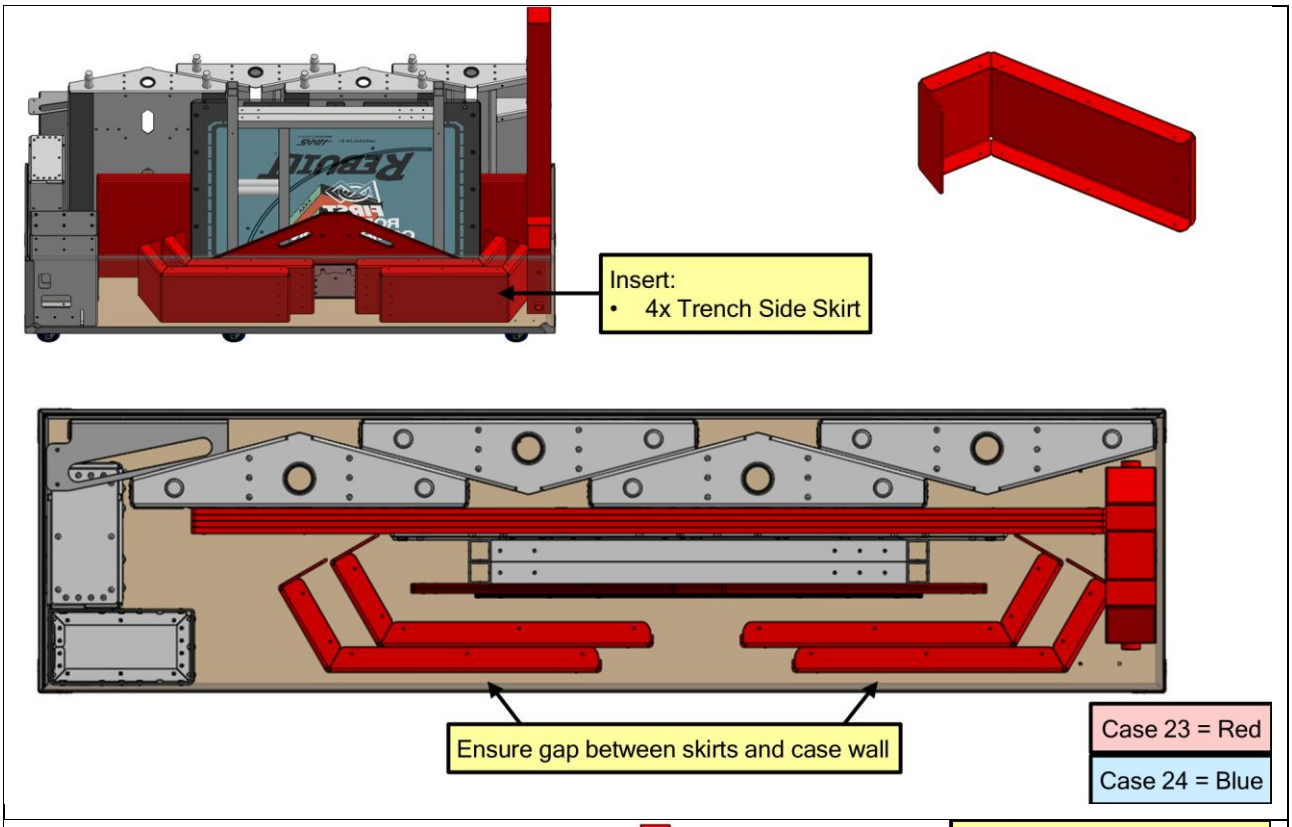
8.


Insert:
• 2x Trench Inner Skirts
• 2x Trench Outer Skirts
approximately centered on frames from previous step
Case 23 = Red
Case 24 = Blue

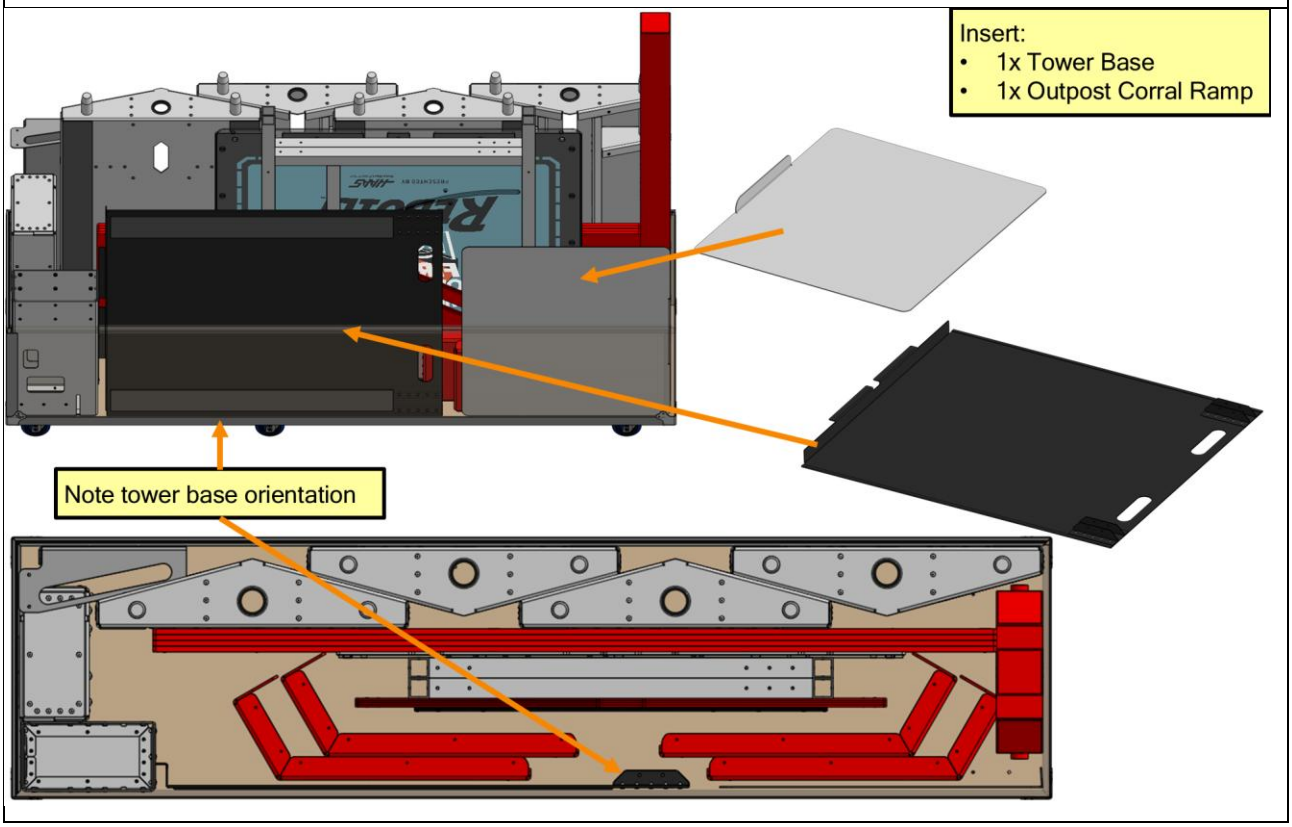
9.


Insert:
• 3x Outpost Corral Plastic
Approximately centered on parts from previous steps

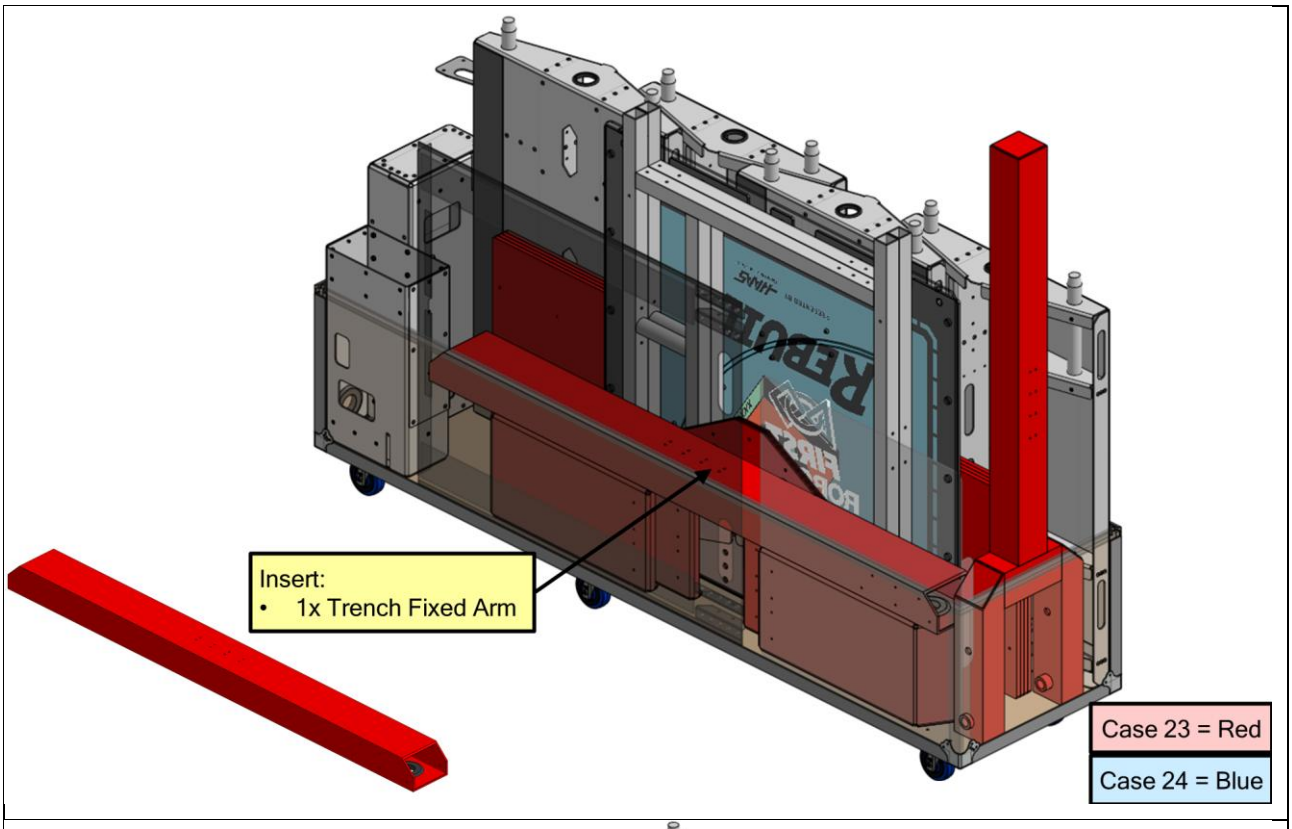
10.


Insert:
• 4x Trench Side Skirt
Ensure gap between skirts and case wall
Case 23 = Red
Case 24 = Blue

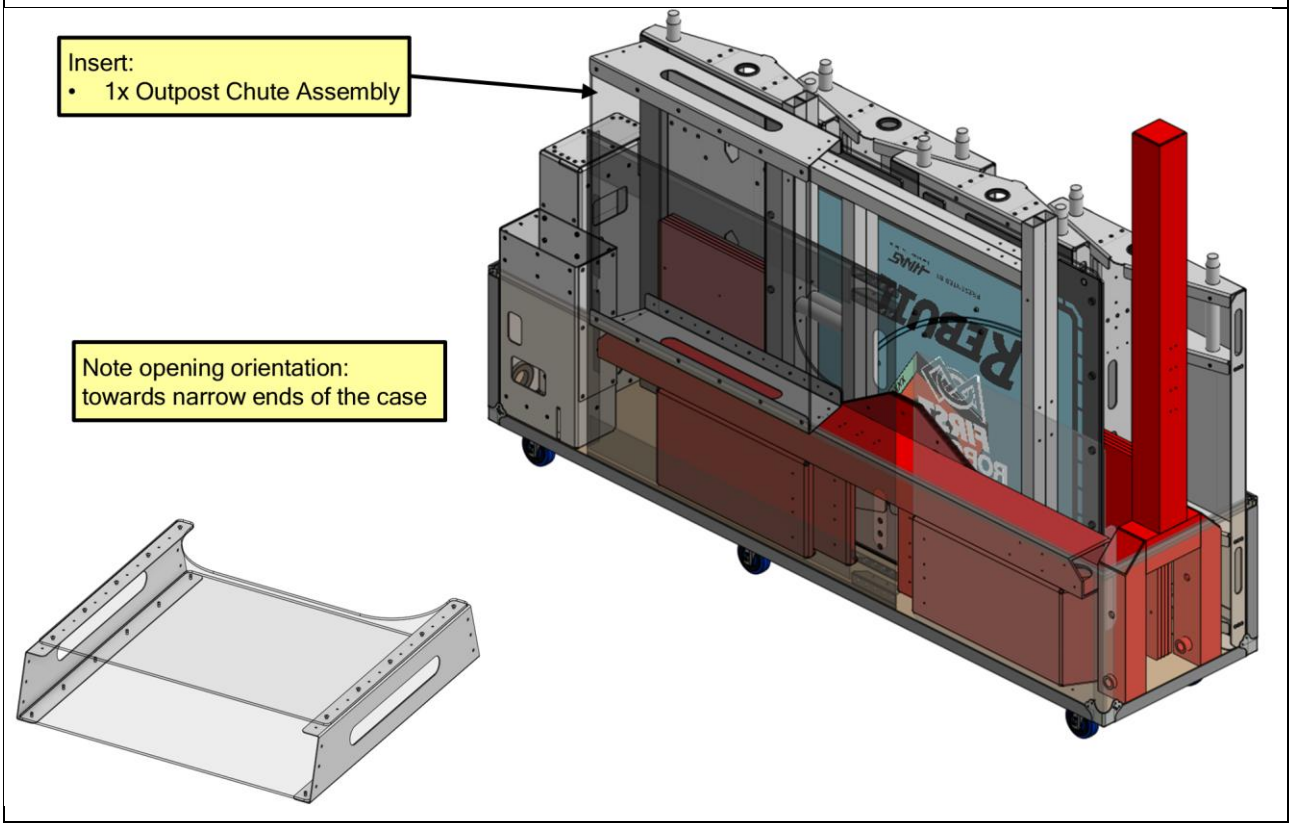
11.


Insert:
• 1x Tower Base
• 1x Outpost Corral Ramp
Note tower base orientation

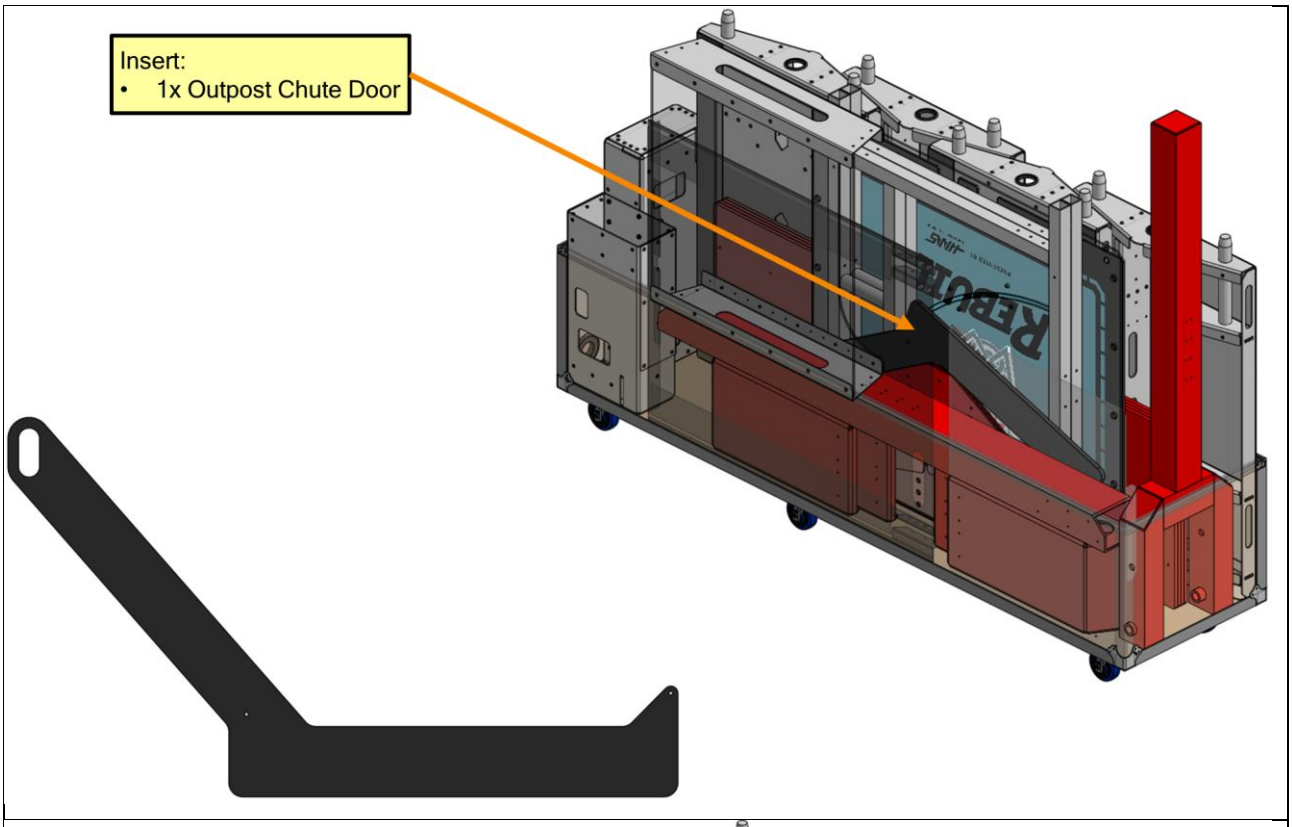
12.


Insert:
• 1x Trench Fixed Arm
Case 23 = Red
Case 24 = Blue

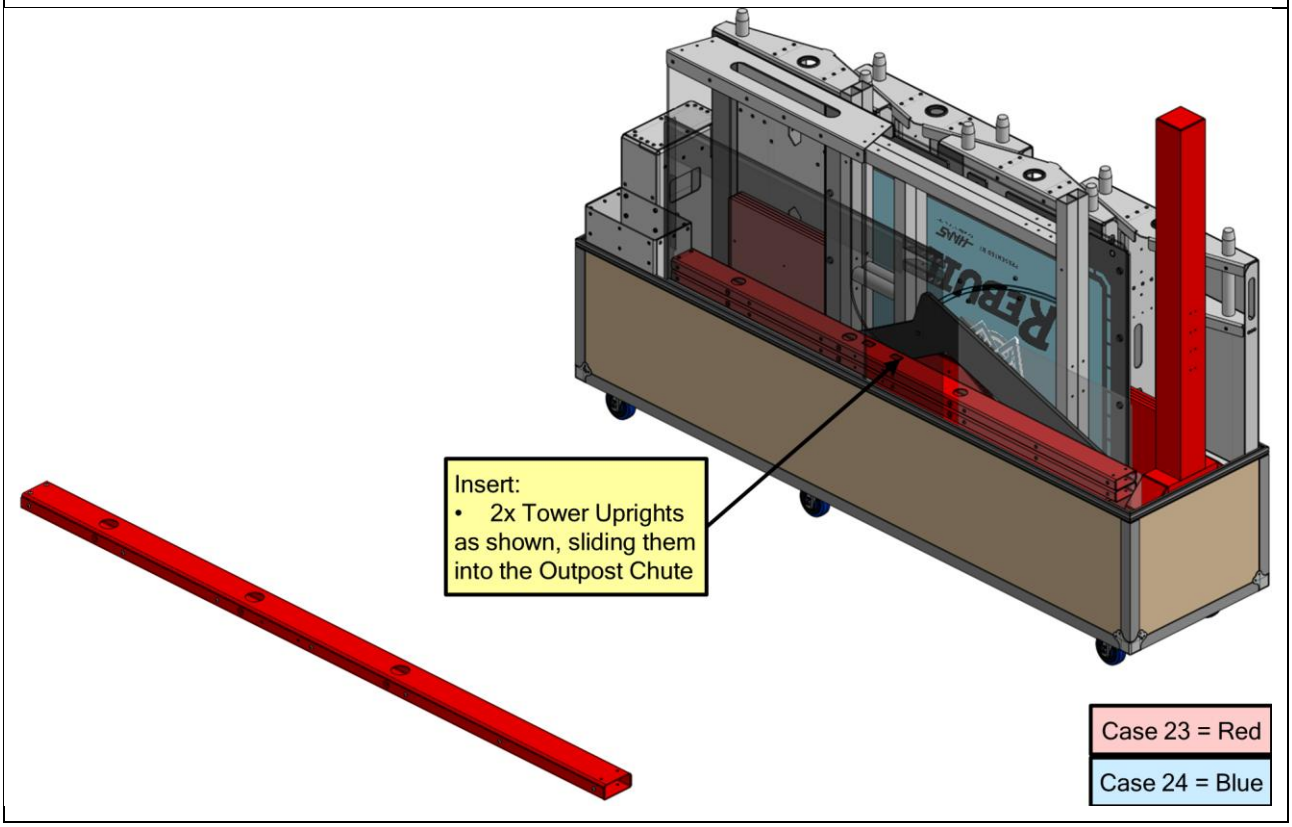
13.


Insert:
• 1x Outpost Chute Assembly
Note opening orientation:
towards narrow ends of the case

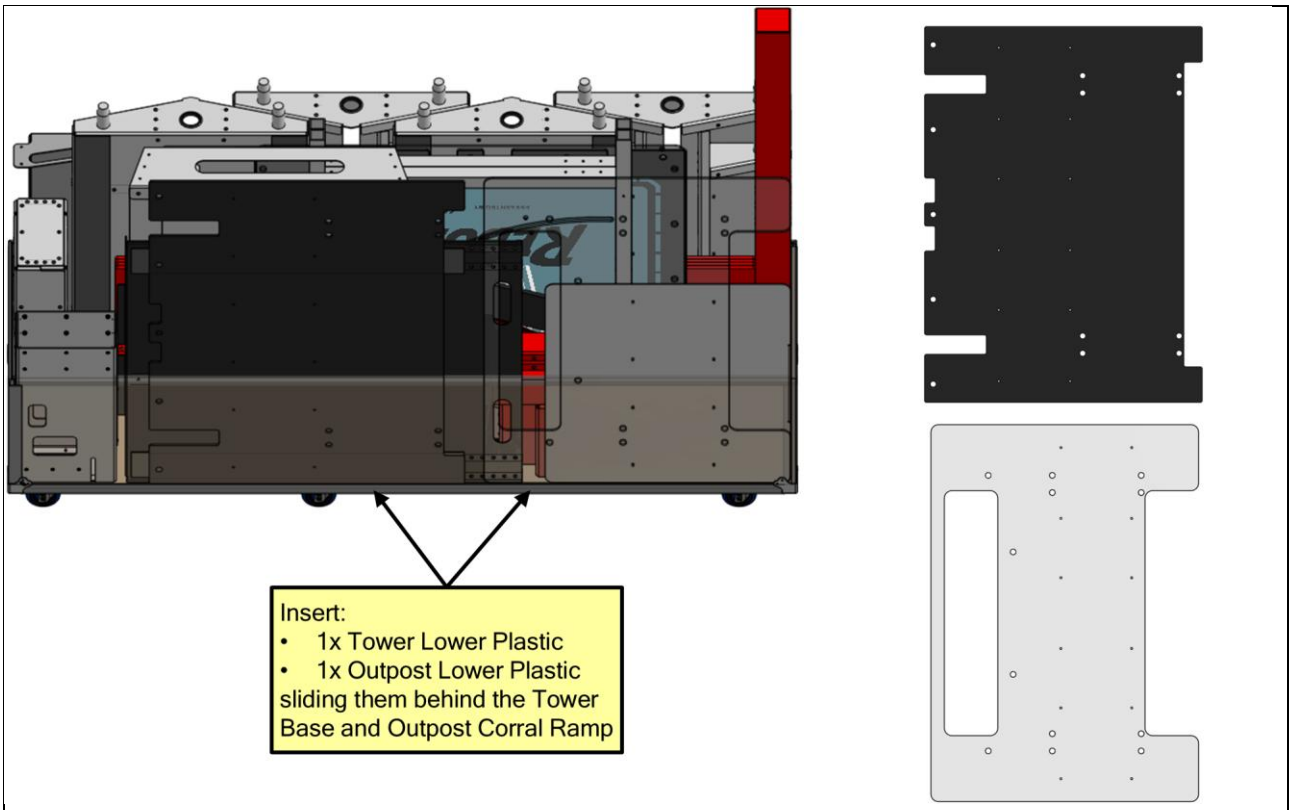
14.


Insert:
• 1x Outpost Chute Door

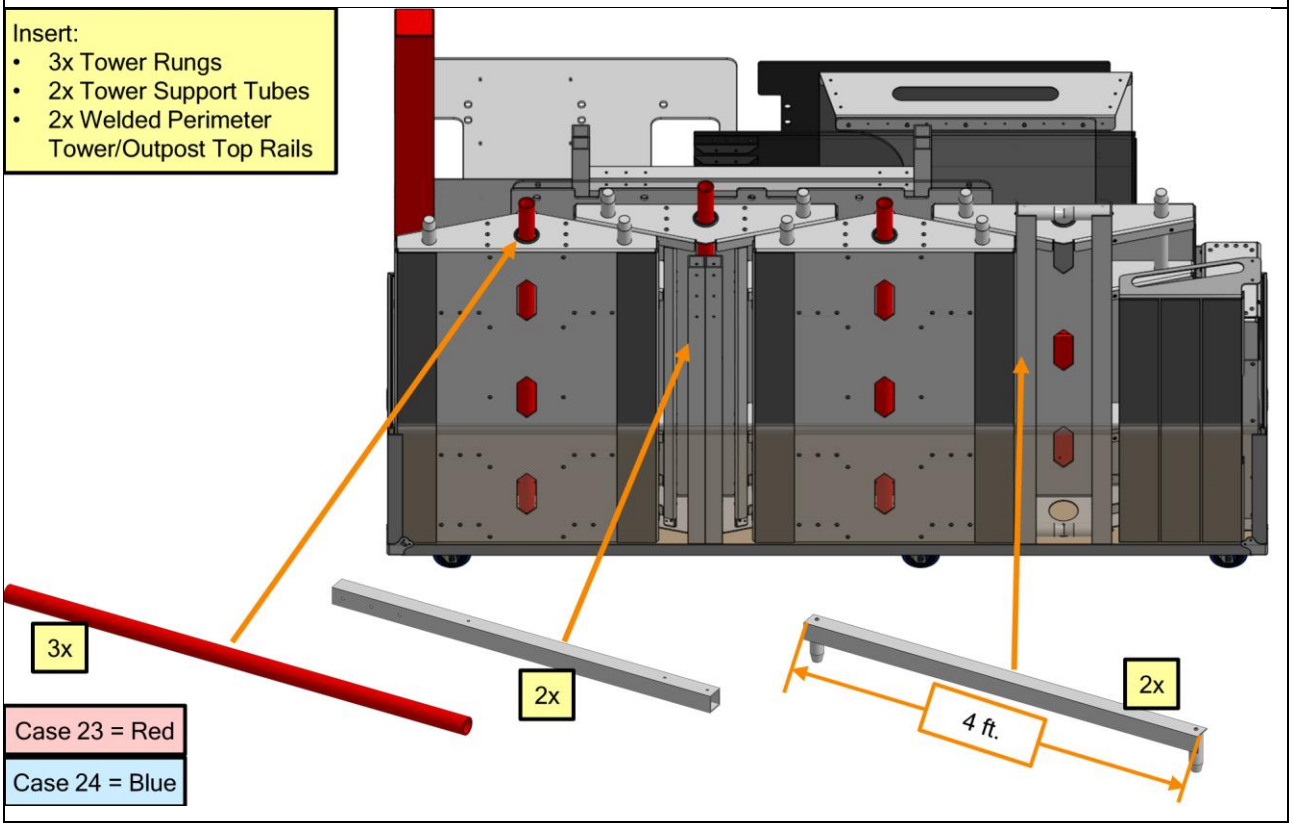
15.


Insert:
• 2x Tower Uprights as shown, sliding them into the Outpost Chute
Case 23 = Red
Case 24 = Blue

16.

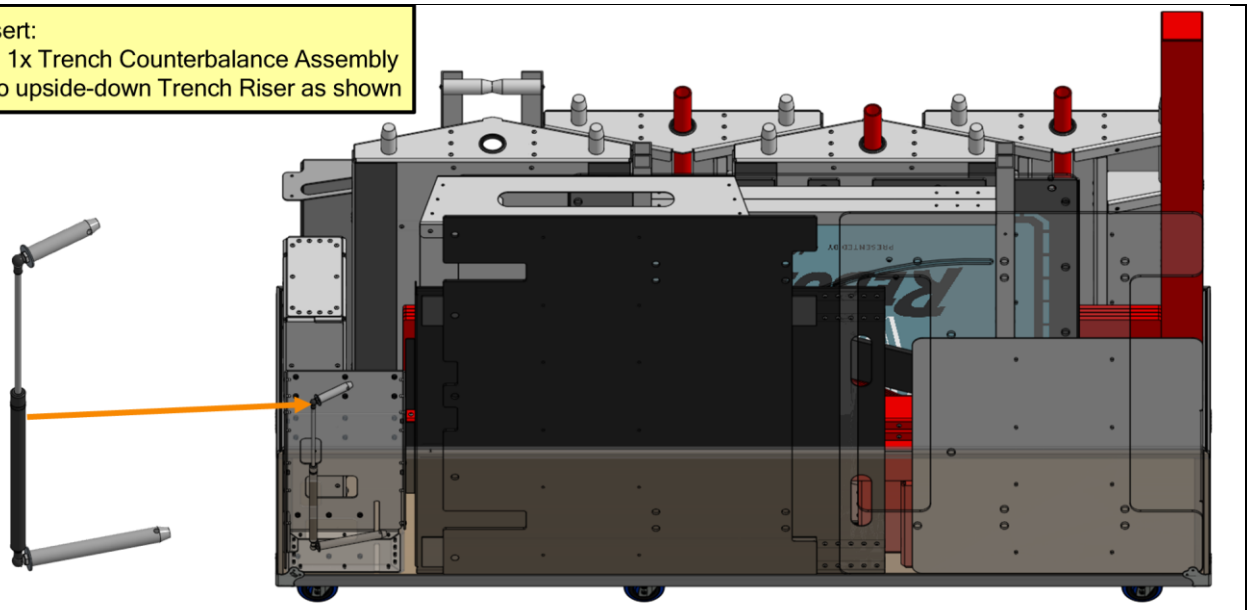

Insert:
• 1x Tower Lower Plastic
• 1x Outpost Lower Plastic
sliding them behind the Tower Base and Outpost Corral Ramp

17.


Insert:
• 3x Tower Rungs
• 2x Tower Support Tubes
• 2x Welded Perimeter Tower/Outpost Top Rails
3x
2x
2x
4 ft.
Case 23 = Red
Case 24 = Blue

18. Insert:
- 1x Trench Counterbalance Assembly

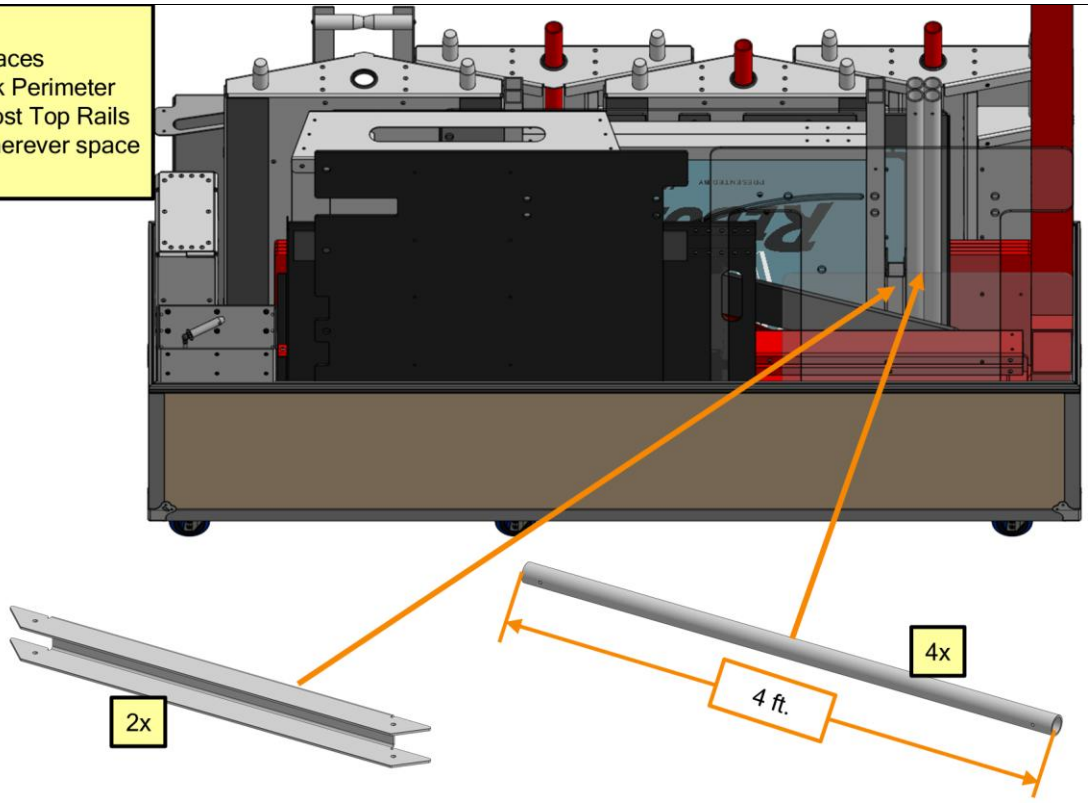
into upside-down Trench Riser as shown



To avoid damaging this assembly, avoid putting other parts in this location in future steps

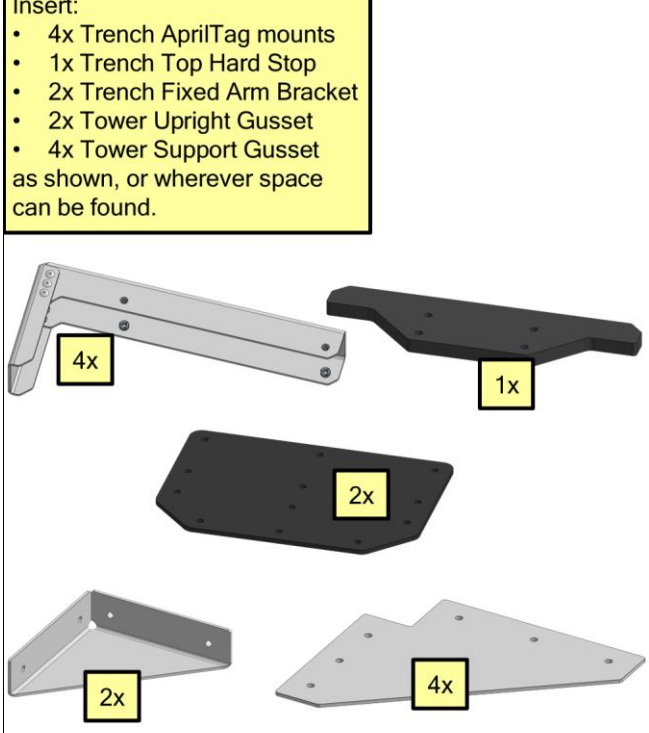
19. Insert:
- 2x Tower Braces
- 4x AndyMark Perimeter Tower/Outpost Top Rails

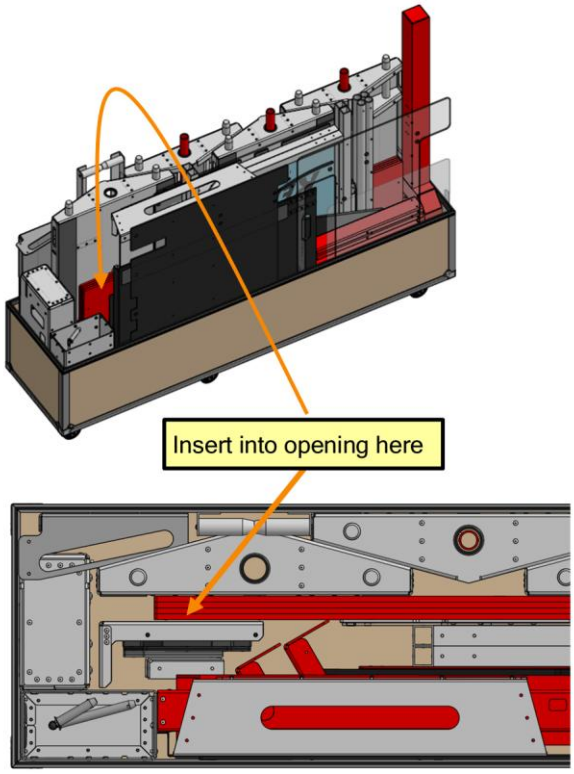
as shown, or wherever space can be found.



20. Insert:
- 4x Trench AprilTag mounts
- 1x Trench Top Hard Stop
- 2x Trench Fixed Arm Bracket
- 2x Tower Upright Gusset
- 4x Tower Support Gusset

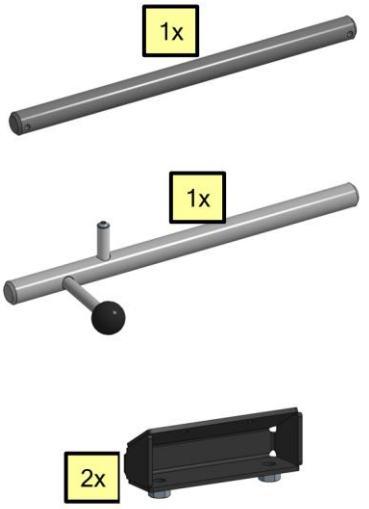
as shown, or wherever space can be found.

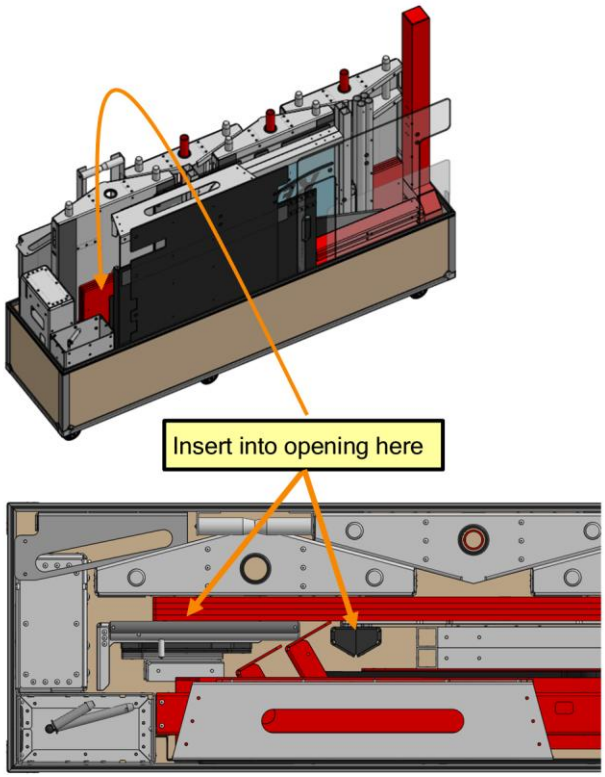




21. Insert:
- 1x Trench Pivot Shaft
- 1x Trench Arm Pin Assembly
- 2x Trench Bottom Hard Stops

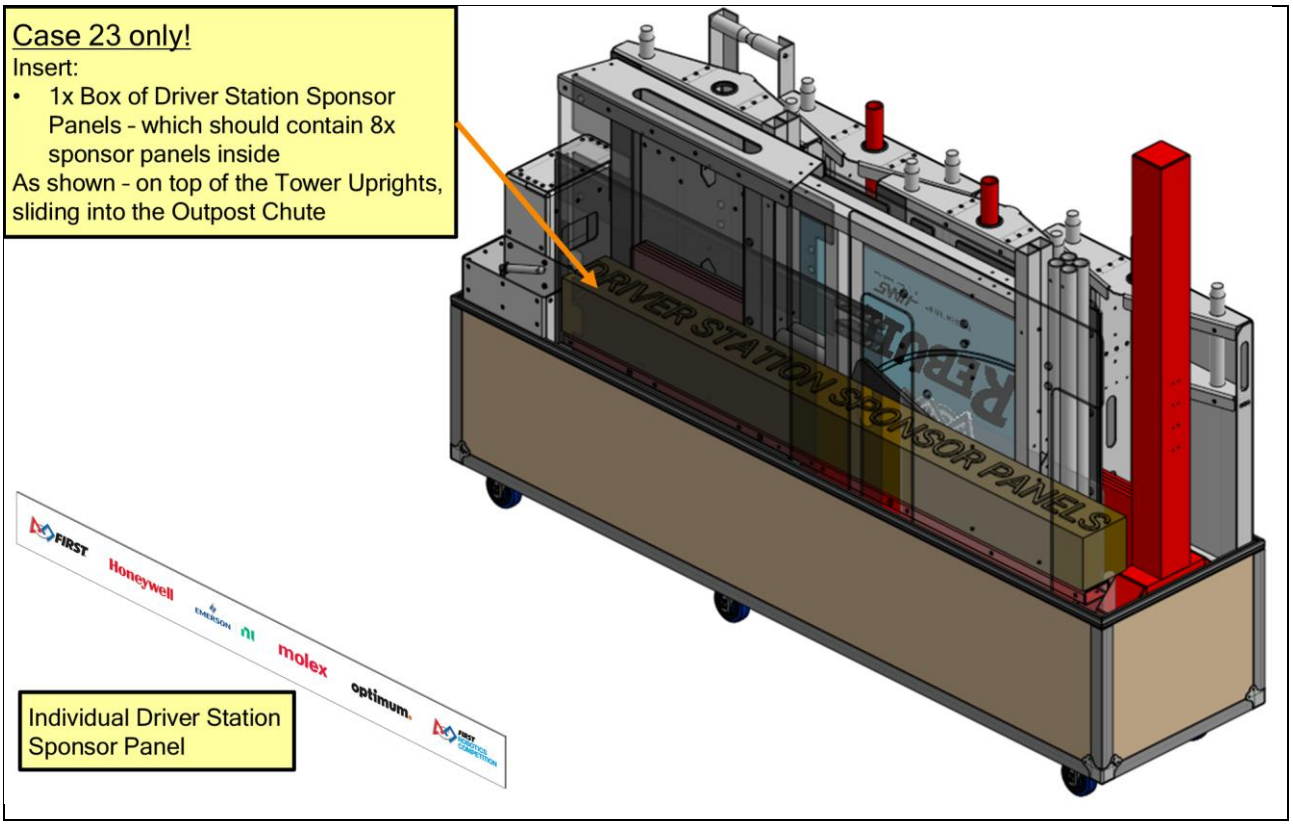
as shown, or wherever space can be found.





22. Case 23 only!
Insert:
- 1x Box of Driver Station Sponsor Panels - which should contain 8x sponsor panels inside

As shown - on top of the Tower Uprights, sliding into the Outpost Chute



Individual Driver Station Sponsor Panel

5.9.2 Case 31

5.9.2.1 Contents

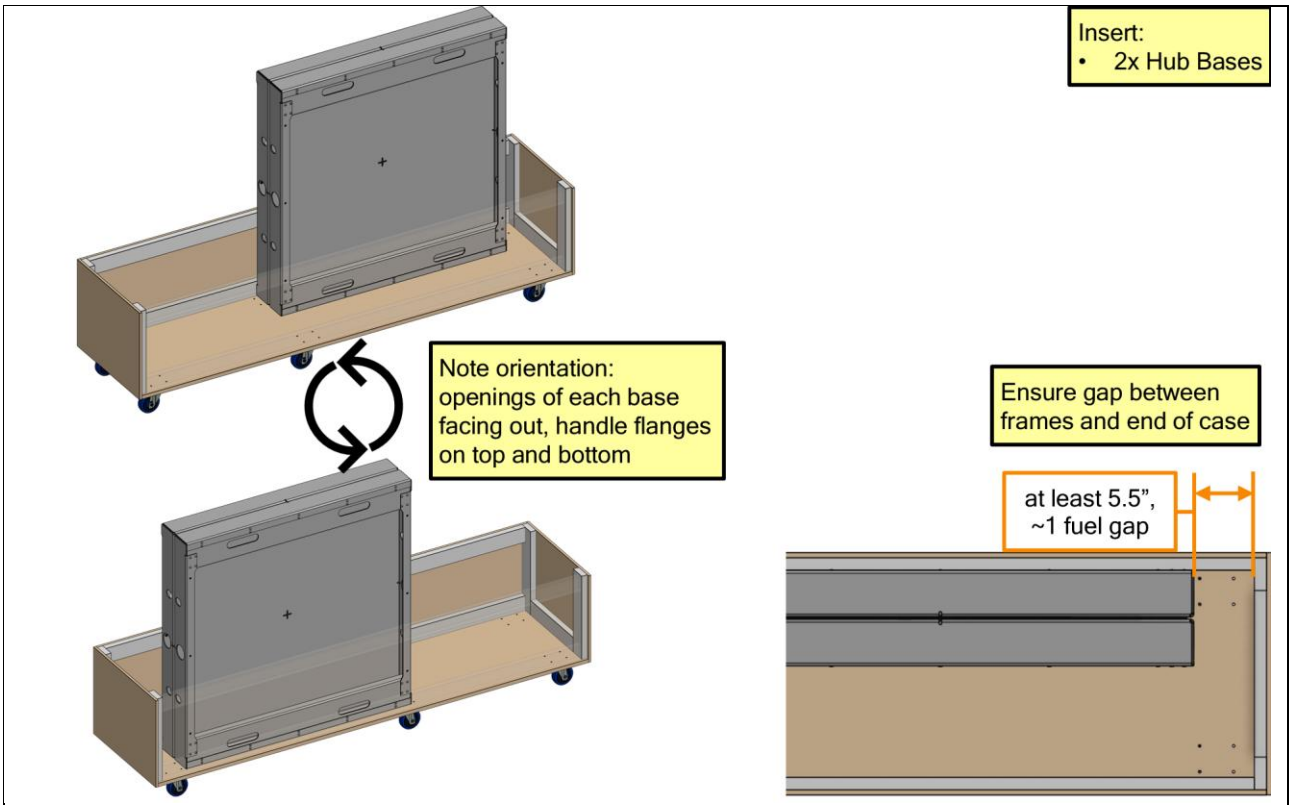
Item Name/Description	Qty	Notes
Hub Base Assembly	2	
Hub Roof Panel	1	
Hub Roof Panel	1	
Hub Side Frame - Weldment	4	
Hub Internal Wall	4	
Hub Ramp, Small	2	
Hub Brace Assembly	12	
Hub Crossbar Assembly	10	
Hub Ramp Angle Assembly	4	
Blue Depot	1	
Red Depot	1	
Hub Funnel Base Assembly	2	
Hub Roof Riser, Right Assembly	2	
Hub Roof Riser, Left Assembly	2	
Hub Front Panel, Bottom	2	
Hub Side Panel Plastic and Vinyl	4	
Hub Net Pole Bottom	2	
Hub Ramp, Large	2	

Item Name/Description	Qty	Notes
Hub Front Diffuser	2	
Hub Rear Diffuser	2	
Hub Side Diffuser	4	
Hub Front Panel, Top	4	
Hub Rear Panel, Bottom	2	
Hub Funnel Side	12	
Lil' Step Stool	2	
Hardware bin 1&2	2	(1 each bin)
Rake Handle	4	
Rake Leg	8	
PVC Tee	4	
PVC 2" Cap	8	
PVC 1" Cap	4	
Hub Net Pole Holder 1, Right Assembly	2	
Hub Net Pole Holder 2, Right Assembly	2	
Hub Net Pole Holder 1, Left Assembly	2	
Hub Net Pole Holder 2, Left Assembly	2	
Hub Light Mount	8	
Hub Pole Connector Bracket	4	
Ball Deflector	6	
Hub Pole Corner Brace	4	
Inlet Funnel	6	
Driver Station Sponsor Bracket	14	
Fuel Pen Holder	2	
Hub Net	3	
Hub Net Pole, Top	2	
Hub Net Pole, Long	4	
Hub Net Pole, Short	4	
Spare gas shock	1	

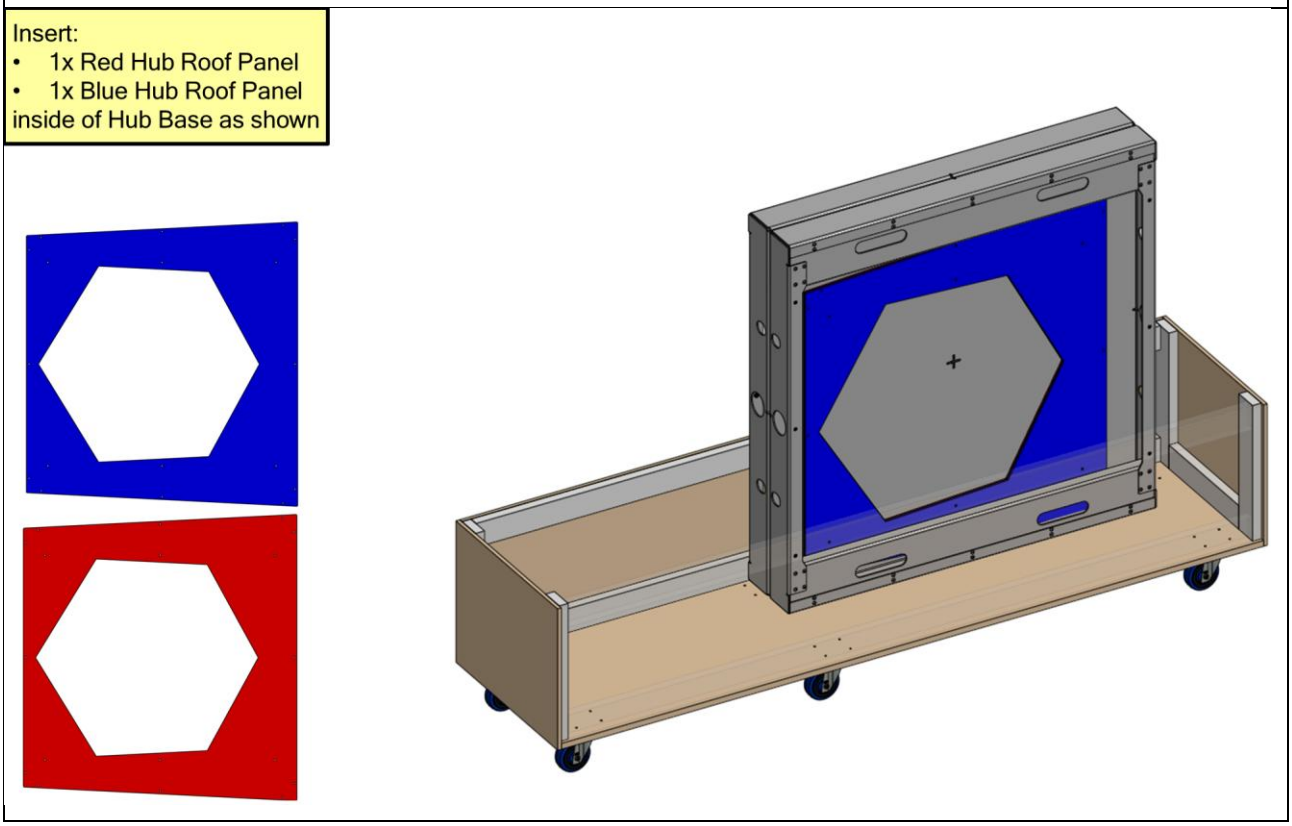
5.9.2.2 Packing Steps

1. 

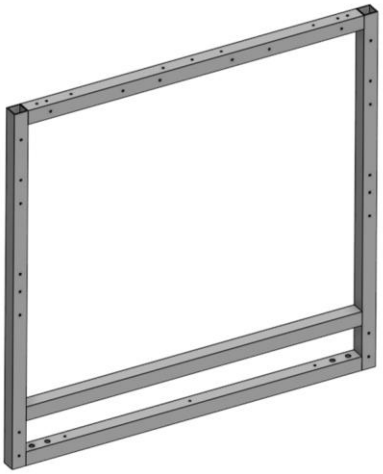
2.

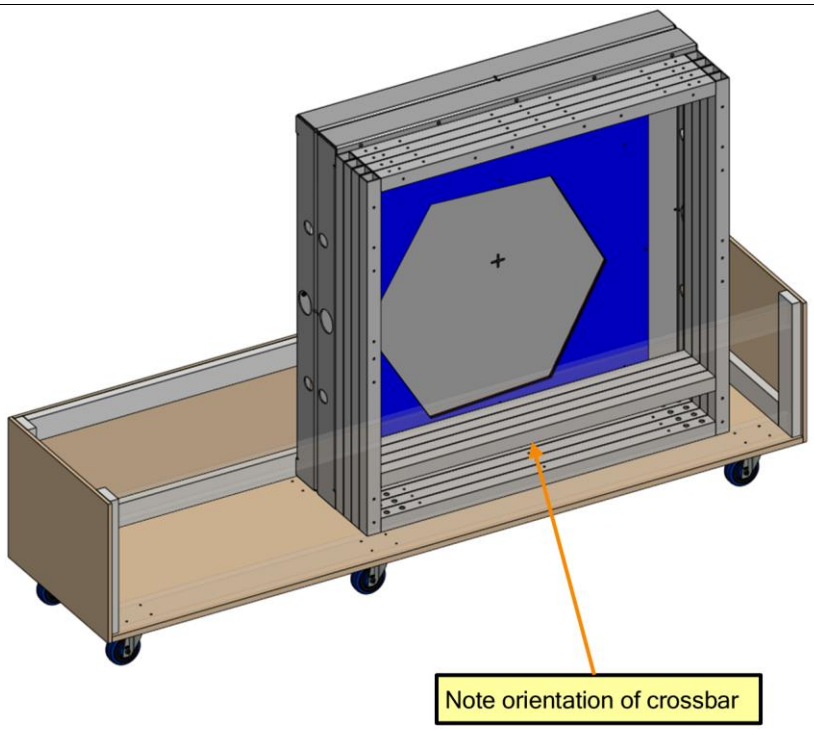

Insert:
• 2x Hub Bases
Note orientation:
openings of each base facing out, handle flanges on top and bottom
Ensure gap between frames and end of case
at least 5.5”, ~1 fuel gap

3.


Insert:
• 1x Red Hub Roof Panel
• 1x Blue Hub Roof Panel
inside of Hub Base as shown

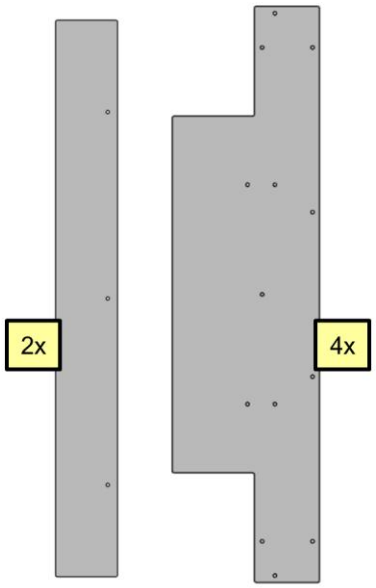
4. Insert:
   - 4x Hub Side Frames aligned with Hub Bases

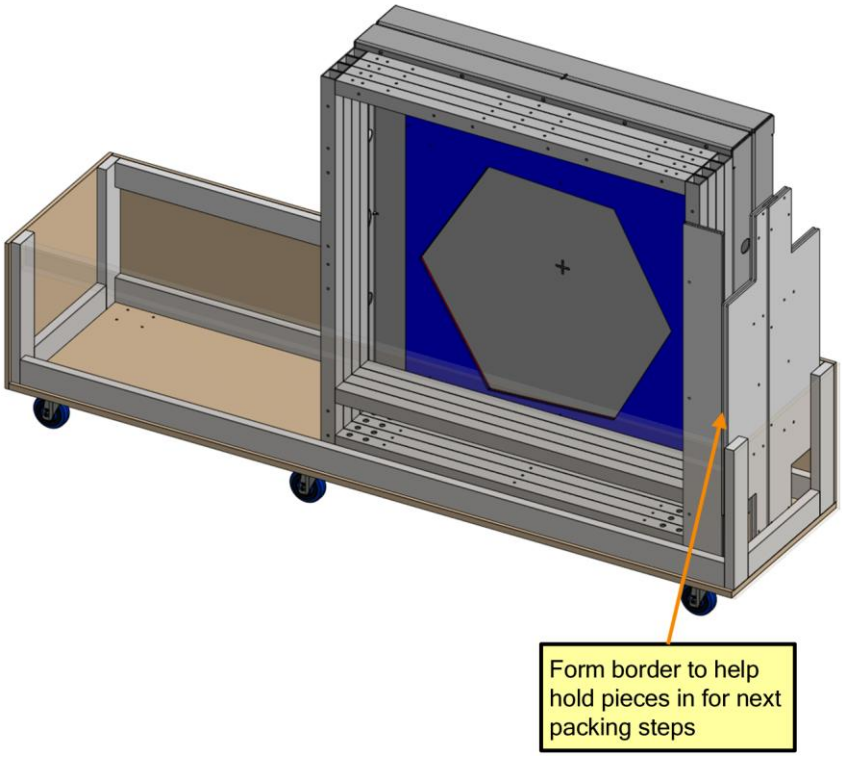




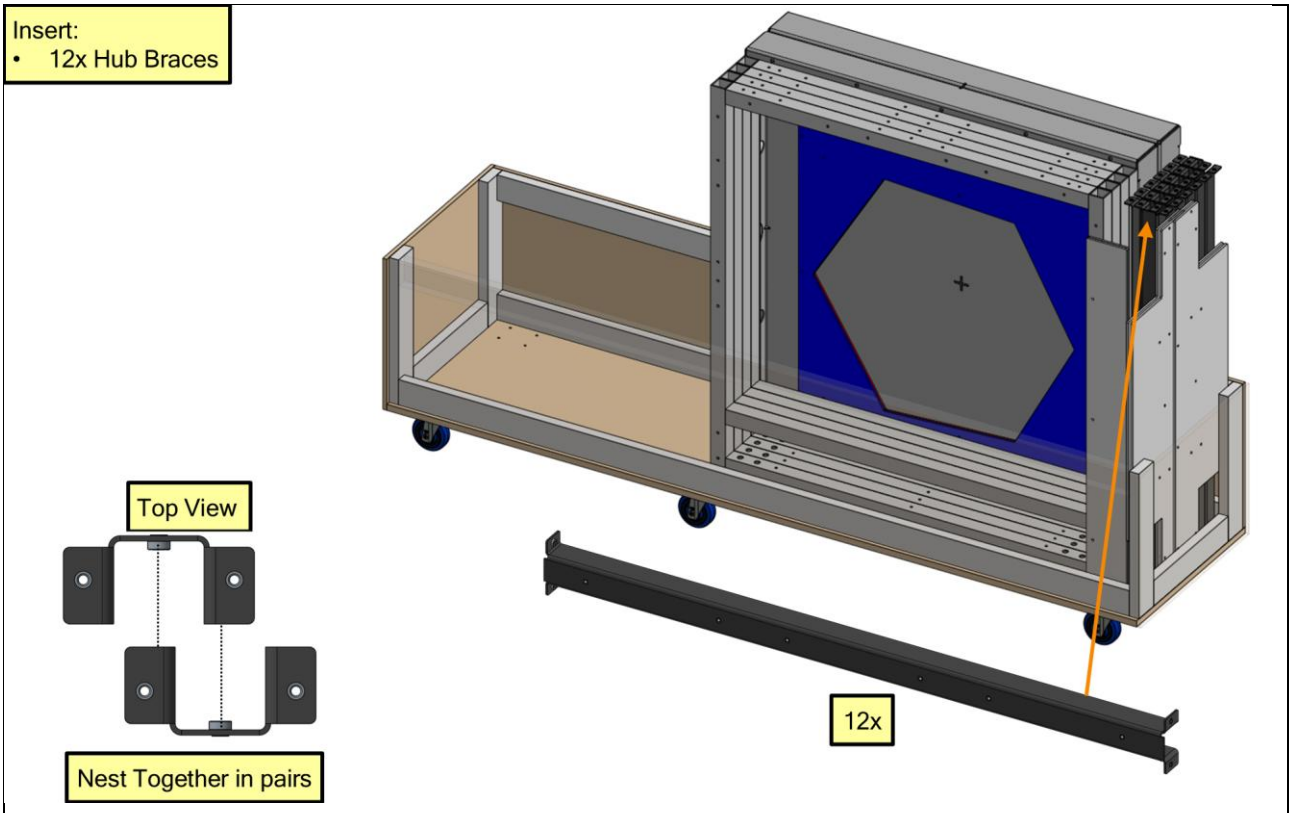
5. Insert:
   - 2x Small Hub Ramps
   - 4x Hub Internal Walls

as shown

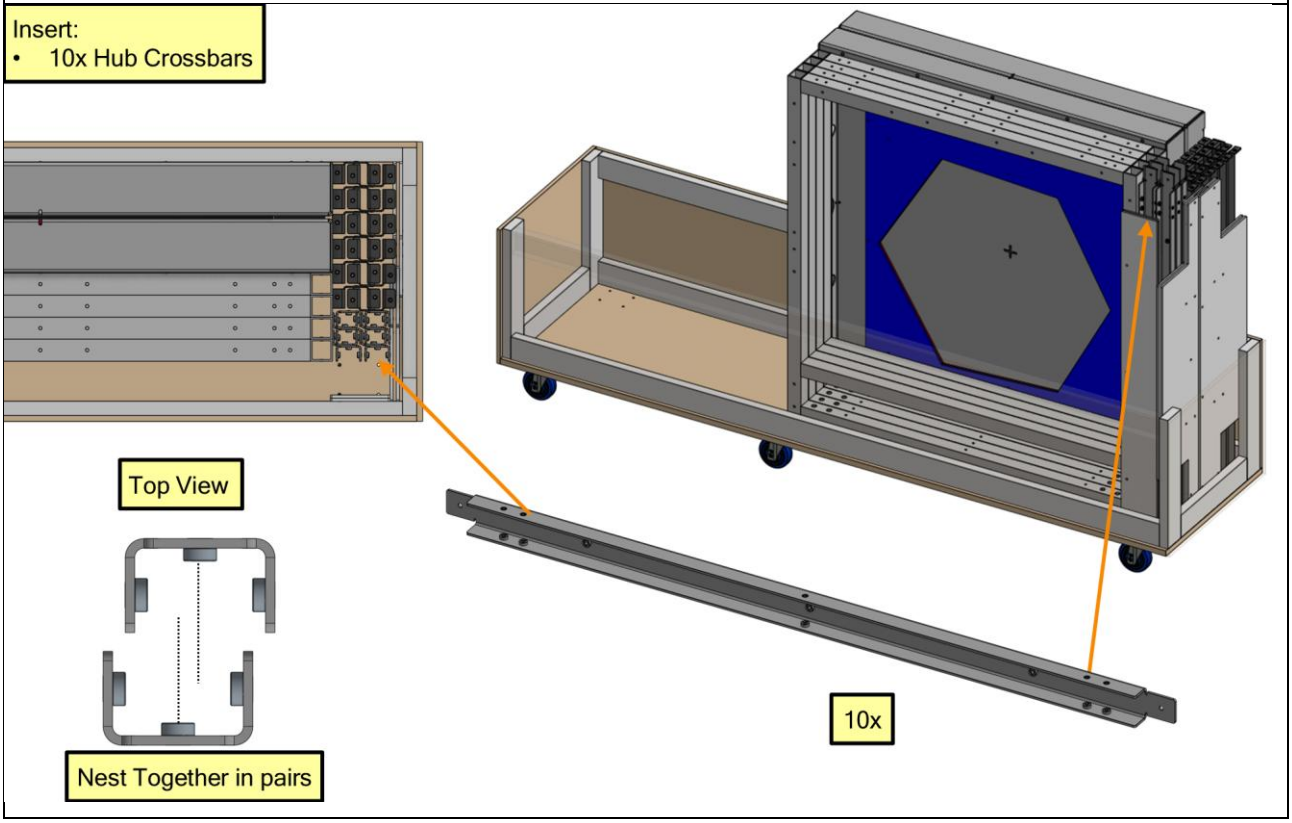




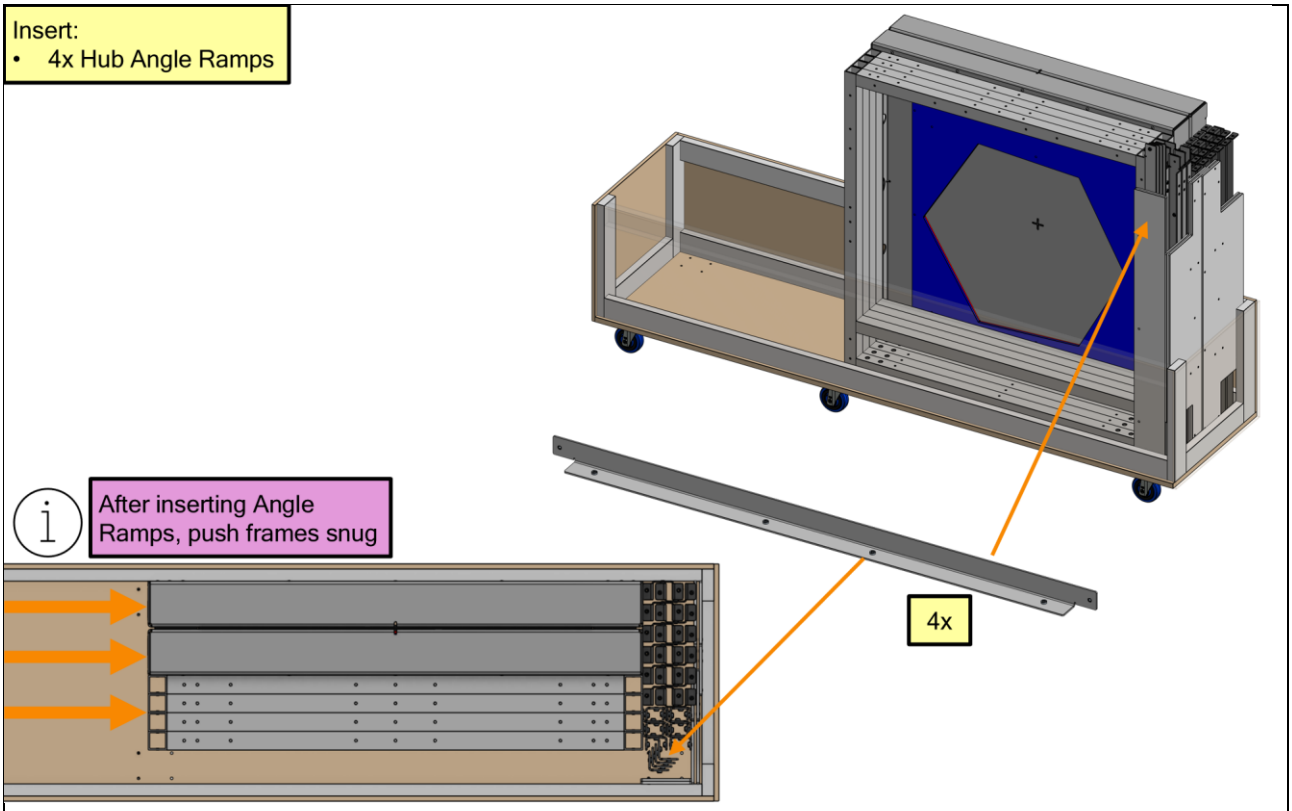
6. Insert:
   - 12x Hub Braces



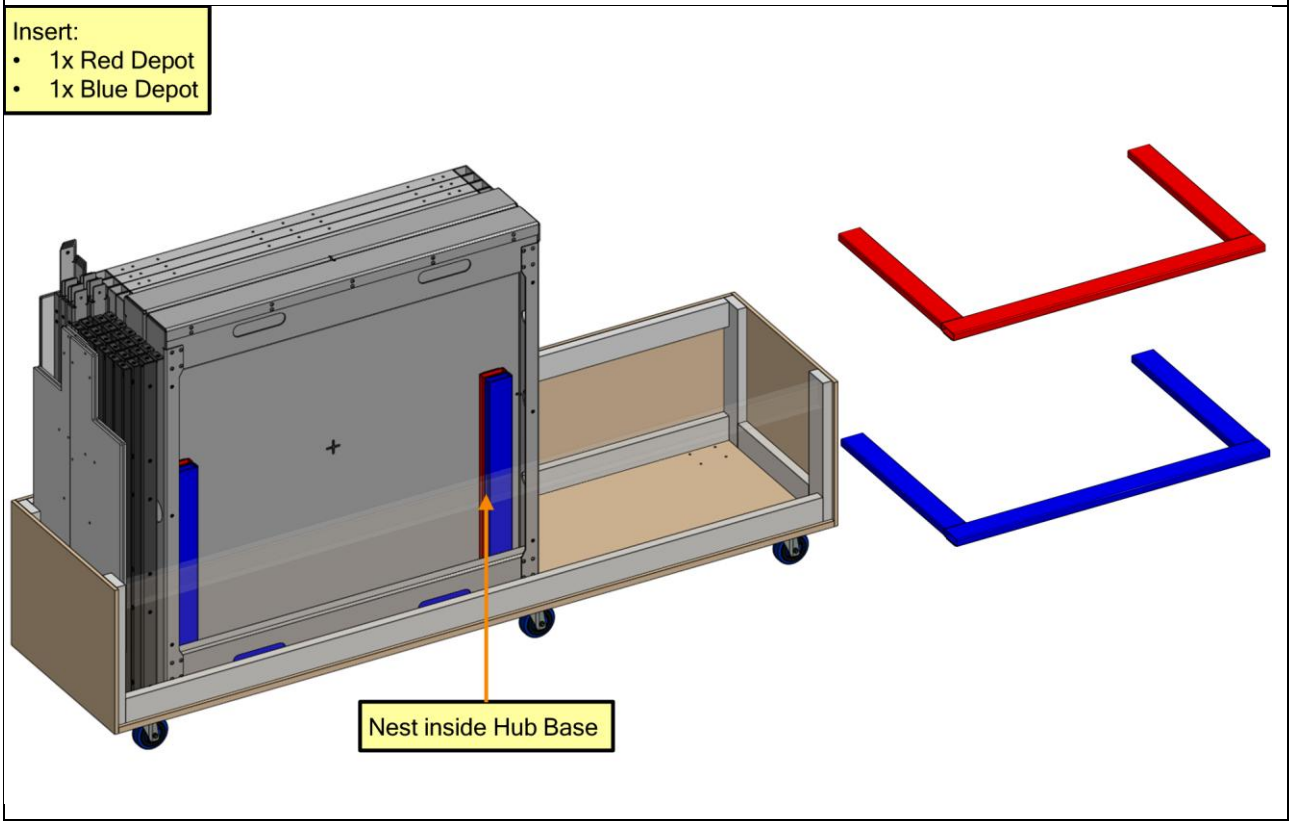
7. Insert:
   - 10x Hub Crossbars



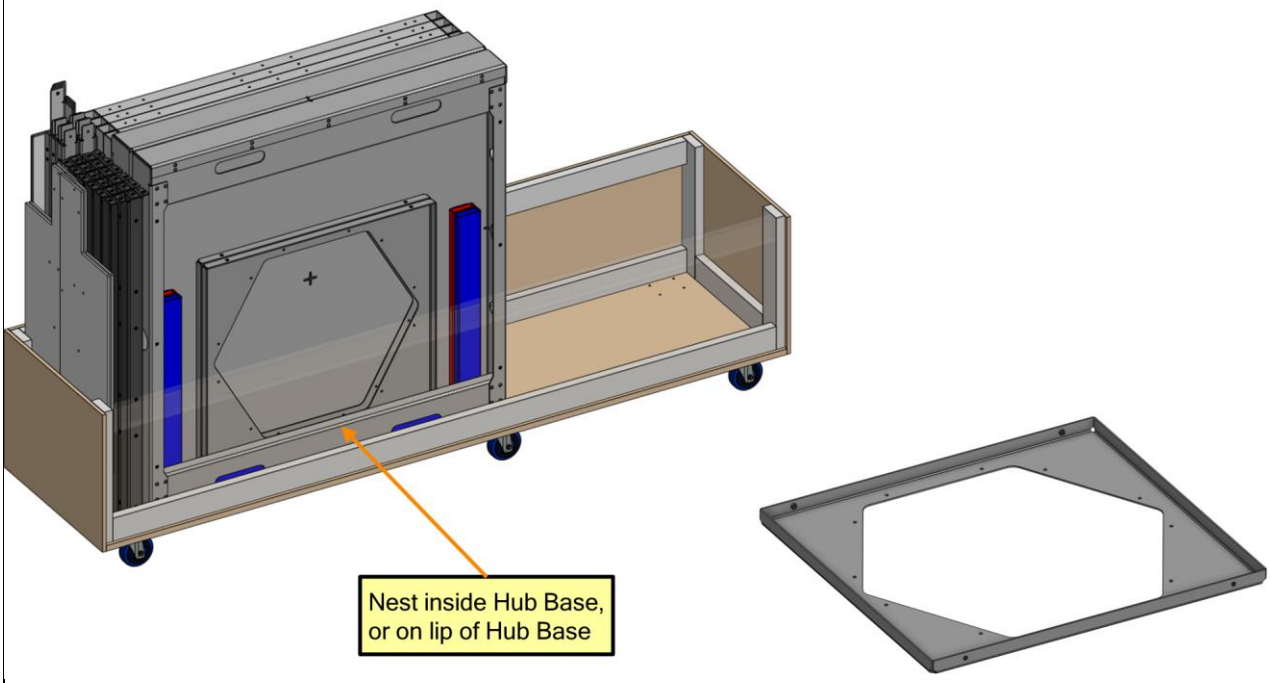
8. Insert:
   - 4x Hub Angle Ramps



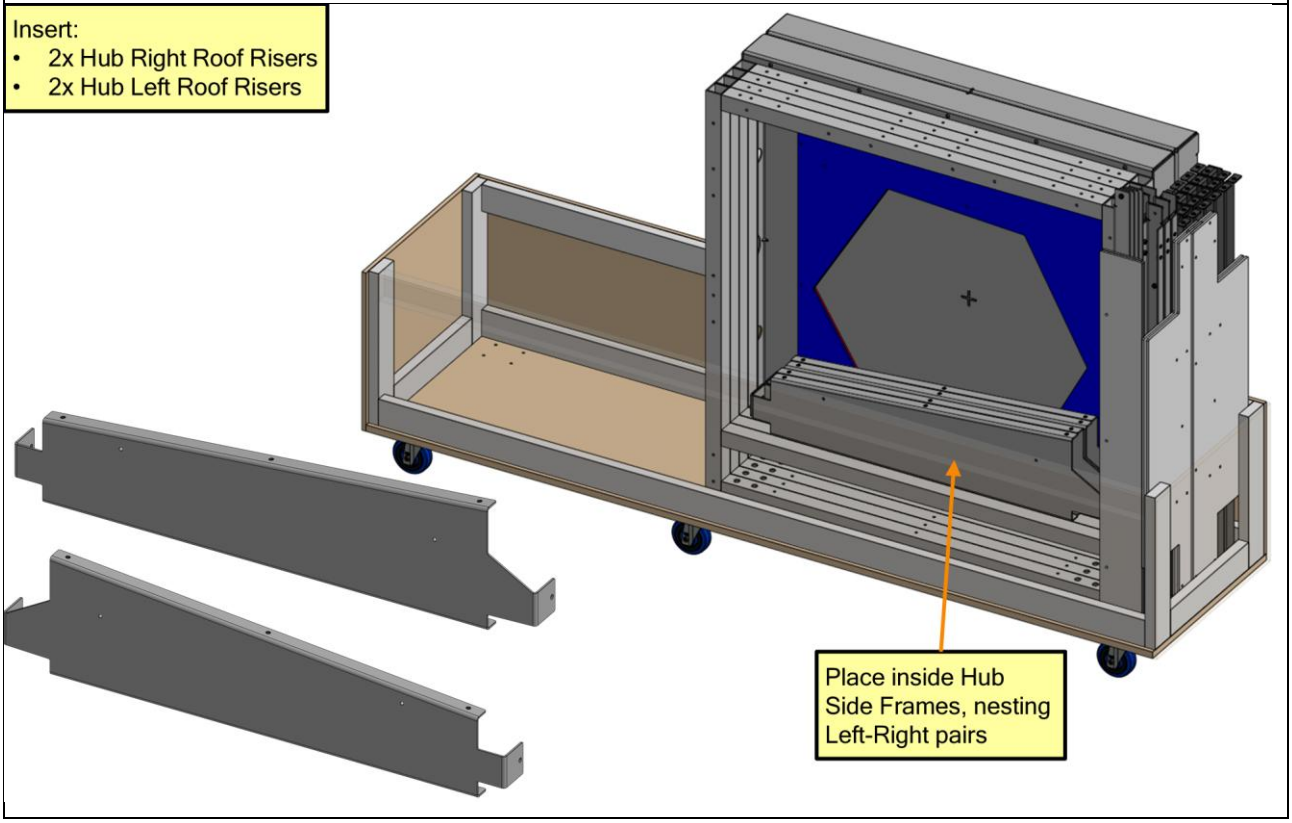
9. Insert:
   - 1x Red Depot
   - 1x Blue Depot



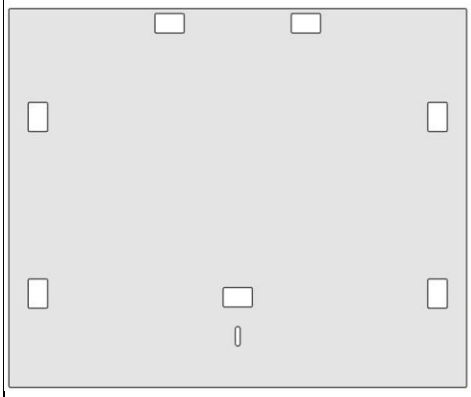
10. Insert:
    - 2x Hub Funnel Base

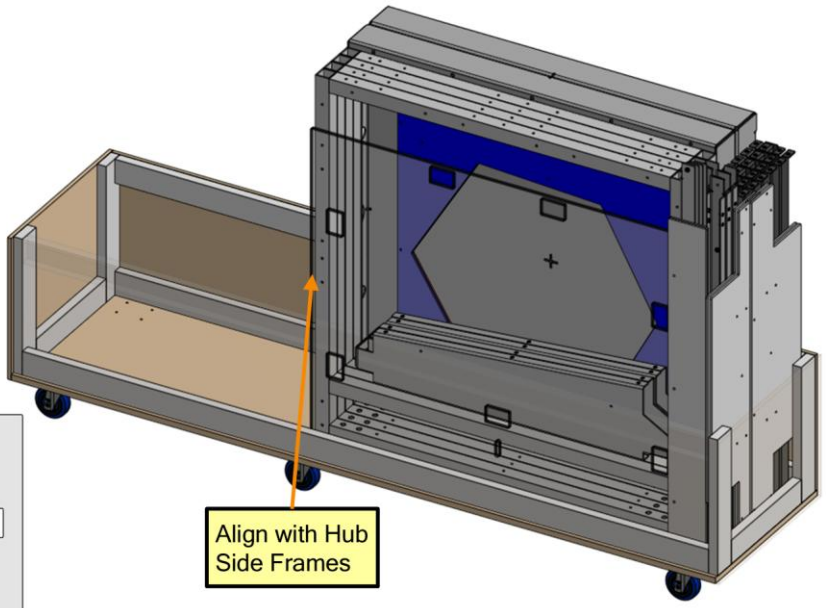


11. Insert:
    - 2x Hub Right Roof Risers
    - 2x Hub Left Roof Risers



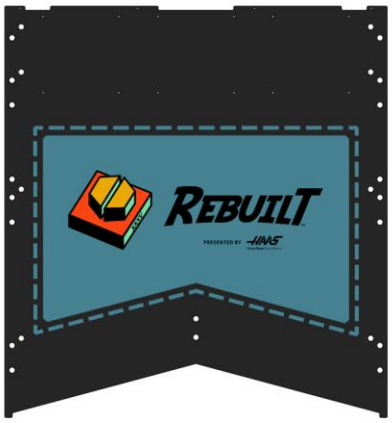
12. Insert:
- 2x Hub Front Panel Bottom

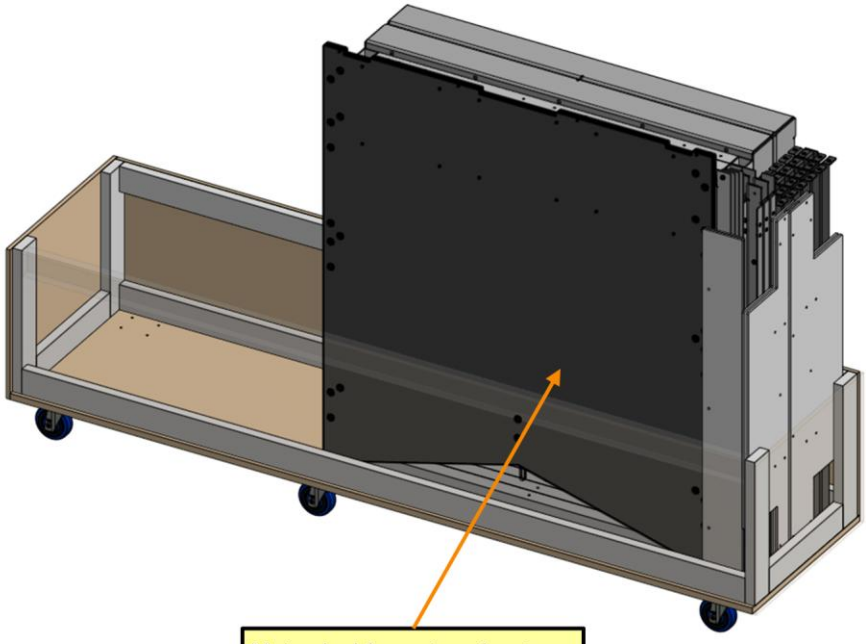




Note # of cutouts, part is similar to Back Panel

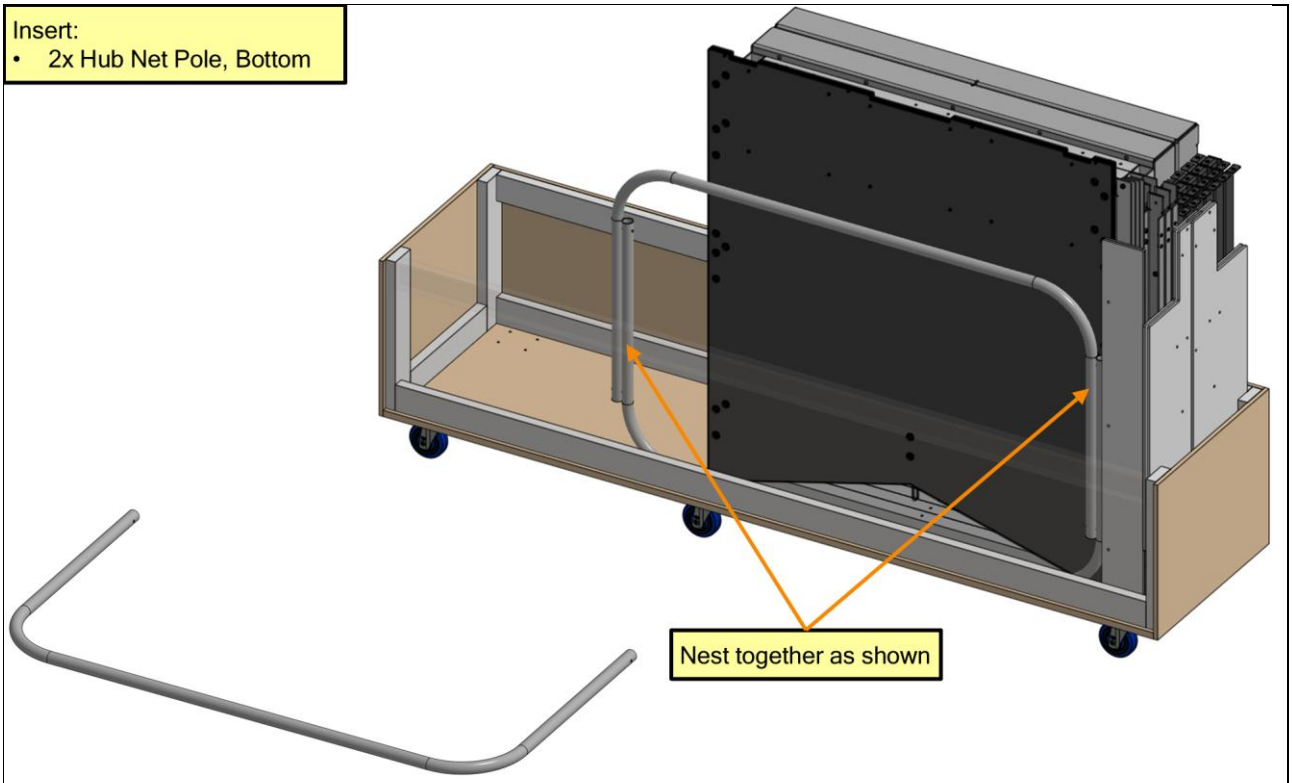
13. Insert:
- 4x Hub Side Panel Plastic



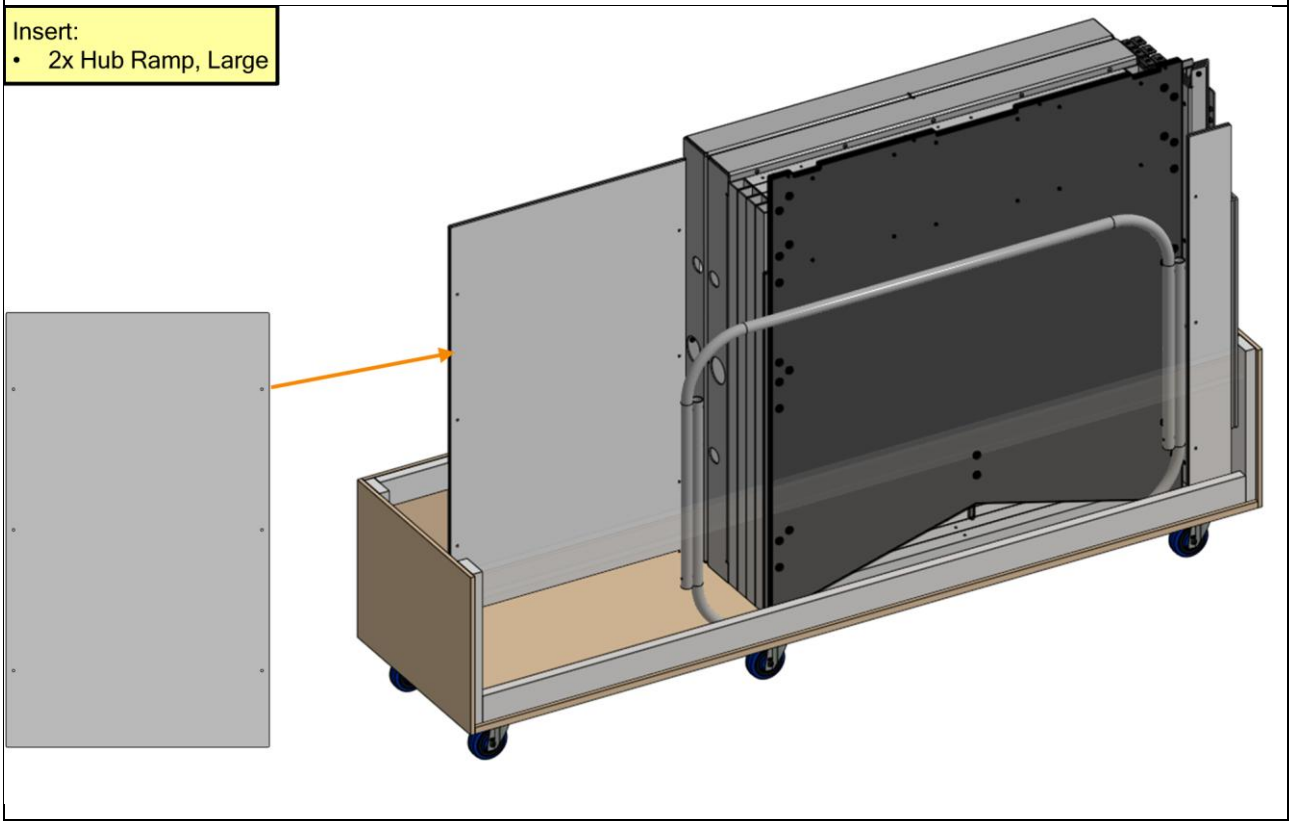


Mate vinyl faces together to protect artwork. Vinyl is on the backs of these parts - white faces should be together.

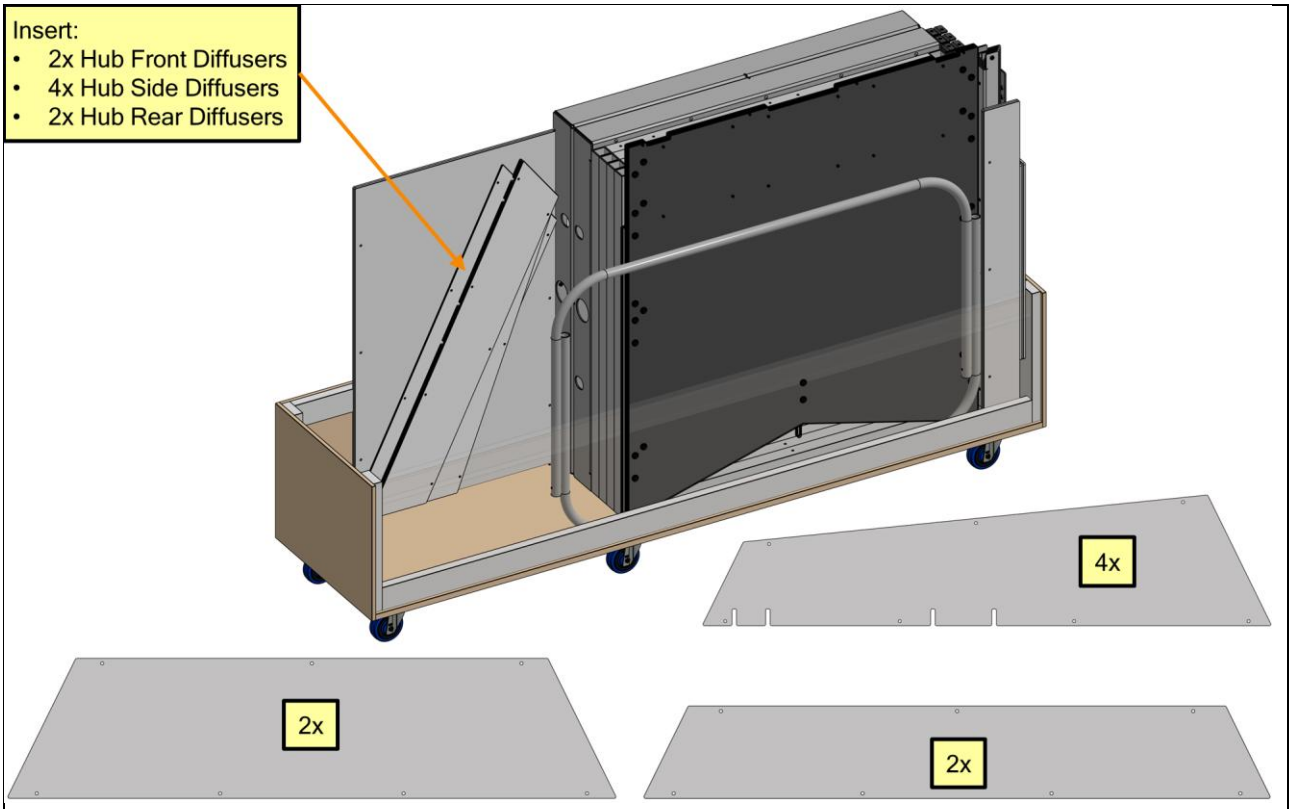
14. Insert:
- 2x Hub Net Pole, Bottom



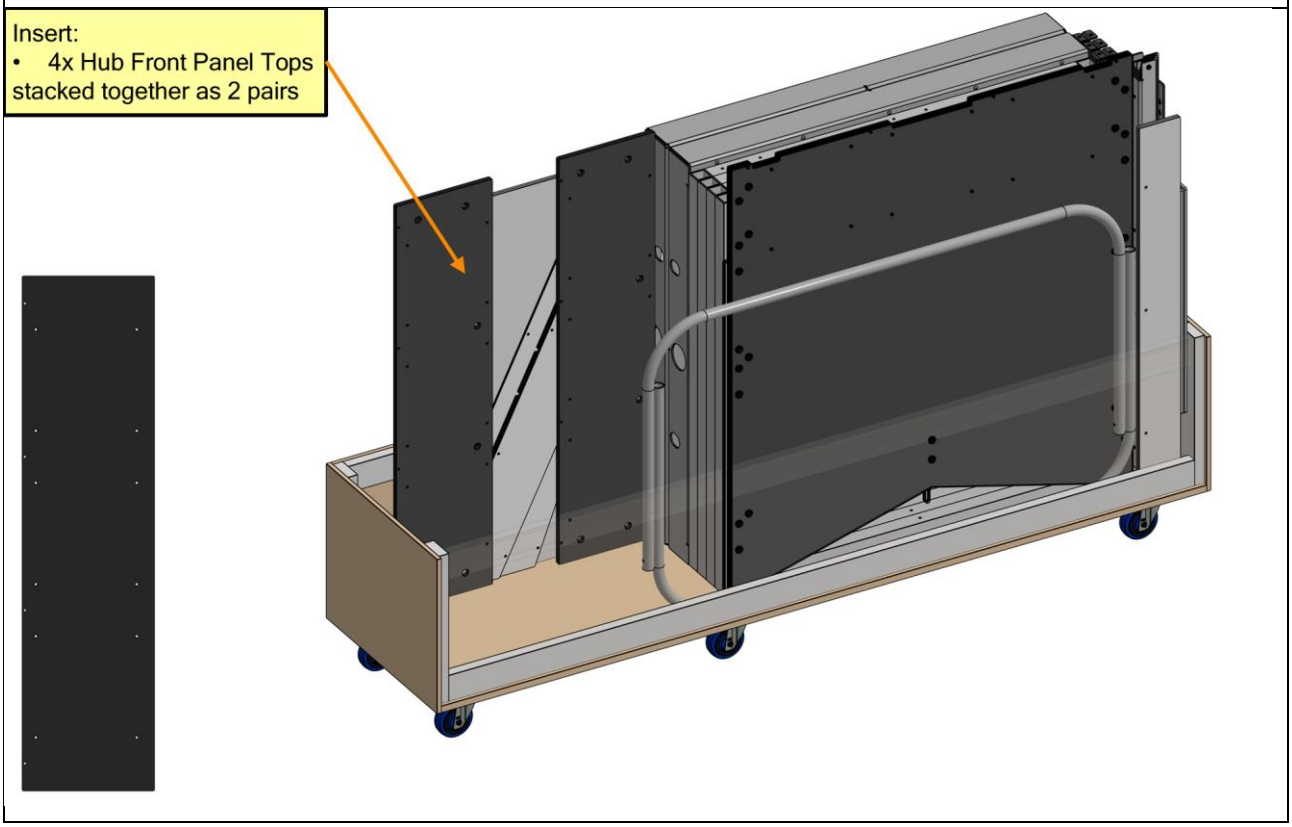
15. Insert:
- 2x Hub Ramp, Large



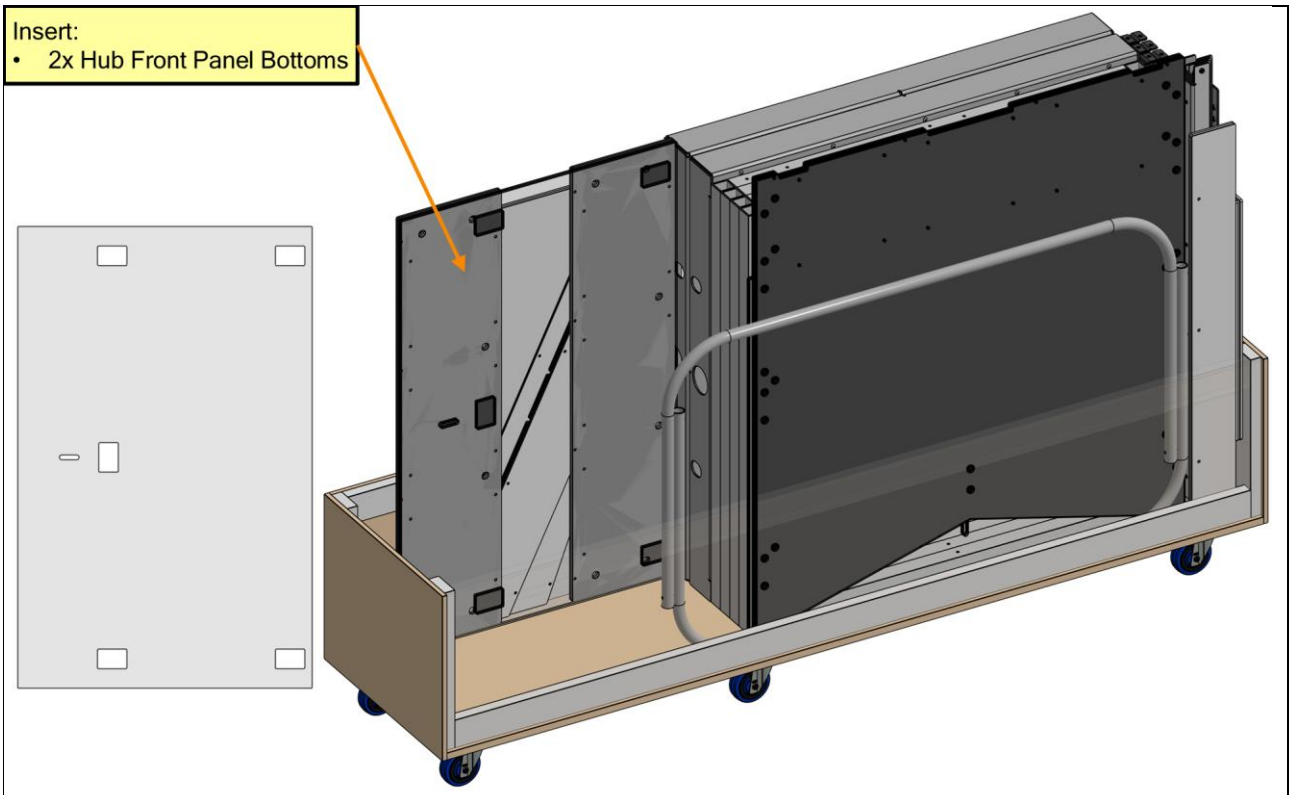
16. Insert:
- 2x Hub Front Diffusers
- 4x Hub Side Diffusers
- 2x Hub Rear Diffusers



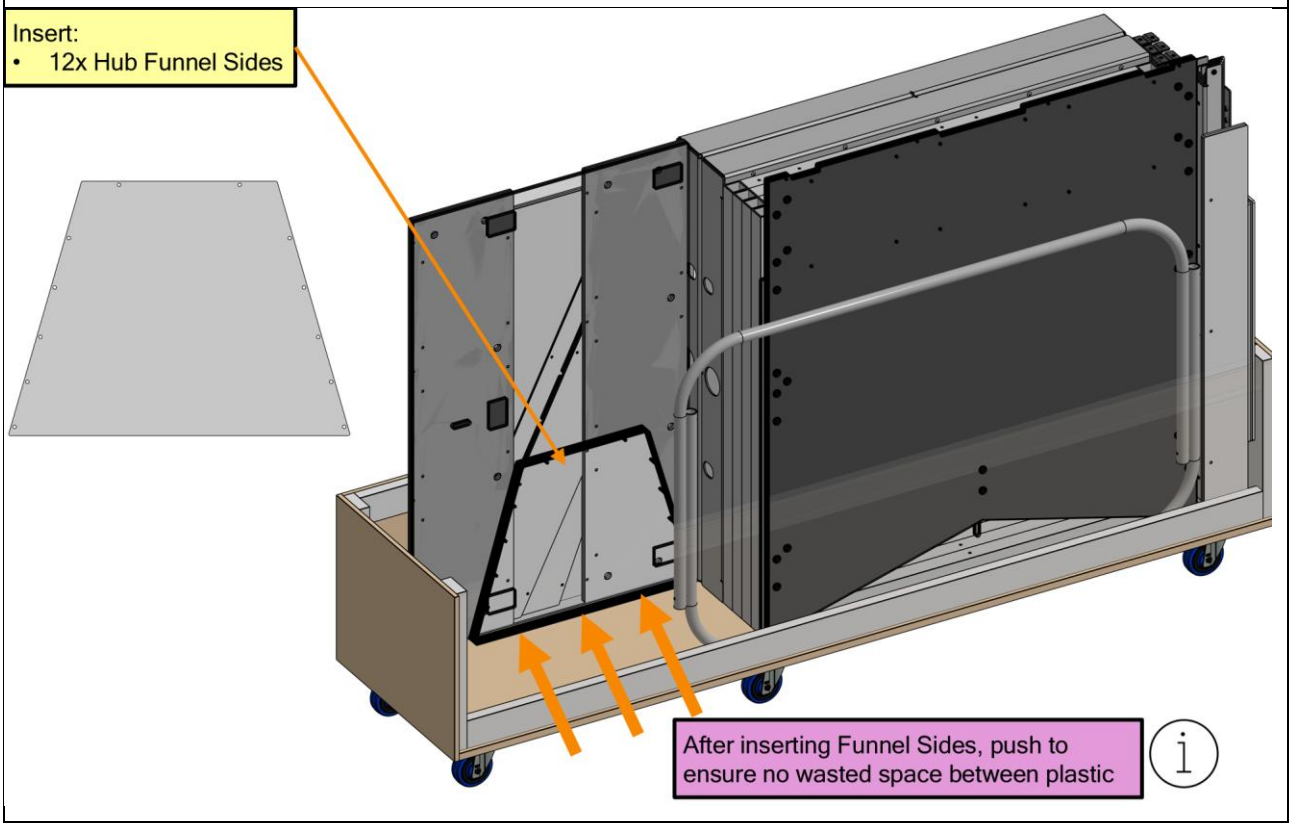
17. Insert:
- 4x Hub Front Panel Tops stacked together as 2 pairs



18.

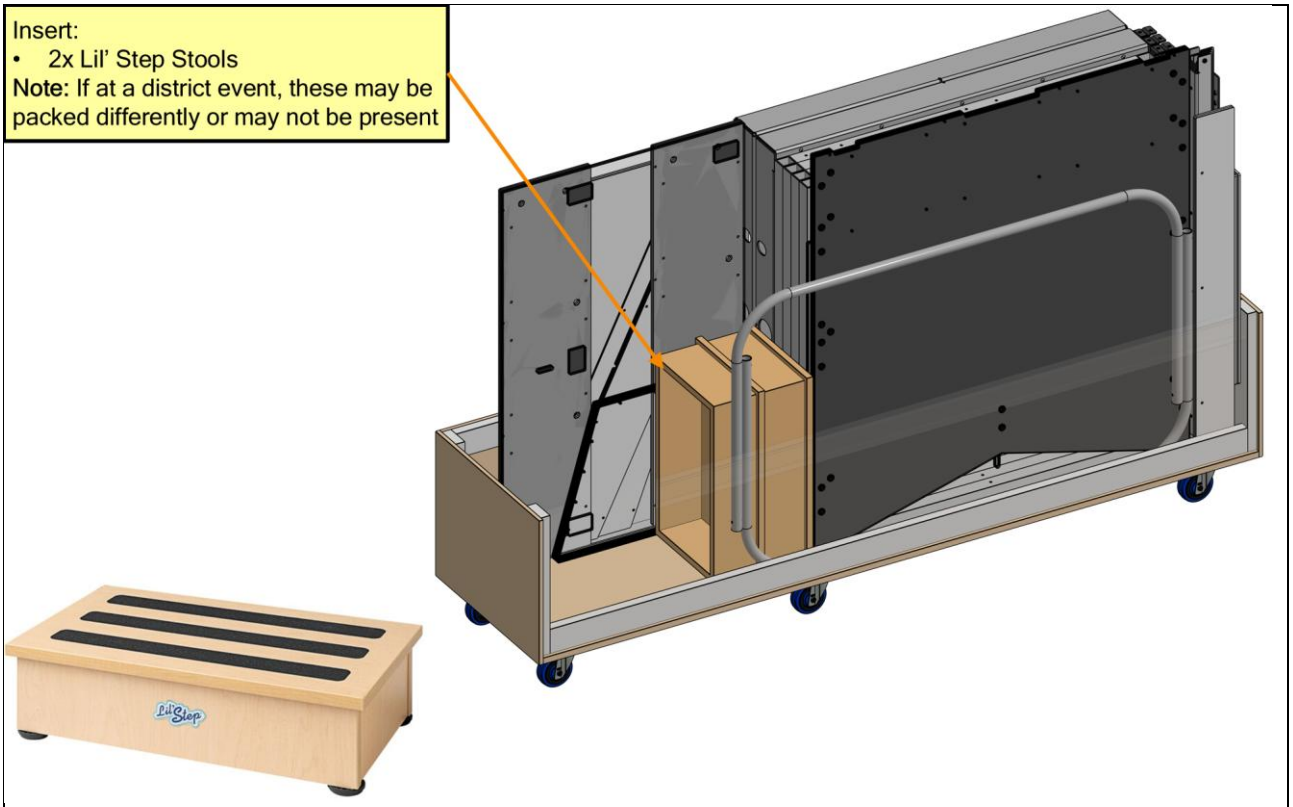

Insert:
• 2x Hub Front Panel Bottoms

19.

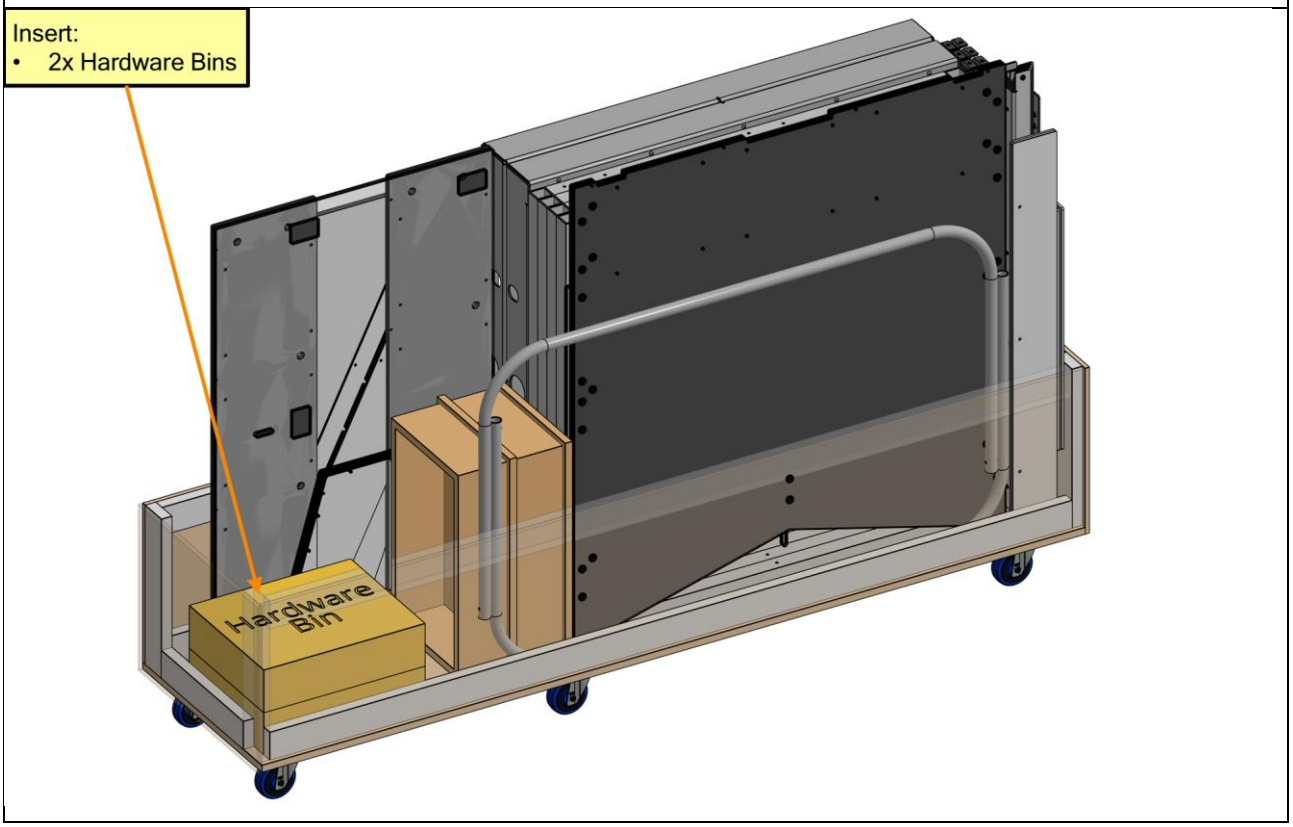

Insert:
• 12x Hub Funnel Sides
After inserting Funnel Sides, push to ensure no wasted space between plastic

20. Insert:
- 2x Lil' Step Stools

Note: If at a district event, these may be packed differently or may not be present

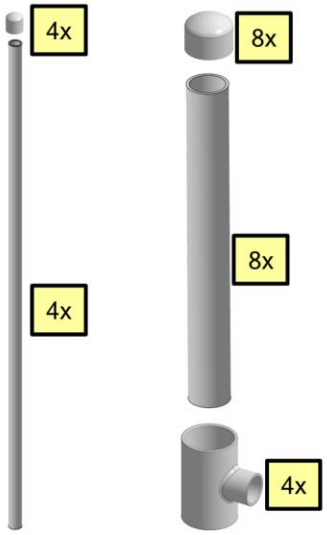


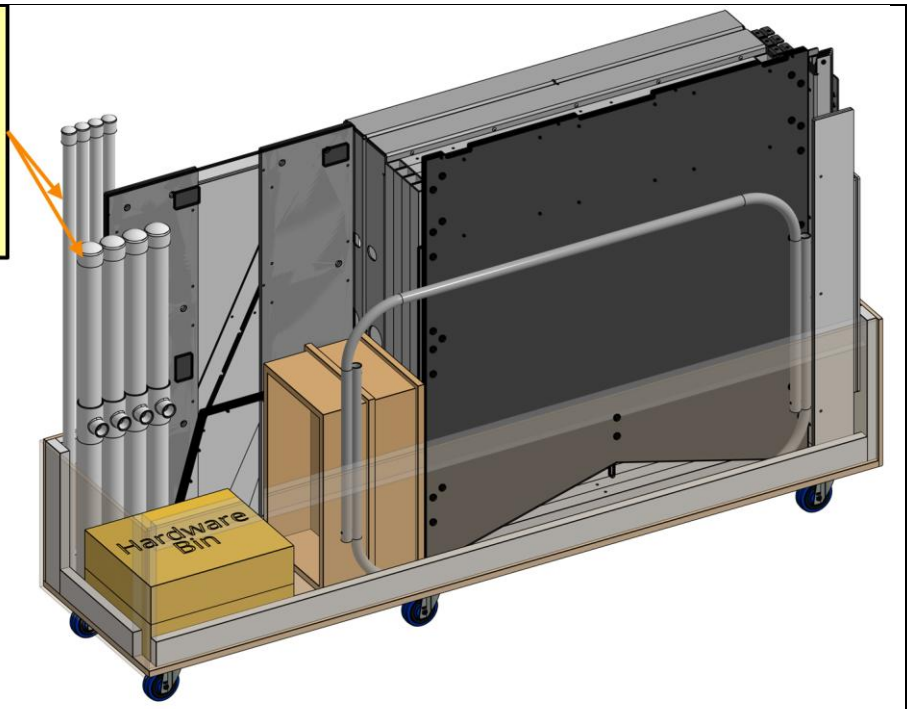
21. Insert:
- 2x Hardware Bins



22. Insert the PVC Rake Components:
- 4x Fuel Rake Handles
- 4x Fuel Rake Handle Caps
- 8x Fuel Rake Legs
- 8x Fuel Rake Leg Caps
- 4x Fuel Rake Connecting Tees

as shown, or wherever space can be found.

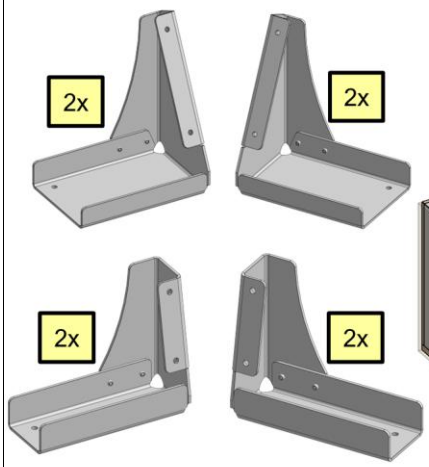


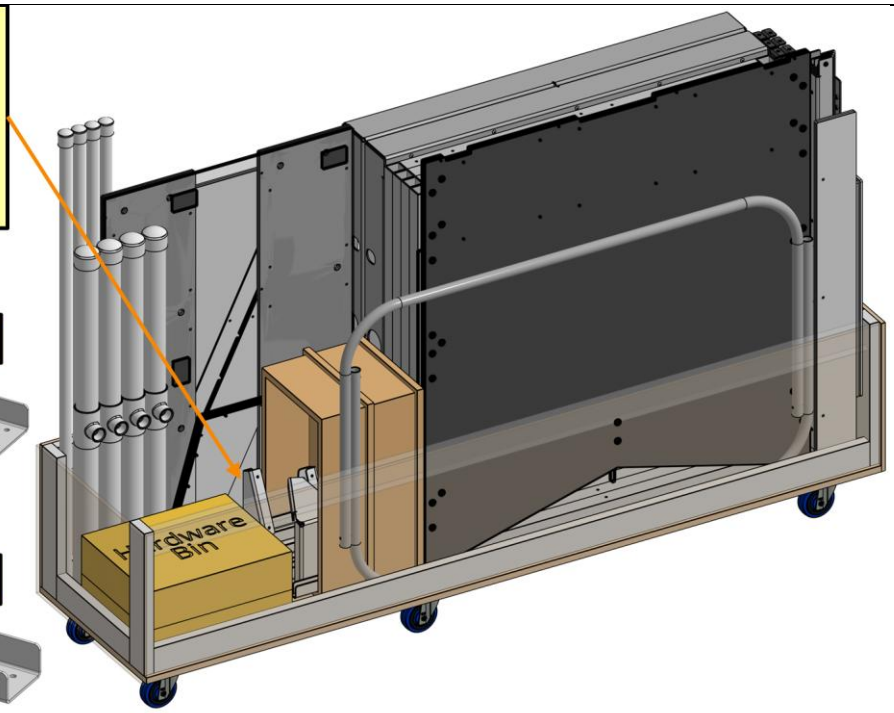


Packing parts partially assembled as shown is optional

23. Insert
- 2x Net Pole Holder 1, Left
- 2x Net Pole Holder 2, Left
- 2x Net Pole Holder 1, Right
- 2x Net Pole Holder 2, Right

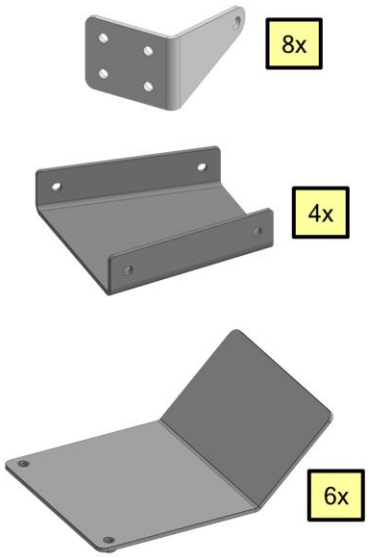
in area shown, or wherever space can be found.

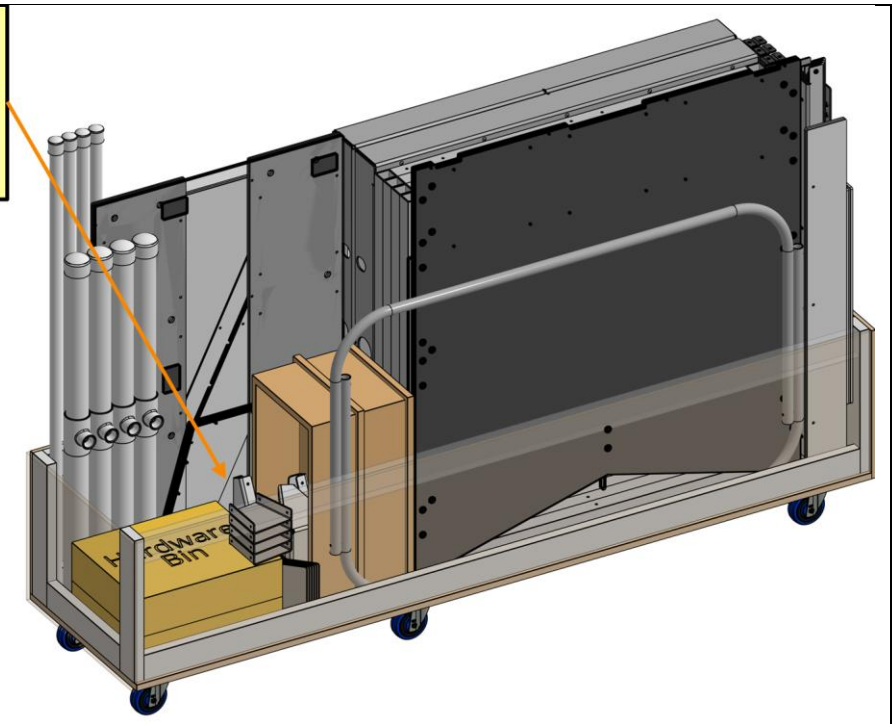




24. Insert
- 8x Hub Light Mounts
- 4x Hub Pole Connector Brackets
- 6x Counter Fuel Deflectors

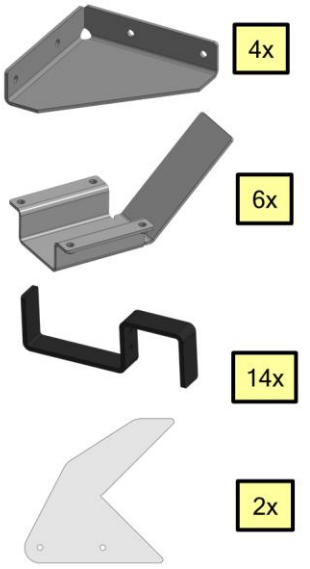
in area shown, or wherever space can be found.

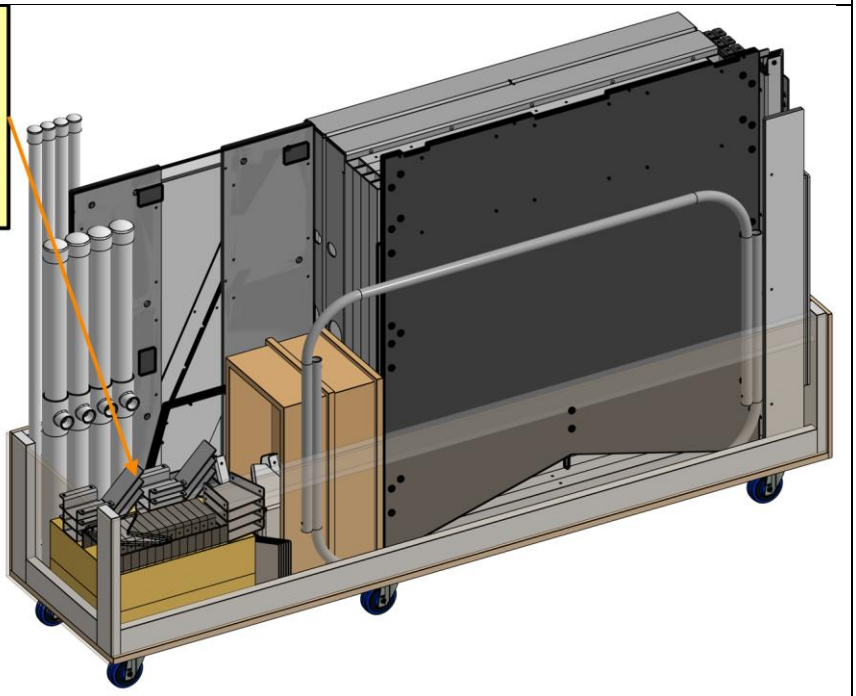




25. Insert
- 4x Hub Pole Corner Braces
- 6x Counter Inlet Funnels
- 14x Driver Station Sponsor Brackets
- 2x Fuel Pen Holder

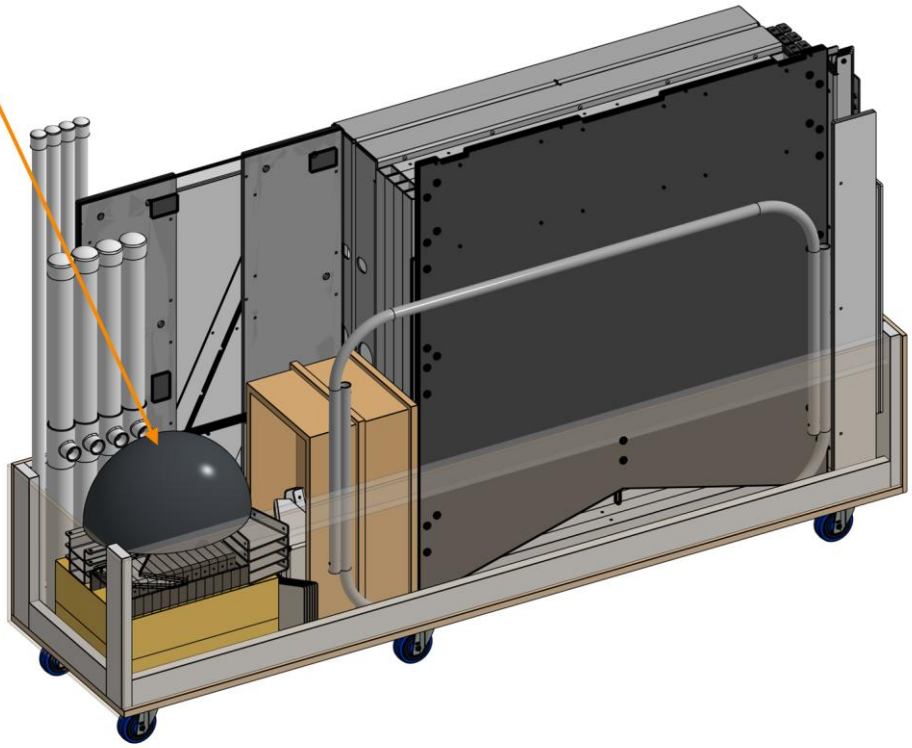
in area shown, or wherever space can be found.





26. Insert
- 3x Hub Nets

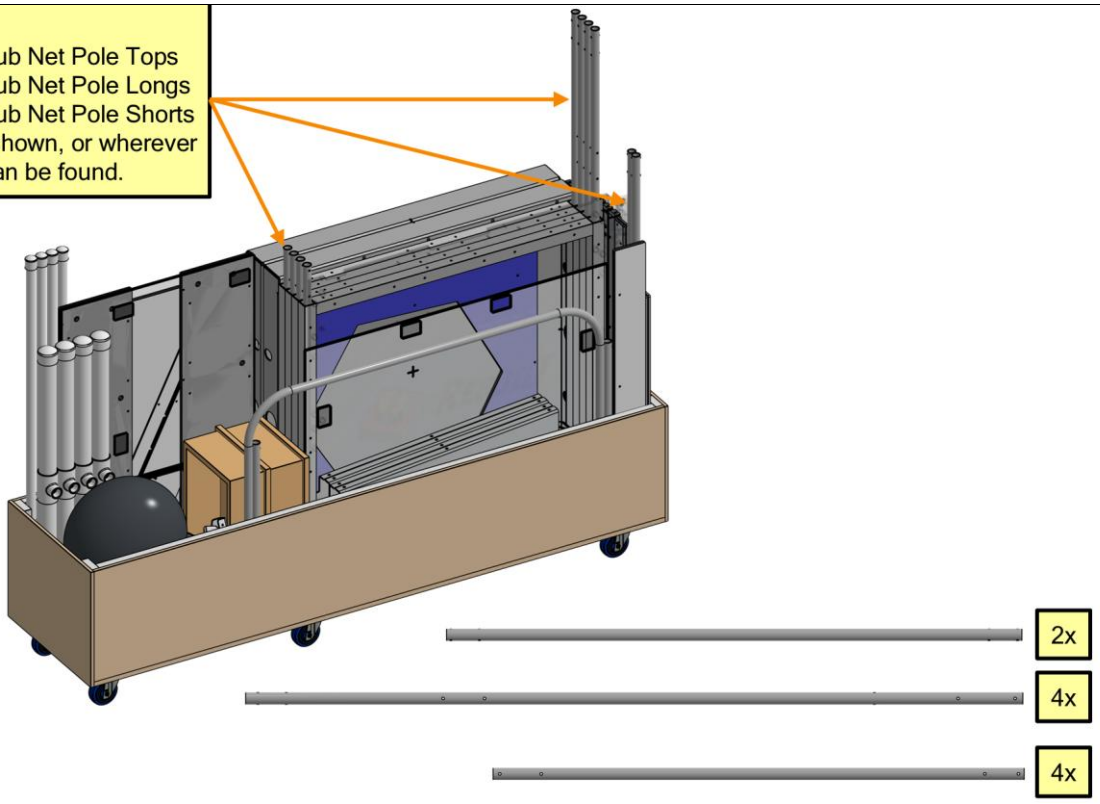
in area shown, or wherever space can be found.



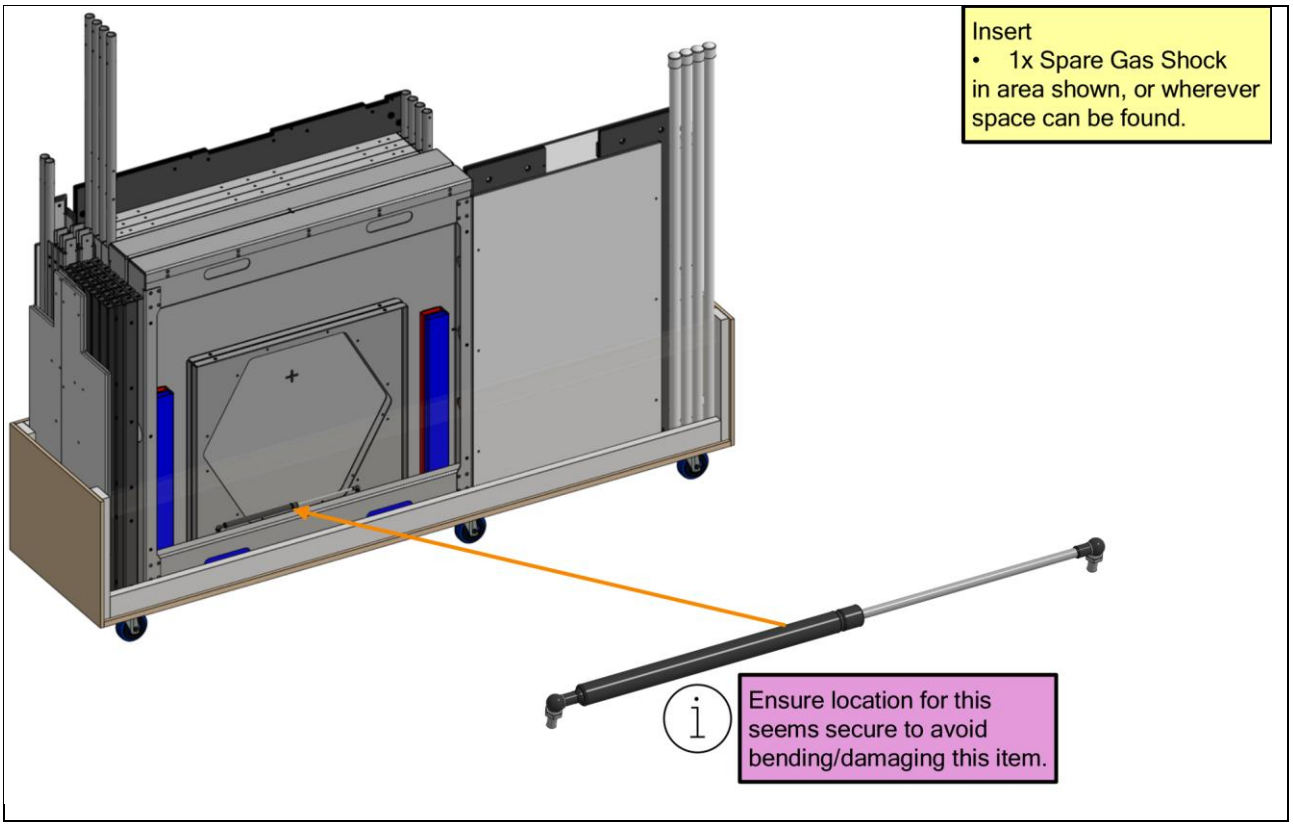
Hub Nets can be packed in to help secure loose small parts.

27. Insert
- 2x Hub Net Pole Tops
- 4x Hub Net Pole Longs
- 4x Hub Net Pole Shorts

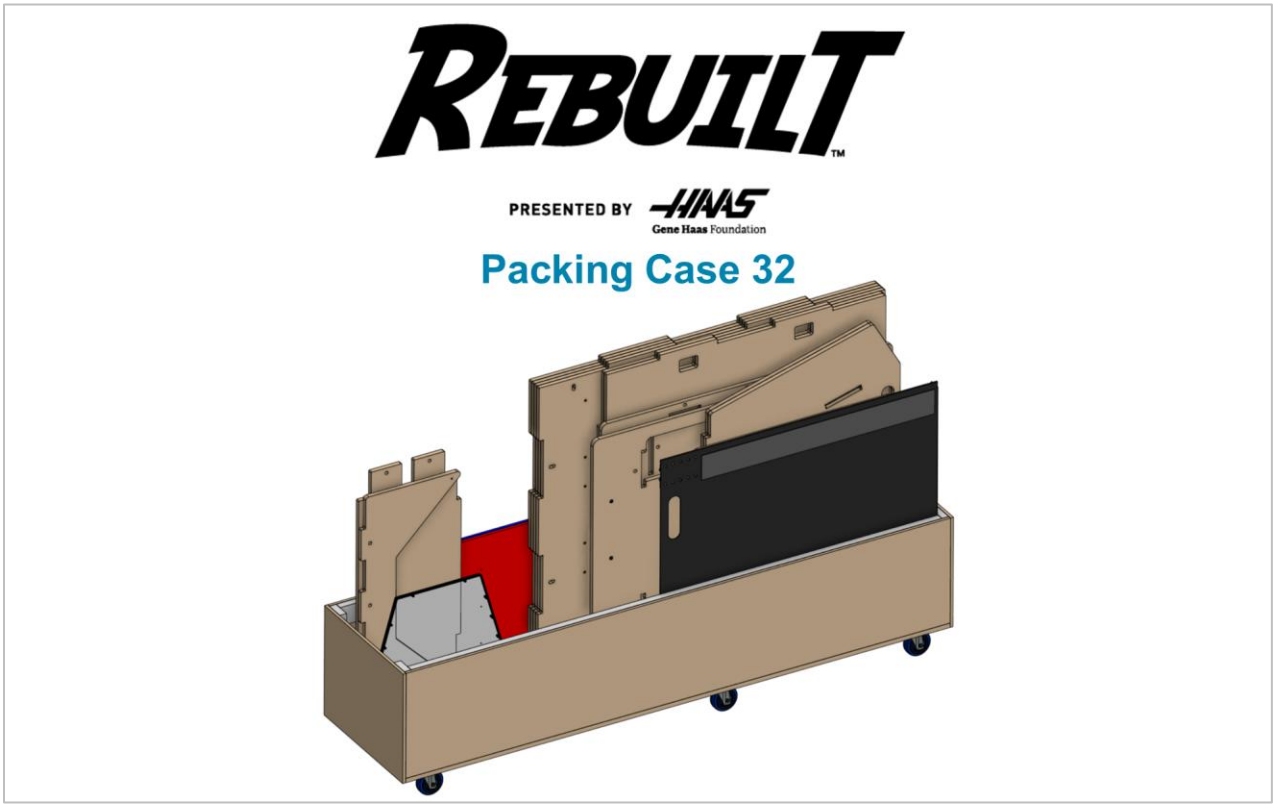
in area shown, or wherever space can be found.



28.


Insert
• 1x Spare Gas Shock
in area shown, or wherever space can be found.
Ensure location for this seems secure to avoid bending/damaging this item.

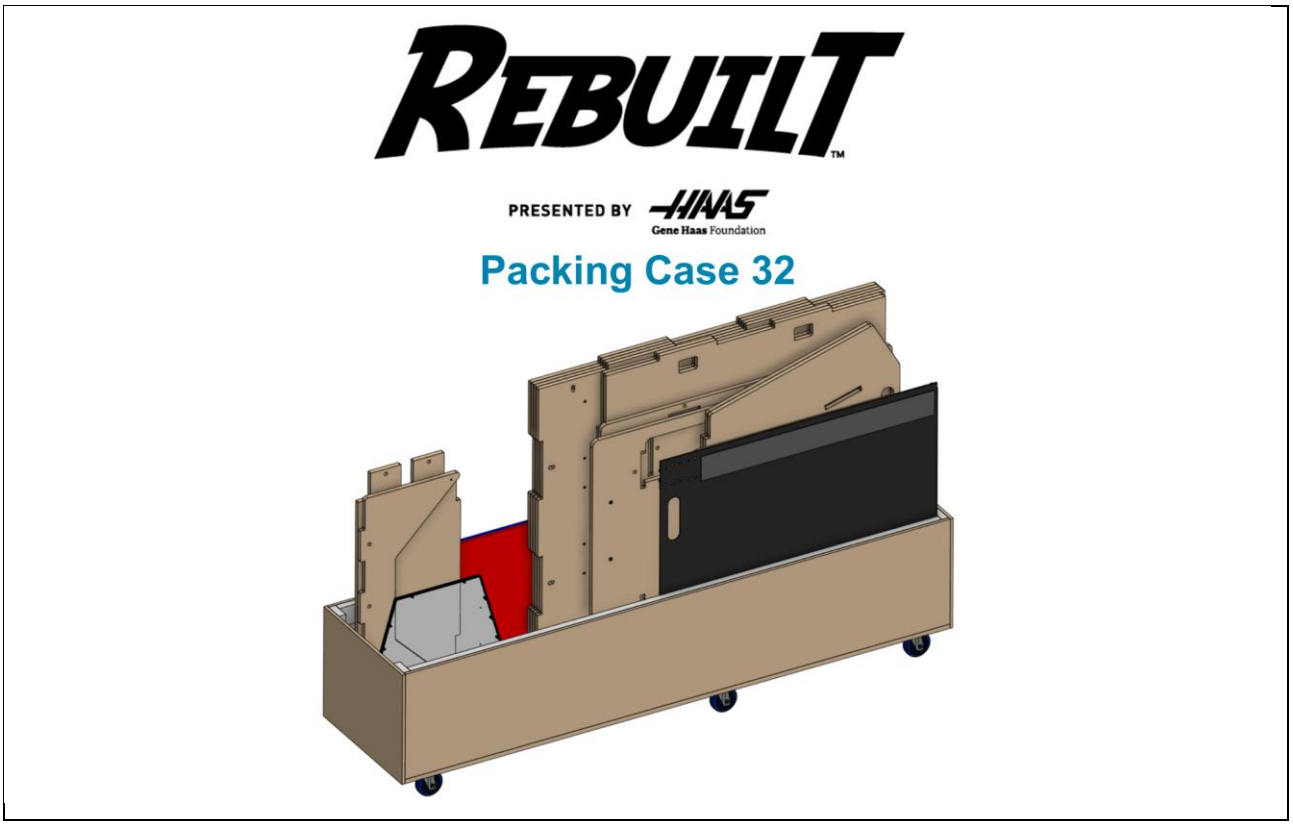
5.9.3 Case 32



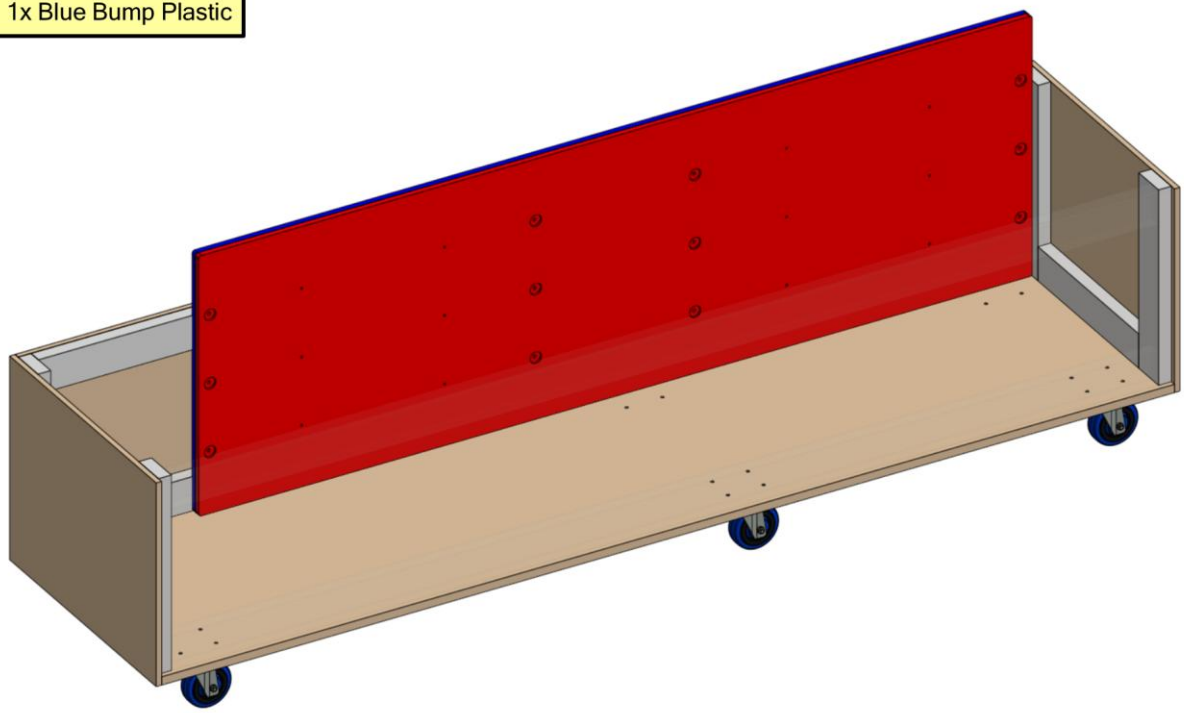
5.9.3.1 Contents

Item Name/Description	Qty	Notes
Bump Plastic	2	1 red 1 blue
Event Test Hub Front Plate Assy	4	
Event Test Hub Top Plate	2	
Event Test Outpost Front Plate Assy	1	
Event Test Tower Front Plate Assy	1	
Event Test Outpost Side Plate	2	
Event Test Outpost Chute	2	
Tower Upright	2	1 red 1 blue
Tower Support Tube	2	
Tower Base	1	
Event Test Tower Support Assy	2	
Hub Funnel Side	6	
Event Test Tower Bottom Horizontal	1	
Event Test Tower Top Support Plate	1	
Tower Rung	3	Mix of red & blue
Outpost Chute Door	1	
Event Test Bump Base	3	
Tower Upright Gusset	2	
Box for Field Reset	10-	Fewer as they get used

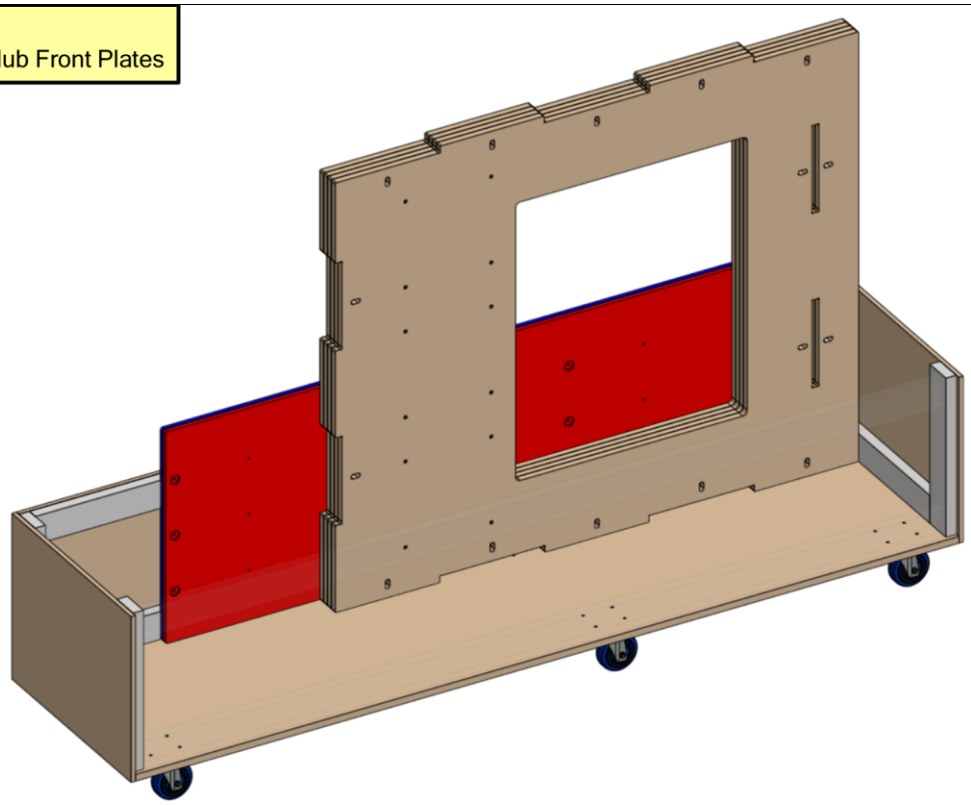
5.9.3.2 Packing Steps

29. 

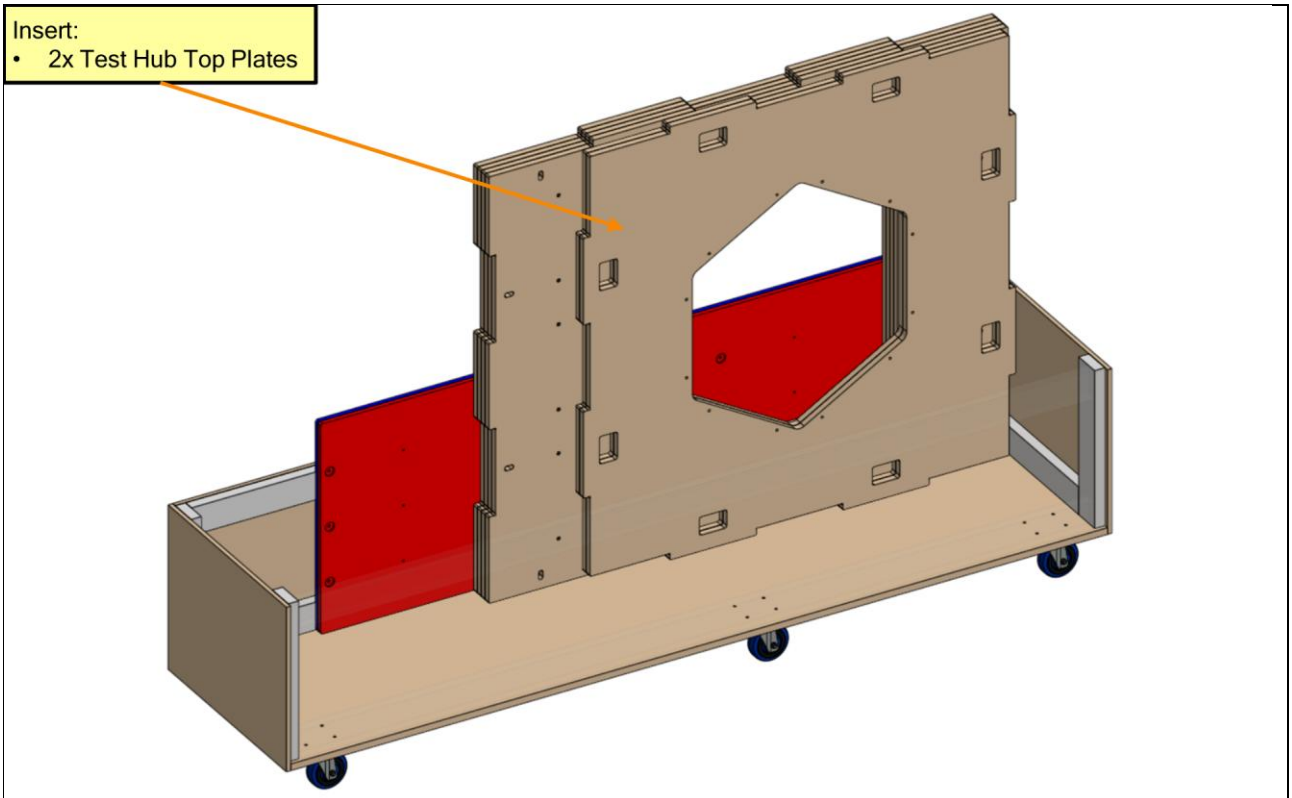
30. Insert:
- 1x Red Bump Plastic
- 1x Blue Bump Plastic



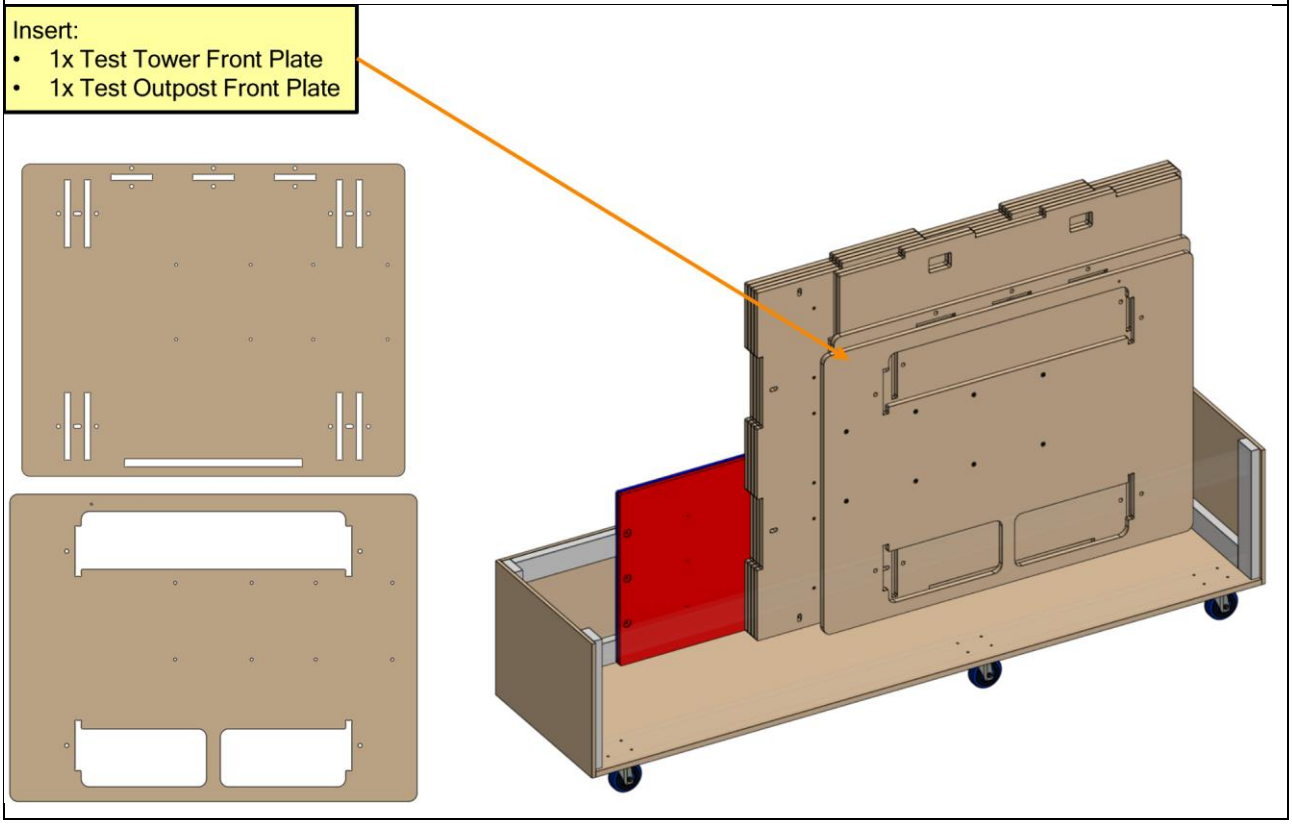
31. Insert:
- 4x Test Hub Front Plates



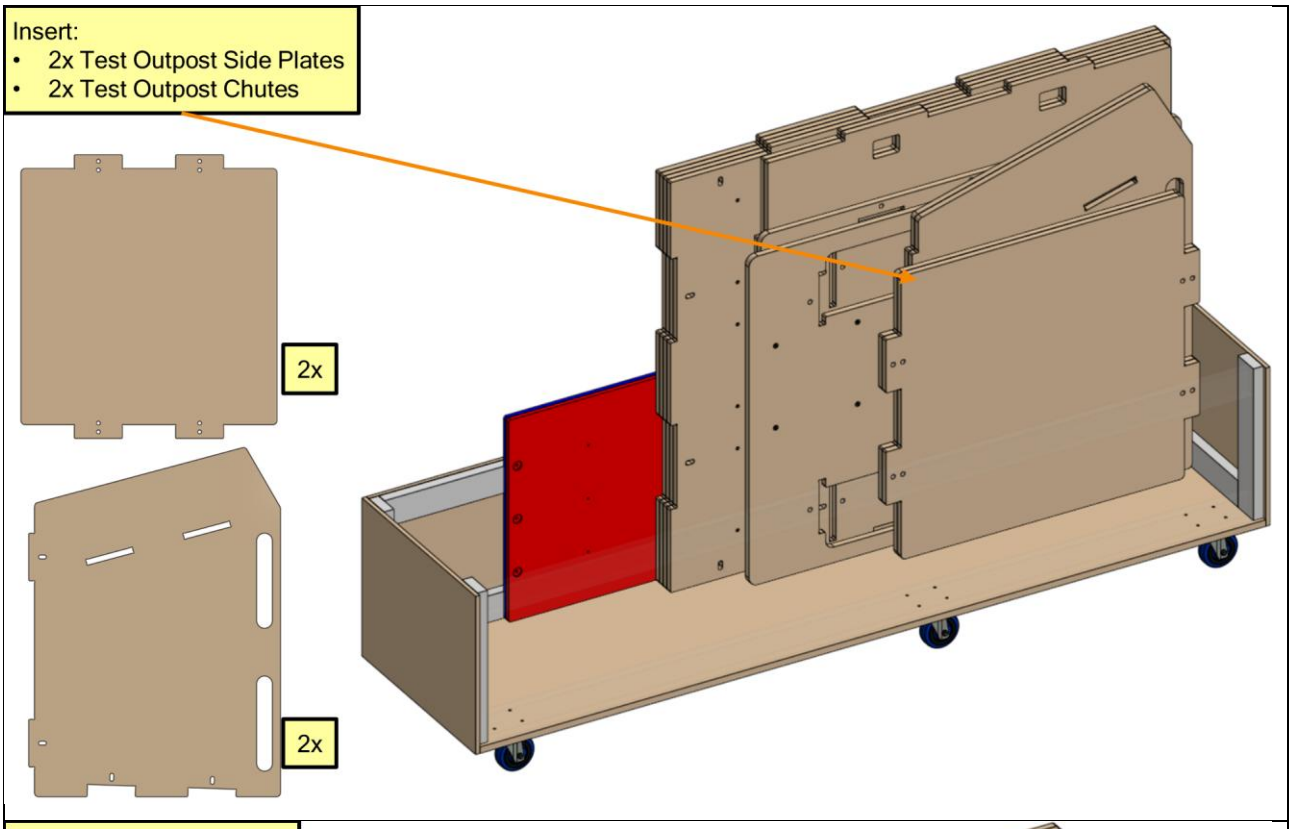
32. Insert:
- 2x Test Hub Top Plates



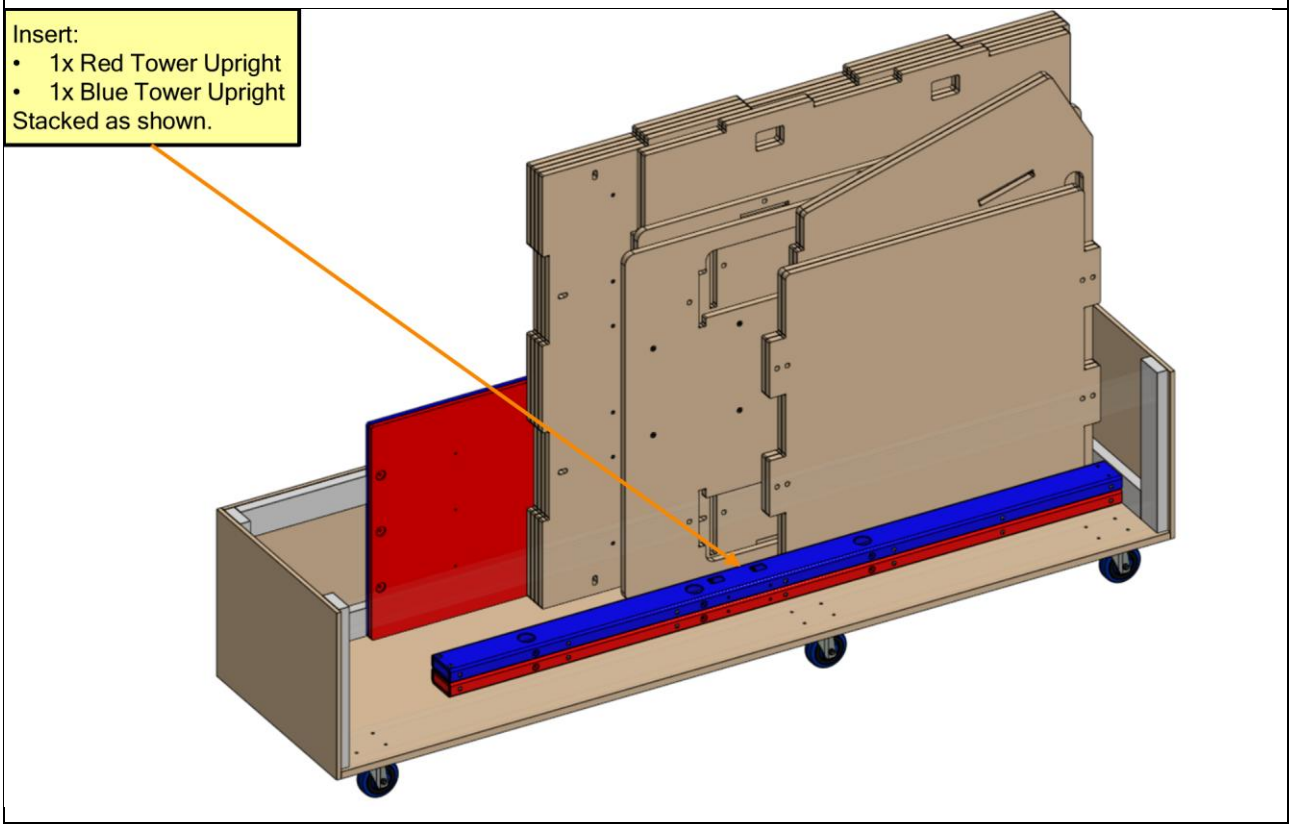
33. Insert:
- 1x Test Tower Front Plate
- 1x Test Outpost Front Plate



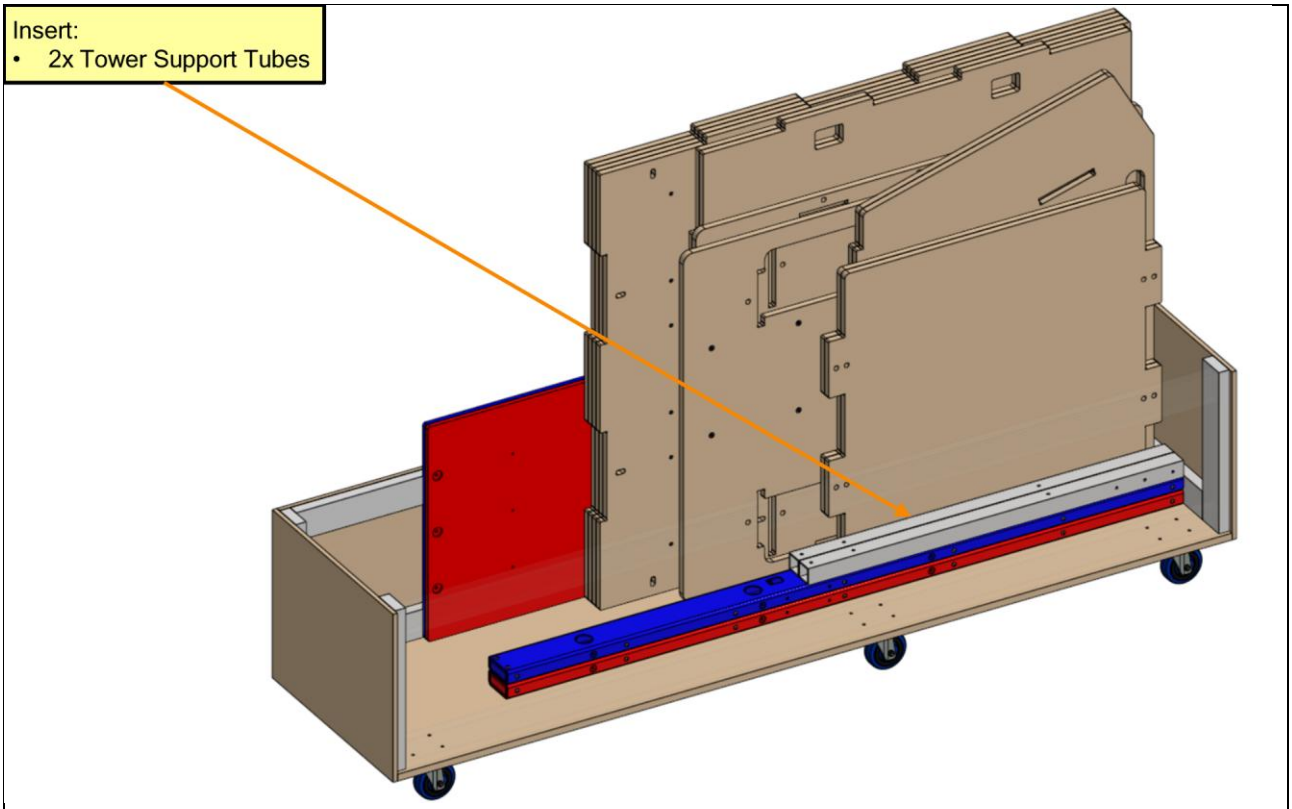
34.


Insert:
• 2x Test Outpost Side Plates
• 2x Test Outpost Chutes
2x
2x

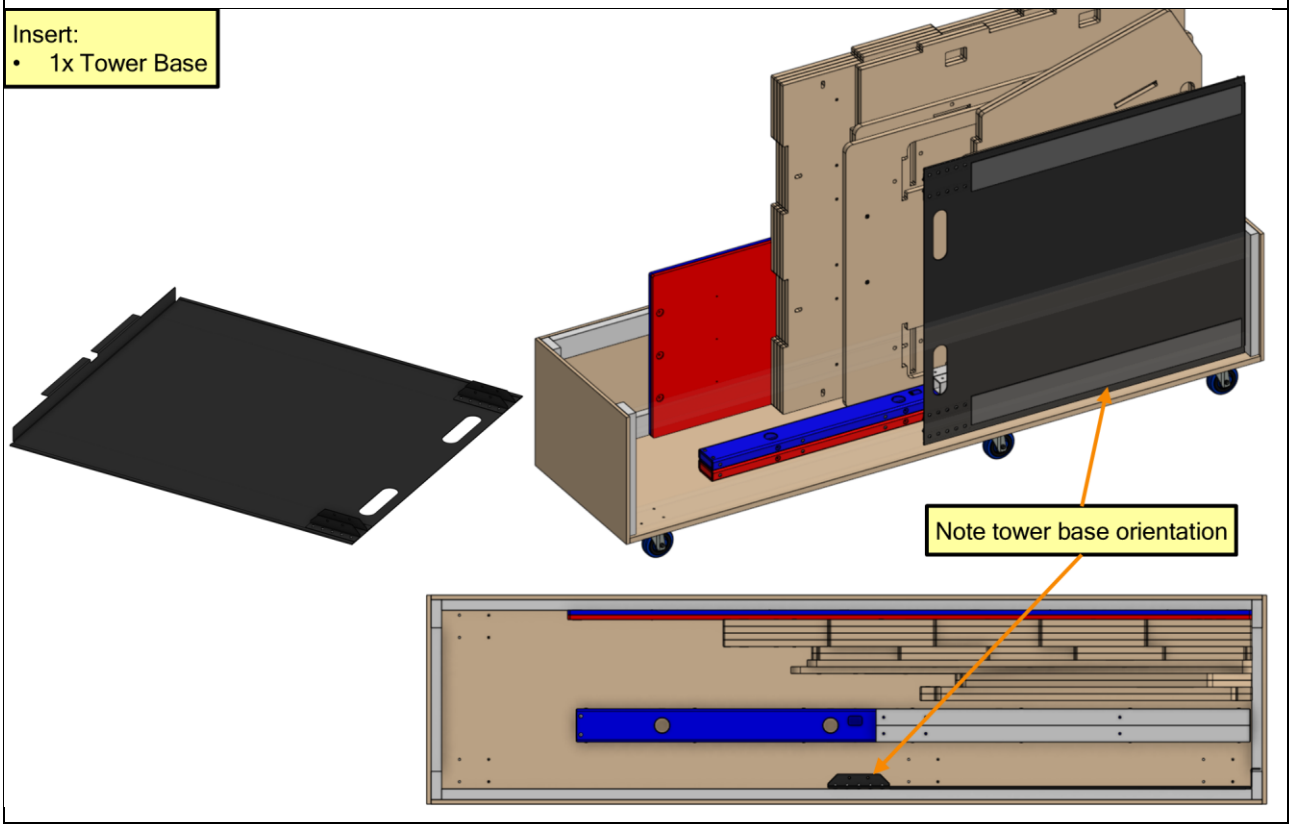
35.


Insert:
• 1x Red Tower Upright
• 1x Blue Tower Upright
Stacked as shown.

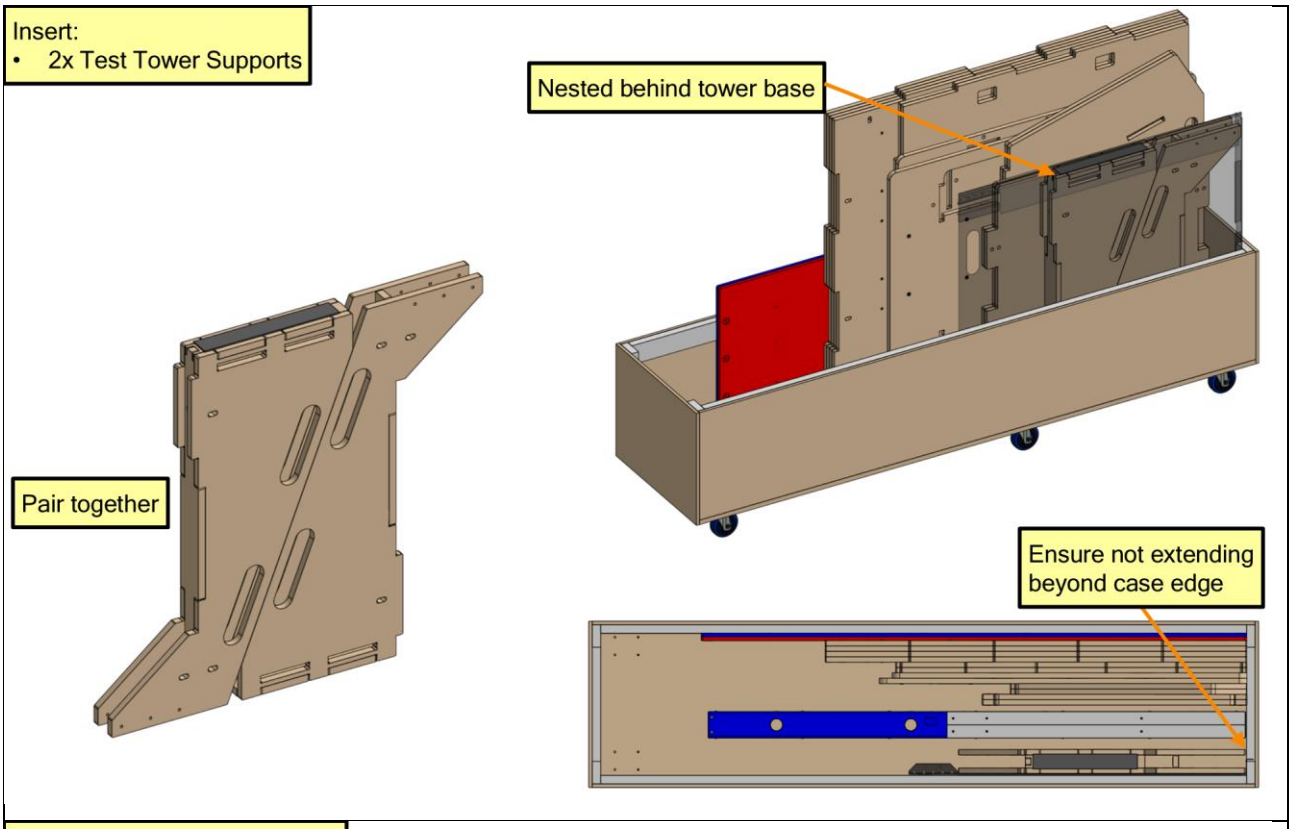
36. Insert:
- 2x Tower Support Tubes



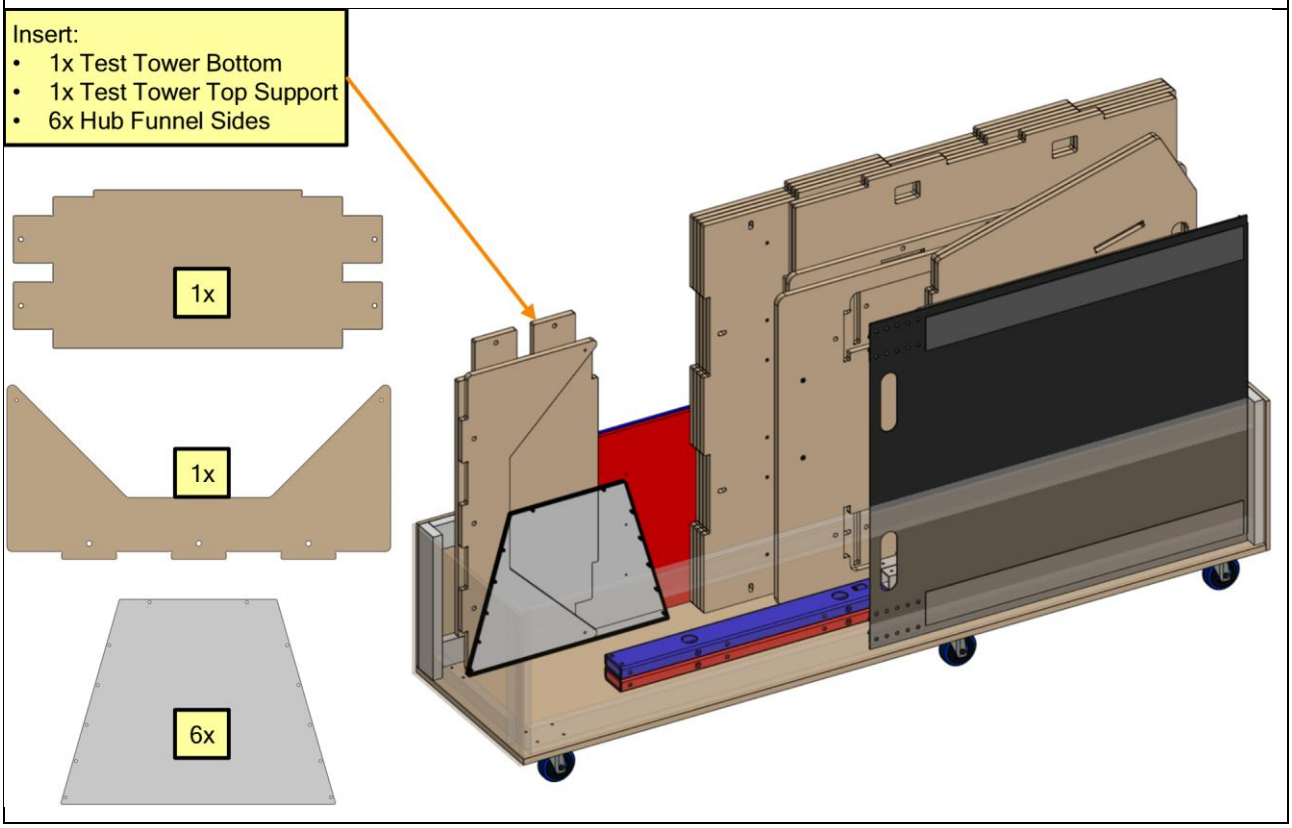
37. Insert:
- 1x Tower Base



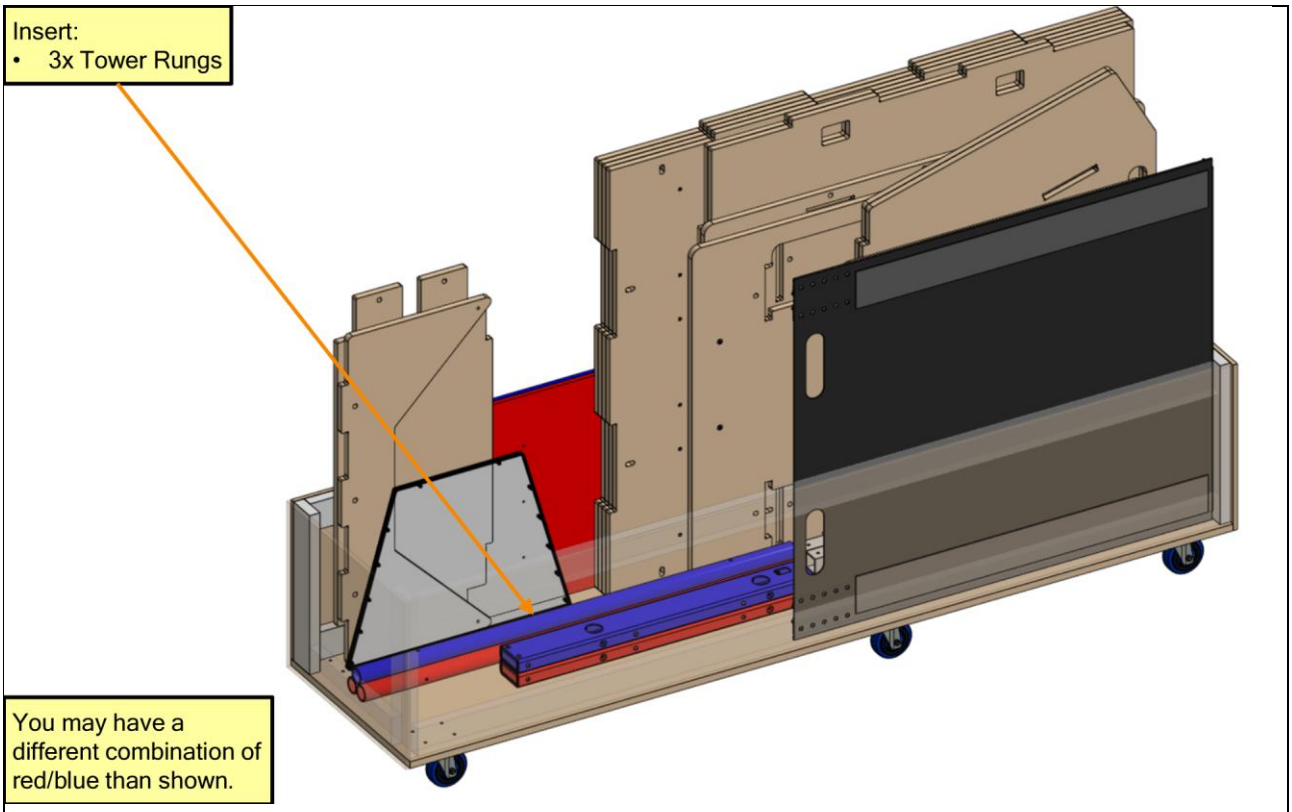
38.


Insert:
• 2x Test Tower Supports
Nested behind tower base
Pair together
Ensure not extending beyond case edge

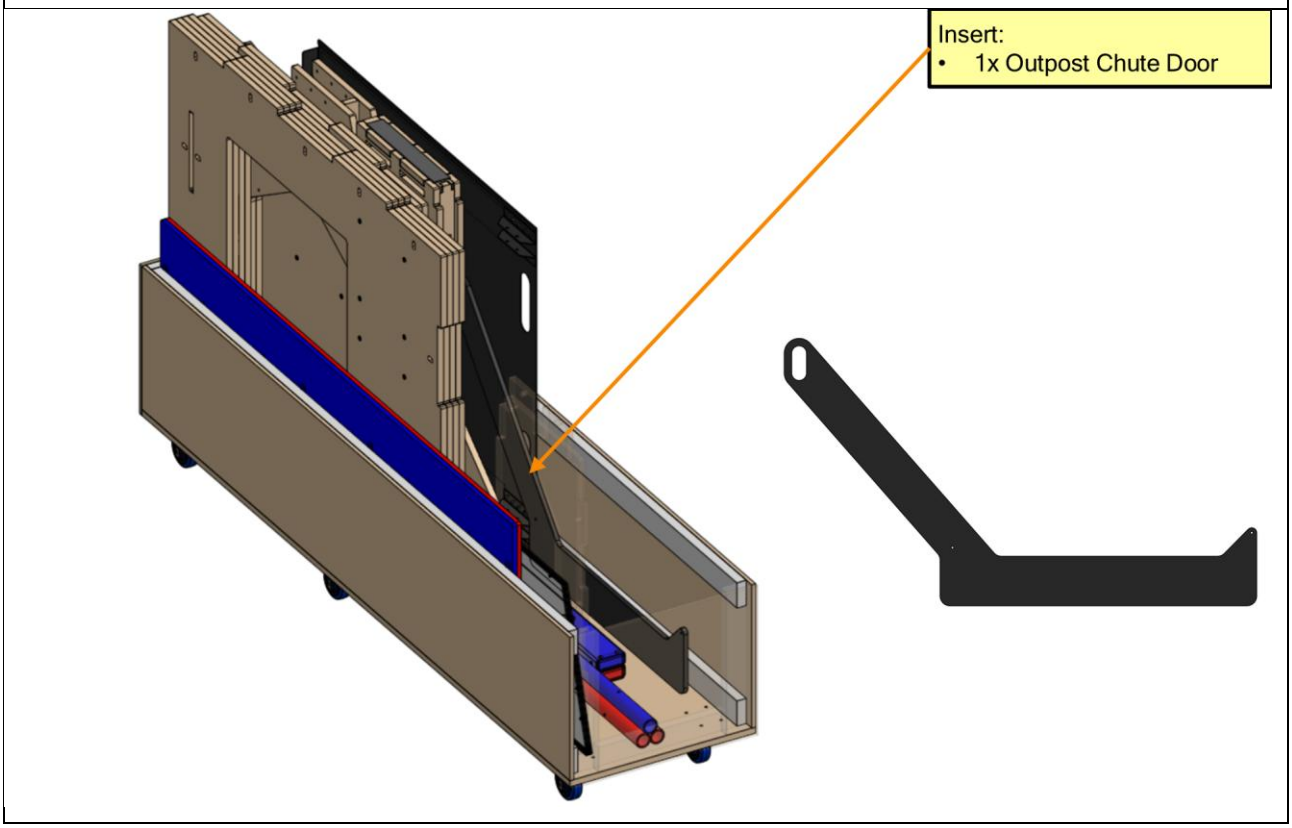
39.


Insert:
• 1x Test Tower Bottom
• 1x Test Tower Top Support
• 6x Hub Funnel Sides
1x
1x
6x

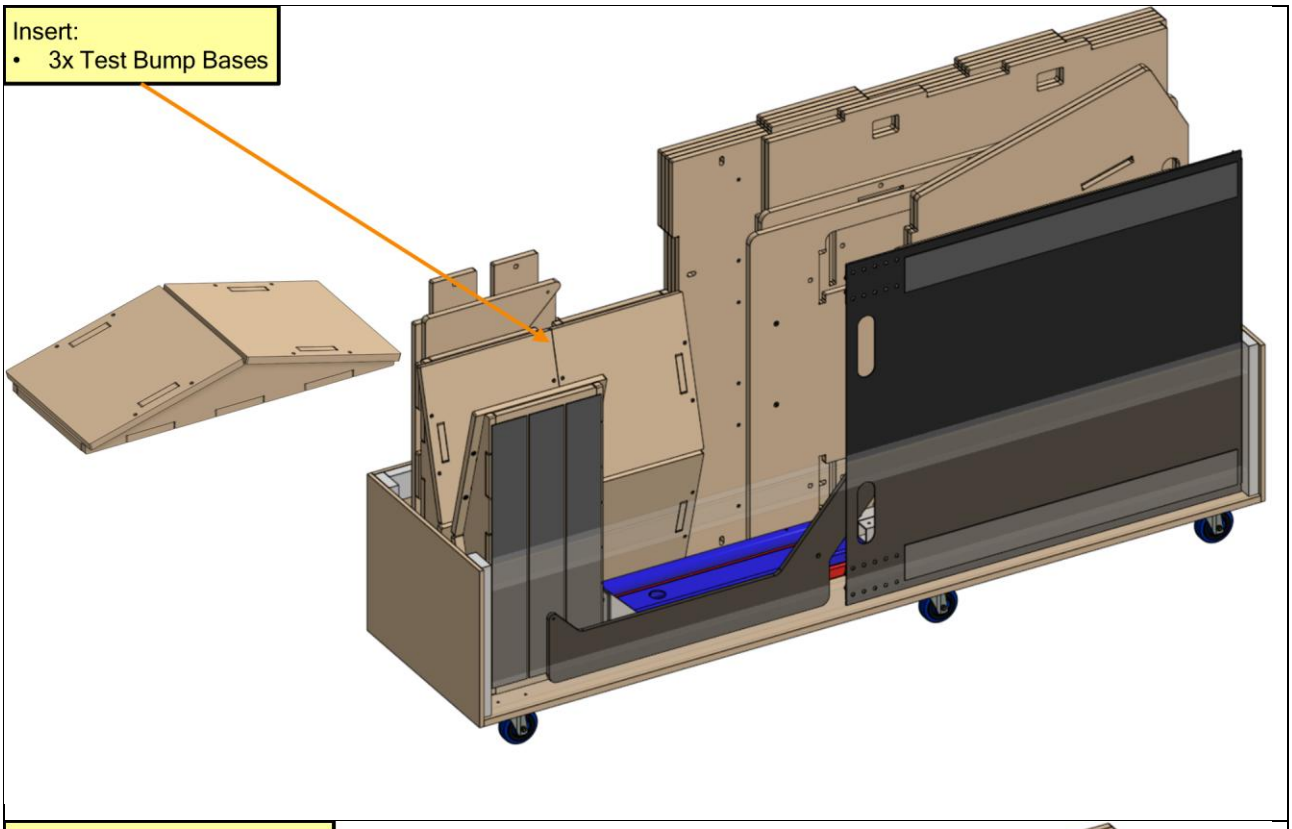
40.


Insert:
• 3x Tower Rungs
You may have a different combination of red/blue than shown.

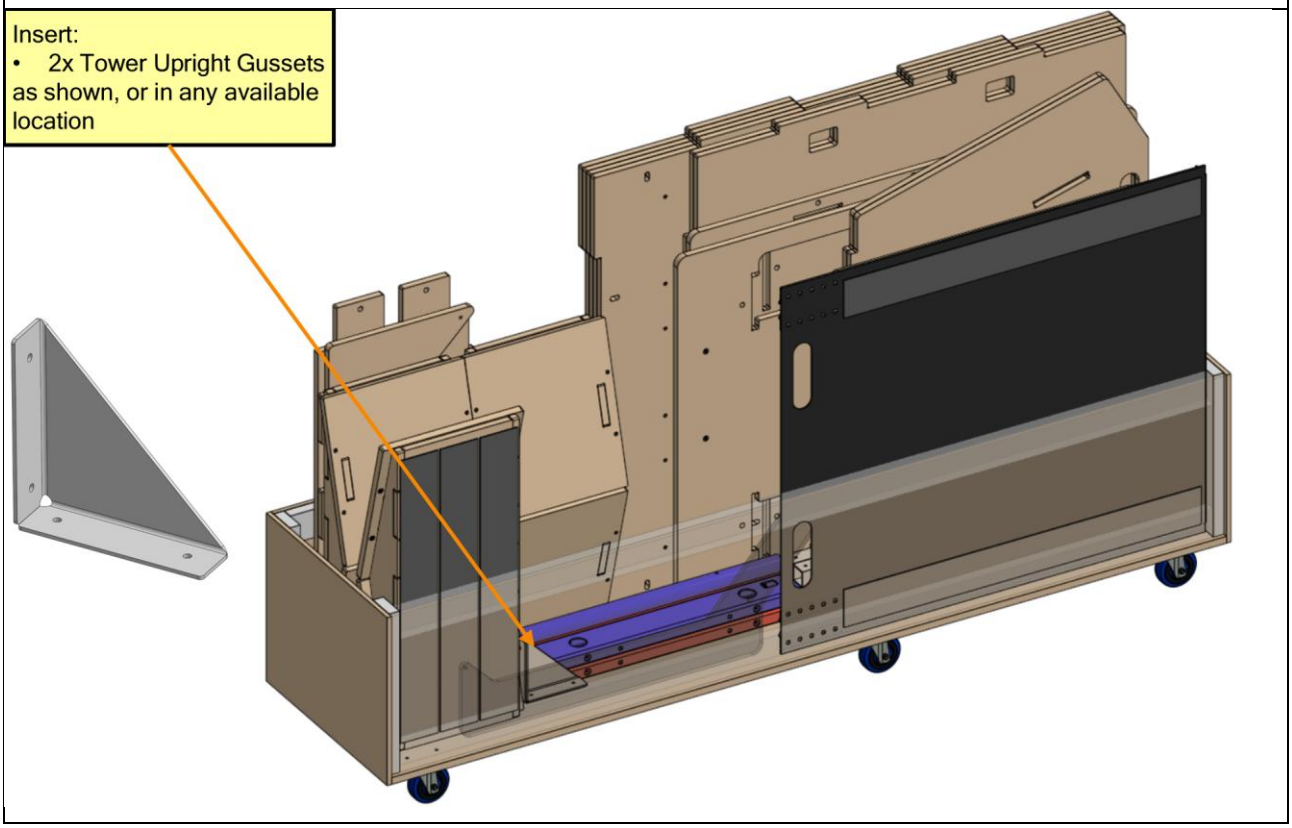
41.


Insert:
• 1x Outpost Chute Door

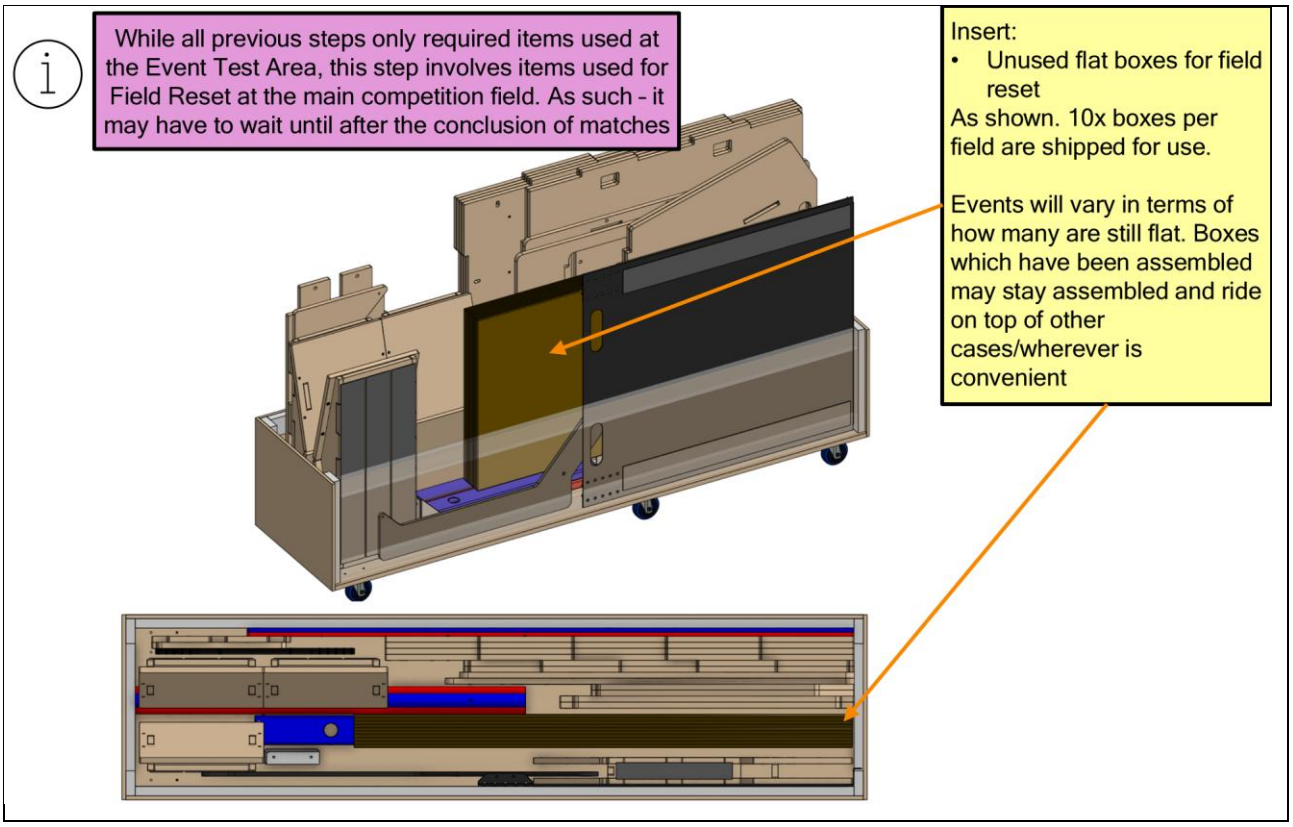
42.


Insert:
• 3x Test Bump Bases

43.


Insert:
• 2x Tower Upright Gussets as shown, or in any available location

44.

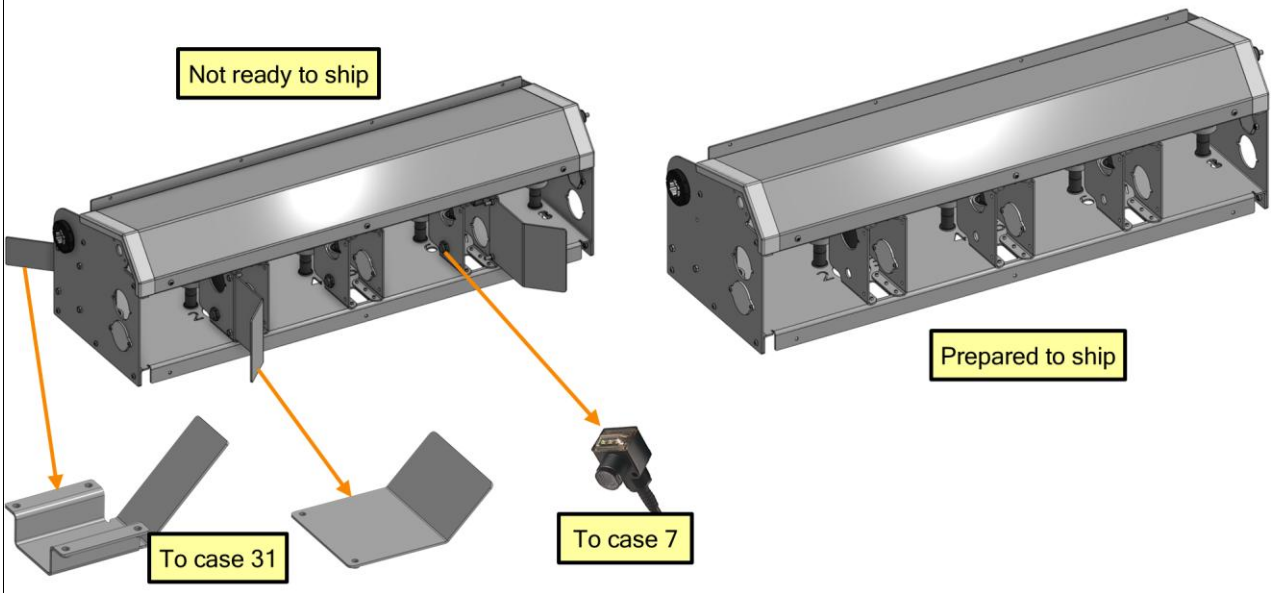

While all previous steps only required items used at the Event Test Area, this step involves items used for Field Reset at the main competition field. As such - it may have to wait until after the conclusion of matches
Insert:
• Unused flat boxes for field reset
As shown. 10x boxes per field are shipped for use.
Events will vary in terms of how many are still flat. Boxes which have been assembled may stay assembled and ride on top of other cases/wherever is convenient

5.9.4 Counter Cart

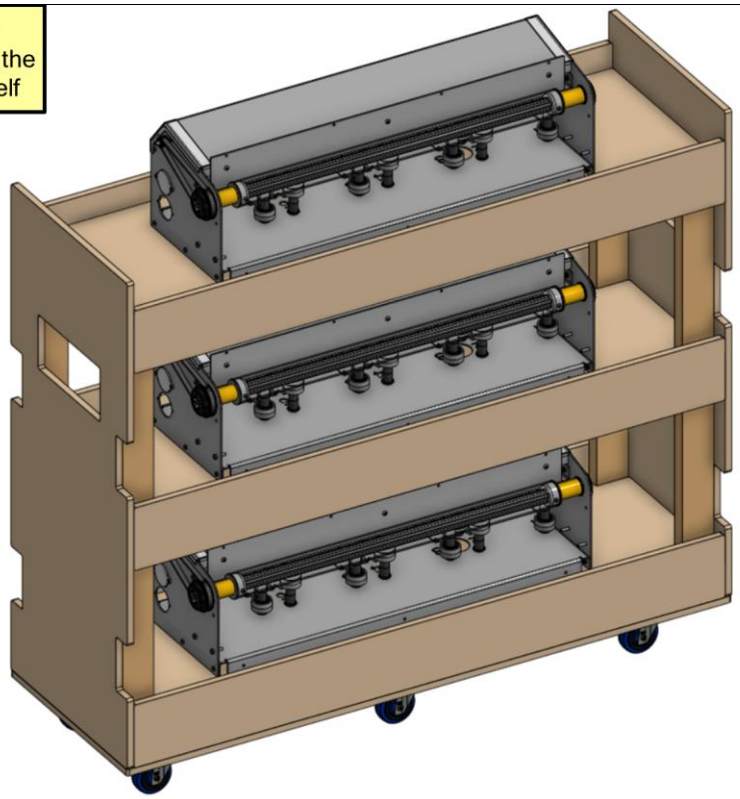
5.9.4.1 Packing Steps

1. 

2. Ensure the counters are prepared for shipping:
   - Counter Inlet Funnels removed (packed in Case 31)
   - Counter Fuel Deflectors removed (packed in Case 31)
   - Counter Sensors removed (packed in Case 7)



3. Pack the prepared Fuel Counter Assemblies on the cart as shown, 1 per shelf



5.9.5 Game Specifics in Field Cases

Case 7	Qty
Polycarbonate AprilTags (ID#1-32)	32
Polycarbonate AprilTags for Practice Field (ID# 2, 3, 4, 5, 8, 9, 10, 11, 13, 14, 15, 16)	12
Fuel Counter Sensors & Associated cables	12
VHSC (Counter box) & Associated cables	2
Motor Power Supply & Associated cables	2
DMX Light Controller & Associated cables	1
Case 34	
Hub Lights & Associated cables	9

5.9.6 Load Out

The truck-packing diagram is located on Box.com. It is based on having a truck with a load area of 110” high, 98" wide and 53' long. Having a vehicle of that size is ideal, but it might not always be same as the vehicle now backing up to the ramp.

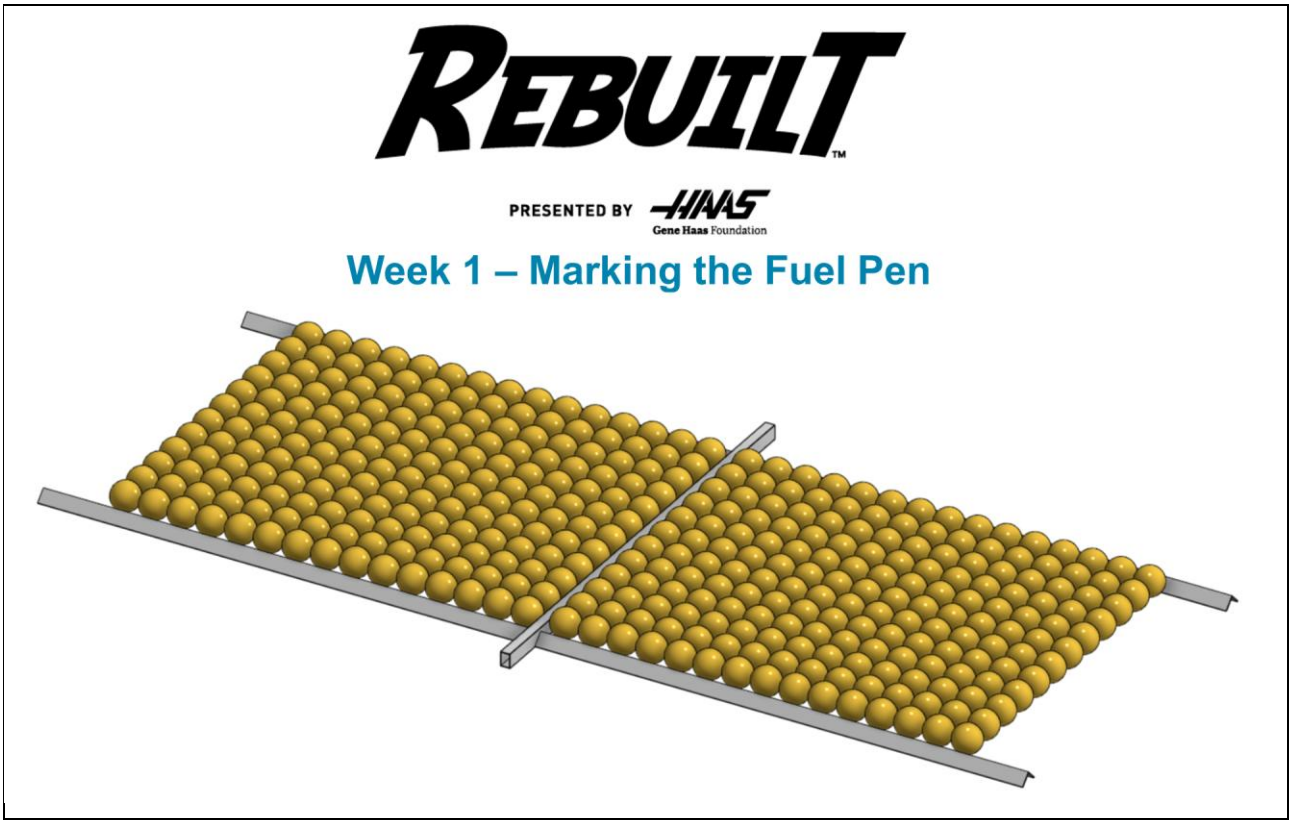
Remember that depending on where you are, the union will have varying degrees of involvement in the packing. Pay attention to the truck loading from the beginning. As much as possible, follow and defend the truck packing instructions.

Periodically use straps, load bars, and moving blankets as required to stabilize the truck’s contents and prevent the load from shifting / tipping over.

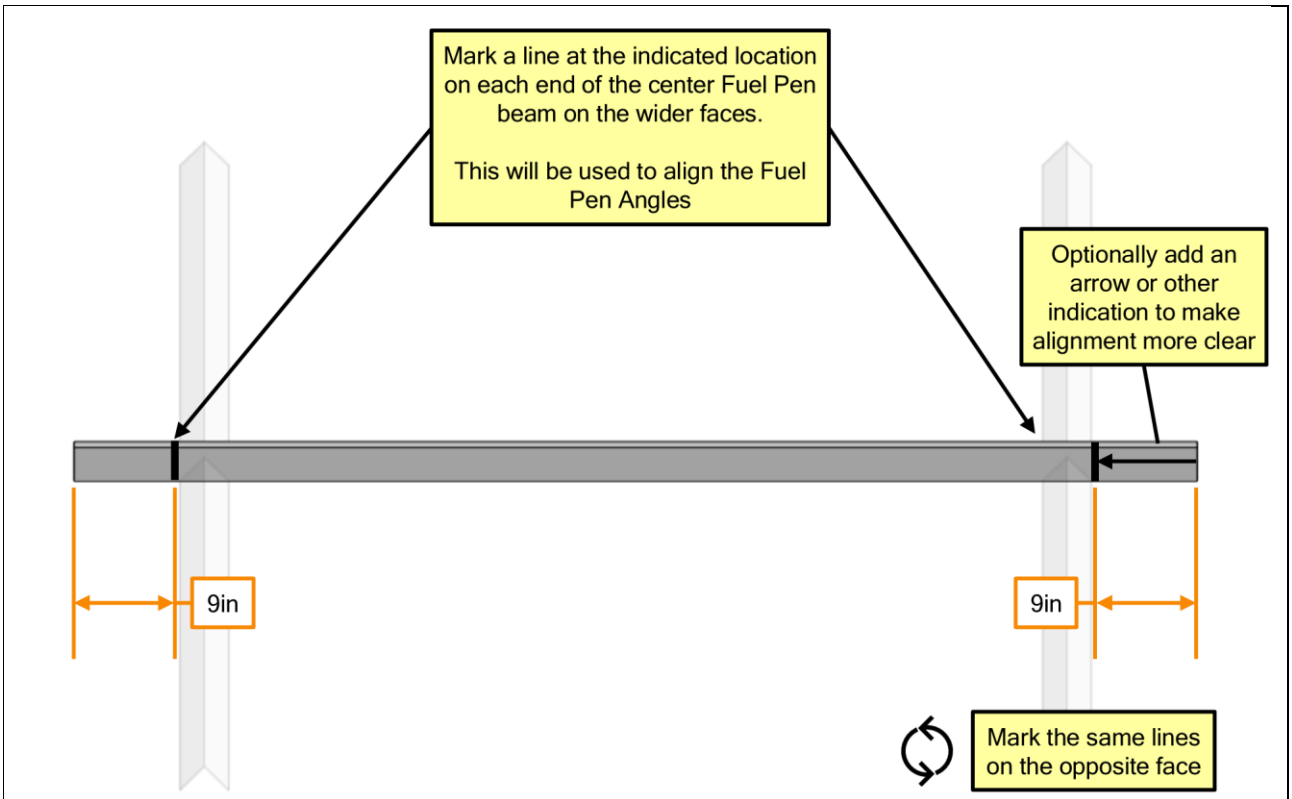
> As you near the end of all this process, you should have 1 or 2 people perform a quick walkthrough of the building to verify no *FIRST* material has been forgotten. If you do find something, obviously add it to the load on the truck, and then do one final walkthrough.

The truck driver may have the FTA sign paperwork. If the truck driver requires a list of what is included in the load, you should have an extra truck packing diagram to give them.

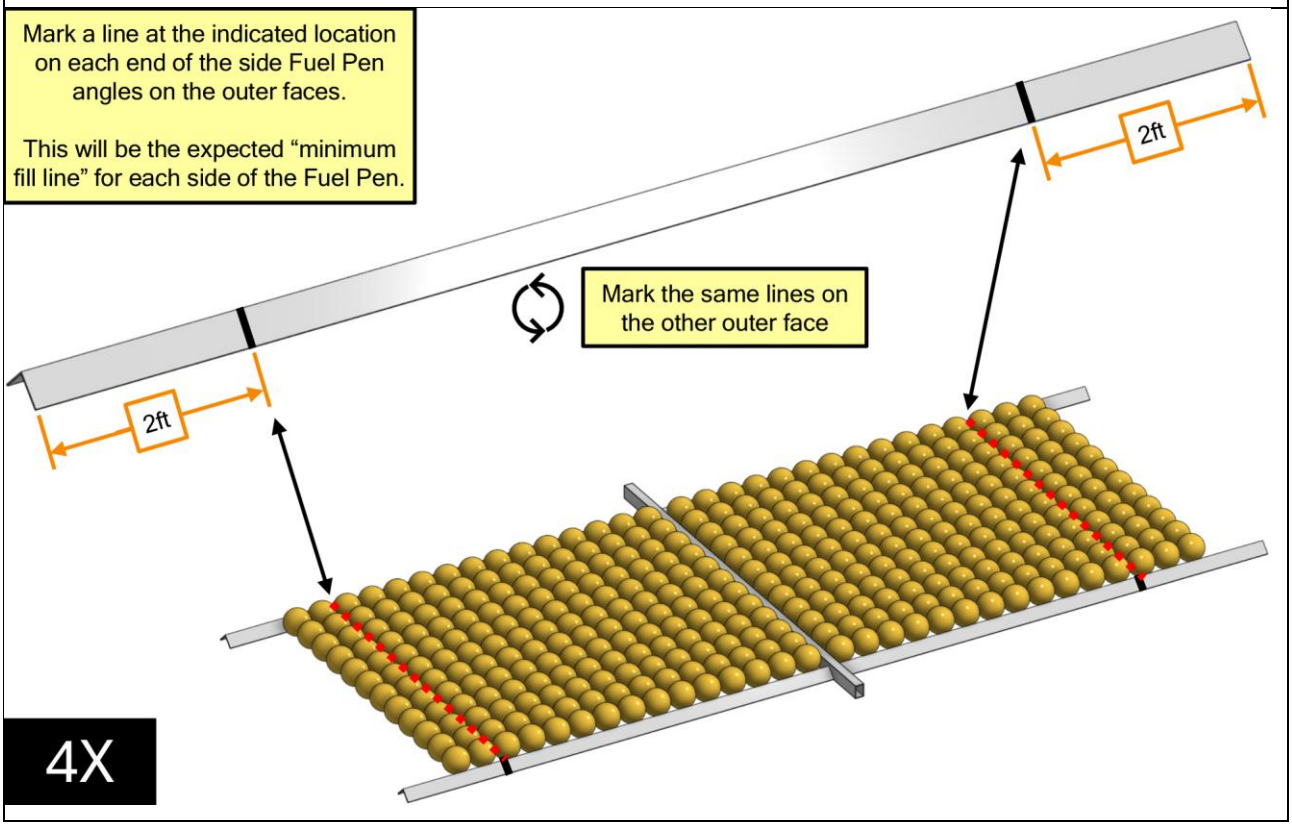
6 1st Event Modifications

4. 

5.


Mark a line at the indicated location on each end of the center Fuel Pen beam on the wider faces.
This will be used to align the Fuel Pen Angles
Optionally add an arrow or other indication to make alignment more clear
9in
9in
Mark the same lines on the opposite face

6.


Mark a line at the indicated location on each end of the side Fuel Pen angles on the outer faces.
This will be the expected "minimum fill line" for each side of the Fuel Pen.
2ft
2ft
Mark the same lines on the other outer face
4X

7.

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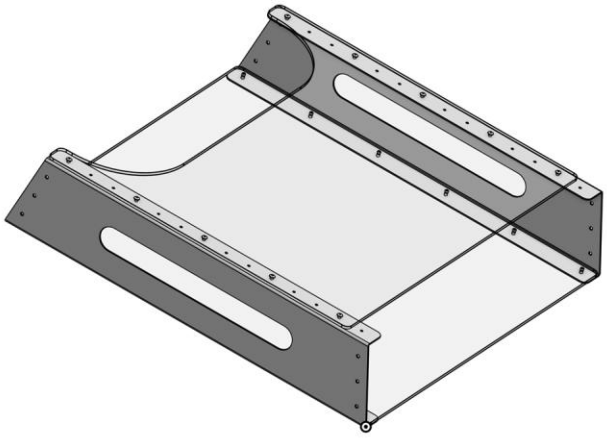
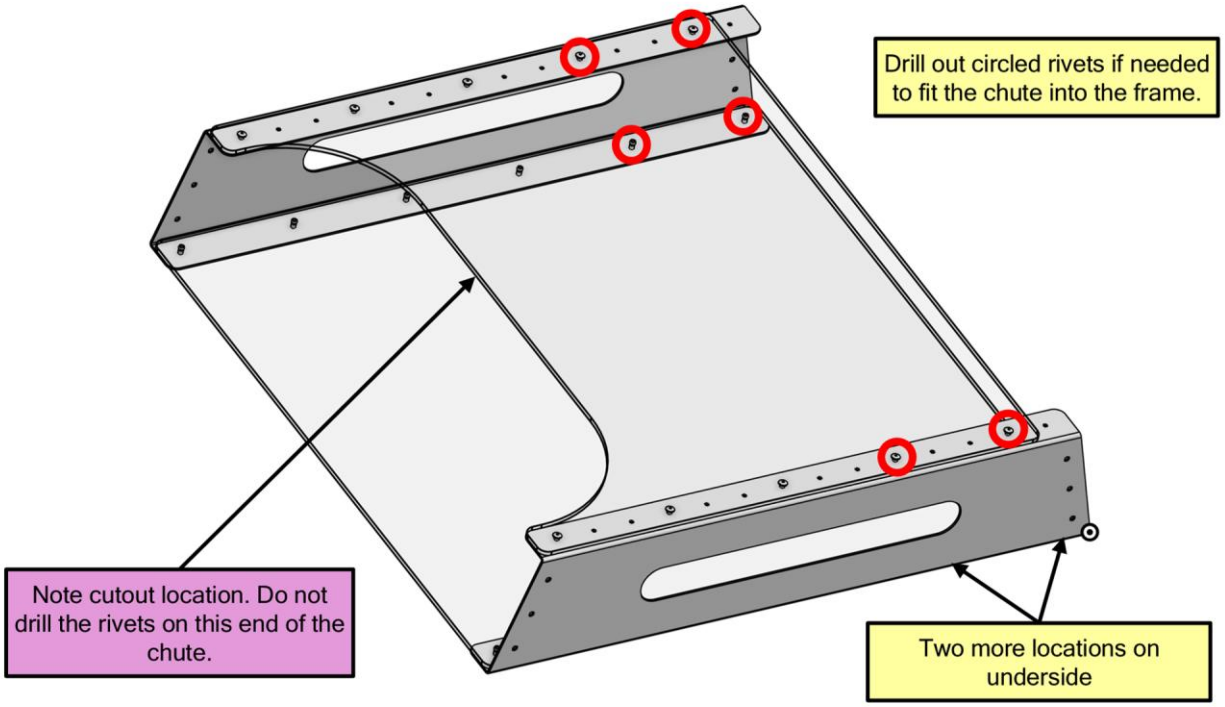
Week 1 – Fixing the Outpost Chutes



8.



7 Field Maintenance

- The edges of the Bump HDPE plastic will get rough from gameplay and need to be cleaned up with tools such as pliers, knives, or files. This part is also reversible, and there is an equivalent part in the Test Area that can be swapped in throughout the season. Material removal should be as minimal as possible while keeping large burrs from existing on the plastic.
- Fuel should be routinely checked for gashes, lost chunks, or other abnormalities that could cause it to act differently than intended. Fuel that is deemed unplayable should be thrown away or given away to avoid cross contamination with playable Fuel.

8 Revision History

Version	Description of Changes	Date
1	• Initial Draft	01/28/2026