

Orbital ATK Launch Vehicle Enclosure Assembly and Operation Manual

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1 Introduction

This document includes the steps to assemble and operate the launch vehicle enclosure designed for use by Orbital ATK. Assembly steps are broken down and accompanied by images for better understanding of the user. The steps necessary to deploy and take down the enclosure are outlined as well. Lastly, a trouble shooting guide has been included to aid the user if any issue should occur during operation or assembly.



2 Bill of Materials

This chapter includes the parts list for all pieces and hardware necessary to construct the enclosure.

Table 1: Bill of materials

Item	Quantity
V-Track	2
V-Groove Wheels	4
Left Base Plate	4
Right Base Plate	4
Base Adaptor	4
Two-foot Carbon Fiber Tube	12
1.5-foot Carbon Fiber Tube	4
Side Hinge	12
$\frac{3}{4}$ " Rod Side Adaptor	12
Top Adaptor	4
Tent Poles	6
Top Arch Side	4
Top Arch Center	2
Eye Bolts	6
30-Foot Paracord	2
$\frac{3}{4}$ " Bolt	8
$\frac{3}{4}$ " Washer	16
$\frac{3}{4}$ " Nut	8
$\frac{5}{8}$ " Bolt	12
$\frac{5}{8}$ " Washer	60
$\frac{5}{8}$ " Nut	12
$\frac{5}{16}$ " Bolt	12
$\frac{5}{16}$ " Washer	24
$\frac{5}{16}$ " Nut	12
$\frac{1}{4}$ " Bolt	4
$\frac{1}{4}$ " Washer	8
$\frac{1}{4}$ " Nut	4
Side Fabric Piece	2
Top Fabric Piece	2

3 Assembly

The following chapter will give step by step directions on how to assemble the structure. Pictures accompany the steps for reference of the builder.

3.1 Launch Pad Preparation

The launch pad will need to be prepped in order to allow for fastening of the launch vehicle enclosure. This includes drilling holes for concrete anchors and connecting the v-tracks for the enclosure to roll on.

3.1.1 Drilling mounting holes in launch pad

1. Using a $\frac{3}{4}$ " wood bit, drill holes to accept the fasteners that will secure the base of the structure and the v-track. Use dimensions provided in Figure 1 below.

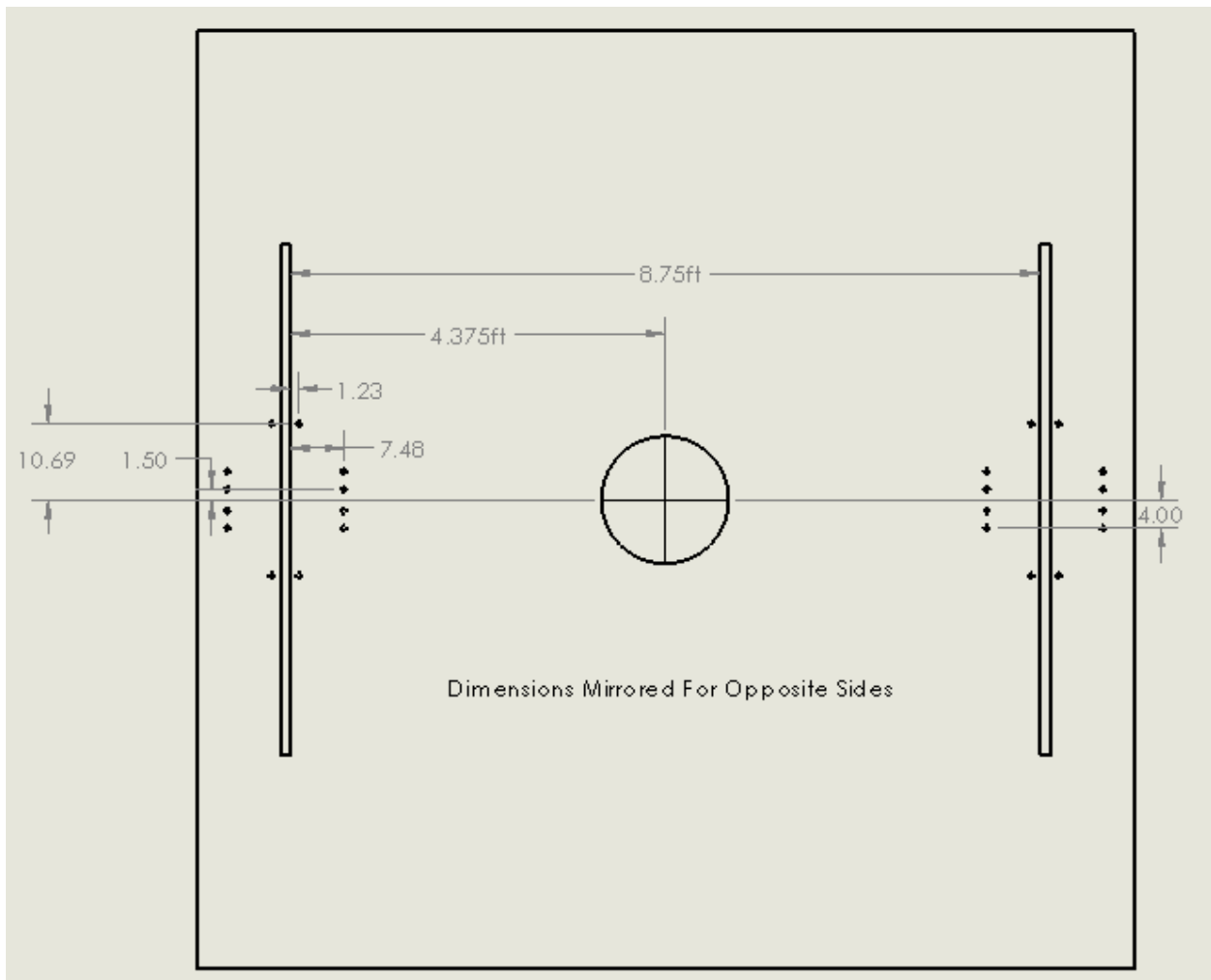


Figure 1: Launch pad hole and v-track locations. Dimensions without units are in inches.

3.1.2 Attaching V-Track to launch pad

1. Space two V-tracks 8.75' on center apart from one another parallel on the launch pad.
2. Secure the end of the V-track by placing 3 nails around each end of the v-track to lock it in place.

3.2 Base Plates

1. Connect one left base plate, v-groove wheel, and right base plate using one 3/4" bolt, two washers, and a 3/4" nut as seen in Figure 2. Repeat this step three times for a total of four base halves.



Figure 2: Base plate half assembly order

2. Place two base plates on each V-track with teeth facing toward one another as seen in Figure 3.



Figure 3: Two base plate halves on v-track

3. Attach a base adaptor to each base half using a 3/4" bolt in the bottom hole of the adaptor and top hole in the base as seem in Figure 4.



Figure 4: Base Adaptor in base plate half

3.3 Main Poles

1. Epoxy side pole hinge to one side of the two-foot Carbon Fiber Tube with 2" of hinge past the end of the tube to allow for next carbon fiber tube to slip into place as seen in Figure 5. Repeat this step for all 12 of the two-foot carbon fiber tubes.



Figure 5: Two-foot carbon fiber tube with hinges

2. Epoxy Main to Top Adaptor to 1.5' carbon fiber tube as seen in Figure 6. Repeat this step for all four of the 1.5' carbon fiber tubes.



Figure 6: 1.5-foot carbon fiber tube with top adaptor

3. Using three two-foot carbon fiber tubes with hinge and one 1.5' carbon fiber tube with adaptor, connect the three two-foot sections by sliding the end with no hinge into the open half of the hinge extending past the other carbon fiber tube as seen in Figure 7. Epoxy in place and ensure that all hinge tabs are faced the same direction. Attach the 1.5' carbon fiber tube to top hinge that is open. Repeat this step three times so that there are four main poles assembled which look like the main pole in Figure 8.



Figure 7: Sections of the main pole being assembled



Figure 8: Completed main pole

4. Place eye bolt through hole in the middle hinge of the main pole. Repeat this step for another main pole. You should now have two main poles with eye bolts in the middle hinge as seen in Figure 9.



Figure 9: Middle hinge with eyebolt attached

5. Place eye bolt through hole in the top adaptor of the main pole. Repeat this step for another main pole. You should now have two main poles with eye bolts in the top adaptor as seen in Figure 10.



Figure 10: Top adaptor with eye bolt

6. Use 5/16" bolt to fasten the 3/4" rod side pole adaptor to the hinge by putting the adaptor between the two hinge tabs as seen in Figure 11. Repeat this step twelve times for all hinges.



Figure 11: Hinge assembly

7. Slide the completed poles into the base adaptors. Each v-track should have a main pole with the middle eye bolt and a main pole with the eye bolt in the top adaptor.

3.4 Attaching base to launch pad

1. Push base half into position above the previously drilled holes in the launch pad.
2. Fasten base plate with three 5/8" bolts and nuts, and three washers per bolt as a spacer between the base plate and launch pad as seen in Figure 12.



Figure 12: Base plate assembly with washers on left. Secured base plate on right.

3.5 Attaching side arches

1. Assemble tent poles by interlocking the sections together by slipping the ferrule ends into one another.

2. With fabric lying flat on the ground with hoops facing up, pass three tent poles through loops in fabric skin as seen in Figure 13.



Figure 13: Tent poles in fabric loops

3. Place each end of the tent poles into the hole in the end of the hinge as seen in Figure 14. Be sure that one tent pole is at the same height hinge for each track.



Figure 14: Tent pole inserted in hinge

3.6 Top arch assembly

1. Attach two top arch sides to the top arch center by sliding the top arch sides into the top arch center and fastening with $\frac{1}{4}$ " bolt, nut, and two washers per hole. The top arch should look like Figure 15 when complete. Repeat this step so that there are two complete top arches.



Figure 15: Top arch assembly

2. Attach top arch to the main poles by sliding each end of the top arch onto the $\frac{3}{4}$ " rod at the top of each main pole.
3. Secure top fabric to top arch and top tent pole using Velcro loops.

3.7 Paracord

1. The paracord should be tied securely to the top eye bolts.
2. The cord should then be passed through the eye bolt at the middle hinge and then the eyelet at the base before being ran away from the structure.

Note: This route should be repeated with paracord between the main poles on the second v-track as well.

4 Operation

The following chapter includes instructions on how to deploy the structure around the launch vehicle as well as take the structure down prior to launch. Steps should be followed carefully to avoid breaking or injury.

4.1 Deployment

1. Pull paracord to bring two halves of the structure together.
2. Insert 3/4" bolt into top hole of base plate to secure main arch in the vertical position.
3. Tie off paracord to a secure location as a preventative measure in case the top bolt fails.
4. Secure Velcro from one half the structure skin to the other half of the structure skin to seal gap between halves.
5. Add guy wires to support structure if high winds occur.

4.2 Takedown

1. Untie paracord.
2. While pulling the paracord tight, remove top bolt from base plates. The two halves of the structure are now free to go down.
3. Slowly let down the two halves by letting paracord in at a controlled speed.
4. Remove bolts securing base plates to launch pad.
5. Pull two halves away from one another on V-track.

5 Trouble Shooting

The following chapter includes tips for how to fix problems that may occur during assembly or operation. This trouble shooting guide was generated based on complications the team encountered during production and testing.

5.1 Assembly

1. Bolts do not fit holes
 - Ream the holes slightly larger to allow for bolt clearance.
2. Hinges do not move freely
 - Loosen the 5/16" bolt that passes through the hinge. It may be clamping the tabs on the 3/4" rod between.
 - File down the 3/4" rod slightly to allow for clearance.
 - Open up the gap between tabs by bending the tabs slightly.
3. Launch pad holes do not line up with base plate
 - Ream the holes in base plate or launch pad using a drill bit.
4. Tent Poles do not fit into side pole adaptor
 - File the dowel on end of tent pole down slightly.
 - Ream the hole in the end of the 3/4" rod.

5.2 Deployment

5. Binding when pulling on paracord
 - Apply pressure upward on main pole to help raise the two halves.
 - Check that the 3/4" bolts through base plates and v-groove wheel are not overtightened.
6. Side arches do not fall into place
 - Check that fabric is not snagged on hinges or side arches above.
 - Pull gently on side poles after checking to make sure there are no snags.

5.3 Takedown

7. Main poles do not want to fall down.
 - Check that top 3/4" bolt is removed from base plate.
 - Make sure Velcro on fabric is undone
 - Slightly apply pressure on the main arch to separate two halves.