

Racks and Caps - Upper Hull Mechanical Report

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Overview

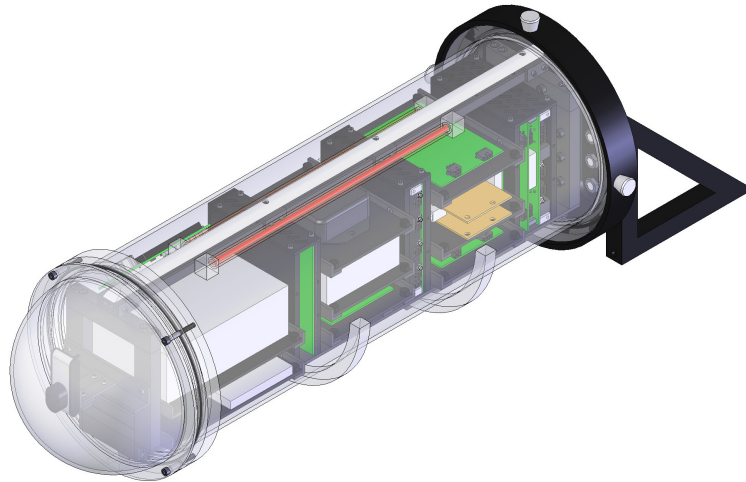


Figure 1: Upper Hull Rack and Structure

1 Project Description

The design and manufacture of the Proteus's upper hull rack and pressure vessel.

2 Purpose

The Upper Hull Rack (UHR) provides a mechanical infrastructure for the majority of Proteus's internal electronics. It will house the power (excluding battery pod boards) and signal infrastructure, computer, cameras, and internal sensors as well supporting boards for external sensors. The Upper Hull Pressure Vessel (UHPV) protects and waterproofs the components in the UHR and serves as an optical viewport for the Proteus's internal cameras. The Upper Hull (UH), a functional grouping of the UHR and UHPV, will be mounted to the Proteus's frame and act as a source of buoyancy.

User's Perspective

3 User's Manual

When Proteus is operating in water, the UH should remain sealed to protect its internal components. When on land, the UHPV can be removed to access its internal components as well as to perform routine maintenance.

- Removing the UHPV
 - Locate the three panels pins on the UH endcap.
 - Pull out and twist each pin so that it remains locked in the retracted position (pulled outwards).
 - Gently pull the UHPV forward until it clears the UHR and guide rail. Store the UHPV in a clean, safe location.
- Resealing the UHPV
 - Check the fitness of the exposed o-ring. If dirty or damaged, replace.
 - Ensure that the panels pins are locked in their retracted position (pulled outwards).
 - Align the UHPV keyway with the guide rail and the UHR.
 - Slide the UHPV back along the UHR until the rear of the UHPV is touching the UH endcap.
 - Gently release the panels pins to their extended position by rotating the pins until they drop inwards.
 - Push the UHPV firmly against the UH endcap until you observe that all three panel pins have extended fully into the UHPV.
- Replacing the o-ring
 - Remove the old o-ring (this may require the o-ring inserter/extractor tool).
 - If the old o-ring is damaged, i.e. nicked or torn, discard old o-ring and acquire a new o-ring. If the old o-ring is only dirty, rinse with water until clean.
 - Apply a relatively thin layer of o-ring grease to the new/cleaned o-ring by applying the grease to your hand and feeding the o-ring across your hand while smoothing the grease over the o-ring.
 - Install the new/cleaned o-ring in the UHPV's rear o-ring gland (this may require the o-ring inserter/extractor tool).
- Removing and installing electronic's trays
 - Disconnect all externally connected cables from the boards.
 - Unscrew the four thumbscrews that secure the tray to the two mounting l-beams.
 - Remove tray.
 - For installation, insert tray, screw in thumbscrews, and connect external cables.

4 Design Specifications

- Upper Hull (UHPV, UHR, UH Endcap, and UH Endcap Braces)
 - Length: 30.5”
 - Mass: 9.04kg
 - Depth Rating: 50’
 - Cost: \$900
- Upper Hull Pressure Vessel
 - Length: 23.75”
 - Hull Diameter: 7”
 - Max. Diameter: 8”
 - Mass: 1.76kg
 - Hull Material: 1/8” thick acrylic
 - Collar Materials: 1/2” thick acrylic
 - Cost: \$200
- Upper Hull Rack
 - Length: 20.5”
 - Mass: 5.26kg
 - Metal Parts: 6061/6063 Aluminum
 - Plastic Parts: Mainly static-dissipative ABS/PVC, some acrylic
 - Supported Devices:
 - * (2) Logitech Quickcam for Notebooks Pro Webcams
 - * (1) Kontron J-rex Computer
 - * (1) Honeywell TCM2-50
 - * (1) Microstrain 3DM-GX1
 - * (2) Humminbird HDR610 Altimeter Boards and Custom Boards
 - * (1) Custom Depth Sensor Board
 - * (2) Cablemax USBG-8X-RS232 USB-to-Serial Adapters
 - * (1) Custom Marker Dropper Board
 - * (2) Power Distribution Boards
 - * (1) Power Merge Board
 - * (1) Serial Adapter Board
 - * (1) Serial Hub Board
 - Cost: \$300

Design Details

5 Requirements

The Upper Hull must:

- provide waterproofing for all internal components.
- support uninterrupted operation of the electronics while the UHPV is removed and replaced.
- provide a viewport for both the downward and forward facing cameras.
- support being mounted to the rest of Proteus.
- support the mounting of all internal electronics in a serviceable manner.
- support electrical connections to the battery pods, thrusters, and all external sensors/devices.
- be designed to minimize the amount of necessary machining outsourcing.
- be designed to minimize the amount of unique types of hardware.

6 Final design

6.1 Upper Hull Pressure Vessel

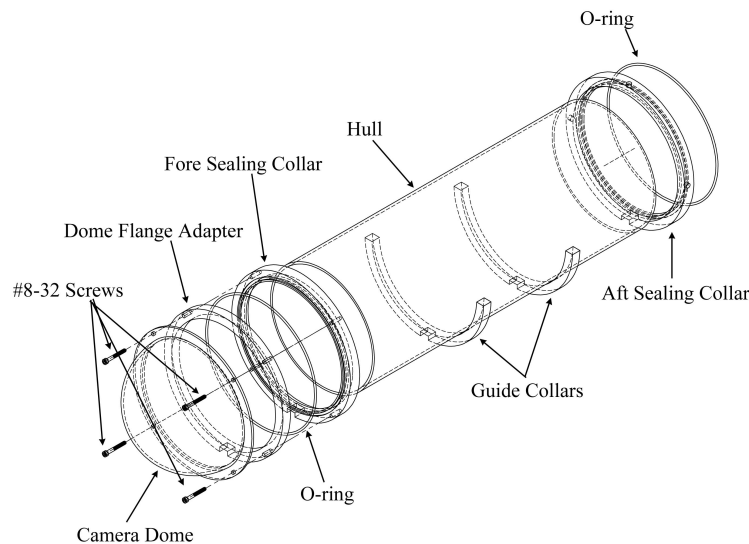


Figure 2: Upper Hull Pressure Vessel

The UHPV consists of the upper hull, camera dome, dome flange adapter, fore sealing collar, aft sealing collar, two guide collars, two o-rings, and four #8-32 screws as illustrated in figure 2

The camera dome, as shown in figure 3, provides a viewport for the forward-looking camera. The dome is custom-shaped by the manufacturer, so the only added features to the dome are the #8 clearance holes to allow the dome to be secured to the hull with screws.



Figure 3: Camera Dome



Figure 4: Dome Flange Adapter

In order for an o-ring face seal to work well, the mating surface must be flat and cover the entire gland. Since the circularity and flatness of the camera dome flange cannot be insured, a part must be constructed to ensure a good seal between the camera dome and the fore sealing collar, know as the dome flange adapter as shown in figure 4. The dome flange adapter is sealed to the back of the camera dome with epoxy and provides a flat, properly shaped mating surface for the fore sealing collar's o-ring gland. The general ring shape will be laser cut from a sheet of plastic. The only machined features of the adapter are four #8 clearance holes, matching those in the camera dome, and a keyway for aligning the UHPV with a guide rail.

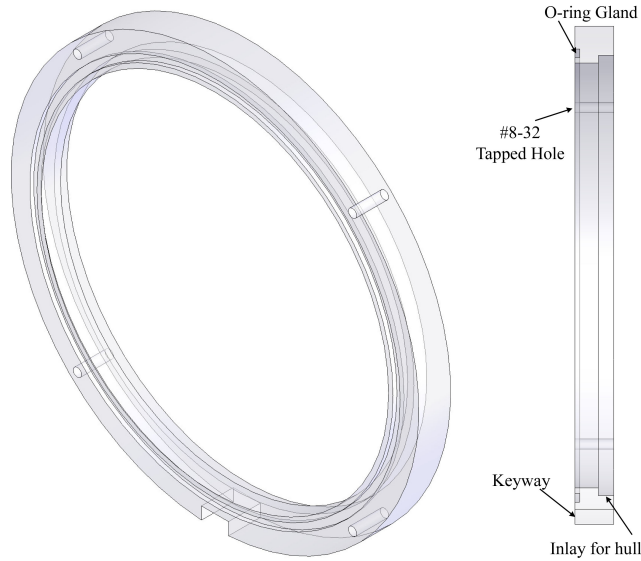


Figure 5: Fore Sealing Collar

The fore sealing collar, as shown in figure 5, features a #167 o-ring gland for sealing to the dome flange adapter, four tapped #8-32 holes for accepting the screws that secure the dome flange adapter and camera dome, an inlay for securely epoxying the fore sealing collar onto the hull, and a keyway to align the UHPV with a guide rail. Excluding the holes, o-ring gland, and hull inlay, the sealing collar will be laser cut from a sheet of plastic. Both the o-ring gland and hull inlay will need to be machined on the lathe.

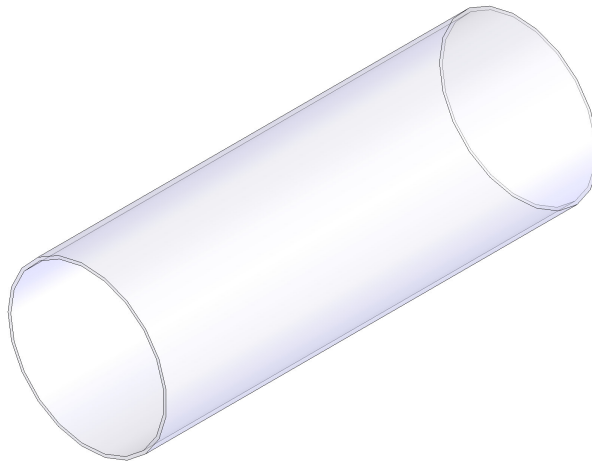


Figure 6: Upper Hull

The upper hull, as shown in figure 6 requires no in-house machining. It provides a viewport for the downward-facing camera and allows for easy field inspection of seal and equipment fitness.

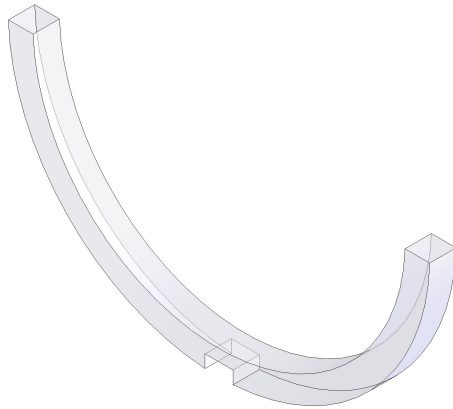


Figure 7: Guide Collar

The guide collar, as shown in figure 7, aids in aligning the UHPV with the Proteus's frame's guide rail, and maintains that alignment while elements of the keyway pass over the gap in the guide rail designed to accommodate the downward-facing camera. The part will be entirely laser cut.



Figure 8: Aft Sealing Collar

The aft sealing collar, as shown in figure 8, is similar in design and function to the fore sealing collar. Rather than having clearance holes for securing the dome, as in the fore sealing collar, there are three holes drilled radially inwards, by which panel pins secure the UHPV to the UH endcap. The aft sealing collar will be laser cut and lathed in the same way as the fore sealing collar, with the addition of the panel pin holes which will be machined with the mill.

6.2 Upper Hull Rack

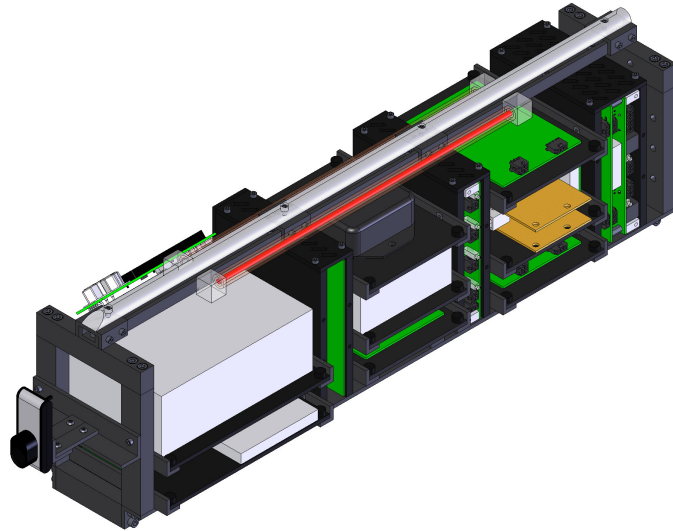


Figure 9: Upper Hull Rack

6.3 Upper Hull Endcap and Braces

7 Reasons for selecting final design

7.1 Upper Hull Pressure Vessel

7.2 Upper Hull Rack

7.3 Upper Hull Endcap and Braces

Logistics

8 Implementation timeline

- Sep 18: Initial design review
- Oct 15: Final design review
- Nov 1: Majority of mechanical design finalized
- Nov 2: First major parts order placed
- Nov 6: Machining begins
- Nov 12: Second major parts order placed
- Nov 20: U-beam, l-beams, and thick bulkheads completed
- Nov 23: Mounting l-beams and (4) thin bulkheads completed
- Nov 28: Guide blocks and guide u-beams completed
- Nov 30: Camera mounting parts completed
- Dec 3: All thin bulkheads completed
- Dec 4: Basic Upper Hull Rack structure assembled
- Dec 18: E-machine Shop Endcap order placed
- Dec 25: Third major parts order placed, plastic tube order placed
- Jan 22:
 - Find bead-blasting or metal polishing service
 - Board box panel models and drawings completed
 - Switch box design completed
 - Hull protective case designs drawn up
- Jan 29: Metals parts completed and shipped out for blasting/anodization
- Jan 31: Plastic parts laser cut
- Feb 7: Upper Hull collars machined
- Feb 12: UHPVs assembled, anodized parts received
- Feb 19: Upper Hull Pressure Vessel and Rack Rev. 1 Assembled

9 Spare parts

9.1 Lab

In the lab, we should have:

- Extra .5" x .75" aluminum stock
- Extra .75 x .75" L-beam
- Extra .75" x .5" U-beam
- Extra .25" thick PVC/ABS plastic
- Extra .125" thick PVC/ABS plastic

9.2 Pool test

Extra O-rings should be brought to pool tests

9.3 Competition

- O-rings
- Extra hull
- Extra plastic for trays and plastic knife.
- Extra thick bulkheads.

10 Known Bugs

The main defect of the UH rack as it stands is that the parts are not perfectly flush. In most cases, they are close enough that it does not matter, but in some cases it may be necessary to modify the parts in order to make things line up properly. The things to try, in order, are:

- Try tightening down the screw while holding the parts flush. In some cases, the pass hole are large enough that you can force it to be flush.
- Widen the pass holes. Using a drill bit the size of the original hole, widen the holes in the direction you need to in order for the tapped piece to line up properly. Do not do this to tapped holes, but to the pass holes that they are going in to.
- File down the offending edge. file down the part that sticks out until it is flush.
- Switch the part out/make another part. If things are absolutely not lining up, it may be necessary to try another part. In some cases, there are extras that can be substituted.

Wrap-up

11 Future improvements

12 Acknowledgements

13 Attachments