Component Name and Drawing Number: CubeSat Propellant Tank, cdm_assm_rev_070115							
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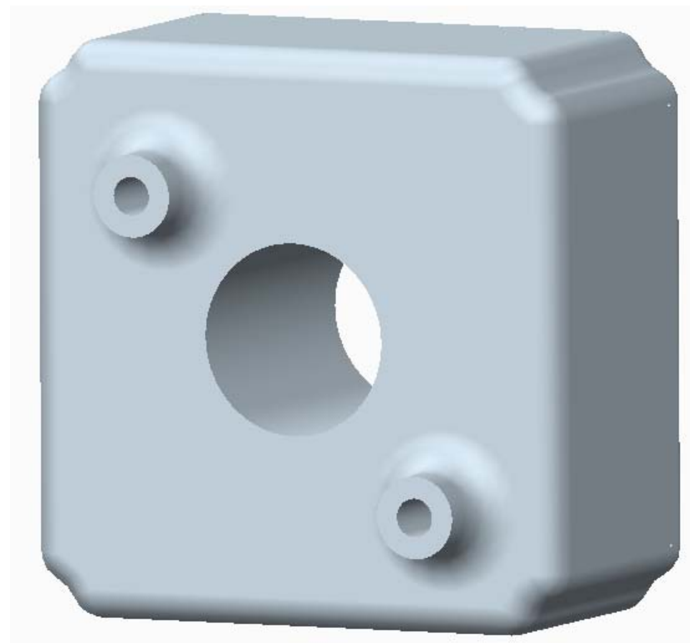
Date:	August 4, 2015	Supported Element/System:	CubeSat Propulsion System-Tank Development				
Fab Loc:	☐ MSFC ☒ Vendor	Material:	Ti-6Al-4V			Guidelines Version:	August 2015
						Template Version:	Rev A.

Executive Summary: (Part description and intended use)

The tank is designed to store and efficiently supply a liquid to a CubeSat Propulsion system for various on-orbit maneuvers. This particular build is to be used for development-level burst testing, and will not be used for a flight application.



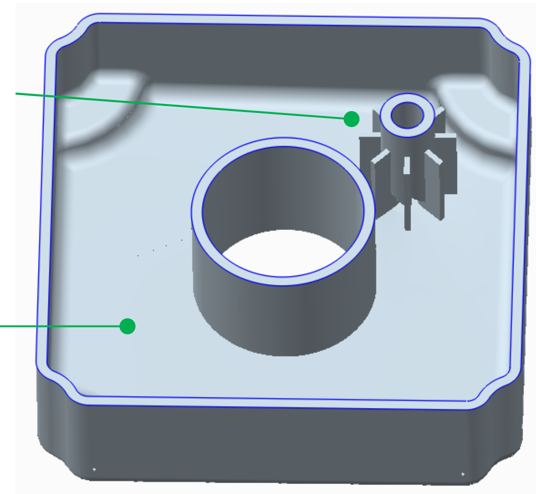
References:

Part Overview

- Titanium 6Al-4V
- Outer Dimensions = 3.75” x 3.75” x 2.42”
- Inside is a Liquid Acquisition Device (LAD)
- Build has mostly rounded internals to better help guide the monopropellant towards the LAD and to reduce stress concentrations.

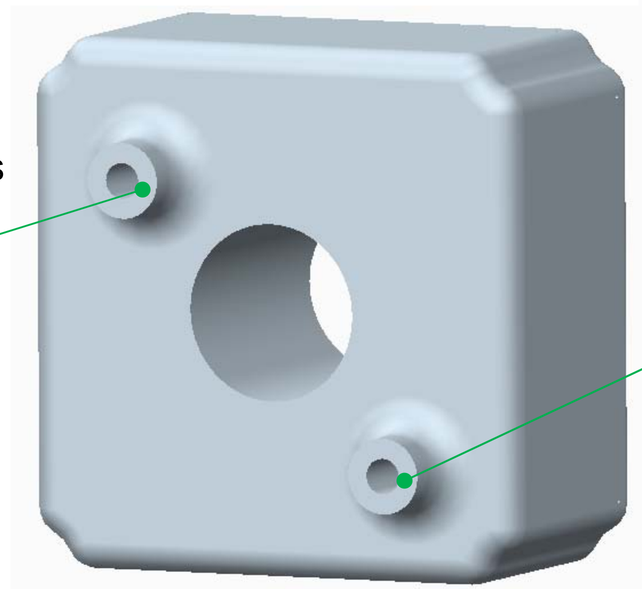
The LAD employs surface tension to acquire propellant in a zero-g environment.

Face of the surface angles the monopropellant towards the LAD



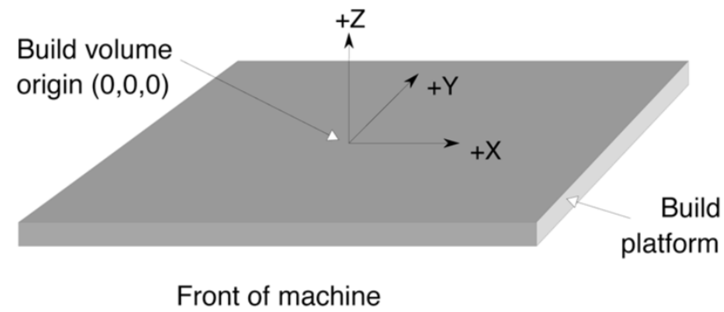
One boss is to be used as a pressure transducer measuring location

Both bosses will be later tapped and threaded for a 1/8” straight thread connection



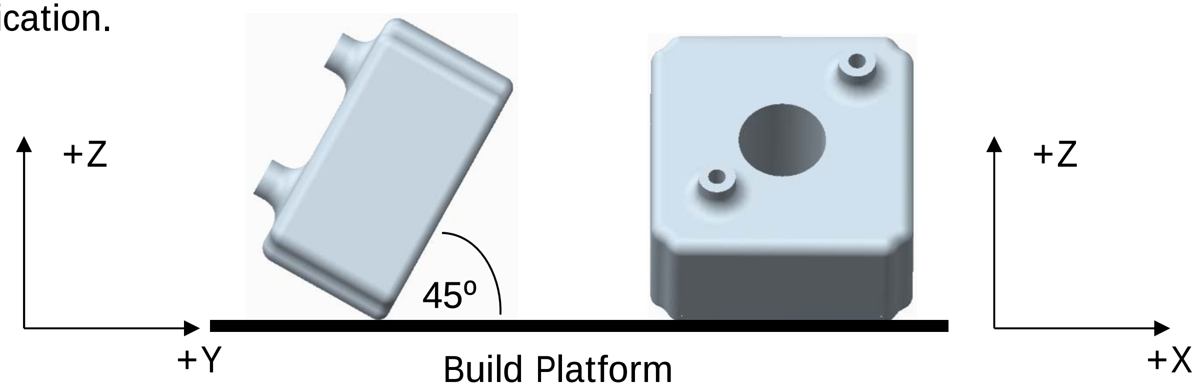
The other boss is used for liquid and gas supply

Build Overview



The build orientation is recommended to have the object printed at a 45º angle with one of the wall edges closest to the printing plate whilst the bosses face upwards. Designs of whatever necessary support structures are needed for the printing process is purely at the discretion of the vendor with the one rule that any physical prints can only be done on the outside of the model. No changes to the internal volume of the tank are to be made. No threading/tapping is to be done on this print.

Lot acceptance specimens shall be placed on the build platform on the downstream side of the part relative to the rake travel direction. Location of lot acceptance specimens shall also be reported with the part certification.



Critical Features and Dimensions

Unfortunately, the critical features and dimensions are inside the fuel tank and can therefore not be measured without being cut open. Additive manufacturing was chosen in order to have the tank built in a uniform fashion which would better help pressure stress concentrations. The most critical feature is the LAD which acts as a sponge and grabs onto any free-floating propellant while in zero gravity. All thicknesses are 0.085in with the exception of the fins on the LAD, which are 0.045in. This build will determine if any dimensions need to be changed if the burst test data shows that the tank ruptured prematurely.

Future builds intended for service will have a fabrication ready mechanical drawing and will have a critical dimension inspection list provided in some form.

Post-builds of this part will have ten holes drilled (all of them tapped) to allow components to attach to the tank. Future builds will have eight holes tapped for mounting applications. The OD of the production parts will most likely be final machined to achieve the required surface finish, but this is not required for this demo.

Little can be done for surface texture inside the tank. It is also not recommended to alter the texture inside as it provides more rough surfaces to allow better adhesion of the propellant to the tank walls.

Build support locations are to be left to the vendor's discretion at this time. Surfaces where build supports were used/removed must be reported in the part certification package.

Fabrication-ready mechanical drawing exists:

☐ Yes ☒ No

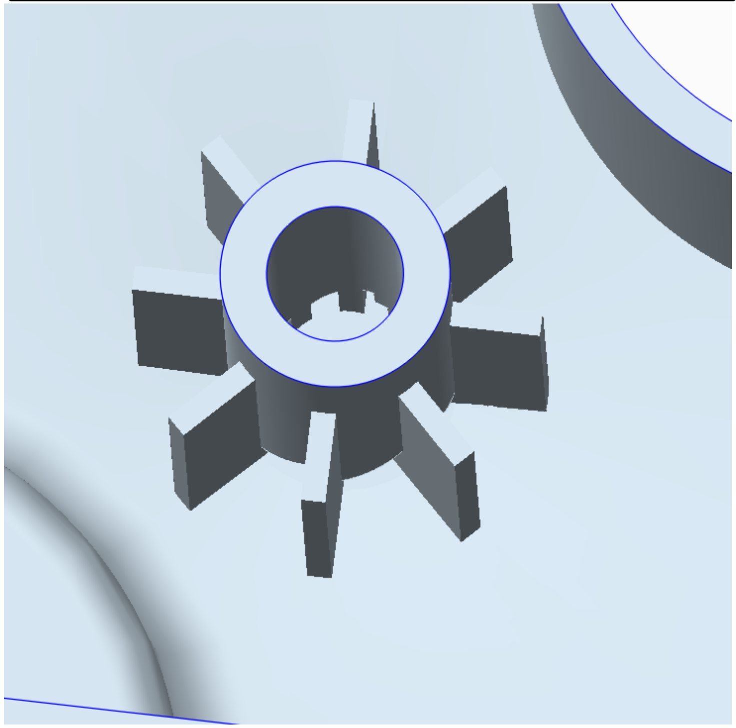
Critical Dimension List and Tolerances Provided by

☐ Reduced Dimension Drawing

☐ Dimension List + Drawing

☐ Drawing Notes

☐ Part specification, procurement contract



Materials and Processes ⇨ Feedstock Control and Thermal Process

Material: Titanium 6Al-4V,

Material/Build Specification: No standards currently exist

Feedstock requirements:

1. Feedstock powder shall meet alloy standard chemistry requirements as shown at right (AMS 5662).
2. Blending of used and virgin powder lots is allowed.
3. No further requirements are levied on the feedstock; however, there are quality control reporting requirements for feedstock in the part certification package.

Chemistry Limits

TABLE 1 Composition

Element	min	max
Aluminum	5.50	6.50
Vanadium	3.50	4.50
Iron	...	0.25
Oxygen	...	0.13
Carbon	...	0.08
Nitrogen	...	0.05
Hydrogen	...	0.012
Yttrium	...	0.005
Other elements, each	...	0.10
Other elements, total	...	0.40
Titanium	remainder	

Source: ASTM 3001

Thermal Processing: (include temperature, time, rate, and environment)

For part and lot test specimens

Step	Process
1	Stress relief on platform: 1950F +/- 25F ; 1.5 hours -5/+15 minutes; inert or vacuum; per ASTM 3001
2	HIP: 1700 °F ; 14750 +/- 250 psi; 3-4 hours; inert

Materials and Processes ⇨ Lot Acceptance Testing

This initial build of the part is intended to serve as a proof of build capability, but also serves to provide needed vendor data. As such, additional testing is planned as a part of this build cycle.

The part build height, expected to be positioned with the axis aligned with the Z build direction, will limit the applicability for “top” and “bottom” build data. The planned specimen evaluation is as follows:

- 4 Z direction tensile (0.5 inch dia x 3 in Z)
- 4 Y direction tensile (0.5 inch dia x 3 in Y)

These 8 specimens are to be printed per build plate.

All tensile specimens are to be ½” diameter cylinders with length equal to the full height of the build. All Z-direction tensile specimens must be located in the downstream rake direction of the part(s), and if space allows it is preferred that all Y-direction specimens be located in the downstream rake direction as well. However, Y-direction specimens can be placed where necessary to facilitate the build, and higher priority should be placed on number of parts per build plate rather than location of Y-direction specimens.

Tensile specimens shall be built and finished in a manner comparable to the exterior of the part.

Test specimens must follow part through all thermal process cycles.

Materials and Processes ⇨ Part Build Parameters

☐ Build parameters specified below

☒ Left to vendor discretion, required report list below

☐ Left to vendor discretion, no report required

Selected Build Parameters to Report

- Machine type/model
- Laser power
- Laser speed
- Layer thickness
- Purge gas used and chamber environment (purity levels)

Quality Control ⇨ Provided Data Checklist

- Parts shall have no cracks or other defects per visual inspection. Consult customer if there are any suspicions of defects.
- Report part build orientation and location of specimens within build box . For example, provide picture of complete build model with machine coordinate system.
- Report part surfaces where build supports were used/removed.
- Certifications shall be provided for all powder materials used. At a minimum these certifications shall include chemistry, impurity limits, and particle size distribution. Specifically:
  - Lot number and manufacturer (if blended, for all blend lots)
  - Verification of powder chemistry
  - If blended, proportions of virgin and used powder
  - Sieve size for cleaning used powder
  - For each lot in the build, the following powder parameters as defined in ASTM B243: type, shape, particle size distribution, tap density (identify method, e.g. ASTM B527), and flow rate.
- Part certification should include the following minimum build process parameters:
  - Machine type/model
  - Laser power
  - Laser speed
  - Layer thickness
  - Purge gas used and chamber environment (purity levels)
- Provide verification, including oven traces, for all thermal process cycles.
- Provide verification that lot acceptance specimens followed part through all thermal process cycles.
- Provide verification information for post-build surface finishing operations.