1.1 Project Scope

1.1.1 Project Description

This project aims to design and prototype a storage container to hold cryogenic propellants in space. The design must limit heat losses and transfers to preserve the propellant in a cryogenic state for an extended period of time.

1.1.2 Key Goals

The main goal of this project is to create a propellant storage solution that the National Aeronautics and Space Administration (NASA) can utilize on upcoming long-term missions. In order to achieve this goal, the container must maintain the fuel at a specified temperature for at least two weeks. Additionally, a solution should be proposed for the storage container to reduce the amount of thermal transfer and thermal gains.

A successful project will be defined by the ability of the team to create a prototype, perform various tests on the container, and present our findings to our project sponsors.

1.1.3 Primary Market

The primary market for this product is NASA, specifically the Marshall Space Flight Center (MSFC) and their commercial partners.

1.1.4 Secondary Market

The secondary market for this product includes other companies interested in space travel , such as SpaceX and Virgin Galactic, as well as aerospace companies that use cryogenic fuel for space flights. Once our design is in use, it is expected that other space agencies will incorporate aspects of the design into their own projects. Another secondary market is cryogenic research facilities with an interest in extending the research, as well as cryogenic manufacturers.

1.1.5 Assumptions

A hypothetical lunar mission with a duration of two weeks is assumed. The tank is assumed to store the fluid with no disturbance, i.e. filling or draining for fuel use. We will also assume that the fuel stored in the container is liquid hydrogen, although liquid nitrogen will be used in testing due to safety requirements and current available resources. A comparison will be performed between the two cryogens. In addition to this, the tank we construct will be on a much smaller scale than one used in practice. This will not be directly scalable, since heat transfer is directly related to the surface area and volume of the tank, but we are assuming that the necessary calculations can be performed to determine the heat transfer for a tank of any size based on our design. It is assumed that the final design will be operated by individuals who are familiar with cryogenic propellant storage and trained to handle the container. Finally, we are assuming that the tank will be utilized on Earth, during liftoff, and in a space environment.

1.1.6 Stakeholders

For this project, the stakeholders are NASA (specifically Marshall Space Flight Center), astronauts, spacecraft mechanics, cryogenic scientists, and other space companies. NASA-MSFC is the sponsor of this project and will receive the benefit of using the design on their spacecraft in the future, making them the primary stakeholder of the project.

With this project being implemented into spacecrafts in the future, more long-term space travel will be possible. This means that more astronauts will have the opportunity to man missions, making them main stakeholders in this project as well.

Spacecraft mechanics are another main stakeholder group, since they will be actively working on the ships. Creating an updated storage solution for cryogenic fuels will require the mechanics to be trained to manufacture and maintain these fuel containers.

Scientists studying cryogenics are another group of stakeholders for this project, because a successful product from this project will propel the field of cryogenics forward. Cryogenics will be put front and center of space travel and cryogenic scientists will be expected to further the technology.

Other space and air travel companies are stakeholders in this project, because a better cryogenic fuel storage solution will advance all of space and air travel. They will either incorporate some of the design aspects or improve their own designs based on the information from this project to advance cryogenic fuel storage.