Project Scope

1.1 Project Description

The objective of this project is to design, build, and test an actively sealed coupler that prevents the leakage of and protects cryogenic fuel during the transfer from depot to vessel for future deep space NASA missions.

1.2 Key Goals

In this project, the Cryogenic Coupler team seeks to design a depot to spacecraft transport interface for cryogenic fuels (below 90 K) that implements solutions to limit leakage during operation under ambient and spacelike conditions. The weight of the design is normally of crucial importance for devices with aerospace applications, however it will not be minimized in this project in order to focus on the success of the sealing and connection portions of the project. The coupler design will be able to remain operable for at least a 90-day lunar mission period. The lunar environment exposes the coupler's vulnerability to damaging solar radiation as well as spacecraft particulate exhaust matter and temperature fluctuations. These conditions demand for a robust and resilient coupler design. The coupler design must also mitigate the transfer of heat to the propellant, as this can lead to boil-off and losses. The connection joint will be active upon mating of the two halves.

1.3 Primary Market

The primary market of this project is NASA –Marshall Space Flight Center (MSFC) as they will be operating as our sponsor and user of the design.

1.4 Secondary Market

Secondary markets for this project include other space exploration companies such as SpaceX, Blue Origin, Lockheed Martin. Other markets the team was able to identify are hydrogen-powered aircraft companies and cryogenic fluid labs. The National High Magnetic Field Laboratory and other companies that require cryogenic fueling systems or are looking for new designs for coupler connections are a market for our coupler design. Additionally, the FAMU-FSU College of Engineering is a market for the project since our project is made for the Mechanical Engineering Senior Design class. All of these industries show interest in incorporating our design in current and future sealed coupler projects.

1.5 Assumptions

Our design is built on the assumption that there is proper vehicle orientation when in use, such that the coupler and vehicle connector are in alignment. Our team assumes liquid hydrogen is the fuel that is passing through our coupler. For safety and availability purposes, liquid nitrogen will be used to test the effectiveness of our design. Our team will analyze any critical differences between liquid hydrogen and liquid nitrogen to ensure the validity of any test that we perform. For this design, we also assume the space and planetary conditions and mission duration. Our cryogenic coupler will be in use for a 90-day lunar mission and will be functional on the surface of the Earth and moon, low earth and lunar orbit, and deep space. The minimum external pressure and expected temperature for this design is assumed for deep space environments. The maximum external pressure is assumed for standard earth atmosphere, and the maximum expected temperature will be no more than extreme earth conditions. Our team assumes that mass/weight is somewhat negligible and we should focus more on the efficacy of fuel leak prevention between fuel transfer negligible shock and vibration.

1.6 Stakeholders

The stakeholders for this project include NASA, NASA astronauts, NASA scientists and engineers, Dr. Shayne McConomy, and the FAMU-FSU College of Engineering.

NASA, our sponsor, provides the funding and specifies the design objectives and constraints. Our design will be used for NASA space missions and operated by NASA astronauts. The engineers and scientists that test and monitor fueling using our coupler also have a vested interest in our design.

Our project manager, Dr. Shayne McConomy, is providing time and effort to aid the success of the project. The FAMU-FSU College of Engineering is being represented as our institution.