Rocket Design Inc.
540 W Woodbury Rd, Altadena,
CA 91001, United States
November 10th, 2015

[redacted] artment Head
Calypso 1738 Rocket Project Manager
RE: The Nuclear Fuel System is Not Sustainable

To Charles Bolden,

On August 26th, 2015 you put me in charge of reviewing the Calypso 1738 Rocket's design. While going over the calculations, it was concluded that the nuclear fission propulsion system used in the design plan is too heavy for the rocket to sustain itself. Since increasing the size of the rocket is not an option and decreasing the size of the fuel tank will not provide us with enough fuel to make it to mars, I have provided two alternative fuel systems which can be implemented. We can either move forward with an ion propulsion engine or a liquid hydrogen propulsion engine with a liquid oxidizer. Because of its extremely low fuel weight and long running efficiency, I highly recommend moving forward with the ion propulsion system.

Very good.

How it works

The ion propulsion system consists of five main parts: a power source, a power processing unit, a propellant management system, a control computer, and an ion thruster. The engine works by first ionizing xenon by basting it with a surplus of ions. The ionized propellant is then magnetically pushed out the back of the engine. The stream of jets creates the thrust that is required to move the spacecraft forward (Dunbar, 2008).

The chemical system using liquid hydrogen as a propellant consists of a fuel tank, an oxidizer tank and a combustion chamber. The engine works by burning the liquid hydrogen with liquid oxygen as an oxidizer. This produces large volumes of extremely hot gas at about 3000 kelvins. This gas expands until it rushes out of the rocket thrusting it forward (Dunbar, 2010).

Ion Propulsion System Advantages and Disadvantages

The ion thruster is the best option and will be more efficient than the originally proposed system. It will have an efficiency of over 90% and can reach speeds of 200 miles per hour. This system uses only 159 pounds of fuel and can last 16,000 hours of thrusting. Since it requires so little fuel we can use a smaller and much cheaper launching vehicle. This fuel system, operating with little material and fuel, is light enough to easily sustain itself.

Because of the system's low acceleration, the ion thruster will not be able to overcome earth's gravity by itself and will need a small system added on to it. The additional fuel system will be very small and just used to thrust into space where the ion thruster then takes its place. Because we need to build two systems, this project will take slightly longer at 10 months opposed to the original 7, however, it is worth it as over time it will prove to be significantly cheaper.

The cost to build this fuel system is $206,000,000, and the cost to fill it up is $976,893. One of the greatest advantages to this system is it uses inert gas instead of combustion which makes it much safer because it eliminates the risk of explosions associated with chemical fuel systems (Dunbar, 2008).

Chemical Propulsion System Advantages and Disadvantages

The chemical propulsion system is also a great option to consider. This is the faster and cheaper option. It will cost $159,000,000 to build, $1,380,000 for the fuel to be filled, and will take a total of 8.5 months. Though it is the fastest and cheapest method, it will not be of the same quality as the ion propulsion system. This rocket will only have 39% fuel efficiency and reach the speed of 79,000 miles per hour.

Chemically fuelled rockets, unlike the ion propulsion system, are mass-limited which means once the fuel runs out the rocket stops. Another downfall to this type of fuel system is once the hydrogen is burned it must all be used. This poses to be unsafe because if there is a fault in the rocket we will not be able to shut down the system. AWK

One of the advantages for this design is we can control how much throttle is used by limiting the flow of the burned hydrogen into the oxidizer. This would allow us to maximize how much fuel is used. However, having liquid fuel in the system also leads to encountering leaks which in turn can cause the rocket to combust (Dunbar, 2010).

Recommendation

While looking at the comparison in Table 1 it is evident that the quality of the ion propulsion system is significantly better than the chemical propulsion system. Even though the ion propulsion system costs about $40,000,000 more, I strongly recommend this option as it is safer, more efficient and can go significantly faster. You also would be saving money in the long term from costs that would occur from complications in the chemical propulsion system. Est? Details?

I look forward to receiving your decision regarding the Calypso Rocket. If you have any questions please don't hesitate to contact me. You may reach me by phone at (202) 358-0001, or by email at C.Permesar@CalypsoRocket.ca.

Table 1 Comparison of the Ion Propulsion System and Chemical Propulsion System

	Ion Propulsion System	Chemical Propulsion System
Cost to Build Fuel System	$206,200,000	$159,075,000
Cost of Fuel	$976,893	$1,380,00
Total Cost	$207,176,893	$160,455,003
Time	10	8.5
Mass Limited	No	Yes
Fuel Efficiency	90%	39%
Speed (mph)	200 000	79 000
Safety Rating	9.5	3.0

Excellent. Keep it up.

15/15

Kind Regards,

[redacted]