Risk Management Plan Technical Report

Dev D. Patel

Virginia Aerospace Science and Technology Scholars

# Abstract

In order for deep space travel to take off, there are several key risks that need to be managed first, including breathing air, waste management, and communication. Without a clean, waste free air supply, the mission would never last past the atmosphere, and without secure, stable communication lines, disaster would strike frequently, and do massive damage to the spacecraft. By using experimental and proven technologies like Catalytic convertors, and compressed oxygen tanks, these risks can be mitigated, and the deep space missions could continue as planned.

# 

# 

# Risk Management Plan Technical Report

The next frontier in space is deep space exploration. Starting on Mars, the possibilities for human transport and settlements across the solar system are endless. However, in order to support deep space missions, there are several issues that need to be taken care of using experimental and proven technologies. This paper will focus on the three issues of Waste Mitigation, Communication, and Breathable Air.

# Research Selection

## Waste Mitigation

Waste accumulated along a deep space mission requires extreme measures to deal with. It is not only toxic, it also poses a huge space efficiency problem, both in transit, and on mars. Waste, whether in liquid, solid, or gas form has to be stored to deal with, often taking up vital space on a mars settlement or deep space mission that could be used for food or supplies (“NASA seeks new ways to handle trash for deep space missions”). This is a much larger issue in transit as opposed to on surface (where there is more space and resources available). With a finite amount of resources in transit, waste contamination becomes a huge issue that could possibly have disastrous consequences for the crew. There are several possible solutions to this problem, one of them developed by NASA itself, which they affectionately call the “Trash to gas” station. The station uses catalytic converters to generate rocket fuel from waste developed in flight(“Repurposing Space Station Trash for Power and Water”). Another possible idea would be to use a Heat Melt compactor developed by NASA, which would generate heat energy from waste(Golliher). However, heat energy is generally unusable for most mission critical tasks. Right now, NASA uses small plastic bags to store trash, which are loaded into the top of the vehicle, and burn during reentry (“Repurposing Space Station Trash for Power and Water”). Possible constraints of using these technologies on deep space missions include possibility of machine failure, and backup space or ejection chambers needed to store the waste to be converted.

## Communication

Communication is one the most important aspects of any mission. The ability to communicate clearly, and effectively is extremely important and can have drastic consequences if not done properly. This is even more critical in an on-surface martian base, where the ability to quickly share thoughts, ideas, and warnings is imperative as even small mistakes can cause life/death situations. Astronauts communicate in space through integrated radios in their space suit, but this communication method is neither secure, or necessarily stable/interference free (“NASA - Communicating in Space”). If communications lines cut out during a spacecraft failure, or during a base construction failure, the possibility of equipment damage, and loss of human life would be high. One possible alternative to traditional radio communication would be to send bits stored with voice data (similar to how we call over cellular data and wifi). This would run on a higher frequency wave, and be more stable, although it would have a smaller range. This type of communication would best work as a supplement to existing radio communication technology, as the combination of both technologies would create the best mix between distance and communication line stability and security. Pre flight training on proper ways to communicate including protocol training, and how to get your point across clearly using proper terminology could also aid in reducing the risk of poor communication.

## Breathable air

Breathable air is probably the most important aspect of the entire mission. Any deep space mission with the possibility of a permanent or semi-permanent settlement requires breathable air. Without it, all astronauts would die, and some equipment would not function either. To combat this issue, NASA uses an airlock system with an Oxygen Generating System (Karl). They combine hydrogen gas with carbon dioxide breathed by astronauts to get Water and Methane. The water is then recycled into hydrogen and oxygen. Urine is also recycled to form water, and gases like methane and ammonia are chemically filtered out. NASA also uses solid fuel oxygen tanks, which can provide oxygen supplies, as well as compressed cylinders of bottled oxygen. In an in transit mission, a similar system, on albeit a larger scale, would likely be used. On a surface base, either using an Oxygen Generating System, or using Vertical farming with plants on Martian Soil would help create an oxygen supply for a permanent or semipermanent base.

**Greatest Danger**

The greatest danger of the three sources I chose would probably be the waste mitigation. Waste mitigation is crucial to supporting a functional deep space mission, and it is the only one of the three that would require experimental technologies. To avoid the contamination of the living quarters, and more importantly, breathing supply, waste management research would be crucial.

# Conclusion

Although deep space travel presents many opportunities for space programs, there are several risks that need to be dealt with first. Three of the most important risks are communication, breathing air, and waste management. Through the usage of technology like catalytic convertors, Oxygen Generating systems, and joint radio and wifi based communication channels, NASA and other space programs can use a combination of both existing and experimental technology to help mitigate these risks and ensure the mission will run smoothly.

# 

# 

Works Cited

Gohd, Chelsea. “NASA’s Big Astronaut Trash Problem.” *Space.Com*, Space, 12 July 2018, www.space.com/41131-nasa-tackles-astronaut-trash-problem.html.

Golliher, Eric. “Evaporative Heat Transfer Mechanisms within a Heat Melt Compactor (EHeM HMC) Experiment.” *Flight Opportunities*, Mar. 2012, flightopportunities.nasa.gov/technologies/45/. Accessed 9 Mar. 2020.

Karl. “How Do Astronauts Breathe in Space?” *Abc.Net.Au*, 8 June 2015, www.abc.net.au/science/articles/2015/06/09/4249936.htm, https://www.abc.net.au/science/articles/2015/06/09/4249936.htm.

“NASA - Communicating in Space.” *Nasa.Gov*, 2016, www.nasa.gov/topics/moonmars/features/hatsman.html.

“NASA Seeks New Ways to Handle Trash for Deep Space Missions.” *NASA*, 2018, www.nasa.gov/feature/nasa-seeks-new-ways-to-handle-trash-for-deep-space-missions.

“Repurposing Space Station Trash for Power and Water.” *NASA*, 2013, www.nasa.gov/content/repurposing-space-station-trash-for-power-and-water/.

‌