Reliability and Maintainability Analysis for the Amine Swingbed Carbon Dioxide Removal System

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I have performed a reliability & maintainability analysis for the Amine Swingbed payload system. The Amine Swingbed is a carbon dioxide removal technology that has gone through 2,400 hours of International Space Station on-orbit use between 2013 and 2016. While the Amine Swingbed is currently an experimental payload system, the Amine Swingbed may be converted to system hardware. If the Amine Swingbed becomes system hardware, it will supplement the Carbon Dioxide Removal Assembly (CDRA) as the primary CO_2 removal technology on the International Space Station. NASA is also considering using the Amine Swingbed as the primary carbon dioxide removal technology for future extravehicular mobility units and for the Orion, which will be used for the Asteroid Redirect and Journey to Mars missions.

The qualitative component of the reliability and maintainability analysis is a Failure Modes and Effects Analysis (FMEA). In the FMEA, I have investigated how individual components in the Amine Swingbed may fail, and what the worst case scenario is should a failure occur. The significant failure effects are the loss of ability to remove carbon dioxide, the formation of ammonia due to chemical degradation of the amine, and loss of atmosphere because the Amine Swingbed uses the vacuum of space to regenerate the Amine Swingbed. In the quantitative component of the reliability and maintainability analysis, I have assumed a constant failure rate for both electronic and nonelectronic parts. Using this data, I have created a Poisson distribution to predict the failure rate of the Amine Swingbed as a whole. I have determined a mean time to failure for the Amine Swingbed to be approximately 1,400 hours. The observed mean time to failure for the system is between 600 and 1,200 hours. This range includes initial testing of the Amine Swingbed, as well as software faults that are understood to be non-critical. If many of the commercial parts were switched to military-grade parts, the expected mean time to failure would be

2,300 hours. Both calculated mean times to failure for the Amine Swingbed use conservative failure rate models. The observed mean time to failure for CDRA is 2,500 hours.

Working on this project and for NASA in general has helped me gain insight into current aeronautics missions, reliability engineering, circuit analysis, and different cultures. Prior my internship, I did not have a lot knowledge about the work being performed at NASA. As a chemical engineer, I had not really considered working for NASA as a career path. By engaging in interactions with civil servants, contractors, and other interns, I have learned a great deal about modern challenges that NASA is addressing.

My work has helped me develop a knowledge base in safety and reliability that would be difficult to find elsewhere. Prior to this internship, I had not thought about reliability engineering. Now, I have gained a skillset in performing reliability analyses, and understanding the inner workings of a large mechanical system. I have also gained experience in understanding how electrical systems work while I was analyzing the electrical components of the Amine Swingbed.

I did not expect to be exposed to as many different cultures as I have while working at NASA. I am referring to both within NASA and the Houston area. NASA employs individuals with a broad range of backgrounds. It has been great to learn from individuals who have highly diverse experiences and outlooks on the world. In the Houston area, I have come across individuals from different parts of the world. Interacting with such a high number of individuals with significantly different backgrounds has helped me to grow as a person in ways that I did not expect.

My time at NASA has opened a window into the field of aeronautics. After earning a bachelor's degree in chemical engineering, I plan to go to graduate school for a PhD in engineering. Prior to coming to NASA, I was not aware of the graduate Pathways program. I intend to apply for the graduate Pathways program as positions are opened up. I would like to pursue future opportunities with NASA, especially as my engineering career progresses.