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Tools and Technology in Support of Integrated Applications (1)

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DESIGN OF A MECHANICAL CHAMBER FOR BIOLOGICAL PAYLOAD IN A 3U NANOSATELLITE

Abstract

The University of Manitoba Space Applications and Technology Society (UMSATS) is currently developing a scientific payload to test the vitality of Enhanced Green Fluorescent Protein (EGFP) modified tardigrades following exposure to the conditions of space, providing further data for the theory of panspermia. This experiment is to take place on a 3U nanosatellite and entails subjecting two samples of tardigrades, in a cryptobiotic (anhydrobiotic) state, to the conditions found in low earth orbit for two weeks and one year respectively. After their exposure to vacuum, the tardigrade chamber is filled with liquid water, which is expected to revive the tardigrades from their cryptobiotic state. Afterward, the tardigrades are monitored determine the survival rate and behavioral characteristics. To support this experiment purpose-built aluminum enclosures were designed. These two identical apparatuses have been created for each population which contains the tardigrade environment and water supply. Each apparatus is broken down into two chambers: the tardigrade chamber and water chamber. The tardigrade chamber contains the tardigrade population along with bdelloid rotifers as the tardigrade's food supply, lichen which provides additional oxygen for the system and a food source for the rotifers, and LEDs which allow the lichen to undergo photosynthesis and cause the tardigrades to fluoresce. The water chamber contains the water supply, which is to be used to flood the tardigrade chamber, and regulates the water pressure to ensure that the water does not become a vapour-liquid mixture. A vapour-liquid mixture is highly undesirable for this experiment as water vapour may obstruct the camera's view of the tardigrades. Pressure regulation is achieved through the use of a pressurized gas bladder which expands into the water chamber as water is transferred into the tardigrade chamber. This water transfer is achieved through

the use of two three-way two-position latching solenoid valves which link the tardigrade chamber, water chamber, and vacuum environment together. The temperature of both tardigrade and water chambers is monitored and controlled to maintain a temperature between 10 to 25 degrees Celsius. The tardigrades are monitored using a camera which, using a filter, detects the 507 nm light emitted by the tardigrades when exposed to the 470 nm LED light source. The images are processed onboard the satellite in real time to determine the survival rate and behavioral characteristics of the tardigrades through the observation of movement patterns. The apparatus has been subjected to vacuum and vibration testing to verify the design.