IAF HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Human Spaceflight Global Technical Session (9-GTS.2)

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PROJECT AURORA: ESTABLISHING A LONG-TERM HUMAN OUTPOST SUPPORTING PLANETARY EXPLORATION

Abstract

Venus, Earth's closest neighbor and sister planet, has long been a subject of interest for further exploration due to its comparative uniqueness with surface temperatures soaring beyond 450, backwards axial rotation, and toxic atmosphere. As a planet that has experienced a runaway greenhouse effect, understanding the underlying effects that caused this phenomenon is crucial to avoid future impacts on Earth, and explore the mitigations to reverse it. A closer study of Venus, enhanced by human presence, is a bold endeavor that has been considered in the past. Following the Apollo missions, NASA expressed interest in a Crewed Venus Flyby but ultimately canceled it following Phase 0 concept studies. The Project AURORA (Atmospheric Understanding and Research of Venus via Orbital Reconnaissance and Analysis) architecture proposes a Venusian orbital space station mission concept enabling the establishment of a human outpost capable of supporting international and multidisciplinary crewed missions of 6 to 8 members for over three decades. Furthermore, the space station shall act as a starting point for future missions, marking the start of multiple technology development efforts to establish a permanent human presence on the planet.

The station aims to be a hub for investigating the long-term effects of space environments on the human body and the unique properties of the Venusian atmosphere for potential habitability and climate change. This research may be supported by deploying aerial vehicles within atmospheric levels as technology demonstrators for other mission concepts. Ultimately, the mission shall evaluate the possibility

of establishing a habitable location in Venus' atmosphere by sending a small crewed mission within the atmosphere, returning them safely to the space station, and a secondary robotic mission to the surface.

A crewed Venusian mission requires addressing several safety risks and concerns, such as broad-spectrum thermal environments, solar radiation, atmospheric toxicity, communication accessibility, and adverse impacts of extended spaceflight activities on the crew during long-duration spaceflight activities. The mission will consider these issues with a combination of current and near-term viable technical readiness levels (TRL) through trades of different technologies and subsystem designs in structures, material selection, power generation, and environmental control and life support systems (ECLSS).

This work results from the efforts of the ACHIEVED Research Team members under the guidance of the Space Exploration Project Group (SEPG) of the Space Generation Advisory Council (SGAC), which enables students and young professionals from diverse backgrounds to work and collaborate on a space mission design project.