

## **Operational Philosophy Concerning Manned Spacecraft Cabin Leaks**

The last thirty years have seen the Space Shuttle as the prime United States spacecraft for manned spaceflight missions. Many lessons have been learned about spacecraft design and operation throughout these years. Over the next few decades, a large increase of manned spaceflight in the commercial sector is expected. This will result in the exposure of commercial crews and passengers to many of the same risks crews of the Space Shuttle have encountered. One of the more dire situations that can be encountered is the loss of pressure in the habitable volume of the spacecraft during on orbit operations. This is referred to as a “cabin leak.” This paper seeks to establish a general cabin leak response philosophy with the intent of educating future spacecraft designers and operators. After establishing a relative definition for a cabin leak, the paper covers general descriptions of detection equipment, detection methods, and general operational methods for management of a cabin leak. Subsequently, all these items are addressed from the perspective of the Space Shuttle Program, as this will be of the most value to future spacecraft due to similar operating profiles. Emphasis here is placed upon why and how these methods and philosophies have evolved to meet the Space Shuttle’s needs. This includes the core ideas of: considerations of maintaining higher cabin pressures vs. lower cabin pressures, the pros and cons of a system designed to ‘feed the leak’ with gas from pressurized tanks vs. using pressure suits to protect against lower cabin pressures, timeline and consumables constraints, re-entry considerations with leaks of unknown origin, and the impact the International Space Station (ISS) has had to the standard Space Shuttle cabin leak response philosophy. This last item in itself includes: procedural management differences, hardware considerations, additional capabilities due to the presence of the ISS and its resource, and ISS docking/undocking considerations with a cabin leak occurring. The paper also offers a look at how different equipment configurations on future spacecraft impact the previously defined cabin leak operational philosophy and includes additional operational methods and considerations that result due to various configurations. The intent is to showcase these various considerations and highlight the variability they allow. The paper concludes with a selection of the author’s personal observations from a spacecraft operator’s point of view and recommendations with the goal of improving the design and operations of future spacecraft.