# Impacts of an Ammonia Leak on the Cabin Atmosphere of the International Space Station

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## ABSTRACT

Toxic chemical release into the cabin atmosphere is one of the three major emergency scenarios identified on the International Space Station (ISS). The release of anhydrous ammonia, the coolant used in the U.S. On-orbit Segment (USOS) External Active Thermal Control Subsystem (EATCS), into the ISS cabin atmosphere is one of the most serious toxic chemical release cases identified on board ISS. The USOS Thermal Control System (TCS) includes an Internal Thermal Control Subsystem (ITCS) water loop and an EATCS ammonia loop that transfer heat at the interface heat exchanger (IFHX). Failure modes exist that could cause a breach within the IFHX. This breach would result in high pressure ammonia from the EATCS flowing into the lower pressure ITCS water loop. As the pressure builds in the ITCS loop, it is likely that the gas trap, which has the lowest maximum design pressure within the ITCS, would burst and cause ammonia to enter the ISS atmosphere. It is crucial to first characterize the release of ammonia into the ISS atmosphere in order to develop methods to properly mitigate the environmental risk. This paper will document the methods used to characterize an ammonia leak into the ISS cabin atmosphere. A mathematical model of the leak was first developed in order to define the flow of ammonia into the ISS cabin atmosphere based on a series of IFHX rupture cases. Computational Fluid Dynamics (CFD) methods were then used to model the dispersion of the ammonia throughout the ISS cabin and determine localized effects and ventilation effects on the dispersion of ammonia. Lastly, the capabilities of the current on-orbit systems to remove ammonia were reviewed and scrubbing rates of the ISS systems were defined based on the ammonia release models. With this full characterization of the release of ammonia from the USOS TCS, an appropriate mitigation strategy that includes crew and system emergency response procedures, personal protection equipment use, and atmosphere monitoring and scrubbing hardware can be established.