Title: Quantifying the Hazards of Onboard Hydrogen Relative to Aviation Kerosene

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Abstract Text:

In this presentation, we will analyze the prospect of hydrogen as an aviation fuel from the perspective of onboard ignition- and combustion-safety. Hydrogen is a zero-emission fuel that is receiving substantial investment. As a prospective replacement to jet fuel, hydrogen is a combination of benefits and detriments. Hydrogen boasts nearly three times the energy density as aviation kerosene by weight, but suffers from a significantly reduced volumetric energy density and is associated with aviation disasters—85 years later, many still connect hydrogen with the crash of the Hindenburg. Although the propensity for hydrogen to ignite has motivated many to conclude it is more dangerous than jet fuel, we will demonstrate that the entire picture is more nuanced with hydrogen being in fact safer than aviation kerosene in some aspects and more hazardous in others.

A major part of this analysis focuses on how current regulatory allowables—for example the ignitability of a kerosene-air environment such as described in FAA Advisory Circulatory 25.981—will change if the fuel under consideration is hydrogen. The analysis is bolstered by hydrogen-specific investigations to provide a framework to assess the hazard of hydrogen relative to aviation kerosene. Key metrics that are examined are flammability, ignitability, detectability, storability, flame heat flux, and detonability. Although the hazards of hydrogen should not be ignored, this analysis demonstrates that hydrogen is less hazardous than jet fuel in several key characteristics and the overall ignition-threat of hydrogen can be mitigated with appropriate design choices.

Multiple aerospace manufacturers are working towards hydrogen-powered flight demonstration vehicles with planned flights set to occur over the next decade. Hydrogen's unique properties imply that transitioning from a demonstration vehicle to a production vehicle will require a radically different ignition-safety strategy than is used in kerosene-based platforms in order to achieve equivalent performance and safety. In the next one to two decades, industry standards will be written that dictate the commercial use of hydrogen. The results of the safety analysis are used to propose best practices, and propose a fire and flammability mitigation strategy to accommodate hydrogen on commercial aircraft.