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Quality and safety, a challenge for traditional and new space (1)

Author: Mr. Barret Schlegelmilch
Massachusetts Institute of Technology (MIT), United States, schlegbw@mit.edu

A FRAMEWORK FOR SAFE SYSTEM DESIGN IN SPACE LAUNCH VEHICLES

Abstract

Developing, testing, and launching rockets is an inherently complex and high risk endeavor. Preceding the launch itself, one of the highest risk times in the operation of a rocket is the static fire testing, also called a hot fire. Hundreds of parameters need to be monitored in real time in order to ensure the system is operating nominally and equipment damage (and possible injury or death) will not occur. Depending on the point of the testing and the resultant speed at which events are occurring, different levels of automatic safing conditions and actions are required to protect the vehicle. Traditionally, the way these safing conditions are derived is through the evaluation of hazard reports, which are themselves based on a “reliability” model: hazards are seen to arise from the failure of individual components and are thus primarily mitigated through increasing component reliability or adding in redundancy. With the level of complexity and required safety of today’s launch systems, it would be beneficial to evaluate a new approach to identifying the underlying hazards in a system, including ones that arise from unsafe component interactions and not simply failures. A systems-based alternative to the reliability-based hazard analysis approach is the Systems-Theoretic Process Analysis (STPA).

The Boeing Company has been selected by NASA as the prime contractor for the Space Launch System (SLS) cryogenic stages. As such, they are working with NASA to develop a comprehensive hazard analysis for core stage test firing and eventual launch operations. A detailed comparison of the traditional reliability-based hazard analysis with an STPA approach aims to assess the viability of such an analysis for test firing of the SLS core stage and by extension future space launch vehicles.