Using the RCC 8-Step Process to Perform Quantitative Risk Assessments on Reusable Launch Vehicles

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Abstract

This paper describes the use of the RCC (Range Commanders Council) 8-Step Process to perform Quantitative Risk Assessments (QRA's) on a Reusable Launch Vehicle (RLV) test program. Existing tools capable of modeling the 8-Step Process are identified, and the reader is shown how their use speeds the analysis. This paper also shows how QRA information can assist mission planners in creating low risk trajectories.

A QRA for NASA's X-34 RLV is the example used in the paper to illustrate how a specific risk equation is derived from the basic risk equation, and how each part of the equation is subdivided into discrete parts for analysis.

Introduction

Since 1997 when the RCC first published the 8-Step Process as a consensus approach to assessing launch risk, the process has been used to assess many launch systems. Rockets, guided missiles and reentry vehicles alike can be assessed by this process.

To begin, the Basic Risk Equation is discussed along with how the 8-Step risk approach is used with existing models to assess RLV flights. Next this paper uses a real world example, the NASA X-34 system, whose development has been terminated, to illustrate the overall process. This QRA considered multiple RLV failure modes along nominal and abort trajectories. The example illustrates how modeling can assist program planners, aid trajectory analysis, and support the environmental and Range Safety processes.

Risk Analysis Approach

The RCC 8-Step approach provides a template for using the Basic Risk Equation to compute Expected Fatality.

Basic Risk Equation: The Basic Risk Equation is as follows:

$$E_F = P_E * P_{F|E} * E_{PH} \quad (1)$$

where:

E_F (Expected Fatality) is the expected risk of fatality due to the planned test flight.

P_E (Probability of Event) is the probability that an event will occur that has the potential to create a hazard.

$P_{F|E}$ (Probability of a Fatality given an Event) is the probability that a person will be killed given that the hazardous event occurs.

E_{PH} (Expected Population Hazarded) is the parameter that represents the number of people expected to be hazarded in a debris area or footprint. If there is no population in the footprint, the E_F for that footprint is zero.

8-Step Risk Approach: The 8-Step Process (figure 1) serves as a guide to develop inputs and scenarios needed to compute risks.

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