SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Launch services, Missions, Operations and Facilities (2)

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SPACE LAUNCH & RE-ENTRY RISK HAZARD ANALYSIS – A NEW CAPABILITY

Abstract

The Australian Department of Defence has introduced a new capability for RCC STD 321-07 compliant Risk Hazard Analysis (RHA) into service. This capability, called the Range Safety Template Toolkit (RSTT), is currently supporting the US/Australia HIFiRE hypersonics flight research program being conducted from Woomera, South Australia as well as a number of guided weapons testing programs.

Aerospace Concepts Pty Ltd, a leading contributor to the development of RSTT and the overall RHA capability, is able to conduct an RHA using RSTT as a service to commercial clients though a sole licence with the Australian Government.

RSTT potentially provides an RHA capability for all space launch and re-entry vehicles, both ballistic and controlled. It offers rapid (minutes to hours) generation of mission-specific templates which are valid for a launch or re-entry undertaken anywhere in a user-specified envelope. The templates can be combined with geospatial information, such as asset locations and population densities, to provide casualty and damage estimates for operational planning and safety analysis.

The templates are generated from a set of ground impact points generated specifically for the mission. Creation of the ground impact point database for a space launch is a once-off, computationally-intensive activity that simulates all (reasonably) possible failures and trajectories using a Six-Degree-of-Freedom (6DOF) model of the vehicle system which includes models of Failure Response Modes (FRMs).

Calculating this database typically takes calendar weeks on a 'farm' of more than 100 high-end computers. The impact database is then used to generate mission-specific templates in a few hours on a standard PC. Templates can also be produced directly from the 6DOF simulation when the range of launch parameters is limited or the configuration of the vehicle is a one-off, such as an experimental launch.

RSTT is able to support experimental vehicle design by including vehicle parameter tolerances as part of the launch envelope thus eliminating the need to 'lock down' design before producing an RHA. For example, a launch service provider may nominate a tolerance on the launch azimuth, thrust profile and vehicle mass. RSTT uses Monte Carlo techniques to vary these parameters to produce a set of safety templates valid for all vehicles and scenarios within that tolerance.

Launch coordinators can use RSTT to quantify the risk to specific assets within potential impact area of a launch which may aid negotiations with asset owners. For example, the HIFiRE team are using outputs from RSTT to better communicate the level of risk to culturally sacred sites of Indigenous Australian land owners from the Woomera region.

The RSTT has been developed within the Australian Defence Science and Technology Organisation's mature, flexible and standards-based modelling and simulation environment from standard component models. Consequently, new vehicles can be quickly added to the system (assuming sufficient vehicle technical data is available) and the resulting 6DOF model used for many other purposes besides generation of range safety templates. For example, we expect that RSTT will play some role in the technical and mission design of several HIFiRE research launches which include sustained horizontal flight of scramjet-powered aircraft.

Future uses of the RSTT could potentially include reducing the time and volume of airspace needed to be restricted for launch operations thus facilitating more dynamic management of airspace to reduce air traffic congestion.