AST Mission

AST's mission is to ensure protection of the public, property, and the national security and foreign policy interests of the United States during a commercial launch or re-entry activity and to encourage, facilitate, and promote U.S. commercial space transportation.

Introduction

The Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (AST) has formulated and instituted a research and development (R&D) activity to support its mission and the FAA's strategic goal of safety. AST has determined that safety-related research is essential in developing the knowledge necessary to maintain and improve FAA/AST policy and guidance material used to verify that products and procedures adequately comply with FAA/AST safety standards. The purpose of AST safety research, with few exceptions, is not to develop the actual aerospace products, but to support the development of the standards and guidance material needed to meet AST goals and objectives.

AST has developed and implemented an AST Research and Development Plan that provides a process for effectively applying resources for research based on AST's clearly identified safety priorities each fiscal year. The Plan was used to solicit candidate research projects from internal sources, such as AST aerospace engineers and projects, and from external sources, such as the Commercial Space Transportation Advisory Committee (COMSTAC) Reusable Launch Vehicle (RLV) Working Group. These candidate research projects were then evaluated by the AST R&D Advisory Board for their relevance to AST's mission, their relative importance, and their cost. The Advisory Board then ranked the candidate research projects to arrive at a prioritized list to present to the AST R&D Senior Steering Committee for its review and evaluation.

The Senior Steering Committee selected the research projects to undertake in FY 2003 that had the greatest potential to fulfill AST's mission and to meet the AST budgeted requirements for R&D. Four research projects were selected and assigned to an AST Division. The R&D Advisory Board and Senior Steering Committee held periodic reviews throughout the year. This document provides a brief description of each project to assess the progress being made and summarizes accomplishments to date.

Non-Traditional Flight Safety Systems and Integrated Vehicle Health Management

AST, with the help of its contractor ITT Industries, completed a report on non-traditional flight safety systems and integrated vehicle health management (IVHM) systems. Flight safety systems minimize the threat to public safety and property posed by a malfunctioning launch vehicle. Non-traditional versions of these systems include fully autonomous systems and semi-autonomous systems that interface with pilots and/or ground controllers. IVHM systems detect, report, and isolate malfunctioning units and sub-systems of a vehicle to ensure safety and mission success. The utility of both of these types of safety systems may be crucial to the development of a reusable launch vehicle capable of maintaining a consistent level of safety at a variety of ranges and spaceports.

Based on a proposal for research made by the COMSTAC RLV Working Group, this report describes proposed and existing designs for these systems based on a survey of the commercial launch industry and government research efforts. It further suggests and describes enabling technologies and verification methods that will assist in their future regulation.

Flight safety systems employed on existing and proposed expendable and reusable launch vehicles, remotely piloted vehicles, and unmanned aerial vehicles are examined and classified according to the following methodologies: range-containment, vehicle destruct, flight safing, thrust termination, and vehicle recovery. Technologies such as GPS-based metric tracking and vehicle command and control systems that will enable the verification of these systems as well as their application are discussed. Further, the report proposes a generalized, multi-step verification methodology that, due to its applicability to many of the technologies described, should be capable

of serving as a draft verification plan for future non-traditional flight safety systems (FSS).

A survey of the industry indicates that IVHM technology has not yet evolved to a corresponding point as the flight safety systems. Several government and commercial experiments and applications of IVHM technology that showed promise at the time this research was proposed have suffered due to changes in funding and priority. However, due to its generalized nature, the multi-step verification methodology proposed should be useful to serve as a basis for a verification plan when these IVHM technologies advance to a more mature state.

Supports FAA Strategic Goal: SAFETY
Human Space Flight Safety

AST established a cooperative research effort with FAA's Civil Aerospace Medical Institute (CAMI) to work on the Human Space Flight Safety Research and Development project. The purpose of the project was to develop (1) medical criteria necessary for human survival during commercial space transportation operations and (2) minimum requirements for Environmental Control and Life Support Systems (ECLSS) on commercial space transportation vehicles with humans on board.

The CAMI proposed use of a senior researcher through CAMI's National Research Council (NRC) program to work on the AST research project. The NRC of the National Academy of Sciences approved CAMI to establish a post-doctoral research associate program in support of FAA research activities. In early August 2003, the NRC of the National Academy of Sciences reviewed and approved a research proposal on "Minimum Requirements for Environmental Control and Life Support System (ECLSS) on Manned Commercial RLVs." This research effort will continue in FY 2004 and will provide AST with information on the minimum safety requirements of RLV equipment to provide a proper environment that will ensure the survivability of humans on board RLVs, especially flight crew when they are part of the RLV flight safety system. AST views this research as a key component for ensuring an adequate level of protection of the uninvolved public during crewed commercial RLV activities.

Supports FAA Strategic Goal: SAFETY
Thermal Protection Systems Inspection

AST conducted a project to research existing and new inspection systems and techniques for inspecting components covered by Thermal Protection Systems (TPS). Thermal protection systems (TPS) are usually comprised of relatively light materials that are capable of withstanding high temperatures while providing effective thermal insulation to protect underlying structures. Bonding of TPS, typically with blankets of ceramic tiles, is very intricate and time consuming. Bonding of the TPS significantly limits the means by which one can inspect critical structural components underneath.

As initially proposed, the project was intended to produce a report examining existing systems for structural inspection in use on existing space launch vehicles and exploring new inspection systems and techniques. A white paper produced by The Aerospace Corporation identified three promising Non-Destructive Evaluation (NDE) techniques with the potential to provide adequate and accurate inspection of the structure beneath the TPS. They are: narrow-band eddy; capacitance; and ultrasonic inspection with electromagnetic acoustic transducers (EMATs).

Based on these findings, the project was redefined to conduct a review of NDE methods used to inspect existing aerospace structures that are covered by TPS. Most current techniques are typically geared toward inspecting the TPS; however, they could be potentially useful for inspection underneath structures. The goal is to identify basic issues concerning the inspection of components protected by TPS, and describe the inherent strengths and limitations of the various techniques as they relate to the projected needs of future RLV systems. The study also will outline the current state of developmental inspection methods that offer strong potential for future application to RLV inspection and that may be relevant to the future needs of RLV systems.

Supports FAA Strategic Goal: SAFETY
Reentry Vehicle Hazard Model Development and Calibration

AST conducted a research and development project to develop a draft document that can be used by FAA and industry to perform expected casualty (Ec) analysis for Reusable Launch Vehicles. AST is developing a tabular handbook that would allow its customers–launch and reentry vehicle developers–to perform a first-hand estimation of casualty expectation for the reentry phase of their mission. AST asked The Aerospace Corporation to focus on the aero-thermal demise of the reentry debris analysis process in developing this handbook.

It is AST's intent to provide this tabular handbook to applicants as an acceptable method of performing a first-hand conservative estimation of their expected casualty. The goal is to provide applicants with a less costly method of performing a debris survivability analysis during reentry. In cases where AST has determined that the above method is not sufficient, the applicant will be required to perform a more rigorous analysis –utilizing less conservative methods.

The Aerospace Corporation has presented to AST the initial documentation of the proposed methodology for calculating the casualty expectation for reentry over populated areas. The Aerospace Corp. also presented a sample of the tabular parameters (i.e. casualty area, expected casualty, probability of impact, etc.) of the lookup tables that are slated for the final handbook.

It is the initial conclusion of AST that this method would provide a significant benefit to industry and the FAA in performing a reentry debris analysis. However, it was also noted that many of the assumptions that are used in the model need to be developed further, and that continued refinement of the methodology is warranted. As a result, this research and development task will continue into FY 2004 with a specific focus on populating the handbook. This will also include refining the earlier assumptions to more accurately reflect the debris demise process.