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TECHNOLOGY CHALLENGES FOR A REUSABLE FIRST STAGE

Abstract

The Reusable Booster System (RBS) concept has been identified as a promising approach to significantly reduce the costs of space lift.

The research has been concentrated on serial burn vertical take-off / horizontal landing configurations. The arrangement of the reusable stage and the upper stage stack is a subject of current study. A piggy back configuration is expected because of a desire to keep the main engine of the reusable stage burning at staging. Open issues include how far forward the upper stage will be mounted.

Another research emphasis is on the rocket-back maneuver. In this maneuver, after staging the booster flips around and uses the main engine to cancel the down range velocity and provide sufficient velocity towards the launch site to allow a gliding re-entry and landing by the booster. There are a number of vehicle and trajectory parameters that will influence the rocket-back maneuver. These include the flight path angle at staging and the throttle range of the main engines. Management of the altitude and vertical velocity during the rocket-back maneuver may also be required.

Highly efficient and lightweight structures are desirable. The current research is focusing on composite main structures with integrated propellant tanks. Key features of the structural concept are the attachment of the wing box and upper stage to the tank stack.

The aerothermal loading of the vehicle is another structural driver. An advantage of the rocket-back maneuver is that re-entry heating is reduced. Speeds of Mach 6 or greater can be achieved on ascent, but materials for conventional warm structures can be used for the acreage of the vehicle.

In order to achieve the significant reduction in costs over current expendable launch vehicles, the RBS needs to be designed for highly efficient operations. This starts with the design of the RBS as an unmanned aircraft systems. A second area of emphasis is the selection of vehicle subsystems. Also, the design philosophy is expected to trade away some performance to be able to avoid the use of toxic propellants and hazardous operations.

Another area of research is ground operations. This topic includes both reducing the number of personnel needed for flight and ground operations. For instance, integration of the launch system horizontally is being considered. This concept may be selected if it reduces manpower needs even though it increased the weight of the RBS because of additional structural loads induced by the horizontal processing.