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RETALT: DEVELOPMENT OF KEY FLIGHT DYNAMICS AND GNC TECHNOLOGIES FOR REUSABLE LAUNCHERS

Abstract

The capability to partially recover and reuse a launch vehicle reusability is currently the most effective way of reducing the cost of access to space, which is a key endeavour to the commercialization of space. Despite this, it remains a great technical challenge, with only two US companies (SpaceX and Blue Origin) having developed the necessary technology to carry out routinely successful recovery missions, both using retro-propulsive vertical landing as the recovery strategy, and both reporting significant cost savings due to the reusability effort. In this context, the RETALT (Retro Propulsion Assisted Landing Technologies) project, funded by the EC Horizon 2020 programme under grant agreement No 821890, had the goal of investigating and maturing key technologies to enable reusability in Europe. One of the great technical challenges in this endeavour lies in the capability to define a feasible mission to safely and robustly return the launcher, and to develop a recovery Guidance, Navigation and Control (GNC) system to perform a precision landing in a fast-dynamic environment, with extremely limited fuel margins, and with significant unknown dispersions accumulated during prior phases. In particular, the project aims to increase the Technology Readiness Level (TRL) of the GNC technologies needed for recovery up to 3. The baseline configuration and the main focus of the project and this paper is RETALT1. The vehicle operates similarly to a typical launcher until separation, after which two scenarios for the first stage recovery are considered: Downrange Landing (DRL) and Return to Launch Site (RTLS). The latter differs in the use of a post-separation flip manoeuvre and boostback burn that modifies the ballistic arc to allow a landing

at or near the launch site, while the former foresees a landing at sea on a floating barge. Both scenarios employ a re-entry burn, in order to reduce velocity and dispersions, and an active aerodynamic descent phase enabled by the use of control surfaces. Finally, the first stage recovery mission ends with an engine-powered descent, which slows the vehicle down to a pinpoint and soft vertical landing. The focus of this paper will be the methodology implemented to assess the feasibility of the recovery mission and identify the mission design envelope for the wide range of launch missions that the system could target, as well as the design, development and test of the GNC solution, that was demonstrated capable of guaranteeing the necessary performance to recover the system.