Paper ID: 16716
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SYMPOSIUM ON COMMERCIAL SPACEFLIGHT SAFETY ISSUES (D6)
Commercial Space Flight Safety and Emerging Issues (1)

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AEROTHERMODYNAMIC AND SYSTEM ANALYSIS OF A SMALL HYPERSONIC AIRPLANE (HYPLANE)

Abstract

Several examples of vehicles flying at supersonic and hypersonic velocities have been studied and developed, with the attention focused on airplanes-like vehicles for passenger transportation at high altitudes and/or for space tourism perspectives. The emerging sub-orbital tourism market has also been seen by many as an intermediate step toward hypersonic point-to-point transportation. Most of the present studies related to commercial hypersonic flight are oriented toward the development of large airplanes able to transport several passengers across intercontinental distances. Conversely, in this work a preliminary study on a 4-6 seat hypersonic airplane for a long duration space tourism mission is presented. It is also consistent with a point-to-point hypersonic trip of about 6000 km, in the frame of the "urgent business travel" market segment. Main idea is to transfer a large part of technological solutions developed for atmospheric re-entry purposes and previous experiences on supersonic fighters to a small hypersonic airplane designed for high-speed space tourism and for point-to-point transportation in the stratosphere. In particular, a winged vehicle characterized by low wing loading, high aerodynamic efficiency and able to manoeuvre along the flight path is considered. An air-launch from a mother airplane (such as White Knight Two of Virgin Galactic) is foreseen at about 10 km altitude, while a trade-off study between Rocket-Based Combined Cycle and Turbine-Based Combined Cycle engines (RBCC Vs TBCC) is performed to ensure higher performances in terms of flight duration and range. Different flight-paths are also investigated. Among them steady state hypersonic cruise and periodic skip trajectories are analyzed in detail. The latter, in particular, take advance of the high aerodynamic efficiency during the unpowered phase, in combination with a periodic engine actuation, to guarantee a long duration oscillating flight path. In addition, skip trajectories offer Space tourists the opportunity to realize extended missions, characterized by repeated periods of low-gravity at altitudes high enough to ensure a wide view of the Earth from Space. After the assessment of a preliminary configuration, aerodynamic performances, static and dynamic stability, for the different flight regimes encountered during the mission, are investigated by means of Computational Fluid Dynamics and engineering tools. Thermal effects are also analyzed and proper hot structures and materials identified to sustain the hypersonic flight conditions, characterized by Mach numbers up to 6 in the range of altitude between 20 and 70 km.