PRELIMINARY SAFETY ASSESSMENT FOR A VTOL HYPERSONIC TRANSPORTATION SYSTEM AIMED AT PERFORMING PARABOLIC FLIGHTS.

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This paper addresses safety issues related to the design, development and utilisation of a hypersonic transportation system.
From the point of view of laws and legal aspects, hypersonic transatmospheric aircraft should be analysed by both the point of view of the outer space laws and aeronautical norms. In addition, considering that we are dealing with a transportation system able to guarantee very fast connections exploiting disrupting technologies, the general public can consider it a promising and fascinating opportunity and in order to conquer a relevant interest in the market, a wide public consensus should be obtained. In this context, the only way to reach it is to demonstrate the level of safety of this system is as high as existing transportation means. Thus, aspects related to safety and risk management should be properly addressed.
First of all it is necessary to understand the different perspectives from which the problem of safety could be addressed: safety with respect to Human Beings (Crew, passengers, on-ground operators and general public, especially ones living in overflown areas), environment (Spaceport areas, overflow areas and airspace) and products (Transportation system itself and infrastructures).
In particular, this paper aims at proposing a methodology for a preliminary safety assessment mixing up NASA and FAA recommendations. This methodology has been thought to be exploitable at high design levels, where the level of uncertainties is very high and several alternatives do exist.
In particular, at first, the methodology will be applied at System of Systems level and than it will be used to define the peculiar propulsion system of a hypersonic aircraft aimed at performing parabolic flights and able to accommodate 4 passengers and performing Vertical Take Off and Landing. Considering enhancing safety levels of crew and passengers at system of system level a detachable crew compartment has been envisaged, guaranteeing the possibility of having an escape system.
Then, as far as systems level is concerned, the need for achieving a vertical take off and landing in addition to an already complex mission imposes to develop special propulsion system architecture. In particular, the reference aircraft is equipped with two airbreathing engines to be exploited during take off, atmospheric climb, descent and landing phases and a rocket motor able to guarantee the required thrust in out-of atmosphere environment. Moreover, ad-hoc strategies like steerable nozzles or throttle adjustments have been envisaged leading to a baseline configuration.
The evaluated methodology is well integrated within the system engineering methodology proposed and used by the authors to design and size a hypersonic spaceplane.
First of all, safety objectives have been identified considering previous space and aeronautics enterprises. In particular, space shuttle data have been taken as reference. Then, starting from the functional analysis, a Functional Hazard Analysis have been carried out leading to the identification of possible mishaps and related consequences. Then, considering the level of complexity of this propulsion system and of the mission itself, concept of operation analysis have lead to the identification of logical block schemes for each mission phases, or better, for each identified operative modes of the system. From each scheme, it has been possible to build a Fault Tree, deriving the solving equation allowing estimating the failure rate at system level, hypothesizing the λ_s at lower levels. In the end, Failure Mode and Effect Analysis have been completed.
Results of this safety assessment are clearly reported in the paper, showing the level of complexity of this kind of analysis and of this kind of solution.