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MISSION DESIGN AND SIMULATIONS FOR HUMAN SPACEFLIGHT ABORT SYSTEM QUALIFICATION

Abstract

Human spaceflight missions involve designing launch vehicles for taking humans in space and bringing them back safely to a predetermined location on the earth. In order to ensure crew safety in the event of unexpected vehicle failure during these missions, abort strategies have to be planned from any given point in the ascent trajectory of the launch vehicle. In case of mission abort during atmospheric phase of flight, separate rocket system(Crew Abort System(CAS)) with sufficiently higher acceleration levels is designed to take away the crew module from failing vehicle. After CAS separation, during terminal flight phase, crew module parachutes are essential to bring the velocity to safe limits at touchdown. To qualify the abort system, several tests are to be carried out to assess the performance of the system at critical phases of ascent flight such as, pad abort, transonic phase, maximum dynamic pressure as well as at specific Mach numbers w.r.t. aerodynamic stability. For safe deployment of parachutes in nominal as well as abort mission, appropriate flight conditions are to be ensured before initiating the deceleration system. For higher altitude aborts in atmospheric phase, where dynamic pressure is low, Reaction Control thrusters (RCS) are effective and will be used to control/orient crew module to meet safe deployment conditions. However, for lower altitude aborts, large aerodynamic forces render RCS ineffective and hence, appropriate mission planning is critical. Similarly, various nominal and failure chains of parachutes also need to be qualified. To characterize various flight parameters of launch vehicle, abort system, crew module and parachute systems, mission design; planning and exhaustive 6 degree-of-freedom simulations required for flight are covered in this paper. Criticalities involved for these test missions will be discussed with the perspective of Indian human space missions planned ahead.