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OPTIMIZATION OF FLIGHT SAFETY SYSTEM ALGORITHM CONSIDERING REDUCTION OF PROBABILITY OF FALSE FLIGHT TERMINATION COMMAND INITIATION AND FULFILLMENT OF SAFETY REQUIREMENTS

Abstract

Modern launch vehicles (LV) are required to ensure a proper level of safety for the population and ground objects along the flight track. This requirement is fulfilled with the help of the flight safety system (FSS) that terminates flight of a LV in case in-flight emergency is detected. There are different FSS architectures such as autonomous onboard systems or systems that receive the command for flight termination from a safety officer (human-in-the-loop system). However there's always a risk of erratic initiation of a flight termination command regardless of the architecture of the flight safety system. There have been several cases when FSS terminated nominal vehicle's flight that suffered from a short-duration, self-restoring failure. Although the probability of such an event is extremely low, the algorithm of FSS should be designed with the intent to minimize the probability of erroneous flight termination decision. In order to reduce the probability of erroneous LV flight termination it is proposed to introduce a delay between the indication of a termination condition and termination command issuance. In the event of failure criterion detection, the delay would allow the flight termination to be delayed and provide an opportunity to double-check the LV flight parameters and determine if the failure criterion was formed due to an actual failure or if it was erroneously formed because of a short-duration, self- restoring failure. The duration of the delay time is a separate optimization problem. On the one hand reduced delay between the indication of a termination condition and the termination command issuance results in a reduced impact area by the failed LV, thereby reducing risks for population and ground objects along the flight track. On the other hand, increase in the delay decreases the probability of making an erroneous decision on the status of the LV failure and thus allows for an increased probability of launch mission success. This work defines the optimization problem of the delay duration decision. Optimization is carried out based on the criterion of acceptable risk for population and ground objects along the flight track as well as the criterion of confidence in emergency situation being detected. The solution method is based on establishing a relationship between the risk for population and ground objects along the flight track, and flight termination duration. The proposed approach is supported by calculations for a medium class liquid propellant LV.