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COLLISION RISK STUDIES WITH 6DOF FLIGHT SIMULATIONS WHEN AERODROME OBSTACLE STANDARDS CANNOT BE MET

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Abstract

This paper presents an effective methodology to assess the safety of aircraft operations when aerodrome obstacle standards cannot be met. The research addresses the cases of potential airplane impact with on-ground obstacles after an engine failure. The discussion focuses on how statistical studies can be supported by deterministic analyses of flight trajectories generated with 6 degree-of-freedom (6DoF) flight simulations. The proposed approach is illustrated by introducing a practical example coming from the authors' professional experience; in the selected scenario a hypothetical wind farm has to be located in proximity of an aerodrome but some of the wind turbines intrude the conventional airspace required by ICAO to ensure safe and regular aircraft operations. The paper presents the relevant safety requirements applicable around airports and introduces a preliminary evaluation technique of the theoretical collision risk (CR) based on the open source flight dynamics model (FDM) software JSBSim. Finally, a Monte Carlo analysis is presented as an additional step to refine the CR assessment.

1 Introduction

The safety of aircraft operations in presence of aerodrome obstacle is ensured by strict requirements on the obstacle relative positioning with respect to conventional volumes or airspaces. Erecting tall wind turbines (90 meter or more above ground level) near airports presents special challenges to wind energy programs when it comes to the choice of a specific site, and is considered a growing problem by airport authorities. At the same time, grounds around airports are often targeted by companies developing wind turbine parks as a preferable option for their plans. Usually these areas are relatively unpopulated, due to noise hindrance constraints, and most of the times do not present large obstacles that could cause wind blockage for the wind turbines. However, the construction of wind farms may intrude the airspace that is required to ensure safe and regular aircraft operations at the airport.

The present paper, which evolves from the work of De Marco *et al.* [1], goes into some details concerning the safety requirements that apply around airports and how a theoretical collision risk (CR) can be evaluated using Monte Carlo flight simulations.

It is well known in aeronautics that rules are defined by authorities on the basis of some historical evidence. Usually a specific airworthiness problem such as the airborne collision with an on-ground obstacle is correlated to a number of accidents occurred in the past. The historical series were used by the authorities to define the clearance rules and a set of virtual volumes surrounding airfields. When an obstacle is designed and positioned in such a way that it intrudes, even slightly, one of the prescribed volumes, the builder is required to provide an "aeronautical study". The study has to demonstrate that the obstacle does not modify the established