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Reducing mid-air collision risk in controlled airspace: Lessons from hazardous incidents

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Abstract

The collection and analysis data on hazardous air traffic management (ATM) incidents is an important task. Expert judgement about such incidents needs to be carried out within a systematic and consistent safety framework. The mark of the genuine safety expert is to be able to ask the right questions concerning potential accidents.

Hazards and risks are not 'facts' or 'events' that 'exist', but rather judgements made about conditional futures and their consequences. A hazardous situation is one in which the outcome was not 'system controlled', with some potential outcomes having significant negative consequences. System controls in this sense cover all the means by which the system is held stable (= defended) against the potential negative consequences.

The ATM system can be (over-) simplified to consist of three structural system layers acting as the system controls: Planning (pre-operational), Operation (the flight in progress), and Alert (the ground and air protection enabled by conflict alert systems, on which the controller/pilot will act). A hazardous event is one in which a high degree of conflict between aircraft is observed plus a low confidence that the remaining system layers would generally provide the necessary corrective action.

Keywords: Collision risk; Air traffic control; Incidents

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1. Introduction

Aviation's safety track record demonstrates that it is an industry whose people are focused on continuous improvement. The prime safety goal of the air traffic management (ATM) of en route commercial flights is to reduce the risk of mid-air collisions. Safety has improved to such an extent that collisions are now rare, so collecting data on hazardous ATM Incidents has therefore always been seen as an important task. This incident data, collected consistently, can be viewed as a key indicator of the 'health' of the ATM system. Incidents can provide insights into the frequency of known error and failure types, and also enable new types to be detected. Analyses of the processes and characteristics of incidents provide insights into potential system design weaknesses. Moreover, planned changes to the system to improve safety can be tested against such incidents to demonstrate that risk is being reduced. [NB: 'risk' is often used in safety analyses as a combination of frequency of occurrence and its severity: in the following, the accidents always have the same severity—an accident with many fatalities.]

A large variety of crucial—and intrinsically difficult—safety questions can be asked about ATM incidents:

> Which incidents should be judged the most important to ATM system safety?
> Which incidents give most guidance about potential accidents?
> In what ways should incidents be categorised and analysed to help pinpoint key safety issues?
> Are 'minor' incidents of any safety importance?
> How should the relevant importance of different incidents be assessed or weighted to provide a true picture of the health of the ATM safety system?

This paper attempts to make a start—no more than that—in answering these kinds of questions. Interpretation of incident data needs a systematic and consistent safety framework. Without such a framework, it is difficult to gain the desired insights into system design weaknesses that have the potential for accidents. There is little point in collecting and categorising a great deal of data, unless it is analysed in a way that systematically reveals the safety lessons that help to reduce the likelihood of potential future accidents.

The aim here is to try to ensure that expert judgement about ATM incidents can be carried out within a systematic and consistent safety framework, rather than producing formulaic prescriptions. The focus is *how* the *system* can be improved rather than the whys of causes. System jargon is avoided: the approach is mainly through an 'ordinary language' analysis of safety terms and logic, plus some metaphors to describe the key features of a safe ATM system.

The following text consists of six sections:

2. The nature of hazardous ATM events
3. ATM system layers and risk probabilities
4. Airproxes, hazards and system layers
5. Discussion
6. Conclusions