

ELEVENTH AIR NAVIGATION CONFERENCE

Montreal, 22 September to 3 October 2003

**Agenda Item 2: Safety and security in air traffic management
(ATM)**

**2.5 Safety and security of the ATM infrastructure
:**

THE FRENCH ATC TERRAIN WARNING SYSTEM

(Presented by France)

SUMMARY

Since commercial aviation came of age in the 1950s, controlled flight into terrain (CFIT) collisions have accounted for the majority of aircraft accidents and have been the main cause of death in the public transport of passengers.

This problem, which is crucial to air traffic safety, has been studied by the whole of the professional aeronautical community, and a certain number of States have committed to developing ground systems to prevent this type of accident.

France has implemented an ATC system that warns the air traffic controller if an aircraft comes dangerously close to the terrain.

The purpose of this paper is to present this system.

Action by the conference is in paragraph 6.

1. INTRODUCTION

1.1 Since commercial aviation came of age in the 1950s, controlled flight into terrain (CFIT) collisions have accounted for the majority of aircraft accidents and have been the main cause of death in the public transport of passengers. This type of accident is all the more dramatic because technical investigations show that prior to impact, aeroplanes are airworthy and the airborne systems are functioning nominally, but the crews are unaware that an accident is imminent.

1.2 This problem, which is crucial to air traffic safety, has been studied by the whole of the professional aeronautical community, and a certain number of States have committed to developing ground systems to prevent this type of accident.

2. THE FRENCH ATC TERRAIN WARNING SYSTEM

2.1 In 1988, France initiated studies on the implementation of a terrain proximity warning system of the MSAW (minimum safe altitude warning) type. This system, which has been installed at approach control centres, entered into operational service in 1997.

2.2 Operating principle

2.2.1 The principle of the system is to activate an alarm when it predicts that an aircraft will violate a safety margin in relation to the terrain. The terrain is modelled in a database, with artificial obstacles also being taken into consideration.

2.2.2 The system uses kinematic data from radar tracking. From the aircraft's position and its horizontal and vertical speeds, the aircraft's flight path is extrapolated and the system can anticipate a potential conflict with the terrain. If along the predicted flight path, the height of the aircraft above the terrain becomes less than a safety margin, an alarm is activated (see Figure 1).

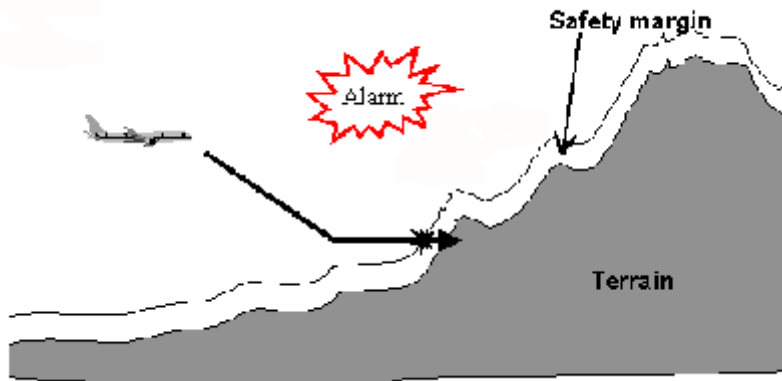


Figure 1. Flight path prediction

2.2.3 In this way, it is verified that the aircraft does not come dangerously close to the terrain. The alarm can therefore be activated while the aircraft is still at a high altitude if it has a very rapid rate of descent.

2.2.4 In addition, the French terrain proximity warning system provides special monitoring of aircraft during their final approach until landing, and warns the controller in the event of a dangerous approach. Specific areas are defined around aerodromes. These make it possible to monitor the aircraft's movements and to check that they do not violate a modelled glide path representing a safe approach. If the aircraft lands safely, the terrain proximity alarm is inhibited (see Figure 2).

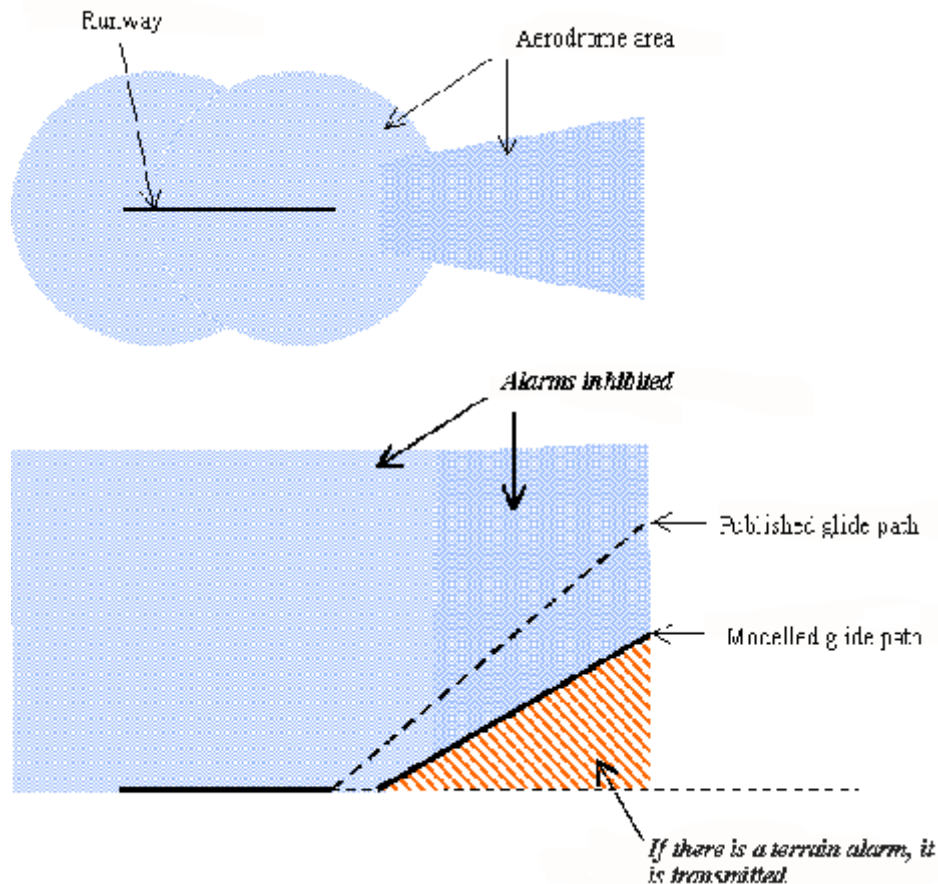


Figure 2. Aerodrome areas in schematic form

2.2.5 When an alarm is activated, it immediately shows up on the controller's radar display. The runway in question moves to red and the aircraft's call sign is displayed, followed by its bearing and distance. At the same time, the message "Terrain Alarm" is broadcast on a loudspeaker in the control room. The controller covering the aeroplane's frequency is responsible as soon as possible for retransmitting the alarm to the pilot of the aircraft concerned.

3. COMPLEMENTARITY OF ATC SYSTEMS AND AIRBORNE TERRAIN WARNING SYSTEMS

3.1 Ground-based systems designed to prevent CFIT were not the first technical solutions proposed in response to the growing number of accidents. The aeronautical industry also offers a range of products known as TAWS, for terrain awareness and warning system, the oldest of which date back to the 1970s. This equipment, better known as GPWS (ground proximity warning system) or EGPWS (enhanced ground proximity warning system), is installed on board aeroplanes. Like the ATC terrain warning systems, they activate an alarm when the aeroplane comes too close to the ground, but the alarm sounds in the cockpit instead.

3.2 ATC terrain warning systems and TAWS, far from being redundant, have proved to be highly complementary. This complementarity is first of all a result of total independence in their processing systems. This independence guarantees that there is no common failure mode, i.e. that if any event causes a failure in one of the systems, there is no risk that it will disrupt the functioning of the other. A brief description of the data entering the system illustrates this concept. In fact, the TAWS systems require that the radio altimeter and airborne instruments (GPS, FMS, IRS or ADC) operate properly, providing the aircraft's kinematic data, while effective monitoring by an ATC terrain warning system requires that the aircraft's transponder respond in the A+C mode and that there must be no anomalies in the radar processing and display system, and presupposes that there is no radio failure.

3.3 International regulations impose the carriage of GPWS systems for only one category of aircraft. Some are thus not equipped with an airborne ground collision avoidance system. Furthermore, only controlled aircraft benefit from the ATC terrain warning system service. The risk that an aircraft will not benefit from any terrain warning system is therefore less.

3.4 Lastly, it was explained above that the algorithms of the system developed by France include inhibitions so that an aircraft that follows a nominal flight path on final approach will not activate an alarm that warns of coming dangerously close to the ground. There are similar mechanisms on the TAWS systems, but they are not based on the same criteria. Consequently, the probability that an alarm will be erroneously inhibited by both systems is low.

4. RECORD OF OPERATION OF THE FRENCH TERRAIN WARNING SYSTEM

4.1 A study carried out on a broad sample between 1988 and 1994 by the Flight Safety Foundation showed that several CFIT events had taken place despite the presence on board the aircraft of GPWS.

4.2 In 2001, France too undertook a study, comparing the performance of a TAWS system, the GCAS (ground collision avoidance system) developed by Thales Avionics with the performance of the operational ATC terrain warning system.

4.3 Simulations and reconstruction of confirmed CFIT and near-CFIT flight paths and of flight tests were processed by both systems. It was proved that the two systems are complementary: in the vast majority of the scenarios studied, depending on the aircraft's position and type of flight path, the ATC terrain warning system compensated for failures by the GCAS, and vice-versa.

4.4 Seven of the largest French airports are equipped with the terrain proximity warning system. The deployment plan calls for the installation of three new sites per year, and all major French approaches should be equipped within two years.

4.5 France thus has much experience in the operational use of a ground-based terrain warning system that helps avoid aircraft collisions with the ground. In several cases, the usefulness of this system has been demonstrated, and the system has made it possible to avoid serious incidents or even accidents, in particular on final approach. Statistically, it is in this flight phase that the largest number of CFIT events and near-CFIT events take place.

5. **CONCLUSION**

5.1 The ATC terrain warning system developed by France that is now in operational service at most major French aerodromes has demonstrated its effectiveness and complementarity with the airborne terrain warning systems.

5.2 It can thus be said that the system makes a significant contribution to improving air transport safety.

5.3 At present, only ATC terrain warning systems based on safe altitudes are taken into consideration in the PANS-ATM. To ensure proper understanding between pilots and controllers, and in order to improve safety, it is important that systems such as the one developed by France should also be taken into consideration by ICAO. For that, such systems must be defined and be the subject of appropriate procedures and phraseology in the PANS-ATM.

6. **ACTION BY THE CONFERENCE**

6.1 The conference is invited to:

- a) take into consideration the contribution to aviation safety of ATC terrain warning systems of the type developed by France, and their complementarity with the airborne systems;
- b) recognize the need to introduce procedures for these systems in Chapter 15 of the PANS-ATM, along with appropriate phraseologies for pilot-controller dialogue. The procedures and phraseology should highlight the differences between systems based on a modelled surface (such as the French system) and those based on a safe altitude (MSAW).

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