International Civil Aviation Organization

ICAO

Fifth Meeting of the Surveillance Implementation Coordination Group (SURICG/5)

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Agenda Item 5: Update on surveillance activities and explore potential cooperation opportunities

DISCUSSION ON TECHNICAL METHODS TO PREVENT RUNWAY INCURSION WITH OPERATION VERIFICATION

(Presented by China)

SUMMARY

This paper first briefly introduces the two types of technology means and methods to prevent runway incursion being researched and applied in China, then introduces the test and verification of the runway incursion prevention system at Shanghai Hongqiao Airport.

1. Introduction

1.1 The Doc.10004"Global Aviation Safety Plan" suggests runway incursion, loss of control in-flight and mid-air collision as the high-risk incident categories, and recommends that states, regions and industries should use Operational Safety Risks (ops) roadmap to assist them in developing a plan to mitigate the risks related to these event categories.

1.2 the main technical means of preventing runway incursion include improving the situation awareness ability of all parties, using Advanced-Surface Movement Guidance and Control Systems (A-SMGCS), stop bars, and runway incursion warning systems (ARIWS)and so on. At present, China is continuously developing the research and application of runway incursion prevention technology from various aspects.

2. Description of the main technical means of preventing runway incursion

2.1 At present, the technical means of preventing runway incursion in China are mainly to prevent the wrong behaviour that may cause runway incursion, or to provide warnings and reminders before or during runway incursions. It can be divided into two categories.

1) One type is for controllers, to enhance their ability to perceive the surface operation situation, detect conflicts in advance, send out warnings and prevent them from sending out wrong commands, through the system such as A-SMGCS, Tower Electronic Flight Strip System, Integrated Tower Automation System and so on.

2) The other is for pilots and vehicle drivers, to provide them with the same situation information as the controllers, and show them the clear runway safety tips, through

the system such as the stop bar, runway state light system, airborne / vehicle mobile terminal system and so on.

2.2 Technical means for controllers

2.2.1 Surface surveillance system

At present, according to the scale and operating environment of the airport, we choose to use SMR, MLAT, ADS-B, video surveillance system for fusion application, so as to realized seamless surveillance coverage of the airport scene (see Table 1 for technical comparison).

1Table 1: Comparison of several surveillance techniques

	Surveillance radar	Video surveillance	ADS-B	MLAT
Target Type	Aircraft, vehicles, etc	Aircraft, vehicles, persons	Aircraft or vehicles equipped with transponder	Aircraft or vehicles equipped with transponder
Detection mode	Non-cooperative	Non-cooperative	Collaboration	Collaboration
Positioning accuracy	7.5 m	-	20 m	7.5 m
Update rate	1Hz	20 frames/sec	1Hz	1Hz or higher
Advantages	No target response; mature technology	No response; more information; low cost	Identifiable; low cost; easy deployment	Identifiable ; High reliability; positioning accuracy; easy deployment
Insufficient	Unable to identify; More false targets; high cost	Weather impact; Small scale	Inconsistent positioning accuracy ; be deceived	More sites; complex systems
Technical positioning	Basic data source, guaranteed target full coverage	important regional surveillance	Supplementary	Supplementary

2.2.2 Advanced-Surface Movement Guidance and Control Systems (A-SMGCS)

A-SMGCS is the main surface surveillance and operation management technology used by large and medium-sized airport. A-SMGCS mainly relies on all kinds of surveillance function mentioned above to obtain surface traffic information. Through the complementary means of various surveillance sources, the full coverage of the surface target is basically realized.

According to ASBU requirement mentioned in Doc.9750“Global Air Navigation Plan”， it includes that the A-SMGCS must have level1 and level 2 functional modules and level 3 and level 4 functional modules will be introduced in 2025.

In China, the Beijing Daxing International Airport achieved to Level IV standard. The alarm functions include runway conflicts alarm, wake turbulence interval alarm, taxiway conflicts and so on, which can improve the situational awareness of controllers and prevent runway incursion.

2.2.3 Tower Electronic Flight Strips System

"European Action Plan for the Prevention of Runway Incursions" (EAPPRI)has mentioned that the instructions given by a controller are available electronically and can be integrated with other data such as flight plan, surveillance, and routing rules.

This technology can detect some potential conflicts much sooner than the current reliance on surveillance data to trigger alerts.

ATMB is currently developing such key functions as the manual locking function of landing runway, the runway state control function, and the runway operation mode reminder function, to assist controllers to detect the airport scene operation conflict.

2.2.4 Integrated Tower Automation System

Integrated Tower Automation System is a computer integrated system for tower controllers. Based on the main line of tower control business, the system integrated the function of A-SMGCS、EFS 、DCL and D-ATIS and other kinds of operation system. And different interface displays are provided for different requirements of control seats.

In the future, the tower controllers will mainly use integrated tower system, so the above prevention functions will be mainly implemented in this system.

2.3 Technical means for pilots and vehicle drivers

Some statistical show that about 80% runway incursions are caused by pilots and vehicle drivers. Therefore, direct runway occupancy tips for pilots and vehicle drivers can effectively prevent runway incursion by enhancing the situational awareness.

2.3.1 Stop bar

According to the ICAO Doc4444," Stop bars shall be switched on to indicate that all traffic shall stop and switched off to indicate that traffic may proceed."

The stop bars are usually controlled by the controller through the Tower Electronic Flight Strips System, which sends the switch instructions directly to the drivers.

2.3.2 Autonomous Runway Incursion Warning System (ARIWS)

ICAO annex 14 introduces the Autonomous Runway Incursion Warning System, which monitors the actual condition on the runway and automatically returns the information to the warning lights installed at the runway entrance and the intersection of the taxiway and the runway. In general, Runway Incursion Warning System includes a separate surveillance system and a warning system which connects the lighting system through the processor.

Runway status light (RWSL) is a kind of Autonomous Runway Incursion Warning System. The two basic visual components of runway state lights are: runway entrance lights (RELs) and takeoff hold lights (THLs). The system automatically controls the lights to remind pilots whether the runway is safe when entering the runway.

2.3.3 Vehicle/borne mobile terminals

Using AeroMACS or 1.8 G wireless network, sent the surface situation information to the terminal onboard or Vehicle, and provide it to the pilots and vehicle drivers.

It can significantly improve the situational awareness ability of pilots and vehicle drivers.

Especially when aircraft and vehicles crossing the runway in use, the alarm is put forward immediately, so the drivers can take measures at the first time to reduce serious consequences.

3. Verification of runway incursion prevention system at Hongqiao Airport

3.1 Shanghai Hongqiao Airport is one of the major airports in China. Because the T1and T2 buildings are located on both sides of the runway, most landing aircrafts need to cross the runway. The number of flights crossing the runway accounts for about 50% of the total number of flights per day, and frequently runway-crossing increases the risk of runway incursion at Hongqiao Airport.

3.2 According to the operation characteristics of Hongqiao Airport, a comprehensive demonstration and verification system for preventing runway incursion is built by applying the relevant technical means mentioned above, and the technical means for controllers, pilots and vehicle drivers are tested and verified.

3.3 The system includes: A-SMGCS system with MLAT, video surveillance system, mobile terminal system and runway status light system.

3.4 Test and validation

3.4.1 A-SMGCS

1) The system detection accuracy of fixed or moving targets in the mobile area can reach 99%.

2) Because of integrating with the MLAT and vehicle positioning terminal data, the false target of SMR is effectively eliminated and the false alarm rate is greatly reduced compared with the original SMR radar.

3) At the same time, the target position update once a second, which provides the controllers with comprehensive target position and identification information.

3.4.2 Vehicle Mobile Terminal System

The vehicle positioning t accuracy reaches sub meter level in runway and main taxiway area, while the position update rate is 1Hz.

3.4.3 Video surveillance system

1) The panoramic video surveillance system was installed on the east side of the runway. Four channels of 1080P HD videos were spliced together to achieve the full coverage of the eastern apron and the east runway. The frame rate was no less than 25FPS, and the picture delay was less than 200ms.

2) At the same time, 33 times optical zoom camera is used to tracking targets. and the camera in the critical area is installed at the crossing position H3.

3) Video detection technology is used to identify the aircraft and vehicle targets crossing the holding line and the give prompt. The detection time for the targets entering the area is less than 1s.

3.4.4 Runway status light system

1) The runway status light system was installed and tested for the first time in Chinese airports. After the installation of the system, shadow mode operation verification, vehicle test and flight test were carried out successively.

2) The system uses a variety of surface surveillance system fusion data for the system, such as MLAT and vehicle positioning terminal, to eliminate the impact of false targets, and to avoid the problem of light error switch effectively caused by the false targets.

3) Two sets of runway status lights were actually installed in the airport, a set of take-off hold lights were installed on runway 18L, and a set of runway entrance lights were installed at the crossing of H3 and west runway. In the system, control decisions are made based on the four groups of THL (takeoff hold lights) and 22 groups of REL (runway entrance lights) of all the runways and crossings. Corresponding light switch status is displayed on the controller terminal for shadow mode verification.

4) The light control system adopts the single light control technology based on optical fiber communication, and together with the LED light drive optimization technology to achieve the low delay response. The average response time of lighting on is 0.8 seconds, and the average response time of extinguishing is less than 0.3 seconds, which can meet the requirements of the state light's timely switch.

5) The overall test results show that the system can accurately control the status of the light based on the traffic data. The pilots and vehicle drivers involved in the test all notes that the light prompt is clear, and the runway status light system is efficiency and accurately.

5. Action by the Meeting

1) The runway incursion prevention is a comprehensive system, which can effectively prevent runway incursion by applying various technical means from the perspective of controllers, pilots and vehicle drivers to enhance their awareness situation.

2) discuss any relevant matter as appropriate

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