

Overview and Suggestions on the Construction of China's Low Altitude Flight Service Guarantee System

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Abstract: The construction of low-altitude flight service system is the basis to promote the development of the navigation industry and the necessary condition to ensure the "two wings fly together" of transport aviation and general aviation. At this stage, the construction of our flight service guarantee system is relatively lagging behind and cannot meet the urgent need of opening low-altitude airspace. This paper first introduces the basic concepts and related policies of the low-altitude flight service guarantee system, analyses the current situation of the low-altitude flight service guarantee system construction in China, and puts forward the requirements and design ideas of the low-altitude flight service guarantee system construction. Next, it analyses the operation management process of low-altitude flight service and summarizes the key technologies of low-altitude flight service support. Finally, a low-altitude flight service support information platform is innovatively designed. This paper studies and improves the theory of low-altitude flight service guarantee system construction, and provides some support for China's low-altitude airspace opening.

Keywords: Low altitude flight service support, Low-altitude airspace, ADS-B technology, Beidou Satellite Navigation Technology.

1. Basic Concepts and Relevant Policies

1.1. Basic concept

The low altitude flight service support system is proposed based on the needs of the development of general aviation and the continuous construction and development of the service support system. The system mainly provides flight planning services, aeronautical information services, meteorological information services, flight surveillance services, etc., as shown in Figure 1, which can effectively solve the bottleneck

problem of "unable to fly, unable to fly smoothly" in the low altitude airspace. It is guided by the diversified development needs of low-altitude airspace users and low-altitude flight activities, based on the convenience of general aviation users and flight service guarantee operation subjects, and adheres to the combination of industry management and social management to promote the safe and efficient operation of low-altitude airspace.

The project team has accumulated a lot of research results in the early stage.

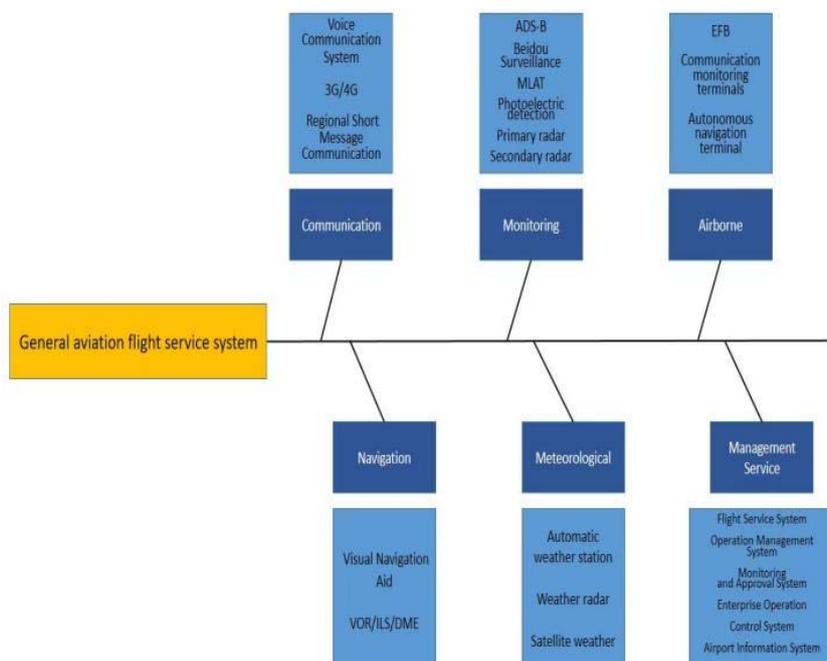


Figure 1. Low altitude flight service support system architecture

Low altitude flight service system consists of national information management system, regional information processing system and flight service station system. The national information management system is the first level system in the low altitude flight service system architecture, and its main function is to collect and summarize information and release product information; The regional information processing system is the second level system in the low altitude flight service system architecture. Its main function is to collect and report information and provide product information; Flight service station system is the third level system in the low altitude flight service system architecture, which is divided into Class A flight service station system and Class B flight service station system. Its main function is to provide services for general aviation flight activities, flight plan and implementation reporting [1].

1.2. Related Policies

In October 2012, the China Civil Aviation Administration issued the Guidelines for General Aviation Flight Service Station System Construction and Management (Trial) (hereinafter referred to as the Guidelines) [2], which clarifies the system positioning and functional zoning of the Flight Service Station. The Guidelines indicate that the flight service station provides services to general aviation users during their flight activities, including pre-flight, in-flight and post-flight phases. Pre-flight services, including pre-flight instructions and declaration of flight plans; In-flight services, including in-flight explanation and flight intelligence services, pilot air reporting, low-altitude communications services, air surveillance services, warning and rescue services, and flight plan implementation reports; Post-flight services, including pilot reports, flight activity statistics and flight plan completion reports.

In September 2018, the Chinese Civil Aviation Administration issued the General Plan for the Construction of Low-altitude Flight Service Guarantee System [2], which accelerates the construction of a low-altitude flight service guarantee system featuring industrial and social co-construction, civil-military integration and efficient and convenient services, in order to promote the development of the general aviation industry and ensure the safe and efficient use of low-altitude airspace.

At present, China is committed to promoting the further reform of low-altitude airspace, focusing on exploring and innovating in such aspects as airspace operation management, flight mission management, flight plan management, flight implementation management, flight service management, flight dynamic monitoring, data information management, special task management, and gradually forming a low-altitude airspace planning and operation management system, monitoring and service guarantee system with Chinese characteristics. Low altitude safety management system and legal standards system.

2. Development status

At present, the construction of the national and regional flight service information system is progressing steadily as planned, and nine provinces have formulated plans for the construction of flight service stations. 24 flight service stations have been built in China, 17 of which have passed the compliance inspection organized by the local civil aviation

authority and formally incorporated into the air traffic control operation system and industry management system. However, at present, the construction of China's low altitude flight service guarantee system is relatively lagging behind, unable to meet the needs of low altitude airspace development, and there are many problems, such as long flight approval time, complicated flight application process, long application cycle, and irregular flights occur from time to time, which seriously threaten air defense safety and the flight safety of public transport flights, and the lack of monitoring means for low altitude airspace flights by air traffic control departments [3].

The Overall Plan for the Construction of Low Altitude Flight Service Guarantee System proposes that a low altitude flight service guarantee system will be initially established in 2022 to provide effective flight planning, aviation information, aviation meteorology, flight information, warning and assistance rescue services for low altitude flight activities; In 2030, the low altitude flight service guarantee system will comprehensively cover the low altitude reporting, surveillance airspace and general airport, with complete functions and service products.

3. Construction Ideas and Contents

3.1. Construction ideas

The construction of China's low-altitude flight service guarantee system will be advanced in the following four aspects in an orderly way:

(1) Promote classified airspace designation, distinguish operational rules, service standards, access conditions and control requirements, and delimit different types of airspace below 3000 meters in height to further expand the space for general aviation flight activities;

(2) Promote the low-altitude route network planning, adopt the rule-based low-altitude visual autonomous flight mode, and construct a flexible, fast and efficient low-altitude route network, so as to achieve "point, line and area" cross-section connection to meet the needs of general aviation;

(3) To implement coordinated and integrated supervision and management to meet the needs of the diversified development of aviation activities, establish an integrity mechanism for low-altitude flight, jointly investigate and strictly punish illegal flights, and standardize the subjects of responsibility and rights of air defense safety, public safety and flight safety;

(4) Strengthen the low-altitude airspace support capability, take the lead of the local government in the overall planning according to the ideas of unified planning, separate construction and resource sharing, and use new technologies such as cloud computing, big data, block chain, Internet of Things, artificial intelligence to build general aviation infrastructure, promote the application of 5G communication, Beidou navigation, ADS-B in the low-altitude communication, navigation and monitoring fields, and realize the digitization, informatization and intelligence of general aviation flight support.

3.2. Main construction contents

3.2.1. Set up flight service station

In principle, each provincial administrative region can set up one to three Class A flight service stations. Class B flight service stations can be set up at general airports, temporary takeoff and landing points and reporting airspace as required

[4]. The flight service station shall define its service scope and deploy information collection and service terminals in relevant airports and navigation activity areas. At the same time, encourage the use of existing air traffic service resources, and encourage local governments and social forces to participate in the construction and operation of flight service stations. All kinds of flight service stations shall be incorporated into the management system and operation system of the civil aviation air traffic control industry. All administrative bureaus cooperate with local governments to formulate layout plans, and all civil aviation units actively assist.

3.2.2. Improve aviation information service capability

Establish a low altitude aviation information service system, and improve the service and support capability of the aviation information system for low altitude flight activities; The Air Traffic Management Bureau of CAAC shall establish a system for collecting, sorting, editing the original information of general aviation information and designing, producing and releasing aviation information service products to provide basic information for general aviation flight activities; According to industry standards, develop visual aeronautical charts to meet the needs of general aviation flight activities, and study the data acquisition specifications of general aviation airports and special aeronautical chart compilation specifications; Strengthen the capacity building of general aviation static data processing and processing of regional aviation information service agencies, provide comprehensive comprehensive information services for general aviation users by integrating data information, develop general aviation information digital products, and provide aviation information customization services according to user needs [5].

3.2.3. Improve low altitude communication monitoring capability

Promote the construction of a low altitude monitoring information platform based on Beidou data and integrating RDSS and ADS-B data to achieve real-time monitoring of general aviation flight positions [6]. The Operation Monitoring Center of the Civil Aviation Administration, together with relevant units, will deeply explore the multiple applications of low altitude surveillance data in the navigation field, continuously expand the low altitude surveillance capability, and provide data support for low altitude airspace management failure, national security monitoring system, and general aviation operations.

3.2.4. Improve low altitude aviation meteorological service capability

Provide timely and accurate meteorological information, provide support for flight plan formulation, prevent low-level flight activities from being affected due to inaccurate ATC meteorological information, and promote the development of navigation industry; Provide support for in-flight plan change, effectively avoid flight accidents caused by meteorological reasons, and improve the safety of low altitude flight activities; Effectively use favorable weather, avoid adverse weather, further optimize low altitude airspace planning means and methods, and improve airspace utilization; Use early warning information of aviation dangerous weather to reduce the damage and economic loss caused by disastrous weather to low altitude flight; Provide strong meteorological information support in important flight activities such as military aviation, rescue and disaster relief [7].

3.2.5. Improve flight plan management

Establish work contact: when the flight service station defines the service scope, it shall specify the unit that approves and files the flight plan and establish work contact; Propose the flight plan: the flight plan can be submitted through telegram, telex, network and other channels, and accepted by the flight service agent; Approval of flight activities: flight activities in the airspace where civil aviation provides control services shall be approved by the civil aviation control unit according to the current regulations, and other flight activities shall not be approved; Reporting relevant plans: flight plans involving only the surveillance airspace and the reporting airspace can be flown after reporting to the relevant flight plan management department through the flight service station [8].

3.2.6. Establish low altitude flight service regulations and standards system

Study and improve the regulatory documents related to low altitude flight service support; Coordinate with relevant departments to gradually simplify the requirements for low altitude navigation flight management and support; Organize the drafting of industry standards related to low altitude flight service system, and define the technical requirements and configuration requirements of low altitude flight service system; The central information management system should gradually enhance its ability to provide flight services to the whole country [9]; Formulate unified data interface and transmission standards, define the content and format of data exchange, and strengthen information sharing; Expand service channels and promote service products and information sharing to facilitate the implementation of general aviation flight.

4. Key Technology

The low altitude flight service support system will develop towards the direction of information, grid and intelligence. To build and develop the low altitude flight service guarantee system, we must strengthen the construction of the flight service center and carry out the construction of the low altitude information system; In terms of monitoring system, it is necessary to promote the construction of low altitude monitoring capabilities such as ADS-B distribution, and build a low altitude airspace monitoring technology service guarantee system with Beidou positioning information as the core and compatible with various monitoring technologies.

4.1. ADS-B technology

ADS-B (Automatic Dependent Surveillance – Broadcast), as shown in Figure 2, is an air traffic control monitoring technology based on GNSS (Global Navigation Satellite System) and using air to ground and air to air data link communication to complete traffic monitoring and information transmission. ADS-B technology is a very important communication and monitoring technology in the new navigation system and will play an important role in the flight service support system.

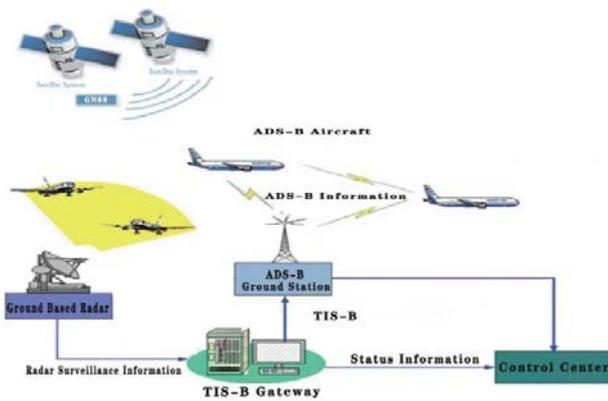


Figure 2. ADS-B Technology

The airborne ADS-B communication equipment broadcasts the navigation information collected from the airborne information processing unit, receives the broadcast information from other aircraft and the ground, and sends it to the cabin integrated information display after processing. The cabin integrated information display provides the pilot with the situation information around the aircraft and other additional information (such as conflict warning information, collision avoidance strategy, meteorological information) based on the collected ADS-B information, airborne radar information, and navigation information of other aircraft and the ground. Using ADS-B technology, it is possible to automatically obtain parameters from relevant airborne equipment and broadcast GNSS based aircraft position, altitude, speed, heading, identification number and other information to other aircraft or ground stations without manual operation or inquiry, so that controllers can monitor aircraft status [12].

4.2. Airspace surveillance technology based on multi-source data fusion

The new generation of general aviation operation monitoring technology mainly relies on "Beidou+Internet plus+cloud computing+Bluetooth" technology, "Beidou+4G/5G" technology, and ADS-B receiving technology.

The Beidou system provides navigation signals of multiple frequency points, and can improve service accuracy by combining multiple frequency signals. Beidou system innovation integrates navigation and communication capabilities, and has multiple service capabilities such as positioning, navigation and time service, satellite based enhancement, ground-based enhancement, precise single point positioning, short message communication, and international search and rescue. The Internet+5G technology is used to transform the available information of big data, quickly form a shared database, and provide information to specific objects through the wireless communication road widened by Bluetooth, which is accurate and efficient, so as to achieve service targeting. It can realize:

- (1) Provide route planning, short message communication and emergency alarm services;
- (2) Provide management, location monitoring and meteorological information services;
- (3) Provide real-time monitoring of flight status and necessary remote warning services;
- (4) Dynamic display of aircraft position and status

information;

- (5) Unified management of user information;
- (6) Provide the setting and management of flight airspace.

4.3. New navigation technologies

Transport aviation is building a smart airport ecosystem, supported by advanced technologies such as cloud computing, big data and artificial intelligence. The ultimate goal of the integrated information platform of the flight service station is also the smart airport ecosystem.

The comprehensive information platform of general aviation flight service station realizes the deep integration of general aviation industry and the Internet, and improves internal efficiency and external service capability. The integrated information platform is connected with the low altitude flight service support system to obtain basic flight support service information; The platform connects with the general aviation management system, obtains the basic data of general aviation administrative supervision, and realizes "Internet plus+government services" such as flight plan declaration.

With the development of science and technology, the high integration of 5G and AI will bring great changes to people's lives. These technologies that replace people are more suitable for the characteristics of "small, scattered" and "one person with many posts" of general aviation, and become the technical support of the integrated information platform of flight service stations. The Internet plus flight activity mode will guide and promote the flight service station to develop towards the integrated information platform of the flight service station.

5. Design of New Generation Low Altitude Flight Service Guarantee Information Platform

In order to effectively promote the healthy and orderly development of general aviation industry and promote the reform of low altitude airspace management system, a new generation of low altitude oriented flight service assurance information platform was designed. The low altitude flight service support information platform, as shown in Figure 3, mainly includes five modules: information support system, flight service system, aviation emergency rescue system, "low slow small" target control system and data center platform, providing services for conflict detection, flight planning, information meteorology, navigation operations, aviation school training, etc. It can improve the control ability of military and civil aviation control departments on general aviation flight, realize "flying, seeing, calling, and controlling", improve the intelligence level of low altitude airspace operation and the efficiency of airspace resources, realize the efficient operation and coordination of aviation emergency rescue, realize the sharing of general aviation resources, and effectively solve the problems in low altitude flight service support, as follows:

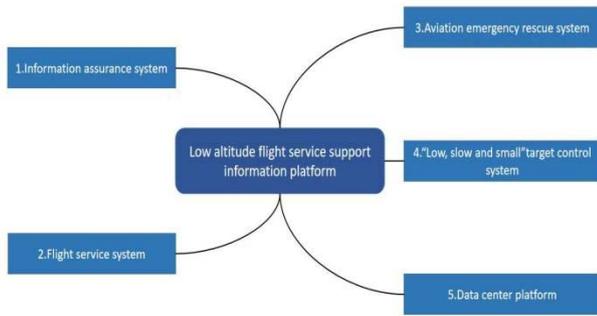


Figure 3. Low altitude flight service assurance information platform

5.1. Information assurance system

The system has the capabilities of real-time monitoring of general aircraft, real-time voice communication between ground and general aircraft, and meteorological services. It needs to be composed of information support base stations distributed in multiple locations to form an information support network. Each information support base station is composed of ADS-B ground station, ground VHF voice radio, automatic weather observation station and other major equipment, and uses the Internet as the transmission means to transmit the monitoring signals, voice signals and weather observation signals distributed in multiple locations to the data center to provide air surveillance, voice communication and weather services for navigation flight services and aviation emergency rescue command. It mainly includes two parts. Air surveillance module: ADS-B technology is used as the main monitoring means, 5G link monitoring is used as the backup monitoring means, and Beidou short message is used as the emergency monitoring means to ensure the continuous ground air surveillance; Voice communication module: VHF ground air voice communication is used as the main communication means, mobile communication is used as the backup communication means, and Beidou short message communication is used as the emergency communication means, that is, the voice communication method with complementary advantages of one main, one standby and one emergency is used to better solve the problem of communication discontinuity in general aviation flight.

5.2. Flight service system

The flight service system takes general aviation operation enterprises, flight individuals, flight service stations, air traffic control departments, etc. as the main users, realizing pre flight, in-flight and post flight services such as application, approval, status feedback, alarm and statistics in a one-stop manner, and providing flight plan, aviation meteorology, aviation intelligence, airspace surveillance, emergency and assistance rescue services for low altitude general aviation flights, mainly including flight plan management module Aviation information processing module, meteorological service module, flight dynamic monitoring module and integrated flight warning module.

5.3. Aviation emergency rescue system

The aviation emergency rescue system can coordinate the resources such as aircraft, ground support personnel, rescue materials and personnel, and implement rapid response to emergency rescue events. Under the guidance of the

emergency management department, it can realize the dispatch and command, operation management, task progress monitoring of the rescue aircraft, and achieve efficient task coordination with the ground emergency rescue departments such as hospitals and fire departments. The aviation emergency rescue system consists of four parts: aviation emergency rescue resource integrated management subsystem, emergency event and aviation emergency rescue task management subsystem, aviation emergency rescue task planning and command coordination subsystem, and aviation emergency rescue task real-time monitoring and exception handling subsystem.

5.4. "Low, slow and small" target control system

The "low, slow and small" target management and control system takes non cooperative UAV targets as the prevention and control object, and takes photoelectric detection, flight prediction, countermeasures, capture and shooting down as the means to effectively solve the black flight of "low, slow and small" targets such as airports, military sensitive units and large activity sites.

5.5. Data center platform

The data center platform is a business processing and computing center for general aviation flight services, aviation emergency rescue command and "low, slow and small" target control, providing necessary computing, storage and network resources for all software operations of aviation flight services, aviation emergency rescue command and "low, slow and small" target control. The data center platform of the general aviation flight service support system is based on business needs, referring to the requirements of the existing air traffic management system, as well as the requirements of relevant laws, regulations and specifications.

The low altitude flight service support information platform can provide comprehensive flight support services for local navigation enterprises and individuals, and can provide one-stop access to flight plan services, aeronautical information services, meteorological services, warning services and other professional services covering all aspects of navigation operations, which will greatly promote the healthy development of the navigation industry and provide effective support for the national low altitude air defense.

6. Conclusion

At present, China's low altitude airspace lacks a scientific and systematic service guarantee platform, the construction of low altitude flight service guarantee system is relatively backward, and the development of general aviation is slow. The main reasons are as follows: the construction of low altitude flight service guarantee system is not perfect, and the general aviation infrastructure and services are insufficient. This paper first introduces the basic concepts and relevant policies of the low altitude flight service support system, analyzes the current situation of the construction of the low altitude flight service support system in China in detail, and puts forward the requirements and design ideas for the construction of the low altitude flight service support system; Summarize the key technologies of low altitude flight service support; Finally, a low altitude flight service support information platform is innovatively designed. This paper studies and improves the theory of low altitude flight service

guarantee system construction, and provides some support for China's low altitude airspace opening.

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The project team has accumulated a lot of research results in the early stage. Fund Projects:

1. Key scientific and technological projects in Henan Province (222102210093): Research on multi-machine intelligent space monitoring, warning and conflict resolution technology based on ADS-B.

2. Research Institute of Laboratory Work in Henan Provincial Universities (ULAHN202145): Exploration on the construction of Empty Pipe and Assignment Experimental Training Platform under the background of new subjects.

3. The Provincial Project of Innovation and Entrepreneurship Training Program for College Students (202210485041): Low-altitude guardian-low-altitude integrated service platform based on ADS-B system.

4. 2022 Research and Practice Project on Educational and Teaching Reform of Zhengzhou University of Aeronautics (zhjy22-82).

5. 2022 Special Subject Construction Project of Zhengzhou University of Aeronautics: Exploration of Master's Collaborative Education Model of Civil Aviation Transportation under the Background of New Subjects.

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