International Civil Aviation Organization

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Agenda Item 18: Any other business

STATUS OF SAFE FLIGHT 21

(Presented by the United States of America)

SUMMARY

Safe Flight 21 is a cooperative government/industry program to evaluate capabilities to improve aviation safety, efficiency, and capacity. It focuses on a manageable set of operational capabilities that are important to the user community. This paper discusses those operational enhancements made possible through the collaborative plans of the aviation industry and FAA to demonstrate, evaluate, and measure the operational benefits, and mitigate the risks of implementing those capabilities that prove beneficial.

REFERENCES

RTCA/DO-242 Minimum Aviation System Performance Standards (MASPS) for Automatic Dependent Surveillance Broadcast (ADS-B), February 19, 1998.

1. INTRODUCTION

1.1 The FAA, working with RTCA (an advisory group to the FAA), recognized that new communications, navigation, and surveillance (CNS) capabilities were needed to increase capacity, improve efficiency, and resolve safety problems. In 1998, the RTCA Free Flight Steering Committee comprised of members from aviation industry, FAA, and RTCA recommended to the FAA Administrator a strategy to resolve risks associated with the new CNS systems before these capabilities could be implemented. Under this strategy, the Safe Flight 21 Program was formed to address the CNS issues and provide information to the FAA and industry so that they could make decisions about implementing these systems. Safe Flight 21 is a cooperative government/industry program to evaluate capabilities for Free Flight. It focuses on a manageable set of operational capabilities that are important to the user community. These include the cockpit display of traffic, weather, and terrain information, improved information for controllers, and improved surface situational awareness. The new technologies are based on the use of Global Positioning System (GPS), Automatic Dependent Surveillance-Broadcast (ADS-B), Traffic Information Service-Broadcast (TIS-B), Flight Information Services-Broadcast (FIS-B), and the use of a multi-functional display in the cockpit and enhanced controller displays.

2. SAFE FLIGHT 21 OBJECTIVES

2.1. The Safe Flight 21 objectives are to identify, evaluate, and mitigate the risks associated with the selection, implementation, and integration of planned CNS capabilities and corresponding procedures. In mitigating these risks, the program will:

- Enhance safety,
- Increase system capacity and efficiency,
- Maximize user operational benefits,
- Minimize user equipage costs and FAA operational costs,
- Address pilot and controller human factors issues,
- Develop and assess new operational procedures and associated training,
- Streamline certification processes and procedures,
- Develop a cost-effective avionics and National Airspace System (NAS) infrastructure, and
- Define a realistic NAS transition path supported by the user community.

3. OPERATIONAL ENHANCEMENTS

3.1 The Safe Flight 21 Program operational enhancements were identified by the operational users through RTCA. The operational enhancements are as follows:

1. Provides weather and other information to the cockpit
2. Affordable means to reduce controlled flight into terrain
3. Improved capability for approaches in low visibility conditions
4. Enhanced capability to see and avoid adjacent traffic
5. Enhanced capability to delegate aircraft separation authority to the pilot
6. Improved capability for pilots to navigate airport taxiways
7. Enhanced capability for controllers to manage aircraft and vehicular traffic on airport surface
8. Provides surveillance coverage in non-radar airspace
9. Establish ADS-B separation standards.

Each of these operational enhancements is further defined in terms of operational applications.

3.2 Operational Enhancement 1 - Provide Weather and Other Information to the Cockpit

- Initial Flight Information Services –Broadcast (FIS-B) based on today's available next generation weather radar (NEXRAD) graphics, aviation routine weather report/aviation selected special weather report (METAR/SPECI), terminal forecasts (TAFs), significant meteorological information (SIGMETs), pilot reports (PIREPs) and severe weather forecast alerts.
- Add products such as notices to airmen (NOTAMs), lightning, icing, turbulence, real time special use airspace (SUA), and volcanic ash.

3.2.1 There is a significant amount of data in the National Airspace System that, if the pilot could have access to in the cockpit, would make the flight safer through improved situational awareness (e.g., weather information) or more cost effective (e.g., knowledge of special use airspace (SUA) restrictions).

3.2.2 This operational enhancement will use the Flight Information Services-Broadcast (FIS-B) to receive current and forecasted weather and weather-related information as well as the status of special use airspace. The enhanced weather products will be available to pilots and controllers, allowing them to share the same situational awareness. The information will be displayed in text and graphics to the pilot.

3.2.3 The expected benefits of this operational enhancement are: increased availability of flight services, increased timeliness and quality of data on weather and system status, increased access to airspace, and reduced flight times and distance.

3.3 Operational Enhancement 2 - Affordable means to reduce controlled flight into terrain

- Low cost terrain situational awareness
- Increased access to terrain constrained low altitude airspace.

3.3.1 There have been many fatal accidents involving controlled flight into terrain (CFIT) due to poor situational awareness. This operational enhancement will increase the pilot's situational awareness by providing a cost/effective terrain database and display in the cockpit.

3.3.2 The expected benefits of this operational enhancement are: reduction in the CFIT rate and increased access to low altitude airspace where terrain imposed restrictions exist.

3.4 Operational Enhancements 3 – 9

3.4.1 Operational enhancements 3 – 9 are based on the use of ADS-B and are included in the RTCA/DO-242 Minimum Aviation System Performance Standards (MASPS) for Automatic Dependent Surveillance Broadcast (ADS-B), February 19, 1998. The MASPS describes the operational applications for each of these enhancements, operational requirements, system level performance standards, interfaces, and minimum system test procedures to ensure that performance meets system level performance standards.

3.4.2 Improved terminal operations in low visibility

- Enhanced visual approaches (visual acquisition with existing procedures, ADS-B only)
- Enhanced visual approaches (with new procedures using ADS-B only)
- Enhanced visual approaches (with new procedures using ADS-B and TIS-B)
- Approach spacing (for visual approaches)
- Approach spacing (for instrument approaches)
- Departure spacing/clearance (visual meteorological conditions (VMC) in radar).

3.4.2.1 During approach operations there are a number of operational problems that limit efficiency. On visual approaches, it is often difficult to identify the aircraft to follow. It is also difficult to judge the distance and speed of the aircraft to follow.

3.4.3 ADS-B, Cockpit Display of Traffic Information (CDTI), and Traffic Information Service-Broadcast (TIS-B) could be used during low visibility approach operations to enable the crew to better identify the aircraft to follow and accomplish approaches at lower minimums, thus maintaining VFR throughput longer. The crew will also be able to maintain better spacing during VFR and IFR approaches.

3.4.3.1 The expected benefits of this operational enhancement are: increased access to airports, increased arrival rates, reduced arrival and departure delays, increased predictability of arrival times, and increased flexibility of arrival scheduling.

3.4.4 Enhanced see and avoid

- Enhanced visual acquisition of other traffic for see-and-avoid (using ADS-B only)
- Enhanced visual acquisition of other traffic for see-and-avoid (ADS-B and TIS-B)
- Conflict detection enhanced see and avoid
- Conflict resolution.

3.4.4.1 There are limitations with today's system of "see and be seen". This results in safety and efficiency issues. It is advantageous to increase safety for all aircraft by maintaining situational awareness of the traffic around them, in instrument meteorological conditions (IMC) and VMC.

3.4.5 ADS-B, CDTI, and TIS-B could provide traffic information to the cockpit. This will enable the pilot to maintain situational awareness of surrounding traffic.

3.4.5.1 The expected benefits of this operational enhancement are: increased pilot access to traffic information for situational awareness resulting in greater safety.

3.4.6 Enhanced en route air-to-air operations

- Pilot situational awareness beyond visual range.

Today's separation standards and procedures provide limited efficiency due to the lack of, and/or limitations associated with the radar-based surveillance.

CDTI and ADS-B could allow delegation of separation authority to the cockpit, resulting in increased efficiency.

3.4.6.1 Expected benefits: increased access to airspace, reduced flight delays and distances flown, increased predictability of flight times and distances flown, and increased flexibility in routes flown.

3.4.7 Improved surface surveillance and navigation for the pilot

- Runway and final approach occupancy awareness (using ADS-B only)
- Runway and final approach occupancy awareness (using ADS-B and TIS-B)
- Airport surface situational awareness.

It is difficult for pilots to navigate the taxiways of an airport especially in low visibility. Under reduced visibility conditions, the pilots may not be able to see other traffic.

A moving map display would enable pilots in the cockpit and the operators of equipped vehicles on the airport surface to "see" all the other traffic, resulting in safer and more efficient surface operations. Aircraft can use augmented GPS navigation and maps and Local Area Augmentation System (LAAS) in extremely low visibility conditions.

3.4.7.1 The expected benefits of this operational enhancement are: reduced runway incursion incidents, reduced taxi delays, and increased predictability of taxi times.

3.4.8 Enhanced surface surveillance for the controller

- Enhance existing surface surveillance using ADS-B
- Surveillance coverage at airports without existing surface surveillance.

Under low visibility conditions, it is difficult for the tower controllers to manage aircraft and other vehicular traffic on the airport surface.

Equipage of aircraft and ground vehicles in the airport movement area with ADS-B using augmented GPS-derived positions will allow the local and ground controllers in the tower to monitor the position and speeds of all the traffic in the movement area.

3.4.8.1 Expected benefits: reduced runway incursion incidents, reduced taxi delays, reduced arrival delays, increased predictability of taxi times, and increased departure/arrival rates.

3.4.9 ADS-B surveillance in non-radar airspace
- Center situational awareness with ADS-B
- Radar-like services with ADS-B
- Tower situational awareness beyond visual range.

Today's system contains areas of airspace that are outside of radar coverage. The lack of surveillance information limits a controller to the use of procedural separation to provide separation services. This type of separation limits both airport and airspace capacity.

ADS-B can provide additional surveillance coverage and fill gaps in radar coverage.

3.4.9.1 Expected benefits: increased access to airspace, increased arrival and departure rates, reduced flight delays and distances flown, increased predictability of flight times and distances flown, reduced deviations from the intended route, and increased flexibility in the routes flown and increased safety.

3.4.10 Establish ADS-B separation standards
- Radar augmentation with ADS-B to support mixed equipage in terminal airspace
- Radar augmentation with ADS-B to support mixed equipage in en route airspace.

Current automation is limited in providing benefits to users based on existing radar accuracy. ADS-B data can be integrated with radar and conflict alert to determine if separation standards can be reduced. Ultimately ADS-B will be integrated with advanced decision support automation.

The expected benefits of this operational enhancement are increased efficiency and maintained or increased safety.

4 SAFE FLIGHT 21 DEMONSTRATION AND EVALUATION

4.1 Safe Flight 21 demonstrates and evaluates the benefits of the applications described above. Prior to committing the FAA and the users to a full-scale implementation of these enhancements, there will be a consensus of the feasibility and business case for the enhancements among the stakeholders. The FAA and industry will jointly define, develop, and evaluate the enhancements.

4.2 The Safe Flight 21 Program Office will demonstrate and evaluate the benefits of this new technology. This will include operational and procedural issues, as well as cost/benefit matters. The review of operations and procedures will ensure that pilot, controller, operator, FAA air traffic maintenance, and flight standards issues are addressed. The cost/benefit activity will define the cost of the data link and quantify and qualify the economic and safety benefits derived from each capability.

4.3 There are two areas of demonstration and evaluation: large air carriers from the Cargo Airlines Association (CAA) in the Ohio River Valley; and smaller, general aviation-type commercial carriers in Alaska, as part of the FAA Alaskan Region's Capstone Program. These evaluations are structured and documented in a Test and Evaluation Master Plan (TEMP) for each application. This is exemplified by the Capstone Test & Evaluation Master Plan for ADS-B Radar Like Services, which is included on the Capstone web site: www.alaska.faa.gov/capstone.

4.4 In 2000, the Safe Flight 21 program conducted an Operational Evaluation in Louisville, Kentucky to demonstrate the efficiency and safety benefits of using ADS-B and to evaluate air traffic controller use of ADS-B in the terminal area environment. In addition, tests were conducted to develop and evaluate avionics and procedural modifications to improve the following applications: departure spacing, approach spacing, runway and final approach occupancy awareness, and airport surface situational awareness. The tests provided more data supporting the potential for using ADS-B avionics in the cockpit in combination with revised procedures to improve aircraft spacing and enhance surface safety.

4.5 In 2001, the Safe Flight 21 program conducted an air traffic modernization forum in Memphis, Tennessee to demonstrate newly installed multilateration surveillance capabilities and the use of on-board moving map displays for monitoring surface aircraft and vehicle movement. Multilateration infrastructure was also ordered for the Louisville, Kentucky test site. Other efforts included the award of four contracts for avionics development and evaluation, the development of a visual concept of use for surface moving map displays, and initial development of a surface moving map database to support this effort.

4.6 In 2002, the multilateration system was installed at Louisville, Kentucky, and a new automation platform for that facility to support on-going ADS-B test and evaluation efforts will be procured. Development and evaluation is continuing on avionics and the procedural modifications needed to improve surface situational awareness and enhance existing surface surveillance using ADS-B. Interoperability and shakedown testing of avionics capable of transmitting and receiving ADS-B messages, receiving TIS-B messages, and displaying the combined ADS-B and TIS-B information to flight crews was conducted in April and May at Memphis International Airport. This data collection effort was designed to demonstrate the end-to-end functionality of the TIS-B infrastructure installed at Memphis, and provided data that will assist in the validation of the avionics. It also provided an opportunity to document the air-to-air and air-to-ground surveillance performance of ADS-B in a light-to-moderate interference environment. Other planned demonstrations and evaluations include: call sign procedures evaluation in Louisville; and ADS-B/automation system integration and surface moving map human factors testing at the FAA Technical Center in Atlantic City, New Jersey. In addition, areas in the lower 48 states that do not have radar services are being evaluated for potential use of ADS-B as a surveillance source.

4.7 In 2000, under the Capstone initiative, the FAA equipped approximately 80 aircraft (out of 150 planned) with avionics equipment that includes a Global Positioning System (GPS), ADS-B using the Universal Access Transceiver (UAT) data link, and a terrain database to aid in terrain situational awareness. An ADS-B ground infrastructure consisting of one ground-based transceiver was established in the Bethel area (Yukon-Kuskokwim Delta region) of southwestern Alaska. Nine of eleven standalone GPS approaches were published for smaller village airports in the surrounding delta region. Two of ten Automated Weather Observation Systems (AWOS's) were installed. In addition, the MicroEARTS automation system at the Anchorage Air Route Traffic Control Center (ARTCC) was modified so controllers can track and monitor ADS-B-equipped aircraft. Based on the completion of these initial Capstone activities, on January 1, 2001, controllers in Anchorage began providing ADS-B "radar-like" services to aircraft in the Bethel area, the first use of non-radar surveillance for control purposes in the United States. The same data link that transmits target data to Anchorage also provides weather text and graphics information to the pilots in the Bethel area.

4.8 In 2001, Alaska continued "radar-like" service coverage in the Bethel area. One additional GPS approach was published, and eight weather systems were installed. In addition, the FAA installed ADS-B avionics on sixty additional aircraft operating in the area. While the Bethel avionics have been approved for Instrument Flight Rules (IFR) radar-like services, initial equipage has been for VFR use only, to allow pilots to adjust to equipment capabilities as well as to fully develop the operational concepts for using ADS-B under IFR conditions. These operational enhancements will be implemented incrementally in the area, based on their potential for improving safety and addressing user requirements. Additional air traffic control planning and procedural development is underway to enhance air traffic services in the Bethel area.

4.9 A plan to extend the Capstone initiative to southeastern Alaska was developed in 2001to enhance flight safety and provide a useable IFR infrastructure. Avionics suites with upgraded certification for IFR applications will be procured. Initially, Capstone will implement an IFR area navigation (RNAV) infrastructure using GPS for primary means of navigation in Southeast Alaska. Once the wide area augmentation system (WAAS) is made available to IFR aviation users, operators equipped to receive the WAAS signal will automatically begin to receive lateral navigation (LNAV) information also. Approximately 200 commercial service airplanes and helicopters operating in the area will be equipped with the upgraded ADS-B systems. The plan identifies infrastructure requirements, related activities, and schedule timeframes.

4.10 In 2002, Alaska is completing installation of remaining ground transceivers, weather systems, and ADS-B avionics in the Bethel area, and working to expand ADS-B "radar-like services". In addition, development of the low-level IFR route infrastructure for southeast Alaska will continue. Initial surveys for determining ground transceiver locations in the Juneau area to support this activity have been initiated. In addition, a contract has been awarded for the primary flight and navigation displays that will be incorporated in the upgraded avionics suites. The installation of these displays should begin in September 2002. A contract for a Minimum Operational Performance Standards (MOPS)-compliant ADS-B avionics transceiver is pending based on a vendor's capability to demonstrate a useable system in the August 2002 timeframe with delivery to begin in the March 2003.

5. CONCLUSION

5.1 These operational procedures have been identified by the users to provide significant safety, efficiency, and capacity benefits. Several of these are "near term," in that benefits would be achievable in a relatively short time period with little or no changes to current ATC procedures. Equipment is provided both as avionics in the aircraft and as infrastructure improvements (i.e., automation system upgrades, ground-based transceivers, etc.) on the ground. Flight activities are prioritized to focus on the near term benefits. These flight activities are designed to focus on crew performance, operational procedures and benefits, and data link technical performance.

5.2 Successful demonstrations will be used to determine if these applications should be made operational on a national basis.

5.3 The meeting is requested to note the material presented in this information paper and consider its applicability to improve safety and efficiency of civil aviation operations within the Asia-Pacific Region. The members are also invited to visit the FAA's Safe Flight 21 websites at:

http://www.faa.gov/safeflight21 and
http://www.alaska.faa.gov/capstone