International Civil Aviation Organization

Fourteenth Meeting of APANPIRG ATM/AIS/SAR Sub-group (ATM/AIS/SAR/SG/14)

Bangkok, Thailand, 28 June – 2 July 2004

Agenda Item 4: Consider problems and make specific recommendations concerning the provision of ATM/ AIS/SAR in the Asia/Pacific Region

CONCEPT FOR OAKLAND AIR ROUTE TRAFFIC CONTROL CENTER'S APPLICATION OF 50/50NM AND 30/30NM SEPARATION IN A MIXED REQUIRED NAVIGATION PERFORMANCE ENVIRONMENT

(Presented by the United States of America)

SUMMARY

This paper presents information on the approach planned for applying reduced separation standards for RNP10 and RNP4 approved aircraft within the Oakland Flight Information Region following Initial Operational Capability of the Lockheed Martin Ocean21 Air Traffic Control System

1. Introduction

1.1 The Federal Aviation Administration (FAA) is responsible for the control of over eighteen million square miles of oceanic airspace in the International Civil Aviation Organization (ICAO) Pacific Region. This airspace is characterized by disparate traffic flows and some of the longest scheduled flights in the world. As demand for air traffic services (ATS) in this region has grown, ATS providers have struggled to find ways to reduce separation standards in order to increase efficiency and capacity for both air traffic controllers and airspace operators, while maintaining adequate levels of safety. Much of this effort has been centered on the application of reduced horizontal separation standards based on required navigational performance (RNP) for aircraft as outlined in the ICAO Doc 9613-AN/937, *Manual on Required Navigational Performance* and the work of the ICAO Separation and Airspace Safety Panel (SASP).

1.2 As a practical matter, aircraft intending to fly in oceanic airspace in the ICAO Pacific Region controlled by Oakland Air Route Traffic Control Center (ARTCC) must meet minimum navigational requirements, in conjunction with exchanging communications via third party high frequency (HF) radio, in order to permit the application of a 100NM lateral separation standard, with longitudinal separation based on time. These standards are applied using the most rudimentary ATS procedures and manual flight tracking.

1.3 However, more accurate aircraft navigational capabilities have enabled further reductions in lateral and longitudinal separation. These reduced separation standards require increased navigational capabilities on the aircraft to meet the approval requirements for RNP10 and RNP4, as well as enhanced communications and surveillance capabilities for both ground and aircraft systems. This paper will consider the FAA's approach to applying these new separation standards.

2. Discussion

2.1 The more stringent technical requirements and requisite aircraft equipage costs associated with both RNP10-and RNP4-based separation standards create a disparity in the capabilities of airspace users. In an environment such as the Pacific, where aircraft not meeting these more advanced RNP standards are not excluded from operating, the mix of separation standards and communications/navigation/surveillance (CNS) equipment become major challenges for the ATS providers when implementing enhanced ground systems for air traffic management and ensuring a continued acceptable level of safety.

2.2 The application of 50NM lateral separation is accomplished based solely on an aircraft meeting the requirements for RNP10. No additional ground automation requirements are necessary; therefore this paper will focus primarily on the application of 50NM/30NM longitudinal and 30NM lateral separation.

2.3 ICAO has approved and published guidelines for the application of 50NM longitudinal separation based on RNP10 and new guidelines for the application of both 30NM lateral and 30NM longitudinal separation standards based on RNP4 in oceanic airspace. ICAO Annex 11 contains the requirements for applying RNP-based lateral separation minima, and Doc 4444, *Procedures for Air Navigation Services - Air Traffic Management* (PANS/ATM) contains the requirements for longitudinal separation minima based on RNP. These minima require the use of direct controller to pilot air/ground communications, including controller pilot data link communications (CPDLC) and data communication provided by Automatic Dependent Surveillance-*Contract* (ADS-C).

2.4 All references in this paper to the terms CPDLC and ADS-C are based on the use of Future Air Navigation Systems (FANS-1/A) compliant aircraft and ground systems. The FAA's goal is to provide maximum benefits to those airspace users equipped for reduced separation while not penalizing those not equipped.

2.5 In order for the FAA to apply these new standards, the current Oceanic Display and Processing System (ODAPS) flight data processor requires replacement, as it does not meet the minimum ground system requirements. Beginning in mid-2004, ODAPS will be replaced with the Lockheed Martin Ocean21 Air Traffic Control System. The Ocean21 system provides the FAA with a robust automation platform to support reduced separation standards based on RNP equipage as described in this paper. The system is expandable to accommodate future airspace changes, additional separation standards, surveillance sources and air traffic management functions.

Oceanic Separation Standards Based on RNP

2.6 30NM/50NM longitudinal and 30NM lateral oceanic separation standards based on RNP require the use of CPDLC or another form of direct pilot-controller communication and ADS-C. Although the 50NM longitudinal standard *may* be applied between aircraft making procedural area navigation (RNAV) position reports via CPDLC, efficiency and controller workload issues dictate that ADS-C reports be used. Procedural position reporting places considerably more workload on both the flight crew and the air traffic controller and was therefore not considered viable for FAA use other than for short periods of time, workload-permitting.

2.7 Development of separation standards that place aircraft into closer proximity requires careful analysis and safety assessment to ensure that target levels of safety (TLS) can be maintained. The safety analyses performed for the distance-based longitudinal standards of 50NM and 30NM considered the following:

a. Communications and controller intervention buffer – the total time for the detection of actual or potential losses of separation, formulation and communication of alternate means of separation, pilot and controller reaction times and aircraft maneuver time, including inherent delays for communications routing;

b. Navigational systems error and RNP type (e.g. RNP4, RNP10);

c. Maximum time between position reports; and

d. Position reporting source – reports based on procedural RNAV (for 50NM longitudinal only) or through ADS-C.

2.8 These factors were considered in the mathematical models used to determine what CNS requirements must be met in order to achieve a TLS of less than $5x10^{-9}$ fatal accidents per flight hour. Subsequent safety analyses will be conducted in conjunction with the implementation of 30NM lateral and 30NM (30/30) longitudinal separation in the Oakland FIR. The CNS requirements for applying both 50NM and 30NM longitudinal separation may be summarized as follows:

a. Communications

- Direct controller pilot communications via voice or CPDLC
- The communications system and an alternate means of communication must allow the controller and pilot to directly communicate to resolve potential conflicts within specific time frames based on the minima being applied.

b. Navigation

- 50NM requires RNP10 or RNP4
- 30NM requires RNP4

c. Surveillance

- Automatic Dependant Surveillance – ICAO specifies additional requirements for ADS-C systems. In order to apply the following standards, specific interval reports are required;
- 50NM longitudinal using ADS-C –
    1. RNP10 – a maximum periodic reporting interval of 27 minutes
    2. RNP4 – a maximum periodic reporting interval of 32 minutes
- 30NM longitudinal using ADS-C – RNP4 with a maximum periodic reporting interval of 14 minutes.
- ADS-C reports not received within specified time parameters will be considered overdue and controllers will be required to take action to obtain an ADS-C report or revert to another form of separation. This alternative separation could be 50NM provided procedural position reports are received within the required parameters.

2.9 Collision risk analyses were conducted for the 30NM lateral separation standard. The models assessed the overall probability of lateral overlap based on navigational error – either pilot or equipment error. Consequently, the minimum ATS requirements for 30NM lateral spacing between RNP4 aircraft are as follows:

a. Communications – Direct controller-pilot voice communications or controller-pilot data link communications (CPDLC)

b. Navigation – RNP4 shall be prescribed for the designated area, tracks, or ATS routes

c. Surveillance – An ADS-C system in which an event contract must be set that includes a lateral deviation event report whenever a deviation from track center line greater than 5NM occurs

Application of 30NM/50NM Longitudinal and 30NM Lateral Separation

2.10 To ensure the greatest flexibility in airspace management and offer the highest level of service, the ATS provider strives to apply the smallest separation standard applicable to an aircraft based on the level of CNS equipage, ground infrastructure, airspace requirements and operational considerations. Implementation of reduced longitudinal and lateral separation standards based on RNP will be accomplished in a manner that allows for their simultaneous application with all other separation standards in order not to segregate airspace for the exclusive use of aircraft with advanced capabilities.

2.11 The Oakland Oceanic FIR airspace will be available for all airspace users. Oakland ARTCC will provide the required separation between RNP4, RNP10 and all other aircraft simultaneously. In order to receive 30NM (RNP4) or 50NM (RNP10) separation standards, users must file an "R" in field 10 of the ICAO flight plan. RNP4 aircraft will also have to file "NAV/RNP4" in field 18 of the ICAO flight plan. All other users will receive 100NM lateral separation with the appropriate time-based longitudinal separation.

2.12 Ocean21 manages the application of individual RNP separation standards using separation "flags" corresponding to the RNP10 - 50NM longitudinal standard and the RNP4 - 30NM longitudinal and 30NM lateral standards. These flags may be enabled or disabled automatically or manually by the controller. Once the flag is enabled, the aircraft will qualify for the corresponding RNP separation standards for conflict prediction purposes.

2.13 When the specified conditions for RNP separation minima have been met, Ocean21 will automatically enable the corresponding separation flags and begin actively monitoring separation. As aircraft enter FAA controlled airspace, the system performs a series of checks to determine if the aircraft is qualified for RNP separation standards. These checks are summarized as follows:

a. RNP qualifier /R in the Field 10 of its ICAO flight plan; <u>and</u>

b. "NAV/RNP4" for RNP4 aircraft in Field 18 of its ICAO flight plan; <u>and</u>

c. An active CPDLC connection; <u>and</u>

d. An ADS-C contract with a periodic reporting interval less or equal to the required 30NM or 50NM longitudinal interval; <u>and</u>

e. For the 30/30 flag, the most recently received ADS-C position report for the flight contains a Figure of Merit (FOM) that meets or exceeds the adapted minimum RNP4 threshold.

2.14 Based on these checks, the system will determine the appropriate separation standard available, and automatically enable the corresponding RNP separation flag. While Ocean21 provides the capability for enabling and disabling the application of RNP based separation manually, the system's strength lies in the automation of the end-to-end application of these standards.
Ocean21 will automatically:

a. Identify RNP qualification (RNP4 or RNP10)

b. Establish CPDLC connections and appropriate ADS-C position reporting contracts

c. Monitor actual navigation performance based on the FOM

d. Monitor ADS-C position reporting intervals

e. Attempt to retrieve missing (by obtaining new) ADS-C reports

f. Monitor longitudinal and lateral aircraft proximity and conformance

g. In the event that these conditions are no longer met, such as a loss of the CPDLC or ADS-C for an individual or group of aircraft, ATOP will revert to higher RNP separation minimums, then non-RNP separation standards as appropriate.

The Application of RNP Separation between the Oakland and Adjacent Participating FIRs

2.15 It is essential that aircraft being afforded reduced separation continue unencumbered when passing between ATS providers that support the same separation standards. This is generally not an issue when older procedural separation standards are applied, but with the advent of separation based on RNP and its reliance on end-to-end aircraft and ground system capabilities, challenges arise that must be considered.

2.16 Separation standards based on FANS-1/A (CPDLC and ADS-C) are dependent upon each provider having the necessary connections in place. The fact that one provider is able to apply reduced separation between two flights does not ensure that the next facility will be able to. It is essential that the implementation of these standards (particularly distance-based longitudinal standards) include the requirement for interoperability testing to be accomplished between all adjacent facilities that plan to offer reduced separation services.

2.17 The full ATS Interfacility Data Communication (AIDC) capability of Ocean21 will facilitate the seamless transfer of aircraft between participating ATS providers. For adjacent facilities with AIDC capabilities, Ocean21 will process all AIDC messaging. It will provide automated coordination that can take full advantage of the negotiating phase for the transfer of an aircraft. Ocean21 will alert the controller when manual coordination must be completed along with providing fully automated coordinating features that will alert controllers of aircraft entering and exiting the FIR.

2.18 As learned during the initial implementation of FANS-1/A in the Pacific, aircraft transfer timing issues in conjunction with the required AIDC coordination must be accomplished in the proper order to prevent unexpected and undesired system responses and satisfy the necessary system checks for the continued application of separation. It will be vitally important for participating ATS providers to develop and refine procedures that permit the uninterrupted transfer of aircraft.

2.19 Procedures should accommodate the following:

a. Identifying aircraft that are RNP qualified.

b. Identifying the pairs of aircraft to which a reduced separation minimum is being applied.

c. Transferring to the receiving facility pairs of aircraft, while monitoring and maintaining the reduced separation minimum being applied.

d. Resolving potentially differing system discrepancies of distances that may exist between a pair of aircraft when a reduced separation minimum is applied.

Differing Separation Standards and the Accommodation of User Preferred Routings (UPRs)

2.20 UPRs are the most economical routes based upon the airlines' own data. UPR trials between Sydney and Los Angeles were conducted on a limited basis during mid-2000. These UPR trial routes were planned so as to avoid significant weather and restricted airspace. The trials revealed training and workload issues for airline dispatchers and the need for accurate databases. Additional UPR trials were conducted during the late 2000. The proposed savings would be expected to offset these workload issues. It may be possible for UPRs to replace the dynamic airborne route program (DARP) in the Pacific. UPR trials are still ongoing, with the most notable limiting factor being the lack of full AIDC capabilities between all necessary facilities, and the controller workload involved in analyzing a new route and re-clearing the aircraft.

2.21 With the Ocean21 system's robust conflict prediction and AIDC capabilities, controllers will be able to quickly and easily analyze a user's request, even if it will span many sectors. Controllers will have the flexibility and the tools to grant those requests, which in turn will provide for a more efficient use of the airspace. This operational cost-effectiveness is manifested through improved routing and reduced fuel burns particularly in the South Pacific.

3. Recommendation

3.1 The meeting is invited to note the information provided in this paper on the concept of operation under Oakland ARTCC's Ocean21 system.

- END -